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Bio-efficacy of Different Doses of Noval Insecticide Against Sap Feeder Insect Pests Infesting Pomegranate

Suresh Kumar Jat[1], Lekha[2] and Mahendra Choudhary[*3]
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ABSTRACT

Field experiments were conducted to evaluate the bio-efficacy of novel insecticide, Cyantraniliprole 10.26% OD 200, 250, 300, 400 g/ha along with two standard checks i.e., Lambda-cyhalothrin 4.9% CS and Fipronil 5% SC @ 2000 ml/ha against sap feeder insect pests infesting pomegranate at KVK, Jhalawar during the years 2021 and 2022. The pomegranate variety Sindhuri was transplanted in a Randomized Block Design with seven treatments with three replications. Cyantraniliprole 10.26% OD was equally effective @ 400 and 300 g/ha to control major sap feeder insects like aphid, thrips and whitefly on pomegranate crop and better than other standard treatments. The mean maximum yield of pomegranate was recorded in the treatment of Cyantraniliprole 10.26% OD@ 400 g/ha which was 98.20 q/ha and 109.20 q/ha during respective year in comparison to control.

Key Words: Bio efficacy, Noval insecticides, Sap feeder, Pomegranate

INTRODUCTION

Pomegranate (*Punica granatum* L.) is one of the important fruit crops in India, cultivated in arid and semi-arid regions of Gujarat, Maharashtra, Karnataka, Uttar Pradesh, Andhra Pradesh and Tamil Nadu (Balikai *et al,* 2011). The adaptability of the crop to extremes of temperature (-12 to + 44°C), suitability to marginal lands with poor fertility, rocky lands with shallow depth etc., pave the way for its potential production in various ecosystem (Pal *et al,* 2014). Till date 91 insects, 6 mites and 1 snail has been reported as pest on pomegranate crop in India (Balikai *et al,* 2011 and Gurjar *et al*, 2023). Among this pest complex, damage due to sucking pests viz., thrips, mealy bugs, aphids and whitefly is major in India. Yield loss incurred due to pest problem results in the reduced income, poverty, food insecurity and loss of biodiversity. Earlier the management measures for these pests included the use of broad-spectrum pesticides. Concerns for health hazards, disruption of the natural ecosystem, increasing in the chances of pest resurgence and development of resistance in pests due to indiscriminate use of pesticides, stimulated the need of using eco-friendly pesticides. In present study, the bio-efficacy of novel insecticide, Cyantraniliprole 10.26% OD against sucking pests of pomegranate was carried out for the evaluation of bio-efficacy on pomegranate against sap feeder insect pests.

MATERIALS AND METHODS

The experiment to evaluate the bio-efficacy of novel insecticide, Cyantraniliprole 10.26% OD against sap feeder insect pests infesting pomegranate ten-year-old orchard at different doses was conducted at KVK, Jhalawar during the years 2021 and 2022. The pomegranate variety Sindhuri was transplanted in a Randomized Block Design with seven treatments including one untreated control with three replications. Other package and practice were followed as per university recommendation. Cyantraniliprole 10.26% OD was evaluated at different doses *i.e.,* @ 200, 250, 300, 400 g/ha along with two standard checks i.e., Lambda-cyhalothrin 4.9% CS and Fipronil 5% SC @ 2000

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Table 1. Bio-efficacy of different doses of novel insecticide, Cyantraniliprole 10.26% OD against aphids in pomegranate during 2021.

Sr. No.	Treatment	Dose		Number of aphids/ 5 cm twig							Per cent ROC @ 10 days after 2nd spray
					First spray			Second spray			
		g a.i./ha	Formulation (ml or g/ha)	Pre count	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	
T_1	Cyantraniliprole 10.26% OD	60	200	10.55* (3.39)**	9.22 (3.20)	8.45 (3.07)	11.36 (3.51)	10.66 (3.41)	9.75 (3.28)	8.78 (3.13)	49.51
T_2	Cyantraniliprole 10.26% OD	75	250	11.45 (3.53)	7.33 (2.89)	4.92 (2.43)	8.33 (3.05)	6.22 (2.69)	5.17 (2.48)	4.11 (2.26)	76.37
T_3	Cyantraniliprole 10.26% OD	90	300	11.55 (3.54)	6.11 (2.67)	3.89 (2.21)	6.86 (2.80)	3.67 (2.15)	2.25 (1.80)	1.36 (1.54)	92.18
T_4	Cyantraniliprole 10.26% OD	120	400	10.89 (3.45)	5.94 (2.63)	3.78 (2.19)	6.75 (2.78)	3.44 (2.11)	2.11 (1.76)	1.22 (1.49)	92.98
T_5	Lambda-cyhalothrin 4.9% CS	25	500	11.75 (3.57)	8.89 (3.14)	7.95 (2.99)	10.67 (3.42)	9.47 (3.24)	8.97 (3.16)	8.45 (3.07)	51.41
T_6	Fipronil 5% SC	100	2000	10.94 (3.45)	9.05 (3.17)	8.14 (3.02)	11.03 (3.47)	9.78 (3.28)	9.45 (3.23)	8.61 (3.10)	50.49
T_7	Untreated control	-	-	11.72 (3.57)	12.36 (3.66)	13.75 (3.84)	15.11 (4.01)	15.75 (4.09)	16.61 (4.20)	17.39 (4.29)	-
	S. Em±			-	0.05	0.04	0.08	0.06	0.05	0.04	-
	CD at 5 %			NS	0.15	0.12	0.23	0.19	0.15	0.12	-

**Original values; **Square root transformed values; DAS – Days After Spray, NS – Non significant; ROC – Reduction Over untreated Control*

Table 2. Bio-efficacy of different doses of novel insecticide, Cyantraniliprole 10.26% ODagainst aphids in pomegranate during 2022.

Sr. No.	Treatment	Dose		Number of aphids/ 5 cm twig							Per cent ROC @ 10 days after 2nd spray
					First spray			Second spray			
		g a.i./ha	Formulation (ml or g/ha)	Pre count	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	
T_1	Cyantraniliprole 10.26% OD	60	200	8.75* (3.12)**	8.03 (3.00)	7.25 (2.87)	10.33 (3.36)	9.22 (3.20)	7.95 (2.99)	7.59 (2.93)	50.13
T_2	Cyantraniliprole 10.26% OD	75	250	9.22 (3.19)	6.45 (2.73)	5.08 (2.47)	7.22 (2.87)	5.69 (2.59)	4.22 (2.29)	3.22 (2.05)	78.84
T_3	Cyantraniliprole 10.26% OD	90	300	8.56 (3.09)	4.78 (2.40)	3.00 (2.00)	5.89 (2.62)	3.56 (2.13)	1.64 (1.62)	0.92 (1.39)	93.96
T_4	Cyantraniliprole 10.26% OD	120	400	9.44 (3.23)	4.56 (2.36)	2.89 (1.96)	5.78 (2.60)	3.41 (2.10)	1.50 (1.58)	0.78 (1.33)	94.88
T_5	Lambda-cyhalothrin 4.9% CS	25	500	8.94 (3.15)	7.53 (2.92)	6.78 (2.79)	9.75 (3.28)	8.67 (3.11)	7.53 (2.92)	7.06 (2.84)	53.61
T_6	Fipronil 5% SC	100	2000	9.75 (3.28)	7.81 (2.97)	7.00 (2.83)	10.11 (3.33)	8.89 (3.14)	7.67 (2.94)	7.20 (2.86)	52.69
T_7	Untreated control	-	-	9.61 (3.25)	10.05 (3.32)	11.69 (3.56)	13.22 (3.77)	13.89 (3.86)	14.64 (3.95)	15.22 (4.03)	-
	S. Em±			-	0.03	0.08	0.06	0.08	0.04	0.05	-
	CD at 5 %			NS	0.09	0.24	0.20	0.24	0.13	0.14	-

**Original values; **Square root transformed values; DAS – Days After Spray, NS – Non significant; ROC – Reduction Over untreated Control*

ml/ha against sap feeder insect pests infesting pomegranate. Each treatment was applied twice first when the sap feeder population crossed the ETL and second was after 10 days interval. Observation on pest population of aphids, thrips and whiteflies were recorded at before spray and 3, 7 and 10 d after each spray. Population of aphids, thrips and whiteflies were recorded from 5 cm shoot length per twig. Four twigs were randomly selected from each plant from four directions (East, West, South and North). Three plants from each plot were randomly selected for taking the observations and data recorded was represented as number per 5 cm twig. Per cent reduction of pest population over untreated control was calculated at 3, 7 and 10 days after each spray. Data recorded on pest population were transformed to square root before the statistical analysis.

RESULTS AND DISCUSSION

Bio-efficacy against Aphids (*Aphis punicae*).

The aphids (*Aphis punicae*) mean population was recorded before first spray and 3, 7 and 10 d after each spray during first and second seasons have been presented in Table 1 and 2. The data revealed that before first spray aphid population was uniform in various treatments since the difference in population was not significant. After spray all the treatments were found significantly effective in controlling the aphid population when compared to untreated control. Amongst the treatments Cyantraniliprole 10.26% OD@ 400 g/ha was more effective at each observation with low pest population which was at par with Cyantraniliprole 10.26% OD@ 400 g/ha during both the year. Next treatment in order of effectiveness was Cyantraniliprole 10.26% OD@ 200 g/ha followed by Lambda-cyhalothrin 4.9% CS 500 ml/ha, which was at par with Fipronil 5% SC @ 2000 ml/ha. The highest aphid population was recorded in untreated control. The per cent reduction in aphid population over control was also calculated and presented in Table 1 and 2. The higher population reduction over control was recorded with the treatment of Cyantraniliprole 10.26% OD@ 400 g/ha , which was 92.98 % and 94.88% in second spray 10 days after application during *Kharif* 2021 and 2022, respectively.

Bio-efficacy against Thrips (*Scirtothrips dorsalis*)

Thrips (*Scirtothrips dorsalis*) mean population was recorded before first spray and at different time intervals after each spray during first and second seasons have been presented in Table 3 and 4. The data revealed that before first spray the thripspopulation was uniform in various treatments since the difference in population was not significant. After spray all the treatments were found significantly effective in controlling the thripspopulation when compared to untreated control. Amongst the treatments Cyantraniliprole 10.26% OD@ 400 g/ha was more effective at each observation time with low pest population which was at par with Cyantraniliprole 10.26% OD@ 400 g/ha during both the year. Next treatment in order of effectiveness was Cyantraniliprole 10.26% OD@ 200 g/ha followed by Lambda-cyhalothrin 4.9% CS 500 ml/ha, which was at par with Fipronil 5% SC @ 2000 ml/ha. The highest aphid population was recorded in untreated control. The per cent reduction in thrips population over control was also calculated and presented in Table 3 and 4. The higher population reduction over control was recorded with the treatment of Cyantraniliprole 10.26% OD@ 400 g/ha , which was 92.84 % and 95.38% in second spray 10 days after application during *Kharif* 2021 and 2022, respectively.

Table 3. Bio-eficacy of different doses of novelinsecticide, Cyantraniliprole 10.26% ODagainst thrips in pomegranate during 2021.

Sr. No.	Treatments	Dose		Number of thrips/ 5 cm twig							Per cent ROC @ 10 days after 2nd spray
		g a.i./ ha	Formulation (ml or g/ha)	Pre count	First spray			Second spray			
					3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	
T_1	Cyantraniliprole 10.26% OD	60	200	11.47* (3.52)**	10.75 (3.43)	9.42 (3.22)	12.89 (3.73)	11.19 (3.49)	10.67 (3.41)	9.81 (3.29)	49.49
T_2	Cyantraniliprole 10.26% OD	75	250	12.15 (3.62)	6.03 (2.65)	3.72 (2.17)	7.22 (2.87)	4.94 (2.44)	3.22 (2.05)	1.61 (1.61)	91.71
T_3	Cyantraniliprole 10.26% OD	90	300	11.67 (3.55)	5.69 (2.59)	3.47 (2.11)	7.03 (2.83)	4.78 (2.40)	3.00 (2.00)	1.53 (1.59)	92.12
T_4	Cyantraniliprole 10.26% OD	120	400	12.50 (3.67)	5.44 (2.54)	3.19 (2.05)	6.78 (2.79)	4.53 (2.35)	2.75 (1.93)	1.39 (1.54)	92.84
T_5	Lambda-cyhalothrin 4.9% CS	25	500	11.21 (3.49)	8.75 (3.12)	6.78 (2.79)	9.33 (3.21)	8.58 (3.09)	7.44 (2.90)	6.53 (2.74)	66.37
T_6	Fipronil 5% SC	100	2000	12.78 (3.71)	9.08 (3.17)	7.22 (2.87)	9.72 (3.27)	8.89 (3.14)	7.67 (2.94)	6.78 (2.79)	65.09
T_7	Untreated control	-	-	11.45 (3.52)	12.55 (3.68)	13.42 (3.80)	15.33 (4.04)	17.33 (4.28)	18.33 (4.40)	19.42 (4.52)	-
	S. Em±			-	0.08	0.09	0.06	0.08	0.08	0.06	-
	CD at 5 %			NS	0.24	0.27	0.19	0.25	0.26	0.20	-

**Original values; **Square root transformed values; DAS – Days After Spray, NS – Non significant; ROC – Reduction Over untreated Control*

Table 4. Bio-efficacy of different doses of novel insecticide, Cyantraniliprole 10.26% OD against thrips in pomegranate during 2022.

Sr. No.	Treatment	Dose		Number of thrips/ 5 cm twig							Per cent ROC @ 10 days after 2nd spray
		g a.i./ha	Formulation (ml or g/ha)	Pre count	First spray			Second spray			
					3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	
T_1	Cyantraniliprole 10.26% OD	60	200	10.19* (3.34)**	8.22 (3.03)	7.22 (2.87)	10.53 (3.39)	9.22 (3.20)	8.44 (3.07)	7.89 (2.98)	51.36
T_2	Cyantraniliprole 10.26% OD	75	250	9.44 (3.22)	3.89 (2.21)	2.08 (1.75)	5.70 (2.59)	4.22 (2.28)	2.20 (1.79)	1.11 (1.45)	93.16
T_3	Cyantraniliprole 10.26% OD	90	300	10.78 (3.43)	3.67 (2.16)	1.83 (1.68)	5.47 (2.54)	3.97 (2.23)	1.78 (1.65)	1.00 (1.41)	93.83
T_4	Cyantraniliprole 10.26% OD	120	400	9.83 (3.28)	3.45 (2.11)	1.67 (1.63)	5.22 (2.49)	3.78 (2.18)	1.58 (1.61)	0.75 (1.32)	95.38
T_5	Lambda -cyhalothrin 4.9% CS	25	500	10.58 (3.40)	6.56 (2.75)	4.64 (2.37)	8.33 (3.05)	6.22 (2.69)	5.42 (2.53)	4.97 (2.44)	69.36
T_6	Fipronil 5% SC	100	2000	9.33 (3.20)	6.72 (2.78)	4.83 (2.41)	8.47 (3.08)	6.70 (2.77)	5.89 (2.62)	5.25 (2.49)	67.63
T_7	Untreated control	-	-	10.09 (3.32)	10.78 (3.43)	11.33 (3.51)	13.56 (3.81)	14.67 (3.96)	15.33 (4.04)	16.22 (4.15)	-
	S. Em±			-	0.07	0.07	0.06	0.06	0.08	0.06	-
	CD at 5 %			NS	0.20	0.22	0.19	0.19	0.23	0.20	-

**Original values; **Square root transformed values; DAS – Days After Spray, NS – Non significant; ROC – Reduction Over untreated Control*

Bio-efficacy against whitefly (*Siphoninus phillyreae*)

The data revealed that before first spray whitefly population was uniform in various treatments since the difference in population was not significant. After spray all the treatments were found significantly effective in controlling the whitefly population when compared to untreated control. Amongst the treatments Cyantraniliprole 10.26% OD@ 400 g/ha was more effective at each observation time with low pest population which was at par with Cyantraniliprole 10.26% OD@ 400 g/ha during both the year. Next treatment in order of effectiveness was Cyantraniliprole 10.26% OD@ 200 g/ha followed by Lambda-cyhalothrin 4.9% CS 500 ml/ha,which was at par with Fipronil 5% SC @ 2000 ml/ha. The highest whitefly population was recorded in untreated control. The per cent reduction in whitefly population over control was also calculated and presented in Table 5 and 6. The higher population reduction over control was recorded with the treatment of Cyantraniliprole 10.26% OD@ 400 g/ha , which was 91.91 % and 93.94% in second spray 10 days after application during *Kharif* 2021 and 2022, respectively.

The result of effectiveness of different insecticidal treatments against pomegranate sap feeders showed that all the treatments were significantly superior over control in terms of population reduction. The findings of present investigation indicated that Cyantraniliprole 10.26% OD@ 400 g/ha was more effective during each observation with low pest population. Observation recorded at 10 days after 2nd spray revealed that lowest population of 1.22 aphids and 0.78/5 cm twig was recorded in Cyantraniliprole 10.26% OD@ 400 g/haand it was found at par with Cyantraniliprole 10.26% OD@300 g/ha (1.36 aphids and 0.92/5 cm twig), respectively during *Kharif*2022 and 2023. Highest population of aphids /5 cm twig i.e. 17.39 and 15.22, respectively during both the year was recorded inuntreated control. Whereas, the reduction in population of thrips over untreated control recorded at 10 days after 2nd spray revealed that highest reduction in the population of thrips over untreated control was recorded in Cyantraniliprole 10.26% OD@ 400 g/ha(92.84 %) which was found similar with Cyantraniliprole 10.26% OD@ 300 g/ha(92.12 %) during 2022 and during 2023 the maximum reduction of thrips population over untreated control was recorded in

Cyantraniliprole 10.26% OD@ 400 g/ha(95.38 %) which was found similar with Cyantraniliprole 10.26% OD@ 300 g/ha (93.83 %). In whitefly observation recorded at 10 days after 2nd spray revealed that lowest population of 0.53 whiteflies/ 5 cm twig was recorded in Cyantraniliprole 10.26% OD@400 g/hawhich was at par with Cyantraniliprole 10.26% OD@ 300 g/ha(0.61 whiteflies/5 cm length of twig). Highest population of whiteflies/5 cm twig i.e. 6.55 was recorded inuntreated control during 2021. Thereafter, during 2022 data recorded at 10 days after 2nd spray revealed that lowest population of 0.36 whiteflies/5 cm twig length was recorded in Cyantraniliprole 10.26% OD@400 g/ha which was at par with Cyantraniliprole 10.26% OD@ 300 g/ha (0.42 whiteflies/5 cm twig). Highest population of whiteflies/5 cm twig length i.e. 5.94 was recorded inuntreated control.

The results are in close agreement with the findings of Bhut *et al* (2013) and Thilagam *et al* (2020) reported that two sprays of chlorantraniliprole proved most effective followed by flubendiamide, novaluron, thiodicarb, endosulfan and malathion. Whereas, Kambrekar *et al* (2015) observed that emamectin benzoate 5 SG @ 0.25 g/ l ha gave highest reduction in the fruit damage followed by spinosad 45 SC 0.20 ml/l. Kumar and Gupta (2018) found rynaxypyr, spinosad, emamectin benzoate and cyazypyr effective; and quinalphos (infestation) and flubendiamide were moderately effective. Rajeshwari *et al* (2019) evaluated different insecticides, and observed that the treatment with Spinosad 45 SC @ 0.2 ml/l was found to be significantly superior in recording a minimum population of thrips (0.92 thrips/three leaves) and aphids (7.54 aphids/three leaves) respectively. Solankar *et al* (2021) observed that the treatment of Cyantraniliprole 10.26 % OD @ 0.9 ml and combination treatment of Lambda-cyhalothrin 4.9 CS (each at 0.3ml) + Propineb 50 WP (1gm) with soluble fertilizer (00:52:34) (5 g/l) were found equally effective for the control of sucking pests viz. aphids and thrips on pomegranate followed by treatment of Flubendiamide 19.92 %+ Thiacloprid 19.92 SC at @ 0.4 ml/ l of water. Gaikwad *et al* (2023) showed that the most effective spray treatment forthe reduction in the population of thrips was Cyantraniliprole 10 OD, followed by Spinosad 45 SC and flonicamide 50 WG, indicating that these insecticides were comparable to one another and somewhat more effective than the other spray treatments.

Table 5. Bio-efficacy of different doses of novel insecticide, Cyantraniliprole 10.26% ODagainst whiteflies in pomegranate during 2021.

Sr. No.	Treatment	Dose		Number of whiteflies / 5 cm twig							Per cent ROC @ 10 days after 2nd spray
		g a.i./ha	Formulation (ml or g/ha)	Pre count	First spray			Second spray			
					3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	
T_1	Cyantraniliprole 10.26% OD	60	200	4.95* (2.44)**	4.22 (2.28)	3.89 (2.21)	5.42 (2.53)	4.95 (2.44)	4.31 (2.30)	3.61 (2.15)	44.89
T_2	Cyantraniliprole 10.26% OD	75	250	5.47 (2.54)	2.56 (1.89)	1.70 (1.64)	3.47 (2.11)	2.61 (1.90)	2.11 (1.76)	1.45 (1.56)	77.86
T_3	Cyantraniliprole 10.26% OD	90	300	5.89 (2.62)	1.86 (1.69)	0.86 (1.36)	2.44 (1.86)	1.53 (1.58)	1.03 (1.42)	0.61 (1.27)	90.69
T_4	Cyantraniliprole 10.26% OD	120	400	4.78 (2.40)	1.78 (1.66)	0.78 (1.33)	2.25 (1.80)	1.45 (1.56)	0.94 (1.39)	0.53 (1.24)	91.91
T_5	Lambda -cyhalothrin 4.9% CS	25	500	5.75 (2.60)	3.22 (2.05)	2.39 (1.84)	4.58 (2.36)	4.00 (2.24)	3.67 (2.16)	3.22 (2.05)	50.84
T_6	Fipronil 5% SC	100	2000	5.81 (2.61)	3.44 (2.11)	2.66 (1.91)	4.67 (2.38)	4.11 (2.26)	3.75 (2.18)	3.30 (2.07)	49.62
T_7	Untreated control	-	-	4.89 (2.42)	5.17 (2.48)	5.36 (2.52)	5.89 (2.62)	6.08 (2.66)	6.33 (2.71)	6.55 (2.75)	-
	S. Em±			-	0.05	0.06	0.02	0.05	0.03	0.01	-
	CD at 5 %			NS	0.14	0.19	0.06	0.15	0.09	0.05	-

**Original values; **Square root transformed values; DAS – Days After Spray, NS – Non significant; ROC – Reduction Over untreated Control*

Table 6. Bio-efficacy of different doses of novel insecticide, Cyantraniliprole 10.26% OD against whiteflies in pomegranate during 2022.

Sr. No.	Treatment	Dose		Number of whiteflies / 5 cm twig							Per cent ROC @ 10 days after 2nd spray
				Pre count	First spray			Second spray			
		g a.i./ha	Formulation (ml or g/ha)		3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	
T_1	Cyantraniliprole 10.26% OD	60	200	3.86* (2.21)**	3.67 (2.16)	3.28 (2.07)	4.44 (2.33)	3.83 (2.20)	3.47 (2.11)	3.21 (2.05)	45.96
T_2	Cyantraniliprole 10.26% OD	75	250	4.00 (2.23)	1.94 (1.72)	1.14 (1.46)	2.67 (1.91)	2.19 (1.79)	1.61 (1.62)	1.22 (1.49)	79.46
T_3	Cyantraniliprole 10.26% OD	90	300	3.67 (2.16)	1.28 (1.51)	0.53 (1.24)	2.00 (1.73)	1.31 (1.52)	0.72 (1.31)	0.42 (1.19)	92.93
T_4	Cyantraniliprole 10.26% OD	120	400	3.83 (2.19)	1.19 (1.48)	0.47 (1.21)	1.89 (1.70)	1.25 (1.50)	0.61 (1.27)	0.36 (1.17)	93.94
T_5	Lambda -cyhalothrin 4.9% CS	25	500	4.06 (2.25)	2.86 (1.96)	2.33 (1.83)	3.67 (2.16)	3.28 (2.07)	3.00 (2.00)	2.81 (1.95)	52.69
T_6	Fipronil 5% SC	100	2000	3.89 (2.21)	2.95 (1.99)	2.44 (1.86)	3.78 (2.19)	3.39 (2.09)	3.11 (2.03)	2.89 (1.97)	51.35
T_7	Untreated control	-	-	3.97 (2.23)	4.39 (2.32)	4.72 (2.39)	5.03 (2.45)	5.33 (2.52)	5.64 (2.58)	5.94 (2.63)	-
	S. Em±			-	0.03	0.02	0.03	0.03	0.02	0.02	-
	CD at 5 %			NS	0.08	0.06	0.10	0.10	0.06	0.07	-

**Original values; **Square root transformed values; DAS – Days After Spray, NS – Non significant; ROC – Reduction Over untreated Control*

Table 7. Effect of different doses of novel insecticide on fruit yield of pomegranate during 2021 and 2022.

Sr. No.	Treatment	Dose		Fruit yield (t/ha) 2021	Fruit yield (t/ha) 2022
		g a.i./ha	Formulation (ml or g/ha)		
T_1	Cyantraniliprole 10.26% OD	60	200	5.76	6.82
T_2	Cyantraniliprole 10.26% OD	75	250	9.11	10.05
T_3	Cyantraniliprole 10.26% OD	90	300	9.31	10.53
T_4	Cyantraniliprole 10.26% OD	120	400	9.82	10.92
T_5	Lambda-cyhalothrin 4.9% CS	25	500	7.56	8.73
T_6	Fipronil 5% SC	100	2000	7.14	8.23
T_7	Untreated control	-	-	3.89	4.62
	S. Em±			0.37	0.41
	CD at 5 %			1.13	1.27

CONCLUSION

The treatment Cyantraniliprole 10.26% OD @ 120 g a.i./ha and @ 90 g a.i./ha were found superior and at par in reducing aphids and whiteflies. Doses of Cyantraniliprole 10.26% OD @ 120 g a.i./ha, @ 90 g a.i./ha and @75 g a.i./ha were found superior and at par in reducing thrips in pomegranate and also recorded higher yield. On the basis results it can be concluded thatCyantraniliprole 10.26% OD @ 90 g a.i./ha can be recommended to control aphids and whiteflies whereas, Cyantraniliprole 10.26% OD @ 75 g a.i./ha can be recommended to control thrips infestation on pomegranate.

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Comparative Analysis of Some Physiological Parameters of Bioindicator Plants (*Amaranthus & Chenopodium*)

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ABSTRACT

Bioindicator plants play a crucial role in environmental monitoring due to their sensitivity to various pollutants and environmental stresses. In this study, a comparative analysis of several biological parameters of two commonly used bioindicator plants, *Amaranthus* and *Chenopodium* was made. The aim was to evaluate their suitability for environmental monitoring and determine any significant differences between the two species. *Amaranthus* and *Chenopodium* plants were grown under controlled conditions and exposed to varying concentrations of pollutants, including heavy metals and air pollutants. Several biological parameters, including growth rate, leaf area, chlorophyll content, and antioxidant enzyme activity, were measured and compared between the two species. The results indicated that both *Amaranthus* and *Chenopodium* exhibited sensitivity to the tested pollutants, as evidenced by changes in their biological parameters. Significant differences were observed between the two species in terms of their response to specific pollutants and their overall tolerance levels. For instance, Chenopodium showed higher tolerance to heavy metal stress, while Amaranthus exhibited greater sensitivity to air pollutants. Thus, it can be said that both *Amaranthus* and *Chenopodium* can serve as effective bioindicator plants for environmental monitoring purposes. However, the choice between the two species should be based on the specific pollutants and environmental conditions of the monitoring site. Further research is warranted to elucidate the underlying mechanisms responsible for the observed differences between these bioindicator plants and to refine their use in environmental assessment and management strategies.

Key Words: *Amaranthus,* Bioindicator plants, Biological parameters, Biomass accumulation, *Chenopodium*, Chlorophyll Content, Environment, Enzyme, Growth rate, Leaf area, Monitoring.

INTRODUCTION

Bioindicators are sensitive to a variety of environmental stresses and pollutants and have become important tools in environmental monitoring. These plants are useful indicators of the quality and health of the environment because they can adapt their biological parameters to reflect changes in their surroundings. *Amaranthus and Chenopodium* species are two of the many varieties of bioindicator plants that have attracted a lot of attention due to their use in environmental monitoring research. *Chenopodium* and *Amaranthus* are both good options for evaluating environmental conditions because of their traits like rapid development, extensive dispersal, and sensitivity to contaminants. Many studies have shown how effective *Chenopodium* and *Amaranthus* are at identifying pesticides, heavy metals, and other contaminants in soil and water (Khan *et al,* 2019; Agnihotri *et al,* 2020). Furthermore, these plants have been used to measure air pollution, especially in cities where industrial operations and vehicle emissions worsen the environment (García-González *et al,* 2018; Chawla *et al,* 2021).

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The main objective of the study was to examine and contrast several important biological characteristics between Chenopodium and Amaranthus under carefully monitored circumstances. Growth rate, biomass accumulation, leaf area, chlorophyll content, and antioxidative enzyme activity were few of these parameters. It is vital to comprehend the disparities in the biological reactions of these bioindicator plants to ensure their efficient application in environmental monitoring initiatives. Therefore, this investigation will shed light on how well-suited and useful *Chenopodium* and *Amaranthus* are as bioindicators for determining pollution levels and environmental quality.

MATERIAL AND METHODS

Two different species, *Amaranthus* (dhimbdo) and *Chenopodium* (goosefoot), were chosen and gathered from various areas within Bhiwani. These plant samples were randomly selected and assembled fresh inside aluminium foil to keep moisture from evaporating. It was sent straight away to the lab for identification before being refrigerated. To prevent fluctuations in the results, samples of every leaf were taken within a day of one another.

Total chlorophyll content

In a 15 mL centrifuge tube, 10 mL of freshly made 80% acetone was combined with 1 g of powdered fresh leaf sample to estimate the total chlorophyll concentration. After achieving complete separation, the leaf extract was centrifuged at 2500 rpm for 180 seconds and then transferred into test tubes using Whatman filter paper. Using an ultraviolet spectrophotometer, the solution absorbance was then measured at 645 and 663 nm in accordance with the ARNON method (Lichtenthaler & Welburn, 1983) after calibration using 80% acetone as the reagent blank.

$$\text{Chlorophyll a} = 12.7 \times A(663) - 2.69 \times A(645) \times \frac{V}{1000 \times W}$$

$$\text{Chlorophyll b} = 22.9 \times A(645) - 4.68 \times A(663) \times \frac{V}{1000 \times W}$$

where V is the sample extract volume (mL), W is the leaf weight (g), and A645 and A663 are the absorbances at 645 and 663 nm, respectively.

Ascorbic acid content

A muslin cloth filter was employed for the juice. 10 ml (W) of juice were pipetted into a 100-ml volumetric flask, and the volume (V_1) contained one milliliter of oxalic acid solution. Someone gave the flask a good shake. Following the juice's filtration, a standard dye (V) solution was titrated against a known quantity (V_2) of solution until a colour emerged that persisted for 15 seconds. The ascorbic acid quantity was determined using the formula (Keller and Schwager, 1977).

Relative water content

The fresh leaves were first weighed to measure their relative water content. They were then promptly immersed in water for 24 hours, blotted dry, and reweighed to estimate their turgid weight. The turgid leaves were then oven-dried for 12 hours at 70 °C, and the dry weight was measured using the procedure outlined by Singh (1977).

$$\text{RWC (\%)} = \frac{\text{(Fresh weight} - \text{Dry weight)}}{\text{(Turgid weight} - \text{Dry weight)}} \times 100$$

RESULTS AND DISCUSSION

Ascorbic Acid

Amaranthus (13.38 mg/g) and Chenopodium (12.5 mg/g) had high ascorbic acid content in the control site, while the polluted site showed a range of 10.9 mg/g (Amaranthus) to 11.8 mg/g (Genus Chenopodium). This and other plant species' lower ascorbic acid content in their leaves confirms how sensitive these plants are to air pollution (Jyothi and Jaya, 2010). The antioxidant qualities of ascorbic acid, which are found in portions of plants that are actively growing, affect a plant's ability to withstand air pollution. Ascorbic acid is consumed during the removal of the cytotoxic radicals generated in response to pollutants that penetrate the leaves, so a decrease in ascorbic acid content is indicative of a decline in the plant defence systems. Conversely, an increase

S. No.	Name of the Zone	Location in the city
Site-A	Bhiwani textile mill	Industrial area
Site-B	Railway station yard	North of city
Site-C	Bus stand yard	HQ region
Site-D (Control site)	Chaudhary Bansi Lal	Campus area

in ascorbic acid levels is associated with increased levels of pollution resistance (Lima *et al,* 2000). Ascorbic acid was found to be more at the control site in both genotypes but only a slight change was observed in the concentration of ascorbic acid at the polluted site as well.

Chlorophyll Content

The genotypes showed purposeful differences in total chlorophyll content in both the polluted and control sites. The Amaranthus showed less chlorophyll content as compared to the controlled site. Maximum chlorophyll content was found in SITE-D and the minimum at SITE-A. The decreased value in chlorophyll content seems to be directly related to the increasing pollution load. There was a major variation within the chlorophyll content in both sites. The mean value of chlorophyll content in *Chenopodium* was equivalent at both sites respectively, whereas *Amaranthus* showed a large deviation in all selected sites.

The present study showed that chlorophyll content was found to be high at the control site as compared to the other three sites. In *Amaranthus* mean total chlorophyll content was found 4.5(mg/g) while in *Chenopodium* it was found to be 6(mg/g) whereas at the polluted site, this value decreased up to 2.5 to 3.5 (mg/g). Previous studies by Tripathi and Gautam (2007) reported similar results on chlorophyll estimation (Fig.1)

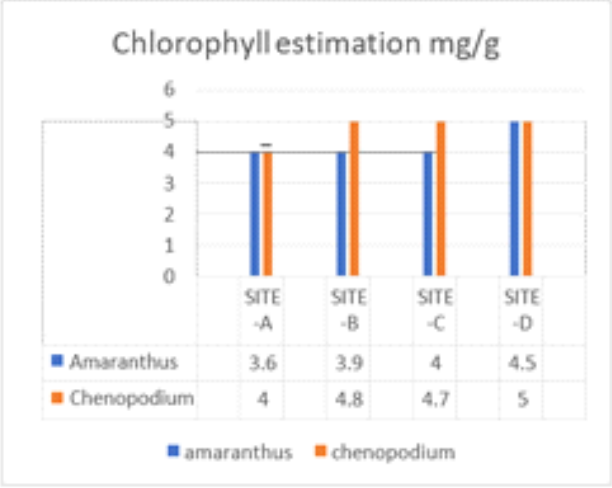

Fig.1 Effect of chlorophyll estimation polluted & control site

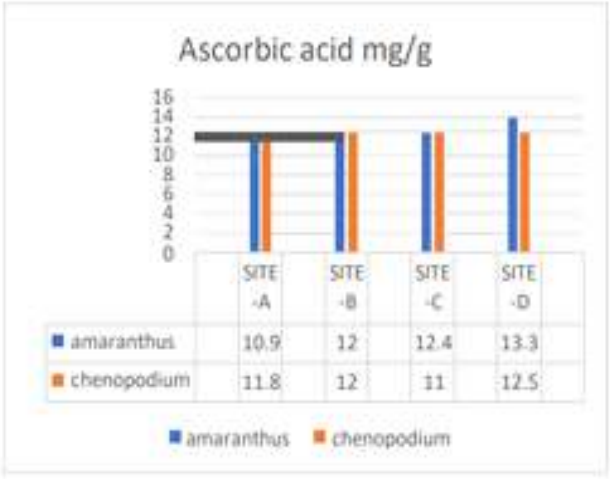

Fig 2. Effect of Ascorbic acid in polluted & control sites

There was a significant variation in ascorbic acid concentration in both genotypes (graph 12). The mean value of ascorbic acid analysis was higher in *Amaranthus* at control (SITE-D) whereas a slight deviation was observed in *Amaranthus* at other respective sites. The same observation was found in *Chenopodium (Fig.2.)*

Both plants showed informative variation in relative water content *i.e.,* maximum percent of relative water content was found at SITE-D and minimum at SITE-A while SITE-C & SITE-B showed the same percentage of water content in both genotypes (Fig.3). Relative water content considerably decreased under stress conditions. Most relative water content was determined in the *Amaranthus* genotype at the control site while the remaining sites showed almost equal amounts of water content in their respective leaf and a minimum was observed in *Chenopodium* at polluted SITE-A whereas the same amount of water content was found in both SITE-B & C

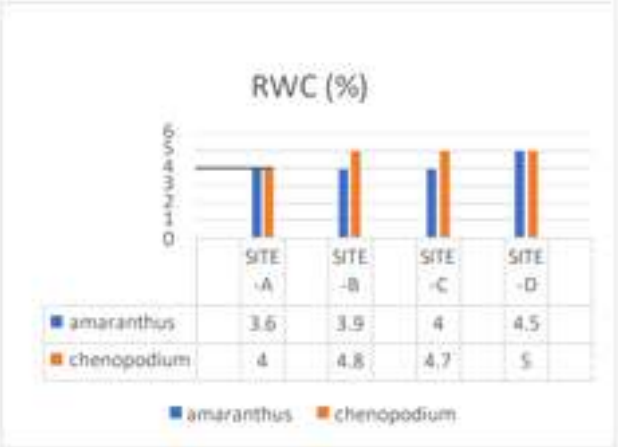

Fig 3. Effect of RWC, polluted & control sites

CONCLUSION

The present investigation aimed to check the impact of bio-indicator plants at polluted and control sites. It was concluded that pollution significantly affected vegetation and results revealed that the earlier researchers might have experienced several morphological and biological problems. When plants are continuously exposed to air pollution, they take in, accumulate, and digest the pollutants, which, depending on how sensitive they are, affect the structure of their leaves. In particular, these plants are highly recommended at polluted sites due to the possibility that they could act as sinks for air pollutants. These plants also seem to be sensitive to the atmosphere, which means that they could be used as effective bioindicators of pollution and help determine which species would be best to plant in the future at polluted sites.

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Dietary Diversity in Urban and Rural Elderly Living in Patiala district of Punjab

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ABSTRACT

The present study was carried out to investigate dietary diversity among urban as well as rural elderly. Two hundred elderly, 100 each from rural and urban area, 60-80 years of age were selected from the Patiala district by random sampling. Food and nutrient related information were determined through a dietary survey using a questionnaire in which information regarding dietary habits and dietary patterns was collected. The results showed that the intake of cereals (292 g), green leafy vegetables (42.74 g), milk and milk products (431.83 g), sugars (32.49 g) and fats and oils (39.82 g) was higher in rural men as compared to the urban men who had higher intake of other food groups *i.e.,* other vegetables (81.36) and fruits (308.88 g). The mean dietary diversity score of urban elderly ranged between 7-10 for both men and women with the mean values of 7.92 and 7.98, respectively whereas the corresponding values for rural elderly ranged between 6-10 in men and 5-10 in women with mean values of 7.64 and 7.48, respectively. The study concluded that there was a higher dietary diversity and food variety score with optimum mean adequacy ratio in the selected elderly population.

Key Words: Elderly, Food intake, Nutrient intake, Dietary diversity, Health

INTRODUCTION

The ageing process is a biological reality which has its own dynamic, largely beyond human control. Ageing is presumed to be a process starting from infancy and continuing until death. On the other hand, being elderly is an unpreventable process that has biological, chronological and social aspects and problems. Older people have a higher prevalence of chronic disease, take multiple medications and supplements, and tend to be sedentary. In the ageing, malnutrition is an important problem that has been seen in hospitals, residential care and in the community. Malnutrition is not an inevitable side effect of ageing, but many changes associated with the process of ageing can promote malnutrition. For example, ageing is frequently associated with decrease in taste acuity and smell, deteriorating dental health, and decreases in physical activity, which may all effect nutrient intake. The change in food intake can also be attributed to some social factors like loneliness and depression. Any change in the nutrient intake can lead to malnutrition with its potentially serious consequences (Singh *et al,* 2014).

Macro and micro nutrient deficiencies among elderly population are public health problem in most developing countries, partly due to monotonous, cereal-based diet that lacks diversity. Dietary diversity is a measure of the number of individual foods or food groups consumed in a given time period. It can reflect household access to a variety of foods and can also act as a proxy for individual nutrient adequacy. A diverse diet increases the probability of nutrient adequacy among elderly people and leads for positive health outcomes such as reduced complications of diabetes, incidence of several cancers and all- cause mortality. As dietary factors are associated with increased risk of chronic diseases, local and international dietary recommendations promote increased dietary diversity but limiting saturated fats, refined sugar and salt. Keeping this in view, this study was conducted to determine the dietary diversity of the elderly living in rural and urban

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areas in accordance to their food and nutrient intake.

MATERIALS AND METHODS

Two hundred elderly, 100 each from rural and urban area, in the age group of 60-80 years were selected from the Patiala district by random sampling. Dietary survey was carried out using food frequency questionnaire and 3 days 24-hour recall method to collect the food intake related information from the respondents. Then food variety score and dietary diversity score was calculated accordingly. Dietary intake of subjects was recorded for the three consecutive days by "24-hour recall method" to assess the food intakes of the subjects. The average daily nutrient intake of diet was calculated by using Indian nutritive software (Diet Cal). The average raw amount in grams of each and every item of food consumed for three consecutive days for each subject was fed in the software and nutritive value of the diets was recorded and compared with RDA. The food intake was compared with the suggested intake (Pasricha and Thimmayamma, 2010) while nutrient intake was compared with Recommended dietary Allowances (RDA) of ICMR (2010). For calculating food variety score, a list of 49 food items commonly consumed by the studied community was prepared. One point was given for each food category eaten either once or at any frequency throughout the week and each food category was scored only once. Points were added and the resultant score represented the Food variety score (FVS) of the respondent. Average FVS for urban and rural elderly was calculated separately by dividing the sum of FVS with total number of respondents.

The relation between food variety score (FVS) and dietary adequacy was determined using the following classification given by (Savige *et al,* 1997). Food Variety Score (FVS) was calculated using a set of 49 food items where '1' point was given for each food category consumed throughout the week. The elderly were categorized into three groups according to FVS obtained i.e. very good having FVS (>30/week), good (25-29/week), fair (20-24/week) and poor (<20/week). For calculating dietary diversity score a set of 12 food groups was used. The choice of 12 food groups was based on outcomes of Food and Nutrition technical assistance (FANTA) project (Swindale and Bilinsky, 2006). Information on respondent's food consumption was collected using the previous 24-hours as a reference (24-hour recall). One code was given for food group consumed during the previous 24-hour and '0' code was given for food group not consumed. DDS was calculated by summing the number of different food groups. Average DDS for urban and rural elderly was calculated separately by dividing the sum of DDS with total number of respondents and interpreted as given in Table 4.

RESULTS AND DISCUSSION

Food intake

Cereals and Pulses

The most commonly used cereals among all the respondents were wheat and wheat products (cracked wheat, refined wheat, semolina etc.) and rice. No significant difference found in the cereal intake of urban and rural elderly men. Whereas the average daily intake of cereals was significantly ($p<0.10$) higher in rural women as compared to urban women with percent adequacy of 123 and 115, respectively. The intake of cereals was found marginally adequate in both urban and rural men, whereas it was found adequate in both urban and rural women. The most commonly used pulses were green gram, bengal grams, lentils and *rajmah*. Results found that the consumption of pulses was significantly higher ($p<0.01$) in urban men and women as compared to the rural elderly men and women. The intake of pulses was found to be marginally adequate in both urban and rural men while adequate in both urban and rural women.

Vegetables

The commonly used green leafy vegetables in elderly were mustard leaves, spinach and fenugreek leaves**.** The intake of green leafy vegetables was found to be marginally adequate in both urban and rural men and women because the data was collected in the months of January to March. During this period, the availability of green leafy vegetables was found to be more as compared to the rest of the

months. The consumption of onions, potatoes, ginger and garlic was most frequent among elderly. The intake of roots and tubers was found marginally adequate in both urban and rural men and women.

Cauliflower, beans, capsicum, peas etc. were most commonly consumed by the elderly men and women. The intake of other vegetables was inadequate in urban men and rural men and women, while it was marginally inadequate in urban women as per classification given by Jood *et al,* (1999). Other vegetables like cabbage, cauliflower, brinjal were not consumed by most of the elderly population as they felt discomfort (gas production) after consuming these vegetables.

Fruits

In context to consumption of fruits in urban and rural elderly there was no significant difference found in the consumption of both urban and rural elderly men and women. The intake of fruits was adequate in both urban and rural men and women. Salehi *et al,* (2010) also reported that the consumption of fruits and vegetables was lower than the recommended minimum of five daily servings. Sharma *et al,* (2013) reported only 41% of elderly were regularly consuming fruits and vegetables in their diet.

Milk and Milk products

Consumption of milk and milk products by the elderly were in the form of milk, tea, curd, *sevian*, *kheer*, cottage cheese and buttermilk. The average daily consumption of milk and milk products in urban and rural elderly men was significantly ($p<0.01$) higher in rural elderly men as compared to urban elderly men with percent adequacy of 144 and 111, respectively. In urban and rural elderly women also, the average daily consumption of milk and milk products was significantly ($p<0.01$) higher in rural elderly women as compared to urban elderly women with percent adequacy of 172 and 111, respectively. The intake of milk and milk products was adequate in both urban and rural men and women.

Sugar and Fat

The intake of sugar was also adequate in both urban and rural men and women. The consumption of fat was mainly in the form of desi ghee, mustard oil, refined oil, butter and hydrogenated fat. Average daily consumption of fats and oils was significantly ($p<0.01$) higher in rural elderly women as compared to urban elderly women with percent adequacy of 206 and 156, respectively. The intake of fats and oils was adequate in both urban and rural men and women.

Nutrient intake

The energy intake was less than the RDA for both urban and rural men and also for rural women. The intake of energy was marginally adequate in both urban and rural men while it was adequate in urban women and marginally adequate in rural women. The intake of protein was marginally adequate in both urban and rural men and women. The intake of fat was adequate in both urban and rural men and women. Olayiwola *et al* (2013) reported fat intake in men and women ranged between 18-38 g for men and 16-35 g for women. The intake of carbohydrates was marginally adequate in both urban and rural men and women. The average intake of ß-carotene in urban elderly men was significantly ($p<0.05$) higher as compared to the rural elderly men and with percent adequacy of 96 and 86, respectively whereas the percent adequacy of urban and rural elderly women was 100 and 97, respectively. The intake of ß-carotene was marginally adequate in both men and women except urban women where it was adequate. The intake of thiamine was adequate in both urban and rural men while marginally adequate in rural women. The results were similar to as reported by Afolabi *et al,* (2015) where thiamine intake was adequate with mean values of 1.2 for men and 1.2 for women having percent adequacy of 100 and 109, respectively. The intake of riboflavin was marginally inadequate in both urban and rural men. In case of women, intake was marginally adequate in urban women but inadequate in rural women. Though the consumption of milk and milk products was adequate but riboflavin intake was inadequate in the diets. The intake of niacin

was marginally inadequate in both urban and rural men and women. The lower intake of niacin rich foods like fish, chicken, mushrooms, peanuts etc. are responsible for inadequacy of the nutrient in the diets. The intake of Vitamin B_{12} was marginally adequate in both men and women except urban women where it was marginally inadequate. Inadequacy of vitamin B_{12} in urban women can be attributed to less consumption of milk and milk products which are rich in Vitamin B_{12}. The intake of vitamin C was adequate in both urban and rural men and women as during the study period, plenty of citrus fruits are available for consumption. Yadav *et al, (2012)* reported mean vitamin C intake of urban elderly men and women was lower in comparison to rural elderly men and women.

The calcium intake of both men and women was higher than the RDA. The intake of calcium was adequate in both urban and rural men and women. This was due to adequate consumption of milk and milk products. The intake of iron was marginally adequate in both urban and rural men while in case of women it was marginally adequate in urban women but marginally inadequate in rural women. This might be due to less consumption of non-vegetarian sources which have high content of iron in rural elderly women as compared to the urban elderly women. The intake of zinc was marginally inadequate in both urban and rural men, while inadequate in both urban and rural women. The low intake of zinc was because of less consumption of non-vegetarian sources. The intake of magnesium was marginally adequate in urban and rural men and women except urban women where it was adequate. The intake of dietary fibre was marginally inadequate in both men and women except rural women where it was inadequate. This might be due to less consumption of other vegetables.

Dietary Diversity Score and Food variety Score

The mean DDS of urban elderly ranged between 7-10 for both men and women with the mean values of 7.92 and 7.98, respectively whereas the corresponding values for rural elderly ranged between 6-10 in men and 5-10 in women with mean values of 7.64 and 7.48, respectively (Table 3). The lower mean of the DDS was associated to the non-vegetarian sources, other vegetables and fruits and the higher one was due to cereals, and milk and milk products. So, the results showed a trend of higher food variety and dietary diversity with good mean adequacy ratio in the elderly population.

The mean food variety score of urban elderly ranged between 21-33 in men and 18-33 in women with the mean values of 25.76 (good) and 26.18 (good), respectively whereas the corresponding values for rural elderly ranged between 19-29 in men and 16-29 in women with the mean values of 24.28 (fair) and 22.78 (fair), respectively.

CONCLUSION

The study concluded that out of 9 food groups, the consumption of other vegetables was inadequate among elderly men and women. Cereals, pulses, Green leafy vegetables, roots and tubers were marginally inadequate among elderly men whereas, green leafy vegetables and roots and tubers were marginally inadequate among elderly women. The intake of pulses, other vegetables, milk and milk products was significantly higher in elderly urban men when compared with elderly rural men. On the other hand, intake of cereals, milk and milk products and fat was significantly higher in rural elderly women when compared with urban elderly women. The average nutrient intake of all nutrients for all the elderly men and women was less than the suggested nutrient intakes except for calcium, fat and vitamin C which was found to be higher than Suggested intake by all the elderly people. Rural men had significantly higher consumption of fat, calcium, and iron when compared to urban elderly men whereas ß-carotene, zinc and magnesium was found to be significantly higher in urban men as compared to rural men. Urban women had significantly higher thiamine, riboflavin, niacin, Vitamin C, iron, zinc, magnesium and fiber when compared to rural women who had significantly higher fat content in their diets. Food variety score and dietary diversity score was found to be higher in urban elderly as compared with the rural elderly.

Table 1 Food intake of the selected subjects

NS Non significant; *Significant at 10%; *** Significant at 1%

Nutrients	Men (n=100)			Women (n=10)			
	Urban (n=50)	Rural (n=50)	P-value	Urban (n=50)	Rural (n=50)	P value	RDA
Energy (Kcal) Range	1145-2266	1130-2180	0.2074NS	1348-	1068-	0.00001***	2008 M, 1900 F
Mean ±SE	1707± 42.41	1637 ± 34.28		1921 ± 45.40	1611 ± 29.27		
Protein (g) Range	50.14-65.72	49.64-66.38	0.8905NS	42.04-62.42	34.64-61.13	0.3850NS	60 M, 55 F
Mean ±SE	58.17 ±0.478	58.24 ± 0.583		53.51 ±0.791	52.53 ± 0.805		
Fat(g) Range	13.06-57.12	23.02-65	0.0001***	13.48- 45.70	17-65	0.00001***	25 M, 20 F
Mean ±SE	30.99 ±1.642	39.38 ± 1.267		23.38 ± 1.057	35.92 ±1.488		
Carbohydrates(g) Range	200.15-253.14	200.86-256.48	0.2009NS	210.34- 232.94	203.46-230.64	0.1963NS	283 M, 233 F
Mean ±SE	232.37 ± 1.463	229.21 ± 1.973		221.70 ± 0.809	220.24 ± 0.775		
β-carotene(µg) Range	409.5-768	126-1036.5	0.049**	416-765	442.75-693	0.2353NS	600
Mean ±SE	575.36 ±12.062	515.04 ± 27.70		600.61 ± 12.14	582.62 ± 8.906		
Thiamine(mg) Range	0.61-2.48	0.58-2.24	0.311NS	0.91-2.62	0.58-1.03	0.00001***	1.2 M, 1.1 F
Mean ±SE	1.41 ± 0.055	1.32 ± 0.052		1.57 ± 0.052	1.03 ± 0.045		
Riboflavin(mg) Range	0.407-1.69	0.36-1.46	0.496NS	0.53- 2.44	0.31-1.34	0.00001***	1.4 M, 1.1 F
Mean ±SE	0.91 ± 0.041	0.86 ± 0.042		1.12 ± 0.051	0.63 ± 0.033		
Niacin(mg) Range	4.25-19.20	4.16-15.29	0.365NS	9.02-21.5	3.82-15.92	0.00038***	16 M, 12 F
Mean ±SE	9.86 ± 0.441	9.32 ± 0.402		10.49 ± 0.460	8.21 ± 0.407		
Vitamin B_{12}(µg) Range	0.21-4.1	0.14- 3.6	0.996 NS	0.24-3.66	0.13-5.18	0.29915 NS	1
Mean ±SE	0.86- ± 0.195	0.84 ± 0.256		0.73 ± 0.791	0.89 ± 0.519		
Vitamin C(mg) Range	35.43-72.5	33.66-66.67	0.159NS	33.03-62.5	26.20-67.7	0.00125 ***	40
Mean ±SE	54.01 ± 1.167	51.72 ± 1.117		53.79 ± 0.884	48.74 ± 1.227		
Calcium(mg) Range	450.94-1822.52	477.56- 1836.42	0.0437**	428.29-1764	601.17-1557.46	0.5253NS	600
Mean ±SE	1037.40 ± 44.14	1163.8 ± 43.36		1133.57 ± 36.00	1164.96 ± 32.487		
Iron(mg) Range	7.53-24.74	6.25-26.24	0.0944*	9.46-26.37	6.13-18.92	0.00001***	17 M,21 F
Mean ±SE	14.61 ± 0.610	15.94 ± 0.502		16.55 ±0.592	10.94 ± 0.423		
Zinc(mg) Range	3.10-10.38	2.68-8.80	0.001***	3.30-12.74	2.47-8.64	0.00001***	12
Mean ±SE	6.28 ± 0.261	5.23 ± 0.195		6.70 ± 0.245	4.83 ± 0.188		
Magnesium(mg) Range	172.06-598.16	122.24-624.27	0. 073*	178.16-636.86	123.53-499.33	0.00099***	340 M, 310 F
Mean ±SE	334.47 ± 14.49	297.48 ± 14.47		363.69 ± 13.32	301.96 ± 12.157		
Dietary Fibre(g) Range	4.37-27.18	1.85-25.26	0.462NS	7.59-31.99	1.90-7.46	0.00001***	25-30
Mean ±SE	13.91 ± 0.782	13.05 ± 0.846		16.12 ± 0.714	7.46 ± 0.369		

Table 2 Nutrient intake of the selected subjects

NS Non-significant; *Significant at 10%; *** Significant at 1%

Food groups (g/day)	Men (n=100)				Women (n=100)			
	Urban (n=50)	Rural (n=50)	P- value	Suggested intake	Urban (n=50)	Rural (n=50)	P-value	Suggested intake
Cereals Range	180-460	198-389.3	0.8531NS	350 a	180-450	150-395	0.08184*	225 a
Mean ± SE	289±9.278	292±7.64			258± 7.215	276 ± 7.502		
Pulses and legumes Range	36-53.3	23-55	0.0003***	50 a	35-56	23-55	0.0048***	40 a
Mean ± SE	46.36 ± 0.652	42.29 ± 0.892			45.84 ± 0.652	42.35 ± 0.888		
Green leafy vegetable Range	13.3-90	17-88	0.1692NS	50 a	23-80	14-90	0.4431NS	50 a
Mean ± SE	38.55± 2.134	42.74 ± 1.868			40.25±1.590	38.26± 1.810		
Roots and tubers Range	73-93	70-90	0.5631NS	100 a	75-96	58.3-100	0.0002***	100 a
Mean ± SE	85.00 ±0.684	85.00 ± 0.629			86.56 ± 0.698	80.06± 0.662		
Other vegetable Range	50-110	40-96	0.0006***	200 a	48-106	50-95	0.0001***	150 a
Mean ± SE	81.36± 1.902	72.24 ± 1.759			82.00 ± 1.864	72.10±1.553		
Fruits Range	130-566	126-528	0.8244NS	200 a	217-466	140-490	0.1835NS	100 b
Mean ± SE	308.88 ± 10.956	305.4 ±11.213			297.64±7.066	279.64 ± 10.983		
Milk and milk products Range	100-654	200-740	0.0001***	300 ab	100-648	210-780	0.00001***	300 ab
Mean ± SE	331.87±14.930	431.83±19.462			331.56±14.922	516.73± 20.58		
Sugar Range	20-54	25-58	0.1815NS	20 ab	21-50	20-55	0.6933NS	20 ab
Mean ± SE	30.20 ± 1.165	32.49 ± 1.243			31.77 ± 1.116	32.43 ± 1.240		
Fats and Oils Range	21-67	22-75	0.4001NS	25 ab	20-43	25.3-70	0.00001***	20 ab
Mean ± SE	37.96 ± 1.361	39.82 ± 1.719			31.16 ± 0.837	41.15 ± 1.424		
Meat and poultry Range	100-347	100-454	0.1081NS	----	100-308	100-250	0.2317NS	----
Mean ± SE	220.94± 12.855	273.25±16.884			206.25± 11.852	170± 9.028		

FVS and DDS was found to be higher in urban elderly men and women as compared to the rural elderly men and women. The FVS of urban elderly was categorized as good having mean values of 25.76 and 26.18 for men and women respectively whereas corresponding values for rural elderly men and women were 24.28 and 22.78, respectively which was categorized as fair.

Table 3. Dietary diversity score (DDS) and Food variety score (FVS) of the selected elderly

[NS] Non significant; *Significant at 10%; *** Significant at 1%

Food items	Men (n=100)			Women (n=100)		
	Urban	Rural	p-value	Urban	Rural	p-value
DDS						
Range	7-10	6-10	0.750 [NS]	7-10	5-10	0.439 [NS]
Mean ± SE	7.92± 0.13	7.64±0.16		7.98±0.13	7.48 ± 0.14	
FVS						
Range	21-33	19-29	0.004***	18-33	16-29	0.001***
Mean ± SE	25.76 ± 0.39	24.28 ± 0.32		26.18 ± 0.51	22.78 ± 0.39	
MAR (%)	95	95.14	-----	101.21	91	----

Table 4 Relationship between food variety score (FVS) and dietary adequacy.

Total Food variety score/week	Dietary adequacy
>30	Very good
25-29	Good
20-24	Fair
<20	Poor
<10	Very poor

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Drip and Fertigation Technology to Enhance Water and Nutrient Use Efficiency in Semi-Arid Region

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ABSTRACT

In an intensive agriculture system introduction of both irrigation and fertilizer management at farmer's fields in Gadda Malliah Guda village, Yacharam Mandal of Ranga Reddy District in Telangana has contributed immensely to increase the yield and quality of crops. Micro irrigation technology has about 90 per cent irrigation efficiency compared to 40-60 per cent for surface irrigation systems. Water and nutrient supply to plants influence plant growth and yield. It has been observed that fertigation leads to 25-40 per cent savings of fertilizer, increased returns and reduced leaching of the nutrients. Adopting micro irrigation cum fertigation leads to saving 20 to 40 % of water and 30% of fertilizers. Precise management of irrigation quantity along with the rate and timing of nutrient application are critical to obtain desired results in terms of productivity and nutrient use efficiency. In rain-fed areas where insufficient availability of water is common, adopting micro irrigation systems with fertigation enhances productivity and reduces resource use, a scenario for better water resource management.

Key Words: Emitter, Fertigation, Management, Nutrient, Water.

INTRODUCTION

The drip irrigation technique involves irrigating the root zone through an emitter mounted on a lateral tube and inserted into the pipe as an emitter tube. Water requirements depend on plant age, plant-to-plant spacing, soil type, water quality and availability, etc., and these are some of the factors that determine the selection of an emission system. A PRA (Participatory Rural Appraisal) was conducted with beneficiary farmers and Agriculture Department officials to identify various vegetable crop interventions and micro irrigation cum fertilization in the project village. Observation was made, flood irrigation system followed in vegetables, water scarcity and uneven and inadequate rainfall distribution are the main problems, and consideration was given to provide priority micro irrigation cum fertigation technology to these farmers in the project area.

The study of the project was to create awareness and effective use of micro irrigation cum fertigation systems in various crops, Krishi Vigyan Kendra (KVK) conducted field trials on drip and fertigation systems in various farmers' fields and also conducted on/off campus training and hands-on practice for farmers. The project village has an irrigated source with 126 farmers covering about 42 ha of crop area. The objectives of the study were to compare conventional irrigation cum fertilizer and fertigation treatment on tomato yields and to create awareness on micro irrigation cum fertigation systems for proper use of water and fertilizer.

MATERIALS AND METHODS

The study area lies between 78º 40' 44" to 78 º 42' 28" longitudes and 17º 04' 54" to 17º 07' 08" latitude covering a geographical area of 250Sq.m of Gadda Malliah Guda Village in Yacharam Mandal of Ranga Reddy District in Telangana State. Micro irrigation systems and fertigation were introduced in 126 farmers covering a total of 42 ha in the vegetable crops. Kumar *et al* (2012) positively and field overwhelmingly found a significant association between financial motivation in drip irrigation technology by farmers, size of land, mass media exposure and socio-economic status of farmers. Irrigation potential was negatively and

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Table 1. Water requirement and productivity of drip system (Av of 126 farmers)

Sr. No.	Parameter	Surface Irrigation	Drip Irrigation
1.	Water applied (cm)	257	128
2.	Percent water Saving	-	50.19
3.	Irrigation efficiency	30-50%	80-90%
4.	Weed problem	High	Very less/Almost nil
5.	Suitable water	Only normal water can be used	Even saline water can be used
6.	Diseases and pests	High	Relatively less
7.	The efficiency of fertilizer use	Heavy losses due to leaching	Very high since supply was regulated

Table 2. Soil Nutrient status of farmer's fields for covering the whole village.

Sr. No	pH (1:2.5)	EC (dS/m)	OC (%)	P (kg/ha)	K (kg/ha)
1	6.14	0.14	0.35	15	175
2	8.26	0.18	0.69	35.3	158
3	8.24	0.12	0.91	288.82	27.66
4	7.55	0.16	0.17	69	235
5	7.89	0.09	0.24	34	19.30
6	7.43	0.23	0.44	83.80	441
7	8.08	0.24	0.83	65.4	146
8	7.37	0.13	0.57	57	283
9	7.47	0.11	0.25	33.04	808.64
10	7.98	0.25	0.60	56.31	77.70
11	6.64	0.05	0.60	13.80	123
12	6.54	0.18	0.76	22.50	840
13	8.35	0.12	0.70	118	613.76
14	7.26	0.39	0.23	35.84	48
15	7.13	0.11	0.51	34.2	439
Mean	**7.49**	**0.17**	**0.52**	**64.13**	**295.67**
SD	**0.67**	**0.08**	**0.24**	**68.14**	**273.72**
Mean ± SD	**6.82 to 8.16**	**0.08 to 0.25**	**0.29 to 0.76**	**-4.00 to 132.27**	**21.95 to 569.39**

significantly associated with experience in agriculture. A non-significant relationship was found with farmers adopting drip irrigation technology.

The on-farm study was conducted at the farmer's fields to use micro irrigation cum fertigation in the best possible way. This study compared two methods of irrigation T1- Drip irrigation cum fertigation method in tomato crops and T2- Conventional irrigation with direct fertilizer application. In the conventional method of fertilizer application, the uniform supply of nutrients was inconsistent with the crop development stages. High nutrient doses and nutrient losses through leaching and volatilization resulted in lower fertilizer use efficiency, yields and crop quality.

Drip and Fertigation

In the pre-project period (2014) in the study village 9 (3% in village) farmers had the facility of micro irrigation system but not knowing about fertilizer application through the drip irrigation system (fertigation). During the post-project period (2018) micro irrigation has increased 126 (42%) farmers, the study area fertigation technology has been popularized. Water requirement and productivity of drip irrigation among selected farmers were compared to surface irrigation with drip irrigation systems in Table 1.

In the drip irrigation system, the total irrigation water of the tomato crop was 128 cm and the irrigation efficiency was 80 to 90%. Similarly, under furrow Irrigation the total irrigation water applied to the crop was 257 cm and the irrigation efficiency of 30 to 50%. Irrigation efficiency increased by 50.19%. These results indicated that the overall yield of the tomato crop was higher under drip irrigation as compared to furrow irrigation.

Monitoring and management of nutrients

Fertigation is a precision agricultural technology that uses its potential to supply plants with required quantities of water and nutrients and with minimal environmental damage. The entire village was divided into three zones and 5 farmers were selected from each zone to determine soil health and availability of nutrients in the fields. Soil samples were collected from identified 15 farmers' fields in the project area, and analyzed in the lab as per standard procedures for soil nutrient status such as PH, EC, OC, P and K, the values are presented in Table 2, and distributed the soil health cards with recommended the farmers to follow balanced nutrient application. In this project for tomato crop introduced the fertigation system with recommend dose of nutrient application.

Drip system water quality criteria to avoid clogging

The criteria for water quality for conventional irrigation was different from the one meant for irrigating through the drip. The clogging hazards with different water qualities were presented below to avoid the clogging of water in drip irrigation system (Table 3).

Study Carried out

A progressive farmer Mr. Suresh Reddy grows all kinds of vegetables throughout the year in GM Guda village of Ragareddy district and he adopted drip and fertigation technology in his fields for tomato. The time was saved by about 50% as compared to the surface irrigation mean while crop time irrigation and total water of irrigation were saved by around 66% in the drip irrigation system. In a drip irrigation system, the total number of irrigation water for the tomato crop is 40 to 45 and the quantity of irrigation was 3388 m^3. Similarly, under surface Irrigation the number times of irrigated with water for the crop is 30 to 35 and the quantity of irrigation is 5646 m^3.

Table 3. The extent of clogging based on the quality of irrigation water

Quality of Water	Clogging Hazard		
	Slight	Moderate	Severe
Suspended Solids (ppm)	<50	50-100	>100
pH	<7.0	7.0-8.0	>8.0
TDS (ppm)	<500	500-2000	>2000
Manganese (ppm)	<0.1	0.1-1.5	>1.5
Iron (ppm)	<0.2	0.2-1.5	>1.5
Calcium and Ma gnesium (ppm)	<20	20-40	>40
Hydrogen sulphide (ppm)	<0.5	0.5-2.0	>2.0
Bacterial population (No./ml)	<10000	10000 -50000	>50000

Source: Dasberg and Dani, 1999

Table 4. Effect of drip irrigation on water saving in tomato.

Sr.No	Particulars /ha	Drip irrigation	Surface irrigation	Saving (%)
1	No. of irrigations	40 to 45	30 to 35	-
2	Time per one irrigation (h r)	6 hrs	12 hrs	100
3	Total time of irrigation (h r)	255	390	53
4	Irrigation cost (Rs.)	18822	31368	66.7
5	Irrigation water (m^3)	3388	5646	66.7
6	Yield (t/ha)	47	23	51

These results indicated that the overall yield of the tomato crop was 51% higher under drip irrigation as compared to furrow irrigation (Table 4).

Nutrient importance in tomato crop

Fertigation precisely delivers the plant nutrients via irrigation in the crop root zone to meet crop demand during the growing season. Fertigation improves fertilizer efficiency, saves fertilizer, increases nutrient availability and uptake, increases crop yield and quality, reduces nutrient leaching below the root zone, has huge savings in time, labor and fuel costs, and accurate and uniform fertilizer application to the crop.

Fertigation increases the water and nutrient use efficiency of various vegetable crops, as fertigation provides an equal supply of water and fertilizer to all crops, with the potential for 25 to 50% higher yields in the study area. Fertilizer utilization efficiency was between 80 to 90% through fertigation, which helps to save at least 25% of nutrients. Generally, 60 to 80% of the recommended dose of fertilizers through water soluble fertilizers has been observed to suffice to secure equivalent yields of crops as obtained with the application of 100% straight fertilizers. The fertigation method had the least loss of nutrients through leaching, 10%, compared to 55% of the conventional farmer's method. Higher water uses efficiency and 30 to 40% economy in the use of irrigation due to ferti-drip in crop production. Time, labour and energy use were reduced substantially. The stage-wise essential nutrient requirements of the tomato crop are shown in Figure 2.

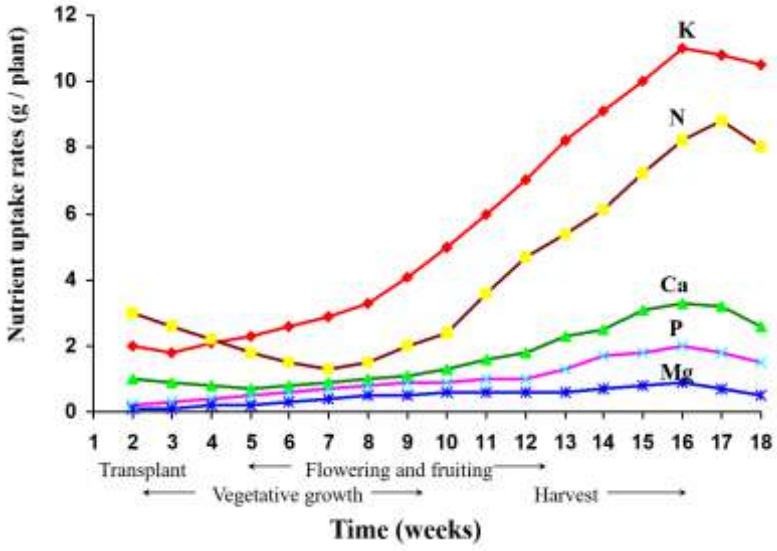

Figure 2: Nutrient uptake rates for tomato (Source: Huett, 1985)

Balanced Nutrient Application and Selection of Fertilizers

Fertigation of the crop is not optional but is necessary when using drip irrigation systems. Fertilizers applied through drip irrigation are 100 per cent water-soluble and 10 liters of water per 1 kg of fertilizer was considered the minimum dilution for any fertilizer tank. The farmer used fertilizers in tomato crops in one season as mentioned below at a fixed time of crop stage (Table 5). Muralidhar *et al* (1999) concluded that the technology of drip and fertigation at 80% of recommended N and K levels with water-soluble fertilizers registered higher tomato yield (22.3 t/ha) compared to 100% and 60% of recommended levels in drip irrigation. Fertigation is one such agro-technique that has proved to be a catalyst to boost the productivity of tomato. In tomato crops, drip irrigation trials showed 75% higher yield, fertigation trials showed a 100% higher yield compared to 28% yield in conventional, and water use efficiency (WUE) was 87% compared to the furrow method. Kumar *et al* (2018) concluded that different levels of nitrogen, phosphorus and potash significantly affected the plant growth, yield and quality of onion bulbs during the Kharif season. Application of N, P2O5 and K2O significantly increased the total onion yield with a combination of 120 kg, 80 kg and 60 kg/ha.

Table 5. Adoption of fertigation schedule for tomato.

Stage	Crop stage & no of application	Duration in days	Fertilizer Grade	Total fertilizer Kg/ha	Nutrient applied			% of requirement		
					N	P	K	N	P	K
1	Transplanting to plant establishment stage	10	19:19:19 13:0:45 Urea (46% N)	65.78 27.77 8.44	12.50 3.61 3.88	12.50 _ _	12.50 12.50 _	10	5	10
					19.99	**12.50**	**25.00**			
2	Flower initiation to flowering	30	12:61:0 13:0:45 Urea (46% N)	40.98 222.22 100.27	4.92 28.89 46.12	25.00 _ _	_ 100.0 _	30	10	15
					79.93	**25.00**	**100.0**			
3	Flowering to fruit set	30	19:19:19 13:0:45 Urea (46% N)	65.78 138.88 63.90	12.50 18.05 29.39	12.50 _ _	12.50 2.50 _	40	5	50
					59.94	**12.50**	**75.00**			
4	Alternate day from picking	80	12:61:0 13:0:45 Urea (46%N)	20.49 111.11 50.14	2.46 14.44 23.06	12.50 _ _	_ 0.00 _	30	5	50
					199.82 or 200.00	62.50	250.00	100	25	100
Recommended dose: 200:250:250 kg/ha										

RESULTS AND DISCUSSION

Drip fertigation systems have demonstrated significant advantages in various vegetable crops, resulting in water savings of 30% to 45%, fertilizer savings of 30% to 42%, and yield increase of 23.91% to 40%. The experiences of progressive farmer Mr. Ch Suresh Reddy serve as an example for approximately 250 farmers in Gadda Malliah Guda and surrounding villages who have adopted this technology. For instance, Mr. Reddy's tomato crop, cultivated on one hectare, yielded 47 t. Dingre *et al* (2012) found that drip fertigation increased onion seed productivity by 12% to 74% compared to conventional methods, with a water saving of 39% and a 2.5 times higher field water use efficiency. Raja Gopala Reddy *et al* (2017) highlighted the benefits of drip irrigation and fertigation for higher production and quality in fruit and vegetable crops. Abraham *et al* (2018) reported that irrigation at 100% Ep and fertilization at 125% NPK, combined with silver-black plastic mulching, significantly improved dry matter and early fruiting in bittersweet under open field conditions in humid tropics. Ngouajio *et al* (2007) noted an 8% to 15% increase in tomato yield and a

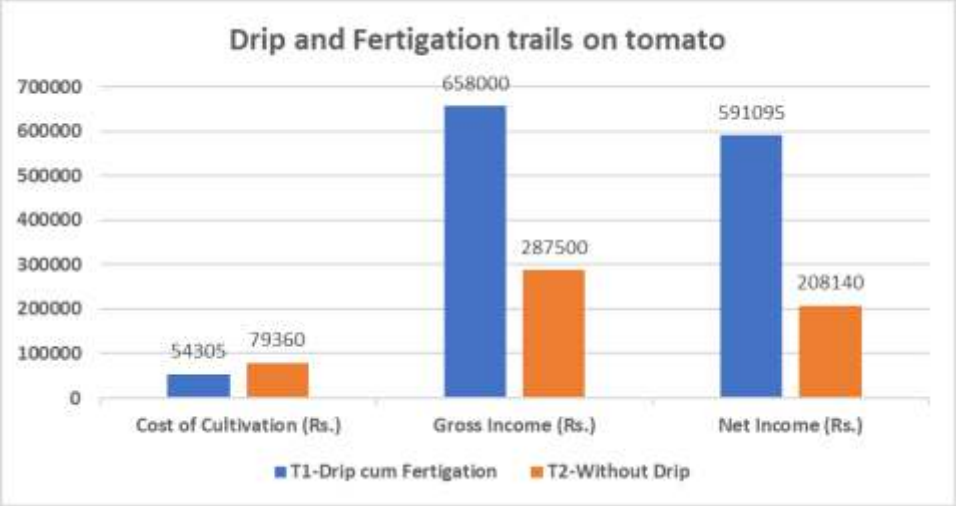

Figure 3: Net Profit difference under fertigation in tomato

12% to 14% increase in fruit number with drip irrigation and fertigation during the flowering and fruit development stages. Krishnamurthy *et al* (2014) recorded the highest yield and benefit-cost ratio using 120:20:80 kg/ha of N, P2O5, and K2O as water-soluble fertilizers, compared to 50% and 25% applications of conventional fertilizers. Water-soluble fertilizers enhance nutrient utilization efficiency due to the uniform distribution of fertilizers in the active root zone. Veeranna *et al* (2001) concluded that 80% of WSF was effective in yielding about 31 and 24.7% higher chilly over soil application of normal fertilizers at 100% recommended level in-furrow and drip irrigation methods, respectively, with 20% of saving in fertilizers. These studies collectively underscore the efficiency and productivity gains offered by drip fertigation systems in agriculture. Singandhupe *et al* (2007) concluded that the pointed gourds (*Trichosanthes dioica*) cultivated in fertigation technology with a 100% recommended dose at monthly intervals gave a higher yield of 4.27 t/ha. Vijayakumar *et al* (2010) concluded that the maximum yield in chili was observed in drip irrigation along with fertigation of 75% of recommended N and K with maximum shoot length and a greater number of branches.

Impact and Economics of the drip and fertigation system

It was observed that for different vegetable crops there is a saving in water (30-45%), fertilizer (30-42%) and an increase in yield (23.91- 40.00%) with drip fertigation systems. The total irrigation water applied by surface and drip system was 840 mm and 520.45 mm representing 39% water saving, while the field water use efficiency of drip fertigation was 2.5 times more than the control. Fertigation is one such farming technique that has proven to be a catalyst for increasing tomato crop productivity.

The crop yields and economics are mentioned (Table 6). A progressive farmers village adopted this drip and fertigation technology. In one hectare of tomato crop with the average price per kg was Rs.14.00 (the price average calculated during 22 pickings and 4 months period) with a range of Rs.8/- to Rs.72/- total yield was 47 t/ha. The total net seasonal income generated was Rs.5,91,095/- while the cost incurred was Rs.66,905/-. Further, resulted in saving water of 58% due to drip irrigation system shown in figure 3.

CONCLUSION

The use of drip irrigation and fertigation significantly increased the yield of the tomato crop, with an average maximum yield of 47 t/ha under drip irrigation compared to 23 t/ha under surface irrigation. The net income per hectare using conventional methods income was Rs. 2,08,140/-, while the net income using fertigation method was Rs. 5,91,095/-. To cultivate the same crop in an additional area using the water saved, the net additional income of Rs.5,91,095/- per ha

Table 6. Economics analysis of fertigation in tomato under drip and without drip area

Sr.No	Particular	T1-Drip cum Fertigation	T2-Without Drip
1	Spacing	60 cm x 45cm	30 cm x 45cm
2	Cost of drip system Rs/ha	Raised bed	Flat bed
	a. Life 5 years for lateral, Dripper and 10 years for main, sub -main and filters.	45000	-
	b. Depreciation, Rs/ ha.	7650	-
	c. Interest, Rs/ ha.	2700	-
	d. Repair and Mai ntenance 5%	2250	-
	e. Total, (2b+2c+2d), Rs/ ha.	12600	-
3	Cost of cultivation of a crop.		
	f. Land preparation	16250	16250
	g. Number of plants /ha	36850	73700
	h. Cost of plants /ha Rs.0.30/plant	11055	22110
	i. Cost of Sowing/Planting	1500	1500
	j. Cost of weeding	6000	8000
	k. Cost of organic fertilizers including applica tion (FYM)	-	4000
	l. Cost of Chemical Fertilizers (100% WSF)	10000	15000
	m. Cost of Plant Protection	9500	12500
	n. Total, (3f+3h+3i+3j+3k+3l), Rs/ ha.	54305	79360
4	Seasonal total cost = (2e+3n), Rs / ha.	66905	79360
	Total no. of pickings	22	10
5	Water u sed in liters/day/plant.	2 to 4	5 to10
6	Yield of produce, t/ha.	47 (22 pickings)	23 (22 pickings)
7	Selling price, Rs/t.	14000	12500
8	Gross income from produce = (7x6), Rs/ ha.	658000	287500
9	Net Seasonal income = (8 -4), Rs/ ha.	591095	208140
10	B:C ratio	8.83	2.62
11	If additional area is cultivated due to saving of water (ha).	1	nil
12	Additional expenditure due to additional area (4), Rs/ ha.	66905	-
13	Additional income due to addit ional area (8), Rs/ ha.	658000	-
14	Additional Net Seasona l income (9), Rs/ ha.	591095	-
15	Gross income (9+14), Rs/ ha. (if grown 2 ha of tomato)	1182190	-

was obtained more. It can be concluded that the studied of the fertigation system resulted in an increase of 58.33% in yield and 51% in water-saving and improved the B: C ratio as compared to surface irrigation. In addition, soluble fertilizers through fertigation improved nutrient use efficiency compared to conventional fertilizer application.

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Drudgery Reduction of Farm Women through Improved Tools

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ABSTRACT

The goal of the current study was to provide farm women with technology tools to lessen their labour and increase their output. Three villages were selected purposively from Kurai block of Seoni district in 2020-23. A total of 80 farm women were selected using simple random sampling technique, out of them 15 *viz.,* 5 from each village were participated in drudgery reduction intervention in three years. Data were collected by using an interview schedule that was pre-tested and self-organized. Additionally, field research was conducted to study women's agricultural activities. On comparing energy expenditure of farm women during performing decortications activities the average energy expenditure (KJ/min.) was 9.40 under recommended practices (RP) against 11.11 in farmer's practice (FP) and per cent reduction in energy was observed to be 15.33. Further, it was also found that average output (Kg/hr) of final product (decorticated seed/split) was11.03% from decorticator and the least output average *viz.,* 2.75 per cent from farmers' practice.

Key Words: Drudgery, Farm women, Efficiency, Energy expenditure, Health and Livelihood.

INTRODUCTION

In India, women perform the majority of the agricultural labour. There are about more than 20 million women working in agriculture field out of which 90% live in villages. It is often known that rural women participate in agricultural activities. Thus, farmwomen have really difficult lives (Suma Haslkar *et al,* 2005). A large percentage of women living in rural areas work in agricultural and related fields, such as fisheries, agro/social forestry, crop production, irrigation, manuring, post-harvest operations, and animal activities. The extent of women's involvement and type of activities performed by them in agriculture and allied fields varies according to location. The farmwomen work long hours on the farm and in the homestead, leading difficult lives. Significant fatigue on the body and mind as well as other health issues results from this. The primary causes of all these issues include ignorance, stale methods of carrying out tasks, technological incompatibilities, and mental barriers such innate conservatism and resistance to change (Thakur *et al,* 2013).

Farm labourers, particularly women, frequently accept pain as a necessary aspect of the job and only seek medical attention when it becomes incapacitating or severe (Kumar *et al,* 2019). The same problem affects precautions intended to lower the frequency of musculoskeletal injuries or other dangerous job exposures (Mrunalini and Snehalata, 2010). Most people associate drudgery with physical and mental exhaustion agony, monotony and hardship experienced by human beings (Momin, 2009). However, women report more fatigue than men (Pugliesi, 1999; Macintyre *et al,* 1996). Thus, the situation of Indian farm women is concerning in this sense since they put in long hours without breaks, handle several household responsibilities, and are still limited by unemployment, malnourishment, and illiteracy (Samanta, 1995). The study was designed to full fill the objective to applicability of drudgery reducing technologies and implements.

MATERIALS AND METHODS

Subsequent to the PRA survey, the KVK carried assessment in response to the requirement, evaluating the drudgery in terms of heart rate, energy expenditure, output, time spent, and muscular-skeletal issues to evaluate the

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applicability of drudgery reducing technologies and implements for farmwomen. A large number of tribal farmers of Kurai block of Seoni residing adjoining to forest area use Mahua (*Madhulika longifolia*) in many ways. Out of them the flower and seed collection are important practice to gather additional income for livelihood by farm women's. In the year 2020-23 implements known as manual mahua seed decorticator was procured from Odisha for the study. This implement was used in three villages namely Rampuri, Chikhli and Rajola.

Measurement of heart rate and energy expenditure Heart rate (bpm) and energy expenditure (KJ/min) were recorded by Metamax (Telemetry Metabolic Analyzer), which directly measures the above mentioned parameters. Though well-structured questionnaire, focused group discussion and personal interview were scheduled and data (Table 1 and 2) were collected before the intervention which could prepare the graph of the socioeconomic indicator of the farm families and 80 farm women were selected for training. After that training were conducted and out of them final 15 farmwomen, 5 from each village were selected for assessment. In the study, various types of primary as well secondary data have been analyzed. The main objective was to assess the awareness about drudgery reducing tools and implements and preparedness of the community in context to adoptability of mechanical mahua seed decortications to accept the intervention regarding improved tools (Acharya *et al*, 2018) and (Patel *et al,* 2015).

RESULTS AND DISCUSSION

Results of study revealed that women friendly drudgery reducing implement like mahua seed decorticator used to asses that take account of the different needs and capacities of women's bodies, moderate pain in wrist, arm shoulder and feet (Kumar *et al,* 2011). The scientists also focused on enhancing farmwomen's quality of life at work by raising awareness of the need to use these tools and implements through various channels of activities.

Farm women's social and personal characteristics

The data (Table 1) show that the majority (48%) of farmwomen belonged to middle age group, 20 per cent were of young age and 12 per cent were old. Maximum numbers of farmwomen were (57%) primary school education. The nuclear and joint family types were 40% and 60%, respectively.

Economic Variables of Farm Women

Economic variables included mainly three traits that annual family income (INR), type of farmers and type of house. As per data (Table 2) the highest majority (56.25%) of farmwomen had relatively medium level of annual family income. Majority (55%) of the farmwomen family had marginal size of land holding and 11.25 % were medium farmers. A little more than one-third farmwomen had semi pucca house (38.75%) and 35 per cent had completely pucca house (Chaudhary *et al,* 2017).

Technology adoption rate

It was revealed that majority (61.3%) of farmwomen had high level of adoption. Only 25% of respondents had medium level of adoption of drudgery reducing implement (Table 3).

Performance of drudgery reducing manual mahua seed decorticator assessed

The recommended practices (Moderate pain in wrist, arm and shoulder) were superior to farmer's practice (Light pain in fingers, shoulders and feet). The three years' study showed that the average energy expenditure (KJ/min.) was 9.40 (RP as shown in fig. 2) against the 11.11 (FP as per fig. 1) and per cent reduction in energy was observed to be 15.33. It was also found that average output (Kg/hr) of final product (decorticated seed/split) was 11.03% from decorticator and the least output average *viz.,* 2.75 percent from farmers' practice. Drudgery was minimized, which boosted production, decreased occupational health risks, and increased efficiency. These improvements enhanced family work productivity, food security and livelihood

Table 1. The personal and social profile of respondents (N=80).

Sr. No.	Personal and Social Variable	Frequency	Percent
A	Age (Yr)		
1.	Young (18 -30)	20.00	25.00
2.	Middle (30 -50)	48.00	60.00
3.	Old (Above 50)	12.00	15.00
B	Education		
4.	Illiterate	5.00	6.25
5.	Primary school education (up to 8 th standard)	57.00	71.25
6.	Secondary school education (9 th to10 th standard)	18.00	22.50
C	Type of Family		
7.	Joint family	48.00	60.00
8.	Nuclear family	32.00	40.00
D	Size of family		
9.	Small (up to 5 members)	41.00	51.25
10.	Medium (6 to 9 members)	31.00	38.75
11.	Large (Above 9 members)	8.00	10.00
E	Cast		
12.	General	3.00	3.75
13.	OBC	11.00	13.75
14.	SC / ST	66.00	82.50

Table 2. Distribution of respondents according to economic variables (N=80).

Sr. No.	Economic Variable	Frequency	Percent
A	Annual family income (INR)		
1.	Low (< 1,00,000)	30.00	37.50
2.	Medium (1,00,000 to 3,00,000)	45.00	56.25
3.	High (> 3,00,000)	5.00	6.25
B	Type of farmers		
4.	Marginal farmer (<1.00 ha)	44.00	55.00
5.	Small farmer (=1.00 to 2 ha)	27.00	33.75
6	Medium farmer (> 2.00 ha)	9.00	11.25
C	Type of house		
7.	*Kuchcha*	21.00	26.25
8.	Semi *Pucca*	31.00	38.75
9.	*Pucca*	28.00	35.00

Table 3. Adoption level of drudgery reducing tools and implement (N=80).

Sr.No.	Adoption level	Frequency	Percent
1	Low (< 50)	11.0	13.8
2	Medium (50 to 65)	20.0	25.0
3	High (> 65)	49.0	61.3
	Total	**80.0**	**100.0**

Table 4. Drudgery Reduction in mahua seed decortication (through hand operated machine).

Sr. No.	Year	Technology/implement assessed	Musculoskeletal problem		Average energy expenditure (KJ/min.)			Average output (Kg/hr)		
			FP	RP	FP	RP	Per cent reduction	FP	RP	% increased
1	2021	Mahua seed decorticator	Light pain in fingers, shoulders and feet	Moderate pain in wrist, arm and shoulder	10.65	9.18	13.80	2.50	10.88	335.20
2	2022				11.41	9.66	15.34	2.87	10.95	281.53
3	2023				11.27	9.37	16.86	2.88	11.25	290.63
Average of three years					11.11	9.40	15.33	2.75	11.03	302.45

Fig 1. Farmers' practice

Fig 2. Recommended practice

possibilities (Acharya *et al,* 2018). The findings also indicated that SC/ST (82.50%) farm women who were involved in mahua seed decortication (Chaudhary et al, 2017).

CONCLUSION

Drudgery of farmwomen is a reality although they do not express it and suffers silently. It was concluded that the high output will be helpful to get maximum income with low burden of work and risk related to manual decortication or injuries as well. As the Krishi Vigyan Kendra has set a long vision to strengthen the inherent power of farm women it will motivate the farm women to take initiative roles for adopt improved technologies.

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Effect of Malic Acid Supplementation on Haemato-Biochemical and Reproductive Parameters of Lactating Kankrej Cows

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ABSTRACT

This study was conducted to evaluate the effect of supplementation of malic acid on haemato-biochemical and reproductive parameters of lactating Kankrej cows. Twenty-four lactating Kankrej cows (15 days post- partum) were assigned randomly into four groups (6 animals in each) and on the basis of their standard lactation milk yield of previous lactation and parity of animals. The four treatment groups were as T_1: Basal diet, in T_2, T_3 and T_4 groups basal diet was supplemented with 30, 60 and 90 g/d of malic acid, respectively. The duration of experiment was of 120 days. The blood samples were collected at the end (on 120th day) of experimental feeding. The mean concentrations of haemoglobin, haematocrit, red and white blood cells count were comparable ($P>0.05$) among the treatment groups. The serum concentrations of total protein, albumin, globulin, urea, creatinine, cholesterol, ALT, and AST were not influenced ($P>0.05$) due to supplementation of malic acid. There was an increase ($P<0.05$) in serum glucose concentration (mg/dL) in T_2 (78.17), T_3 (79.83) and T_4 (78.67) groups as compared to the T_1 (73.67) group. In reproductive parameters, the first heat after calving, services period and number of services per conception in malic acid supplemented groups showed improvement than the control. It may be concluded that malic acid supplementation in lactating Kankrej cows had beneficial effect on reproductive performance Moreover, dietary malic acid did not have any adverse effect on haemato-biochemical parameters of Kankrej cows.

Key Words: Blood metabolites, Haematology, Kankrej, Malic acid, Reproduction.

INTRODUCTION

India has one of the twelve mega biodiversity countries in the world, is home to a large and diverse array of cattle genetic resources, with 193.46 million cattle and 53 registered native cattle breeds (Srivastava *et al,* 2019; BAHS. 2023). Among these, the Kankrej breed from Gujarat is notable for its distinct body size and characteristic "savai chal" gait (Madhavatar *et al,* 2023). During the early lactation (14 to 100 d after calving), cows achieve peak milk production, undergo weight loss, reduced feed intake and alterations in haemato-biochemical parameters. Assessment of haemato-biochemical profile is very important for monitoring the metabolism and health status of dairy animals during the lactation period (Patel *et al,* 2022; Modi *et al,* 2023). The values of haemato-biochemical parameters of cows are influenced by several factors such as breed, age, physiological status, sex, nutrition or season (Antunović *et al,* 2017). Blood biochemical parameters indicate possible metabolic disorders and disorders caused by inadequate nutrition (Rios *et al,* 2006). Dietary supplementation of organic acid in lactating cows may have beneficial influence on their metabolism and reproduction.

Organic acids act as acidifiers by favourably manipulating intestinal microbial populations and improving the immune response. Among these, malic acid is the most widely used organic acid in ruminant animals. Its molecular

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formula is $C_4H_6O_5$, and it has two stereoisomeric forms (L- and D-enantiomers), though only the L-isomer occurs naturally. In the citric acid cycle, malic acid, in the form of malate, plays an important role in energy production (Pearlin *et al,* 2020). It also alters the microbial fermentative pattern by enhancing the numbers and growth of *Selenomonas ruminantium* bacteria (Bugra *et al,* 2020), stimulating the utilization of lactate and converting it to propionic acid, which is essential for promoting energy availability in the form of glucose. It also beneficially affects reproductive parameters. Wang *et al*. (2009) supplemented malic acid to Holstein dairy cows, resulting in a substantial increase ($P<0.01$) in serum glucose levels. Similarly, El-Zaiat *et al* (2019) and Gouda *et al*. (2022) observed same findings. In contrast, Carrasco *et al* (2012) reported no effect found on glucose due to malic acid feeding in cows. For reproductive performance El-Nour *et al* (2009) reported no any significant effect found on reproductive parameter. There is scarce literature available on the effects of feeding malic acid on the haemato-biochemical and reproductive parameters of Indigenous cows. Therefore, the present study was planned to evaluate the effects of malic acid supplementation on the haemato-biochemical and reproductive parameters of lactacting Kankrej cows.

MATERIALS AND METHODS

Twenty-four lactating Kankrej cows (14 days post-partum) were assigned randomly into four groups (6 cows per group) on the basis of body weight and standard milk yield of previous lactation. All the selected animals were apparently healthy and free from diseases. The four experimental groups were as T_1: Basal diet, T_2: Basal diet + 30 g/animal/day of malic acid supplementation; T_3: Basal diet + 60 g/animal/day of malic acid supplementation and T_4: Basal diet + 90 g/animal/day of malic acid supplementation. The duration of experiment was of 120 days. The experimental animals were fed as per ICAR (2013) to the nutrient requirements. The use of animals and the experimental procedure were approved by institutional Animal Ethics Committee (approval No. VETCOLL/IAEC/2023/21/PROTOCOL-1).

The blood samples were collected at the end (on 120th day) of experimental feeding. The blood samples from external jugular vein were collected from each experimental animal in two sterilized vials one with anti-coagulant for hematological parameters and other without anti-coagulant for analysis of blood biochemical parameters. The fresh blood samples the one with anti-coagulantwere analysed for haematological parameters *viz.,* haemoglobin, haematocrit, erythrocytes, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), leucocytes, neutrophils, lymphocytes and monocytes using automatic analyser. The serum was harvested from the blood without anti-coagulant. The serum samples were analysed for glucose, total proteins, albumin, urea, creatinine, triglycerides, cholesterol, alanine amino-transferase (ALT) and aspartate aminotransferase (AST) concentrations using commercial diagnostic kits.

Reproductive parameters, such as the first heat after calving, service period and the number of services per conception, were recorded during the experimental period.

All the experimental data obtained were statistically analyzed using SPSS v.16.0 (SPSS Inc., Chicago IL) as per the standard statistical method (Snedecor and Cochran, 1994). Significant differences between means of treatments were assessed by Duncun's test, and differences between treatments were declared significant at $P<0.05$.

RESULTS AND DISCUSSION

The effect of supplementation of malic acid on haematological parameters of lactating Kankrej cows is given in Table 1. The mean haemoglobin (Hb) and haematocrit values were comparable ($P>0.05$) among the treatment groups. The obtained values of Hb and haematocrit were within normal range of 8-15 g/dL and 26-37% (Kaneko *et al,* 2008). There was no effect ($P>0.05$) on red blood cells count (erythrocytes, MCV, MCH and MCHC) due to dietary addition of malic

Table 1. Effect of supplementation of malic acid on haematological parameters of lactating Kankrej cows (n=24).

Attribute	Groups[¥]				SEM	P value
	T_1	T_2	T_3	T_4		
Haemoglobin (g/dL)	11.20	10.28	9.93	11.02	0.245	0.216
Haematocrit (%)	27.08	28.99	29.78	29.50	0.549	0.312
Erythrocytes (10^6/µL)	5.89	5.18	5.47	5.50	0.137	0.347
Leukocytes (10^3/ µL)	9.75	9.92	10.40	9.63	0.455	0.946
MCV (fL)	49.23	49.62	49.00	48.30	0.833	0.961
MCH (pg)	18.73	17.72	17.47	19.07	0.601	0.768
MCHC (g/dL)	36.62	35.02	36.62	37.68	0.760	0.694
Granulocyte (10^3/ µL)	3.78	3.85	3.72	3.38	0.207	0.877
Lymphocytes (10^3/ µL)	3.43	3.82	3.70	3.47	0.227	0.930
Monocytes (10^3/ µL)	0.65	0.60	0.68	0.65	0.045	0.940

[¥]*T_1: Basal diet; T_2: Basal diet + 30 g/d of malic acid; T_3: Basal diet + 60 g/d of malic acid; T_4: Basal diet + 90 g/d of malic acid*

MCV: meancorpuscular volume, MCH:mean corpuscular haemoglobin, MCHC: mean corpuscular haemoglobin concentration

acid at different supplemental doses in lactating Kankrej cows. Rate variables for red blood cells observed in this study agreed with the reference described by Jones and Allison (2007). Therefore, no inflammatory process was reported in the lactating cows during the experimental period due to malic acid supplementation. The red blood cells series reflect the animals' health and nutrition (Jones and Allison, 2007). The white blood cell counts (leucocytes, neutrophils, lymphocytes, monocytes and eosinophils) were not influenced (P>0.05) by the dietary addition of malic acid in lactating Kankrej cows. Results for all dietary treatments groups agreed with reference for cattle (Jones and Allison, 2007). The haematological parameters reported in the present study was also in line with the findings of previous studies conducted in lactating Kankrej cows (Ahuja *et al,* 2022; Pawar *et al,* 2023). The results obtained for the counts of red and white blood cells in this trial clearly showed that supplementation of malic acid at the dose rate 30, 60 and 90 g/d were safe for use in dairy cattle without compromising the health and welfare of animals.

The effect of supplementation of malic acid on blood biochemical parameters of lactating Kankrej cows is presented in Table 2. The serum concentrations of total protein (7.73, 7.47, 8.20 and 7.47 g/dL), albumin (3.80, 3.48, 3.67 and 3.62 g/dL), globulin (3.93, 3.98, 4.53 and 3.85 g/dL), urea (31.64, 34.62, 33.71 and 35.74 mg/dL), creatinine (1.14, 1.09, 1.10 and 1.08 mg/dL), triglycerides (17.83, 19.78, 17.78 and 18.23 mg /dL), cholesterol (288.93, 307.58, 329.97 and 306.60 mg /dL), ALT (47.73, 46.37, 49.93 and 39.32 U/L) and AST (70.73, 66.90, 73.73 and 71.87 U/L) were not affected (P>0.05) by the dietary supplementation of malic acid in Kankrej cows. No effect on serum concentrations of total protein, albumin and globulin in lactating Kankrej cows suggesting that feeding of malic acid unaltered protein catabolism in the muscles of cows.

Table 2. Effect of supplementation of malic acid on blood biochemical parameters of lactating Kankrej cows (n=24)

Attributes	Groups ¥				SEM	P value
	T_1	T_2	T_3	T_4		
Glucose (mg/dL)	73.67 [a]	78.17 [ab]	79.83 [b]	78.67 [b]	0.764	0.013
Total Proteins (g/dL)	7.73	7.47	8.20	7.47	0.186	0.485
Albumin (g/dL)	3.80	3.48	3.67	3.62	0.088	0.675
Globulin (g/dL)	3.93	3.98	4.53	3.85	0.130	0.238
Urea (mg/dL)	31.64	34.62	33.71	35.74	1.657	0.862
Creatinine (mg/dL)	1.14	1.09	1.10	1.08	0.022	0.748
Triglycerides (mg/dL)	17.83	19.78	17.78	18.23	1.058	0.912
Cholesterol (mg/dL)	288.93	307.58	329.97	306.60	7.480	0.297
SGPT (U/L)	47.73	46.37	49.93	39.32	2.645	0.548
SGOT (U/L)	*70.73*	*66.90*	*73.73*	*71.87*	*2.195*	*0.756*

¥T_1: Basal diet; T_2: Basal diet + 30 g/d of malic acid; T_3: Basal diet + 60 g/d of malic acid; T_4: Basal diet + 90 g/d of malic acid

[ab]Means with different superscriptsin a row differed significantly (P<0.05).
ALT: alanine aminotransferase; AST: aspartate aminotransferase

Moreover, lack of effect on liver enzymes ALT and AST due to feeding malic acid in lactating Kankrej cows indicates that supplementation did not have any adverse effect on liver function. The serum urea levels in ruminants are known to be dependent on the amount of ammonia nitrogen concentration in rumen, which is formed from deamination of proteins. No change in serum urea concentration was indication of no effect on deamination and nitrogen concentrations in rumen as well as efficient use of nitrogen (Pawar *et al,* 2019). The blood biochemical parameters reported in the present study was also in line with the findings of previous studies conducted in lactating Kankrej cows (Joshi *et al,* 2021; Pawar *et al,* 2021).

The serum glucose concentration was 73.67, 78.17, 79.83 and 78.67 mg/dL in T_1, T_2, T_3 and T_4 groups, respectively. There was a significant increase in serum glucose level in the lactating Kankrej cows supplemented with different doses of malic acid in diet. The increase in serum glucose level in malic acid supplemented groups might be due to higher digestibility of organic matter and facilitation of increased rumen propionate absorption through ruminal papillae. This absorbed propionate is then transported to the liver, where it undergoes active conversion to glucose through gluconeogenesis. Consequently, this process results in elevated glucose synthesis (El-Zaiat *et al,* 2019). El-Nour *et al* (2009) and Wang *et al* (2009) reported that serum glucose levels were significantly increased in the malic acid supplemented group than in control group. Similarly, Gouda *et al* (2022) also reported increased glucose concentration in goats fed malic acid.

The effect of supplementation of malic acid on reproductive parameters of lactating Kankrej cows is presented in Table 3. The first heat post-calving numerically occurred 2, 5 and 4 days

Table 3. Effect of supplementation of malic acid on reproductive parameters of lactating Kankrej cows (n=24)

Attributes	Groups				SEM	P value
	T_1	T_2	T_3	T_4		
First heat after calving (days)	102.67	100.50	97.33	98.17	1.492	0.611
Service period (days)	163.17	161.67	159.17	160.17	1.148	0.656
Number of services per conception	2.00	1.83	1.67	1.67	0.147	0.849

¥T_1: Basal diet; T_2: Basal diet + 30 g/d of malic acid; T_3: Basal diet + 60 g/d of malic acid; T_4: Basal diet + 90 g/d of malic acid

earlier in T_2, T_3 and T_4 groups, respectively than the control. Similarly, the service period was 2, 4 and 3 days earlier in T_2, T_3 and T_4 groups, respectively as compared to the control. Malate supplement increases in ruminal propionate. It improves ovarian sensitivity, achieved through the release of the GnRH hormone by the pituitary gland.

Moreover, the impact of elevated glucose levels extends to the regulation of insulin and its receptors, playing a pivotal role in the synthesis and release of hormones such as LH (luteinizing hormone), progesterone and estradiol. These hormonal changes influence reproductive performance (Abou-Seri and Mahmoud, 2022). In agreement with the results of present study, Abou-Seri and Mahmoud (2022) reported significant ($P<0.05$) decrease in time duration between calving to the first oestrus and calving to conception. Additionally, there was a reduction in the number of services per conception. In contrast, El-Nour *et al* (2009) reported no change in reproductive performance of buffaloes supplemented with malic acid.

CONCLUSION

Based on the results, it may be concluded that malic acid supplementation in the diet of Kankrej cows during lactation improved serum glucose and reproduction performance. Moreover, there was no adverse effect of malic acid supplementation on haemato-biochemical parameters of lactating Kankrej cows.

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Effect of Pinching, GA_3 and NAA on Growth and Flowering on Fenugreek (*Trigonella foenum-graecum* L.) cv. Pant Ragini

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ABSTRACT

An experiment entitled effect of pinching, GA_3 and NAA on growth and flowering of fenugreek (*Trigonella foenum-graecum* L.) *cv*. Pant Ragini under Garhwal Hills was carried out during 2020-21 at Department of Horticulture, H.N.B. Garhwal University, Srinagar (Garhwal), Uttarakhand with 18 treatments combination, comprising two seed soaking S_0 (control) and S_1 (GA_3 50 ppm) with three stages of spraying of GA_3 and NAA G_0(Control), G_1(GA_3 50 ppm) and G_2(NAA 50 ppm) and three stages of pinching P_0(Control), P_1(Single pinching at 45 DAS) and P_2(Double pinching at 60 DAS). These treatments were replicated thrice in factorial randomized block design (FRBD) and analyzed. Treatment with seed soaking S_0 (GA_3 50 ppm) and spraying of plant growth regulators G_1 (GA_3 50 ppm) recorded minimum days taken to first germination, significant maximum plant height, number of primary branches and days to taken to first and 50 % flowering. Significant maximum plant height and days taken to first and 50 % flower inhiation were recorded with treatment P_0 (control). Double pinching at 60 DAS (P_2) recorded significant maximum number of branches/plant and days taken to first germination.

Key Words: Fenugreek, Growth Regulators, Flowering and Pinching.

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) is an annual spice herb belonging to the Papilionaceae subfamily of the Leguminaceae family. It is also known as Methi. Methi is a self-pollinated legume and diploid with a chromosome number of 2n = 16. Fenugreek holds enormous importance in human beings' lives as food and medicine are valued not only as a spice but also as a potential source of diosgenin. It is cultivated globally and thrives in warm temperate and tropical areas, demonstrating adaptability to semi-arid conditions and tolerance to mild salinity. India is the world largest producer, consumer and exporter of spices so it is known as the Land of Spices. Fenugreek plays a crucial role in Indian agriculture, ranking as the third most important seed spice after coriander and cumin. In India, fenugreek grown on approximately 156 thousand ha, with a production of 241 thousand Mt and a productivity of 1.54 Mt/ha. (Anonymous, 2021).

Pinching is a technique used to manipulate canopy structure, typically accomplished by removing the growing tip. This action redirects the movement of auxin from the apical part of the plant to lower regions, which stimulates the development of lateral branches. This in turn increases the potential podding points on the plant, thereby enhancing the number of fruits produced per plant. Effective management of cutting or pinching practices significantly impacts the growth and yield attributes in fenugreek, Krishnaveni *et al* (2014). Plant growth substances play a crucial role in various physiological processes that regulate the growth and development of crops. Changes in endogenous hormone levels, influenced by both biotic and abiotic stress factors, have a significant impact on

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crop growth. GA_3 plays a pivotal role in plant growth regulators, known for enhancing the photosynthesis process and inhibiting the action of the protein DELLA, which restricts cell proliferation and expansion. Additionally, foliar application of GA_3 and NAA has emerged as a pivotal avenue for achieving remarkable enhancements in physiological efficiency, particularly the photosynthetic capacity of plants. The application of these substances improves germination, longitudinal growth, increases the number of branches, encourages early flower initiation, enhances fruit set and ultimately leads to higher yields. Humidi *et al* (2005), Ghodrat and Rousta (2012), Nelson and Steber (2016) and Singh *et al* (2017).

MATERIALS AND METHODS

This field experiment was conducted at the Horticultural Research Centre, Chauras Campus, Department of Horticulture, H.N.B. Garhwal University, Srinagar (Garhwal), Uttarakhand during the *rabi* season of 2020-21. The experiment was laid out in a Factorial Randomized Block Design with three replications. The experiment consisted of two seed soaking levels *viz.,* control (S_0) and GA_3 50 ppm(S_1), spraying of PGRs with three levels *viz.,* control (G_0), GA_3 50 ppm(G_1) and NAA 50 ppm(G_2) and three pinching levels *viz.,* no pinching (P_0), single pinching at 45 days (P_1) and double pinching at 60 days after sowing (P_2). The seeds were sown manually in rows at a spacing of 20 cm and plants to plants 10 cm. Before soaking, the seeds of fenugreek were first cleaned to remove the broken and other foreign materials and then soaked in GA_3 50 ppm for 8-10 hr. at room temperature. Then the seeds were dried at room temperature. The plant growth regulators *i.e.,* GA_3 50 ppm and NAA 50 ppm were spraying at 30 and 60 days after sowing with the help of hand sprayer. The pinching was done by removing the apical buds manually without causing damage to the plant parts. The data were recorded on growth and flowering parameters *viz*., days taken to first germination, plant height (30 DAS, 60 DAS and at harvest), number of branches per plant (30 DAS, and at harvest), days taken to first flowering and days taken to 50 % flowering. The data were analysed according to the procedure of analysis of FRBD with three replications suggested by Panse and Sukhatme (1985). The significance of the treatments was tested through F test at 5 per cent level of significance. The critical difference CD was calculated to assess the significance of difference among the different treatments.

RESULTS AND DISCUSSION

Effect of seed soaking

The result of the effect of pinching, GA_3 and NAA revealed that treatments significantly affected all characters. Data (Table 1) from seed soaking treatments showed that treatment S_1 (GA_3 50 ppm) had the minimum days taken to first germination (4.81 days), whereas treatment S_0 (control) had the maximum days taken to first germination (8.80 days). Significantly maximum plant height at 30, 60 DAS and at harvest (5.34, 18.00 and 98.28 cm) and number of primary branches at 30 DAS and at harvest (2.31 and 10.46) were observed in treatment S_1 (GA_3 50 ppm), whereas minimum plant height at 30, 60 DAS and at harvest (5.16, 17.47 and 83.50 cm) and number of primary branches at 30 DAS and at harvest (1.85 and 8.12) were observed in treatment S_0 (control). The data (Table 2) revealed that treatments significantly minimum days taken to first flowering (75.24) and days taken to 50 % flowering (81.81) were observed in treatment S_1 (GA_3 50 ppm), whereas maximum days taken to first and 50% flowering (87.71 and 89.43 days) were observed in treatment S_0(control).

The treated seeds were evaluated for their improvement in growth and early flowering parameters, using untreated seeds as a control. The increase in field emergence may be attributed to higher metabolic activity before sowing, induced by pre-sowing seed treatment, which prepares the seeds for immediate germination upon planting. Gibberellic acid facilitates seed germination by breaking dormancy, stimulating enzyme production and enhancing cell elongation and division. It increases cell wall extensibility, which is a critical factor in seed germination. Renowned for its growth-promoting properties, gibberellic acid significantly enhances the germination process. The results obtained align with previous research conducted by various scientists on various crops, indicating similar findings by Khan

and Chaudhry (2006), Sundareswaran (2011), Datta (2012), Tania *et al* (2015) and Tavelu *et al* (2018).

Effect of plant growth regulators

The data (Table 1) revealed that treatments significantly affected to all characters. Regarding spraying of GA_3 and NAA treatments it was found that, treatment G_1 (GA_3 50 ppm) had the minimum (4.81) days taken to first germination, whereas treatment G_0 (control) had the maximum days taken to first germination (7.84 d). Significantly maximum plant height at 30, 60 DAS and at harvest (5.57, 18.30 and 95.28 cm) and number of primary branches at 30 DAS and at harvest (2.31 and 10.46) were observed in treatment G_1 (GA_3 50 ppm), whereas minimum plant height at 30, 60 DAS and at harvest (4.91, 17.03 and 84.07 cm) and number of primary branches at 30 DAS and at harvest (1.71 and 7.86) were observed in treatment G_0 (control). The data (Table 2) revealed that treatments significantly affected to all characters. Minimum days taken to first flowering (75.61) and days taken to 50 % flowering (81.17) were observed in treatment G_1 (GA_3 50 ppm), whereas maximum days taken to first and 50 % flowering (89.56 and 89.61) were observed in treatment G_0 (control).

The growth and flowering parameters were comparatively better with treatment G_1 (GA_3 50 ppm) compared to the other treatments. This increase in growth attributes germination of seed and plant height could be due to the typical action of gibberellins. Gibberellic acid has been found to increase cell wall activity thus, creating water diffusion pressure deficit which results in water uptake, thereby causing cell elongation (Bisht *et al,* 2018). GA_3 increases the primary and secondary branches by inhibiting auxins responsible for apical dominance. It stimulates lateral growth by redirecting metabolites to auxiliary buds. GA_3 improves flower development through enhanced cell division, enlargement and increased photosynthate production. Similar result was reported by Vasudevan *et al* (2008), Bairva *et al* (2012), Krishnaveni *et al* (2014) and Reddy and Hore (2020).

Effect of pinching

The data (Table1) revealed that treatments significantly affected to all characters. Data from pinching treatments showed that treatment P_1 (Single pinching at 45 DAS) had the minimum days taken to first germination (5.67), whereas treatment P_0 (control) had the maximum days taken to first germination (8.09). Maximum plant height at 30 DAS, 60 DAS and at harvest (6.47, 19.40 and 95.56 cm) were observed in treatment P_0 (control), whereas minimum plant height at 30 DAS, 60 DAS and at harvest (4.57, 16.43 and 83.53 cm) were observed in treatment P_2 (Double pinching at 60 DAS). Maximum number of primary branches at 30 DAS and at harvest (2.24 and 10.60), whereas minimum number of primary branches at 30 DAS and at harvest (1.89 and 7.74) was observed in treatment P_0 (control). The data (Table 2) minimum days taken to first flowering (78.63) and days taken to 50 % flowering (81.00) were observed in treatment P_0 (control), whereas maximum days taken to first flowering (85.97) and days taken to 50 % flowering (90.86) were P_2 (double pinching at 60 DAS).

The effect of pinching on growth and flowering parameters indicated that the plant height and flowering inhiation was considerably decreased with the increased number of pinching treatments, mainly due to the removal of apical meristematic tissue, while plants without pinching continued their vegetative growth using stored food material. Similar results were reported by Vasudevan *et al* (2008). Maximum number of branches were observed with treatment P_2 (double pinching at 60 DAS). This might be due to the fact that the double pinching provided sufficient time for the regeneration of vegetative parts and enhanced the development of lateral productive branches as well as a flowering. These changes influenced the plant parts by maintaining the source-sink relationship of nutrients. This could be attributed to the pinched plants producing a greater number of branches per plant. Similar results were reported by Vasudevan *et al* (2008), Krishnaveni *et al* (2014), Lakshmi *et al* (2016), Saini and Baloda (2016,) Sowmya *et al* (2017) and Kauser *et al* (2018) in fenugreek.

Table 1. Effect of pinching, GA_3 and NAA on days taken to first germination, plant height (cm) and number of primary branches per plant of fenugreek cv. Pant Ragini.

Treatment	Days taken to first germination	Plant height (cm)			Number of primary branches	
		30 DAS	60 DAS	At harvest	30 DAS	At harvest
Seed Soaking						
S_0 (Control)	8.80	5.16	17.47	83.50	1.85	8.12
S_1 (GA_3 50 ppm)	4.81	5.34	18.00	98.28	2.31	10.46
SEm±	0.06	0.04	0.14	0.67	0.02	0.07
CD at 0.05%	0.18	0.12	0.39	1.92	0.04	0.19
Spraying of PGRs						
G_0 (Control)	7.84	4.91	17.03	84.07	1.71	7.86
G_1 (GA_3 50 ppm)	4.81	5.57	18.30	95.28	2.31	10.46
G_2 (NAA 50 ppm)	6.12	5.34	17.90	93.32	2.23	9.52
SEm±	0.08	0.05	0.17	0.82	0.02	0.08
CD at 0.05%	0.22	0.15	0.48	2.35	0.05	0.24
Pinching						
P_0 (Control)	8.09	6.47	19.40	95.56	1.89	7.74
P_1 (Single pinching at 45 DAS)	6.67	4.71	17.37	93.57	2.11	9.53
P_2 (Double pinching at 60 DAS)	5.67	4.57	16.43	83.53	2.24	10.60
SEm±	0.08	0.05	0.17	0.82	0.02	0.08
CD at 0.05%	0.22	0.15	0.48	2.35	0.05	0.24

CONCLUSION

The study revealed that the application of pinching, GA_3 and NAA significantly influenced the growth and encourage early flowering inhiation of fenugreek. The application of seed soaking and foliar application of GA_3 at 50 ppm, along with double pinching treatment might be attributed to their function in stimulating metabolic activities and hormonal regulation.

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Table 2. Effect of pinching, GA_3 and NAA on days taken to first flowering and days taken to 50% flowering of fenugreek cv. Pant Ragini.

Treatment	Days taken to first flowering	Days taken to 50 % flowering
Seed Soaking		
S_0 (Control)	87.71	89.43
S_1 (GA_3 50 ppm)	75.24	81.81
SEm±	0.63	0.65
CD at 0.05%	1.79	1.86
Spraying of PGRs		
G_0 (Control)	89.56	89.61
G_1 (GA_3 50 ppm)	75.61	81.17
G_2 (NAA 50 ppm)	79.28	86.08
SEm±	0.77	0.80
CD at 0.05%	2.20	2.28
Pinching		
P_0 (Control)	78.63	81.00
P_1 (Single pinching at 45 DAS)	79.83	85.00
P_2 (Double pinching at 60 DAS)	85.97	90.86
SEm±	0.77	0.80
CD at 0.05%	2.20	2.28

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Effect of Shoot Pruning and Growth Regulators on Yield, Quality and Marketability of Kiwifruit (*Actinidia deliciosa*) Cv. Allison

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ABSTRACT

An study was conducted by KVK, Bageshwar during 2021 at Sama village of Kapkot block of district Bageshwar to find out the suitability and efficacy of different crop regulating options of kiwifruit in farmer's perspective. The prime purpose of the study was to increase the yield of A grade fruits to maximize the returns. Four treatments (T1- No pinching and no use of plant growth regulators, T2- Pinching 20 percent growth at petal fall that continued till harvest at one month interval, T3- T2 + Fruit dipping at 20 days after full bloom in 50 ppm GA3 solution for 5 second,T4- T2 + Fruit dipping at 20 Days After Full Bloom in 50 ppm 2,4 D solution for 5 second) were applied for the assessment of various technologies. Pinching of 20 percent shoot growth at petal fall stage that continued till harvest at one month interval was found most appropriate. This practice gave 24 kg A grade fruits (>70 g) per vine, 17 kg B grade fruits (50-70 g) per vine and 7 kg C grade fruits (<50 g) per vine, while the farmer's practice (no pinching) resulted in 6 kg A grade fruits (>70 g) per vine, 13 kg B grade fruits (50-70 g) per vine and 21 kg C grade fruits (<50 g) per vine. The total soluble solid content (TSS°B) of fruits from pinching treatment was also higher (16.10 °B) than the fruits from no pinching vines (14.95 °B). Use of GA 3 (50 ppm) and 2,4 D (20 ppm) as fruit dip method at 20 days after full bloom (20 DAFB) could not further increase the grade A and B fruit yield significantly over pinching alone. Thus, Pinching of 20 percent shoot growth at petal fall stage that continued till harvest at one month interval is recommended for obtaining maximum quantity of "A"grade fruits that will successfully compete in market for better price.

Key Words: Days after full bloom (DAFB), Economic analysis, Fruit grading, Marketability and Shoot pruning.

INTRODUCTION

Kiwifruit (*Actinidia deliciosa*)is a dioecious vine having separate male and female plants with deciduous nature that require 700-800 chilling hours during dormancy for proper flowering and fruiting.Its fruits are exceptionally high in vitamin C and contain an array of other nutrients, notably nutritionally relevant levels of dietary fiber, potassium, vitamin E and folate, as well as various bioactive components, including a wide range of antioxidants, phytonutrients and enzymes, that act to provide functional and metabolic benefits**.** The enzyme actinidain present in kiwifruit helps in protein digestion also (Richardson *et al*, 2018). These nutritional benefits are making the kiwifruit a prime choice for the consumers. Its precocious bearing character, hardy nature, comparatively longer shelf life is making the kiwifruit a favorable fruit crop for the hill farmers. Even though, a recent introduction among the fruit crops, kiwifruit has occupied an area of 5000 ha with 16000 MT production (Anonymous. 2023) in India. But the major challenge of its successful marketing is fruit quality. Fruit size and taste are the two major characteristics that largely decide the fruit quality that eventually influences the fetching price. Chandel and Devi, 2010 also emphasized that profitable kiwifruit production depends upon the yield of good size fruits. Kiwifruits are graded on the basis of fruit weight. Fruits having > 70 g weight comes under A grade, while B grade fruits range from 50 g to 70 g and fruits below 50 g

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Glimpses of the experiment

weight are C grade fruits. A grade fruits are having bright marketing opportunities and they fetch highest prices, while B and C grade fruits grab low price and generally sold in local market and used for processing also.

The size of fruit depends on the number and size of cells and this is influenced by hormonal signals that originate in the developing seeds (Phillips, 2004).Manipulating fruit growth using both natural and synthetic exogenous plant growth regulators has been studied in several species by Petri *et al* (2001), Jindal *et al* (2003), Banyal *et al* (2013) and Thakur *et al*(2020).In addition to the role of plant growth regulators, competition between vegetative growth and fruiting greatly influences the fruit size and quality in kiwifruit (Rana *et al*, 2011).

Therefore, it is necessary to access the best intervention in the form of plant growth regulation in farmer's perspective that produces more proportion of A grade fruits with good blend of TSS and acidity for realizing the actual monetary benefits.

MATERIALS AND METHODS

The present study was conducted during 2021 at Sama village of Kapkot block of district Bageshwar situated at 29° 58' 54" N and 80° 01' 28" E and 1720 m amsl to find out the suitability and efficacy of different crop regulating options of kiwifruit in farmer's perspective. Ten years old kiwifruit plants of cv. Allision having almost same trunk girth and vine spread were selected for the experiment. Almost same winter pruning was also done and all the vines under experiment received same manure and fertilizers. There were four treatments *viz*., T 1- No pinching and no use of PGRs (Farmer's practice/ control), T 2- Pinching of 20 percent growth at petal fall that continued till harvest at one month interval, T3- T2 + Application of 50 ppm GA3 solution at 20 DAFB, T4 - T2 + Application of 50 ppm 2,4 D solution at 20 DAFB. The experiment was conducted in Randomized Block Design (RBD) with five replications and there was
one vine per plot.

After harvesting, fruits were graded manually in three grades (A Grade > 70g, B Grade- 50g- 70g and C Grade- < 50 g) by estimating the sorting size corresponding to weight of fruit. Observations were taken for individual yield of A, B and C grade fruits and total yield. The fruits were also tested for chemical quality attributes. The total soluble solid (TSS) content of fruits was measured by a digital refractometer (Extech Instrument, MI 722-01). Before taking sample appraisal, zero was set with distilled water and then for each sample a drop of juice was put at the designated place on the refractometer to get the reading. The acidity of fruits was estimated by titrating the fruit pulp extract with 0.1N NaOH using phenophthaline as indicator by applying the procedure described by Ranganna (1986). 10 g fruit sample was blend with small amount of distil water and filter into 100 ml volumetric flask. Final volume was made upto mark. Take 10 ml aliquot and titrate against 0.1N NaOH by using phenolphthalein as indicator. Mathematically, the titratable acidity was determined by using the following formula and was expressed as percentage malic acid.

$$\text{Titratable acidity (\%)} = \frac{\text{Titre value x 0.1 x 100 x equivalent weight of acid x 100}}{\text{Volume of aliquot taken x Weight of sample x 1000}}$$

TSS - Acid ratio was calculated by dividing the fruit TSS content with its corresponding acidity as mentioned below;

$$\text{T.S.S. - Acid ratio} = \frac{\text{T.S.S. (°Brix)}}{\text{Acidity (\%)}}$$

For calculating the real monetary benefits, cost of cultivation, gross income, net income and B:C were also calculated on real time as per the established methods.

RESULTS AND DISCUSSION

The data showed that the maximum total yield was obtained under T4 (48.5 kg/ Vine) that was statistically at par to T2, while the minimum yield was recorded under T1 (40.0 kg/ Vine). The total yield was directly proportional to the amount of A grade fruits under each treatment. Amount of A grade fruits was maximum and statistically *at par* under T4 (24.5 kh/ Vine) and T2 (24.0 kg/ Vine). Maximum amount of C grade fruit was recorded under T1 (21.0 kg/ Vine). It was also observed that differences between total yield were comparatively less as compared to the amount of A grade fruits among control and other treatments. The increased yield in kiwifruit, in the present investigation, may be due to larger fruit size and weight induced by growth regulating practices. These results clearly indicate that growth regulating interventions are necessarily required for getting the considerable amount of A grade fruits. Pinching of 20 percent growth at petal fall that continued till harvest at one month interval (T2) marked clear difference for getting A grade fruits. Further addition of dipping the fruits in 50 ppm 2,4 D had non significant increase in getting the A grade fruits. Pinching in itself is a growth regulating technique that suppressed the translocation of photosynthates towards vegetative growth and thus fruit growth was promoted. Pramanick *et al (*2015) also observed the benevolent effect of pinching in providing the maximum amount of A grade fruits in kiwifruit. 2, 4 -D acts as growth retardant and further supported the photosynthates translocation towards the developing fruits. However, non-incremental effect of GA3 was observed. These results were in confirmatory to the findings of Famiani *et al* (2007).

The data pertaining to chemical quality attributes (Table 1) depicted that these attributes were also influenced significantly among various treatment. TSS and TSS: Acid remained high and acidity remained low among all the growth regulating treatments as compared to the control. A high TSS: Acid is always preferred by the consumers and fetches high price. Thus, the growth regulating treatments especially pinching of 20 percent growth at petal fall that continued till harvest at one month interval not only imparted the higher amount of A grade fruits, the chemical quality attributes that are responsible for taste were also affected positively. Similar results of pinching and exogenous application of growth

Table 1 Effect of shoot pruning and growth regulators on yield, fruit grade and chemical attributes.

Treatment	Total Yield (kg/ Vine)	A Grade Fruits (kg/ Vine)	B Grade Fruits (kg/ Vine)	C Grade Fruits (kg/ Vine)	TSS (°Brix)	Acidity (%)	TSS: Acid
T1	40.0 ^{a*}	6.0 ^{a*}	13.0 ^{a*}	21.0 ^{c*}	14.95 ^{a*}	0.85 ^{b*}	17.59 ^{a*}
T2	48.0 ^{c}	24.0 ^{bc}	17.0 ^{c}	7.0 ^{b}	16.10 ^{bc}	0.81 ^{a}	19.88 ^{b}
T3	45.0 ^{b}	23.0 ^{b}	16.0 ^{b}	6.0 ^{a}	16.00 ^{b}	0.82 ^{a}	19.51 ^{b}
T4	48.5 ^{c}	24.5 ^{c}	17.5 ^{c}	6.5 ^{ab}	16.25 ^{c}	0.80 ^{a}	20.31 ^{b}
CD	0.89	1.32	0.80	0.75	0.17	0.02	1.58

*Values within columns having common letter are statistically *at par*.

Sorting and grading of the produce

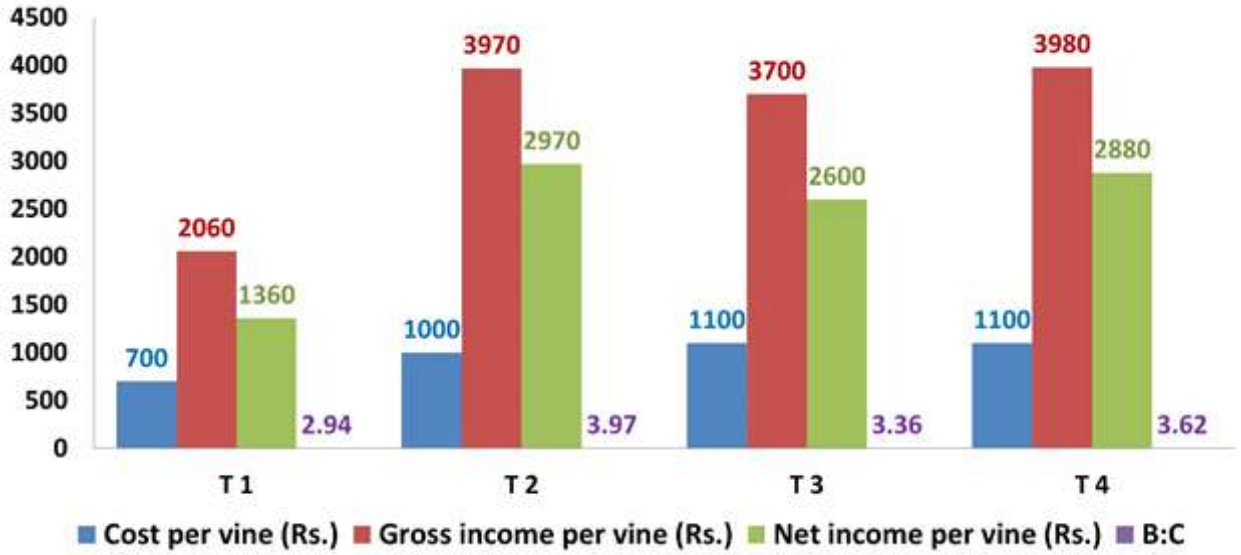

Fig. 1. Economic analysis of the effect of shoot pruning and growth regulators in kiwifruit

regulators on TSS, acidity and TSS: Acid were obtained by **Rana *et al* (2011), Guollo *et al* (2013)** and **Pramanick *et al*(2015)** in kiwifruit.

Economic analysis of this study displayed by Fig. 1 showed that relative amount of A, B and C grade fruits considerable affected the gross return, while varying expenditure on cost of cultivation due to pinching practices and PGR application resulted in different net return and B:C for different treatments. The maximum gross return was calculated for T4 (Rs. 3980 per vine), while the maximum net return (Rs. 2970 per vine) and B:C (3.97) was found for T2. The cost of cultivation was the lowest for T1 (Rs.700 per vine), but its returns were also remained minimum. Such type of economic difference due to variation in A, B and C grade fruits induced by growth regulators was also noticed by Thakur *et al* (2020).

CONCLUSION

The present study clearly established that production of higher amount of A grade fruits is necessary for good marketability and profitability of kiwifruit. Pinching of 20 percent growth at petal fall that continued till harvest at one month interval was found most appropriate for producing A grade fruits and profitability. It was also

observed that preparation and application of PGR formulations are cumbersome operations and difficult to adopt and economically not superior than pinching.

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Effect of Zinc Biofortification in Sweet Corn (*Zea mays* L. *saccharata*)

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ABSTRACT

A field experiment was carried out at the Student's Research Farm, Khalsa College, Amritsar during *Kharif* season of 2022. The experiment consisted of ten treatments *viz,* T_1: Control, T_2: Seed inoculation (*Bacillus subtilis*), T_3: Seed treatment with $ZnSO_4$@0.5%, T_4: Foliar application of $ZnSO_4$@0.5%, T_5:Seed treatment with $ZnSO_4$@0.5% + foliar application of $ZnSO_4$@0.5%, T_6: Seed treatment with $ZnSO_4$@1%, T_7: Foliar application of $ZnSO_4$@1%, T_8: Seed treatment with $ZnSO_4$@1% + foliar application of $ZnSO_4$@1%, T_9: Seed inoculation (*Bacillus subtilis*) + seed treatment with $ZnSO_4$@0.5% + foliar application of $ZnSO_4$@0.5%, T_{10}: Seed inoculation (*Bacillus subtilis*) + seed treatment with $ZnSO_4$@1% + foliar application of $ZnSO_4$@1% with four replications in RBD design.The results revealed that treatment (T_{10}) *i.e.* Seed inoculation (*Bacillus subtilis*)+ seed treatment with $ZnSO_4$@1% + foliar application of $ZnSO_4$@1% recorded higher grain yield (37.6 q/ha), stover yield (70.5 q/ha), harvest index (34.7%), zinc content in grains (40.7 mg/kg), zinc uptake by grains (153.0 g/ha), zinc content in stover (53.1 mg/kg), zinc uptake by stover (374.3 g/ha) than control and treatments where zinc was applied as seed treatment and foliar application. All these parameters were followed by T_9, T_8, T_5, T_7, T_4, T_6, T_3, T_2, T_1.

Key Words: Zinc biofortification, Solubilizer, Sweet corn, Zinc.

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop of the world (Tollennar and Lee, 2002) also called Queen of Cereals because of its high productive potential as compared with any other cereal crop. In Punjab, during 2022, maize occupied an area of 105.2 thousand hectares, with a production of 413.4 thousand tonnes (Anonymous, 2022a). Sweet corn (*Zea mays* L. *saccharata*) is very popular in consumers for its unique taste, pleasant flavour and sweetness (Bodhare, 2023). Sweet corn differs from maize due to its genetic mutations that confer a sugary endosperm (Fritz *et al,* 2010). Sweet corn (*Zea mays* L. *saccharata)* also known as Sugar Corn is a hybridized variety of maize (*Zea mays* L.) specifically bred to increase sugar content. Total sugar content in sweet corn at milky stage ranges 25 to 30 per cent as compared with 2 to 5 per cent of normal corn. Modern sweet corn varieties are classified as normal sugary (Su), sugary enhanced (Se) and shrunken (Sh_2) which are also called as super sweet.These differ in sweetness and ratio of conversion of sugar to starch (Singh *et al,* 2014). Sweet corn has highly nutritional value, according to a study per 100g of sweet corn contains 19.02g carbohydrates, 2.70g dietary fiber, 1.18g fat and 3.2g protein. Zinc activates enzymes responsible for the synthesis of certain proteins. It is helpful in the formation of chlorophyll and some carbohydrates. Zinc is essential in the formation of auxins, which help in growth regulation. Zinc deficiency not only retards the growth and yield of plants but also affects human beings (Ayalew, 2016) with malnutrition, neuronal disorders of susceptibility to various infectious diseases (Hafeez *et al*, 2013). More than two billion people around the world are victims of hidden hunger (Garg *et al*, 2018).

Bio-fortification is an evolving techniques to overcome micro-nutrient malnutrition (Ngozi, 2013). It is attained by applying micro-nutrients to soil or directly to foliage of crop (Valenca *et al*, 2017). The unavailable zinc compounds can be

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converted back to available form through bio-augmentation of plant growth promoting *Rhizobacteria* (PGPR) inoculants having the ability to solubilize zinc compounds, may be called as Zn solubilizing bacteria (ZSB). Several ZSB strains have been documented for their ability to solubilize unavailable forms of Zn thus improving plant growth, yield and grain quality. Among several ZSB strains, Zn solubilizing *Bacillus* strains solubilize unavailable Zn compounds through production of chelating ligands, secretion of organic acids, amino acid, phytohormones. They are beneficial for plants as they increase the root functions, decrease disease impact, increase plant growth and development (Rana *et al*, 2012; Ramesh *et al,* 2014; Abaid-Ullah *et al*, 2015). Zn solubilizing *Bacillus* strains have the ability to increase uptake and translocation of Zn. Zinc fertilizers are widely used to enhance the yield and Zn contents and quality of edible grains of different crops. Seed priming with Zn sulphate solution speed up the emergence of crop and finally increased grain yield (Aboutalebian *et al,* 2012). Foliar Zn application is more effective as compared with soil applied Zn to increase grain Zn contents of cereals, whole grain Zn concentration including endosperm could be increased by foliar application (Cakmak *et al,* 2010).Therefore, this field experiment was designed to evaluate the effects of different methods of Zn application on yield and quality characteristics of sweet corn.

MATERIALS AND METHODS

The field experiment entitled Effect of Zinc Biofortification in Sweet Corn (*Zea mays* L. *saccharata*) was conducted at Student's Research Farm, Khalsa College, Amritsar during *Kharif* season of 2022.The weekly mean meteorological data recorded during crop season (July to November, 2022) at Amritsar is located at 30-38' N latitude, 74-52' E longitude and altitude of 236 m above sea level.This tract is characterized by semi humid climate. During the research period, the maximum wind speed was observed 5.20 Km/hr and minimum was 1.58 km/hr. The maximum relative humidity was 82.29 per cent and minimum was 13.07 per cent. The monsoon generally start in the second week of July. The soil in the experimental field was sandy loam.The experiment was laid out in Randomized Block Design (RBD) with four replications and ten treatments comprising T_1:Control, T_2: Seed inoculation (*Bacillus subtilis*), T_3: Seed treatment with $ZnSO_4$@0.5%, T_4: Foliar application of $ZnSO_4$@0.5%, T_5: Seed treatment with $ZnSO_4$@0.5%+ foliar application of $ZnSO_4$@0.5%, T_6:Seed treatment with $ZnSO_4$@1%, T_7: Foliar application of $ZnSO_4$@1%, T_8: Seed treatment with $ZnSO_4$@1%+ foliar application of $ZnSO_4$@1%, T_9: Seed inoculation (*Bacillus subtilis*)+ seed treatment with $ZnSO_4$@0.5%+ foliar application of $ZnSO_4$@0.5%, T_{10}: Seed inoculation (*Bacillus subtilis*)+seed treatment with $ZnSO_4$@1%+ foliar application of $ZnSO_4$@1%. Sowing was done as per treatment. Sweet corn variety Sugar-75 was sown by dibbling two seeds per hill keeping row to row spacing of 60 cm and plant to plant spacing of 20 cm. Generally irrigations was applied during the pre-tasselling, silking and grain filling stage. Fertilizer nitrogen was applied at 125 kg/ha and and zinc sulphate (monohydrate) at 15 kg/ha. For plant protection measures, Coragen 20 SC (Chlorantranilliprole) @ 200 ml/ha in 150 litres of water was applied at 25 and 36 days after sowing of crop. Sweet corn was harvested when endosperm inside the kernels was still liquid. Observations on different parameters such as grain yield, stover yield, harvest index, Zn content and uptake by grains and stover were recorded and further analysis. Data recorded were subjected to analysis of variance (ANOVA) using EDA software developed by Department of Mathematices and Statistics, PAU, Ludhiana.

RESULTS AND DISCUSSION

Effect of Zinc Biofortification on grain yield, stover yield and harvest index in sweet corn (*Zea mays* L. *saccharata*).

Grain yield (q/ha)

The grain yield varied significantly with different zinc application methods (Table 2).The data showed that higher grain yield (37.6 q/ha) was observed in T_{10} when zinc was integrated through 3 methods which was also at par with T_9 having grain yield of (36.1 q/ha) and T_8 having

grain yield of (35.3 q/ha) as compared with all other treatments where one or two methods of zinc was applied. T_5 produced grain yield of (34.1 q/ha) which was significantly better as compared with T_1 (28.2 q/ha) and T_2 (29.1 q/ha) and remained at par with T_7, T_4, T_6, T_3. Per cent increase in grain yield in T_{10}(33.3%), T_9 (28.0%), T_8 (25.1%), T_5(20.9%), T_7(17.7%), T_4(13.8%), T_6(10.9%), T_3(6.73%), T_2(3.19%) was recorded as compared with control. Seed treatment with Zinc sulphate showed increase in grain yield (Harris *et al,* 2007). Zinc solubilizing *Bacillus* strains solubilize unavailable Zn compounds through production of chelating ligands, secretion of organic acids, phytohormones and thus improving plant growth, yield and grain quality. Higher grain yield recorded might be due to fulfillment of source (leaves) to sink (grain), through supply of required nutrients by 3 methods, Zn application showed beneficial effect on physiological process, plant metabolism, growth thereby leading to higher grain yield. Zn application also enhanced the carbohydrates supply to kernels, increasing yield components like cob length, number of grains per cob which was due to better vegetative growth of crop plant, which have direct influence on grain yield. Similar results were given by Naik *et al* (2019), Shivay and Prasad (2014), Mumtaz *et al* (2018).

Stover Yield (q/ha)

Stover yield is an important parameter of the biological yield to evaluate its productivity index for judging the ultimate performance of a crop.The data showed that higher stover yield of (70.5 q/ha) was observed in T_{10} which was at par with T_9 having stover yield of (69.6 q/ha) and T_8 having stover yield of (68.3 q/ha). T_5 gave statistically higher stover yield of (67.8 q/ha) as compared with T_1(61.8 q/ha), T_2(62.2 q/ha) and remained at par with T_7, T_4, T_6, T_3. Per cent increase in stover yield in T_{10}(14.0%), T_9 (12.6%), T_8 (10.5%), T_5(9.70%), T_7(7.11%), T_4(6.47%), T_6(4.20%),T_3(3.07%), T_2(0.71%) was recorded as compared with control.This might be due to more vegetative growth. These results were in line with Preetha and Stalin (2014).

Harvest index (%)

The harvest index signifies the yield of the plant parts of economic interest, as per cent of total biological yield in terms of dry matter.The data indicated that harvest index was not significantly influenced by different zinc applications methods. However, highest harvest index (34.7%) was recorded in T_{10} and the lowest harvest index (31.3%) was recorded in T_1. Per cent increase in harvest index in T_{10}(10.8%),T_9(9.26%),T_8(8.62%), T_5(6.90%), T_7(6.70%), T_4(4.47%), T_6(4.46%), T_3(2.23), T_2(1.59%) was recorded as compared with control. Similar results were given by Azab *et al* (2015).

Effect of Zinc Biofortification on Zn content and Zn uptake by grains and stover in sweet corn (*Zea mays* L. *saccharata*).

Zn content in grains (mg/kg)

Zn content in grains is an indication of potential yield response to applied zinc solubilizers, seed and foliar application. It was evident that Zn content in grains was influenced by different zinc application methods. Higher Zn content (40.7 mg/kg) in grains was recorded in T_{10} which was significantly higher as compared with T_1, T_2, T_3, T_6 and was at par with rest of treatments and the lowest Zn content (31.1 mg/kg) in grains was found in control. Per cent increase in Zn content in grains in T_{10}(30.8%), T_9(27.0%), T_8(19.9%), T_5(19.2%), T_7(17.0%), T_4(13.5%),T_6(9.96%), T_3(6.43%), T_2(2.89%) was recorded as compared with control. Zn solubilizing *Bacillus* strains has the ability to increase uptake and translocation of Zn. Whole grain Zn concentration including endosperm could be increased by foliar application of Zn (Cakmak *et al,* 2010). Higher zinc content in grains might be due to Zn function to improve metabolic reactions, activation of enzymes that leads to improvement in quality parameters like Zn content.Similar results were reported by Kumar (2011) and Mumtaz *et al* (2018).

Zn uptake by grains (g/ha)

Zn application also influenced the Zn uptake by grains. It was noted that Zn uptake by grains (153.0 g/ ha) was the highest in T_{10} and it was statistically higher than all treatments except T_9 and the lowest Zn uptake by grains (87.7 g/ha) was recorded in control. Per cent increase in Zn

Table 1. Weekly mean meteorological data recorded during the crop season (July-November, 2022).

Date	Standard meteorological week	Wind speed (Km/hr)	Relative humid ity (%)	Total rainfall (mm)	T max. (^{o}C)	T min. (^{o}C)
July	21	5.20	31.14	9.08	39.51	25.80
	22	2.80	23.26	5.28	43.48	28.71
August	23	3.37	13.07	0	46.29	30.21
	24	3.53	24.08	20.96	44.44	31.82
	25	3.15	48.27	43.01	36.32	25.84
	26	3.04	42.05	28.05	40.71	29.41
	27	2.39	57.13	24.83	38.36	29.49
	28	3.21	62.03	90.6	37.03	28.65
September	29	2.28	70.81	101.28	35.67	27.46
	30	2.29	80.08	56.92	32.87	26.34
	31	1.86	82.29	68.27	32.98	26.48
	32	2.40	81.47	70.42	33.14	25.90
October	33	3.14	80.52	47.61	32.70	25.54
	34	2.83	79.64	45.88	32.89	25.72
	35	1.58	79.17	4.38	33.45	25.04
November	36	1.82	74.49	22.00	33.36	24.78
	37	1.87	74.65	23.74	33.43	24.82
	38	2.02	73.31	25.00	33.48	24.40
	39	2.28	75.09	43.87	31.72	22.54

uptake by grains in T_{10}(74.4%), T_9(62.4%), T_8(50.0%), T_5(44.2%), T_7(37.7%), T_4(29.1%), T_6(22.0%), T_3(13.5%), T_2(6.84%) was recorded as compared with control.The improvement in uptake of nutrients may be due to stimulation of root proliferation by effects of bacterial strains and Zn play an important role in biosynthesis of enzymes and resulted in favourable effects of Zn on metabolic reaction within plants which provide more uptake of nutrients for plants.This might be also due to slow release of these micro-nutrients into soil solution which facilitate more Zn uptake by grains. Similar results were given by Dwivedi *et al* (2002).

Zn content in stover (mg/kg)

Zn content in stover is an indication of Zn applied to the crop and uptake by the plant. Zinc content in stover was influenced by different zinc application methods. Higher Zn content (53.1mg/kg) in stover was recorded in T_{10} and the lowest Zn content in stover (42.1 mg/kg) was found in T_1. Per cent increase in Zn content in stover in T_{10} (26.3%), T_9 (26.1%), T_8(20.4%),T_5(16.6%), T_7(14.0%),T_4(13.3%), T_6(9.97%), T_3(9.0%), T_2(2.61%) was recorded as compared with control. Increase in zinc content in stover might be due to bacterial strains provide Zn by symbiosis to corn roots and seed and foliar application also enhances Zn absorption in stover.Similar results were given by Mumtaz *et al* (2018).

Zn uptake by stover (g /ha)

Zn application also influenced the Zn uptake by stover. Higher Zn uptake by stover (374.3 g/ ha) was recorded in T_{10} which was statistically higher from all other treatments except T_9 and the lowest Zn uptake by stover (260.1 g/ha) was found in control. Per cent increase in Zn uptake by stover in T_{10}(43.9%), T_9(41.2%), T_8(33.1%), T_5 (27.9%), T_7(22.6%), T_4 (20.6%), T_6 (14.5%), T_3(12.5%), T_2(3.30%) was recorded as compared with control. This might be due to colonization of ZSB that facilitate solubilization of tightly bound fraction of nutrients. Plant absorb and accumulate more Zn in stover as compared with grain. Similar results were given by Tariq *et al* (2014).

Table 2. Effect of Zinc Biofortification on grain yield, stover yield and harvest index in sweet corn (*Zea mays* L. *saccharata*).

Symbol	Treatment	Grain Yield (q/ha)	Stover Yield (q/ha)	Harvest index (%)
T_1	Control	28.2	61.8	31.3
T_2	Seed inoculation (*Bacillus subtilis*)	29.1	62.2	31.8
T_3	Seed treatment with $ZnSO_4$@0.5%	30.1	63.7	32.0
T_4	Foliar application of $ZnSO_4$@0.5%	32.1	65.8	32.7
T_5	Seed treatment with $ZnSO_4$@0.5% + foliar application of $ZnSO_4$@0.5%	34.1	67.8	33.5
T_6	Seed treatment with $ZnSO_4$@1%	31.3	64.4	32.6
T_7	Foliar application of $ZnSO_4$@1%	33.2	66.2	33.4
T_8	Seed treatment with $ZnSO_4$@1%+ foliar application of $ZnSO_4$@1%	35.3	68.3	34.0
T_9	Seed inoculation (*Bacillus subtilis*)+ seed treatment with $ZnSO_4$@0.5%+ foliar application of $ZnSO_4$@0.5%	36.1	69.6	34.2
T_{10}	Seed inoculation (*Bacillus subtilis*)+ seed treatment with $ZnSO_4$@1%+ foliar application of $ZnSO_4$@1%	37.6	70.5	34.7
CD (p=0.05)		3.27	5.06	NS

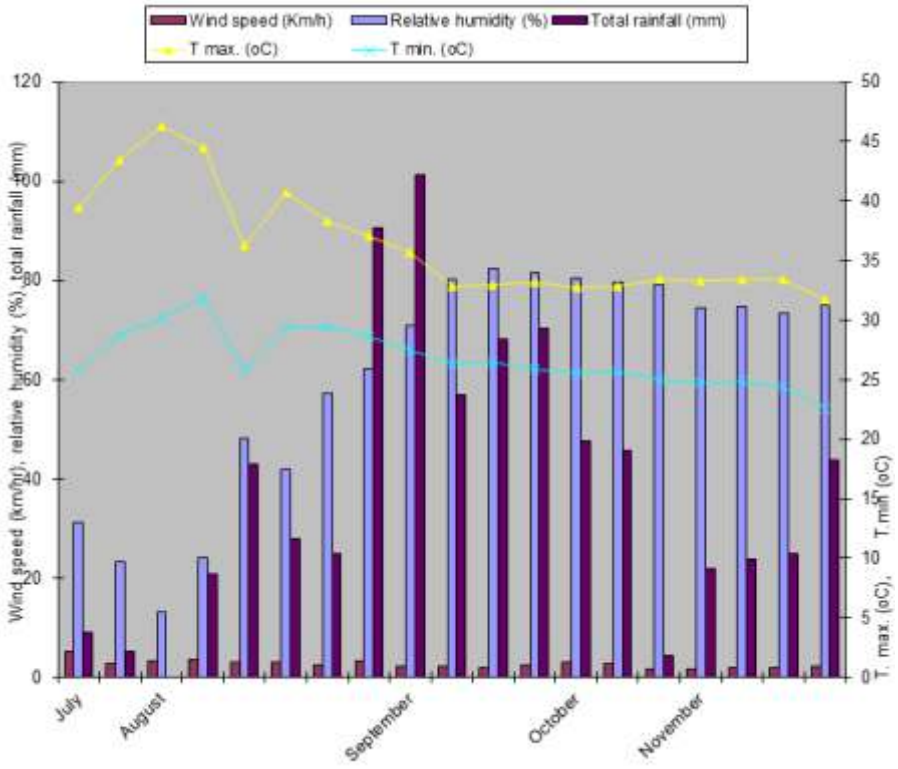

Figure1 Weekly mean meteorological data recorded during the crop season (July-November, 2022).

Table 3. Effect of Zinc Biofortification on Zn content and uptake by grains and stover in sweet corn (*Zea mays* L. *saccharata*).

Symbol	Treatment	Zn content in grains (mg/kg)	Zn uptake by grains (g/ha)	Zn content in stover (mg/kg)	Zn uptake by stover (g/ha)
T_1	Control	31.1	87.7	42.1	260.1
T_2	Seed inoculation (*Bacillus subtilis*)	32.2	93.7	43.2	268.7
T_3	Seed treatment with $ZnSO_4$@0.5%	33.1	99.6	45.9	292.3
T_4	Foliar application of $ZnSO_4$@0.5%	35.3	113.3	47.7	313.8
T_5	Seed treatment with $ZnSO_4$@0.5%+ foliar application of $ZnSO_4$@0.5%	37.1	126.5	49.1	332.8
T_6	Seed treatment with $ZnSO_4$@1%	34.2	107.0	46.3	298.1
T_7	Foliar application of $ZnSO_4$@1%	36.4	120.8	48.2	319.0
T_8	Seed treatment with $ZnSO_4$@1%+ foliar application of $ZnSO_4$@1%	37.3	131.6	50.7	346.2
T_9	Seed inoculation (*Bacillus subtilis*)+ seed treatment with $ZnSO_4$@0.5%+ foliar application of $ZnSO_4$@0.5%	39.5	142.5	52.8	367.4
T_{10}	Seed inoculation (*Bacillus subtilis*)+ seed treatment with $ZnSO_4$@1%+ foliar application of $ZnSO_4$@ %	40.7	153.0	53.1	374.3
CD(p=0.05)		6.20	20.8	7.60	26.1

CONCLUSION

Keeping in view the results obtained after experimental period, it may be concluded that seed inoculation (*Bacillus subtilis*) + seed treatment with $ZnSO_4$@1% + foliar application of $ZnSO_4$@1% (T_{10}) significantly produced higher grain yield, stover yield, harvest index and higher quality characteristics such as Zn content and uptake by grains and stover and this is contributing to human nutrition (biofortification).

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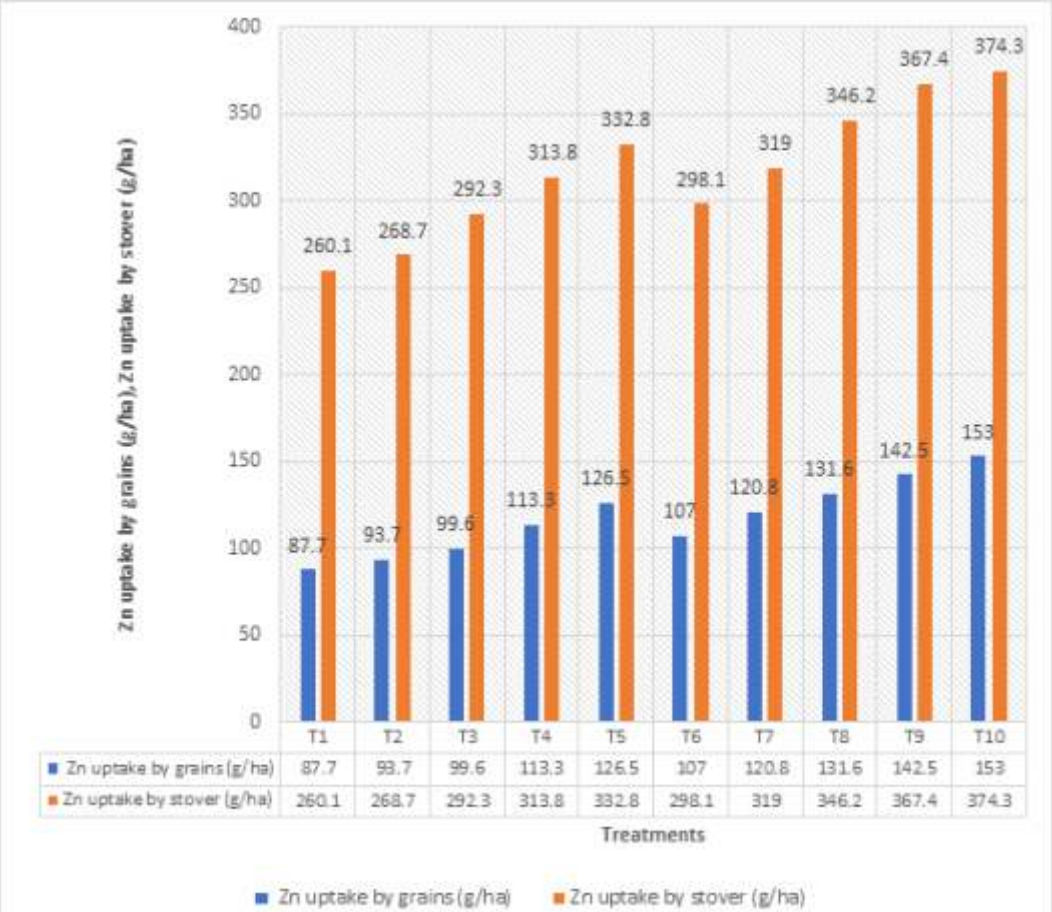

Figure 2 Effect of Zinc Biofortification on Zn uptake by grains and Zn uptake by stover in sweet corn (*Zea mays* L. *saccharata*).

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Effectiveness of Trainings on Knowledge Gain about Milk Processing

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ABSTRACT

In order to evaluate effectiveness of scientific trainings on knowledge gain about milk processing, 60 farmers from on campus trainings were selected. Majority of trainees (46.67 %) were less than 30 years of age and 65 per cent trainees had annual income between 1-6 lakh. Significant increase in the proportion of correct responses given for different knowledge statements was observed. There was significant (P<.01) increase in knowledge index from 11.93 ± 1.54 before training to 54.53 ± 1.37 after training with a knowledge gain of 42.60 ± 1.42. Further, it was clearly seen that training interaction with mass media exposure and extension agency contact had significant impact on the scores obtained before and after training.

Key Words: Food, Knowledge, Milk, Processing, Technique,Training.

INTRODUCTION

Milk is highly a perishable food because it is an easy medium for the growth of bacterial pathogens and other microorganisms which can lead to milk spoilage and result in diseased condition for the consumers. Milk processing allows the preservation of milk for days, weeks or months and largely helps to reduce food-borne illness. The shelf life of milk can be extended for several days through techniques such as cooling (essential to ensure raw milk quality), fermentation, pasteurization etc. Pasteurization is a heat treatment process that extends the keeping quality of milk and reduces the numbers of possible pathogenic microorganisms to levels at which they do not represent a significant health hazard. Milk can be processed further to convert it into high-value, concentrated and easily transportable dairy products with long shelf-lives such as butter, cheese and ghee. Processing of dairy products gives small-scale dairy producers higher cash incomes than selling raw milk and offers better opportunities to reach regional and urban markets.

Milk processing can also help to deal with seasonal fluctuations in milk supply. The transformation of raw milk into processed milk and products can benefit entire communities by generating off-farm jobs in milk collection, transportation, processing and marketing. Providing a big push to the country's dairy industry, the Finance Minister announced in Union Budget 2020, that the government aims to take India's milk processing capacity to double the current levels. While the country processes 53.5 Mt currently, the same will be scaled up to 108 Mt by 2025. The milk production has increased from 176.3 Mt in 2017-18 to 187.7 Mt in 2018-19 registering a growth of 6.5 %. Also the per capita availability of milk increased from 233 g/day in 2004-05 to 394 g/day in 2018-19 (BAHS 2019). The annual increase in milk production will increase to 9 per cent by 2022 from current 6.3 per cent on the back of several government initiatives (Economic Times, 2018). Surplus raw livestock products can be processed and marketed to prevent wastage, maximize profit in addition to providing nutritional security. Processing diversifies product development which helps in increasing consumer appeal and also increases storage time so that these might be used when needed.

In order to encourage milk processing, training programmes specially designed for this purpose are a necessity. Training is a prerequisite for any worthwhile action and it can help counter limitations like low awareness of improved

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technologies/ practices and poor knowledge level regarding the enterprise, by imparting know how directly. Hundal *et al* (2016) analysed the role of training in changing knowledge level of dairy farmers and revealed that 69.6 %, 26.0 % and 4.4 % farmers belonged to low, moderate and high level knowledge category before training, respectively. However, 81.9 % ($P<0.01$) farmers possessed high level knowledge after training. Shelly and Sharma (2022) have highlighted the importance of training in technology adoption by farmers. This study was designed to find the effectiveness of meat processing trainings conducted by Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana in terms of knowledge gain of the trainees.

MATERIALS AND METHODS

About 60 trainees from various milk processing trainings conducted by Guru Angad Dev Veterinary and Animal Sciences University from August 2021 to August 2022 were selected. Questionnaire on knowledge test was prepared and pretested. Knowledge test included 25 multiple choice questions. All the 25 questions had total four options with single correct option. These questions about knowledge test were collected from the various lectures conducted by subject matter specialists and scheduled regularly during the training programmes.

Questions were included on a wide variety of areas like pasteurization types, vacuum packaging, forms of khoa, mozarrella cheese, milk adulteration testing kit, fat and SNF percent in various milk types etc. For knowledge evaluation through test, each correct answer was scored as one and each wrong answer was scored zero. The sum of score was taken as knowledge score. For each training programme, maximum possible score was 25 and minimum was 0. Knowledge Index (KI) at pre and post evaluation stage was calculated by dividing the total score obtained by the maximum obtainable score and multiplying the result with 100. Data were analyzed using SAS 9.3.

$$KI = \frac{Obtained\ score}{Maximum\ possible\ score} \times 100$$

Knowledge gain = KI (pre test) – KI (post test)

RESULTS AND DISCUSSION

Socio-personal and communication profile of Milk processing trainees:-

Out of the 60 respondents from milk processing (Table 1), 46.67 % were less than 30 years of age. Majority (43.33 %) were graduates and above. It was seen that many educated urban residents attended the training in the hope of learning best methods of preparing unique milk products. Most respondents (65 %) had annual income between 1-6 lakh. At least 43.33 percent had both land and animal as source of income and 30.0 % had business/service as occupation. Majority (45 %) had land holding between 0.4-2 ha. Forty five percent had low level of mass media exposure (Table 1) and an equal number had medium level of exposure. Majority (70 %) had medium level of extension agency contact. However, 60 percent respondents had low level of social participation.

Impact of Milk processing training on knowledge level of trainees

The data (Table 2) list the pre-training and post training scores of respondents after week long training programme. Only 10 % knew about high temperature short time pasteurization before training but after training 80 % were aware of the same.

Similarly knowledge regarding fat percent in different milk types (23.33 % before *vs* 95 % after), whey drink preparation (11.67% before *vs* 51.67% after), reason for *khoa* becoming hard (23.33% before *vs* 86.67% after), scrapped surface heat exchanger (18.33% *vs* 61.67%), fermented dairy products (31.67% *vs* 90 %) and basis for determining cost of cow milk (53.33% *vs* 91.67%) increased profoundly and significantly ($P<.01$). Therefore, training is very helpful in equipping the trainees with correct knowledge for requirement of enterprise.

Evaluation of Pre-training KI, Post-training KI, Knowledge gain in Milk processing w.r.t. independent variables

The overall pre KI of 11.93 ± 1.54 increased to post KI of 54.53 ± 1.37 with a knowledge gain of 42.60 ± 1.42 which was significant ($P<.0001$). Age doesn't have much

Table 1. Socio-personal and communication profile of trainees.

Attribute	Parameter	Frequency (percentage)
Age (years)	≤ 30 years	28 (46.67)
	31-45 years	23 (38.33)
	≥ 46 years	9 (15.00)
Education	High school	13 (21.67)
	10+2	21 (35.00)
	Graduate and above	26 (43.33)
Income /year	< 1 lakh	15 (25.00)
	1-6 lakh	39 (65.00)
	≥ 6 lakh	6 (10.00)
Income source	Only land	7 (11.67)
	Only animals	4 (6.67)
	Land and animals	26 (43.33)
	Land and others (service/business)	5 (8.33)
	Others	18 (30.00)
	All three (land, animals, others)	-
Land (ha)	Landless	16 (26.67)
	0.4-2.0	27 (45.00)
	2.0-4.0	9 (15.00)
	>4.0	8 (13.33)
Mass media exposure	Low	27 (45.00)
	Medium	27 (45.00)
	High	6 (10.00)
Extension agency contact	Low	12 (20.00)
	Medium	42 (70.00)
	High	6 (10.00)
Social participation	Low	36 (60.00)
	Medium	24 (40.00)
	High	-

effect except for post KI which was lowest (49.78 ± 2.84) in ≥ 46 years category. Pre KI and post KI were lowest (6.15 ± 1.73 and 46.77 ± 1.66 respectively) in 'high school' education category. Further, pre KI and post KI were highest (28.67 ± 6.96 and 67.33 ± 7.19 respectively) in '≥6 lakh' annual income category but knowledge gain was not statistically significant (P<.05) between categories. As far as income source is concerned, pre KI is lowest (3.43 ± 2.38) in 'only land' category and knowledge gain is highest (50.86 ± 4.59) in this category. Again pre KI was highest (20.0 ± 5.42) in '5-10 acres' land holding category but knowledge gain was lowest (34.67 ± 5.12) in this category.

CONCLUSION

The study demonstrated significant increase (P<.01) in the Knowledge Index of trainees after training. The awareness level regarding various

Table 2. Impact of milk processing training on knowledge level of trainees.

Q. No.	Statement	Correct responses (%)			
		Pre-training	Post-training	Chi square value	P value
1	Fermented dairy products	19 (31.67)	54 (90.00)	42.845	<.0001
2	Cheese for pizza manufacture	6 (10.00)	59 (98.33)	94.288	<.0001
3	SNF includes ?	26 (43.33)	56 (93.33)	34.659	<.0001
4	Cost of cow milk based on ?	32 (53.33)	55 (91.67)	22.111	<.0001
5	FSSA, 2011 standards for fat and SNF	4 (6.67)	17 (28.33)	9.755	0.002
6	Scrapped surface heat exchanger	11 (18.33)	37 (61.67)	23.472	<.0001
7	Three forms of khoa	7 (11.67)	20 (33.33)	8.076	0.004
8	Difference in three khoa forms	0	12 (20.00)	13.333	0.0003
9	Product to save khoa from fungus	0	15 (25.00)	17.143	<.0001
10	Reason for khoa becoming hard	14 (23.33)	52 (86.67)	48.619	<.0001
11	Tin packaging for khoa	5 (8.33)	46 (76.67)	57.323	<.0001
12	Technique to make milk germ free	2 (3.33)	11 (18.33)	6.988	0.008
13	Adulteration testing kit	2 (3.33)	12 (20.00)	8.086	0.004
14	Vaccum packing	0	16 (26.67)	18.462	<.0001
15	LTLT pasteurization	0	15 (25.00)	17.143	<.0001
16	HTST pasteurization	6 (10.00)	48 (80.00)	59.394	<.0001
17	Protein percent in mozzarella cheese	1 (1.67)	38 (63.33)	52.004	<.0001
18	Small air bubbles on mozzarella cheese	0	12 (20.00)	13.333	0.0003
19	Mozarella cheese pH	0	6 (10.00)	6.316	0.012
20	Whey drink preparation	7 (11.67)	31 (51.67)	22.182	<.0001
21	Fat percent in buffalo milk	0	29 (48.33)	38.242	<.0001
22	Easy digestibility of goat milk	10 (16.67)	54 (90.00)	64.821	<.0001
23	Milk types based on fat percent	14 (23.33)	57 (95.00)	63.777	<.0001
24	Fat and SNF in green packed milk	0	17 (28.33)	19.806	<.0001
25	Material to prepare curd cups	13 (21.67)	46 (76.67)	36.310	<.0001

aspects of milk processing also increased many fold. Therefore scientific trainings on milk processing are a must to gather information for efficient milk processing in order to prevent wastage and ensure quality products.

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Table 3. Pre-training KI, Post-training KI, Knowledge gain and Adoption score percent of milk processing training w.r.t. independent variables.

Parameter	Pre KI (Mean ± SE)	Post KI (Mean ± SE)	Knowledge gain (Mean ± SE)	Adoption score percent (Mean ± SE)
Age				
< 30 years	11.28^{a} ± 2.22	55.71^{a} ± 1.99	44.43^{a} ± 2.38	4.36^{b} ± 2.31
31-45 years	13.22^{a} ± 2.63	54.96^{a} ± 2.38	41.74^{a} ± 2.06	20.77^{a} ± 5.42
≥ 46 years	10.67^{a} ± 3.89	49.78^{b} ± 2.84	39.11^{a} ± 2.56	32.09^{a} ± 9.88
Education				
High school	6.15^{b} ± 1.73	46.77^{c} ± 1.66	40.62^{b} ± 1.56	22.22^{a} ± 7.55
10+2	12.95^{a} ± 1.72	52.76^{b} ± 1.92	39.81^{b} ± 1.92	17.99^{ab} ± 5.96
Graduate and above	14.00^{a} ± 3.06	59.85^{a} ± 2.19	45.85^{a} ± 2.69	8.55^{b} ± 3.22
Income/year				
< 1 lakh	10.93^{b} ± 1.32	55.73^{b} ± 2.32	44.80^{a} ± 2.87	19.26^{a} ± 5.89
1-6 lakh	9.74^{b} ± 1.77	52.10^{b} ± 1.37	42.36^{a} ± 1.82	12.54^{a} ± 3.79
≥ 6 lakh	28.67^{a} ± 6.96	67.33^{a} ± 7.19	38.67^{a} ± 3.21	18.52^{a} ± 10.61
Income source				
Only land	3.43^{b} ± 2.38	54.28^{a} ± 5.15	50.86^{a} ± 4.59	7.94^{a} ± 7.94
Only animals	13.00^{a} ± 4.12	52.00^{a} ± 4.62	39.00^{bc} ± 5.74	13.89^{a} ± 13.89
Land and animals	14.62^{a} ± 2.17	55.08^{a} ± 1.49	40.46^{bc} ± 2.22	17.52^{a} ± 4.45
Land and others (service/business)	14.40^{a} ± 3.92	49.60^{a} ± 3.92	35.20^{c} ± 2.65	26.67^{a} ± 12.47
Others	10.44^{a} ± 3.51	55.78^{a} ± 3.32	45.33^{ab} ± 2.17	10.49^{a} ± 5.71
All three (land, animals, others)	-	-	-	-
Land (ha)				
Landless	12.75^{b} ± 3.71	60.50^{a} ± 3.20	47.75^{a} ± 2.69	0^{b}
0.4-2.0	9.78^{b} ± 1.44	52.30^{b} ± 1.68	42.52^{a} ± 1.74	31.28^{a} ± 5.10
2.0-4.0	20.00^{a} ± 5.42	54.67^{b} ± 3.26	34.67^{b} ± 5.12	0^{b}
>4.0	8.50^{b} ± 3.50	50.00^{b} ± 3.30	41.50^{a} ± 2.61	5.55^{b} ± 3.64
Overall	11.93 ± 1.54	54.53 ± 1.37	42.60 ± 1.42	14.81 ± 3.03

Figures with different superscripts in a column for different variables differ significantly (P<.05)

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Ergonomic Evaluation of Different Paddy Threshing Methods in Meghalaya

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ABSTRACT

Paddy threshing is an essential part of harvesting in paddy production in which farm machinery plays a crucial role for efficient threshing, reduced threshing losses and improved threshing capacity. Traditionally, farmers often thresh paddy by hand beating using a stick, or hitting a punch of harvested paddy on a wooden log followed by hand beating with a locally evolved hand tool. In this study, three different paddy threshing methods, including conventional hand beating, cycle-type pedal-operated thresher, and foot-type pedal-operated thresher, were subjected to ergonomic measures such heart rate (HR), energy expenditure rate and overall discomfort rating (ODR). It was observed that energy demand and ODR are significantly high ($P<0.05$) in farmers in the case of conventional hand-beating paddy threshing method than in paddy threshing by cycle-type pedal-operated thresher, and foot-type pedal-operated thresher. It was noticed that mean working EER, mean energy expenditure, and mean working ODR decreased by 19.69 and 15.15 percent, by 38.72 percent and 26.66 percent, and by 50 and 34.37 percent in case of paddy threshing by cycle-type and foot-type paddy thresher respectively as compared to hand-beating paddy threshing method with a significance level of $P<0.05$. The results suggested that cycle-type and foot-type paddy thresher gave better performance from ergonomics perspective as compared to traditional hand-beating method.

Key Words*:* Energy expenditure, Ergonomics, Heart rate, Paddy, Threshing.

INTRODUCTION

Rice crop production costs are rising drastically due to higher daily wages and greater demand for labour in paddy cultivation and post-harvesting (Devi *et al,* 2020). Moreover, modern agriculture is heavily dependent on farm mechanization. The availability of farm electricity and effective farming equipment, as well as their economic use, determine farm productivity. Agricultural mechanization makes it possible to use various inputs like seeds, fertilizer, plant protection measures, and effective irrigation systems efficiently. It also aids in improving agricultural production, which boosts agricultural output and boosts the economy of many farmers by making farming a lucrative business (Kanta and Devi, 2017). However, the level of farm mechanization is extremely low in northeast India. Factors such as hilly terrain, high transportation costs, lack of governmental funding, various financial restrictions brought on by socioeconomic conditions, and lack of agricultural machinery manufacturing businesses have prevented these states' economies from growing in the farm equipment industry (Rajkhowa *et al,* 2020). Moreover, the bulk of the tribal population in northeast India are prone to excessive drudgery in farm operations. The dominance of traditional farming practices and a low level of mechanization are two major factors in the region's inferior agricultural productivity. Local artisans and small-scale manufacturers produce tools and equipment without using

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ergonomic principles, which have a low level of operating effectiveness and frequently fail to lessen the arduousness of operation in hills. While introducing enhanced machinery for adoption, difficulties have been encountered in various regions of the nation.

Paddy threshing is the separation of the paddy kernels from the panicle of the rice plant. The impact and stripping rubbing motion cause the grains to separate from the panicle (Perumal *et al,* 2013). The traditional method of threshing rice by hand involves beating bundles of panicles with a flail or against a hard object (such as a bamboo bar, bar stone, bamboo table). Depending on the kind of rice, the production per man-hour ranges from 10 to 30 kg of grain. When threshing is done too late, this procedure results in grain losses of between 1% and 4% (Paulsen *et al,* 2015); some unthreshed grains might also be lost over the threshing area. Trampling with persons and animals while threshing traditionally results in significant losses (Belay *et al*, 2013; Lad, 2020). Most of the paddy threshing in Meghalaya is generally done by hand beating by farmers.

For the design of manual material handling jobs, ergonomic studies on operator capabilities are crucial. Threshing operations, according to (Kathrivel and Shivkumar, 2003), use 25% of the total energy used in rice production. The most laborious process, traditional threshing involves thrashing the grain bundle on stones or a wooden platform while bending over. Bending over while working adds to the tedium that has to be eradicated with the right technology (Kathrivel and Sivakumar, 2003; Khadatkar *et al*, 2017). Therefore, the mechanization of these processes should be emphasized to reduce labour needs in rice threshing. Human energy is mainly used in agriculture for seedling raising, weeding, harvesting, and cleaning. In order to improve the efficiency of human work, simple, adequate, and efficient machines or tools must be available to increase agricultural production in Meghalaya (Devi *et al*, 2020). Economic situations, tiny and dispersed land holdings, a lack of/uncertainty in electricity, etc. are some of the obstacles that prevent small-holding farmers from using power threshers. For them, employing human force to do the threshing is the finest option. To lessen the labour-intensive nature of threshing, it was imperative to conduct ergonomic studies of small machine such as pedal-operated paddy thresher for popularization and adoption among the farmers. Therefore, research on the ergonomics of farmers engaged in paddy threshing is essential (Khadatkar *et al*, 2017). Hence, considering the above issue, an ergonomic study was conducted for performance evaluation of different paddy threshing methods in Meghalaya.

MATERIALS AND METHODS

Pedal Thresher

For the ergonomic experiment, two types of pedal threshers from ICAR (NEH, Meghalaya) were selected. The selected thresher were cycle-type pedal threshers with seating arrangements and another one is a foot-type pedal-operated, both threshers attach with a wire loop-type cylinder. The selected threshers were also facilitated with power transmission systems, foot and cycle-type pedals, and mild steel sheet bodies. Specifications of both threshers are given in Table 1.

Selected area for experiment

Umeit and Pynthor are two villages of Ri - bhoi district of Meghalaya that was selected for the experiments. The latitude and longitude of the selected villages are 25.7176° N & 25.9363° N, and 92.0191° E & 91.7666° E respectively. Both villages are situated nearby ICAR for the NEH complex of Meghalaya, India. People of those villages follow traditional hand-beating for the paddy threshing process.

The ergonomic experiment was carried out on ten male farmers (N=10) based on anthropometric characteristics between the 5^{th} and 95^{th} percentile, and these ten workers handled all of the study's operations. The chosen ten farmers were in the age range of 20 to 39 years. The experiments were carried out between 8 am to 1 pm in the month of December 2022. The anthropometric dimensions like stature (cm), age (years), weight (kg), and heart rate (HR) (bpm) were recorded. Additionally, the subject's height and weight were divided to calculate the subject's body mass index (BMI) (m^2). Hume's formula (1966) and DuBois and DuBois's formula were

Table 1. Specifications of selected threshers

Sr. No.	Specifications	Cycle -type pedal - operated thresher	Foot -type pedal - operated thresher
1	Diameter of Drum (mm)	300	300
2	Width (mm)	500	600
3	Height (mm)	890	800
4	Length (mm)	780	700
5	Power Source	One person	One Person
6	Transmission System	Cycle -type pedal with 1:4 gear ratio	Crank mechanism with 1:4 gear ratio
7	Weight , kg	43	37

used to computing each subject's body surface area (m^2) and lean body mass (kg) (Shuter and Aslani, 2000). Hume's formula (2.1) was used to calculate the lean body mass (LBM) weight (Hume, 1966).

LBM=[(body weight× 0.29569)+(body height × 0.41873) - 43.29]..... (2.1)

Each participant's Body Surface Area (BSA) was calculated using the DuBois and DuBois formula based on their weight and height as specified in eq. 2.2.

$$BSA = Weight^{0.425} \times Height^{0.725} \times 0.007184 \quad \ldots\ldots (2.2)$$

By dividing each subject's weight in kilograms by the square of their height in meters square, the body mass index, or BMI, was also calculated. The World Health Organization (BMI) gave the body mass index the following category. BMIs of 18.5 or below is considered underweight, whereas those between 18.5 and 24.9 are regarded as medium weight. People that are overweight have a BMI of 25 or above. By utilizing the formula of Robergs and Landwehr (HR_{max} = 205.8 - 0.685 × Age), the maximum HR was determined (Robergs and Landwehr, 2002).

The study was conducted in an open rice field on male agricultural workers of Meghalaya. Three distinct paddy threshing procedures, including conventional hand beating, cycle-type pedal-operated thresher, and foot-type pedal-operated thresher, were subjected to ergonomic measures (HR, ODR and energy expenditure rate) for a period of 30 minutes each. Major instruments used for conducting the field experiments are a tachometer, Polar HR monitor M10, measuring tape, weighing machine, etc. (Fig 1). Before beginning the experiments, the subjects were given enough time to rest in order to calculate their resting heart rates (HR rest).

Circulatory stress was evaluated using the cardiac cost of labour and the cardiac cost of recovery. The cardiac cost of recovery is the sum of all heartbeats above the resting rate between ending work and returning to sleep (Saha, 1976). The heart rate was determined using a Polar heart rate monitor using the formula HR=beat/min.

Heart rate

Heart rate is one of the primary physiological indicators connected to increasing physical strain and energy requirements. Three different types of heart rates were considered for the evaluation of the physiological responses. In this investigation, a Polar heart rate monitor was used to assess heart rate. Resting heart rate (Rhr), average working heart rate (Rw), peak heart rate (Phr), and other cardiovascular characteristics are taken into account throughout the field trial. The following definitions include some particular words associated with heart rate.

Maximum heart rate (HR_{max})

The maximum heart rate (HR_{max}), which decreases with age, is the greatest heart rate a person may achieve without exhausting themselves excessively. The most accurate

a. Measurement of cylinder speed by tachometer

b. Meghalaya traditional hand beater for paddy threshing

c. Polar M10 HR Monitor

d. Attaching Polar M10 on the chest

Figure 1. Instrumentation for carrying out the field experiment

method for determining HR_{max} is a cardiac stress test because HR_{max} varies from person to person. For determining the HRmax, the formula from Robergs and Landwehr (2002) was used (HR_{max} = 205.8 - 0.685 Age) (Robergs and Landwehr, 2002).

Resting heart rate (R_{hr})

The resting heart rate, measured in beats per minute (bpm), is the typical pulse rate while at rest. The basal or resting heart rate (Rhr) is the heart rate of an individual while they are awake, in a temperature-neutral environment, with no recent activity or stimulus, such as stress or surprise. A substantial amount of data indicates that the typical range is 60–100 bpm. Mortality is commonly correlated with resting heart rate. The remaining farmers were given 5 minutes to relax while the resting heart rate was monitored under field circumstances.

Working heart rate (R_w)

Working heart rate is the typical HR that participants have while they are working (R_w). In order to determine the effects of heat stress on R_w during labour, it evaluated the working heart rate under three distinct WBGT circumstances.

Table 2. Discomfort in body parts (adopted from Kwatra *et al,* 2010)

Sr. No.	Particulars	Intensity of pain
1	Very severe	4
2	Severe	3
3	Moderate	2
4	Mild	1
6	very Mild	1

Table 3. Physical characteristics of selected farmers

Sr. No.	Particulars	Statistic of Subjects
1	Height (cm)	161.6±1.42
2	Age (yr)	30.10 ±5.13
3	Weight (kg)	60.4±4.08
4	BSA (m^2)	1.63±0.05
5	BMI (kg/m^2)	23.12±1.48
6	LBM (kg)	46.10±1.82
7	HR_{max} (bpm)	185.19±3.6

Peak heart rate (P_{hr})

Peak heart rate is the maximum heart rate that can be reached without running any danger of cardiovascular disease or the highest heart rate that can be measured while working (P_{hr}).

Recovery heart rate (HR_r)

Recovery heart rate is the decrease in heart rate that occurs one minute after a peak effort. While a heart rate of 50 to 60 bpm is considered exceptional, a recovery heart rate of 25 to 30 bpm is considered good. By allowing the farmer to rest for five to ten minutes, recovery heart rate (HR_r) may be very helpful for detecting the cardiovascular strain under heat stress and monitoring the resting heart rate in field situations. Work strain is determined by adding values for the recovery heart rate (SRHR) throughout the 5 to 10-minute recovery interval (Dey *et al*, 2007).

Energy Expenditure Rate

In addition, it was generally accepted that there was a connection between heart rate and energy expenditure. Based on the empirical equation, the energy expenditure rate (EER) (2.3) was estimated with the aid of heart rate (Saha *et al*., 1979; Yadav *et al*., 2007).

$$EER=(HR-66)/2.4\ldots\ldots(2.3)$$

Measurement of Pain Intensity

The occurrences of discomfort the individuals reported during the performance of the activity indicated by different locations on a body map were used to calculate the muscular strains. On the five-point scale shown below (Table 2), the degree of discomfort in the bodily parts mentioned above was scored:

RESULTS AND DISCUSSION

The demographic information of the selected farmers is detailed in Table 3. Most farmers reported that they rely on traditional methods for threshing due to the ease of use and low cost, despite the advent of modern mechanical methods. The physiological parameters during paddy threshing in three different methods is shown in Table 4. Fig. 2 showed the experiment for ergonomic evaluation carried out at Umeit and Pynthor villages of Ri -bhoi district of Meghalaya by adopting three different methods of paddy threshing i.e. traditional hand beating (Fig 2a), cycle-type pedal-operated thresher (Fig. 2b) and foot-type pedal-operated thresher (Fig. 2c) for 30 minutes.

The variation in heart rate of selected farmers at different paddy threshing processes was presented in Fig. 3. The heart rate of each farmer was measured with the help of polar H10 by

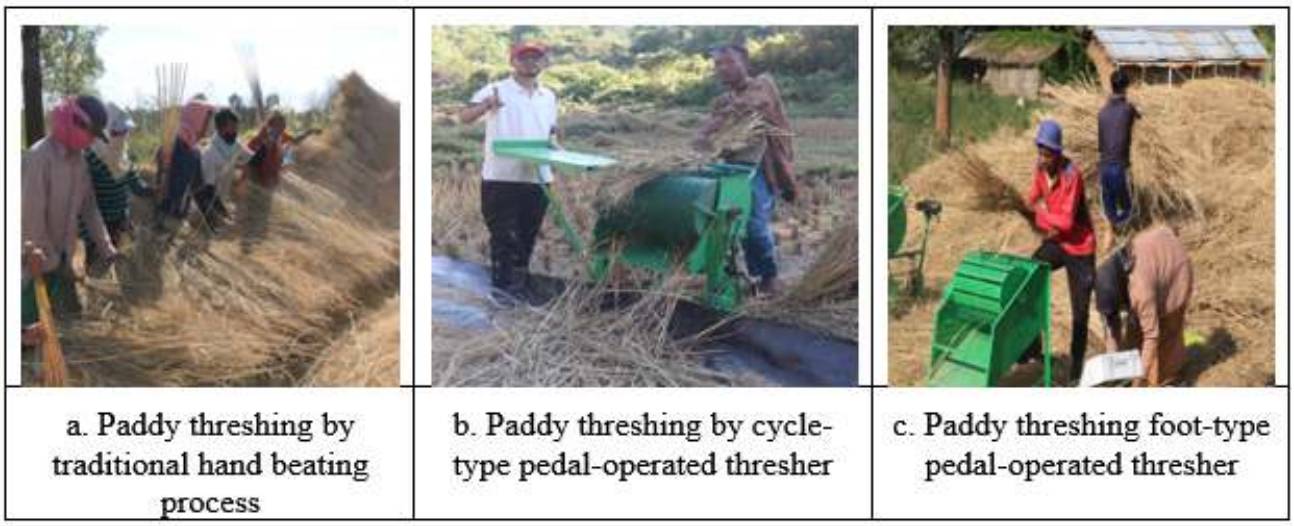

Figure 2. Ergonomic evaluation of paddy threshing using different methods

Table 4. Physiological parameters during paddy threshing in three different methods

Sr. No	Parameters	Hand heating Paddy threshing	Cycle-type pedal-operated thresher	Foot-type pedal-operated thresher
1	Mean Working HR, bpm	132	106	112
2	Mean Resting HR, bpm	90	85	87
3	Mean Recovery HR, bpm	109	95	99
5	Energy Expenditure Rate, KJ/min	27	17	19

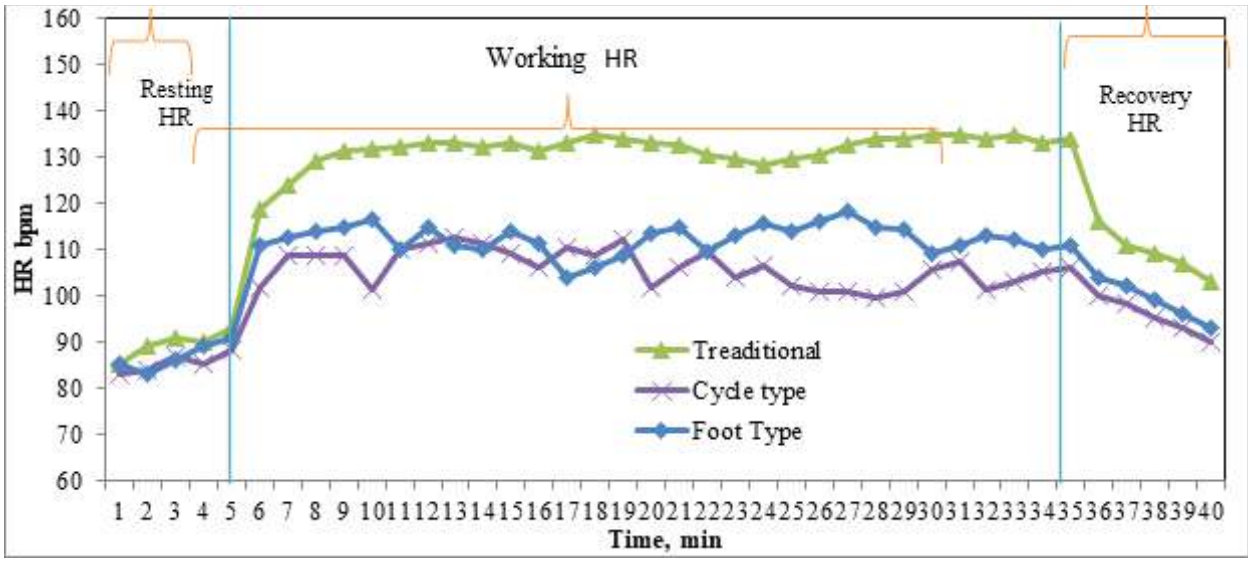

Figure 3. Mean heart rate of selected farmers using different paddy threshing methods

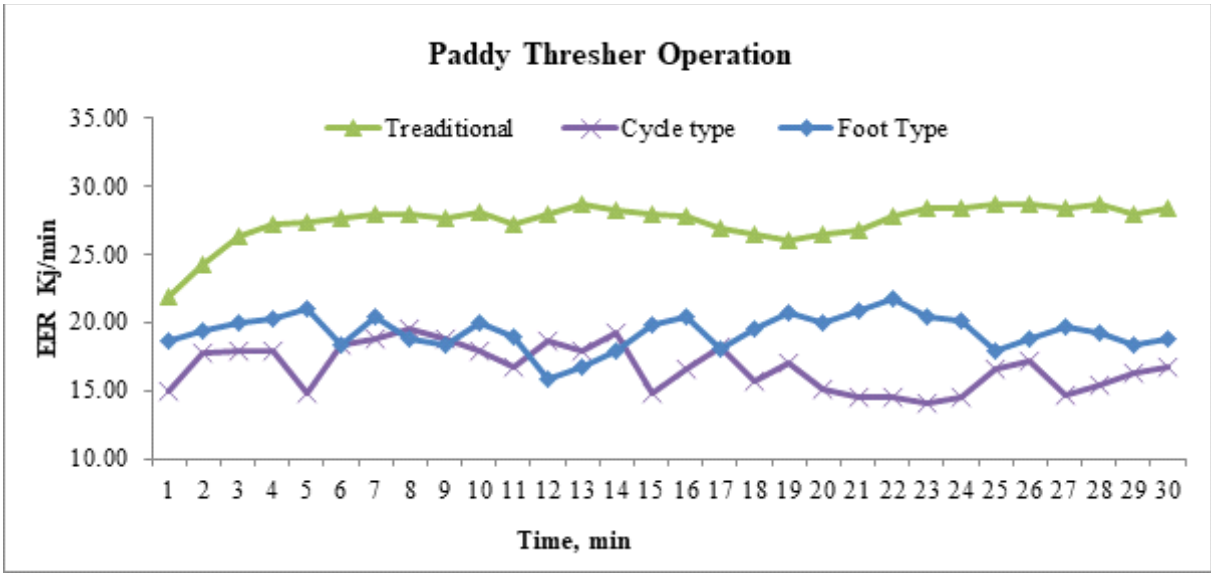

Figure 4. Variation in energy consumption during paddy threshing

Table 5. Recommended work category with the rate of energy expenditure

Sr.No.	Work category	EER, kJ/min
1	Light	<9.10
2	Moderate	9.11-18.15
3	Heavy	18.16-27.22
4	Extremely heavy	>27.22

attaching it to the chest of a farmer with a suitable belt arrangement. The mean heart rate for 30 minutes duration of selected farmers varied from 118 to 135 bpm during paddy threshing by hand beating, 101 to 113 bpm during paddy threshing by cycle-type pedal-operated thresher, and 104 to 116 bpm during paddy threshing by foot-type pedal-operated thresher respectively. The mean working HR, mean resting HR, and mean recovery HR is presented in Table 4. The mean resting HR and mean recovery HR for 5 min duration. It was observed that mean working HR decreased by 19.69 and 15.15 percent in the case of paddy threshing by cycle-type and foot-type paddy thresher compared to hand-beating paddy threshing. It was also noticed that the recovery HR has not come to normal after threshing performed by hand beating for a duration of 5 min. However, more rest may be required to recover the HR after the hand-beating paddy threshing for the duration of 30 min. It was observed that HR was significantly increased ($P<0.05$) in the case of hand-beating paddy threshing compared to paddy threshing by cycle-type and foot-type paddy thresher with the help of paired *t*-test.

Energy Expenditure Rate

The graphical presentation in Fig. 4 showed the variation in energy consumption under working conditions at various processes of rice threshing. The mean energy expenditure varied between 21.86 to 28.70 KJ/min during paddy threshing by hand beating 14.78 to 19.44 KJ/min during paddy threshing by cycle-type pedal-operated thresher and 15.78 to 21.69 KJ/min during paddy threshing by foot-type pedal-operated thresher respectively. The mean±SD energy expenditure was 27.37±1.50 KJ/min, 16.77±1.63 KJ/min, and 19.30±1.29 KJ/min respectively for three different paddy threshing processes. The classification of agricultural work according to energy expenditure values was carried out by Nag *et al*. (1980) (Table 5). It represented that paddy threshing by hand beating is extremely heavy and, paddy threshing by cycle-type pedal-operated thresher and foot-type pedal l-operated thresher are under the heavy category. It

Table 6. Comparison of ODR between traditional paddy threshing and cycle-type pedal-operated thresher for the duration of 30 minutes

Condition	Sample	Mean	SD	df	*t*-value	*P*-value
Traditional paddy threshing	10	3.20	0.92	9	25.92	0.0002
Cycle-type pedal-operated thresher	10	1.60	0.84	-	-	-

Table 7. Comparison of ODR between traditional paddy threshing and foot-type pedal-operated thresher for the duration of 30 minutes

Condition	Sample	Mean	SD	df	*t*-value	*P*-value
Traditional paddy threshing	10	3.20	0.92	9	22.52	0.0115
Foot-type pedal-operated thresher	10	2.10	0.99	-	-	-

was observed that EER decreased significantly by 38.72 percent and 26.66 percent respectively in the case of paddy threshing by cycle-type and foot-type paddy thresher compared to hand-beating paddy threshing. It was also observed that EER is significantly increased ($P<0.05$) in the case of hand-beating paddy threshing compared to paddy threshing by cycle-type and foot-type paddy thresher with the help of paired t-test.

Overall Discomfort Rating (ODR)

The farmers' overall discomfort rating (ODR) was found to be 3.2±0.91 when paddy was threshed manually by hand pounding, as opposed to 1.6±0.84 & 2.1±0.99 while utilizing cycle-type and foot-type paddy threshers. When compared to hand-beating paddy threshing, it was shown that ODR dramatically lowered for cycle-type and foot-type paddy threshers by 50 and 34.37 percent, respectively. When pounding rice crop bundles by hand, the discomfort was mostly caused by the standing posture used. However, when using a foot-type paddy thresher, the discomfort was mostly caused by pedalling while standing. The same findings were reported by Dewangan (2007). The seating configuration of the cycle-type paddy thresher also makes it less uncomfortable. It was also observed that ODR is significantly increased ($P<0.05$) in the case of hand-beating paddy threshing compared to paddy threshing by cycle-type and foot-type paddy thresher with the help of paired *t*-test (Tables 6 and 7).

CONCLUSION

This ergonomic study was carried out to know the workload of Meghalaya farmers working in different types of paddy threshing systems. It was observed that mean working EER, mean energy expenditure, and mean working ODR decreased by 19.69 & 15.15 percent, by 38.72 percent & 26.66 percent, and by 50 and 34.37 percent in case of paddy threshing by cycle-type and foot-type paddy thresher respectively as compared to hand-beating paddy threshing method with a significance level of $P<0.05$. Therefore, the results suggest that cycle-type and foot-type paddy thresher gives better performance from ergonomics perspective as compared to traditional hand-beating method.

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Evaluation of Bio-Efficacy of Various Insecticides Against Pink Bollworm of Bt-Cotton

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ABSTRACT

A field experiment was conducted to evaluate of bio-efficacy of insecticides against cotton pink bollworm with 10 treatments and three replicates at Entomological Research farm, College of Horticulture, Mandsaur, during *Kharif* 2020-21. Nine molecules *viz*; imidacloprid 70% WG @ 50 g *a.i.* / ha, emamectin benzoate 5% SG @ 200 g *a.i.* / ha, lambda cyhalothrin 4.9% CS @ 300 g *a.i.* / ha, thiamethoxam 25% WG @ 200 g *a.i.* / ha, imidacloprid 17.8% SL @ 200 g *a.i.* / ha, indoxacarb 14.5% SC @ 500 g *a.i.* / ha, flubendiamide 20% WG @ 250 g *a.i.* / ha, chlorpyrifos 50% + cypermethrin 5% EC @ 1250 g *a.i.* / ha, Beta-cyfluthrin 8.49% + imidacloprid 19.8% OD @ 1250 g *a.i.* / ha were evaluated. Treatment chlorpyrifos 50% + cypermethrin 5% EC 1250 g *a.i.* / ha was found effectiveness against cotton pink bollworm and followed by beta-cyfluthrin 8.49% + imidacloprid 19.8% OD1250 g *a.i.* / ha.

Key Words: Boll damage, Cotton, Fiber crop, Insecticides, Pink Boll Worm.

INTRODUCTION

Cotton (*Gossypium sp.*) known as "white gold," is a member of the Malvaceae family (Dhawan et al, 2011), grown in India as a *Kharif* cash and fiber crop. Cotton is a globally important fiber crop that is grown in tropical and sub-tropical regions of more than 70 nations. Cotton seeds are primarily used to produce oil, cake as animal feed, linters, and hull. Cotton seed oil is used for edible purposes after hydrogenation, as well as in the manufacture of soap paints and varnishes, in the leather industry and as a lubricant. The pink bollworm (*Pectinophora gossypiella*) is a major pest of cotton that can cause significant damage to crops and reduce yields (Baraskar *et al,* 2019).

Cotton is a leading cash crop and the most widely used non-food crop in the world. China is the world's largest cotton producing country, followed by India, with an area of 120.69 lakh hectares, 362.18 lakh bales, and an average productivity of 510 kg/ha. In India, it is primarily grown in Maharashtra, Gujarat, Madhya Pradesh, Karnataka, Andhra Pradesh, Punjab, Tamil Nadu, and Haryana. In Madhya Pradesh, cotton is grown on 6.16 lakh hectares, with a yield of 20 lakh bales and a productivity of 578 kg lint per ha mainly in the Nimar and Malwa Plateaus, specifically in the districts of Khargone, Khandwa, Indore, Dewas, Ujjain, Neemuch, Mandsaur and Barwani (Anonymous, 2020-21). Cotton requires more than 80 per cent of the pesticides to manage insects and pests. Pest control and farmer profit have suffered as a result of in discriminate pesticide use. Furthermore, approximately 10% of insecticides globally and 45.00% in India are used for insect pest management in cotton crops alone (Nagtilak, 2016).

The pest spectrum of the crop is quite complex, with approximately 1326 species of insects reported on the cotton crop from sowing to maturity in various cotton-growing regions around the world, with 162 insect pests identified in India. Insect infestations are known to reduce crop yields

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Table 1. Treatment details.

Sr. No.	Treatment	Name of insecticide	Applied dose (g or ml/ha)
1	T_1	Imidacloprid 70%WG	50
2	T_2	Emamectin Benzoate 5% SG	200
3	T_3	Lambda Cyhalothrin 4.9% CS	300
4	T_4	Thiamethoxam 25% WG	200
5	T_5	Imidacloprid 17.8% SL	200
6	T_6	Indoxacarb 14.5% SC	500
7	T_7	Flubendiamide 20% WG	250
8	T_8	Chlorpyrifos 50% + Cypermethrin 5% EC	1250
9	T_9	Beta-cyfluthrin 8.49% + Imidacloprid 19.8% OD	1250
10	T_{10}	Untreated check	-

by 56-60 percent (Meghna *et al,* 2018). Aphids [*Aphis gossypii*(Glover)], jassid [*Amrascabiguttulabiguttula* (Ishida)], thrips [*Scirtothripsdorsalis* (Hood)], whitefly [*Bemisia tabaci* (Gennadius)], mealy bugs [*Phenococcus spp*.] and bollworms are major pests of cotton crop (Ramesh *et al,* 2016). Besides this, American boll worm, pink boll worm and spotted boll worm are the major pests in India. Cotton yield loss was 46.5 per cent due to sucking pests alone, with the bollworm complex accounting for 44.5 per cent (Prabhavathi et al, 2018).There are various management practices that should be followed to help mitigate some of the environmental risks associated with growing of cotton (Gill and Bhatt, 2015)

Bt-cotton is a genetically engineered crop. Cotton that has been genetically modified is referred to as transgenic cotton (Choudhary *et al,* 2016 and Gurjar *et al,* 2023). Bt-cotton contains a toxic protein-inducing gene from the soil bacterium *Bacillus thuringiensis*, allowing the crop to produce toxin, resulting in decreased bollworm infestation, reduced insecticide application, increased yield and improved 'Kapas' quality (Kaur *et al,* 2014). Bt-cotton has shown potential in the management of bollworm populations but these cotton hybrids have recently been found to be susceptible to pink boll worm. The continuous cultivation of Bt-cotton reduced bollworm infestation but increased the severity of sucking pest. A number of sprays of various insecticides are required to control pests. It is well known that the continuous and repeated application of various insecticides has resulted in a multiplication of insecticide resistance, but management of these insect pests is a continuous process (Sayyed *et al,* 2011).Keeping in view the present investigation is emphasized to test the new combination molecule with other insecticides against pink bollworm complex.

MATERIALS AND METHODS

The field experiment was carried out at the Research farm, College of Horticulture, Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during *Kharif* season of 2021-2022. The College of Horticulture, Mandsaur is situated in Malwa plateau in Western part of Madhya Pradesh at 23.45^0 to 24.13^0 North latitude, 74.44^0 to 75.18^0 East longitudes and at an altitude of 435 meters above mean sea level. This region comesunder agro climatic zone No.10 of the State.The experiment was made in Randomized Block Design (RBD). The ten treatments were used in this experiment including an untreated control with three replications. A Popular Bt cotton hybrid Dhandev Gold was sown with a spacing of 0.5X0.5 m^2 and date of sowing 13/08/2021. The gross and net plot size for present experiment was 9 m^2 and 6.25 m^2 , respectively. Continuous two foliar applications of insecticides with knapsack sprayer fitted with a hollow cone nozzle at Economic Threshold Level (ETL) were applied. Spraying of insecticides was started at the

Table 2. Bio efficacy of various insecticides on green boll damage against pink boll worm.

Treatment	Applied Dose g.*a.i.*/ha	Green boll damage % (Mean)	Reduction over untreated check (%)
T_1- Imidacloprid 70%WG	50	12.49(20.68)	61.78
T_2- Emamectin Benzoate 5% SG	200	11.99(20.25)	63.31
T_3- Lambda Cyhalothrin 4.9% CS	300	12.73(20.90)	61.05
T_4-Thiamethoxam 25% WG	200	10.99(19.79)	67.85
T_5- Imidacloprid 17.8% SL	200	13.91(21.52)	58.97
T_6- Indoxacarb 14.5 % SC	500	12.99(21.12)	60.25
T_7- Flubendiamide 20% WG	250	10.78(19.02)	67.01
T_8- Chlorpyrifos 50% + Cypermethrin 5% EC	1250	8.78(17.23)	73.13
T_9- Beta-cyfluthrin 8.49% + Imidacloprid 19.8% OD	1250	9.74(18.18)	70.20
T_{10}-Untreated check	-	33.58(35.82)	-
S Em±	-	1.23	-
CD at 5%	NS	2.49	-
CV%	-	13.47	-

Figures in parentheses transformed value

ETL of insect pests. Pre-treatment, observation was taken one day before and post treatment observations were recorded 3, 7 and 10 days after first and second spray.

The observations on sucking insect pests population was taken on 5 plants per plot and 3 leaves per plant. Thrips population was counted on top 03 tender leaves of 05 plants per plot. The last observation of each spray was considered as pre-treatment observation for the next Spray. Green boll damage was counted based on number of healthy and damaged bolls on five randomly selected plants from each treatment before and post of 1st and 2nd sprays. Similarly, observations of open bolls and locules damage by pink bollworm were recorded at the harvest. The data obtained was subjected to statistical analysis after using appropriate transformations. The data obtained were tabulated and analyzed by the method of "Analysis of variance" as suggested by Fisher and Yates (1963).

RESULTS AND DISCUSSION

The results found after insecticidal treatments were presented in Table 2 and 3 showed significantly superior of all the treatments over control in green boll damage, open boll and locule damage due to pink bollworm of cotton during experimentation.

Green Boll Damage

Mean per cent green boll damageddue to pink bollworm of cotton varied between 8.78 to 13.91 % in various treatments.All the treatments showed significantly superior over untreated check (33.58 %) in reduction of the green boll damage during 1st and 2nd sprays. Among the tested insecticides, Chlorpyrifos 50% + Cypermethrin 5% EC (70.13) was showed highest effective in reduction of green boll damage over control and followed by the treatments Flubendiamide 20% WG and Beta-cyfluthrin 8.49% + Imidacloprid 19.8% OD which were at par with Thiamethoxam 25% WG, Emamectin Benzoate 5%

SG, Imidacloprid 70%WG and Lambda Cyhalothrin 4.9% CS all the treatments showed significantly superior over untreated control. Next best treatment was Beta-cyfluthrin 8.49% + Imidacloprid 19.8% OD with 70.20% reductions in green boll damage over untreated check. Kharbade and Wayal (2009) reported that on the basis of pink bollworm larvae per 20 infested green bolls, the percentage damaged green bolls and loculi, open bolls and locule damage and yield of seed cotton, λ-cyhalothrin 5 EC andchlorpyrifos 20 EC were the best treatments, followed by β-cyfluthrin 5 EC. Abudulai et al (2018) suggested that alternate applications of Chlorpyrifos +Cypermethrincan be recommended as a replacement for endosulfan for control of cotton pink bollworms and improvement of cotton yield.

Open boll damage

The overall percent of mean of two sprays revealed that least open boll damage was recorded in Chlorpyrifos 50% + Cypermethrin 5% EC @ 1250 g *a.i.* / ha 5.26 % and next best treatments was Beta-cyfluthrin 8.49% + Imidacloprid19.8% OD@ 1250 g *a.i.* / ha 6.28% open boll damage. The present findings were in accordance with Abudulai *et al* (2018) suggested that (Chlorpyrifos + Cypermethrin) can be recommended for control of cotton open bollworm damage and improvement of cotton yield. Similarly, Gosavi *et al* (2020) found most effectiveness of imidacloprid 19.8% OD against pink bollworm and better improvement in yield. Further, spraying of imidacloprid 19.8% OD on 2nd and 6th day after crossing ETL of moth trap catches in pheromone trap and imidacloprid 19.8% OD showed most effective management of pink bollworm on Bt-cotton and found minimum open boll damage. Sabry (2013) suggested that chlorpyrifos 50% was the most effective pesticide against the pink bollworm larvae.

Locule boll damage

Significantly highest locule damage per cent was noted in untreated check (29.18%). Found the result that treatments,Chlorpyrifos 50% +Cypermethrin 5% EC @ 1250 g *a.i.*/ha (3.09%) showed maximum reduction in locule damage. Treatments Flubendiamide 20% WG and Emamectin Benzoate 5% SG and at par with Lambda Cyhalothrin 4.9% CS and Imidacloprid 70%WG. The next best treatment was Beta-cyfluthrin 8.49% + Imidacloprid 19.8% OD 4.09% reduction in locule damage over untreated check. The present findings were correlated with the results of Gosavi *et al* (2020) lambda-cyhalothrin 5 EC most effective against pink bollworm. Further, spraying of lamda-cyhalothrin 5 EC on 2nd and 6th day after crossing ETL of moth trap catches in pheromone trap showed most effective management of pink bollworm on Bt-cotton. Sabry (2013) suggested that lambda-cyhalothrin was the most effective pesticide against the pink bollworm larvae. Thilagam and Gopikrishnan (2020) and Divya *et al* (2020) revealed that, the application of Chlorpyrifos + Cypermethrinwas found superior over the other treatments with minimum locule boll damaged.

Yield of Cotton

The cotton yield showed significant difference in over untreated check. The highest seed cotton yield was collected with Chlorpyrifos 50% +Cypermethrin 5% EC(22.45 q/ha) spray was at par with Beta-cyfluthrin 8.49% + Imidacloprid 19.8% OD (20.45 q/ha) spray. However, lowest yield was obtained in the Imidacloprid 17.8% SL (11.73 q/ha). The present findings on seed cotton yield corroborated with the results of Nemade *et al* (2017) revealed that highest seed cotton yield was observed with Cypermethrin 5% EC. Asif *et al* (2016) obtained maximum extrapolated yield (2.99 tons / ha) in Chlorpyrifos 50% treated plots. Patel *et al* (2014) and Jakhar and Jat (2021) revealed that application Flubendiamide 20% WG showed best cotton yield and BC ratio. The above findings were in partial agreement with the present study as these studies did not include the combination of insecticides, but individual performance of insecticides in present study also exhibited better.

CONCLUSION

It was concluded that the treatment Beta-cyfluthrin 8.49% + imidacloprid 19.8% OD and Chlorpyrifos 50% + Cypermethrin 5% EC resulted tin maximum reduction in green, open and locule damage in Bt-cotton and found maximum yield as compared to untreated check.

Table 3. Bio efficacy of various insecticides on open boll damagedby pink bollworm (mean of three picking).

Treatment	Applied doses g.*a.i.*/ha	Open boll damage % (Mean)	Reduction over untreated check (%)
T_1- Imidacloprid 70%WG	50	9.98 (18.26)	69.76
T_2- Emamectin Benzoate 5% SG	200	9.17 (17.62)	71.58
T_3- Lambda Cyhalothrin 4.9% CS	300	10.89 (18.69)	68.52
T_4-Thiamethoxam 25% WG	200	8.74 (17.19)	72.92
T_5- Imidacloprid 17.8% SL	200	10.46 (18.86)	67.59
T_6- Indoxacarb 14.5 % SC	500	10.24 (18.66)	68.27
T_7- Flubendiamide 20% WG	250	7.96 (16.38)	75.33
T_8- Chlorpyrifos 50% + Cypermethrin 5% EC	1250	5.26 (11.21)	79.55
T_9-Beta-cyfluthrin 8.49% + Imidacloprid 19.8% OD	1250	6.28 (13.63)	77.50
T_{10}-Untreated check	-	34.88 (36.60)	-
S Em±	-	0.74	-
CD at 5%	NS	2.16	-
CV%	-	10.96	-

Figures in parentheses transformed values

Table 4. Bio efficacy of various insecticides on open boll damaged by pink bollworm (mean of three picking).

Treatment	Applied Dose g.*a.i.*/ha	Locule boll damage % (Mean)	Reduction over untreated check (%)
T_1- Imidacloprid 70%WG	50	5.99 (14.75)	81.25
T_2- Emamectin Benzoate 5% SG	200	5.05 (13.10)	81.91
T_3- Lambda Cyhalothrin 4.9% CS	300	6.01 (14.89)	80.45
T_4-Thiamethoxam 25% WG	200	5.19 (13.16)	82.77
T_5- Imidacloprid 17.8% SL	200	6.64 (14.93)	77.96
T_6- Indoxacarb 14.5 % SC	500	6.23 (14.45)	79.32
T_7- Flubendiamide 20% WG	250	4.64 (12.43)	84.60
T_8- Chlorpyrifos 50% + Cypermethrin 5% EC	1250	3.09 (11.66)	86.43
T_9- Beta-cyfluthrin 8.49% + Imidacloprid 19.8% OD	1250	4.09 (12.09)	86.43
T_{10}-Untreated check	-	29.18 (30.28)	-
S Em±	-	0.52	-
CD at 5%	NS	1.56	-
CV%	-	7.82	-

Table 5. Yield of various insecticides against pink boll worm.

Treatment	Applied Dose g.*a.i.*/ha	Yield (q/ha)
T_1- Imidacloprid 70%WG	50	15.89
T_2- Emamectin Benzoate 5% SG	200	15.55
T_3- Lambda Cyhalothrin 4.9% CS	300	13.25
T_4-Thiamethoxam 25% WG	200	17.85
T_5- Imidacloprid 17.8% SL	200	11.73
T_6- Indoxacarb 14.5 % SC	500	13.09
T_7- Flubendiamide 20% WG	250	19.11
T_8- Chlorpyrifos 50% + Cypermethrin 5% EC	1250	22.36
T_9- Beta-cyfluthrin 8.49% + Imidacloprid 19.8% OD	1250	20.45
T_{10}-Untreated check	-	9.85
S Em±	-	0.94
CD at 5%	NS	2.79
CV%	-	11.46

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Evaluation of Germination on Treated Cowpea Seeds

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ABSTRACT

Seed protectants made from chemicals are commonly used to manage pests in stored pulses. However, these chemicals pose risks to both living organisms and the growth of treated seeds. Therefore, using botanicals for seed treatment is important to ensure germination. Recent research has examined the effectiveness of cashew nut shell liquid as a seed protectant against bruchids. The study aimed to assess how cashew-based treatments affect the germination of treated seeds. Germination studies were conducted using DC-15 cowpea seeds at the soil and water testing laboratory of KVK, Kollam, during 2021-2022. All the cashew-based treatments resulted in higher germination percentages compared to untreated seeds. However, a slight decrease in germination was observed with higher concentrations of cashew treatments during the initial stages. Nevertheless, there were minor differences in germination parameters such as seedling length, seed vigor index, and speed of germination among the treatments.

Key Words: Cashew nut shell liquid, Cowpea, Germination, Protectant, Seed.

INTRODUCTION

Cowpea is an essential pulse crop which is cultivated mostly in tropical and subtropical areas of the world for vegetables, cereals, and as a fodder crop. It is popularly known as poor men's protein source. It is one of the most adaptable pulse crop due to its smothering nature, resistance to drought, ability to restore soil and other multipurpose uses (Oyewale and Bamaiyi, 2013).

Cowpea, however, is prone to insect pests during all stages of growth, including maturation and storage. The pests that cause the most damage are those that appear during the flowering and podding stages, such as the flower thrips, pod borers, and complex of pod and seed sucking pests, as well as the storage pest, bruchids. Pest control programmes using insecticides in various crops around the world unfortunately caused significant environmental harms, pest resurgence, resistance to insecticides, and lethality to non-target organisms, necessitating the introduction of alternatives to harmful insecticides (Oyewale and Bamaiyi, 2013).With benefits like low mammalian toxicity, low risk of pest resistance and pest resurgence, less hazards to non-target organisms, no adverse effect on plants, seed viability, less expensive and easy availability, botanical pesticides are a significant substitute for the use of toxic chemical pesticides (Prakash *et al*, 2008).

Cashew nut shell liquid (CNSL), a byproduct of cashew processing industry, that reported to possess insecticidal property is gaining attention among botanical pesticides. The highly reactive phenolic compounds in CNSL attributes to the insecticidal and fungicidal properties as well as provide excellent preservative effect on timbers, books and stationary to prevent the attack of insects (Gowri and Saxena, 1997). In the present study the effect of CNSL based botanicals on the germination parameters of the treated cowpea seeds was evaluated.

MATERIALS AND METHODS

Germination studies were conducted using grain cowpea seeds of variety DC 15 collected from progressive farmer of KVK, Kollam, The study was conducted at the soil and water testing laboratory of KVK Kollam during the year 2021-2022. The treatments included crude CNSL and CNSL 20 % EC formulation at three different concentrations (2, 4 and 6 mL/kg seed), crushed cashew nut shell (20 g and 40 g/kg seed) and dry

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powdered rhizome of sweet flag (1%) along with chemical check (Malathion 50 EC 0.06 mL/kg seed) and untreated control. Twenty-five healthy seeds per replication were taken and thoroughly mixed with the respective treatments. Two layers of germination paper were placed in a sterile Petri dish of 9 cm diameter for the germination experiment and was moistened with sterile distilled water. The treated seeds were then evenly distributed on the germination paper maintaining suitable distance between them. Sufficient moisture was maintained throughout the experiment. Seeds treated with distilled water served as untreated control (Rawat *et al*, 2018).

Germination

Germination experiment was conducted using cowpea seeds (25 numbers per replication) in a completely randomized block design with 11 treatments and 3 replications. The number of germinated seeds were counted at 1, 2, 3, 4, 5, 6 and 7 DAT. The germination percentage was worked out with the formula proposed by Rajasekaran *et al*. (2017).

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds taken}} \times 100$$

Seedling length

Seedling length was measured on the seventh day after germination with a ruler. Shoot length and root length were measured separately. Shoot length was measured from the tip of the terminal leaf (top most) to the base of shoot while root length was measured from the tip of the primary root to the base of hypocotyls (Dash, 2012). The seedling length was calculated by adding both the shoot and root length and expressed in centimeter (cm).

Seed vigour index I

Seed vigour index 1 was calculated using seedling length and germination percentage. The formula for calculating seed vigour index 1 is as detailed below (Abul-Baki and Anderson, 1973).

Seed vigour index 1 = Germination (%) x Seedling length (cm)

Speed of germination

Speed of germination or germination rate is calculated by the following formula proposed by Maguire (1962). Observations were taken for seven days. The values at each count are added to obtain the germination rate.

$$\text{Speed of germination} = \frac{X1}{Y1} + \frac{X2}{Y2} + \cdots \frac{Xn}{Yn}$$

Where,

Xn – Number of seeds germinated at n^{th} count

Yn – Number of days taken for n^{th} count

RESULTS AND DISCUSSION

Germination

Germination aspects of treated seeds were observed for a period of seven days. It was noted that germination of cowpea seeds were initiated in all the treatments even at 1 DAT. No significant difference was observed in germination percentage of the different treated seeds treatments (Table 1). Among the different botanicals, crushed cashew nut shell at 20 g/Kg seed recorded the highest germination rate (42.67%). This was followed by *A. calamus* 1% (34.67 per cent) and crushed cashew nut shell at 40 g/Kg seed (32.00). The untreated control recorded higher germination per cent of 52.00 and was comparable with the above treatments.

At 2 DAT, cent per cent germination was noticed in untreated control and was statistically similiar with the germination obtained in all other treatments. The observations in botanical treatments *viz*., dry powdered rhizome of *A. calamus* 1% (98.67 %), crushed cashew nut shell at 20 and 40g/Kg seed (93.33 % each), CNSL 20 % EC formulation 2 mL /Kg seed (93.33 %), CNSL 20 % EC formulation 4 mL /Kg seed(90.67 %), CNSL 20 % EC formulation 6 mL /Kg seed(89.33 %), crude CNSL 2 mL /Kg seed (81.33 %) and crude CNSL 4 mL /Kg seed (64.00 %) were recorded.

At 3 DAT, seeds treated with dry powdered rhizome of *A. calamus* 1%, crushed cashew nut shell at 20g/Kg seed and CNSL 20 % EC formulation 2 mL /Kg seed attained cent per cent germination and was comparable with crushed cashew nut shell at 40g/Kg seed, CNSL 20 % EC formulation 4 mL /Kg seed, crude CNSL at 2 mL /Kg seed, crude CNSL at 4 mL /Kg seed and

CNSL 20 % EC formulation 6 mL /Kg seed with germination percentages of 98.67, 98.67, 98.67, 97.33 and 97.33, respectively. Malathion 50 EC recorded the lowest germination per centage (88.00) and was found to be on par with crude CNSL 6 mL /Kg (93.33 %)

Crude CNSL 2 mL /Kg seed, CNSL 20 % EC formulation 2 and 4 mL /Kg seed, crushed cashew nut shell at 20 and 40g/Kg seed and dry powdered rhizome of *A. calamus* 1% attained cent per cent germination of treated seeds at 4 DAT. This was on par with crude CNSL at 4 mL /Kg seed and CNSL 20 % EC formulation at 6 mL /Kg seed with germination percent of 98.67 each and was significantly different from all other treatments. Crude CNSL at 6 mL /Kg seed recorded comparatively lower germination (96.00 %) and was significantly different from all other treatments. The lowest germination per cent of 89.33 was observed in chemical check, malathion 50 EC.

At 5 DAT, cent per cent germination was observed in all treatments except in crude CNSL at 6 mL /Kg seed (97.33 %) and chemical check (90.67%), while both the treatments were significantly different from each other. At 6 and 7 DAT, no significant difference was observed among the treatments since all the treatments recorded cent per cent germination except the chemical check, malathion 50 EC (92.00 %).

Seedling length

Root and shoot length of seedlings of treated grain cowpea were measured at 7 DAT (Table 2).Untreated control recorded the highest root length (5.58 cm). Among the botanicals, CNSL 20 % EC formulation 2 mL /Kg seed recorded the highest root length (5.37 cm) and was on par with all other treatments. The lowest root length was registered in malathion 50 EC (4.14 cm). Shoot length was also found higher in CNSL 20 % EC formulation 2 mL /Kg seed (10.33 cm) among the botanicals and was on par with all other treatments. Shoot length was lowest in malathion 50 EC (4.63 cm). Same as above, highest seedling length (15.70 cm) was observed in CNSL 20 % EC formulation 2 mL /Kg seed and was found on par with untreated control (18.60 cm) which in turn was found to be on par with all other treatments. The lowest seedling length was noticed in chemical check, malathion 50 EC measuring 8.73 cm.

Seed vigour index 1

The treatment, CNSL 20 % EC at 2 mL /Kg seed recorded a higher seed vigour index of 1570.00 which was statistically similiar with untreated control and the value being 1860.33. This was followed by CNSL 20 % EC 4 mL /Kg seed and crushed cashew nut shell at 20 g/Kg seed recording a seed vigour index of 1328.00 and 1318.67, respectively and were on par with all the treatments. The lowest seed vigour index was recorded in chemical check, malathion 50 EC with value of 803.16 (Table 2).

Speed of germination

The speed of germination was recorded throughout the observation period and presented in Table 2 where the untreated control recorded the highest speed of germination (19.00) and was on par with crushed cashew nut shell at 20 g/Kg seed (17.33) and dry powdered rhizome of *A. calamus* 1% (16.77), which in turn was on par with crushed cashew nut shell at 40 g/Kg seed (16.23), CNSL 20 % EC formulation 2 mL /Kg seed (15.39), CNSL 20 % EC formulation 4 mL /Kg seed (14.75) and chemical check, malathion 50 EC (14.26). Crude CNSL 6 mL /Kg recorded the lowest germination rate (12.04).

Although the initial germination percentage was lower in the CNSL based treatments, it hiked to over 95% at 3 DAT, and cent per cent germination was achieved in all treatments at 6 DAT with the exception of the chemical check, malathion 50 EC (92.0%). In the study it was observed that reduction in germination was coupled with increase in CNSL content. Raja (2008) reported a similar decline in germination of treated seeds with increase in CNSL dosage. The germination rate of CNSL treated seeds significantly reduced to 90% in CNSL at 6 mL/kg seed while the lower doses recorded 98% germination. CNSL at higher doses (above 6 mL) caused only 88 % germination. The germination in higher concentrations of crude CNSL was lower when compared to CNSL EC formulation at

Table1. Effect of different treatments on germination of Cowpea seeds (DAT)*

Treatments	1 DAT	2 DAT	3 DAT	4 DAT	5 DAT	6 DAT	7 DAT
Crude CNSL 2mL/kg seed	16.00 (22.88)^{de}	81.33 (68.87)^{bcd}	98.67 (85.77)^{a}	100.00 (89.43)^{a}	100.00 (89.43)^{a}	100.00 (89.43)	100.00 (89.43)
Crude CNSL 4mL/kg seed	14.67 (20.81)^{e}	64.00 (53.70)^{cd}	97.33 (84.14)^{a}	98.67 (85.77)^{a}	100.00 (89.43)^{a}	100.00 (89.43)	100.00 (89.43)
Crude CNSL 6mL/kg seed	12.00 (19.46)^{e}	58.67 (50.37)^{d}	93.33 (75.20)^{bc}	96.00 (78.46)^{b}	97.33 (82.12)^{b}	100.00 (89.43)	100.00 (89.43)
CNSL 20 % EC formulation 2 mL/kg seed	25.33 (30.12)^{bcde}	93.33 (80.76)^{ab}	100.00 (89.43)^{a}	100.00 (89.43)^{a}	100.00 (89.43)^{a}	100.00 (89.43)	100.00 (89.43)
CNSL 20 % EC formulation 4 mL/kg seed	21.33 (27.20)^{cde}	90.67 (72.64)^{abc}	98.67 (85.77)^{a}	100.00 (89.43)^{a}	100.00 (89.43)^{a}	100.00 (89.43)	100.00 (89.43)
CNSL 20 % EC formulation 6 mL/kg seed	17.33 (24.57)^{cde}	89.33 (71.82)^{abc}	97.33 (82.12)^{ab}	98.67 (85.77)^{a}	100.00 (89.43)^{a}	100.00 (89.43)	100.00 (89.43)
Crushed cashewnut shell at 20g/kg seed	42.67 (40.78)^{ab}	93.33 (80.76)^{ab}	100.00 (89.43)^{a}	100.00 (89.43)^{a}	100.00 (89.43)^{a}	100.00 (89.43)	100.00 (89.43)
Crushed cashewnut shell at 40g/kg seed	32.00 (34.36)^{abcd}	93.33 (77.57)^{ab}	98.67 (85.77)^{a}	100.00 (89.43)^{a}	100.00 (89.43)^{a}	100.00 (75.17)	100.00 (75.17)
Dry powdered rhizome of *Acorus calamus* 1%	34.67 (35.56)^{abc}	98.67 (85.77)^{ab}	100.00 (89.43)^{a}	100.00 (89.43)^{a}	100.00 (89.43)^{a}	100.00 (89.43)	100.00 (89.43)
Malathion 50 EC at 0.06 ml/kg seed	25.33 (29.99)^{bcde}	85.33 (67.63)^{bcd}	88.00 (69.73)^{c}	89.33 (71.01)^{c}	90.67 (72.29)^{c}	92.00 (73.57)	92.00 (73.57)
Untreated control	52.00 (46.16)^{a}	100.00 (89.43)^{a}	100.00 (89.43)^{a}	100.00 (89.43)^{a}	100.00 (89.43)^{a}	100.00 (89.43)	100.00 (89.43)
CD(0.05)	(12.255)	(18.961)	(8.106)	(4.709)	(3.424)	N/S	N/S

*DAT- Days after treatment *Mean of three replications Figures in parenthesis are angular*

similar dose. This might have resulted by the higher amount of phenolic compounds in crude CNSL than in 20 % CNSL EC formulation. Asawalam and Anaeto (2014) found significantly higher germination percentage in cowpea seeds treated with botanicals *viz*., *Curcuma longa* L., *Allium sativum* L., *Zingiber officinale Roscoe* , *Garcinia kola Heckel* and Ficus *exasperate Vahl*) while the control recorded the least germination percentage (35 per cent). Kashere *et* (2015) also reported that germination of cowpea seeds was not affected by n- hexane, pet-ether, acetone, steam distillate methanol and ethanol extracts of cashew kernel. Significant difference in seedling length between botanical treatments, chemical check and untreated control was evident from the observations. All the botanical treatments containing CNSL showed a reduced seedling length (ranging from 9.28 – 15.70 cm) than untreated control (18.60 cm), however the seedling length was significantly higher compared to chemical check, malathion 50 EC (8.73 cm).

Table 2. Effect of different treatments on seedling length, seed vigour index I and speed of germination.

Treatment	Root length (cm)	Shoot length(cm)	Seedling length(cm)	Seed vigour index I*	*Speed of germination
Crude CNSL 2 mL/kg seed	4.94^{abcd}	6.62^{cd}	11.57^{cd}	1156.67^{cd}	13.68^{def}
Crude CNSL4 mL/kg seed	5.22^{abc}	6.04^{cd}	11.26^{cd}	1126.33^{cd}	12.75^{ef}
Crude CNSL6 mL/kg seed	4.26^{cd}	5.02^{cd}	9.28^{cd}	928.33^{d}	12.04^{f}
CNSL 20% EC formulation 2mL/kg seed	5.37^{ab}	10.33^{ab}	15.70^{ab}	1570.00^{ab}	15.39^{bcde}
CNSL 20% EC formulation 4mL/kg seed	4.82^{abcd}	8.46^{bc}	13.28^{bc}	1328.00^{bc}	14.75^{bcde}
CNSL 20% EC formulation 6mL/kg seed	4.24^{d}	5.81^{cd}	10.05^{cd}	1005.00^{cd}	14.14^{cdef}
Crushed cashew nut shell at 20g/kg seed	4.93^{abcd}	8.26^{bc}	13.19^{bc}	1318.67^{bc}	17.33^{ab}
Crushed cashew nut shell at 40g/kg seed	4.31^{cd}	6.24^{cd}	10.54^{cd}	1054.33^{cd}	16.23^{bcd}
Dry powdered rhizome of *Acorus calamus* 1%	4.52^{bcd}	7.60^{bcd}	12.12^{bcd}	1212.00^{bcd}	16.77^{abc}
Malathion 50 EC at 0.06mL/kg seed	4.14^{d}	4.63^{d}	8.73^{d}	803.16^{d}	14.26^{cdef}
Untreated control	5.58^{a}	13.02^{a}	18.60^{a}	1860.33^{a}	19.00^{a}
CD (0.05)	(0.972)	(3.445)	(3.714)	(369.062)	(2.682)

Mean of three replications cm-centimeter

Reduction in seedling length of cowpea seeds treated with different concentrations of CNSL was also reported by Raja (2008) where, CNSL treatments at doses more than 6 mL/kg seed affected the seedling length when the germination test was carried out after six months of storage. None of the botanical treatments adversely affected the seed vigour except crude CNSL 6 mL/kg seed (928.33) and chemical check, malathion 50 EC (803.16). A maximum seed vigour index of 1860.33 was observed in untreated control and was found statistically similar to that of CNSL 20 % EC at 2 mL/kg seed (1570.00) which in turn were found to be on statistically comparable with all other treatments and the values ranged from 1005.00 to 1328.00. Seed treatment with higher concentrations of CNSL resulted in decreased seedling vigour in cowpea, redgram and black gram seeds (Raja, 2015; Raja and Sivasubramaniam, 2015).

Crushed cashew nut shell at 20g/ kg seed recorded the highest speed of germination among the botanical treatments (17.33). This was on par with dry powdered rhizome of *A. calamus* 1% (16.77) and crushed cashew nut shell at 40g/ kg seed (16.23). Speed of germination was comparatively lower in crude CNSL than in CNSL 20 % EC formulations. Matias *et* (2017) reported that the germination percentage, rate of germination and the seedling growth of CNSL treated seeds depend not only on the dose but also on the physiology of the tested species.

CONCLUSION

Although all treatments recorded higher germination of treated seeds and did not differ significantly from each other, seedling length, seed vigour index and speed of germination differed slightly among the treatments. Increase in the concentration of CNSL treatments affected the germination parameters in comparatively low range. Considering the germination aspects, crude CNSL at lower concentrations (2 and 4 mL /Kg seed) and CNSL 20 % EC at higher concentrations (4 and 6 mL /Kg seed) can be recommended for eco friendly management of bruchids in storage.

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High-Density Farming of Striped Snakehead *Channa Striata* (Bloch, 1793) in Artificial Tanks

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ABSTRACT

The study was conducted to evaluate the growth performance of Channa striata during high-density farming in artificial tanks. The fish reached an average weight of 420.28± 30.5 g and a length of 35.07± 5.5 cm in 250 days when fed with a formulated diet. The total production was 235.5 kg from an area of 12.6 m^2 during 250 days. The feed conversion ratio was 1.8, and the average production cost per kg was Rs.312/Kg. Though the ammonia level was as high as 9.6-11 mg/l, a higher survival percentage of 97 was recorded. The ability of *Channa striata* to overcome high ammonia levels and lower oxygen levels makes it compatible with high-density farming. It can also be farmed in artificial tanks. This fish can accept formulated feed during all stages of growth. Among the various issues reported by the farmers, marketability was the primary issue.

Key Words: Artificial tanks, Channa striata, Formulated feed, Growth performance, High-density farming, Water quality.

INTRODUCTION

Channa striata is a benthopelagic fish species commonly found in wetlands, freshwater ponds, lakes, reservoirs, canals, swamps, *etc*. It is endemic to India and Southeast Asian countries. *Channa striata* is a nutritious fish since its flesh is abundant with bioactive albumin, amino acids (glycine, lysine, arginine), and fatty acid (arachidonic acid 20:4n-6) (Kumar *et al,* 2022; Vikas *et al,* 2014; Vikas, 2023). The flesh of *Channa striata* possesses wound-healing ability, involves antinociception, gastroprotection, and disease resistance, and acts as an excellent antioxidant agent (Musa *et al,* 2022). Nutritional superiority and fleshy meat having less intramuscular spines enhance consumer demand.

Channa striata can survive in harsh environments with low dissolved oxygen and ammonia high due to air-breathing ability (Chitra *et al,* 2020). They do air-breathing with the support of the supra branchial organ above the gills (Kumar 2020). There is increased demand for farm-produced *Channa striata* as availability from natural grounds became less due to overfishing, destruction of natural breeding grounds by reclamation of wetlands and other natural water bodies, etc. (Chitra *et al,* 2020). Since the tropical climatic conditions are ideal for *Channa striata* farming, there is a massive scope for its culture. High fat and protein are required in their feed since they are typically carnivores and hunt small fishes, insects, tadpoles, frogs, and crustaceans. The non-availability of pellet-weaned seed is a limitation in promoting *Channa striata* farming. The present study aims to evaluate the growth performance of *Channa striata* in artificial tanks when fed with a formulated diet.

MATERIALS AND METHODS

A high-density polyethylene (HDPE) lined tank of 4 m diameter supported by a galvanized iron (GI) frame was used for the study. A water depth of 0.3 m to 1.2 m was maintained during the culture. A continuous water-circulating multi-stage filtration unit continuously removed suspended particles and dissolved ammonia. The slurry and wastewater were sucked from the tank bottom and charged at the rate of 16000 L per hour into the first stage filter- containing nylon nets packed to 200 kg/m^3

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density. The second stage filter, containing ten units of biological sponge, each 600mm×400mm×60 mm in size, separates solid waste while acting as a natural filter to remove ammonia. The third and final stage filtering tank was also a biological filtration unit that contains 8 kg moving bed bioreactor media (K1 media) that provides the most active surface for bacteria to colonize, ensuring aerobic respiration by delivering vigorous aeration in the final stage of filtration to aid faster growth of aerobic bacteria. Water pH was tested using a universal indicator solution (Merck, India) and maintained at an optimum level between 7.0 and 7.5 by adding CaMgCO3 powder.

Eight hundred numbers of healthy striped murrel seeds, each of size 70 mm, were brought from M/s Rosen Fisheries, Fish hatchery, Ernakulam, during July 2022, acclimatized and stocked in the tank and provided gentle aeration using a high-blow air pump of capacity.

120 L/min. Floating formulated feed was administered daily until satiation at 6.00 am, 5.00 pm and 11.00 pm, as detailed in Table 1.

The formulated feed used in the study was procured from M/s Uno feeds Komarada, Bhimavaram– 534 201, W.G. Dt. Andhra Pradesh, India. Standard methods analyzed .This feed for crude protein, crude lipid, moisture, and ash (AOAC, 2000). Moisture was determined by oven-drying at 105°C until constant weight. Crude protein (N×6.25) was determined by the Kjeldahl method after acid digestion using a semi-automated Kjeldahl System (FOSS Kjeltec). Crude lipid was determined by the ether-extraction method using a Soxhlet System (FOSS Soxtec). Ash content was determined by incinerating the sample in a muffle furnace at 550 °C for 24 h. The proximate analysis is provided in Table 2.

Water samples from the culture tank and also source water were collected on the 30th, 120th and 210th day of culture and tested pH, salinity, alkalinity, carbonate, bicarbonate, hydroxide, calcium, magnesium, total hardness, ammonia, nitrite, and sulfide by following the standard procedure (Boyd *et al,*1985).Fishes were collected using a hand net, and length and weight were recorded regularly. The survival percentage was calculated using the following formula:

Survival percentage = (Number of fish at the end of the experiment ÷Number of fish at the beginning of the experiment) × 100.

The feedback of farmers on high-density farming of *Chana striata* was collected using a structured questionnaire. The main points sought were the acceptability of the technology, production ease, water requirement, feed cost, marketability, ecological issues, environmental issues, and replicability. Kirkpatrick's (Kirkpatrick *et al,* 2016) training evaluation was adapted and applied to analyze the farmers' feedback.

RESULTS AND DISCUSSION

The water quality of the culture tank was significantly different from that of the source water. The source water pH was lower, ranging from 4.2 during the rainy season to 5.3 and 5.1 in the consecutive post-monsoon periods, whereas pH varied from 5.9 to 6.6 in the culture tank (Table 3). Salinity was zero throughout the culture since there was no addition of salts. The alkalinity of source water was less during the rainy season (20 mg/l) and slowly increased to 25 mg/l after 150th d and 40 mg/l at the 250th d of culture. The alkalinity was high in the culture tank (120 mg/l) on the 50th day of culture and, after that, reduced to 45 mg/l and 75 mg/l. Carbonate and hydroxide content were zero both in the source and culture water. Calcium content was eight mg/l during the initial phase of the culture, which increased to 10 mg/l during the culture in both cases. Magnesium was 72 mg/l at the initial period and decreased gradually at 150thand 250thd of culture (50 mg/l, 55 mg/l, and 15 mg/l in source and culture water, respectively). Total hardness was high at 80 mg/l on the 50thd of culture and reduced to 65 mg/l and 25 mg/l at a later stage of culture. Ammonia was nil in the source water but increased drastically to 11 mg/l, 10.6 mg/l, and 9.6 mg/l during culture. This shows that *Channa striata* can withstand high ammonia levels and attain satisfactory growth. Nitrite level was high during the 150th d(2.3 mg/l) and the 250th d of culture (0.49 mg/l). Sulfide was nil in source and culture water throughout the culture period.

Table 1. Specification of the feed.

Day	Size (mm)	Quantity of feed offered percentage of body weight
1 to 30	0.6	10.0
31 to 60	1.0	7.0
61 to 90	2.0	5.0
91 to 120	3.0	3.0
121 to 150	4.0	2.0
151 to 300	6.0	1.5

Table 2. Proximate composition of the feed.

Pellet size, (mm)	Moisture (%)	Crude protein, (%)	Crude fat (%)	Crude fiber (%)	Crude ash (%)	Acid insoluble ash (%)	Carbohydrate (%)
10	5.81	33.05	4.49	2.31	12.46	6.37	41.88
7.0	5.92	31.05	4.45	2.52	12.24	6.42	43.81
4.0	3.87	34.12	6.22	2.23	12.33	5.61	39.27
2.0	5.45	33.57	5.44	2.47	12.52	5.31	40.56
1.5	5.69	34.79	6.06	2.45	10.50	4.65	40.51
0.8	5.45	31.10	3.53	2.53	10.46	4.60	46.94

Table 3. Water quality data.

Sr. No.	Water quality Parameter	Unit	Days of culture					
			50		150		250	
			Source	Tank	Source	Tank	Source	Tank
1	pH		4.2	6.6	5.3	6.0	5.1	5.9
2	Salinity	ppt	0	0	0	0	0	0
3	Alkalinity	mg/l	20	120	25	45	40	75
4	Carbonate	mg/l	0	0	0	0	0	0
5	Bicarbonate	mg/l	20	120	25	45	40	75
6	Hydroxide	mg/l	0	0	0	0	0	0
7	Calcium	mg/l	8	8	10	10	10	10
8	Magnesium	mg/l	72	72	50	55	15	15
9	Total	mg/l	80	80	60	65	25	25
10	Ammonia	mg/l	BDL	11.0	BDL	10.6	BDL	9.6
11	Nitrite	mg/l	BDL	BDL	BDL	2.3	BDL	0.49
12	Sulfide	mg/l	BDL	BDL	BDL	BDL	BDL	BDL

Table 4. The growth rate of *Striped murrel.*

Day	Length (cm)	Weight(g)
1	5± 2.0	0.2±0.02
50	7.4± 2.3	20± 1.4
75	15± 3.2	40.66± 3.5
125	19.1± 3.6	110± 8.2
175	30.65 ± 4.5	285.3± 15.5
250	35.07± 5.5	420.28± 30.5

Table 5. Cost economics

Sr. No.	Particular		Amount (Rs)
Capital cost			
1.	Tank and aeration system		50000.00
A. Annual fixed cost			
	a.	Depreciation on capital cost, @20%	10000.0
	b.	Insurance premium @ 2% of the capital cost	1000.00
	c.	Interest on capital cost @8%	4000.00
	Total		15000.00
2	Electricity charges, 8 months@ Rs.200/-		1600.00
3	Feed, 423.9 kg @ Rs115/- per kg		48749.00
	Total		58349.00
	Total Operational cost (A+B)		73349.00
C. Gross benefit			
1	Receipt, 235.5 kg @ Rs.350/- per kg		82425.00
2	Gross income		24076.00
3	Net income		9076.00
3	BC Ratio		1.1

The fish were harvested towards the end of 250 days of rearing. The survival percentage was 97. The fish reached an average weight of 420.28± 30.5 gm from the initial seed weight of 0.2±0.02 gm within 250 days. Similarly, length also increased from 5± 2 cm to 35.07± 5.5 cm. The growth data is given in Table 4.

The total production reported in our culture system was 235.5 kg within 250 days of culture from a tank area of 12.56 m2, i.e., 18.75 kg/ m^2. The average production earlier reported by Rahman *et al*. (2012) from 40 m^2 (1 percent) of natural production system was only 6.06 kg (0.1515 kg/m^2). The significantly higher production observed in the present study indicates the improved efficiency of the aquaculture system and the feed used for this species.

The average production cost was Rs.312/ Kg. The FCR realized from the culture was 1.8. The wholesale market price realized was Rs.350/ kg. The BC ratio was 1.1 (Table 5).

Table 6. Water budget.

Month	Water depth, m	Volume of water, m^3	Water exchange interval, days	Percent water exchanged at a time	Quantity of water exchanged at a time, m^3	Monthly water exchange, m^3
1	0.3	3.768	10	30	1.13	3.39
2	0.3	3.768	8	40	1.51	5.65
3	0.5	6.28	7	50	3.14	13.46
4	0.5	6.28	6	60	3.77	18.84
5	0.8	10.048	5	70	7.03	42.20
6	0.8	10.048	4	80	8.04	60.29
7	1.2	15.072	3	90	13.56	135.65
8	3	90	1.2	15.072	13.56	135.65
TOTAL						415.13

Table 7. Farmers' feedback.

Feedback	Level of Agreement					
	Very high	High	Medium	Low	Very low	Rank
Marketing issues	8	2				1
Water requirement	9	1				2
Feed cost	10					3
Environmental issues		3	5	2		4
Acceptability of the technology	8	2				5
Drudgery				2	8	6
Adoption		1	1	8		7
Ecological issues			2	5	3	8

The water budget is detailed in Table 6. The total water for a single culture was 415.1 m3, and the water required to produce 1 kg of fish was 1.8 m3. Verdegem (2009) reported a water requirement of 5.2 m3 per kg of fish produced in inland conditions. This indicates that the freshwater required in natural inland aquaculture is higher than that required for artificial tank systems.

Feedback from farmers is presented in Table 7. Marketability was reported as the primary issue among various issues, followed by high water requirements. The issue of feed cost was ranked 3rd,and all the farmers reported feed cost as very high.

CONCLUSION

Though the ammonia level was 9.6-11 mg/l, the *Channa striata* performed well, with a survival percentage 97. The ability of *Channa striata* to withstand high ammonia levels and low dissolved oxygen levels makes it compatible with high-density farming in tanks. During all stages of growth, this fish can take formulated feed of appropriate sizes. After the culture period, the fish reached an average weight of 420.28± 30.5 g and a length of 35.07± 5.5 cm. The total production was 235.5 kg during 250 days from an area of 12.56 m^2. The average production cost per kg was Rs.312/-, and the FCR was 1.8. The benefit-cost. The ratio

was 1.1. The water required to produce 1 kg of fish was 1.8 m^3. Among various issues reported by the farmers, marketability was the primary issue. Channa striata is an ideal candidate for high-density farming in artificial freshwater tanks.

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Impact Assessment of KVK Interventions in Tribal Districts of Madhya Pradesh

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ABSTRACT

Krishi Vigyan Kendra Dindori adopted more than 30 villages in different years to enhance income of the tribal families through enhancing farm profitability, engaging rural youth and farm women in subsidiary occupations and imparting skills in agriculture. Keeping in view the above, 100 beneficiaries and 50 non-beneficiaries were selected in 10 villages during 2021-22. Data were collected on different aspects and scoring was done for comparing the impact of activities in adopted villages. It was observed that a total of 48 per cent of respondents were young aged (up to 35 yrs) and 74 per cent the respondents were belonged to schedule tribe caste. Among them 55 and 48 per cent of the respondents were having secondary school education in both categories *i.e.*, beneficiary and non-beneficiary respectively. Farming was main occupation and having medium technical orientation among beneficiaries; and low in non-beneficiaries. Majority of them had small land holding in both categories, whereas 65 per cent have up to 5 cattle and 40 per cent had up to 2 cattle in non-beneficiaries. Majority (62 %) of beneficiaries were medium to high farming experience and 62 per cent non-beneficiaries had low net income. In respect to adoption of agricultural technologies, 55 per cent beneficiaries grouped in medium adoption level, however 64 per cent non-beneficiaries categorized into low adoption level. Overall adoption quotient found 74.6 and 32.72 for beneficiaries and non-beneficiaries respectively.

Key Words: Adopted Villages, Entrepreneurship, Extension activities,Impact, Training, Technologies.

INTRODUCTION

Dindori, a district of Madhya Pradesh state has 3,74,879 ha geographical area spread over 932 villages and has 2,05000 ha area under cultivation. The district has tribal dominated community. The major crops of district are paddy, kodo, kutki, maize, pigeonpea and niger in kharif season and wheat, chickpea, mustard, lentil and linseed in rabi season. The average annual rainfall received in district about 1528 mm. The climate of region is cool and pleasing with temperature ranging from 2ºC to 44ºC. Krishi Vigyan Kendras have adopted villages in different blocks of the district and conducting various activities in collaboration with state department pf agriculture and allied departments. One of the important mandates of Krishi Vigyan Kendra is to provide and improve the knowledge of the trainees about the improved farm practices. KVK's are playing vital role in transfer of agricultural technology and in increasing productivity and income of the farmers. KVKs draws all the information requirement of farmers, most suitable technological suggestions, management of technologies, including optimal use of inputs, changing farm system options (integrated farming, mixed farming and crop diversification, animal husbandry, fisheries), sourcing reputed input dealers, collective action with other farmers, consumer and market demands for products, quality standards for produce, suitable time to buy inputs and sell produce, off-farm income-generation activities and options, approach to credit and loans, sustainable resource management and coping with changing climatic conditions. Therefore, it was desirable to know the impact of KVK trainings on farmer's economic condition. Keeping this in mind, an attention was therefore, focused in present study “An Impact Assessment of KVK Interventions in Tribal Districts of Madhya Pradesh” was conducted with

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Table 1. Details of sample selection.

S.No.	Beneficiary Respondents			Non-beneficiary Respondents		
	Block	Village	Respondents	Block	Village	Respondents
1.	Dindori	Rusamal	20	Dindori	Lukampur	10
2.	Samnapur	Poudi	20	Samnapur	Devalpur	10
3.	Bajag	Pindrukhi	20	Bajag	Khargahna	10
4.	Karanjiya	Dhanras	20	Karanjiya	Mohtara	10
5.	Shahpura	Ghundisarai	20	Shahpura	Indori	10
Total	05	05	100	05	05	50

the specific objectives- To study the socio-personal and economic characteristics of the beneficiaries; and impact of KVK activities on adoption of improved agricultural practices.

MATERIALS AND METHODS

The present study was undertaken in Dindori district of Madhya Pradesh in the year 2021-2022. The dindori district comprises of 7 blocks namely Dindori, Sahpura, Samnapur, Bajag Karanjiya, Amarpur and Mehandwani from these blocks Dindori, Samnapur, Bajag, Sahpura and Karanjiya were selected purposively. Thus, 100 farmers were selected from 05 villages from each selected block. From each selected village 20 beneficiary farmers were selected through random sampling method as respondents for the study purpose. Apart from this, in order to assess the impact of KVK in terms of adoption of improved agricultural production practices a sample of 50 non-beneficiary farmers was selected from control villages. One village from each selected block 10 respondents from each village. Thus, a total of 150 farmers were selected as respondents for the study purpose. The data were collected using a well-structured interview schedule and analyzed by using various statistical tools and methods. To measure the extent of adoption of improved agriculture production technologies an index was developed by following the recommended procedure. The respondents were asked to respond to each item of adoption of these practices with respect to their extent of adoption on a three-point continuum namely full adoption, partial adoption, and non-adoption with respective weightage accorded. Based on the response of each item, total score of individual respondents was computed by summing up these scores. Thus, total score secured by an individual was the obtained score. For each respondent the adoption quotient was worked out by following quotient

$$\text{Adoption Quotient (AQ)} = \frac{\text{Adoption score obtained by respondent}}{\text{Maximum possible adoption score}} \times 100$$

Overall adoption level in the area was also worked out by calculating the arithmetic mean of the adoption quotient of all the respondents as below:

Overall adoption level = $\sum AQ/N$

Where, AQ= Adoption quotient for the respondents, N= Total number of respondents

The adoption scores assigned to each respondent was tabulated and mean score of adoption (x) and standard deviation (SD) were computed. Adoption behavior was categorized into three levels i.e. (i) Low extent of adoption (ii) Medium extent of adoption (iii) High extent of adoption

RESULTS AND DISCUSSION

The majority of the beneficiary respondents belonged to young age group (48 %) Similar trend was also observed in case of non-beneficiary respondents, majority of the respondents, beneficiary (74 %) as well as non-beneficiary (72 %) belongs to schedule tribe group caste category. Forty per cent of the beneficiary respondents educated up to high school and forty-four per cent of the non-beneficiary respondents educated up to high school. Main occupation of the majority was farming with dairy in both category beneficiary and non-beneficiary respondents. It was observed the majority of the beneficiary respondents belong to small sized land holding category with medium level of net income. The frequency distribution of

Table 2. Profile of the respondents.

Variable	Category	Respondents			
		Beneficiaries (n=100)		Non-beneficiaries(n=50)	
		Frequency	Per cent	Frequency	Per cent
Age (Yrs)	Young (Up to 35)	48	48	23	46
	Middle (36 -55)	34	34	19	38
	Old (56 and above)	18	18	08	16
Caste	Schedule caste	20	20	09	18
	Schedule tribe	74	74	36	72
	OBC	05	05	03	06
	General	01	01	02	04
Education	Illiterate	05	05	02	04
	Primary (I to V)	10	10	07	14
	Middle (VI to VIII)	28	28	15	30
	Secondary School (IX to XII)	55	55	24	48
	Graduate (above XII)	02	02	02	04
Occupation	Farming	12	12	07	14
	Farming+Dairy	75	75	30	60
	Farming+Dairy+Service	08	08	09	18
	Business	05	05	04	08
Land holding	Marginal (up to 1 ha)	36	36	12	24
	Small (1.01 to 2.0 ha)	46	46	28	56
	Medium (above 2.0 ha)	18	18	10	20
Net income	Low (up to 1 lakh)	30	30	31	62
	Medium (up to 3 lakh)	62	62	14	28
	High (more than 3 lakh)	08	08	05	10
Animal possession	No animal	12	12	08	16
	Up to 2 animal	15	15	20	40
	Up to 5 animal	65	65	16	32
	Above 5 animal	08	08	06	12
Scientific orientation	Low	22	22	26	52
	Medium	49	49	18	36
	High	29	29	06	12
Farming Experience	Low (upto 10 years)	30	30	10	20
	Medium (11 -20 years)	55	55	35	70
	High (more than 20 years)	15	15	05	10

respondents on their farm family net income appears more in case of beneficiary respondents of the KVKs than those of non-beneficiary respondents. The fig.1 shows frequency distribution of respondents appears to be highly skewed towards higher side of scientific orientation among the respondents from adopted villages of KVK. In case of non-adopted villages, the frequencies fell into a more or less normal distribution, though slightly skewed towards lower side of scientific orientation. Majority of the respondents in both categories had medium level of farming experience (Fig.2)

Overall adoption quotient for different aspects of agricultural production practices were analyzed and results presented in table 3, it is clearly indicated adoption quotient for different aspect of agricultural practices is highly skewed towards beneficiary respondents.

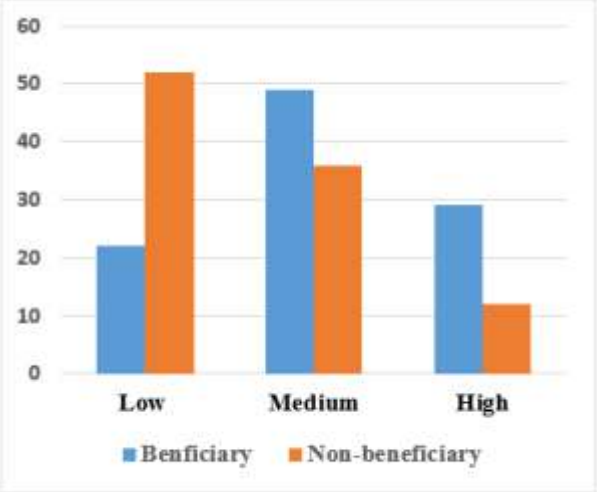

Fig. 1. Scientific orientation of respondents

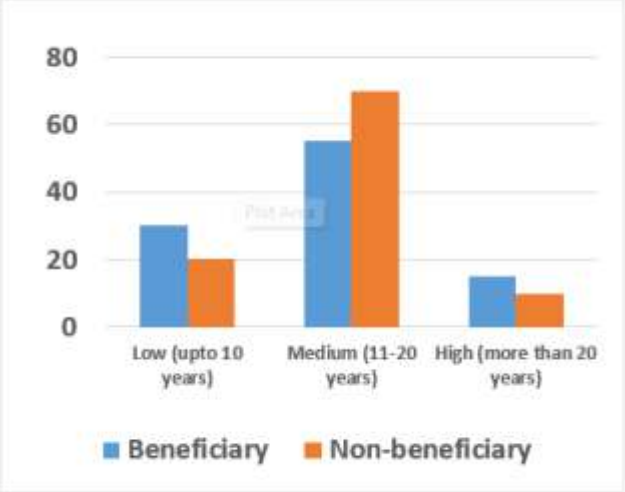

Fig.2 Farming experience of the respondents

Table 3. Overall adoption of improved agricultural production practices.

Aspects	Beneficiary			Non-Beneficiary		
	Total score	Mean score	Adoption quotient	Total score	Mean score	Adoption quotient
Preparatory cultivation	445	4.45	89.00	180	3.60	36.00
Seed & spacing	435	4.35	87.00	175	3.50	35.00
Cropping pattern & crop rotation	455	4.55	91.00	185	3.70	37.00
Fertilizer management	299	2.99	59.80	169	3.38	33.80
Irrigation management	320	3.20	64.00	140	2.80	28.00
Weed management	340	3.40	68.00	154	3.08	30.80
Plant protection	310	3.10	62.00	140	2.80	28.00
Harvest & post -harvest management	380	3.80	76.00	170	3.40	34.00
			596.80			**261.80**

Table 4. Distribution of the respondents according to the level of adoption.

Category	Respondents			
	Beneficiary (n=100)		Beneficiary (n=50)	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Low	12	12	32	64
Medium	55	55	14	28
High	33	33	04	08

Table 5. Difference between adoption quotients of beneficiary and non-beneficiary respondents.

Mean Adoption Quotient	
Beneficiary respondents	Non-beneficiary respondents
74.60	32.72

Level of adoption

The data presented in table 4 revealed that nearly 88 per cent beneficiary respondents had high to medium level of adoption of improved agricultural production practices. While, only 12 per cent of the respondents had low level of adoption. In case of non-beneficiary respondent's majority of the farmers (64 %) had low level of adoption of improved agricultural practices. The results clearly show the non-beneficiary respondents seem to have the low level of adoption and were in agreement with Shelke and Murai (2024).

In obvious from table 5 that the difference between two means was statistically significant. It means adoption quotient of beneficiaries was significantly higher than the adoption quotient of non-beneficiaries. This shows positive and significant impact of activities of KVK on adoption of improved agricultural production technologies. These results occur could be due to the exposure of beneficiary farmers to improved cultivation technologies through demonstration (OFTs, FLDs, CFLDs) and trainings conducted by KVK findings were in agreement with Malabasari and Hiremath (2016), Sharma *et al* (2014).

Impact of KVK activities in farming community

It was observed that, earlier vegetables were brought from neighbor district Jabalpur, now organic vegetables grown in the district, being sold in Jabalpur. Krishi Vigyan Kendra's influence on tribal women was less initially, as they didn't attend the trainings due to hesitation but now, they participate in it frequently. Baiga tribal women stated that earlier they used to attend the farmers fair to eat puri which was not prepared by them but now they cultivate wheat and can make puri as per their wish. It was observed that farmers frequently contacting KVK scientists for agricultural advisories. Kisan Mobile Advisory Services helped them in getting information related to agriculture and allied subjects in time. Various WhatsApp groups made by KVK for day-to-day information as per the requirement of the farmers and crop losses minimized as well as it lead to save the time and money as they need not to visit KVK every time. KVK imparted technical information through the training programmes which lead to enhance the rate of adoption of the new technology. In every activity, quarterly published technical newsletter 'Jawahar Krishi Sandesh' provided to farmers which plays an important role in providing technical information to them. KVK regularly organize various camps, awareness porgrammes i.e. plantation, parthenium eradication, soil health awareness campaign, cuscuta management in niger, health awareness of woman and adolescence children, cleanliness in fields, surroundings and public places of the village which improved the livelihood of the farm families.

CONCLUSION

KVK played important role in enhancing the adoption level of farmers in various aspects of agricultural production technologies. KVK activities created awareness and motivated the other farmers to adopt improved production technologies. KVK seemed to have a positive effect in enhancing the farmers technical knowledge on agricultural production practices. Trainings, on farm trials, frontline demonstration and other extension activities helped in enhancing the knowledge level of farmers which lead to higher adoption of agricultural technologies. The findings indicated that KVK through its spectrum of activities, have a positive impact on farming community in terms of productivity per unit area, income from agriculture, sustainable use of land, water and other resources.

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Impact of *Moringa* Leaf Powder on Tribal Malnourished Adolescent Girls' Health

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ABSTRACT

Moringa oleifera which widely used as vegetable in various part of world, is considered good not only in terms of taste but in health also as it contains eight essential Amino acids and eighteen other amino acids required for the normal growth and development. Its antibacterial properties can protect us against various infections. Anaemia is a widely prevalent health problem among adolescent girls which is defined as low level of haemoglobin in the blood, mainly due to the iron deficiency. The study has been planned to highlight the impact of administration of *Moringa oleifera* leaves in malnourished adolescent girls and the socio demographic factors related to anaemia during 2020-21 in village Sultanpur of Harda district. *Moringa* leaf powder 20 g was incorporated in the daily diet of anaemic adolescent girls for the period of three months. A biochemical test (haemoglobin level) was done after the intervention. The positive impact of *Moringa* was found after intervention that the average Hb level was increased from 10.8 mg/dl to 11.9 g/dl which shows 1.1% enhancement in Hb and BMI was also increased from 17.7 to 18.3.

Key Words: Adolescent girls, Anaemia, Malnutrition, Moringa Leaf Powder, Tribal.

INTRODUCTION

Moringa oleifera Lam. is a multipurpose and exceptionally nutritious vegetable tree with a variety of potential uses (Jeevitha and Sujatha, 2017). The beans, leaves and flowers of *Moringa* are edible and is considered good not only in terms of taste but also in health. Its leaves, fruits, oil, juice, roots, bark, seeds, beans/pods and flowers have medicinal values. *Moringa* leaves contain elements such as Vitamin D, Vitamin C, Vitamin E, Iron, Magnesium, Potassium and Zinc. It is commonly said that *Moringa* leaves contain more Vitamin A than carrots, more calcium than milk, more iron than spinach, more Vitamin C than oranges, and more potassium than bananas", and that the protein quality of *Moringa* leaves rivals that of milk and eggs. *Moringa* leaves are also rich sources of flavanols such as kaempferol and 3'-O Mequercetin (Francis and Amos, 2009).

Adolescence is a significant period of growth and maturation. The World Health Organization (WHO) defines an adolescent as any person between age 10 and 19 year. Adolescent girls are backbone of healthy and progressive family and thus future builders of positive health of community. In today's era adolescent girls are facing many health problems: in that Anaemia is the most prominent one due to their life style modifications like eating junk food, snacking, skipping meals, etc. (Choudhary *et al*, 2020).

In rural Madhya Pradesh, over 58 percent of adolescent girls (aged 15-19 years) suffer from anaemia. 63% population of non-pregnant women age 15-49 years are anaemic and 69.4% women age 15-19 years are anaemic in Harda District of Madhya Pradesh (District Fact Sheet, National Family Health Survey (NFHS-5, 2019-21). The tribals of Madhya Pradesh largely depend on forest produce as their food for livelihood, but the civilization and development process have gradually invaded the forest area, depriving tribal community of their means of existence confronting them to poverty, food insecurity, poor health and malnutrition. Dietary Intake and food habits play a key role in determining the nutritional

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Table 1. Nutrient Content and Shelf Life of *Moringa* Leaf Powder (MLP).

Sr. No.	Test Parameter	Amount (Per 100g)
1.	Energy Value (Kcal)	588
2.	Moisture (gm)	7.00
3.	Protein (gm)	24.16
4.	Iron (mg)	25.9
5.	Calcium (mg)	3900
6.	Vitamin C (mg)	182.5
7.	Vitamin A (mcg)	3413

status whereas inadequate nutrition is responsible for the health problems that may arise due to consumption of unbalanced diet (Bathla *et al*, 2018)

MATERIALS AND METHODS

The study was planned to highlight the burden of anaemia in malnourished adolescent girls and to study the socio demographic factors related to anaemia as it may be helpful further to reduce the associated morbidities by required interventions. The present study was carried out on 20 malnourished adolescent girls aged 13 to 15, in Sultanpur village of Harda block of Harda District during 2020–21 for three months to evaluate the effect of consumption of *moringa* leaf powder along with regular diet and nutrition education. *Moringa* leaf powder was given to them and the processing method of making *moringa* leaf powder was also taught to the respondents i.e. Collecting the leaves, washing, drying in shed, Grinding and then Storage of *moringa* powder so that they could incorporate it in their diet in future. The sample size was estimated on the basis of anaemia prevalence amongst adolescent girls with allowable error of 10%. The anaemic adolescent girls were randomly selected on the basis of the survey carried out with the help of local *Anganwadi* workers. The basis of classifying the adolescent girls as malnourished was their dietary habit and 24-hour diet recall.

The height and weight of the subjects were measured using standard techniques before and after the study. The haemoglobin level amongst these selected malnourished adolescent girls was estimated with the help of haemoglobin colour scale developed by World Health Organization (WHO) which simple, inexpensive clinical devise for diagnosing anaemia. Pre and post evaluation was done to find out the impact of *Moringa* leaf powder on malnourished adolescent girls with the help of questionnaire and observations taken during the study.

RESULT AND DISCUSSION

Dry *moringa* leaves powder a mild positive relationship in the improvement of anaemia. The haemoglobin levels of the adolescence showed a significant improvement post intervention with *moringa* leaves powder. This may be promoted in the community as a dietary supplementation in anaemic girls. After supplementation of 20 g of *moringa* leaves powder approximate Energy 196 Kcal., Protein 7.2 gm, Calcium 1170 mg, Iron 7.7 mg, vitamin C 54.7 mg and Vitamin A 1023.9 mcg extra nutrients are consumed by the adolescence girls. Table-1 shows higher content of protein and iron in *moringa* leaf powder supplemented to adolescent girls under study.

Moringa leaves powder which was included in the daily diet of the tribal adolescent girls for the period of three months, helped them to get rid of from malnutrition and anaemia as it supplemented 19.6 kcal energy, 7.2g protein, 7.7g iron and 1.17g calcium per day (Table 2) to the girls under study over control where no energy source was included.

The Assessment of Anthropometric data shows (Table 3) after conducting Pre and Post intervention among the 20 anaemic tribal adolescence girl age between 13-15 for the period of 90 days the average weight was increased from 43 kg to 44.6 kg respectively. In case of height no

Table 2. Incorporation of *Moringa* Leaf Powder in daily diet of the Respondents.

Detail of Technology	Per capita Consumption (g/day)	Nutrient Intake (Unit)			
		Energy (kcal)	Protein (g)	Iron (mg)	Calcium (mg)
Control group	Not taking MLP in daily diet	-	-	-	-
Intervention group	20 g per day with daily diet	19.6	7.2	7.7	1.17

Table 3. Mean Anthropometric Measurements of Respondents.

Anthropometric parameters	Before intervention (Mean)	After intervention (Mean)
Height (cm)	156	156.1
Weight (kg)	43	44.6
BMI (kg/m ^{2})	17.7	18.3

Table 4. Biochemical Assessment of the Respondents.

Biochemical Analysis (gm/dl)	Normal (gm/dl)	Before Intervention (gm/dl)	After Intervention (gm/dl)
Haemoglobin	12-16	10.8	11.9

significant observation was found as it noted to be 156 cm before and after intervention. Body mass index (BMI) was calculated using formula weight (kg) and height (in m^2) before intervention it was 17.7 and after intervention it was recorded 18.3 (Table 3). Another research study showed that giving MoLP a dose of 500 mg for 14 days had a significant effect (P value = 0.000) on increasing Hb levels in adolescent girls. Before the intervention, respondents with mild anaemia were 90% and those with moderate anaemia were 10%, after the intervention, respondents with mild anaemia were 33%, and respondents with normal Hb levels were 67% (Kurniawati *et al*, 2018)

According to the World Health Organisation (WHO) /UNICEF, the estimated level of haemoglobin (Hb) for mild, moderate, and severe anaemia in adolescent girls are:

- Mild anaemia: Hb level of >11 g/dl. and < 11.9 g/dl.
- Moderate anaemia: Hb level of >8 g/dl. and <10.9 g/dL
- Severe anaemia: Hb level of less than <8 g/dL
- A haemoglobin level of 12 g/dL or higher is considered normal.

The normal Hb level for Adolescent girls is 12 to 16 g/dL. When the haemoglobin level is low, the patient has *anaemia*. An *erythrocytosis* is the consequence of too many red cells; this results in haemoglobin levels above normal.

It was observed that after the supplementation of *moringa* leaf powder, an increase of 1.1 g/dl was noted after 90 days the average of Hb (mean) over intervention which 10.80 g/dl (Table 4). These results indicated a significant difference between Hb before and after the intervention. The supplementation of *moringa* leaf powder appears to be effective in improving the anaemia in adolescent girls. A research study showed that giving MoLP a dose of 25 mg for 3 months had a positive relationship to increase Hb levels in adolescent girls by 1.4 g/dL (Choudhary *et al*, (2020)

CONCLUSION

The findings of the current study demonstrated the benefits of giving malnourished adolescent girls powdered *Moringa oleifera* leaf. The blood haemoglobin percentage of the malnourished adolescent girls showed a notable improvement. Additionally, the BMI improved, indicating that *moringa* leaf powder is highly beneficial in enhancing the malnourished adolescent girls' health.

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Impact of Mulch Thickness on Enhanced Vegetative Growth of *Khirni* and Increased Microbial Populations in Soil

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ABSTRACT

A field study for the effect of mulch thickness on enhanced vegetative growth of khirni and microbial populations in soil cv. Thar Rituraj was conducted during the 2019–20 at the College of Horticulture and Forestry, Jhalawar, Rajasthan. Among different thicknesses, application of T6–12 cm of dry grass to individual plants was significantly superior to all other treatments, but it was on at par with T5–10 cm thickness of dry grass. In treatment T6, an increase in shoot and leaf parameters, such as plant height (32.61%), petiole length (6.64%), leaf length (13.45%), leaf width (18.85%), leaf area (31.03%), leaf perimeter (18.92%), chlorophyll content (29.75%) and microbial populations Bacteria (×105 cfu/g soil) (4.35) and Fungi (×103 cfu/g soil) (3.10) recorded.

Key Words: Dry Grass, Microbial Population, Thar Rituraj and Chlorophyll Content.

INTRODUCTION

Khirni (Manilkara hexandra Roxb.) is one of the important underutilized fruit crops of tropical and sub-tropical region of India. It belongs to the family Sapotaceae or mahua family. It is also known as *Rayan*. *Khirni* is a native of tropical south-east Asia. It occurs naturally in forests and common lands particularly in Central and Deccan peninsular India. Madhya Pradesh is famous for availability of large number of naturally occurring *khirni* trees and production of its best quality fruits. The major *Khirni* growing states in the country are Madhya Pradesh, Gujarat, Rajasthan, Karnataka, Maharashtra, and Tamil Nadu. The genus *Manilkara* contains about 70 genera and 800 species. However, *Manilkara achras* (sapota) is grown commercially as a fruit crop. *Khirni* is a hardy plant and performs well in wide range of soil. It is generally grown on degraded land soil having poor fertility status and low water holding capacity. It can also be cultivated on saline and sodic soil condition. The plant is well adapted to varying climate conditions. It can tolerant extreme hot during summer and extreme cold during winter.

Shah *et al* (2004) studied the effect of the flavonoid rich fraction of the stem bark of *Manilkara hexandra* (Roxb.) Dubard, on gastric ulcers in animal. Oral administration of the ethyl acetate extract (extract A3) inhibited the formation of gastric lesions induced by ethanol. *Khirni* fruits are milky, sweet, sour, cooling, aphrodisiac, appetizer, emollient and tonic. The seeds contain approximately 25 per cent oil which is used for cooking purposes. The fruit is good source of iron, sugars, minerals, protein, carbohydrate, etc. Fresh fruits are good source of vitamin A (675IU).

Mulching is an essential cultural technique which, helps to produce healthier plants. Mulch is often defined as any material applied to the soil surface as cover. It can be divided into two general groups-organic and inorganic. Organic mulches such as dry grass is usually a bi-product of farm waste and decompose readily over time. Inorganic mulches such as plastic sheet does not decompose quickly and may actually remain in the environment for an identify period of time. Both types have found use for various types in horticulture. However; the benefits provided by organic mulch may outweigh the use of inorganic

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Table 1. Effect of mulching on height of the plant (cm) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period

Treatments	Initial value (March)	Height of the plant (cm)					
		April	June	August	October	December	February
T_0 Control (Without mulch)	72.80	73.25 (0.61)	74.69 (2.59)	78.68 (8.07)	79.67 (9.43)	80.10 (10.02)	80.97 (11.22)
T_1 (2 cm thickness of dry grass)	70.45	71.57 (1.58)	73.24 (3.96)	76.87 (9.11)	78.74 (11.76)	80.13 (13.74)	81.42 (15.57)
T_2 (4 cm thickness of dry grass)	71.24	72.45 (1.69)	74.31 (4.30)	77.98 (9.46)	81.12 (13.86)	82.87 (16.32)	84.51 (18.62)
T_3 (6 cm thickness of dry grass)	71.66	73.12 (2.03)	74.84 (4.43)	78.68 (9.79)	81.98 (14.40)	84.35 (17.70)	86.81 (21.14)
T_4 (8 cm thickness of dry grass)	73.54	75.13 (2.16)	77.23 (5.01)	82.26 (11.85)	85.91 (16.82)	87.75 (19.32)	90.32 (22.81)
T_5 (10 cm thickness of dry grass)	68.14	70.12 (2.90)	72.35 (6.17)	78.61 (15.36)	83.02 (21.83)	86.14 (26.41)	89.76 (31.72)
T_6 (12 cm thickness of dry grass)	72.60	74.86 (3.11)	77.32 (6.50)	85.42 (17.65)	89.12 (22.75)	93.05 (28.16)	96.28 (32.61)
SEm ±	-	0.02	0.02	0.07	0.09	0.12	0.30
CD (5%)	-	0.06	0.06	0.22	0.27	0.38	0.91

types. Organic mulch has a number of positive attributes. It conserves soil moisture by reducing water loss thorough evaporation, minimizing soil erosion, moderating soil temperature, inhibiting weed growth, encouraging the growth of beneficial soil microorganism, and reducing the spread of soil-borne pathogen by preventing soil form splashing onto plants during rainstorms and watering. Mulch can also eliminate mowing around tree and shrubs, and mechanical injury to trunk. Keeping in mind the importance of different thickness of mulching current study was planned to enhanced vegetative growth of *khirni* and increased microbial populations in soil. An experiment entitled Impact of mulch thickness on enhanced vegetative growth of *khirni* and increased microbial populations in soil.

MATERIALS AND METHODS

This field experiment was conducted at Department of Fruit Science, College of Horticulture and Forestry, Jhalarapatan, Jhalawar in the newly established orchard of *Khirni* cv. Thar Rituraj during 2019-20. It consists of six mulch treatments along with the control, T_0 (Control), T_1 (2 cm thickness of dry grass), T_2 (4 cm thickness of dry grass), T_3 (6 cm thickness of dry grass), T_4 (8 cm thickness of dry grass), T_5 (10 cm thickness of dry grass) and T_6 (12 cm thickness of dry grass) laid out in randomized block design with three replications. The treatments were applied during first week of March 2019 after recording initial (base) growth and development parameters of plants and observations were noted at 2 months interval for

Table 2. Effect of mulching on petiole length (cm) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period.

Treatments	Initial value (March)	Petiole length (cm)					
		April	June	August	October	December	February
T_0 Control (Without mulch)	0.685	0.686 (0.14)	0.688 (0.43)	0.691 (0.87)	0.693 (1.16)	0.694 (1.31)	0.696 (1.60)
T_1 (2 cm thickness of dry grass)	0.625	0.627 (0.32)	0.630 (0.8)	0.636 (1.76)	0.641 (2.56)	0.644 (3.04)	0.647 (3.52)
T_2 (4 cm thickness of dry grass)	0.781	0.784 (0.38)	0.788 (0.89)	0.796 (1.92)	0.802 (2.68)	0.806 (3.20)	0.810 (3.71)
T_3 (6 cm thickness of dry grass)	0.713	0.716 (0.42)	0.721 (1.12)	0.730 (2.38)	0.740 (3.78)	0.745 (4.48)	0.749 (5.04)
T_4 (8 cm thickness of dry grass)	0.723	0.727 (0.55)	0.733 (1.38)	0.743 (2.76)	0.751 (3.87)	0.757 (4.70)	0.762 (5.39)
T_5 (10 cm thickness of dry grass)	0.699	0.704 (0.71)	0.710 (1.57)	0.721 (3.14)	0.730 (4.43)	0.737 (5.43)	0.743 (6.29)
T_6 (12 cm thickness of dry grass)	0.677	0.683 (0.88)	0.690 (1.92)	0.701 (3.54)	0.709 (4.72)	0.717 (5.90)	0.722 (6.64)
SEm ±	-	0.01	0.02	0.04	0.05	0.08	0.13
CD (5%)	-	0.03	0.07	0.12	0.17	0.25	0.39

a total period of 12 months. For the measurement of rootstock and scion girth of plant marked at a fix point with white paint and values were expressed in mm. The plant height was recorded from the base of soil to highest tip of the plant with the help of measuring scale and noted in centimeter (cm). The numbers of nodes and internodes/ shoot and number of leaves/plants were counted manually. For measuring leaf length, selected tagged leaves under various treatments of *Khirni* were measured in April, June, August, October, December and February. The average increase in leaf length was calculated on the basis of cumulative increase in initial value. The average increase in leaf area index was calculated on the basis of recorded values of leaf area and plant spread as per the given formula (Watson, 1947). The microbial population like bacterial population and fungal population in soil was determined by soil dilution and plate count method (Pramer and Schmidt, 1964).

LAI=(Leaf area)/(Ground area)

The data were statistically analyzed as per analysis of variance technique as suggested by Panse *et al* (1995). The significance of the treatments was tested through F test at 5 per cent level of significance. The critical difference CD was calculated to assess the significance of difference among the different treatments.

RESULTS AND DISCUSSION

The thickness of the dry grass mulch affected plant development. The thickest dry grass, T_6–12 cm, showed the largest increase in plant height (32.61%), whereas T_5–10 cm thick dry grass showed a comparable increase (31.72%)

Table 3. Effect of mulching on leaf length (cm) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period.

Treatments	Initial value (March)	Leaf length (cm)					
		April	June	August	October	December	February
T_0 Control (Without mulch)	3.31	3.32 (0.30)	3.33 (0.60)	3.36 (1.51)	3.38 (2.11)	3.40 (2.71)	3.42 (3.32)
T_1 (2 cm thickness of dry grass)	3.43	3.45 (0.58)	3.48 (1.45)	3.56 (3.79)	3.63 (5.83)	3.68 (7.28)	3.72 (8.45)
T_2 (4 cm thickness of dry grass)	3.55	3.58 (0.84)	3.62 (1.97)	3.72 (4.78)	3.80 (7.04)	3.88 (9.29)	3.93 (10.70)
T_3 (6 cm thickness of dry grass)	3.63	3.67 (1.10)	3.71 (2.20)	3.83 (5.50)	3.92 (7.98)	3.99 (9.91)	4.04 (11.29)
T_4 (8 cm thickness of dry grass)	4.100	4.15 (1.21)	4.20 (2.43)	4.34 (5.85)	4.44 (8.29)	4.55 (10.97)	4.61 (12.43)
T_5 (10 cm thickness of dry grass)	3.80	3.85 (1.31)	3.91 (2.89)	4.06 (6.84)	4.15 (9.21)	4.22 (11.05)	4.30 (13.15)
T_6 (12 cm thickness of dry grass)	3.27	3.33 (1.83)	3.40 (3.97)	3.55 (8.56)	3.64 (11.31)	3.65 (11.62)	3.71 (13.45)
SEm ±	-	0.02	0.04	0.08	0.11	0.14	0.17
CD (5%)	-	0.06	0.12	0.25	0.35	0.43	0.52

(Table 1). T_0-control showed the least amount of plant height increase (11.22%).

Similarly, maximum increase (6.64%) in petiole lenght was noted in T_6 followed with T_5 (6.29%) and minimum increase (1.60%) was observed in T_0 treatment (Table 2). Leaf length maximum (13.45%) application of 12 cm thickness of dry grass followed with application of 10 cm thickness of dry grass (13.15%) and minimum increase with the control (3.32%) (Table 3). From the table 4 and 5, it apparently appears that maximum increase in leaf width and leaf area (19.36 and 31.03%, respectively) was observed with treatment $T_6$and A found at par with T_5 (18.85%, 29.44%, respectively). The lowest increase in leaf width and leaf area (5.77% and 18.13%, respectively) was recorded in control (Table 4 and Table 5). The highest increase (18.92%) in leaf perimeter was observed in T_6-12 cm thickness of dry grass and found at par with T_5 - 10 cm thickness of dry grass (18.36%) (Table 6). The lowest increase (12.98%) in leaf perimeter was noted in T_0- control. Maximum increase in leaf area index and chlorophyll content (1.50% and 29.75%, respectively) was observed with treatment T_6 and found at par with T_5 (1.46, 27.73%, respectively). The lowest increase in leaf area index and chlorophyll content (0.46 and 20.20%, respectively) was recorded in control (Table 7 and Table 8). The treatment T_6- 12 cm thickness of dry grass had maximum microbial population [(Bacteria 4.35 $\times 10^5$ and Fungi 3.10 $\times 10^3$ ($\times 10^5$ cfu/g soil)] in end of the experiment during February and it is found superior over other

Table 3. Effect of mulching on leaf width (cm) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period.

Treatments	Initial value (March)	Leaf width (cm)					
		April	June	August	October	December	February
T_0 Control (Without mulch)	2.25	2.26 (0.44)	2.27 (0.88)	2.31 (2.66)	2.34 (3.99)	2.36 (4.88)	2.38 (5.77)
T_1 (2 cm thickness of dry grass)	2.15	2.17 (0.93)	2.20 (2.32)	2.28 (6.04)	2.33 (8.37)	2.37 (10.23)	2.40 (11.62)
T_2 (4 cm thickness of dry grass)	2.24	2.27 (1.33)	2.31 (3.12)	2.41 (7.58)	2.47 (10.26)	2.52 (12.50)	2.56 (14.28)
T_3 (6 cm thickness of dry grass)	2.56	2.60 (1.56)	2.65 (3.51)	2.77 (8.20)	2.84 (10.93)	2.89 (12.89)	2.95 (15.23)
T_4 (8 cm thickness of dry grass)	2.34	2.39 (2.13)	2.45 (4.70)	2.56 (9.40)	2.63 (12.39)	2.70 (15.38)	2.74 (17.09)
T_5 (10 cm thickness of dry grass)	2.28	2.33 (2.19)	2.40 (5.26)	2.52 (10.52)	2.59 (13.59)	2.63 (15.35)	2.71 (18.85)
T_6 (12 cm thickness of dry grass)	2.22	2.28 (2.70)	2.36 (6.30)	2.47 (11.26)	2.55 (14.86)	2.60 (17.11)	2.65 (19.36)
SEm ±	-	0.04	0.10	0.12	0.11	0.15	0.30
CD (5%)	-	0.13	0.30	0.37	0.34	0.46	0.92

treatments and minimum microbial count [(Bacteria 2.70 $\times 10^5$ and Fungi 1.80 $\times 10^3$ ($\times 10^5$ cfu/g soil)] observed in control (Table 9) at the time of completion of experiment.

The shoot parameters were recorded comparatively better with T_6-12 cm thickness of dry grass treatment as compared to rest of treatments. Healthier shoot attributes observed under T_6 treatment may be due to relatively more amenable effect of this treatment in modification of microclimate, better improvement in texture of soil, conservation of soil moisture, improvement of fertility and control of weeds. This treatment might also influence hydrothermal regimes by changing radiation balance, rate of heat, water vapour transfer and minimized hit of soil with sun more effectively in comparison to other treatments. Effective prevention of moisture deficit leading to improved cell division and elongation, perhaps also led to better shoot parameters in T_6 (12 cm thickness of dry grass) treatments over other treatments evaluated. Similar effect of the mulching on the plant growth was reported by Chattopdhyay and Patra (1992), Borthakur and Bhattacharyya (1996), Mal *et al* (2006). Ali and Gaur (2013).

The effect of mulching on leaf parameters viz., petiole length, leaf length, leaf area, leaf width, leaf perimeter, leaf area index and chlorophyll content observed maximum increase with T_6-12 cm thickness of dry grass. These results may be clarified in the light of improvement of

Table 4. Effect of mulching on leaf area (cm^2) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period.

Treatments	Initial value (March)	Leaf area (cm^2)					
		April	June	August	October	December	February
T_0 Control (Without mulch)	7.28	7.34 (0.82)	7.49 (2.88)	7.96 (9.34)	8.31 (14.14)	8.46 (16.20)	8.60 (18.13)
T_1 (2 cm thickness of dry grass)	7.37	7.45 (1.08)	7.63 (3.52)	8.25 (11.94)	8.57 (16.28)	8.79 (19.26)	8.91 (20.89)
T_2 (4 cm thickness of dry grass)	7.95	8.04 (1.13)	8.28 (4.15)	9.05 (13.83)	9.40 (18.23)	9.62 (21.00)	9.75 (22.64)
T_3 (6 cm thickness of dry grass)	9.28	9.39 (1.18)	9.72 (4.74)	10.61 (14.33)	11.04 (18.96)	11.37 (22.52)	11.50 (23.92)
T_4 (8 cm thickness of dry grass)	9.59	9.72 (1.35)	10.12 (5.52)	11.03 (15.01)	11.48 (19.70)	11.92 (24.29)	12.13 (26.48)
T_5 (10 cm thickness of dry grass)	8.66	8.80 (1.61)	9.21 (6.35)	10.09 (16.51)	10.53 (21.59)	10.84 (25.17)	11.21 (29.44)
T_6 (12 cm thickness of dry grass)	7.25	7.39 (1.93)	7.80 (7.58)	8.79 (21.24)	9.21 (27.03)	9.42 (29.93)	9.50 (31.03)
SEm ±	-	0.03	0.06	0.25	0.21	0.30	0.63
CD (5%)	-	0.10	0.18	0.77	0.64	0.92	1.91

physico-chemical properties of soil through comparatively better congenial environment in the root zone (Kumar *et al,* 2008, Singh *et al,* 2004 in plum and Helaly *et al,* 2017 in gooseberry).

The microbial population [(Bacteria 4.35 $\times 10^5$ and Fungi 3.10 $\times 10^3$ ($\times 10^5$ cfu/g soil)] as presented in Table 4.9 was recorded maximum in T_6 (12 cm thickness of dry grass) treatment at the time of final observation during February. It might be due to the decomposition of applied mulch material. Garg *et al* (2007) reported that the average fungal and bacterial counts in the guava orchard soil were highest under banana leaf mulch.

CONCLUSION

Therefore, it can be said that the administration of treatment T6, which involved applying dry grass with a thickness of 12 cm, had a greater impact on the growth and development of *Khirni* plants. The dry grass with a thickness of 12 cm showed superior growth and development efficacy.

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Table 5. Effect of mulching on leaf perimeter (cm) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period.

Treatments	Initial value (March)	Leaf perimeter (cm)					
		April	June	August	October	December	February
T_0 Control (Without mulch)	9.47	9.52 (0.52)	9.64 (1.79)	9.95 (5.06)	10.39 (9.71)	10.52 (11.08)	10.70 (12.98)
T_1 (2 cm thickness of dry grass)	9.42	9.48 (0.63)	9.68 (2.76)	10.13 (7.53)	10.48 (11.25)	10.65 (13.05)	10.84 (15.07)
T_2 (4 cm thickness of dry grass)	9.75	9.83 (0.82)	10.05 (3.07)	10.54 (8.10)	10.91 (11.89)	11.06 (13.43)	11.27 (15.58)
T_3 (6 cm thickness of dry grass)	10.88	10.98 (0.91)	11.23 (3.21)	11.81 (8.54)	12.20 (12.13)	12.40 (13.97)	12.64 (16.17)
T_4 (8 cm thickness of dry grass)	10.25	10.35 (0.97)	10.60 (3.41)	11.15 (8.78)	11.51 (12.29)	11.75 (14.63)	11.99 (16.97)
T_5 (10 cm thickness of dry grass)	9.69	9.80 (1.13)	10.04 (3.61)	10.59 (9.28)	10.95 (13.00)	11.19 (15.47)	11.47 (18.36)
T_6 (12 cm thickness of dry grass)	9.46	9.58 (1.26)	9.86 (4.22)	10.40 (9.93)	10.79 (14.05)	11.02 (16.49)	11.25 (18.92)
SEm ±	-	0.02	0.05	0.15	0.16	0.13	0.21
CD (5%)	-	0.06	0.14	0.45	0.49	0.39	0.64

Table 6. Effect of mulching on chlorophyll content (mg/g) of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during growth period.

Treatment	Chlorophyll content (mg/g)	
	Initial value (Ma rch)	Final value (February)
T_0 Control (Without mulch)	0.99	1.19 (20.20)
T_1 (2 cm thickness of dry grass)	1.03	1.25 (21.35)
T_2 (4 cm thickness of dry grass)	1.08	1.33 (23.14)
T_3 (6 cm thickness of dry grass)	1.15	1.43 (24.34)
T_4 (8 cm thickness of dry grass)	1.18	1.49 (26.27)
T_5 (10 cm thickness of dry grass)	1.19	1.52 (27.73)
T_6 (12 cm thickness of dry grass)	1.21	1.57 (29.75)
SEm ±	-	0.32
CD (5%)	-	0.99

Table 7. Effect of mulching on soil microbial population of *Khirni* (*Manilkara hexandra* Roxb.) cv. Thar Rituraj during end of experiment (February, 2020).

	Bacteria ($\times 10^5$ cfu/g soil)	Fungi ($\times 10^3$ cfu/g soil)
Initial values	**2.90**	**1.90**
Treatment	**End of experiment (February, 2020)**	
T_0 Control (Without mulch)	2.70	1.80
T_1 (2 cm thickness of dry grass)	2.85	1.93
T_2 (4 cm thickness of dry grass)	3.95	1.97
T_3 (6 cm thickness of dry grass)	3.40	2.20
T_4 (8 cm thickness of dry grass)	3.90	2.55
T_5 (10 cm thickness of dry grass)	4.20	2.90
T_6 (12 cm thickness of dry grass)	4.35	3.10
SEm ±	0.04	0.03
CD (5%)	0.12	0.09

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Influence of Technological Interventions on Yield Attributes, Yield of Field Pea and its Diffusion in Jabalpur District of Madhya Pradesh

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ABSTRACT

To realize the impact of field pea improved cultivar, integrated weed, nutrient and pest management techniques, Integrated Crop Management demonstrations were conducted in participatory mode in *rabi* season during four consecutive years from 2018-19 to 2021-22 at 100 farmers' fields located in fourteen randomly selected villages under five blocks of the district. Four years pooled data revealed that pods/plant under demonstration were 25.71 per cent more to that of farmer's practice. Grains/pod, pod length and test weight (1000 grain) were noted to be 8.7, 6.45 cm and 229.85g respectively in ICM demonstrations which were 30.83, 9.69 and 10.29 per cent higher over farmer's existing practice respectively. Average field pea yield under demonstrated plots was found to be 1956 kg/ha which was 28.43 per cent higher to that of farmers existing practice (1523 kg/ha). Four years economics of the technology demonstrations resulted Rs.21150/ha additional net return over the traditional farmers' practice. The adoption of ICM components of field pea, the revenue increased to a great extent and recorded 272.15 crores in 2021-22 with the additional revenue of Rs.137.38 crores in the district in comparison to that of 134.77 crores before technology dissemination in 2017-18.

Key Words: cultivar, ICM demonstration, promising parameters, yield, adoption, diffusion.

INTRODUCTION

Pulses usually contain 20 to 25 per cent protein by weight which is double the protein content of wheat and three times that of rice. Moreover, pulses subsidize substantively to food production system by enriching the soil through biological nitrogen fixation and improving soil physical conditions. Though pulses are consumed all over the world, its consumption is higher in those parts of the world where animal proteins are scarce and expensive (Ofuya and Akhidue, 2005). Being leguminous in nature, pulses are considered to be important components of cropping systems because of their feasibility to fix atmospheric nitrogen, add substantial amounts of organic matter to the soil and produce reasonable yields with low inputs under harsh climatic and soil conditions (Rakhode *et al*, 2011).

Owing to stagnant pulse production and continuous increase in population, the per capita availability of pulses has decreased considerably. The major constraints in pulse production are inadequate supply of quality seeds, low SRR, insufficient use of inputs, cultivation mostly under rainfed conditions because more than 87% of the area under pulses is presently rainfed, biotic and abiotic stress, technology gap, lack of attractive market price, lack of proper procurement and poor storage facilities of the farm produce (Singh *et al*, 2020). According to recent estimates, pulses were cultivated 28.78 million ha area with the production of 25.46 million tonnes at a productivity level of 885 kg/ha in the country during 2020-21 (Anonymous, 2022). Among the major producing states, Madhya Pradesh is the leading state in the country which contributed 25 percent and 5.97 million tonne of the total pulse production.

Madhya Pradesh is the second largest state in field pea production in the country which

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produces 0.91 million tonnes in 0.2 million hectares of land with productivity of 879 kg/ha (Anonymous, 2022) which is quite low than the National average. Field pea widely grown in Kymore Plateau & Satpura Hills region of the state especially in Jabalpur district however the productivity is quite low looking the availability of the resources. Major cropping pattern of the district is rice-wheat, rice-chickpea, Fallow-fieldpea-wheat-greengram. Nearly 77 percent of the net sown area is double cropped with more than 80 per cent irrigated area in the district. Field pea reported to be grown in 23980 ha in the district during *rabi* 2017-18 with the production of 37200 tone at productivity level of 1520 kg/ha (Anonymous, 2018). There are ample possibilities to uplift the productivity looking the climate and prospective availability of natural resources in the region. The area under field pea in the district is progressively increasing due to heightened irrigated area in the district as well as in the agro-ecological region. Integrated crop management practices can improve the field pea production and productivity by improving vegetative growth, better availability and translocation of nutrients (Ganga Devi *et al*, 2017, Gaur and Jadav 2020, Sharma *et al*, 2005 and Singh *et al*, 2009). Keeping in view the significant role in appropriate transfer of technologies and changing methodical nature of the famers, ICM frontline demonstrations on field pea were conducted in different blocks with the intention to have better impact of the demonstrated technologies on the farmers and field level extension functionaries.

MATERIALS AND METHODS

Frontline demonstrations were conducted in participatory mode on field pea in *rabi* season to evaluate the impact of Integrated Crop Management (ICM); a pragmatic approach to the production of crops; using improved cultivar with integrated nutrient, weed and pest management in rice-field pea, and Fallow-fieldpea-wheat-greengram cropping system at 25 farmers' fields during 2018-19 to 2021-22 respectively in fourteen randomly selected villages spread over five blocks namely Panagar, Majholi, Patan, Shahpura and Sihora of the district. Each demonstration was conducted in an area of 0.40 ha with a check plot closest to the demonstration site was kept as farmers' practice. The improved production technology package included powdery and downy mildew tolerant/resistant cultivars Aman, VRP 5, VRP 6 and Pusa Pragati in 2018-19, 2019-20, 2020-21 and 2021-22 respectively in the demonstrations. Seed treatment was carried out with pre-mix fungicide (carbendazim 12% + menkojeb 63%) @ 2g/kg seed, followed by biofertilizers (rhizobium & phosphate solubilizing bacteria) @ 10g/kg seed for increasing the availability of nitrogen to the crop and better phosphorus use efficiency. All the demonstrations were laid in IInd fortnight of November every year using the seed rate of 75 kg/ha. Sowing was carried out with seed-cum-ferti-drill and the distance between the rows and plants within rows was kept 30 and 10 cm respectively. Soil application of FYM @ 5 t/ha, phosphate solubilizing bacteria (PSB), *Trichoderma viridae* @ 5 kg/ha and vesicular arbuscular mycorrhiza (VAM) was done @ 10 kg/ha respectively in each demonstration before sowing. NPK was applied @ 20:50:20 kg/ha on the basis of soil test values through urea (46% N), single super phosphate (16% P_2O_5 and 12% S) and potassium chloride (60% K_2O). Entire quantities of the NPK fertilizers were applied during sowing. Pendimethalin 38.7% CS as pre-plant incorporation (PPI) was applied through flat fan nozzle sprayer @ 750 g a.i./ha for efficient weed management. Foliar application of plant growth promoting rhizobacteria i.e. *Pseudomonas floroscence* was done twice at 25 and 35 DAS @ 2.5 l/ha for better crop vigour and spray of Emamectin Benzoate 5% SG @ 250 g/ha was done at pod formation stage for control of pod borer and sucking pests. The crop was harvested at maturity stage in IInd fortnight of February every year.

RESULTS AND DISCUSSION

Promising Parameters

The mean promising parameters of the technology demonstrations on field pea (Table 1) revealed that the plant height under demonstrated plot was 97.6 cm which was 4.5 per cent greater over farmers practice (93.4 cm). The yield attributing character i.e. pods/plant under demonstration was 18.48 which were 25.71

Table 1. Effect of technology demonstrations on promising parameters of field pea.

Promising parameters	Unit	Observation		Per cent increase over FP
		Farmers' practice	Improved practice	
Plant height	cm	93.4	97.6	4.50
Pods/plant	Number	14.7	18.48	25.71
Grains/pod	Number	6.65	8.7	30.83
Pod length	cm	5.88	6.45	9.69
Test weight (1000 grains)	g	208.4	229.85	10.29

Table 2. Economics of field pea frontline demonstrations (pooled data of four years).

Particulars	Pooled yield (2018-19 to 2021-22) in kg/ha	Cost of Cultivation (Rs/ha)	Gross Return (Rs/ha)	Net Return (Rs/ha)	Additional Net Return (Rs/ha)	Benefit Cost (B:C) Ratio	Incremental BCR
Improved practice	1956	24232	95844	71612	21150	3.96	0.87
Farmer's practice	1523	24165	74627	50462	--	3.09	--

percent greater to that of farmers' practice. Number of grains/pod, one of the important yield attributes, was recorded to be 8.7 in technology demonstrations and it was 30.83 per cent high over farmer's practice (6.65). The data pertaining to test weight (1000 grains) indicated that it was 229.85g in technology demonstrations which was 10.29 per cent higher over existing practice. The findings confirm with the findings of Yadav *et al* (2007), Meena *et al* (2012); and Meena and Singh (2017) who found higher yield attributes in pulses under FLD plots.

Economic Parameters

Four-year ICM demonstration results revealed that the average field pea yield under demonstrated plots was observed to be 1956 kg/ha (Table 2) which was 28.43 per cent higher over farmers existing practice (1523 kg/ha). Increase in grain, straw and biological yield, harvest index and grain and straw ratio by application of integrated crop management practices that helps in better dry matter partitioning, photosynthetic efficiency, plant protection and better utilization of nutrients, moisture, light and space which resulted more growth and yield attributing character and ultimately more grain, straw and biological yield, harvest index and grain and straw ratio in field pea crop (Kumari *et al,* 2012). The economics of the technology demonstrations indicated that an additional net return of Rs.21150/ha recorded over the traditional farmers' practice. The B:C ratio under technology demonstration was noticed to be 3.96 which was 0.87 units greater over farmers practice (3.09). The higher additional returns and effective gain obtained under technology demonstrations could be due to improved technology, non-monetary factors, timely operations of crop cultivation and technical monitoring. The results were in conformity with the findings of frontline demonstrations on pulses by Chaudhary (2012), Dayanand *et al* (2012), Gauttam *et al* (2011), Lothwal (2010), Meena and Dudi (2012), Meena and Singh (2017) and Yadav *et al* (2004).

Table 3. Yield improvement through ICM dissemination of field pea and additional revenue generation in the district.

Field pea area (ha)			Yield (kg ha $^{-1}$)		Yield enhancement %	Total production in metric tonne (yield/ha x area in ha)		Revenue generation in district (in crores)		Added revenue generation in district (in crores)
BTD * (2017 -18)	ATD @ (2021 -22)	AADT # (2021 -22)	FP¶	IP§		BTD	ATD	BTD (@ Rs.40/ kg)	ATD (@Rs. 49/ kg)	
23980	30500	6520	1405	1821	30.58	33691.9	55540.5	134.77	272.15	137.38

*Before technology dissemination, @After technology dissemination, #Absolute area under disseminated technology, ¶Farmer's practice, §Improved practice

Socio-economic and environmental impact of the technology

Cultivation of improved varieties (Aman, VRP 5, VRP 6 and Pusa Pragati) with proper seed treatment reduced the cost of production as it reduced various seed born/aerial diseases and pest infestation as most of the farmers spray the fungicides after disease initiation which does not effectively control the disease but cost of the production increased. Seed treatment with rhizobium & PSB, soil application of *Trichoderma viridae* and PSB increased the beneficial fungi, solubility and availability of P_2O_5, N_2 fixation; and other essential nutrients to plants which saved phosphatic, potassic and micronutrient fertilizers to the greater extent. Similar results were reported by Rudresh *et al* (2005) in chickpea. The impact of four years of ICM demonstration on field pea evaluated through a detailed survey carried out during 2021-22; and agricultural statistics reported by Farmer's Welfare & Agricultural Development (FW&AD) department which reflected that the demonstrated varieties and other technology components disseminated in 30500 ha over the area recorded before technology dissemination during 2017-18 which was 23980 ha (Table 3). Due to adoption of the improved cultivars and technology, a considerable increase in area was noticed and it reached to 30500 ha in 2021-22 (27.2%) and increased net return that ultimately lifted the socio-economic status of the farming community in the district. Due to ICM practices, the revenue from the crop increased to a greater extent and it recorded 272.15 crores in the district in 2021-22 in comparison to that of 2017-18 (134.77 crores). Additional revenue of Rs.137.38 crores generated through the technology demonstrations in the district.

Horizontal spread of the technology

The block wise net sown area and absolute area under demonstrated technology of field pea (Table-4) revealed that highest area under field pea observed in Shahpura block followed by Patan, Panagar and Jabalpur blocks of the district with 3990, 1345, 602 and 255 ha absolute area under disseminated technology respectively. Since field pea crop requires much water than the other *rabi* legumes i.e. lentil and chickpea, hence among the resources, perhaps availability of irrigation facility due to increased irrigated area largely contributed in the better adoption vis-a-vis area enrichment of the demonstrated field pea technology with remarkable increase in yield.

Table 4. Block wise net sown area and absolute area under field pea after technological interventions.

Blocks	Net sown area in ha (2021-22)	Area under field pea (ha)		
		BTD* (2017-18)	ATD@ (2021-22)	AADT#
Jabalpur	26100	645	900	255
Panagar	36401	328	930	602
Kundam	22917	0	52	52
Patan	52633	8655	10000	1345
Shahpura	59976	14130	18120	3990
Sihora	30100	96	258	162
Majholi	27540	126	240	114
Total	**266698**	**23980**	**30500**	**6520**

*Before technology dissemination, @After technology dissemination, #Absolute area under disseminated technology,

Technology adoption and diffusion mechanism

Subsequent to assessment of improved cultivars with integrated nutrient, weed and pest management techniques through on farm trials; integrated crop management demonstrations on field pea were conducted in *rabi* season during the year 2018-19 to 2021-22. Trainings on different aspects were conducted for farmers and farm women in the study villages, besides this farmers' seminar, training to extension personnel, group discussion and field day was organized and the technology was popularized through news coverage, scientific advisories, popular articles and folders/pamphlets. The neighbour villagers also adopted the whole technological package after conducting the frontline demonstrations in the cluster of villages and the mass diffusion of the technology was carried out in convergence with Agriculture Technology Management Agency (ATMA), Farmer's Welfare & Agricultural Development (FW&AD) through various extension tools.

CONCLUSION

It may be inferred that frost tolerance, powdery mildew resistance in particular and high yielding characteristics which were the strength of demonstrated cultivars, resulted in remarkably greater yield when coupled with integrated nutrient, weed and pest management components. The cluster demonstration approach and various extension tools boosted diffusion of the cultivars which not only raise the grain yield but acreage and revenue of the district at the same instance.

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Management Strategies for *Aphis craccivora* in Broadbean (*Vicia faba*)

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ABSTRACT

Aphis craccivora Koch is a polyphagous aphid and a major pest of legume crops. The yield losses of broad bean due to *Aphis craccivora* Koch is huge. Field trials were conducted during two cropping seasons at Churachandpur district, Manipur to determine the effectiveness of two insecticides including yellow sticky trap in broadbean against *A. craccivora* population and yield of broadbean. The population of the aphids were significantly reduced when the plants received Imidachloprid @ 0.4ml/l and Buprofezin 15% + Acephate 35% WP in broadbean. On the other hand, yellow sticky trap installed treatment significantly decreased the aphid population and increased yield against the untreated plot. The result of the study indicated that that neonicotinoid and organo phosphorus groups of insecticides can be used for management of *Aphis craccivora* population in broadbean against *A. craccivora* and increased the yield.

Key Words: Broadbean, *Aphis craccivora* Koch, Yellow sticky traps, Yield.

INTRODUCTION

Faba bean, commonly known as the broad bean (*Vicia faba*), is widely cultivated as a crop for human consumption, and also as a cover crop. The faba bean is a meat substitute (Ebadah *et al*, 2006) and a major source of plant protein for human use. *V. faba* has a very low content of saturated fatty acids and is an excellent source of proteins, complex carbohydrates and dietary fiber (Crepon *et al*, 2010 and Ofuya *et al*, 2005). Broad bean is grown extensively in both the valley and hilly terrains of Manipur basically in localized pockets on marginal and poor land without any proper care. It is hardy and grown as sole, mixed or intercrops. The crop is grown mostly grown on residual moisture without any assured water supply system in general except in kitchen gardens. However, productivity is far below the national average (Juliana *et al*, 2012). Insect pest species attack faba bean plants at various stages of growth development, of which aphids being the most destructive, resulting in a loss in seed yield of 12.79 to 61.07 percent (El-Defrawi and El-Harty, 2009). Among the insect pest *A. craccivora* Koch a polyphagous aphid species a major pest of legume crops was found the major pest causing direct damage to the plant by sucking the sap deforming it with toxic saliva. Moreover, this pest excretes a large amount of honeydew that attracts ants and encourages the growth of sooty mould, which impart photosynthesis and respiration, resulting in plants deformed and indirect viral disease transmission (Aly, 2014, El-Sarand *et al*, 2019; Khodeir *et al*, 2020). Rekha and Mallapur (2007) reported *A. craccivora* as a serious pest of leguminous crop, which suck the sap from tender shoots, inflorescence and pods resulting in drying up of tender shoot and premature fall of flower buds, flowers and tender pods.

Biotic factors like insect and pests are the major constraints in achieving the potential yield of pulses. The sucking pests which were earlier recognized as minor pests in pulses with lesser economic significance are attaining a status of major pests (Saxena *et al*, 2018). So the management of these sucking pests with chemical

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Table 1. Description of insecticide used

Commercial product	Active ingredient	Application rate	Chemical sub group	Mode of action
Confidor	Imidacloprid 17.8 % SL	0.4 ml/ha	Neonicotinoid	Systemic
Tapuz	Buprofezin 15% + Acephate 35% WP	1250 gm/ha	Organo phosphorus	Systemic and contact

insecticides is neither eco-friendly nor recommended. Reasonable application of insecticides is the basis. Therefore, the insecticides should be applied at the proper rate and at the correct time for controlling aphids successfully (Roy *et al*, 2014). Installation of yellow sticky traps at 1-2 traps per 50-100 m^2 slightly above crop canopy helps to bring down the active flying adult populations of whiteflies, leafhoppers in green gram, black gram and cowpea (Srinivasan, 2014). Pulse productivity and quality has been severely threatened by increasing difficulties in managing these sucking pests due to their ability to evolve resistance to insecticides, resurgence and their secondary outbreak due to indiscriminate and injudicious application of synthetic insecticides (Khatake *et al*, 2023). Thus, the objective of this experiment was to investigate the efficacy of insecticides against *A. craccivora* infestation and to determine the most effective treatment to manage aphid infesting broadbean in relation to yield.

MATERIALS AND METHODS

The present investigation was carried out under the agro-climatic condition of Churachandpur district, Manipur. The experiment was laid out in Randomized Block Design (RBD) and each treatment was replicated five times. Four different treatments modules consisting of T_1 = Buprofezin 15% + Acephate 35% WP, T_2 = Imidachloprid @ 0.4ml/l, T_3 = Yellow sticky trap, including T_0= Untreated control were used against *Aphis craccivora* Koch. All the standard agronomic practices were strictly followed for managing the crop. The crop was raised with recommended package and practices in 2 m x 3 m plots at a spacing of 30 cm x 20 cm. Counts of *Aphis craccivora* were done from three randomly selected leaves (upper, middle and lower)/plant from five randomly selected plants/ plot before and after spray (very next day, third day seventh day and ten days after spray). Observation was taken during early morning hours. The collected data on incidence were subjected to ANOVA after transformation of data. The commercial yellow sticky sheets 20cm (height) x 15 cm (width) size were used. These traps were installed in the field seven days after germination of the crop using bamboo sticks. One trap per treatment plot was installed. Also, care was taken that the height of the trap was one feet above the crop canopy, throughout the experimentation. Observations were recorded at 10 days interval. After recording the data, the yellow sticky trap was changed. The yield of broadbean was recorded from each plot during harvest. The data of pests' population and yield recorded of two years were statistically analyzed and B:C ratio was calculated.

RESULTS AND DISCUSSION

The findings during the two consecutive years indicated that, Buprofezin 15% + Acephate 35% WP and Imidacloprid 17.8 % SL, had higher effects on aphid population without significant differences among them. The effect of different treatments on *Aphis craccivora* Koch incidence showed that Imidacloprid 17.8 % SL significantly superior. The neonicotinoid insecticides were highly effective against various aphid species and reduced the aphid population under field conditions (G Abdu-Allah, 2012). The mean data revealed that maximum numbers of aphid was recorded on T_3 (24.3) aphids/plant and lowest numbers of aphid population/plant was observed in T_2 (11.5) followed by T_1 (15.6) against the T_0 untreated control (107.4) Table 2. Besides, average numbers of aphids were trapped on yellow sticky trap was 48.33 aphids/trap were recorded during the experimental period. The present findings were in accordance with those of Tam and Webb (1993) who reported that *A.*

Table 2. Relative effect of conventional insecticides on the population of *Aphis craccivora* Koch and yield of broadbean during *rabi* 2020-21 and 2021-22.

Treatment	[1]Mean population (no)/plant	[2]Yield (q/ha)	B:C ratio
T_1 = Buprofezin 15% + Acephate 35% WP	15.6 (4.00)	6.4 (2.60)	2.8
T_2 = Imidachloprid @ 0.4ml/l	11.5 (3.45)	7.2 (2.75)	3.3
T_3 = Yellow sticky trap	24.30 (4.29)	6.0 (2.54)	2.5
T_0=Farmer Practice	107.4 (10.38)	5.1 (2.34)	2.0
SEm (±)	0.10	0.15	-
CD (0.05)	0.33	0.46	-

Figures in parentheses are √X + 0.5 transformed values. [1]Mean aphid population of three time intervals under observation based on three application data. [2]Mean broadbean yield (t/ha) based on three replication.

craccivora was caught more often in yellow traps as compared to green traps in watermelon plants. Similarly, Khatake *et al* (2023) reported that white and yellow sticky traps are effective tools against aphid. Roth *et al* (2016) also reported similar result indicating yellow sticky color traps were more effective for aphid. Similar results were observed by Khade *et al* (2014) reported highest percent reduction in population of sucking pests in cowpea by imidacloprid 17.8 SL @ 0.005%. Preetha *et al* (2012) opined that imidacloprid 17.8 SL was quite promising in reducing the population of aphids and leafhoppers on cotton crop. Muhammad Afzal (2014) showed that imidacloprid and diafenthiuron gave maximum mortality against sucking pests of cotton during first spray (92.42 and 88.56%) and second spray (90.87 and 85.67%) after 72 h of application. Another study found that neonicotinoid insecticides were highly effective against cowpea aphid (*Aphis craccivora* Koch) compared to the other groups of insecticides (Patil *et al,* 2017). The results were in agreement with those obtained by Jansen and Warnier (2011).

Effects of insecticides on the yield of broadbean

The pod yield of broadbean under different insecticidal treatments was significantly higher over untreated control. Imidacloprid 17.8 % SL produced the highest pod yield of 7.2 q/ha which was significantly higher than the other all treatments (Table 2). The yellow sticky trap installed treatment significantly produced a yield of 6.0 q/ha. Similarly, the highest B:C ratio was also recorded from Imidacloprid 17.8 % SL (3.3) closely followed by Buprofezin 15% + Acephate 35% WP (2.8) against the untreated plot (2.0), respectively. The finding showed a close resemblance with the research carried out by Mohammad and Semaskiene (2021) reported that applications according to local threshold with contact and systemic insecticides increased grain yield at the same level, and it was in line with the full control treatment. Hodgson *et al* (2012) reported that suitable insecticide timing is decisive for the control of soybean aphid (*Aphis glycines*), and the aphids can recover from insecticide applications in the absence of natural enemies.

The percent avoidable loss due to *Aphis craccivora* Koch infestation varied from nil in Imidacloprid 17.8 % SL sprayed plots to 35.13 % in untreated check. Among the insecticidal treatments maximum avoidable yield loss (18.91%) was observed in yellow sticky installed plot (Table 3). Similarly, the highest marketable yield in terms of increased production over control was recorded from combined application of Imidacloprid 17.8 % SL (29.16%) followed by Buprofezin 15% + Acephate 35% WP (20.31%) respectively.

Table 3. Avoidable loss of broadbean due to *Aphis craccivora* Koch and increase yield of different insecticidal treatments over control during *rabi* 2020-21 and 2021-22.

Treatments	Broadbean yield (q/ha)	Avoidable loss (%)	Increase yield over control	
			(q/ha)	Percentage (%)
T_1 = Buprofezin 15% + Acephate 35% WP	6.4	10.8	1.3	20.31
T_2 = Imidachloprid @ 0.4ml/l	7.2	-	2.1	29.16
T_3 = Yellow sticky trap	6.0	18.9	0.9	15.0
T_0 = Farmer Practice	5.1	35.13	-	-

CONCLUSION

Results of the present findings showed that using of Neonicotinoid and organo phosphorus groups of insecticides gave highest control of aphid and increased the yield broadbean. Thus, both the groups could be included as useful tactic in aphid management however, ensure safe application. Based on the current study it is also indicated that yellow sticky traps are effective tools against aphid. Therefore, they could be used in the integrated pest management program of this insect pest particularly in *Aphis craccivora*.

Figures in parentheses are $\sqrt{X}$ + 0.5 transformed values. [1]Mean aphid population of three time intervals under observation based on three application data. [2]Mean broadbean yield (t/ha) based on three replication.

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Nature of Occupational Mobility of the Tribals in Mayurbhanj District of Odisha from Agriculture to Non-Agriculture Sectors

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ABSTRACT

The tribal people as the dwellers of hills and forests have unproductive and uneconomic holdings, lack of irrigation facilities, traditional skills and primitive implements along with land alienation indebtedness. Their economy revolving around hunting, collecting, shifting cultivation and plough work. Due to lack of sufficient scope for livelihood and deterioration of natural resources on which the tribal people depend much for their hereditary occupation, they migrate to other occupations or other places in search of job. The present study was carried out with the objectives to analyse the nature of the occupational mobility from the agriculture to non-agricultural activities. The study was conducted in Mayurbhanj district of Odisha purposefully in which the tribals occupy 58.72 % of the total population. Four blocks were selected randomly each one from four sub divisions. Fifteen tribal people were selected from each village as respondents randomly from twelve villages, three from each block totaling to sample size of 180. The result showed that majority (72.22 %) of the respondents had crop production as their primary traditional hereditary as well as farming (35.0%) as their primary occupation. On the basis of the study it is suggested that literacy level should be enhanced among the tribal people to increase their efficiency and better understanding of the scientific agriculture which can be implemented for checking mobility of the tribal people from agriculture to non-agriculture sector. There should be more investment and creation of employment opportunity in agriculture sector to make it more remunerative which will also develop more number of entrepreneurs among tribal people.

Key Words: Agriculture, Education, Hereditary occupation, Mobility, Secondary occupation, Tribal.

INTRODUCTION

The tribal people as the dwellers of hills and forests are surviving since time immemorial. Most of tribals have unproductive and uneconomic holdings, lack of irrigation facilities, traditional skills and primitive implements along with land alienation indebtedness. Majority of cultivators use land only in kharif season and migrate to other places for alternative occupation like brickwork, construction work and industrial purposes during lean period. As there are various agencies working for the development of tribal people including line departments. Though due to intervention of different extension activities, the situation has been improving, still there are some areas of concern to be looked into specifically for the overall development. Due to lack of sufficient scope for livelihood and deterioration of natural resources on which the tribal people depend much for their hereditary occupation, they migrate to other occupation or other places in search of job.

Karade (2009) described occupation is one of the best indicators of class, because people tend to agree on the relative prestige they attach to similar jobs. The mobility of the tribal people mainly depends on the availability of work/job, job satisfaction, relative economic advantage etc. The consequences of occupational mobility can be either positive or negative and are not restricted by

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Table.1 Distribution of the respondents according to their Age. (n=180)

Sr. No.	Category	Number	Percentage
1	Young (18-35 years)	103	57.22
2	Middle (36-50 years)	46	25.56
3	Old (more than 50 years)	31	17.22

Table 2. Distribution of the respondents according to their category/caste of tribal. (n=180)

Sr. No.	Category	Number	Percentage
1	Santal	61	33.89
2	Bhumij	36	20.00
3	Kolha	22	12.22
4	Bathudi	18	10.00
5	Bhuyan	16	08.89
6	Ho	09	05.00
7	Munda	09	05.00
8	Sabar	09	05.00

Table 3. Distribution of the respondents according to their Educational Status. (n=180)

Sr. No.	Category	Number	Percentage
1	Illiterate	36	20.00
2	Primary Level	40	22.22
3	Middle school Level	33	18.33
4	Matriculation	40	22.22
5	Higher secondary	18	10.00
6	Graduation	06	03.33
7	Post-Graduation and above	04	02.22
8	Any technical degree	03	01.66

the direction of the movement. Giraldo (1993) observed that a higher educational level in the younger generations would also reinforce migration because of lacking opportunities at home; these potential migrants would continue to flow to unskilled and semi-skilled markets abroad. Chattopadhyay and Khan (2004) stated that occupational mobility dealt with the movements of individuals over job categories during their employment periods. Since the time interval between successive job changes was a random variable. Shniper (2005) found that when economic conditions were favorable, individuals might have more opportunities to change jobs to earn more money, did the kind of work they prefer, or reduced their commuting time. Conversely, when economic conditions were less favorable, fewer opportunities with such desirable characteristics might be available.

Giuseppe and Vella (2008) provided evidence that high unemployment somewhat offsets the role of individual worker considerations in the choice of changing career. Occupational mobility declines with age, family commitments and education, but when unemployment was high these negative effects were weaker, and reversed for college education. Ray and Majumder (2010) indicated strong inter generational stickiness in both educational achievement and occupational distribution among the scheduled castes (SCs) and scheduled tribes (STs), as well as occupational mobility was lower than educational mobility, indicating that

Table 4. Distribution of the respondents according to their Land holding. (n=180)

Sr. No.	Category	Number	Percentage
A	**Land holding**		
1	Less than 0.4 ha	67	37.22
2	Within 0.4-0.8 ha	56	31.12
3	Within 0.8-2.0 ha	42	23.33
4	More than 2.0 ha	15	08.33
B	**Annual Family Income**		
5	More than 1 lakh	22	12.22
6	75,000-1 lakh	09	05.00
7	50,000-75,000	39	21.66
8	25,000-50,000	74	41.11
9	Less than 25,000	36	20.00
C	**Farming Experience**		
10	Less than 5 years	74	41.11
11	5-10 years	47	26.11
12	11-15 years	09	05.00
13	16-20 years	19	10.55
14	More than 20 years	31	17.22

Table 5. Distribution of the respondents according to their extent of social participation. (n=180)

Sr. No.	Organisation	Extent of Participation			
		Very often	Often	Occasionally	Never
		Number	Number	Number	Number
1	Village level society	76(42.23)	73(40.55)	31(17.22)	0
2	Block level society	13(07.22)	45(25.00)	73(40.55)	49(27.23)
3	District level society	03(01.66)	07(03.88)	42(23.33)	128(71.11)
4	State level society	0	0	13(07.22)	167(92.78)
5	National level society	0	0	03(01.66)	177(98.34)

**Figures shown in the parentheses indicates the percentage*

educational progress was not being transformed into occupational improvement. Reddy (2012) observed that majority families (66.67 %) of Alayabad Tanda depend on the cattle-rearing as their main source of living, while most of the families (62.35 %) at the other Tanda primarily depended on cultivation for their livelihood. An analysis of mobility of occupation during the last three generations revealed that among the Sugalis of Alayabad Tanda there was no much change in their traditional occupation i.e., pastoralism from the generation of grandfather to that of ego. On the contrary, he found that at Lakshmaiahkunta Tanda there was a gradual decline of traditional occupation which was of great significance.

Table 6. Distribution of the respondents according to their Cosmopoliteness (n=180)

Sr. No.	Place	Extent of Visit			
		Very often	Often	Occasionally	Never
		Number	Number	Number	Number
1	Visit to block level office	43(23.88)	58(32.22)	70(38.88)	09(05.00)
2	Visit to district level office	10(05.55)	24(13.33)	58(32.22)	88(48.88)
3	Visit to state level office	0	05(02.77)	38(21.11)	137(76.12)
4	Visit to national level office	0	0	02(01.11)	178(98.89)
5	Visit to KVK	15(08.33)	09(05.00)	27(15.00)	129(71.67)
6	Visit to nearby city	13(07.22)	75(41.66)	70(38.88)	22(12.22)

**Figures shown in the parentheses indicates the percentage*

MATERIALS AND METHODS

The study was conducted in Mayurbhanj district of Odisha purposefully as the district enriched with most number of tribal people. The tribals occupy 58.72 % of the total population. The districts and sub divisions were selected purposively where as random sampling technique was followed to select blocks, villages and respondents. Four blocks were selected randomly each one from four sub divisions like Shamakhunta from Baripada Sadar, Kaptipada from Kaptipada, Bijatala from Rairangpur and Jasipur from Karanjia. Three villages were selected randomly from each block. Likewise twelve villages in total were selected randomly. Fifteen tribal people were selected from each village as respondents randomly totaling sample size of 180.

RESULTS AND DISCUSSION

It was found that most of the respondents (57.22 %) belonged to young age group (between 18- 35 years) followed by medium age group (25.56 %) whereas only 17.22 per cent represented to old age group (above 50 years).

It was found that majority of the respondents belonged to Santal caste (33.89%) followed by Bhumij (20 %), Kolha (12.22%), Bathudi (10%), Bhuyan (8.89 %) and 5 per cent each to Ho, Munda and Sabar. It was also conforming to the demographic figure about the distribution of the tribal in the district where Santal and Bhumij caste are predominant.

Education is the way of life for socio-economic development The data revealed that majority of the respondents made their education up to primary level and matriculation level (22.22 % each) followed by illiterates (20%), middle school level (18.33%), higher secondary level (10 %), graduation level (3.33%) and post graduate level (2.22 %). Only few (1.66 %) had technical degree. Thus, it was evident that most of the respondents had very poor educational background.

It was found that the majority of the respondents belonged to marginal land holding category (37.22 %) followed by 31.12 pe rcent having land holding in between 0.4-0.8 ha and 23.33 per cent in between 0.8-2.0 ha. This clearly justified as most of the tribal people were marginal and small farmers. Majority of the respondents had annual family income in the range Rs 25,000 to 50,000 (41.11 %) followed by in the range of 50,000 to 75,000 (21.66 %), less than 25,000 (20 %), more than one lakh (12.22%) and 75,000 to 1.0 lakhs (5 %). Further, it was found that majority of the respondents had total farming experience less than 5 years (41.11%) followed by 5 to 10

years (26.11 %), more than 20 years (17.22 %), 16 to 20 years (10.55 %) and 11 to 15 years (5.0 %). Hence, it was observed as either most of the respondents were young farmers or some were engaged in other vocations.

It was observed that all the respondents had participation in village level society out of which 42.22 per cent, 40.55 per cent and 17.22 per cent had very often, often and occasional participation, respectively. Among them only 7.22 per cent and 1.66 per cent had participated occasionally in state level and national level society respectively. Majority of the respondents (71.11%) never participated in the district level society. They had fairly involvement in the block level societies where 40. 55 per cent occasionally and 25 per cent often participated in these societies.

Cosmopoliteness influences their socio-economic status and mobility of the tribal people. It was found that only 1.11 per cent respondents had visited to national level office occasionally as well as only 2.77 per cent respondents often visited and 21.11 per cent occasionally visited to state level office. From the study it gave impression that 43 per cent and 10 per cent respondents visited to block level office and district level office very often. Out of total respondents 5.0 per cent, 48.88 per cent, 76.12 per cent and 98.89 per cent never visited to block level, district level, state level and national level office any time respectively. It was evident that most of the tribal people had contact within the block level office and also they were somehow access to the district level office whereas there was very poor linkage with the state and national level office. Majority of the respondents (41.66 %) often and 38.88 percent occasionally visited to the nearby city. In that place, 12.22 percent never visited to the city, but 7.22 per cent were very regular visitors of the city. Among the tribal people under survey, 8.33 percent and 5.00 per cent visited to KVK very often and often whereas 15.00 per cent occasionally visited but 71.67 per cent of the respondents were never visited the KVK.

It was clearly indicated (Table 7) that majority (72.22 %) of the respondents had crop production as their primary traditional hereditary occupation whereas collection of minor forest produce as the secondary traditional hereditary occupation which constituted around 26.66 per cent. It was also found that other primary occupations of tribal people under study were wage earning (11.66%), animal husbandry (7.22%), minor forest produce collection (6.66%) and priest work (2.22 %) whereas other secondary occupations were wage earning (25.55%), animal husbandry (22.22%), crop production (20.0 %) and household value added product (5.55 %).

Majority of the respondents had farming (35.0%) as their primary occupation followed by wage earner (20.55 %). Only 7.22 percent respondents had government service and no one had primary occupation on fishery, minor forest produce collection and ritual works. It was also noted from the table that majority of the respondents had animal husbandry as secondary occupation which constituted 35.0 per cent followed by farming (23.88 %), wage earner (16.66 %) and skilled work (14.44 %) like carpentry, masonry work, painting job etc. The finding pointed out that though the tribal people are diverting towards multifarious activities, still most of respondents have farming as their occupation either primary or secondary. Due to changing scenario no one is engaging on some of their traditional occupation like collection of minor forest produce, ritual works.

The findings showed that, majority of the respondents (35.0 %) had fully engaged in the farming sector more than six months in a year whereas 38.88 per cent respondents were engaged less than half of the year in that vocation. Other major area in which the respondents were engaged was the occupation of wage earning in which 20.55 per cents were engaged more than six years whereas 16.66 per cent were involved less than six years. The tribal people also had an affinity to animal husbandry occupation in which 6.66 per cent were fully engaged and 35.0 per cent respondents were partially engaged. The respondents were engaged in the sectors like government service, private/NGO service, industrial sector, political job and contract job those constituted 7.22 , 5.0 , 5.0 , 1.66 and 5.0 per

Table 7.Distribution of respondents according to their traditional hereditary occupation. (n=180)

Sr. No.	Occupations	Primary		Secondary	
		Number	Percentage	Number	Percentage
1	Farming	130	72.22	36	20.00
2	Animal Husbandry	13	07.22	40	22.22
3	Minor Forest Produce Collection	12	06.66	48	26.66
4	House hold value added products	0	00.00	10	05.55
5	Priest work	04	02.22	0	00.00
6	Wage earning	21	11.66	46	25.55

Table 8. Distribution of respondents according to their present occupation. (n=180)

Sr. No.	Sectors	Primary		Secondary	
		Number	Percentage	Number	Percentage
1	Govt. service	13	07.22	0	0
2	Private/NGO service	09	05.00	0	0
3	Business	07	03.88	03	01.66
4	Farming	63	35.00	43	23.88
5	Animal husbandry	12	06.66	63	35.00
6	Fishery	0	0	15	08.33
7	Collection of minor forest produce	0	0	0	0
8	House hold products	09	05.00	0	0
9	Industrial sector	09	05.00	0	0
10	Wage earner	37	20.55	30	16.66
11	Political work	03	01.66	0	0
12	Contract job	09	05.00	0	0
13	Skilled work	09	05.00	26	14.44
14	Ritual works	0	0	0	0

cent, respectively. It was interesting to note that no one was engaged in collection of minor forest product and ritual works.

It was observed that mobility of the respondents according to their occupation was highest in case of agricultural labourer (53.88 %) followed by labour in construction work.

It was amply evident that all the independent variables (socio-economic traits) together had explained 80 % of the variance embedded with the dependant variable *i.e.,* nature of occupational mobility.

CONCLUSION

Although the majority of population in the state still depends on agriculture directly or indirectly, the state economy revolves around the agriculture sector. But in a changing trend there has been diversifying and shift moving away from the agricultural sector to non-farm sectors. On the basis of the finding of the study following points

Table 9. Distribution of respondents according to their nature of occupational mobility. (n=180)

Sr. No.	Mobility to Sectors	Nature of mobility			
		More than 6 months/year		Less than 6 months/year	
		Number	Percentage	Number	Percentage
1	Govt. service	13	07.22	0	0
2	Private/NGO service	09	05.00	0	0
3	Business	07	03.88	03	01.66
4	Farming	63	35.00	70	38.88
5	Animal husbandry	12	06.66	63	35.00
6	Fishery	03	01.66	12	06.66
7	Collection of minor forest produce	0	0	0	0
8	Household produces	06	03.33	03	01.66
9	Industrial sector	09	05.00	0	0
10	Wage earner	37	20.55	30	16.66
11	Political work	03	01.66	0	0
12	Contract job	09	05.00	0	0
13	Skilled work	09	05.00	36	14.44
14	Ritual works	0	0	0	0

Table 10. Distribution of respondents' mobility according to their type of occupation. (n=180)

Socio economic traits	Unstandardised Coefficients		Standardised Coefficients	't' value	Sig.
	B	Std. Error	Beta		
(Constant)	2.078	0.368		5.649	0.000
Age (x_1)	-0.306	0.112	-0.174	-2.740	0.007
Education (x_3)	-0.661	0.063	-0.811	-10.470	0.000
Land holding (x_7)	-0.205	0.048	-0.480	-4.251	0.000
Annual family income (x_{12})	-0.550	0.146	-0.498	-3.767	0.000
Farming experience (x_{13})	0.015	0.011	0.108	1.411	0.160
Social participation (x_{15})	0.225	0.056	0.383	4.022	0.000
Cosmopoliteness (x_{16})	0.097	0.050	0.213	1.958	0.052
Dependent Variable (y): Occupational mobility					

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.895	0.800	0.780	0.632

Table 11. Multiple regression analysis of nature of occupational mobility with the socio-economic traits of respondents.

Sr. No.	Type of work	Extent of mobility					
		Always		Sometimes		Never	
		Number	%	Number	%	Number	%
1	Agricultural labourer	97	53.88	0	0	83	46.11
2	Labour in industrial sector	09	05.00	0	0	171	95.00
3	Brick making	09	05.00	18	10.00	153	85.00
4	Labour in construction work	18	10.00	09	05.00	153	85.00
5	Domestic servant	0	0	09	05.00	171	95.00
6	Supervising job	09	05.00	0	0	171	95.00

were suggested which can be implemented for checking mobility of the tribal people from agriculture to non-agriculture sector. The literacy level should be enhanced among the tribal people to increase their efficiency and better understanding of the scientific agriculture. There should be more investment and creation of employment opportunity in agriculture sector to make it more remunerative which will also develop more number of entrepreneurs among tribal people.

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Opinion of Farmers regarding Video-Based Information Dissemination for Tomato Cultivation

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ABSTRACT

Information and Communication Technology (ICT), including video resources, plays a crucial role in bridging this gap by enhancing access to innovative agricultural techniques. This study focused on assessing this effectiveness of instructional videos on tomato cultivation, aiming to ascertain farmers' opinion regarding different aspects of the video. A total of 160 respondents were selected for the study and the data were collected using a structured interview schedule. The videos covered key aspects of tomato cultivation, and farmers were asked to give their opinion based on accuracy, content coverage, relevance, clarity, and other criteria. Results indicated that the instructional videos were well-received, with 72.5 per cent of respondents rating them highly for accuracy, 75.0 per cent for content coverage, and 88.8 per cent for relevance. The positive opinion underscores the potential of video-based education in agriculture. The integration of such instruction videos can provide farmers with accessible, reliable, and comprehensive information, ultimately improving agricultural practices and outcomes.

Key Words: Dissemination, Information, Instruction, ICT, Opinion, Videos.

INTRODUCTION

Agricultural extension involves not only the dissemination of technological packages developed by researchers but also the sharing of experiences and effective techniques among local farming communities. Various extension methods and approaches have been employed over the years. These include the agricultural technology management agency (ATMA), commodity approach, extension reforms approach, farming system approach (FSA), general extension approach, information and communication technology (ICT), participatory approach, project approach (Kareem and Phand, 2018). Some of these methods aim to provide first-hand information and tailored advice to meet the specific circumstances and needs of farmers (Karubanga *et al,* 2016; Okry *et al,* 2014).

Despite the efficacy of these approaches, rural farmers often lack access to best practices and knowledge essential for enhancing their skills and organizational capabilities to capitalize on market opportunities. In the rapidly evolving landscape, ICT plays a crucial role in supporting agricultural extension efforts by facilitating the dissemination of innovative practices. Technologies such as television, radio, video, telephones and social media significantly improve farmers' access to information and stimulate learning (Bashir *et al*, 2022; Bentley *et al*, 2014). Videos complement traditional extension tools, particularly in situations where resources for demonstrations are limited. Consequently, videos have been widely utilized across various contexts (Zossou *et al,* 2009; Zossou *et al* 2016). Karubanga *et al* (2016) demonstrated that in Uganda, videos effectively complement traditional extension methods and can fill gaps left by the absence of extension agents.

Videos integrate both auditory and visual elements. Given the favorable results obtained from the use of videos in agriculture and other contexts, disseminating agricultural information through videos, such as tomato cultivation

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practices, can significantly enhance farmers' knowledge. This improvement in knowledge can lead to the adoption of better practices and ultimately increase productivity. However, there are no studies in the literature on developing videos specifically for tomato cultivation.

These videos covered various practices, including nursery raising, irrigation scheduling, weed management, insect-pest management, disease management, and harvesting of tomato crops. After developing these videos, they were shown to tomato growers, who were then asked for their opinions on different aspects of the videos. Therefore, this study aimed to ascertain the opinions of tomato growers regarding these developed videos.

MATERIAL AND METHODS

The present study was conducted in the Punjab state, specifically targeting two districts namely, Amritsar and Patiala in Punjab. These districts were purposively selected due to the extensive area under tomato cultivation, making them ideal for this research. From each district, two villages were randomly selected from each block, resulting in a total of eight villages being included in the study. Twenty respondents were selected from each of the eight villages, therefore, a total of 160 respondents were selected for the study. An interview schedule was meticulously prepared and utilized for data collection from the tomato growers, ensuring that comprehensive and relevant information was obtained regarding their opinion towards the developed videos.

The videos on tomato cultivation were meticulously developed through a structured process that included both the development and validation phases. Initially, content for the videos was carefully crafted to cover essential aspects of tomato cultivation, ensuring accuracy, clarity, and relevance. Experts in the field were consulted to validate the content, and the videos were subsequently refined based on their feedback. Once finalized, these videos were exposed to the selected tomato growers. The growers were then asked to provide their opinions on various aspects of the videos, such as accuracy, coverage of content, relevancy, clarity, addressability of queries, mode of video screening, simplicity of message, self-explanatory nature, intent of motivation, usefulness, newness of ideas, and duration.

RESULTS AND DISCUSSION

Opinion of respondents towards different aspect of instructional videos

The analysis of respondents' opinion toward instructional videos highlighted several key aspects contributing to the effectiveness of these educational tools. The accuracy, coverage, relevancy, and clarity were highly rated, indicating the videos' strong credibility and comprehensiveness were crucial for building trust and ensuring effective knowledge transfer among tomato growers.

Accuracy of the videos

The accuracy refers to how well a video reflects the correctness of the subject matter. In this case, 72.5 per cent of respondents found the video to be fully accurate, indicating a high level of confidence in the information presented. The mean opinion score of 2.73 out of 3 suggested that viewers perceive the video as mostly or completely accurate, which was crucial for building trust and credibility. The findings emphasized that providing reliable information is essential for successful knowledge transfer, aligning with previous research that highlights the significance of accuracy in educational media (Smith *et al,* 2020).

Coverage of content

The coverage of content assessed whether the video adequately addressed the topics it intends to be covered. In present investigation, 75.0 per cent of respondents felt that the videos fully covered the content, indicating a comprehensive treatment of the subject matter, while 10 per cent found that the content of the videos was somewhat covered and 15 per cent felt that videos content was not fully covered, suggesting room for improvement. The mean opinion score of 2.60 out of 3 suggested that most of the content was covered as per the opinion of the respondents. Comprehensive coverage of essential topics ensured that the audience can apply the knowledge practically, which is vital for

Table 1. Distribution of respondents according to their opinion regarding different aspects of the instructional videos (n=160).

Sr. No.	Opinion towards different aspects of the videos	Frequency	Percentage	Opinion score Mean ±SD
1.	**Accuracy**			
	Fully accurate	116	72.5	2.73±0.45
	Somewhat accurate	44	27.5	
	Not accurate	0	0.0	
2.	**Coverage of content**			
	Fully covered	120	75.0	2.60±0.74
	Somewhat covered	16	10.0	
	Not fully covered	24	15.0	
3.	**Relevancy**			
	Relevant	142	88.8	2.89±0.32
	Somewhat relevant	18	11.3	
	Not relevant	0	0.0	
4.	**Clarity**			
	Clear	144	90.0	2.90±0.30
	Somewhat clear	16	10.0	
	Not clear	0	0.0	
5.	**Addressability of queries**			
	Fully address queries	105	65.6	2.52±0.63
	Somewhat queries	33	20.6	
	Not address queries	22	13.8	
6.	**Mode of video screening**			
	Appropriate	134	83.8	2.84±0.37
	Somewhat appropriate	26	16.3	
	Not appropriate	0	0.0	
7.	**Simplicity of message**			
	Simple	140	87.5	2.88±0.33
	Somewhat simple	20	12.5	
	Not simple	0	0.0	
8.	**Self-explanatory**			
	Self-explanatory	160	100.0	3.00±0.00
	Moderately self-explanatory	0	0.0	
	Not Self-explanatory	0	0.0	
9.	**Intent of motivation**			
	Highly motivation	98	61.3	2.61±0.49
	Somewhat motivation	62	38.8	
	Not at all motivation	0	0.0	
10.	**Usefulness**			
	Useful	103	64.4	2.46±0.79
	Somewhat useful	27	16.9	
	Not useful	30	17.7	
11.	**Newness in ideas**			
	New	90	56.2	2.43±0.71
	Somewhat new	49	30.6	
	Not new	21	13.1	
12.	**Duration**			
	Appropriate	160	100.0	3.00±0.00
	Somewhat appropriate	0	0.0	
	Not appropriate	0	0.0	

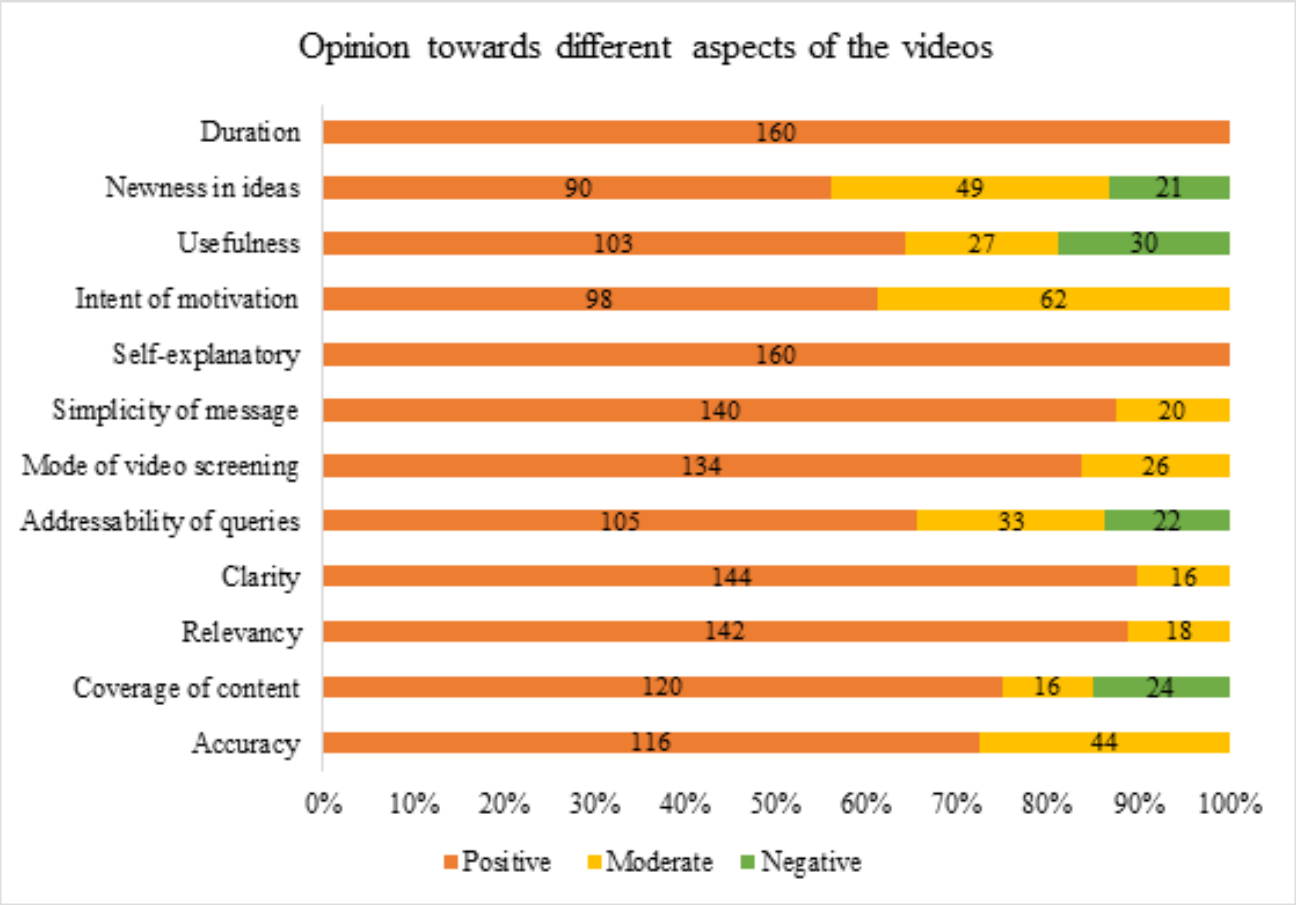

Figure 1: Opinion of the respondents regarding various aspects of the instructional videos (n =160).

enhancing farming practices (Chaudhary, 2004; Van der Meij, 2017).

Relevancy

Relevancy measures how pertinent and applicable the content of the video was to the viewers' interests or needs. The videos were perceived as highly relevant, with 88.8 per cent of respondents finding the content applicable to their needs. The mean score in this category suggested that the videos resonated well with the audience's practical challenges. This alignment with real-world concerns was critical for fostering engagement and knowledge uptake, as confirmed by previous studies (Chen *et al*, 2018).

Clarity of videos

Clarity refers to the ease of understandability and in-depth explanation content of the video. With 90.0 per cent of respondents rating the video as clear, with a high mean score of 2.90 out of 3. The clear presentation of information was crucial for ensuring that complex agricultural concepts are easily understood by growers, regardless of their educational background. This clarity made it easier for farmers to absorb and apply the information in their daily practices (Brown and Smith, 2017; Li *et al*, 2019).

Addressability of queries

Addressing viewer queries was rated moderately, with 65.6 per cent of respondents indicating their questions were fully addressed (mean score of 2.52) followed by 20.6 per cent of the respondents who felt their queries were partial addressed. However, 13.8 per cent felt their concerns were not resolved. This suggested a need for improvement in providing detailed responses to specific queries. Enhanced content that includes interactive elements or supplementary materials may better address this gap.

Mode of videos screening

The mode of video screening evaluates whether the method of presenting the video was suitable and effective. The mode of video screening was well-received, with 83.8 percent of respondentsfound it appropriate, reflected in a mean score of 2.84. The technical aspects of the videos, such as audio-visual quality and the user interface, contributed to an effective viewing experience. These factors were crucial for delivering an engaging and accessible learning platform (Shrestha *et al*, 2022).

Simplicity of message

The simplicity of the message was another highly rated aspect, with 87.5 per cent of respondents appreciating how straightforward and simple the content was, resulting in a mean score of 2.88. The simplicity ensured that the videos were accessible to a wide audience, making complex topics easy to grasp without the need for additional explanations. Simple messaging was essential for effective communication, particularly for audiences with varying levels of literacy (Brown and Smith, 2017).

Self-explanatory

All respondents found the video as self-explanatory, indicating unanimous agreement that the content was clear and easily comprehensible. The highest possible mean opinion score of 3 out of 3 confirms that viewers found the video exceptionally easy to grasp.

Intent of motivation

In terms of motivation, 61.3 per cent of respondents found the videos highly motivational, though the mean score of 2.61 suggested room for improvement. Incorporating motivational elements, such as success stories of other growers or emotional appeals, could further inspired viewers to adopt new practices and apply the techniques presented in the videos (Chepkoech, 2015).

Usefulness

The data showed that majority of the respondents (64.4%) were having opinion that the content covered under the videos were useful to them while 17-18 per cent of the respondents found the content somewhat or not useful at all. This could be due to either their pre-existing adoption of those practices or their lack of awareness regarding the potential benefits of adopting them. The mean score of 2.46 reflects that there is potential to increase the practical applicability of the videos. Including more detailed instructions or real-life case studies could make the content more relevant to farmers' everyday needs, enhancing its usefulness (Muyal, 2018).

Innovative ideas

Newness or novelty in ideas refers to fresh, original and innovative concepts, approaches or solution that were different from the existing ones. The data (Table 1) showed that 56.2 per cent of respondents felt that the video introduced new ideas, there were also those who perceived the idea as somewhat new or not new at all, resulting in a mean score of 2.43. While the videos introduced some new ideas, there is an opportunity to incorporate more cutting-edge practices or recent research findings to make the content more engaging and forward-thinking (Thapa *et al,* 2020).

Duration

The duration of the videos was unanimously considered appropriate, with all respondents agreeing that the length was ideal, resulting in a perfect mean score of 3 out of 3. This balance ensures that the videos maintain viewer interest without being too lengthy or too brief, allowing the audience to absorb the content without feeling overwhelmed (Nisha, 2021).

The instructional videos were well-received by the respondents, with high levels of satisfaction across multiple aspects such as accuracy, clarity, relevance, and simplicity. These characteristics are crucial for effectively communicating agricultural practices to farmers. The thoroughness of the content ensured that essential topics were adequately covered, aiding in knowledge building and practical application in tomato cultivation. The appropriate duration of the videos also played a key role in maintaining viewer engagement, making the information easier to absorb and retain.

Despite these positive outcomes, there are areas for improvement. The addressability of queries could be enhanced by providing more detailed answers to farmers' specific concerns. This could involve incorporating more interactive elements or supplementary materials to fully resolve common questions. Additionally, while the videos were perceived as useful, there is room to increase their practical applicability by providing more hands-on examples, demonstrations, and case studies that can be directly replicated by farmers.

The innovative aspect of the videos was moderate, and respondents indicated a desire for more fresh ideas and updated agricultural practices. Incorporating cutting-edge techniques or novel approaches could keep the content engaging and encourage farmers to explore new methods. Furthermore, while the videos were motivational to some extent, they could be enhanced to inspire farmers more effectively. Adding emotional appeals, success stories, and testimonials from fellow farmers could boost the motivational impact, encouraging a proactive approach to adopting new practices.

Overall, the instructional videos were effective in delivering accurate, relevant, and clear information, addressing the identified areas for improvement could significantly increase their practical usefulness, innovation, and motivational impact. By making these adjustments, the videos could serve as even more powerful tools for educating and empowering tomato growers, ultimately contributing to improved farming outcomes (Chaudhary, 2004; Chepkoech, 2015; Van der Meij, 2017; Shrestha *et al,* 2022).

CONCLUSION

The findings revealed a positive opinion among farmers towards instructional videos, emphasizing their perceived accuracy, comprehensive content coverage, relevance to local farming contexts, and clarity of presentation. These attributes were crucial in building trust and credibility among users, essential for effective knowledge transfer. The study underscored the transformative potential of video-based information dissemination in agriculture, offering scalable solutions to address the information gaps faced by rural farmers. By leveraging technology to disseminate practical knowledge effectively, agricultural extension efforts can be significantly enhanced, leading to improved farm productivity and sustainable agricultural practices.

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Performance of Fenugreek (*Trigonella foenum-graecum*) and Spinach (*Spinacia oleracea* L.), Varieties Under Shade Net Condition in Villupuram District of Tamil Nadu

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ABSTRACT

The field study was conducted to assess the performance of fenugreek and Spinach varieties for leaf purpose under shade net condition in Villupuram district of Tamil Nadu during 2023. In this study, fenugreek variety Ajmer fenugreek 5 and Spinach variety Arka Anupama along with local cultivars were evaluated under 50 % green agro shade net house. The earlier and uniform germination was observed in Ajmer fenugreek 5 (4.33 days) and Arka Anupama (6.80d) compared to local cultivar. Ajmer fenugreek 5 and Arka Anupama palak recorded better growth, leaf yield and quality. Ajmer fenugreek 5 recorded significantly higher plant height (21.82 cm) and leaf yield (0.98 kg/m^2). Anupama Spinach recorded significantly higher plant height (30.54 cm) and leaf yield (4.16 kg/m^2).

Key Words: Cost ,Fenugreek, Germination, Herbage yield, Plant height, Spinach.

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) is used as green leafy vegetable and micro greens for its medicinal properties. The fenugreek leaves are used for preparing curries with other vegetables, making chapatis, puris and fish curry. Spinach is used as green leafy vegetable for its nutritional properties. The Spinach leaves were used for making curries, palak panner, chapatis, puris and other items. Since both vegetables prefer cool climate, they are cultivated well in open condition during cool weather condition. Because of their soft stem and susceptibility to root rot, they are not recommended for cultivation during rainy season. Cultivation of fenugreek and Spinach is difficult under open condition during summer due to the prevalence of high temperature. During summer, protected structures *viz*., poly house and shade net house are used to improve the yield and quality of leafy vegetables (Dixit *et al*, 2005; Shahak *et al*, 2008; Singh and Choudhary, 2020; Lal *et al*, 2018). Shade net house is one of the best protected and low cost structures for cultivation of fenugreek and Spinach. Production of fenugreek and Spinach is possible under shade net house for cultivation during off season. During summer, lower temperature and light intensity favours better growth of leafy vegetables under shade net condition compared to open field cultivation where higher temperature and light intensity hinders the germination and growth. Keeping these views in mind, the trial was conducted during summer season of 2023 in Villupuram district to study the performance of fenugreek and Spinach varieties under shade net condition.

MATERIALS AND METHODS

The trial was conducted on cultivation of fenugreek and Spinach under shade net condition at Villupuram district, Tamil Nadu, India during 2023. The experiment was laid out in a completely randomized block design with five replications. The land is ploughed inside the shade net house and weeds were removed. The enriched farm yard manure with *Azospirillum, phosphobacteria* and *potash bacteria* was applied into beds and mixed well. The raised beds of 3 feet width were formed. Fenugreek variety Ajmer Fenugreek 5, Spinach variety Arka Anupama and local varieties were taken for this study. Fenugreek variety Ajmer

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Table 1. Performance of fenugreek varieties under shade net condition

Varieties	Days taken for germination	Germination (%)	Plant height (cm)	Herbage yield (kg/m^2)	Herbage yield (kg/200m^2)
Ajmer Fenugreek 5	4.33	91.33	21.82	0.98	194.30
Local	5.46	65.00	10.36	0.61	121.65
Mean	4.90	78.17	16.09	0.80	157.98
SEd	0.36	2.45	1.06	0.11	3.11
CD (p=0.05)	0.71	4.89	2.11	0.23	6.22

Table 2. Cost economics of fenugreek cultivated under shade net condition

Varieties	Gross cost (Rs./ha)	Gross income (Rs./ha)	Net income (Rs./ha)	BCR
Ajmer Fenugreek 5	3,410	7,850	4,440	2.30
Local	3,250	4,840	1,590	1.49

Fenugreek 5 is suitable for leaf production under shade net. Spinach variety Arka Anupama is a multi-cut type, high yielding, late flowering with medium large, dark green, thick and succulent leaves. The fenugreek seeds were soaked in water for 4 hours. The Spinach and fenugreek seeds were treated with *Trichoderma viride* at the rate of 4 g / kg of seed. The treated seeds were dried under shade for 30 minutes. The treated fenugreek and Spinach seeds were sown at a spacing of 15 cm x 5 cm and 20 cm x 10 cm respectively in 50% green agro shade net house during March. The intercultural operations were followed as standard horticultural practices to raise the healthy crop.

The growth and yield parameters viz., days taken for germination, germination percentage, number of branches, plant height and herbage yield were recorded. The data on germination was recorded and subjected to statistical analysis. The gross cost, gross income, net income and BCR were calculated for fenugreek and Spinach. The data were statistically analysed as per the method suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Fenugreek

The growth and yield parameters of fenugreek are presented in Table 1. Seeds were germinated in 4.33 days. The germination percentage was also higher in Ajmer fenugreek 5 (91.33%) compared to local cultivar (65.00%). Harvesting of fenugreek was done after 24 days of sowing. Plant height was higher in fenugreek variety Ajmer fenugreek 5 (21.82 cm). The growth of Ajmer fenugreek 5 was better than local cultivar under shade net condition due to the genetic character of these varieties. The results indicated that growing of fenugreek in shade net house significantly increased leaf yield. The Ajmer fenugreek 5 produced highest leaf yield (0.98 kg/m^2) than local cultivar (0.61 kg/m^2). The higher yield was recorded in fenugreek under shade net condition during summer (Dixit *et al*, 2005; Kotadia *et al*, 2012). This might be due to presence of suitable temperature and light inside shade net house.

Table 3. Performance of Spinach varieties under shade net condition

Varieties	Days taken for germination	Germination (%)	Plant height (cm)	Herbage yield (kg/m^2)	Herbage yield (kg/200m^2)
Spinach Arka Anupama	6.80	89.45	30.54	4.16	410.01
Spinach (Local)	8.15	67.44	16.12	3.08	315.03
Mean	7.48	78.45	23.33	3.62	362.52
SEd	0.88	2.11	1.39	0.40	3.13
CD (p=0.05)	1.78	4.20	2.77	0.79	6.26

Table 4. Cost economics of Spinach cultivated under shade net condition

Varieties	Gross cost (Rs./ha)	Gross income (Rs./ha)	Net income (Rs./ha)	BCR
Spinach Arka Anupama	5,100	16,400	11,300	3.22
Spinach(Local)	8,600	14,050	5,450	1.63

The gross income was higher in Ajmer Fenugreek 5 (Rs.7,850/-) compared to local cultivar (Rs.4,840/-). The net income of Rs.4,440/- was recorded in Ajmer Fenugreek 5 with BCR of 2.30 compared to control with net income of Rs.1,590/- and BCR of 1.49 (Table 2).

Spinach

The growth and yield parameters of Spinach are presented in Table 3. Spinach variety Arka Anupama seeds were germinated earlier (6.80 days) than local cultivar (8.15 days). Harvesting of Spinach was done after 29 days of sowing and subsequently three cuttings at an interval of 15 days. The germination percentage was also higher in Spinach variety Arka Anupama (89.45%) compared to local cultivar (67.44%). Plant height was higher in Spinach variety Arka Anupama (30.54 cm) compared to local cultivar (16.12 cm). The growth of Spinach variety Arka Anupama was better than local cultivar under shade net condition due to the genetic character of these varieties. The results indicated that growing of Spinach in shade net house significantly increased leaf yield. Spinach variety Arka Anupama produced highest leaf yield (4.16 kg/m^2) than local cultivar (3.08 kg/m^2). The yield varied with shade intensity in the protected structure (Dodiya *et al*, 2021). The leaf yield was influenced by sowing time (Singh *et al*, 2013), spacing (Waseem *et al*, 2000), number of cutting (Narayan *et al*, 2018), fertilization (Singh *et al*, 2003) and environmental condition (Dabhi, 2015). The prevalence of suitable temperature and light inside shade net house was also favoured the better growth. Mahajan *et al*, 2017 reported that the leaf yield was higher in coriander var. JD 1 under 50% shade net compared to coriander grown in open condition.

The gross income was higher in Spinach variety Arka Anupama (Rs.16,400/-) compared to local cultivar (Rs.14,050/-). The net income of Rs.11,300/- was recorded in Spinach variety Arka Anupama with BCR of 3.22 compared to control with net income of Rs.5,450/- and BCR of 1.63 (Table 4).

CONCLUSION

The higher yield and net income was obtained from shade net cultivation of fenugreek variety Ajmer fenugreek 5 and Spinach variety Arka Anupama. Fenugreek variety Ajmer

fenugreek 5 and Spinach variety Arka Anupama were found suitable for growing under 50% shade net condition in Villupuram district. Since the demand is increasing for Spinach, fenugreek greens and microgreens, there is a lot of scope for upscaling the fenugreek and Spinach cultivation.

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Performance of The Punjab Agricultural University Farmer Information Centre Extension Model

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ABSTRACT

The Punjab Agricultural University (PAU) Farmer Information Center Extension Model was established in December 2020. The objective of the study was to gather information from focus groups with stakeholders on the model's perceived strengths and limitations as well as appropriate corrective and developmental strategies. Using a purposive and random sampling technique, 220 respondents in total were selected, comprising 110 farmers who were beneficiaries (10 from each Farmer Information Center) and 110 farmers who were non-beneficiaries from villages near the Farmer Information Center (FIC). The study showed that 51 respondents (46.36%) preferred monthly visits. The majority of farmers (92.72%) had access to PAU Publications and 70.09 % had the benefit of seeds being available on time. Farmers had increasing benefits through the services provided under PAU-FIC Centres, over the span of years. The majority of the farmers were satisfied with the services provided at the FIC and the functioning of the FIC a good number of the demonstrations are been held in the FIC.

Key Words: Agriculture, Extension, Extension Model, Farmer Information Centre, Stakeholders, Farmers.

INTRODUCTION

In India majority of the farmers are small and marginal. The main challenge is an inadequate public extension system and advisory services, unlike most Asian and African countries using different models (Anderson and Feder, 2007). Several unique approaches were launched as pilot projects around the world. Each technique had strengths and limitations that were not anticipated during deployment but were discovered during the approach review. (Davis 2008) outlined a novel extension method in Africa in which the SG-2000 program first sought a pool of relevant technology to be distributed before collaborating closely with government officials through the use of national extension employees. These changes altered the approaches throughout the system rather than the system itself. In 2001, NAADS launched its novel approach to public-private extension in Uganda, showcasing its capabilities in decentralization, outsourcing, farmer empowerment, market orientation, and cost recovery (Anderson, 2007). In an economy that is primarily rural and heavily reliant on agriculture for the lives of rural households, the promotion of agricultural growth is crucial to ensuring equitable access to food and nutritional security within the rural region (Mahendra 2014).

Indian farmers are facing a number of development issues. The depletion of natural resources makes a number of factors, such as the scarcity of land and water resources, which are already a problem, worse. Additionally, climatic changes, shifts in demand and consumption patterns towards high-value agriculture, growing population pressures, and the liberalization of trade all play a role in exacerbating these challenges (Lele 2010). The recent surge in global food prices and the concurrent rise in inflation rates have presented favourable circumstances for enhancing farmers' profitability. In order to fully comprehend the advantages of increased pricing, it is imperative for farmers to have access to a broader spectrum of information. This knowledge

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Sr.No.	Block	Villages
1	Jagraon	Pabbian, Attiana,Mohie
2	Siddhwan Bet	Leelan,Bhundri, Rauwal
3	Mangat	Noorpur Bet
4	Dehlon	Jassar
5	Ludhiana II	Kanech
6	Pakhowal	Bihla kheri , Jodhan
	Total	**11**

should encompass not just production methods but also postharvest procedures, opportunities to access profitable markets, price information, and strategies for business development (Sulaiman 2003). The integration of this information could be facilitated by services that provide support for its utilization. For instance, the inclusion of technical information necessitates the provision of substantiating evidence from credible sources pertaining to the technology as well as the identification of accessible references. The significance of agricultural extension in enhancing agricultural progress in India is currently being acknowledged and supported through escalating investments.

Since the public extension system is often questioned for its efficiency and efficacy, there is always a need for alternative techniques to complement it. These include private, NGO, public-private, fee-based, farmers' organizations, and privatized extension services. No extension approach is flawless but they have strengths and weaknesses that might be considered in future farmer-friendly extension initiatives. Coordinated planning, execution (including field visits), task division, and information and resource sharing are all part of innovative initiatives, which include official institutional linkages and unofficial networks among extension service providers. How organizations, people, and local communities build and maintain informal networks is the fundamental difference from formal institutional relationships.

As a pilot initiative in one block of the Ludhiana District, PAU created the PAU Farmer Information Centre Linkage Extension Model in December 2020 to enhance the public extension system's outreach to the vast majority of farmers dispersed across a variety of climatic and geographic areas. Later, the strategy was applied to different blocks to strengthen the extension network. This model trained farmers in improved farm methods with the support of the local Agricultural Development Officer, the Multipurpose Society Secretary, and Punjab Agricultural University Extension Education Department experts. Farmers were demonstrated superior PAU varieties in their fields, resulting in farmer-to-farmer learning. The Multipurpose Society Secretary became a PAU-FIC para extension agent with the support of the PAU Extension Education Department. The PAU-Farmer Information Centre Extension Model was designed to connect with farmers through village-level liaison bodies. The selection of these bodies is predicated on their participation in delivery methods. The Departments developed two primary categories of Farmer Information Centers: those that collaborate with agricultural development or extension officers and those that work with cooperative society secretaries. The Departments of Extension Education established these centers with the objectives of establishing demonstration centres and identifying suitable farming systems, assessing farmers' training needs and providing appropriate training and creation of model villages to enhance the adoption of PAU-recommended technologies and encouraging adopting villages to use the farm-home integrated unit as a development model.

MATERIAL AND METHODS

The investigation used an ex-post fact design with the assistance of a questionnaire survey instrument in correlation with structured and flexible interview schedules. Respondents were categorized into three groups: beneficiary farmers, non-beneficiary farmers and extension employees of respective areas. The extension workers included scientists, secretaries of multi-cooperative organizations, and extension

Table 1. Distribution of beneficiary farmers based on frequency of visits to the FIC (n=110)

Sr. No	Category	Frequency (%)
1.	On weekly basis	37(33.63)
2.	Monthly	51(46.36)
3.	Quarterly	17(15.45)
4.	Not at all	5(4.54)

Table 2. Distribution of farmers based on the facilities available at the centre. (n=110)

Sr.No.	Facility	Frequency (%)
1.	PAU Publications (Package of practices of *Rabi/kharif*/Vegetables /Fruits /Flowers)	102 (92.75)
2.	Leaflets and brochures on agricultural technologies	95 (86.40)
3.	Improved crop varieties	110 (100)
4.	Display material	110 (100)

Table 3. Distribution of farmers on the basis of time of availability of seeds. (n=110)

Sr.No	Timing	Frequency (%)
1.	Earlier than expected time	11(10.00)
2.	On expected time	78(70.10)
3.	Delay	21(19.10)

Table 4. Distribution of farmers based on the benefits received from services offered by PAU-FIC Centres. (n=110)

Sr.No	Demonstrated technology under continued adoption	Total number of farmers in a particular year		
		2020-2021	2021-2022	2022-2023
		Frequency (%)	Frequency (%)	Frequency (%)
1.	Paddy	65(59.10)	91(82.70)	104(94.55)
2.	Wheat	48(43.62)	64(58.20)	98(89.10)
3.	Oil Seed	26(23.62)	34(30.10)	69(62.70)
4.	Awareness of secondary occupations	18(16.35)	40(36.36)	46(41.80)
5.	Conservation techniques	42(38.20)	57(51.80)	65(59.10)

Table 5. Distribution of farmers on the basis of the satisfaction level of the farmers from the services offered at FIC. (n=110)

Sr.No	Satisfaction level	Frequency (%)
1.	Satisfied	78(70.91)
2.	Not at all satisfied	08(07.29)
3.	Partially satisfied	24(21.80)

functionaries supported by the State Department of Agriculture. Later, ten farmers who were to benefit were selected from each block and the community in which the FIC was situated. A total of 110 beneficiary farmers and 110 non-beneficiary farmers made up the sample size. Ten non-beneficiary farmers were chosen from the surrounding communities. In addition, eight extension workers were specifically selected for this study.

RESULT AND DISCUSSION

A total of 110 beneficiary farmers were surveyed and categorized based on the frequency of their visits to the Farmers' Information Centre (FIC). Notably, 46.36 per cent of farmers visited once a month. This indicates a common trend

Table 6. Distribution of farmers on the basis of their satisfaction levels regarding the functioning of PAU-FIC. (n=110)

Sr.No	Item	Frequency (%)
1.	Information on seed availability at the village level	80(72.72)
2.	Availability of seeds based on requirements/demand	84(76.36)
3.	Reduction in transaction or transportation costs in getting the seeds	84(76.36)
4.	Establishing demonstrations of improved crop varieties	81(73.63)
5.	Enhancing the learning and visibility of the demonstrated technology among neighbouring farmers	78(70.90)
6.	Organizing of field days for demonstrations" set up by farmers	83(75.45)

Table 7. Distribution of farmers on the basis of the demonstrations conducted for PAU-recommended technologies under the PAU FIC (2020-2023)(*)

Sr.No	Demonstration	Variety / Technology	f*
1.	Varietal demonstration of Paddy	PR130	59
		PR126	91
2.	Varietal demonstration ofWheat	PBW 826	47
		Punjab sunehri (766)	8
3.	Promotion of bio fertilizers	Wheat	61
		Paddy	67
4.	Varietal demonstration ofOil seeds (Mustard)	GSC -7	72
5.	Varietal demonstration ofMaize	PMH-13	83
6.	Introduction of leguminous crops in crop rotations	SML 1827	71
		SML-668	42
7.	Cultivation of Turmeric	Punjab haldi 2	46
8.	Mushrooms cultivation	Dhingri mushrooms	46
		Button mushrooms	51
9.	Laying down of kitchen garden	Kitchen garden	159
10.	Resource conservation technologies	DSR	172
		Happy seeder	59

*= *total number of demonstrations in last three years*

where a significant proportion of individuals prefer engaging in activities monthly. On the other hand, the group with the least frequency and percentage of trips to the PAU FIC was represented by the never category. There were just five persons that fit this description, which makes up a meager 4.54 percent of all participants. This indicated that relatively few people decided not to participate at all.

Most of the participants had access to the publications and materials from PAU in agricultural technology, which underlines the importance of informational support. As for the sources of information, all participants received information on improved crop varieties and display materials, which means equal access to these resources. All eleven FICs offered the facilities and the farmers stressed the need to obtain the up-to-date PAU publications and informative and detailed leaflets and folders on different agricultural technologies.

The data (Table 3) demonstrated the farmers' perception of the timely availability of seeds. 70.10 per cent of the participants responded that they received seeds at proper time, which shows that there was efficient management of seed distribution that observes the expected time of delivery. A very small percentage (10. 0%) reported that they received seeds before the expected time, while 19. 10% of the respondents complained of delayed delivery of seeds. Those farmers who complained of delayed seed

availability blamed it on their own inability to pick seeds from the PAU FIC when they got there and synchronize with their planting calendar.

In paddy cultivation, the use of contemporary farming methods has steadily increased. The adoption rate of advanced practices in paddy farming increased dramatically from 59.10% in 2020–2021 to 82.70% in 2021–2022, reaching a peak of 94.55% in 2022–2023. Comparably, the adoption of technology in wheat production increased steadily, with a starting point of 43.62% in 2020–2021 and a peak of 58.20% in 2021–2022, before ultimately reaching 89.10% in 2022–2023. Technology adoption in oilseed farming, while growing, saw a more modest increase. Adoption rates started at 23.62% in 2020-2021, rose to 30.10% in 2021-2022, and reached 62.70% in 2022-2023, suggesting slower progress compared to paddy and wheat farming sectors.

Awareness of subsidiary occupations among farmers also saw significant growth, with awareness levels increasing from 16.35% in 2020-2021 to 36.36% in 2021-2022, and further to 41.80% in 2022-2023, indicating farmers' increasing recognition of diversifying income sources. The adoption of conservation techniques showed a consistent increase, starting from 38.20% in 2020-2021, rising to 51.80% in 2021-2022, and further to 59.10% in 2022-2023. This trend reflected growing awareness and commitment among farmers to integrate sustainable farming practices. In conclusion, oilseed farming has advanced slowly than paddy and wheat farming, despite the latter two showing notable increase in technology adoption, likely due to government initiatives and resource availability. Farmers were becoming more committed to implementing conservation strategies for sustainable agricultural practices and becoming more conscious of the value of diversifying their revenue streams through side businesses.

Assessing farmers' satisfaction with services provided by farmer information centers (FICs) is an ongoing process. The data (Table 5) show how participants rated their satisfaction levels. A significant majority, 70.91 percent, reported being satisfied with the services, indicating positive reception. About 21.80 percent expressed moderate satisfaction, suggesting areas for improvement. A small minority, 7.29 percent, reported complete dissatisfaction, highlighting specific issues needing attention. Overall, the assessment reflects generally positive feedback towards FIC services, with identified areas for enhancement.

A well-developed farmer information center is crucial for farmers as it offers information through field days, demonstrations, training, and information access. Table 6 presents other areas of PAU-FIC operations that have elicited a lot of satisfaction among the farmers. The table provides information on farmers' satisfaction with various aspects of agricultural practices and services that are essential for farming. 72.72% of the farmers expressed satisfaction with the information provided to them regarding village-level seed availability, which aided in their planning for agricultural endeavors. Further, a high level of satisfaction was recorded on seed availability; 76.36% of the farmers were satisfied with the availability of seeds that meet their needs, thus implying that they were able to access seeds that are crucial for the production of crops. Likewise, an equal percentage of farmers (76.36%) appreciated the decrease in transaction and transportation costs of acquiring seeds, thus making seeds cheaper and readily available. Farmers perceived that demonstrations of improved crop varieties were as important learning and decision-making tools by 73.63% of the farmers. Furthermore, 70.90% of the farmers expressed satisfaction with the enhanced awareness and exposure of agricultural technologies among their surrounding farms, emphasizing the effective exchange of knowledge and technology within the community, leading to an improvement in agricultural practices. Ultimately, 75.45% of the farmers expressed satisfaction with the way field days are organized to allow for farmer demonstrations, which supports the study's claim that field days are a good way to learn novel concepts. The high levels of satisfaction seen in these crucial areas—seed availability, cost-cutting, and knowledge accessibility—indicate that these programs have

proven to be highly beneficial to the farming community and may even enhance crop productivity and the sustainability of agriculture as a whole. These practices should be sustained and developed further to achieve even higher levels of farmer welfare and the sector's growth.

Agricultural demonstrations educate farmers with adequate skills, enable them to implement new technologies and advocate for proper farming. From the year 2020 to 2023, the PAU FIC program performed numerous demonstrations of various technologies. For instance, in Paddy varietal demonstrations, PR130 was used in 59 cases while PR126 was used 91 times. Likewise, Wheat varietal demonstrations included PBW 826 in 47 demonstrations and Punjab Sunehri 766 in 8 demonstrations, where PBW 826 had higher yield potential. Biofertilizers were demonstrated through 61 no. for Wheat and 67 no. for Paddy to improve the crop yield. In Mustard cultivation, GSC-7 was illustrated in 72 cases, which proves that this variety has a high yield. Maize had the PMH-13 variety demonstrated in 83 shows. New leguminous crops were introduced including SML 1827 with 71 demonstrations and SML-668 with 42 demonstrations while Punjab Haldi 2 was found suitable for successful demonstration of Turmeric in 46 demonstrations. Among the mushrooms, Dhingri mushrooms were demonstrated in 46 demonstrations and Button mushrooms in 51 demonstrations, which are good for farming. Kitchen gardens were initiated 159 times, which helped in growing most of the household vegetables. Further, the other conservation technologies like DSR done in 172 demonstrations and Happy Seeder in 59 demonstrations also focused on the need to adopt sustainable technologies for improving the productivity of agriculture. Every demonstration category entailed certain activities, and the frequency signified the number of times or the number of people involved in a particular instance.

CONCLUSION

The PAU Farmer Information Center Extension Model was launched as a trial project in a single Ludhiana District block. This initiative was meant to improve the coverage of the public extension system to many farmers located in different climatic and geographical areas. This can also help to bring down the cultivation costs of farmers to the barest minimum since seeds and facilities were made available at the centre in time. Several research institutions may use this site-specific methodology to connect more farmers, both local and remote, with the technology developed there.

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Planting and Using Medicinal Plants for Health Care

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ABSTRACT

A study was undertaken in Ludhiana district of Punjab state to analyze the effect of different extension strategies in motivating families to plant and use medicinal plants for health care. Data were collected through observations and by personally interviewing the female head of the family. Beside recording observations at all stages, data were collected both before and after the interventions. It can be concluded that adoption status of selected medicinal plants changed significantly after intervention in all experimental groups. There was a significant difference in change in adoption status after the intervention between the experimental groups. ICT based media should be developed to enhance the planting and use of medicinal plants for health care.

Key Words: Adoption, Extension, Experimental, Health care, Intervention, Medicinal, Plants, Strategies.

INTRODUCTION

Plants have been used in traditional medicine for thousands of years and herbal medicines are much in demand throughout the world (Naik *et al,* 2012). Even after the induction of 200 years of modern system of medicine, people in rural India take the help of local health practitioners for the treatment of various diseases. Chinese, Indian, Arabian and other traditional systems of medicines make extensive use of about 5,000 plants. Large human population in developing countries is dependent on plant resources for healthcare because allopathic medicine can cure a wide range of diseases, but its high prices and occasional side-effects are causing many people to return to herbal medicines which tend to have fewer side effects. In last few decades, traditional knowledge on primary healthcare has been widely acknowledged across the world. It is estimated that 60 per cent of the world population and 80 per cent of the population of developing countries rely on traditional medicine, mostly plant drugs, for their primary health care needs.

Indigenous knowledge (IK) is accumulated over a period of times in various aspects such as food security, human and animal health, education, natural resources management and other vital activities. Traditional knowledge, folk knowledge, local knowledge and wisdom of elders are some of the other terms being used but all these refer to its local origin and promotion by community. It acts as basis of decision making at the local level by communities and is a key element of the social capital of the poor. It is their asset which helps them to gain control of their own lives (Gorjestani, 2000). (Abhijit *et al*, 2020) studied ITK for control of insects pests in filed crop and diseases in livestock in Bar-ka-Nagla village of Farah block of Mathura district of Uttar Pradesh, India. Mahajan *et al* (2012) provided information on the indigenous therapeutic application and other traditional uses of 40 plant species belonging to 27 families that are used by the natives of Jammu areas.

Sharma (2015) studied the usage pattern of medicinal plants particularly for preventing and treating respiratory health problems. It was found that women older in age were using more of medicinal plants then the younger women. The users were mainly using the plants for medicinal purpose because they were convinced that these do not have side effects and were cost effective. Kaur *et al* (2017) revealed that women with more awareness regarding the use of medicinal plants were the actual users.

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India is rightly called the Botanical garden of the World as it is the largest producer of medicinal plants (Umadevi *et al,* 2013). One hundred fifty-one herbs of one state of India (Punjab) playing an important role in curing different health problems had been documented (Singh *et al,* 2018). Sidhu (2006) attempted to understand the awareness status of rural women regarding medicinal plants. Less than 10 percent of the women were familiar with certain plants, such as Indian seena and Touch me not, whereas all of the women were aware of others including *Chebulic myrobalan,* Turmeric, Black pepper, Indian lilac Dry ginger and Arecanut. It was suggested that extensive plans must be made for the intra-social distribution of the information to ensure continuity of this rich legacy. Sekhri *et al* (2013) conducted a study on perception and knowledge about use of medicinal plants and use of herbal products. It was found that 60.77 percent of respondents had used herbal medication for various ailments. Highest frequency was recorded for the use of Ginger (37.50%) followed by *Neem* (16.66%) Turmeric (15%) and *Tulsi* (13.33%). Sharma and Sidhu (2016) emphasized planned extension strategies for the passage of indigenous knowledge of medicinal plants among the masses.

Varied extension strategies have been used to study and document information about herbs and plants. However, planned strategies for grassroot dissemination need to be formed and used to sensitize younger generation of their properties and use so as to help in passage of this useful information. Higher consumption will help not only in more plantation to earn profits but also preserve highly useful plants beside reducing load on modern medical system of health care.

MATERIALS AND METHODS

Study Area and Selection of Respondents

The study was conducted in Ludhiana district of Punjab. Five blocks namely Pakhowal, Doraha, Sudhar, Samrala and Jagraon were selected out of 13 blocks for convenience of strategy implementation. Keeping in view the nature of the design one village was randomly selected from each of these blocks. Hence a total of five villages namely Mansuran from Pakhowal, Rampur from Doraha, Bopa Rai Kalan from Sudhar, Bhagwanpura from Samrala and Pabian from Jagraon block were selected.

Out of each of the village, a sample of 30 households having space for plantation with or outside the house were selected randomly for implementation of the strategy. Each household represented one unit for data collection and implementation of the selected strategy. Hence, a total of 150 households were selected as sample of the study and the female working head of the selected family was considered as the main target for implementation of the strategy and the sample of the study.

Data collection and intervention schedule

Three approaches were used in four combinations and implanted in four villages to study their effect on adoption status of medicinal plants.

- **Group Approach:** A group meeting of selected respondents from the village was called and a lecture was organized on importance of medicinal plants and their use. Live plants were shown and their use for different health purposes was discussed with the respondents.
- **Individual approach:** Each selected respondent was contacted during personal home visits. Respondents along with available family members were made aware of the importance of medicinal plants and their use for health. They were shown the seven selected plants and their use for health was told and discussed.
- **Mass approach:** WhatsApp were sent in pre-decided format to the selected families. The completion of WhatsApp messages to each family took nine days.

The data were collected through observations and by personally interviewing the working female head of the family. Beside recording observations at all stages, data were recorded both before and after the intervention.

In first village implemented strategy under Experimental group 1: Individual + Group approach.In second village implemented

strategy under Experimental group 11: Individual + Mass approach. In third village implemented strategy under Experimental group III: Group+ Mass approach and in Fourth village implemented strategy under Experimental group IV: Individual +Group + Mass approach

Adoption: Adoption status was measured on a scale of 0 to 8 which represented different adoption status ranging from symbolical to actual plantation or use or both of selected medicinal plants by the family before and three months after the intervention. Plantation, procurement and data regarding use of each plant before and after the intervention was collected. The score ranged between 0-8 depending upon the respondent's status of procurement, plantation and use of each plant. In view of the limitation of action research, only seven medicinal plants which can be easily grown in the state were selected.

RESULTS AND DISCUSSSION

Medicinal plants grown before and after the intervention

Holy Basil *(Ocimum tenuiflorum)* was grown by majority of the respondents before the intervention. However, there was an increase in percentage of respondents after the intervention. In experimental groups percentage increased from 62.5 per cent to 75.8 per cent. Whereas this percentage increased from 66.7 per cent to 70.0 per cent in control group. Highest increase among experimental groups was found in experimental group III followed by experimental group II. The change was similar in both the other groups. Most of the families were willing to plant when the new plants start growing from seeds in adjoining houses in which it was already planted in the village.

Turmeric *(Curuma longa)* was planted by only one respondent in control group (3.3%) after the intervention as there were no plantation before the intervention. Percentage increase was very less (5.0% to 5.8 %) in experimental groups as only one respondent in experimental group I also planted it after the intervention. Lesser plantation can be attributed to easy availability of dry turmeric powder in the market and its use in daily cooking.

Heart-leaved moonseed *(Tinospora cordifolia)* was already planted by two respondents before the intervention and two more planted it in control group showing an increase from 6.7 per cent to 13.3 per cent. However, in experimental groups, number increased from 19 to 31 showing an increase in respondent percentage from 15.8 per cent to 25.8 per cent. Maximum percentage of respondents increased in experimental group II (10.0 % to 26.7%) followed by experimental group IV (23.3% to 26.7%).

It was found that the Curry Tree (*(Murraya koenigii*) was planted by 02 more respondents in control group (23.3% to 30.0%) and 30 in experimental group (15.0% to 40.0%) after the intervention, showing a considerable increase in experimental groups after the intervention. Maximum percentage of these respondents were in experimental group I (10. % to 53.0%) followed by experimental group IV (16.7 % to 46.7%) and least in experimental group II (20.0 % to 26.5%).

No new plantation of Aloe Vera *(Aloe barbadensis miller)* was seen in control group whereas percentage increased from 32.5 per cent to 55.8 per cent in experimental groups. This increase in experimental groups was mostly seen in experimental group II (20.0 % to 63.3 %) followed by experimental group IV (10.0% to 36.7%) and least was in experimental group I (50.0 % to 53.3 %) as twenty-eight plants were planted after the intervention.

Brahmi *(Bacopa monnieri)* was neither planted before nor after the intervention in any of the group. Lemon grass was not planted in any of the group before but only in experimental group IV it was planted by 11 respondents after the intervention showing an increase of 36.7 per cent. An overall increase of 9.2 per cent was observed in experimental groups.

Table 1. Distribution of respondents according to growing and using selected medicinal plants for health care (n=150)

Plants	Control group (n^c=30)		Experimental group									
			EG I (n^1=30)		EGII (n^2=30)		EGIII (n^3=30)		EGIV (n^4=30)		EG (n^5=120)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	Frequency (%)		Frequency (%)		Frequency (%)		Frequency (%)		Frequency (%)		Frequency (%)	
Aloe vera *(Aloe barbadensis miller)*	15 (50.0)	15 (50.0)	15 (50.0)	16 (53.3)	6 (20.0)	19 (63.3)	15 (50.0)	21 (70.0)	3 (10.0)	11 (36.7)	39 (32.5)	67 (55.8)
Brahmi *(Bacopa monnieri)*	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Curry tree *(Murraya koenigii)*	7 (23.3)	9 (30.0)	3 (10.0)	16 (53.3)	6 (20.0)	8 (26.7)	4 (13.3)	10 (33.3)	5 (16.7)	14 (46.7)	18 (15.0)	48 (40.0)
Holy basil *(Ocimum tenuiflorum)*	20 (66.7)	21 (70.0)	23 (76.7)	26 (86.7)	17 (56.7)	21 (70.0)	20 (66.7)	26 (86.7)	15 (50.0)	18 (60.0)	75 (62.5)	91 (75.8)
Heart -leaved moonseed (Giloy) *(Tinospora cordifolia)*	2 (6.7)	4 (13.3)	7 (23.3)	8 (26.7)	3 (10.0)	8 (26.7)	2 (6.7)	7 (23.3)	7 (23.3)	8 (26.7)	19 (15.8)	31 (25.8)
Lemon grass *(Cymbopogon citratus)*	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	11 (36.7)	0 (0.0)	11 (9.2)
Turmeric *(Curuma longa)*	0 (0.0)	1 (3.3)	5 (16.7)	6 (20.0)	1 (3.3)	1 (3.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	6 (5.0)	7 (5.8)

Hence, it can be concluded that few respondents were growing selected medicinal plants except Holy Basil *(Ocimum tenuiflorum)* and Aloe *(Aloe barbadensis miller)* vera before the intervention. Percentage of respondents growing medicinal plants except Brahmi *(Bacopa monnieri)* increased within three months of the intervention.

Maximum increase after intervention was observed in case of Aloe vera followed by Curry Tree *(Murraya koenigii*), Holy Basil *(Ocimum tenuiflorum)*, Heart Leaved Moonseed (*Giloy*) *(Tinospora cordifolia)* and in Lemon Grass *(Cymbopogan citratus)*. Least increase was observed in case of planting Turmeric *(Curuma longa)* (except Brahmi) *(Bacopa monnieri)* after the intervention for health purpose.

Medicinal plant parts procured before and after the intervention

Many of the respondents reported procurement of parts of selected medicinal plants. Comparative data pertaining to procurement before and after the intervention as in Table 2.

Holy basil *(Ocimum tenuiflorum)* was procured by 33.3 per cent before and after the intervention in control group. However, same percentage was found 37.5 per cent before and after the intervention in experimental groups. Most of the respondents were procuring Turmeric *(Curuma longa)* before the intervention for different purpose and some were using it for health benefits. Hence, there was no change in the procurement status. Those who were not procuring were the growers of turmeric. All the respondents in control group, experimental group III and IV were already using it by procurement.

These finding were agreement with Gautam *et al* (2011) reported the use of plants-based remedies to heal about ten different sorts of disorders pertaining to the stomach, mouth, cough, cold, skin, blood, vitality and strength, bones, muscles and other areas like memory and swelling etc. Anand (2016) found use for curing cough and cold in Tamil Nadu and Gupta *et al* (2018*)* in Rajasthan. Even Sharmila *et al* (2018) reported that medicinal plants were being used for skin care.

Heart- leaved moon seed *(Tinospora cordifolia)* plant was not procured by any respondent after the intervention in control group but there was exponential increase in experimental groups from 6.7 per cent to 80.8 per cent. Nearly same percentage increase was

Table 2. Distribution of respondents according to procurement of selected medicinal plants /parts for their use for health. (n=150)

Plants	Control group (n^c=30)		Experimental group									
			EG I (n^1=30)		EGII (n^2=30)		EGIII (n^3=30)		EGIV (n^4=30)		EG (n^5=120)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	f (%)		f (%)		f (%)		f (%)		f (%)		f (%)	
Aloe vera *(Aloe barbadensis miller)*	0 (0.0)	0 (0.0)	0 (0.0)	14 (46.7)	0 (0.0)	10 (33.3)	0 (0.0)	9 (30.0)	0 (0.0)	19 (63.3)	0 (0.0)	52 (43.3)
Brahmi *(Bacopa monnieri)*	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Curry tree *(Murraya koenigii)*	1 (3.3)	1 (3.3)	1 (3.3)	15 (50.0)	1 (3.3)	23 (76.7)	1 (3.3)	21 (70.0)	1 (3.3)	17 (56.7)	4 (3.3)	76 (63.3)
Holy basil *(Ocimum tenuiflorum)*	10 (33.3)	10 (33.3)	7 (23.3)	7 (23.3)	13 (43.3)	13 (43.3)	10 (33.3)	10 (33.3)	15 (50.0)	15 (50.0)	45 (37.5)	45 (37.5)
Heart -leaved moonseed (Giloy) *(Tinospora cordifolia)*	1 (3.3)	1 (3.3)	3 (10.0)	25 (83.3)	1 (3.3)	23 (76.7)	3 (10.0)	26 (86.7)	1 (3.3)	23 (76.7)	8 (6.7)	97 (80.8)
Lemon grass *(Cymbopogo n citratus)*	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Turmeric *(Curuma longa)*	30 (100.0)	30 (100.0)	25 (83.3)	25 (83.3)	29 (96.7)	29 (96.7)	30 (100.0)	30 (100.0)	30 (100.0)	30 (100.0)	114 (95.0)	114 (95.0)

Table 3. Adoption status of medicinal plants for health care before and after the intervention.

Adoption status (Range 0-8)		Experimental group				
	CG	EGI	EGII	EGIII	EGIV	EG
Pre intervention	1.05	1.18	0.86	0.99	0.83	0.97
Post intervention	1.63	5.30	5.36	5.50	5.54	5.44
Difference	0.58	4.11^{B}	4.50^{AB}	4.51^{AB}	4.70^{A}	4.46
't' value	4.76**	44.20**	31.77**	42.02**	44.53**	75.11**
't' value CG with EG	29.07**					

*Mean values followed with different superscripts are significantly different (p<0.05) using Tukey's test. **significant at the 0.01 level*

found in all experimental groups such as in experimental group III (10.0% to 86.7 %), experimental group I (10.0% to 83.3%) and 3.3 per cent to 76.7 per cent in experimental group II and experimental group IV.

Curry tree *(Murraya koenigii)* leaves saw an increase of nearly 60.0 percent in experimental groups whereas there was no increase in control group. Maximum increase in respondents who started to procure curry tree leaves after the intervention was found in experimental group II (3.3 % to 76.7%) and nearly same in experimental group II (3.3 % to 70.0%). Least increase was observed in experimental group experimental group I (3.3 % to 50.0 %). None of the respondents started procuring and using Brahmi and Lemon grass before and after the intervention.

Hence, it can be concluded that procurement of plants for health purpose increased for all plants except Turmeric *(Curuma Longa)* after the intervention as Turmeric *(Curuma Longa)* was already procured by majority of the respondents. Lemon grass

(Cymbopogon citratus) and Brahmi *(Bacopa monnieri)* was neither procured before nor after the intervention for their use in health care.

Adoption status of medicinal plants for health care before and after the intervention

The mean difference in adoption status before and after the intervention was highest in experimental group IV (4.70) followed by experimental group III (4.51), experimental group II (4.50) and least difference after the intervention was observed in experimental group I (4.11). This change in adoption status after the intervention was found to be statistically significant at 1.0 per cent level of significance using 't' test. Further, the mean change was significantly higher in experimental groups as compared to control group (t test value= 29.07).

Tukey's test was used to compare the effect of different strategies on adoption status. It was found that even though the change in experimental group III (mean difference score=4.51) was higher than that happened in experimental group II (mean difference score 4.50) but comparison within these two groups was not statistically significant. On the other hand change was significantly different between EGI and other EG's and EGII and other EG's.

Findings of the study indicated that adoption status of selected medicinal plants changed significantly after intervention in all experimental groups and change was significantly different between control group and experimental groups. Maximum increase in adoption status was observed in experimental group IV followed by experimental group III, experimental group II and least in experimental group I. Samal and Dehury (2018) also recommended higher level of awareness and governmental patronization to make this system useful for the common population. Sandhu K (1994) and Chand *et al* (2011) also emphasized on the characteristics of innovations for their adoption. Show casing relative advantage of medicinal plants and their easy use trialability can improve perception leading to their adoption. Rogers (2003) found adoption to be dependent on perception as was also found in case of the present study.

CONCLUSION

Taking into account the pre and past intervention adoption status which was reflected in new plantation, decision to plant later and use medicinal plants by procurement, it can be concluded that medicinal plants were being used for different health purposes along with other purposes like adding taste and flavour to food, improving its nutritive value and storage. The present study shows that very few families were growing selected medicinal plants except Holy basil *(Ocimum tenuiflorum)* before the intervention even when they had sufficient space to grow either at home or in the adjoining area to their home. Large percentage were procuring Turmeric *(Curuma longa)* as an important ingredient of Punjabi cooking and were using it for health care too. Lesser plantation can be attributed to the season of plantation as post intervention adoption data was collected within three months of the intervention. Plants like Heart-leaved moonseed (Giloy) *(Tinospora cordifolia),* Aloe vera *(Aloe barbadensis miller)* and Lemon grass *(Cymbopogon citratus)* are readily available at the household level free of cost and planted during rainy season. hence, the decision to plant later was very evident. It was concluded that all approaches used together generated very positive change in adoption status but group and mass approach combined together emerged as the best strategy among those strategies in which only two approaches were used. Hence, use of ICT emerged as the common factor which created more positive impact particularly taking into account the resources both human and non-human. Use of developed material repetitively using ICT can save lot of resources beside creating a diffusion effect through its passage within the social system.

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Popularization of Low-Cost Mushroom Technology for Changthang Region of Cold Desert

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ABSTRACT

Mushroom is rich source of protein, carbohydrate, vitamins and good for health which can play important role in mitigating the malnutrition amongst resources poor people especially remote areas. In Changthang region of Ladakh availability of fresh vegetable limited, thus cultivating mushroom in such harsh climate is big challenge. To fulfil the requirement of local people of Changthang KVK, Nyoma located at +14000 ft took initiative to design and assessed low-cost mushroom technology 14X3X8 ft size black plastic unit was made inside (already exist) local mud type greenhouse 32X 18 ft size for mushroom cultivation and utilized temperature and humidity of green house. In every single shift 15 mushroom bags can be installed and harvested 4 times @ 120 -128g bag and sold @320/-kg. The cost of cultivation including inputs and unit was only Rs 2000/- and got net return of 3760/- in 4 months with B.C Ratio 1.28, mushroom can grow in entire season if temperature of greenhouse remains optimum and increase net profit. Hence, this low-cost technology is not only a source of income generation for remote nomadic farmers of Changthang but also became a supplement for nutritional security and their socio-economic upliftment.

Key Words: Low-Cost Technology, Malnutrition, Nutritional Security, Socio Economic, Nomadic.

INTRODUCTION

Agriculture sector is one of most important sectors in India it has a key position to provide the employment to unemployed peoples. The growing population and nutritional security are major challenges for the agricultural scientists and Indian government. In this context, mushrooms have a great role to play which can be grown even by landless people that need agricultural waste materials and could be a source for proteineous food (Ambili and Nitiya, 2014). There are 20 species of mushroom grown in the country, of which 5-6 are poisonous; and the recommended species for cultivation are oyster (*Pleurotus spp.*) and white button mushroom (*Agaricus bisporus*) Milky mushroom (*Calocybe indica*) are more popular mushroom (Bhatia and Mohammed, 2007). Similarly, Oyster mushroom is one of the most suitable fungal organisms for producing protein rich food from various agro wastes without composting. Oyster mushroom can be grown in the plains and in temperatures ranging from 32 to 38^{0}C and it's also grown in hilly area. Dey *et al* (2020) stated that about 85-90% moisture contain in the fresh mushroom ,3% of protein, Carbohydrates 4%, 0.3-0.4% fats and 1% minerals and vitamins. Keeping in view, the remotest area Changthang located in Ladakh where temperature varies from +35^{0}C to -32^{0}C and availability of fresh vegetable is very less, and getting healthy nutritious food cum vegetable for women, children is biggest challenges. Under such circumstances mushroom is a good source of protein for those women of remotest area. To fulfil the requirement of local people of Changthang KVK Nyoma located at +14000ft took initiative to design and assessed low-cost mushroom technology for income generation and a supplement for nutritional security and their socio-economic upliftment in such a harsh climatic condition.

MATERIAL AND METHODS

The present study was conducted in Krish Vigyan Kendre Nyoma (Changthang) SKUAST-K Leh

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Table 1. Material required for mushroom cultivation.

Sr.No	Material	Quantity
1	Barley straw	10kg
2	Spawn	1 Kg
3	Formalin	125ml
4	Bavistin	7.5 gm
5	Water	90 lt

Source: Angmo et al (2021) Good Agriculture Practice book

located at highest altitude +14000ft in 2021-22. *Changthang* region falls in the eastern part of Ladakh and the originals are known as *Changpas*. The temperature in the region varies from -5 ºC to -35 ºC in winter and up to maximum of 30 ºC in summer. The average precipitation mostly in the form of snow is less than 10 mm and can be fatal to the livestock of the nomads during winter month. The region is spread over an area of 22000 km^2 and comprises of two subdivisions *i.e.,* Nyoma and Durbuk. The present study was based on Changthang region of Ladakh where availability of fresh vegetable limited, thus cultivating mushroom in such harsh climate is big challenge. To fulfil the requirement of local people of Changthang KVK Nyoma located at +14000ft took initiative to design and assessed low-cost mushroom technology for income generation of remote nomadic farmers.

MATERIAL USED FOR MUSHROOM CULTIVATION

Oyster at +14000 ft KVK Nyoma

During this study we used already exist low-cost mud type green house of 32 x16ft size normally available at every farmer's house, 15 m black polyethene sheet for mushroom unit, and also applied black colour paints at back side of greenhouse to maintain heat, local available resources such as local mud bricks and willow branches or called Talu were also used.

Procedure for Design Mushroom unit

Step 1: Took existing local mud type greenhouse of 32 X 16 ft size, normally we left foot path where back of greenhouse wall exist, we utilized that area for mushroom cultivation. For demonstration purpose, we made a size of 14x3x8 ft black plastic unit and colour the back wall of green house with black paint to maintain heat inside the green house.

Step 2: Utilizing left over material of talu (willow branches) and made two parallel willow frames with hollow inside (in Ladakh we called stair shape) with the help of nails and local bricks used for support and made a vertical support for making shelf.

Step 3: Made 4 shelves in which 15 mushroom bags installed at a time.

Step 4: To stop entry of the solar light this black polyethene was properly join with tape or any binding material.

Procedure for Cultivation Method

Cultivation methods of Oyster mushroom followed and material used was as under (Table 1).




Boiling method of sterilisation (without using chemical)

For cultivating oyster mushroom we need in large number of agro wastes such as cereal straw, sugarcane bagasse, sawdust, dried grass, discarded newspaper etc. In Ladakh maximum we used barley straw as it is most easily available agro waste resources. Barley straw substrate can be sterilised either by using chemical method (Bavistin and Formaldehyde) or boiling method to eliminate the competitor fungi. While in boiling methods, sterilisation can be done just by boiling the straw was spread on a clean surface so that excess water is drained out. When the straw is left with around 60-70% moisture (few drops should come out when pressed in palm) it is ready for spawning. In the chemical method, the barley straw was soaked in the water with Bavistin and Formalin for overnight (10-12 hrs) in airtight condition. When the straw is left with around 60-70% moisture (few drops should come out when pressed in palm) it is ready for spawning

Spawning and Inoculation

Spawn is basically the mushroom seed prepared in lab. The method of mixing of spawn with the substrate is known as spawning. This can be done by different methods such as layer spawning and broadcasting. We observed that layer spawning was more effective than broad casting in case of oyster mushroom. Spawning was done by placing one layer of straw and one layer of spawn, up to 3-4 layers in the polybag, give small cut in corner of polybags for excessive drainage of water and provide aeration. Lastly the bags were closed tightly and around 10-15 holes are made on the bags. Then the bags were kept in the dome shelf for spawn run.

Management technique

The optimum temperature required for oyster mushroom spawn run is 22^0C to 26^0C with relative humidity 80-85% for its mycelia growth

Table 2. Cost of cultivation of mushroom.

Total Cost of Cultivation (Rs)	2000 for 15 bags
Days of first picking	25-35 days
No. of picking (nos)	04
Market rate (Rs /kg)	320
Gross return for 15 bags (Rs)	5760
Net return (Rs)	3760
B.C. (Rat io)	1:2.88

(Mycelium is the vegetative part of fungus.). When the mycelium fully colonises the substrate, its forms thick mycelia mat which is called spawn run. This indicated its readiness for fruiting. Normally, it was observed in green house around 25-30 days for complete spawn run. We observed even at lower temperature and humidity spawn run occurs but takes longer time than at optimum level. Proper ventilation is needed during the fruiting period for air .Pin head formation only takes place after full spawn run occurs which later turns into the fruiting bodies.

Harvesting

Harvesting of mushroom was ready in 7-10 d after pinhead formation. They were harvested while the edges of the mushroom still curled down., Oyster mushroom can be stored for 2-3 days at normal room temperature without deterioration after harvesting. It can also be sun dried and stored for 4-6 m successfully without losing its original properties. For Ladakhi / Nomadic people this can be a nutritious diet especially during winter months. Although optimum temperature and humidity was needed for maximum production, but growing it in highest altitude and coldest place like Changthang there were less chances of contamination as compared to other plane areas.

RESULTS AND DISCUSSION

The cost of the cost of cultivation for 15 poly bags was Rs. 2000/- with four-time pickings. First harvest was done within 20-30 days as per temperature and humidity in green house. The mushroom was in great demand in Ladakh, cost of mushroom was Rs.320/ Kg . The gross return and net return were Rs.5760/- and Rs.1760/-, respectively with B.C ratio 1:2.88. The B.C ratio can be increased if this low-cost technology implemented at large scale and having its own local resources like barley straw, and greenhouses etc. Seeing the technology more reliable and low cost, KVK Nyoma disseminated this technology among farmers through trainings to farmers, youth, SHG's and also demonstration unit at farmers field and boost the knowledge of mushroom cultivation among the farmers, farm women and youth and enhance socio economic status of remote area.

CONCLUSION

Mushrooms are low fat high protein fungi having high economic value. Seeing the problem of malnutrition and socio-economic issues in remotest area of Changthang in Ladakh. Low-cost mushroom technology was designed as per farmers needs, and played innovative role in mitigating the mal nutrition amongst poor people especially farm women's, children's in those remote areas. Meantime its uplift the Socio-economic status of the nomadic farmers along with supplement for nutritional security and their socio-economic upliftment

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region.

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Preferred Heel Designs Among Female Consumers

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ABSTRACT

Wearing high heels can pose several disadvantages, affecting both short-term comfort and long-term health. One of the most immediate issues is foot pain and discomfort, particularly in the balls of the feet and toes, due to the unnatural position heels force the feet into. This study examines the preferences, usage patterns, and ergonomic considerations of female consumers regarding heel designs. The survey reveals that the majority of respondents are young women aged 18-34, with students (48%) and professionals (32%) being the largest demographic groups. Heel usage varies, with 30% wearing heels occasionally and 5% daily. Medium heels (2-3 inches) are the most preferred for their balance of style and comfort, followed by low heels (1-2 inches). Block heels are favoured for their stability and comfort, while stilettos and strappy heels are associated with higher discomfort levels. The findings highlight a strong emphasis on comfort and functionality, with a preference for features like cushioned insoles and arch support. Ergonomic concerns indicate a need for designs that mitigate pain and discomfort from prolonged wear. Despite the popularity of online shopping (54%), many consumers still value the in-person experience of physical stores (64%). Additionally, a significant number of respondents are willing to pay more for heels that combine style and comfort. These insights underscore the importance of designing heels that meet both aesthetic and practical needs, catering to the evolving demands of modern women.

Key Words: Heel design preferences, Footwear ergonomics, Comfort and functionality in heels, Demographic trends in fashion, Foot health and well-being

INTRODUCTION

For centuries, one of the constant fashion trends has been women wearing high-heeled shoes. Interestingly, these shoes weren't initially meant for women. They first appeared in Western Asia before the 16th century, linked to Persian men's military and horse-riding attire(Wade, 2022). Modern high heels are considered footwear specifically designed for adult women. They are commonly associated with women's allure, male admiration towards women, and are seen as a significant aspect of female gender expression, (Morris *et al,* 2013). The allure of high-heeled shoes has been a constant throughout history, captivating the attention of women and designers alike.

The footwear industry has played a pivotal role in this fascination, with shoe-makers and designers dedicating considerable effort to the innovation of heel design. High-heeled shoes are not merely a fashion statement but also a showcase of avant-garde design that merges art with fashion. The heels of these shoes are not just a structural element; they are a canvas for creativity and a key

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aspect of the shoe's overall aesthetic appeal (Boxuan Wei, 2010). In recent years, the industry has witnessed a significant evolution, with a growing emphasis on the fusion of comfort and elegance. The purpose of footwear has transcended its original intent of merely protecting the feet, becoming an integral component of the fashion industry. This shift has led to the development of customized footwear that caters to the unique anatomical needs of each individual. The use of plastic materials and additive manufacturing techniques has opened new avenues for the production of outer soles, allowing for the creation of prototypes that are both functional and tailored to the wearer's anatomy. Studies leveraging Finite Element Analysis (FEA) and Topology Optimization have been instrumental in optimizing the design and functionality of these custom heels, ensuring that they meet the dual demands of comfort and style (Stoica *et al,* 2022). The footwear industry plays a crucial role in designing heels that not only meet aesthetic preferences but also address comfort and functionality. This synthesis examines how heel design is influenced by footbed shapes and material functionalization to enhance the overall experience of the wearer

Elevated heel shoes and soft soles are less comfortable and less stable than standard shoes, while standard laced shoes with a low collar and standard hardness provide optimal dynamic stability for walking on even and uneven surfaces(Menant et al, 2008). Larger heel base supports increase gait stability, reduce ankle injury risk, and improve comfort during high heel walking, while using a total contact insert decreases plantar pressure (Wang et al, 2021) Ergonomics in heel design is a critical aspect of footwear engineering that aims to optimize comfort, safety, and functionality for the wearer. This synthesis examines the importance of ergonomic considerations in the design of heels and other footwear. Footwear ergonomics, including heel design, is essential for preventing work-related musculoskeletal disorders and overuse injuries by aligning the feet and improving lower limb function during prolonged standing and walking activities (Parashar, 2020). By examining these factors comprehensively, this research aims to provide insights into the nuanced preferences of female consumers regarding heel designs. The findings will not only contribute to enhancing footwear design strategies but also inform marketing approaches that resonate with the diverse needs and preferences of female consumers in the ever-evolving fashion landscape.

MATERIALS AND METHODS

This study employs a descriptive research design using a quantitative approach to investigate the preferences of female consumers regarding heel designs. Data from 50 respondents, aged from 18 to 44 years, were collected through a Google Form questionnaire using convenience sampling. The questionnaire covered various aspects of heel design preferences, including heights, shapes, materials, comfort factors, style influences, and purchase behaviors. Data analysis included descriptive statistics and, where applicable, inferential statistics using SPSS and Excel. Ethical considerations were prioritized, ensuring informed consent, data privacy, and adherence to ethical guidelines. The results were interpreted to identify patterns and trends, discussing significant findings, demographics-based differences, implications for the footwear industry, and recommendations for future research and practical applications.

FINDINGS AND DISCUSSION

Demographic Information

Age of the respondents

Based on the age distribution data of respondents in Table 1 it was evident that the majority of participants fall within the 18-34 yrs age range, with 36% in the 18-24 category and a significant 62% in the 25-34 category. This indicates a strong representation of younger demographics in the survey, reflecting a keen interest among younger women in heel designs. However, it's notable that only a small proportion, 10%, belong to the 35-44 age group, suggesting a potential shift in preferences or priorities in heel design as women age.

Table 1. Demographic Characteristics of the respondents

Sr.No	Demographic characteristic	Frequency	Percentage
1	Age (yr)		
	18-24	18	36
	25-34	31	62
	35-44	5	10
2	Occupation		
	Student	24	48
	Professional	16	32
	Homemaker	4	8
	Others	6	12
3	Frequency of use		
	Daily	5	10
	Several times a week	4	8
	Occasionally	30	60
	Rarely	11	22
4	Preferred heel height		
	Low (1-2 inches)	16	32
	Medium (2-3 inches)	25	50
	High (3-4 inches)	4	8
	Very High (4+ inches)	5	10
5	Preferred heel shape		
	Stiletto	1	2
	Block	18	36
	Wedge	15	30
	Platform	2	4
	Cone	3	6
	Kitten	1	2
	Other	6	12
6	Heel with additional features		
	Yes	21	42
	No	12	24
	Depends	17	34

Occupation

It was evident that a significant portion of respondents (48%) were students, highlighting their influence and interest in fashion trends, including footwear. Professionals constitute 32% of the respondents, indicating that working women also play a substantial role in shaping preferences for heel designs. The 8% of homemakers participating in the survey reflect a smaller but still notable segment, suggesting that heel design preferences are relevant across various lifestyles. The remaining 12% categorized as "Others" further diversify the participant pool, emphasizing the broad spectrum of occupations contributing to insights on preferred heel designs.

Frequency of use

The data (Table 1) revealed varied patterns. While a significant portion, 30%, use

heels occasionally, indicating a regular but not constant incorporation of heels into their attire, 11% use them rarely, suggesting a preference for more casual or practical footwear options. Interestingly, a small percentage of respondents, 5%, reported using heels daily, showcasing a dedicated segment that prioritizes heels as part of their daily attire.

Preferred heel height

The findings (Table 1) indicated a diverse range of preferences for heel height. The majority of respondents, comprising 25% of the sample, prefer medium heel heights ranging from 2 to 3 inches, highlighting a balance between style and comfort. Low heels, spanning 1 to 2 inches, were also favored by a considerable proportion, with 16% of participants opting for this height range, likely due to its practicality and ease of wear. On the other hand, higher heel heights were less popular, with only 4% preferring heights between 3 to 4 inches, and 5% opting for very high heels exceeding 4 inches. According to (Ko and Lee, 2013; Witana *et al*, 2009; (Emmanouil and Rousanoglou, 2018; Hapsari and Xiong, 2016) preferred heel height for balance and comfort is between 3 to 5 centimeters, with specific wedge angles associated with different heights for perceived feel, and that both very low and very high heels can negatively affect arch height and functional mobility.

Preferred heel shape

The findings (Table 1) regarding preferred heel shape among female consumers demonstrated a varied set of preferences. Block heels emerged as the most favored, with 18% of respondents choosing this style for its stability and comfort, aligning with trends emphasizing practicality in footwear choices. Wedge heels followed closely, preferred by 15% of participants for their combination of style and ease of walking. Other notable choices include cone heels (3%), platform heels (2%), and stiletto heels (1%), each catering to specific style preferences within the sample. Additionally, 6% of respondents opted for Other heel shapes, indicating a diversity of niche preferences not covered by the predefined categories.

Heel with additional features

The data (Table 1) showed that many women like heels with extra things like ankle straps or fancy decorations, with 21% of them preferring these features. However, about 17% said they only like these extras depending on how they're designed and if they're useful. Meanwhile, 12% prefer heels without any extra features. This tells us that while some women really like fancy heels, others prefer simpler ones, and some were in between liking extras.

Comfort and Functionality

The survey findings revealed that respondents prioritize comfort and functionality, such as ease of walking and stability, when making heel purchases. Specifically, participants prefered heels that offer features like cushioned insoles or arch support, which enhance comfort and stability during wear. This emphasis on practical aspects highlights a consumer preference for heels that not only look stylish but also provide a comfortable and supportive experience, aligning with the growing trend of prioritizing footwear that promotes foot health and overall well-being.

Ergonomic Considerations

The findings from the survey indicated that users often experience pain and discomfort after wearing heels for extended periods, particularly throughout the day. Reported issues include pain in the little finger, shoe bites commonly associated with stilettos and strappy heels, as well as pressure and discomfort in various parts of the foot. From an ergonomic standpoint, these findings highlighted the need for footwear designs that prioritize both style and comfort, incorporating features such as adequate cushioning, arch support, and materials that reduce friction and pressure points. Addressing these ergonomic concerns can contribute significantly to improving the overall wearing experience of heels and reducing the risk of discomfort and pain associated with prolonged use.

Rating of heel designs based on Pain Assessment chart

The pain assessment study, conducted using a 6-point scale ranging from No Pain to Hurts Worst, with scores 1-No Pain, 2-Hurts a

Table 2. Rating of heel designs based on Pain Assessment chart

Heel design	Weightage score	Mean
Stiletto	194	3.88
Block	112	2.24
Wedge	96	1.92
Platform	136	2.72
Cone	193	3.86
Kitten	176	3.52

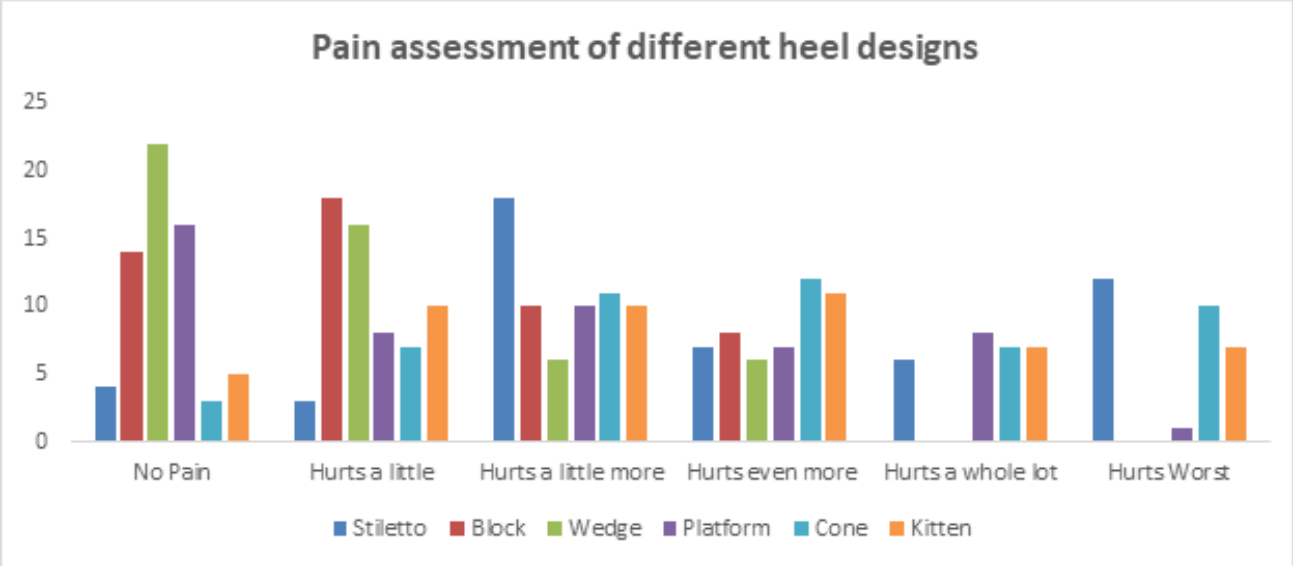

Fig 1. Rating of heel designs based on Pain Assessment chart

little, 3-Hurts a little more, 4-Hurts even more, 5-Hurts a whole lot and 6-Hurts Worst yielded insightful findings regarding the discomfort levels associated with different heel types (Table 2, Fig 1) . The mean scores indicate that stiletto heels have the highest average discomfort level at 3.88, followed closely by cone heels at 3.86 and kitten heels at 3.52. These findings suggested that users generally experience moderate to significant discomfort when wearing these styles. In contrast, block heels showed the lowest average discomfort level at 2.24, followed by wedge heels at 1.92 and platform heels at 2.72. This indicated that users tend to experience lower levels of discomfort with these styles compared to stilettos, cones, and kitten heels.

Purchase Preferences

The findings highlighted a mix of online and offline shopping behaviors. While online retailers were favored by a majority at 54%, indicating a significant preference for the convenience and accessibility of online shopping platforms, physical stores such as malls and boutiques remain popular with 64% of respondents. This suggested that despite the rise of e-commerce, many consumers still value the experience of in-person shopping and the ability to try on shoes before making a purchase. Department stores and specialty shoe stores each garnered 16% and 12% of preferences, respectively, indicating a notable but smaller segment of consumers who prefer these shopping environments. Interestingly, footpaths, typically associated with street vendors or informal sellers, also received a 12% preference rate, underscoring the diversity in shopping preferences among respondents. It was also found that majority of respondents will to pay more for heels that are designed for both style and comfort.

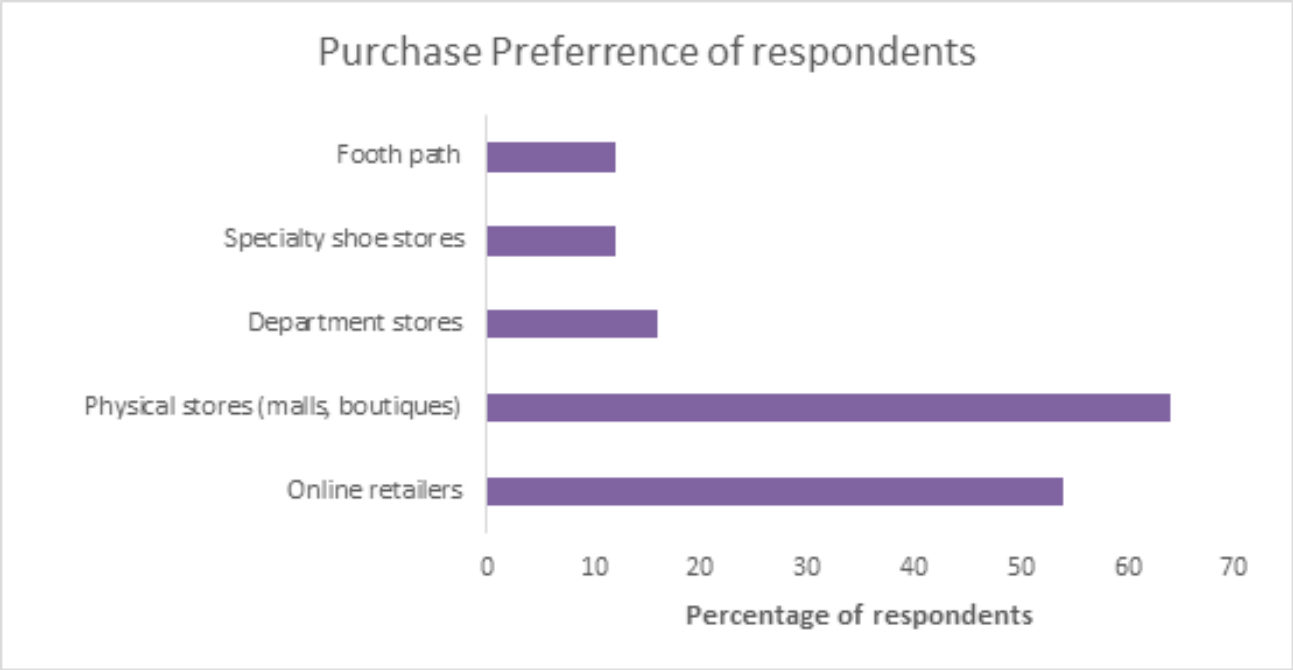

Fig 2. Purchase Preferrence of respondents

CONCLUSION

The survey revealed key insights into women's preferences and usage patterns for heel designs. The majority of respondents were young women aged 18-34, with students and professionals being the largest groups. Heel usage varies, with occasional use being the most common (30%), and a small group (5%) wearing heels daily. Medium heels (2-3 inches) were the most preferred for their balance of style and comfort, followed by low heels (1-2 inches). Block heels were favored for their stability and comfort, while stilettos and strappy heels were associated with higher discomfort. Comfort and functionality were top priorities, with a preference for features like cushioned insoles and arch support. Ergonomic concerns highlight the need for designs that reduce pain and discomfort from prolonged wear. While online shopping was popular (54%), many still prefer the in-person experience of physical stores (64%). A significant number were willing to pay more for heels that combine style and comfort. Overall, the findings emphasize the importance of designing heels that prioritize both aesthetics and practical features to meet the diverse needs of modern women.

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Prevention of Preharvest Fruit Drop in Apple- A Menace in Temperate Fruit Industry

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ABSTRACT

This study was conducted during the years 2021-22 and 2022-23 on 13 years of Red Delicious, Royal Delicious, and Vance Delicious old apple plants grafted on wild (seedling) rootstock. Plants were treated according to the SKUAST-Kashmir recommended package of practice. Results revealed that maximum preharvest drop in all apple cultivars happened under control. 2,4,5T @ 30 ppm was more effective than NAA @ 10 ppm in reducing preharvest drop percentage irrespective of cultivar. The highest average yield/tree in Red Delicious (157.91kg), Royal Delicious (130.57 kg), and Vance Delicious (161.62kg) was observed in 2,4,5T @ 30ppm treated plants. Preharvest drop in terms of weight was maximum (22.39kg/tree) in Red Delicious, 21.56kg/tree in Royal Delicious, and 18.42 kg/tree in Vance Delicious under control. The highest gross income per ha (Rs 18,32,725) was observed in Vance Delicious treated with 2,4,5T @ 30 ppm followed by Rs 18,01,912/ha under the same treatment in the case of Royal Delicious. Production cost/ha and marketing cost/ha were higher in the case of treated orchards than in control irrespective of apple cultivars. The highest net returns/ha (Rs. 12,20,528) and BC ratio (2.32) were obtained in Royal Delicious sprayed with NAA @ 10 ppm.

Key Words: Apple, Rootstock, Preharvest drop, Cultivar, Gross Income.

INTRODUCTION

Apple (*Malus* x *domestica* Borkh.) is the most popular temperate fruit and ranks third as per global fruit production (FAOSTAT, 2023). Production depends on the high-value fresh market which needs harvesting at optimum time to maintain optimum fruit quality during better storage and shipping (Greene *et al*, 2014). Jammu and Kashmir (UT), Himachal Pradesh, and Uttarakhand are the main apple-producing regions in India and provide the major source of income (Rehman *et al*, 2023). In J&K (UT), Kashmir Valley produces major junk of apples and adds almost 7000 crores to the valley's gross domestic product (Wani *et al*, 2021) and is also an employment generator for over 3.5 million people (Mir and Sampath, 2022). Apple fruit drop that happens during the later stages of fruit development is a challenge to growers across the globe. Dal Cin *et al* (2009) defined June drop as fruitlet drop occurring 5-6 weeks after full bloom and reported it as a major concern in the northern part of the globe, whereas preharvest fruit drop begins approximately 4 weeks before harvest (Arseneault and Cline, 2016) and was the main concern of the current study.

Many apple cultivars grown in Kasmir are susceptible to pre-harvest drop as reported by Raja *et al*, 2017. Ethylene production by ripening fruits stimulates the production of enzymes that cause cell wall disintegration, resulting in the formation of an abscission layer (Yuan and Carbaugh, 2007). After abscission zone formation, the fruit is connected to the tree only by the vascular elements, which easily break causing fruit to drop (Marinho *et al*, 2005). Arseneault and Cline, 2016 reported that preharvest fruit drop before horticultural maturity can occur in several important apple cultivars. The severity of drop is cultivar-specific and henceforth Irish-Brown *et al*, 2011 categorized various apple cultivars as more prone, intermediate, and less prone. Yue *et al*, 2013 reported that the selection of apple cultivars by orchardists is determined by consumer preference

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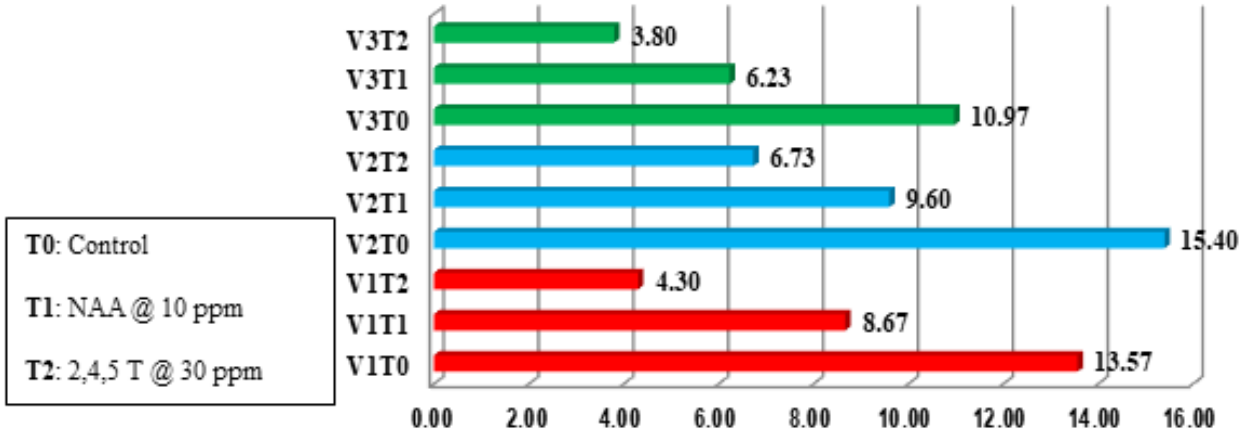


Fig 1: Preharvest drop (%) as influenced by various treatments across studied apple cultivars

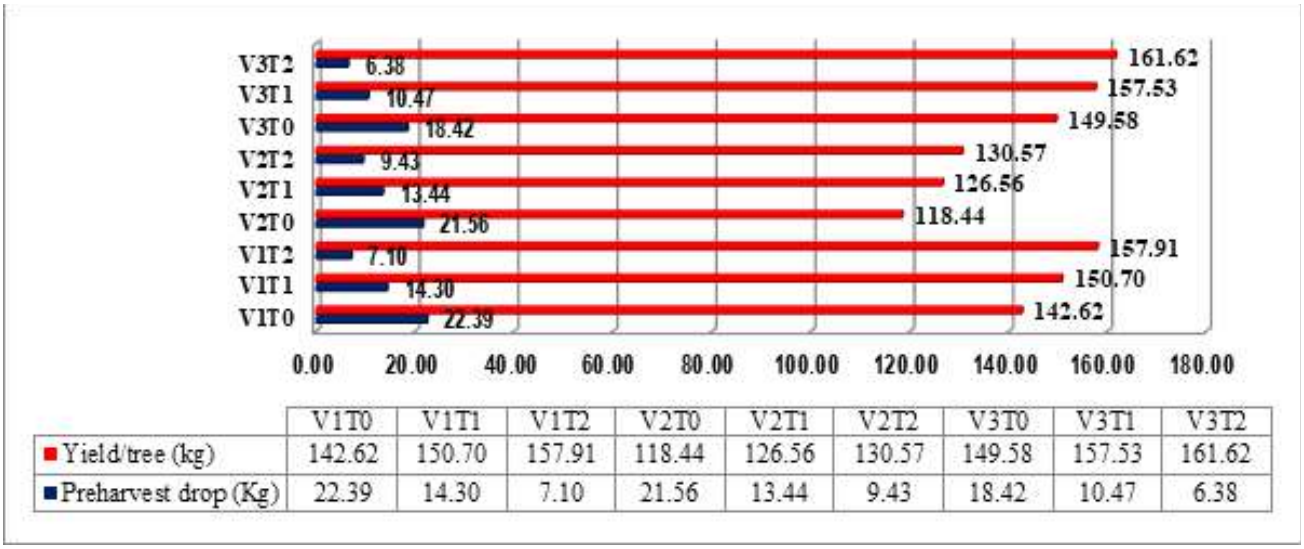
for specific fruit characteristics rather than for ease of production as a result challenges like preharvest fruit drop are inevitable. Plant growth regulators influence the metabolic system in plants and regulate ripening and preharvest drop as reported by Raja *et al*, 2017. Plant bioregulators, such as amino ethoxyvinyl glycine, NAA, and 2,4,5 T, which hamper or reduce ethylene biosynthesis within the plant system, are effective in reducing preharvest fruit drop in apples and other temperate fruits (Yuan and Li, 2008). Such types of plant growth regulators can widen the picking window thereby resulting in fetching better prices by avoiding market glut thereby regulating the market (Unrath *et al*, 2009).

MATERIAL AND METHODS

The experiment was conducted during 2021-22 and 2022-23 on thirteen years Red Delicious (V1), Royal Delicious (V2), and Vance Delicious (V3) old apple plants grafted on wild (seedling) rootstock of uniform size and vigor. A standard package of practices as per SKUAST-K was given to experimental trees. Jammu and Kashmir (UT) are situated in the extreme North of the Indian subcontinent at 32°.17 to 37 °.05 N latitude and from 72°.40 to 80 °.30 E longitude. The maximum and minimum temperatures of the valley range between 23^{0}C and 29.9 ^{0}C and -5.8 ^{0}C to 12 ^{0}C, respectively, with 43.90 percent relative humidity and annual precipitation of 650-800 mm mostly received during winter months (December to April). The experiment was set up in a randomized block design, with three replications and five trees per replicate of each cultivar. Treatments were performed 2-3 weeks before the predicted harvest dates of the various apple cultivars. Treatments were labelled as T0: untreated control; T1: NAA @ 10 ppm and T2: 2,4,5T @ 30 ppm. Fruit drop was evaluated 4 times, at 5-day interval to determine the average fruit in each treatment expressed in kilograms/tree. Total fruit drop which includes May, June, and Preharvest drop was expressed as a percentage of total fruit yield as per Yildiz *et al* (2012). Total costs comprising both production (variable) and marketing costs along with gross returns were calculated by formulating specific questionnaires. This information was interpolated to gross return/tree, gross return per ha, and depicted in the form of a graph. The average market price of produce during the study years was used for calculating the gross return, net return, and BC ratio of each treatment and later on expressed in the form of a graph for easy interpretation.

RESULTS AND DISCUSSION

From Figure 1, it can be interpreted that maximum preharvest drop in all apple cultivars when no treatment was done i.e. T0. The drop percentage decreased significantly irrespective of apple cultivars in T1 and T2. 2,4,5T @ 30 ppm was more effective in reducing preharvest drop percentage irrespective of cultivar. Just 3.80% preharvest drop was observed in Vance Delicious when 2,4,5T @ 30 ppm was sprayed as compared to 10.97% in the case of control. Similarly in Red



	V1T0	V1T1	V1T2	V2T0	V2T1	V2T2	V3T0	V3T1	V3T2
Yield/tree (kg)	142.62	150.70	157.91	118.44	126.56	130.57	149.58	157.53	161.62
Preharvest drop (Kg)	22.39	14.30	7.10	21.56	13.44	9.43	18.42	10.47	6.38

Fig 2: Average preharvest drop (Kg/tree) and yield/tree (kg) as influenced by various treatments

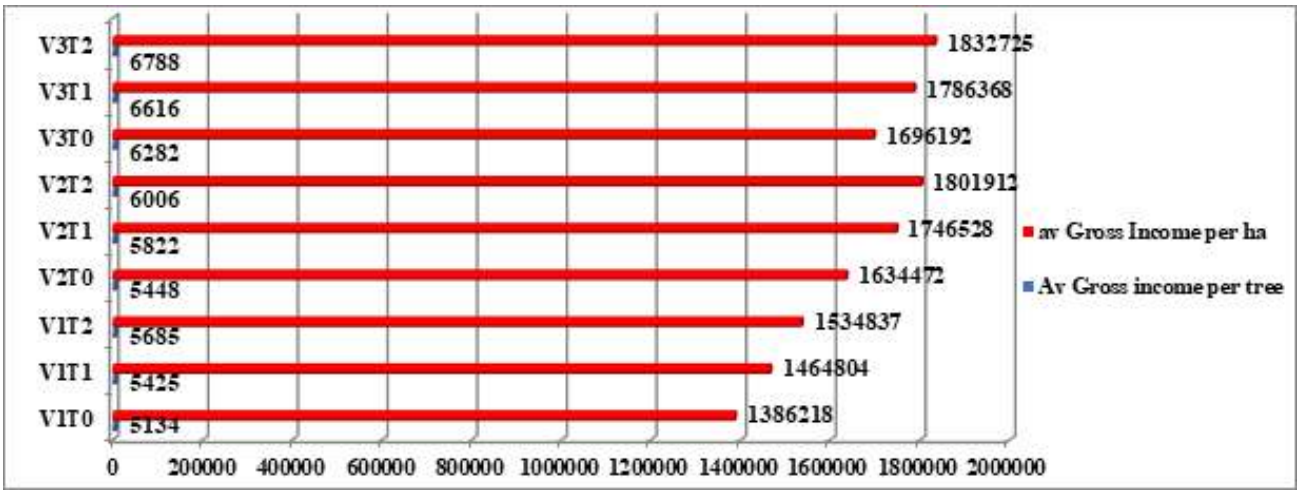


Fig 3: Gross return/tree (Rs) and gross return/ha (Rs) as influenced by various treatments

Delicious and Royal Delicious, results were promising in treated plants in terms of preharvest drop percentage prevention but 2,4,5T performed better (Fig. 1). Exogenous application of auxins a few weeks before the expected harvest date has been reported to reduce the preharvest drop in a number of temperate fruits including apple (Basak and Buczek, 2010; Sazo and Robinson, 2013 and Chishti *et al*, 2022).

Figure 2 shows that better results in terms of average yield per tree (kg) were observed in treated plants as compared to control. The highest average yield/tree in Red Delicious (157.91 kg), Royal Delicious (130.57 kg), and Vance Delicious (161.62 kg) was observed in 2,4,5T @ 30 ppm treated plants. NAA @ 10 ppm also resulted in better yield/tree as compared to control but results were significantly higher in 2,4,5T treated plants irrespective of cultivars. Preharvest drop in terms of weight was maximum (22.39 kg/tree) in Red Delicious, 21.56 kg/tree in Royal Delicious, and 18.42 kg/tree in Vance Delicious under control treatment when no spray was done. The least preharvest drop irrespective of cultivar was observed in plants sprayed with 2,4,5T @ 30 ppm (Fig. 2). Higher yields/tree obtained in the case of 2,4,5T and NAA sprayed plants are obviously because of the reduction of preharvest fruit drop as compared to control (T0) as reported earlier (Rehman *et al*, 2018; Moneruzzaman *et al*, 2011; Iqbal *et al*, 2009; Ghosh *et al*, 2012; Raja *et al*, 2017 and Arseneault and Cline, 2017).

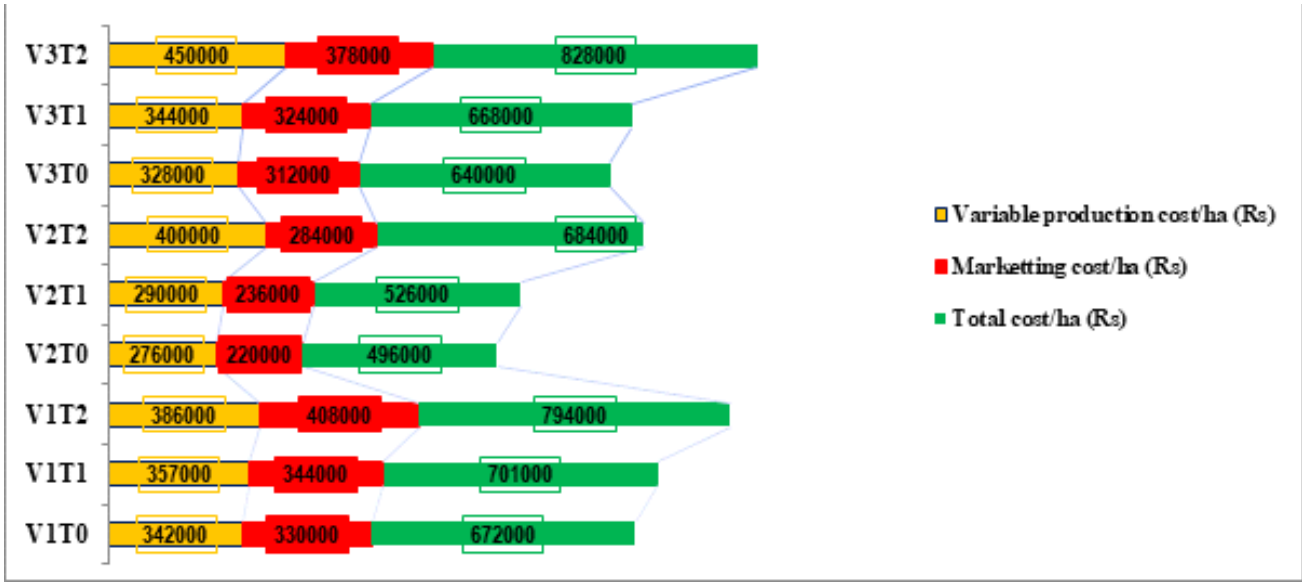


Fig 4: Production cost (Rs/ha) as influenced by various treatments during the study

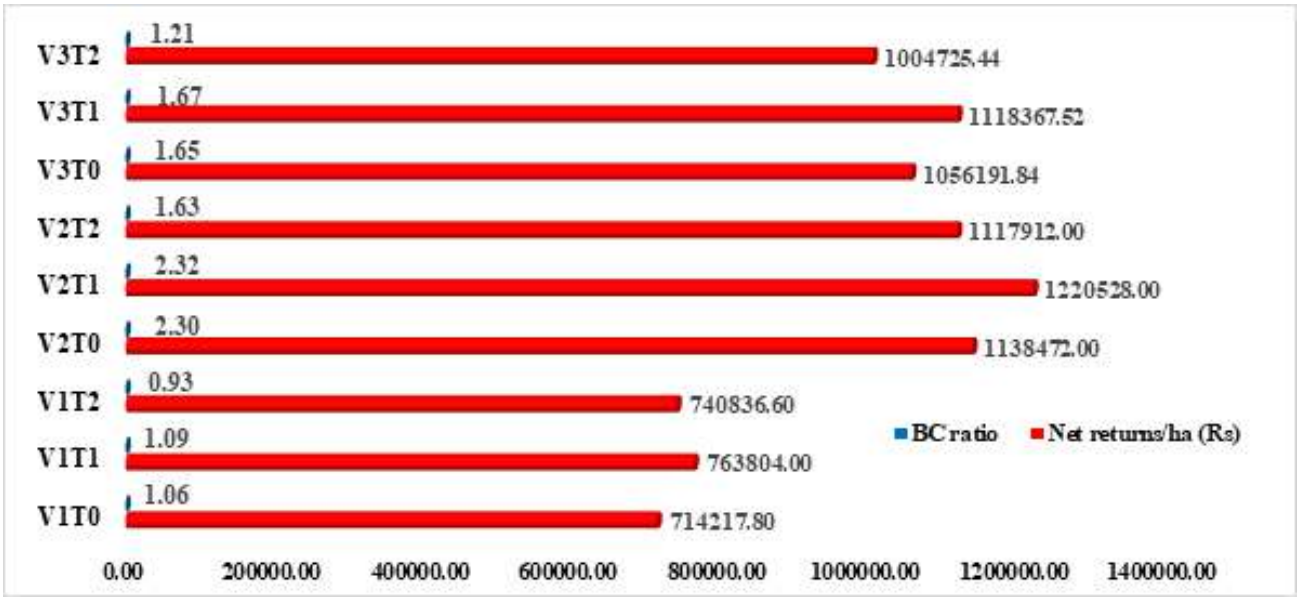


Fig 5: Graphical representation of net return/ha (Rs) and BC ratio of various treatment combinations

collecting specific information. Afterward, gross income per tree was interpolated to gross income per ha (Rs) and represented in the form of Figure 3. As evident from Figure 3, the highest gross income (Rs 18,32,725/ha) was observed in Vance Delicious treated with 2,4,5T @ 30 ppm followed by Rs 18,01,912/ha under the same treatment in the case of Royal Delicious. A spray of both NAA @ 10ppm and 2,4,5T @ 30ppm improved both gross income per tree and per ha basis as compared to control but gross returns obtained in 2,4,5T @ 30 ppm treated were comparatively better. Higher yields obtained in the case of treated plants contributed to more gross returns/tree in the current study. The above results were in conformity with the findings of Byers *et al*, 2005; Yuan and Carbaugh, 2007; Dal Cin *et al*, 2008 and Aglar *et al*, 2016.

From Figure 4, it can be seen that total costs/ha varied among various treatments across studied apple cultivars and was found maximum (Rs. 828000/ha) in 2,4,5T treated orchards of Vance Delicious followed by Rs. 794000 in the case of 2,4,5T@ 30 ppm treated orchards of Red Delicious. Minimum total cost/ha was observed in control orchards of Royal Delicious (Rs. 496000).

Figure 4 also depicts that production cost/ha and marketing cost/ha were higher in the case of treated orchards as compared to control irrespective of apple cultivars. Higher costs/ha obtained in NAA and 2,4,5T treated plants as compared to control are because of higher marketing costs because of higher yields. The production cost of 2,4,5T treated plants was higher as compared to NAA treatment due to the high market price of 2,4,5T.

Net returns/ha and BC ratio of various treatments of various apple cultivars are represented in the form of Figure 5. From Figure 5, it can be deduced that the highest Net returns/ha (Rs. 12,20,528) and BC ratio (2.32) were obtained in Royal Delicious sprayed with NAA @ 10ppm. 2,4,5T sprayed orchards resulted in minimum net returns/ha and least BC ratio during the study across the studied apple cultivars when compared with NAA @ 10ppm as depicted in figure 5. A better BC ratio and more net returns/ha obtained in T1 as compared to T2 may be attributed to higher total costs/tree in T2. While as, a better BC ratio of T0 as compared to T2 is mainly due to less marketing cost although yields are comparatively less in T0 as compared to other treatments and these results are in concordance with the results reported by Naqash *et al*, 2019; Rather *et al*, 2013; Hassan *et al*, 2020 and Shaheen *et al*, 2019.

CONCLUSION

Preharvest fruit drops result in direct economic loss as it happens just a few weeks before harvest and henceforth was the focus point of the current study. From the results of this study, it can be concluded spraying of growth regulators like NAA and 2,4, 5 T decreased drop percentage at varying degrees irrespective of cultivar thereby resulting in higher yields per tree as compared to control. Spraying of both growth regulators improved gross returns/ha as compared to control, however, NAA results in higher net returns and BC ratio as compared to control and 2,4,5 T application. The availability of such molecules in various markets across the valley has remained an issue and the decrease in the post-harvest life of harvested apples is the main concern that needs further study in this regard.

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Productivity Assessment of Different Genetic Groups of Pigs in Manipur

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ABSTRACT

The purpose of the study was to evaluate the performance of two different genetic groups of pigs that were subjected to the identical agro-environmental conditions. A total of sixteen piglets of three months age were distributed evenly across four business. The pigs were raised in a rigorous manner, with approximately sixty percent of their diet coming from local sources and the remaining forty percent being a supplementary concentrate mix. Regular monthly measurements of body weight were recorded, together with information regarding the age at which the animal reached sexual maturity, the first time the animal gave birth, the number of offspring in each litter, the weights of the newborns, and the time at which they were weaned. Both the age at which the first farrowing occurred (AFF) and the weight of the litter at the time of weaning were shown to be significantly influenced by the genetic group. A comparison was made between the weaning litter weight of the graded Hampshire pigs, which was 82.60±2.77 kg, and the weaning litter weight of the graded Large White Yorkshire (LWY) pigs, which was 76.40±3.96 kg. The Hampshire pigs came out with a higher weight. Furthermore, it was worth noting that the Hampshire pigs exhibited a reduced average finishing age (AFF) amounting to 375.80±4.87 d, in contrast to the graded LWY pigs, who exhibited an AFF of 395.60±6.12 d. Hampshire pigs consistently got higher scores, despite the fact that there were no significant differences identified in other economic factors. When compared to LWY pigs, the results reveal that Hampshire pigs have greater performance under village management conditions. In order to improve the non-descript desi pig population in the state, Hampshire boars are recommended as a means of increasing the population.

Key Words: Body weight, Genetic factors, Hampshire, Large White Yorkshire.

INTRODUCTION

Pig farming in Manipur is an important contributor to the growth of the rural economy since it ensures that families have access to enough nutrition and generates additional income for businesses. This is especially beneficial for women who are interested in farming, as well as for agricultural labourers, small and marginal farmers, and other agricultural workers (Singh *et al,* 2019). Animal protein can be obtained from pork in a manner that is both economical and effective. According to Park *et al* (2017), pigs have a high dressing %, a short generation interval, rapid growth rates, cheap maintenance costs, and the ability to use unconventional feedstuffs. Pigs also have an outstanding feed conversion efficiency. There are around two to three pigs that are raised in the backyards of almost every tribal home in Manipur and other Northeastern states. It is not possible for the state to produce enough pork to satisfy the demand, despite the fact that there is a substantial number of pigs and a big interest in pig farming. In the local pig production system, the primary emphasis is placed on subsistence, the system is dependent on local resources, and it is defined by traditional practices that revolve around the feeding of unremarkable pigs with local vegetables, crop leftovers, and rubbish from

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the kitchen. When it comes to pork, consumers in this region have a penchant for meat that is obtained from black-colored pigs, who are generally uninteresting and exhibit substandard development and reproductive capacities, in addition to wasting feed. Efforts to increase pig production in the state are hampered by the limited availability of high-quality animals in the state. In light of this, the primary objective of this study was to improve the local pig breeds by means of crossbreeding with Hampshire or Large White Yorkshire pigs. The purpose of this study was to evaluate the growth and production capacities of these pig breeds under conditions of rural management.

MATERIALS AND METHODS

Two distinct genetic groups of pigs were compared in order to accomplish the purpose of this study, which was to evaluate alternative breeding strategies for the purpose of increasing the amount of pigs produced in the state. Within the scope of the research, there were a total of sixteen piglets, with each of the two groups consisting of eight piglets in an equal distribution. There were a total of four farmers in the Ziontlang village, which is situated in the Chandel area, who were given piglets that were approximately three months old. Each farmer received two sets of piglets: one set consisted of a male and a female of the Hampshire breed, while the other set was comprised of a male and a female of the Large White Yorkshire (LWY) breed. Both sets of piglets were given to each individual farmer.

Management Practices

Immediately following the distribution of the piglets, each and every one of them was given an anthelmintic drug and inoculated against swine fever. On the other hand, the swine fever vaccine was re-administered one year after the initial vaccination. The pigs were raised in wooden huts under harsh conditions for their whole lives. Pigs were reared in an intense system by the farmers in the village, and they used a variety of management strategies for their pigs. There was approximately sixty percent of these pigs' diet that consisted of feed that was sourced from the immediate area. The following ingredients were added in this feed: green grasses, vegetable waste, agricultural by-products, kitchen scraps, hotel garbage, fermented rice, colocasia, banana stems and leaves, and pumpkin. Furthermore, approximately forty percent of their diet consisted of extra concentrate feed, which included crushed maize and wheat bran, among other things. When the piglets were eight weeks old, they were taken away from their mother and eventually made the transition to eating solid food. Beginning with the time they were dispersed and continuing until they reached nine months of age, their body weight was assessed on a monthly basis.

RESULTS AND DISCUSSION

It was observed that the genetic group did not exert a significant influence on weight at different ages, beginning with the initial body weight at three months, which was 9.86±0.25Kg. These findings were consistent with the findings that Anonymous (2014) obtained from their research on the hybridization of Hampshire and Ghungharoo pigs. The results were consistent with the findings of Kumaresan *et al* (2006), who revealed that the starting weights of exotic pigs in Mizoram were 9.78±0.48Kg. and that the weights of crossbreeds were 10.44±0.59kg. When Singh and Devi (1997) reported that the values of exotic and diversified crossbred sows were comparable, ranging from 7.58±0.20 to 10.79±0.61 Kg.in terms of their values. Furthermore, Sharma and Singh (1995) made the observation that exotic and crossbred pigs had bigger litter sizes at delivery ranging from 9.02±0.75 to 10.17±0.62. This was in contrast to desi pigs, which had litter sizes of 6.92±0.29.

Litter size at weaning

The genetic group did not have a statistically significant impact on the size of the litter when the mothers were weaning their young. When comparing the results to those reported by Kumaresan *et al* (2006) for exotic breeds (8.33±0.55) and crossbreeds (8.06±0.66) in Mizoram, we found that the average litter size at weaning for graded Hampshire (8.80±0.37) and graded LWY (7.60±0.51) was comparable. Despite this, Singh *et al* (1989) found that litter sizes decreased during the weaning phase in

Table 1. Showing the effect of genetic group on various economic traits of pig.

Parameter	Genetic group	
	Graded Hampshire	Graded LWY
Weight at 3rd month	17.32±1.46 (8)	16.65±1.5 2 (8)
Weight at 4th month	28.82±1.81 (8)	24.58±1.69 (8)
Weight at 5th month	36.98±2.15 (8)	34.87±2.08 (8)
Weight at 6th month	48.37±2.81 (8)	45.85±2.33 (8)
Weight at 7th month	58.85±2.94 (8)	56.52±2.59 (8)
Weight at 8th month	69.24±2.17 (8)	67.76±3.20 (8)
Weight at 9th month	81.67±3.72 (8)	78.22±3.15 (8)
Reproductive traits		
ASM (Days)	255.00±4.18	272.20±6.84
AFF (Days)	376.80±4.87	395.60±6.12
Litter size at birth	9.80±0.58	8.20±0.66
Litter size at weaning	8.80±0.37	7.60±0.51
Litter weight at birth (kg)	10.1 6±0.42	9.02±0.62
Litter weight at weaning (kg)	82.60±2.77	76.40±3.96
Weaning weight (kg)	9.24±0.17	9.06±0.18
Pre-weaning mortality (%)	6.72 ±2. 77	9.68 ±2.90

Hampshire pigs, with the range of litter sizes falling between 5.51 and 6.02. Sharma and Singh (1995) discovered that exotic breeds, crossbreeds, and desi pigs had reduced litter numbers when they were weaned compared to domestic breeds. The litter sizes for exotic breeds ranged from 6.50±0.30 to 7.13±0.26. For crossbreeds, the litter sizes were 7.70±0.49, and for desi pigs, the litter sizes were 5.20±0.23. As an additional point of interest, Singh and Devi (1997) made the observation that the litter sizes of foreign breeds (6.10±0.45 to 7.55±0.48), crossbreeds (6.00±0.93 to 7.08±0.49), and desi pigs (4.36±0.43 to 5.86±0.50) were smaller at the time of weaning.

Litter weight at birth

Among the graded Hampshire and LWY pigs, the birth weight was 10.36±0.42 kg for the former and 9.02±0.62 kg for the latter for the former. Neither of the two groups exhibited any discernible differences from one another. The results were in agreement with the findings of Sharma and Singh (1995), who conducted a study in which they discovered that the litter weights at birth for Large White Yorkshire, Tamworth, and crossbreeds were 10.51±0.86 kg, 10.28±0.52 kg, and 10.09±0.70 kg, respectively. There were no discernible differences found between these weights that were monitored. In spite of this, they observed a significant divergence in the litter weights at birth between Landrace sows, which weighed 13.05±0.37 Kg. and desi sows, which weighed 6.14±0.32 Kg. Singh and Devi (1997) discovered that the genetic group had a significant influence on the weight of litters. When comparing the weight of desi pigs to that of Landrace pigs, the weight ranged from 5.06±0.56 kg to 13.45±0.69 kg.

CONCLUSION

Pigs that have been bred in Hampshire have shown remarkable performance despite the agroclimatic conditions and intensive management practices that are prevalent in the state. For this reason, it is recommended that Hampshire boars be utilized in order to enhance the nondescript pig population in the rural areas of Manipur. In addition, prior to beginning the process of pig rearing, it is strongly suggested that farmers receive extensive training in the field of scientific pig farming. This program will include the acquisition of high-quality pig genetics, the

management of housing in an efficient manner, the provision of well-balanced feeding, and the implementation of appropriate health care measures in order to guarantee increased profitability in pig farming.

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Raising Productivity and Profitability of Red Gram (*Cajanus cajan* L.) in Guntur District of Andhra Pradesh

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ABSTRACT

Krishi Vigyan Kendra, Lam, Guntur carried out cluster frontline demonstrations (CFLDs) on Red gram in the Andhra Pradesh state during the *kharif* season of 2020-2021, 2021-2022 and 2022-2023 in the villages of Guttikonda, Jullakallu, and Batluru , respectively. The variety LRG-152, when treated with imidacloprid at 2 ml/kg, carbendazim at 1g/kg, and *Rhizobium* spp. at 25 g/kg, along with plant protection (yellow sticky trap + neem oil + insecticide), fertilizer, and weed control, produced the highest average yield of 21.56 kg/ha (2016–17) compared to the farmers' usual yield of 1863 kg/ha. The fluctuation in minimum support price selling rates as announced by GOI resulted in the greatest net returns of Rs.60560 /- during the year 2022–23 and the least net returns of Rs. 58250/– during the year 2020-21. According to the study, there was an average 343 kg/ha extension gap between farmers' practices and the technology that was exhibited. Over the course of all the years, the technological gap averaged 380 kg/ha. The improved performance of suggested varieties with various treatments and the increased viability of recommended technologies during the study period were the reasons for the variations in the technology gap between years. In a similar vein, every research demonstration's technology index complied with the technological gap. It was clear from this that adopting new technologies through CFLDs could increase the production of red gram. Therefore, it's imperative to use efficient extension techniques to spread the upgraded technologies among farmers, such as trainings and demonstrations.

Key Words: Demonstration, Grain , Redgram, *Rhizobium* , Sticky trap, Yield.

INTRODUCTION

Red gram (*Cajanus cajan* L.) is India's second most important legume crop after chickpea. It makes up 22% of all pulse production in India and 1.76% of the country's gross cultivated area. Due to its special ability to fix atmospheric nitrogen in symbiotic relationship with *Rhizobium* bacteria found in the root nodules, red gram plants function as miniature fertilizer factories, replenishing and preserving soil fertility. The ability of red gram to produce high economic yields under soil moisture deficit makes it an important crop in rain fed and dry land agriculture. Red gram is an important rain fed crop in the state of Andhra Pradesh cultivated in 2,40,000 ha and suitable for inter-cropping, with different crops (Cotton, Sorghum, Pearl millet, Green gram, Black gram, Maize, Soybean, Groundnut) for increasing production and maintaining soil fertility. The active constituents in the leaves and seeds are alkaloids, cyanogenic glycosides, flavonoids, saponins and tannins. Red gram variety LRG 52 has a yield potentiality of 20- 25 q/ha and duration of 165 -170d . Its salient feature is tolerant to wilt and brown seeded variety.

Over the last few years, the area and production of pulses in Andhra Pradesh State increased tremendously due to inception of CFLD concept at farmers' field. Front Line demonstration is a long-term educational activity conducted in a systematic manner at farmers' fields to show worth of a new technology on “Seeing is Believing” principle. Traditional or farmer's practices are no longer sustainable towards pulse production as it

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Table1. Particulars showing the details of Red gram grown under CFLD and farmers' practice.

Operation	Existing practice	Improved practices demonstrated
Name of the variety	LRG-41	LRG-52
Seed rate and spacing	7.5-10.0 Kg/ ha, 120 X 30 cm	5.0-7.5 Kg/ ha, 120 X 45 cm or 180X45 cm or 90X90 cm
Seed treatment	No seed treatment	Seed treatment with Imidacloprid @ 2ml/kg + Carbendazim@1g/kg +Rhizobium spp @ 25g/kg of seed
Wilt	No tolerance	Tolerant variety
Weed management	No weed	Weeds control by using herbicide Pendimethalin 1kg / ha in 500 liter of water as preemergence treatment for effective control of weeds within two days after sowing
Plant protection measures	Not practiced	Chlorpyriphos 2.5 ml/L for Maruca
Use of pheremone traps	Not practised	Use of maruca traps 10/ha
Manures	Not applicable	20 Kg P as basal, 8 Kg N, Multi-K foliar spray at pod development stage
Whole package	Farmers are cultivating the Redg ram crop without adoption of any improved technology	All the crop (production and protection) management practices as per the package of practices for kharif crop by Andhra Pradesh State Agricultural University were followed for raising the crop

shows huge gap in yields in comparison to scientific production technologies. Constant efforts are needed to bridge this gap through demonstration of improved production technologies.

MATERIALS AND METHODS

The present investigation was conducted by Krishi Vigyan Kendra, Guntur in villages namely Guttikonda, Jullakallu and Batluru of Andhra Pradesh state during the *kharif* season of years 2020-2021, 2021-2022 and 2022-2023. The demonstration was conducted in an area of 90 ha with 225 farmers. In 2020-21, 100 demonstrations were conducted in 40 ha of area; 75 demonstrations were conducted in 30 ha in 2021-22 and during 2019-20 about 50 demonstrations were conducted in 20 ha. The demonstrations were carried out at different locations to study the yield potential and spread the technology to a larger area. Each frontline demonstration was laid out in 0.4 ha and farmers allotted some area for carrying out their traditional practice. It was conducted with active participation of farmers to demonstrate the improved technologies of Red gram in different villages so as to establish production potentials and expand the area under the crop in the district.

Table 2. Details of need based inputs of Redgram used in CFLD

Name of the Cluster	Number of Demon.	Area in ha	variety	Technology Demonstrated	Need Based Inputs
Guttikonda	100	40 ha	LRG 52	•LRG-52 Resistant to wilt, high yielding variety w ith ICM Practices • Seed treatment with Imidacloprid @ 2ml/kg + carbendazim @1g/kg +Rhizobium spp @ 25g/kg of seed •Fertilizer recommendation based on soil test results • Neem oil + insecticide	• Treated seed •Rhizobium spp • Neem oil • Coragen • Multi -K (13:0:45)
Jullakallu,	75	30 ha	LRG 52		
Batluru	50	20 ha	LRG 52		

Present study with respect to CFLDs and farmers' practices are given in Table 1. The soils in selected villages were sandy loam.

Farmers were trained to follow the package of practices for Red gram cultivation as recommended by the State Agricultural University and need based input materials provided to the farmers (Table 2). Pre-sowing trainings were organized involving the selected farmers on the crops. Selected Red gram variety, LRG-52 was high yielding, tolerant to wilt and suitable to all seasons. Critical inputs along with technologies like seed treatment, fertilizer application, water and weed management, integrated pest and disease management etc., were demonstrated at every stage of the crop with appropriate trainings.

Regular visit by the scientist helped in proper execution of trials as well as collecting farmer's opinion on the demonstrated varieties. The performance of the variety in the trials was judged visually as well as quantitatively by farmers themselves. Crop yields were recorded from the demonstration and check plots at the time of harvest to identify the yield gaps between demonstration and check plots.

The data with respect to grain yield from CFLD plots and farmers plots of the area were collected and evaluated. Potential yield was taken in to consideration on the basis of standard plant population and average yield per plant under recommended package of practices. Different parameters as suggested by Yadav *et al* (2004) was used for gap analysis, and calculating the economics. The details of different parameters and formula adopted for analysis were as under different villages so as to establish production potentials and expand the area under the crop in the district.

Extension gap = Demonstration yield - Farmers' practice yield

Technology gap = Potential yield - Demonstration yield

$$\text{Technology index} = \frac{\text{Potential yield - Demonstration yield}}{\text{Potential yield}} \times 100$$

RESULTS AND DISCUSSION

Seed yield

The productivity of Red gram under improved production technology was 2150 2120 and 2090 kg/ha during the year 2020-2021, 2021-2022 and 2022-2023, respectively as against a yields of 1820,1760 and1750 kg/ha, respectively under farmers' practice. In comparison to farmer's practice there was an increase of 18, 20 and 19 per cent in productivity of red gram under improved technologies during the years 2020-2021, 2021-2022 and 2022-2023,

Table 3. Seed yield of Red gram under CFLD and FP.

Name of the Cluster	Year	Area (ha)	Demonstrations	Yield (kg/ha)		Additional yield (kg/ha) over farmer's practice	Percent increase
				Demo n.	Farmers practice		
Guttikonda	2020-21	40 ha	100	2150	1820	330	18
,Jullakallu,	2021-22	30 ha	75	2120	1760	360	20
Batluru	2022-23	20 ha	50	2090	1750	340	19

Table 4. Pooled analysis of three years yield of Redgram.

	IMPROVED PRACTICE YIELD	FARMER PRACTICE YIELD
Mean	2120	1776.66
Variance	900	1433.33
Observations	3	3
Pooled Variance	1166.6666	
Hypothesized Mean Difference	0	
df	4	
t Stat	12.3108	
P(T<=t) one-tail	0.0001	
t Critical one-tail	2.1318	
P(T<=t) two-tail	0.00025	
t Critical two-tail	2.77644	

Table 5 .Yield and yield parameters of demo and control varieties of Red gram.

Parameter	No. of Branches/plant	No. of Pods / plant	Test weight (g)	Yield (kg/ha)
LRG 52	13	104	11	2120
LRG 41	9	79	10	1776

respectively. The difference in yield observed during different years was due to variation in available irrigation facility at different places, dissimilarities in soil fertility levels, pest and disease incidence, improper usage of manures and fertilizers. The increased grain yield with improved technologies was mainly because of line sowing, seed treatment, nutrient management and weed management. These findings were in line with Meena *et al* (2012) and Meena and Dudi (2018) .

The seed yield of red gram under FLD and FP was given in table 3. Pooled analysis of three years yield of Redgram is presented in table 4. Yield and yield parameters of demonstrations and control varieties of Red gram were detailed in table 5.

Since the p-value (0.0002) (table 4) was less than 0.01, hence it can be concluded that there was significant difference between two practices with regard to yield in which improved practice significantly more yield (2120 kg/ha) than that of farmers' practice (1776 kg/ha).

Economics

Economic returns as a function of gain

Table 6. Economics Analysis of Redgram under CFLD and FP.

	Demonstrated plot				Farmers' plot			
Year	Gross Cost (Rs ha-1)	Gross returns (Rs ha-1)	Net return (Rs ha-1)	B:C ratio	Gross Cost (Rs ha -1)	Gross returns (Rs ha-1)	Net return (Rs ha-1)	B:C ratio
2020-2021	29000	87250	58250	1.80	33540	69870	36330	1.08
2021-2022	28650	87730	59080	2.06	32420	67870	35450	1.09
2022-2023	28000	88560	60560	2.16	34000	68470	34470	1.01

Table 7. Technological gap analysis of frontline demonstrations on Redgram farmers' field.

Year	Number of FLDs	Potential yield (kg/ha)	FLD yield (kg/ha)	FP yield (kg/ha)	EG (kg/ha)	TG (kg/ha)	TI (kg/ha)
2020-21	100	2500	2150	1820	330	350	14
2021-22	75	2500	2120	1760	360	380	15.2
2022-23	50	2500	2090	1750	340	410	16.4
AVERAGE		2500	2120	1776	343	380	15

EG= Extension gap; TG= Technology gap; TI= Technology index; FP= Farmers practices

yield and MSP sale price varied for LRG 52 (Demon.) LRG 41 (farmers' practice) . The maximum gross returns of Rs. 88,560/- and net returns of Rs. 60560/- during the year 2022-23 and minimum of Rs. 87250/- and net returns of Rs. 58250/- during the year 2020-21 were obtained due to variation in MSP sale rates as declared by GOI. The higher additional returns and effective gain obtained under demonstrations could be due to improved technology, nonmonetary factors, timely operations of crop cultivation and scientific monitoring and also sale of seed to other farmers as a seed. The lowest and highest benefit cost ratio were 1.80 and 2.16 in 2020-21 and 2022-23, respectively (Table 6) depends on produced grain yield and MSP sale rates. The results were in confirmity with the findings of front line demonstrations on pulses by Chaitanya *et al* (2020).

Performance of CFLD

Yield of frontline demonstration trials and potential yield of the crop was compared to estimate the yield gap further it was categorized into extension gap, technology gap and technology index. The extension gap and technology gap observed that it may be attributed due to dissimilarities in soil fertility levels, pest and disease incidence, improper usage of manures and fertilizers. Hence, to narrow down the yield gaps location specific technologies needs to be adopted. The study revealed that an extension gap of 330 to 360 kg/ha was found between demonstrated technology and farmers' practice and on average basis the extension gap was 343 kg/ha. The extension gap was highest (360 kg/ ha) during 2021-22 and lowest (330 kg/ha) during 2020-21. Such gap might be attributed to adoption of improved technology especially with high

yielding new varieties sown in line with balanced nutrition, weed management and appropriate plant protection measures in demonstrations which resulted in higher grain yield than the traditional farmers' practices.

The study further exhibited a wide technology gap during different years. The average technology gap of all the years was 380 kg/ha. The difference in technology gap in different years was due to better performance of recommended varieties with different interventions and more feasibility of recommended technologies during the course of study. Similarly, the technology index for all demonstrations in the study was in accordance with technology gap. Higher technology index reflected the inadequate transfer of proven technology to growers and insufficient extension services for transfer of technology. Hence, it can be inferred that the awareness and adoption of improved varieties with recommended scientific package of practices have increased during the study period. These findings were in the conformity of the results of study carried out by Meena and Sing (2017), Meena and Dudi (2018).

CONCLUSION

Cluster frontline demonstrations on Red gram conducted in three villages resulted average highest yield 21.20 q/ha in demonstration plot compared to farmers plot 17.76 q/ha. The cluster frontline demonstrations conducted on Red gram at farmer's field revealed that the adoption of improved technologies significantly increased the yield as well as gross and net returns to the farmers. Improved technologies can be spread by the successful implementation, demonstration and various extensions activities like training programme, field day, exposure visit organized in CFLDS programmes in the farmers' fields.

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Relationship between Socio-Economic Characteristics of Farmers and Adoption of Polyhouse Cultivation Technology

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ABSTRACT

Polyhouse or greenhouse is a structure made-up of translucent materials like polyethylene or shade nets, where the plants are grown under controlled climatic conditions, both considered identical, but the greenhouse is used more commonly in India. The knowledge for the present study was operationalized as the level of adoption about polyhouse technology in the Jaipur division of Rajasthan. Jaipur and Alwar districts were selected because they have a maximum number of polyhouse farmers. Out of both districts, the first three tehsils having a maximum number of polyhouse farmers was selected purposively. In this way, 160 respondents from the Jaipur district and 60 respondents from the Alwar district was selected. Thus, the total sample size was comprised of 220 farmers. The present study showed that education, annual income, sources of farm information, extension contacts and economic motivation had significant correlation with the adoption of farmers at 1 per cent level of significance ($P \leq 0.01$), followed by age had significant correlation with the adoption of farmers at 5 per cent level of significance ($P \leq 0.05$), and remaining independent variables like caste, occupation, land holding and farm mechanization had non- significant correlation with the adoption of farmers.

Key Words: Adoption, Cultivation, Farmers, Independent variables, Polyhouse, Technology.

INTRODUCTION

India is the predominantly an agriculture-based country where majority of the people are engaged in agriculture. It plays a pivotal role in respect of socio-economic transformation of people in general and rural people in particular. Protected cultivation is a promising technology and becoming popular all over the world. There are 115 countries in the world which have undertaken greenhouse vegetable cultivation commercially. India is the second largest producer of vegetables in the world i.e., next to China. Total vegetable production of India is 191.769 million tons of its total area 10.353 million ha (as per NHB database, 2019-20). Polyhouse or greenhouse is a structure made-up of translucent materials like polyethylene or shade nets, where the plants are grown under controlled climatic conditions, both considered identical, but the greenhouse is used more commonly in India. The size of the structure can differ from small shacks to big-size buildings as per the need. Polyhouse is a type of greenhouse, or a smaller version of the greenhouse, where polyethylene is used as cover. In India, farming and nursery are highly dependent on open field seed production because of many reasons like; low economic status of farmers, lack of technical know-how, etc. Seedlings grown under natural conditions are susceptible to the sudden changes in climatic conditions, affecting both their quality and yield. Protected cultivation involves protection from adverse environmental conditions and offers distinct advantages of quality, productivity and favourable market prices to the growers . Problems of crop pests and diseases can also be minimized through polyhouse cultivation.

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Table1. Relationship between selected independent variables of farmers with adoption about PCT.

Sr.No	Independent variable	Correlation Coefficient (r)		
		Jaipur District n_1=160	Alwar District n_2=60	Overall (n=220)
1.	Age	0.057	0.111	0.134*
2.	Caste	0.059	0.071	0.068
3.	Education	0.165*	0.326*	0.242**
4.	Occupation	0.151	0.082	0.128
5.	Annual family income	0.155*	0.292*	0.192**
6.	Land holding	0.103	0.041	0.048
7.	Farm mechanization	0.089	0.013	0.115
8.	Sources of farm information	0.162*	0.275*	0.257**
9.	Extension contacts	0.168*	0.262*	0.263**
10.	Economic motivation	0.196*	0.321*	0.244**

** Significant at 1 per cent level of significance ($P \leq 0.01$)
* Significant at 5 per cent level of significance ($P \leq 0.05$)

Though India is the second-largest producer of vegetable crops globally, its vegetable production is slightly less than the required quantity if a balanced diet is to be provided to every individual. The per capita recommendation of vegetables is 400g/d, but the availability of vegetables per capita is 393.76g/ per person per day (Horticulture Statistics, 2018, Government of Rajasthan, Jaipur). Protected cultivation can be defined as a cropping technique where in the micro climate surrounding the plant body is controlled partially/fully as per the requirement of the plant species grown during their period of growth (Chandra 2001). Polyhouse technology is the unique technique of providing favourable conditions to the plants. In spite of many challenges, man has learnt how to grow plants under natural environment. Even in extreme adverse climatic conditions where no crops can grow, man has developed a method of growing high value crops which is called as Polyhouse Technology. Protected Cultivation technology is a relatively new technology for our country. The total area covered under protected cultivation in our country is approx, 70,000 ha (Choudhary and Verma, 2018). the objective was to study relationship between socio-economic characteristics of farmers and adoption of polyhouse cultivation technology.

MATERIALS AND METHODS

The present study was conducted in the Jaipur division of Rajasthan in 2023. Jaipur division was purposively selected, as it stands first among several beneficiaries under polyhouse cultivation technology. The second stage of the sampling process involved the selection of districts from the divisions. Jaipur (355) and Alwar (147) districts were selected purposively based onthe maximum number of farmers using polyhouse technology as compared to other districts of the Jaipur division. Jaipur and Alwar districts comprised of 21 and 14 tehsils, respectively. Out of both districts, the first three tehsils with a maximum number of farmers with polyhouses were selected purposively. Thus, the total sample size was comprised of 220 farmers.The information was collected through a personal interview with the help of a pre-tested structured schedule. The knowledge for the present study was operationalized as the level of adoption about polyhouse cultivation technology.The programme included all the major aspects about polyhouse vegetable cultivation. This was measured by scale developed by Singh

(2001), which was used with slight modifications) as suggested by the experts. The farmers' adoption of polyhouse cultivation was measured by asking various questions related to PCT (Polyhouse Cultivation Technology). The collected data were analyzed by using Coefficient of correlation (r).

Correlation coefficient

The Correlation Coefficient ('r' value) was used to measure the relationship between the knowledge of farmers about Polyhouse Cultivation Technology and selected independent variables *viz.,* age, caste, education Occupation, annual income, land holding, farm mechanization, sources of farm information,extension contacts and economic motivation dependent and independent variables.The Correlation Coefficient between two groups was calculated by using the following formula: -

$$r = \frac{\sum (XY) - \frac{\sum X \sum Y}{n}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{n}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{n}\right]}}$$

Where r = Correlation Coefficient

X = Independent variable

Y = Dependent variable

n = Total number of respondents

RESULTS AND DISCUSSION

The relationship between the adoption of the farmers about polyhouse cultivation technology and independent variables viz., age, caste, education, occupation, annual family income, land holding, farm mechanization, sources of farm information, extension contacts, economic motivation and adoption index was worked out in terms of correlation coefficient ("r"). On the basis of operational measures used for the variables, research hypotheses in null form were derived for testing the relationship and significance on zero order correlation. The zero order correlation (r values) has been given in Table1 and its characteristics wise relationship is being described in subsequent pages.

Age

The data (Table1) revealed that age had positive and non-significant correlation with adoption of farmers about PCT in both districts (Jaipur and Alwar). Hence the null hypothesis (NH05.3.1) was accepted, which showed that there was no relationship between age of farmers and their adoption about PCT and research hypothesis was rejected. This indicated that, adoption of farmers was not influenced by their age. It may be due to the fact that the farmers from the different age groups were similar in taking benefits under PCT. These results were similar with the findings obtained by (Singh *et al,* 2011) who observed that age had non-significant relationship with the adoption.**Caste**

The data (Table1) showed that caste had positive and non-significant correlation with adoption of farmers about PCT in both districts (Jaipur and Alwar). Hence the null hypothesis (NH05.3.2) was accepted, which showed that there was no relationship between caste of farmers and their adoption about PCT and research hypothesis was rejected. This indicated that, adoption of farmers was not influenced by their caste. These findings were in congruence with the findings obtained by (Prakash *et al,* 2021) who observed that caste had non-significant relationship with the adoption.

Education

The data (Table1) expressed that education had positive and significant correlation ($P \leq 0.05$) with the adoption of farmers about PCT in both districts (Jaipur and Alwar). Hence, the null hypothesis (H04.3) was rejected, which showed that there was no relationship between education of farmers and their adoption about PCT and research hypothesis was accepted. This indicated that, adoption of farmers was influenced by their education level. It might be due to the fact that education has changed the outlook of farmer which helped in changing the in adoption behaviour. These findings were similar with the results reported by (Singh *et al,* 2016 and Nayak *et al,* 2020) who observed that education had significant relationship with the adoption.

Occupation

The data (Table1) explained that occupation had positive and non-significant correlation with the adoption of farmers about PCT in both districts (Jaipur and Alwar). Hence, the null hypothesis (NH05.3.4) was accepted, which showed that there was no relationship between occupation of farmers and their adoption about PCT and research hypothesis was rejected. This indicated that, adoption of farmers was not influenced by their occupation. It may be due to the fact that there was no biasedness in the distribution of PCT benefits, whatever might be like occupation of farmers. These results were similar with the findings of (Sharnagat, 2008) who observed that occupation status had non-significant relationship with the adoption.

Annual income

The data (Table1) showed that annual income had positive and significant correlation ($P \leq 0.05$) with the adoption of farmers about PCT in both districts (Jaipur and Alwar). Hence, the null hypothesis (NH05.3.5) was rejected, which showed that there was no relationship between annual family income of farmers and their adoption about PCT and research hypothesis was accepted. This showed that, adoption of farmers was influenced by their annual family income. It also showed that higher the annual family income, more favourable adoption about PCT and vice-versa. It might be due to the fact that high annual income helped the farmers in spending more money for utilizing the latest polyhouse production technologies. These results were in accordance with the results of (Kumar *et al,* 2012 and Harisha *et al,* 2020) who observed that annual family income had significant relationship with the adoption.

Land holding

The data (Table1) indicated that land holding had positive and non-significant correlation with the adoption of farmers about PCT in both districts (Jaipur and Alwar). Hence, the null hypothesis (NH05.3.6) was accepted, which showed that there was no relationship between size of land holding of farmers and their adoption about PCT and research hypothesis was rejected. It might be due to the reason that most of the farmers had medium to large land holdings, so the attitude of farmers was not influenced by their size of land holding. These findings were similar to the finding obtained by (Barau *et al,* 2020) who observed that land holding had non-significant relationship with the adoption.

Farm mechanization

The data (Table1) revealed that farm mechanization had positive and non-significant correlation with the adoption of farmers about PCT in both districts (Jaipur and Alwar). Hence the null hypothesis (NH05.3.7) was accepted, which showed that there was no relationship between farm mechanization of farmers and their knowledge about PCT and research hypothesis was rejected. This indicated that, adoption of farmers was not influenced by their farm mechanization. It might be due to the fact that with different farm mechanization techniques, the benefits derived by the farmers were uniform. These findings were similar with the results obtained by (Jaganathan *et al,* 2009 and Pawar *et al,* 2019) who observed that farm mechanization had non-significant relationship with the adoption.

Sources of farm information

The data (Table1) showed that sources of farm information had positive and significant correlation ($P \leq 0.05$) with the adoption of farmers about PCT in both districts (Jaipur and Alwar). Hence, the null hypothesis (NH05.3.8) was rejected, which showed that there was no relationship between sources of farm information by farmers and their adoption about PCT and research hypothesis was accepted. This pointed out that, adoption of farmers was influenced by their sources of farm information. It might be due to the reason that the high frequency of sources made by the farmers with farm information enabled them to acquire more information, improved their skills and thus increased their knowledge. These results were in congruence to the findings reported by (Kumar *et al,* 2012) who observed that sources of farm information had significant relationship with the adoption.

Extension contacts

The data (Table1) revealed that extension contacts had positive and significant correlation (P≤0.05)with the adoption of farmers about PCT in both districts (Jaipur and Alwar). Hence, the null hypothesis (NH05.3.9) was rejected, which showed that there was no relationship between extension contact of farmers and their adoption about PCT and research hypothesis was accepted. This indicated that, adoption of farmers was influenced by their extension contacts. It showed that more contact of the farmers with the extension personnel, more favorable adoption towards PCT was found and vice-versa. It might be due to the fact that the high frequency of contacts made by the farmers with extension agency enabled them to acquire more information, improved their skills and increased their knowledge. The findings were in accordance with the results obtained by (Singh, 2001) who observed that extension contacts had significant relationship with the adoption.

Economic motivation

The data (Table1) showed that economic motivation had positive and significant correlation (P≤0.05) with the adoption of farmers about PCT in both districts (Jaipur and Alwar). Hence, the null hypothesis (NH05.3.10) was rejected, which showed that there was no relationship between economic motivation of farmers and their adoption about PCT and research hypothesis was accepted. This pointed out that, adoption of farmers was not influenced by their economic motivation. It might be due to the fact that it was believed that economic motivation was the basic character upon which other drives, motives and attributes were built. It psychologically brought an individual to orient himself to achieve higher income and horticultural crops are remunerative in nature. So, it was natural that horticulturist of this area are moderately economically motivated and having moderate to high adoption towards PCT that was reflected into significant relationship. These findings were similar with the results of (Jaganathan *et al,* 2009 and Patel *et al,* 2015) who observed that economic motivation had significant relationship with the adoption.

CONCLUSION

The present study showed that education, annual income, sources of farm information, extension contacts and economic motivation had significant correlation with the adoption of farmers at 1 per cent level of significance(P≤0.01), followed by age had significant correlation with the adoption of farmers at 5 per cent level of significance (P≤0.05) and remaining independent variables like caste, occupation, land holding and farm mechanization had non- significant correlation with the adoption of farmers. In Jaipur district it was observed that education, annual income, sources of farm information, extension contacts and economic motivation had significant correlation with the adoption of farmers at 5 per cent level of significance(P≤0.05). Other independent variables like; age, caste, occupation, land holding and farm mechanization had non-significant correlation with the adoption of farmers. In Alwar district it was observed that education, annual income, source of farm information, extension contacts and economic motivation had significant correlation with the adoption of farmers at 5 per cent level of significance (P≤0.05). Other independent variables like age, caste, occupation, land holding and farm mechanization had non-significant correlation with the adoption of farmers about PCT.

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Relationship between Profile of the Vegetable Growers and Hazardous Effects of Pesticides in Gujarat

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ABSTRACT

Vegetables are very important perishable higher nutritional valuable crops in India as well as in Gujarat. The present study was conducted in Banaskantha district of Gujarat, due to major vegetable producing area. Three talukas were selected purposively where potato and tomato crops were grown. Five villages from each taluka and ten vegetable growers from each village were selected randomly (five tomatoes and five potatoes growers). Thus, in total 150 respondents *i.e.,* 75 for potato growers and 75 for tomato growers selected for study. The data were collected from farmers through personal interviews conducted at their homes and farms. Statistical tools such as frequency, rank, arithmetic mean, standard deviation, and correlation coefficient (r) were used to derive the inferences. The study concluded that mostly respondents had medium to low level of knowledge about the hazardous effects of pesticides

Key Words: Pesticides, Knowledge, Vegetables, Hazardous and Farmer

INTRODUCTION

In India, agriculture contributes around 20.19 per cent to the gross domestic product (GDP) while providing employment to around 60.00 per cent of country's work force (Anonymous, 2020). The second largest producer of vegetables in the world is India. India shares almost 8.6 per cent of the world vegetables output from 2.00per cent of the cropped area in the country. During 2020-21, India produced 191.77 million Mt of vegetables on an area of 10.35 million hectares. India exported vegetables worth 4969.73 crores (Anonymous, 2020). Vegetable cultivation has become an important means for reducing poverty of small farmers in India. It helps to generate valuable income for farmers and labourers. Farmers training needs were playing a pivotal role in the widespread adoption of latest technology in awareness of health (Kumar *et al,* 2024). In the present study, knowledge refers to know about various hazardous effects of pesticides on environment, water, soil as well as human health possessed by the vegetable growers. Adequate knowledge about hazardous effects of pesticides is essential for vegetable growers for the optimum and safe use of pesticides. Therefore, it was essential to gather information from vegetable growers regarding their knowledge of the hazardous effects of pesticides.

Due to intense competition and high demand, many farmers are increasingly overusing organophosphate pesticides to boost their agricultural yields (Choudhary *et al*, 2014). As a result, pesticides have become indispensable in agro-ecosystems, despite the numerous problems associated with them (Dey *et al*, 2013). The use of pesticides in agriculture has led to several issues, including the death of beneficial insects, secondary pest outbreaks, the development of pest resistance, and significant human health problems.

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Table 1. Distribution of vegetable growers according to their knowledge level about the hazardous effects of pesticides. (n= 150)

Sr. No.	Category	Respondents	
		Frequency	Per cent (%)
1	Low	31	20.67
2	Medium	93	62.00
3	High	26	17.33
Total		150	100.00
Mean=37.49	SD=10.17		

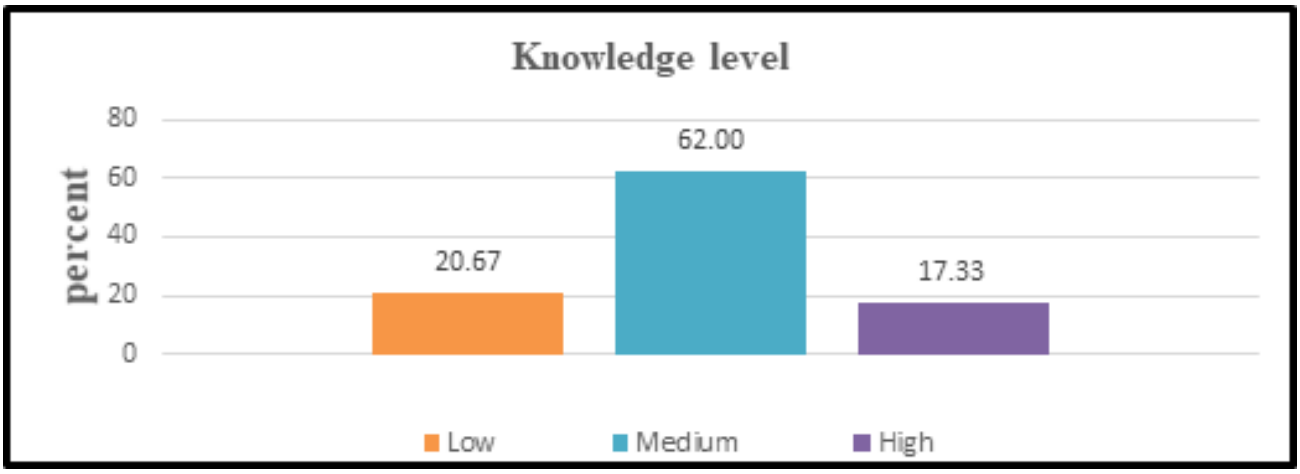

Fig. 1. Distribution of vegetable growers according to their knowledge level about the hazardous effects of pesticides

These health issues include both acute and chronic diseases, such as cancer, neuro-behavioral defects, congenital malformations, and other health risks like leukemia and neoplasms. Pesticides used in agricultural fields can spread into the environment and come into direct or indirect contact with humans.

MATERIALS AND METHODS

The present study was conducted in Banaskantha district of North Gujarat region. This district was selected basis on highest (91405 ha) vegetable production (*Department of Horticulture, Banaskantha*). Banaskantha district consists of fourteen talukas. Three talukas were selected purposively in which potato and tomato crops grown on 65974 ha area (*Department of Horticulture, Banaskantha*). Five villages from each taluka were selected randomly. From each selected village ten vegetable growers were selected randomly, which were five tomatoes and five potatoes growers selected. Thus, in total 150 respondents *i.e.,* 75 for potato growers and 75 for tomato growers selected for study.

An interview schedule was developed to encompass all independent and dependent variables. Data regarding knowledge of the hazardous effects of pesticides and respondents' opinions on alternatives to pesticides were collected through personal interviews. The data from the interviews were then transferred to a master sheet. Statistical tools such as frequency, rank, arithmetic mean, standard deviation, and correlation coefficient (r) were used to draw inferences.

RESULTS AND DISCUSSION

Knowledge level of vegetable growers about the hazardous effects of pesticides

It was found that slightly more than half (62.00%) of the vegetable growers had medium level of knowledge about the hazardous effects of pesticides, followed by low and high level of knowledge with 20.67 per cent and 17.33 per cent , respectively.

It can be said that a large majority (82.67%) of the vegetable growers were found with medium to low level of knowledge about the

Table 2. Distribution of respondents based on socio-economic profile. (n= 150)

Sr. No.	Variable	Numbers	Per cent
A.	Age		
1.	Young age group (Up to 35 yr)	40	26.67
2.	Middle age group (Between 36 to 50 yr)	74	49.33
3.	Old age group (Above 50 yr)	36	24.00
B.	Education		
4.	Illiterate	25	16.66
5.	Primary education (1 st to 8thstd.)	50	33.33
6.	Secondary education (9 th to 10thstd.)	43	28.67
7.	Higher secondary education (11 th and 12thstd.)	19	12.67
8.	Graduation and Post -graduation and above	13	08.67
C.	Land Holding		
9.	Marginal (Up to 1.00 ha)	30	20.00
10.	Small (1.0 to 2.0 ha)	34	22.67
11.	Semi medium (2.0 to 4.0 ha)	74	49.33
12.	Medium (4.0 to 10.0 ha)	12	08.00
13.	Large (more than 10.0 ha)	00	00.00
D.	Annual Income		
14.	Up to Rs. 50000/ -	33	22.00
15.	Rs. 50001 to 100000/ -	71	47.33
16.	Above Rs. 100001/ -	46	30.67
E.	Social Participation		
17.	No membership	38	25.33
18.	Membership in one organization	64	42.67
19.	Membership in more than one organization	34	22.67
20.	Holding position in organization	14	09.33
F.	Farming Experience		
21.	Low level of farming experience	35	23.33
22.	Medium level of farming experience	82	54.67
23.	High level of farming experience	33	22.00
G.	Extension Participation		
24.	Low extension participation	29	19.33
25.	Medium extension participation	84	56.00
26.	High extension participation	37	24.67
H	Source of Information		
27.	Low source of information	22	14.66
28	Medium source of information	100	66.67
29.	High source of information	28	18.67
30.	Mass Media Exposure		
31.	Low mass media exposure	25	16.67
32.	Medium mass media exposure	96	64.00
33.	High mass media exposure	29	19.33
I.	Scientific Orientation		
34.	Low scientific orientation	29	19.33
35.	Medium scientific orientation	87	58.00
36.	High scientific orientation	34	22.67
37.	Risk Orientation		
38.	Low risk orientation	37	24.66
39.	Medium risk orientation	91	60.67
40.	High risk orientation	22	14.67

Table 3. Ranking of knowledge statement on the basis of mean per cent score.

Sr. No.	Statement	Mean Score	MPS	Rank
1	Do you know excessive use of pesticides causes harmful effects on human health?	2.90	96.66	1
2	Do you know about use of agro chemicals such as pesticides can contaminate vegetables?	2.86	95.55	2
3	Do you know use of pesticide causes hazardous effects to soil?	2.78	92.88	3
4	Do you know best time of application of pesticides	2.76	92.22	4
5	Do you store your loose pesticides container at right place?	2.60	86.66	5
6	After spraying, do you wash your body surface?	2.60	86.66	5
7	Do you know use of pesticides causes hazardous effect in water?	2.56	85.55	7
8	Do you generally wash your cloth after application of pesticides?	2.53	84.44	8
9	Do you dispose your unused or expired agro chemicals?	2.33	77.77	9
10	Do you cover your nose mouth with any cloth?	2.30	76.66	10
11	Do you read the literature (14 languages) given with pesticides container?	2.26	75.55	11
12	Do you know the topics given in the literature?	2.20	73.33	12
13	Do you perform the following operations – rinsing, filling, washing for spraying?	2.12	70.66	13
14	Do you know any hazardous effects of pesticides on environment?	2.10	70.00	14
15	Did you ever hear about botanical pesticides?	1.86	62.22	15
16	What is the result of improper, excessive and careless use of pesticides?	1.63	54.44	16
17	Do you know the meaning of antidotes?	1.56	52.22	17
18	Do you know, after spraying of pesticides it goes to where?	1.46	48.88	18
19	Do you cover your hand with gloves?	1.40	46.66	19
20	Do you re-use pesticides container for household purpose?	1.26	42.22	20

hazardous effects of pesticides. The probable reason for above finding may be due to their primary to secondary level of education, they can't proper understand the literature given with pesticides container regarding time, dose and other operation related to the application method. Another reason might be due to unreadable of instructions about safe waiting period of pesticides and unaware about self-protection from pesticides. This result was in line with the findings of Adhikary (2012).

Socio-economic profile of farmers

The data (Table 2) illustrate that a significant portion (49.33%) of the middle-aged group (Jhansi and Kalal, 2022) predominantly possessed primary education (33.33%), followed by secondary education (28.67%) (Shinde *et al,* 2021). The majority (49.33%) of respondents were semi-medium landholders (Chaudhary, 2013; Dhepe, 2014). According to the data, 47.33% of respondents earned up to 50,000/- annually. Social participation among respondents indicated membership in one organization (42.67%), followed by no membership (25.33%). A majority (54.67%) of respondents had a medium level of farming experience (Rabari, 2006). Additionally, more than half (56.00%) of vegetable growers exhibited a medium level of participation in various extension activities (Chaudhary, 2010). The study concluded that two-thirds (66.67%) of vegetable growers had medium sources of information (Shinde, 2017), while nearly two-thirds (64.00%) had medium exposure to mass media (Chaudhary, 2010; Upadhyay, 2010). The majority (58.00%) of vegetable growers displayed a medium level of scientific orientation (Choudhary, 2010), and over half (60.67%) demonstrated a medium level of risk orientation (Patel *et al*, 2012).

Relationship between Profile of the Vegetable Growers and Hazardous Effects

Table 4. Relationship between profile of respondents and their level of knowledge

Sr. No.	Variable	r value
(I)	Personal characteristics	
1	Age	-0.1130^{NS}
2	Education	0.1858**
(II)	Socio economic characteristics	
3	Annual income	0.1848**
4	Land holding	0.1502*
5	Farming experience	0.1553*
(III)	Communication characteristics	
6	Extension participation	0.1492*
7	Source of information	0.1514*
8	Mass Media exposure	0.1274^{NS}
9	Social participation	0.1562*
(IV)	Psychological characteristics	
10	Risk orientation	0.1887**
11	Scientific orientation	0.1533*

*Where, NS = non-significant, * = significant at 0.05 and ** = significant at 0.01 level of probability.*

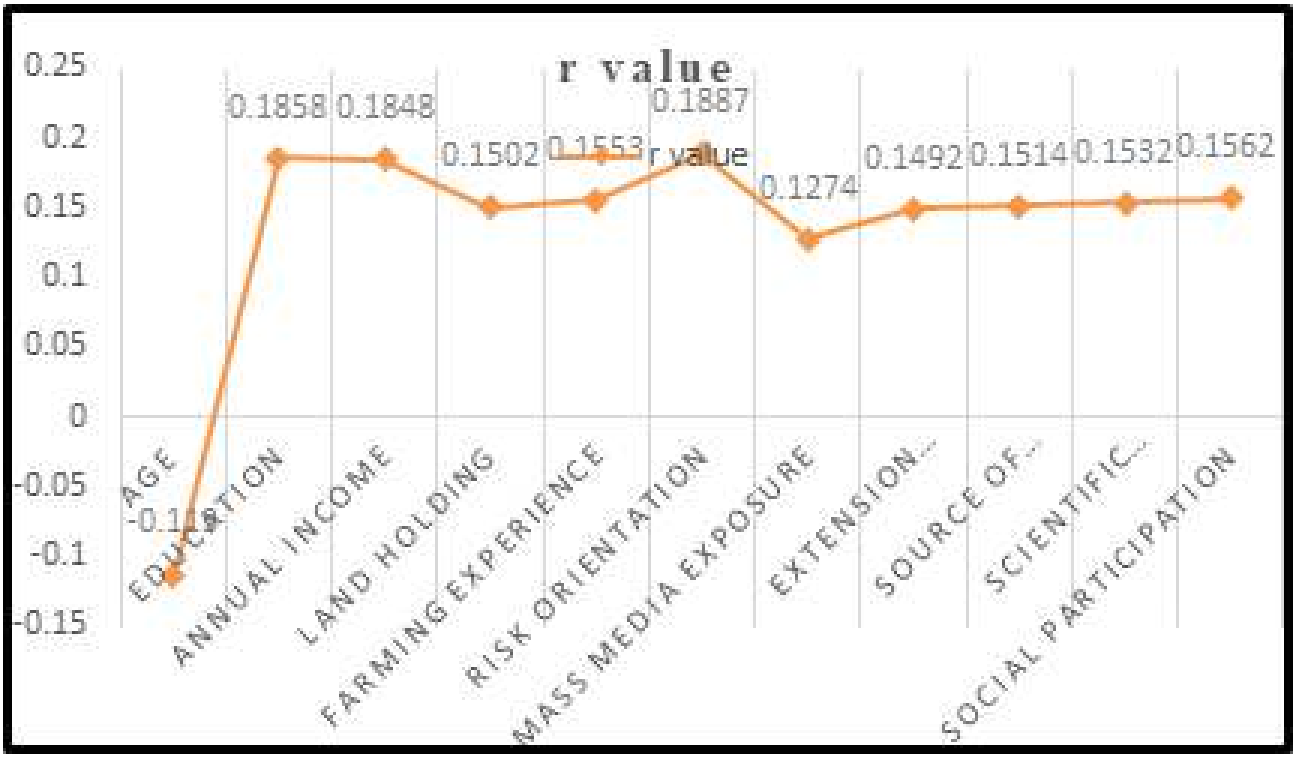

Fig.2. Relationship between profile of vegetable growers and their knowledge level about hazardous effects of pesticides

Ranking of knowledge statement on the basis of mean per cent score

The data indicated that the farmers had very good amount of knowledge in four aspects. The finding was in concurrence with the findings reported by Rijal *et al* (2018).

Relationship between profile of respondents and their level of knowledge

The relationship between profiles characteristics of the vegetable growers with level of knowledge were worked out with the help of coefficient of correlation. The regarding relationship between variables are given in table 4 and diagrammatically depicted in fig. 2.

The independent variables viz; age (r = -0.1130), supported by Kumar *et al* (2016), mass media exposure (0.1274) of respondents were non-significant (at 0.05 and 0.01 level of significance), the similar findings have been reported by Dodia (2015). The ages of respondents were negative correlated but mass media exposure was having positive correlation with knowledge. The other variables such as education (r = 0.1858),the similar findings have been reported by Muhammad *et al* (2019)**,** annual income(r = 0.1848) the similar findings have been reported by pole (2018), land holding (r = 0.1502) the similar findings have been reported by Desai (2016), farming experience(r = 0.1553) the similar findings have been reported by Hasan *et al* (2021), extension participation(r = 0.1492) the similar findings have been reported by pole (2018), source of information(r = 0.1514) the similar findings have been reported by Atar (2012), social participation(r = 0.1562) the similar findings have been reported by Desai (2016), risk orientation(r = 0.1887) the similar findings have been reported by Nale (2014) and scientific orientation(r = 0.1858) the similar findings have been reported by Salunkhe and Pandey (2017) were highly significant and positively correlated with respondents knowledge (at 0.05 and 0.01 level of significance)level about hazardous effects of pesticides.

CONCLUSION

The study facilitates in knowing the characteristics of the vegetable growers which would help to guide for the programmers and extension agencies to planning and implementing programme related to promote safe and efficient use of the pesticides for increase vegetable production and reduce hazardous effects of pesticides on water, soil, human health and environment. The distribution of the respondents showed that majority of the vegetable growers fell under medium category with respect to personal, socio economical, communicational and psychological characteristics studied. The farmers had very good amount of knowledge of, excessive use of pesticides causes harmful effects on human health, use of agro chemicals such as pesticides can contaminate vegetables, pesticide causes hazardous effects to soil and best time of application of pesticides It implies that the vegetable growers of Banaskantha district are in transitional state of advancement. Hence, the intensity of extension efforts should be modified in best possible way to bring desired behavioral changes in farmers. The farmer's back ground factors which impact knowledge of vegetable growers about the hazardous effects of pesticides must be reckoned with in any best programme of planned communication. The study also revealed that personal and socio-economic variables like education and annual income had contributed highly significantly to the prediction of knowledge of vegetable growers about hazardous effects of pesticides. It therefore, implies that efforts should be prepare for considering the training should be arranged for pesticides dealers for imparting better knowledge about safe and balance use of pesticides.

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Satisfaction Level of the Farmers towards Quality of Videos on Crop Residue Management Technology

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ABSTRACT

Paddy straw management is a key barrier to paddy farming in northwestern India. For the long-term sustainability of agriculture and natural resources accurate and timely information is seen to be a key component for changing farmers' behavior. Information and communication technologies have been advanced as a promising way to address these problems by providing more timely and low-cost information services to farmers. Punjab Agricultural University, Ludhiana produced a diverse array of videos covering wide range of topics pertinent to farming. Among these, four videos were carefully chosen, addressing essential aspect of Crop Residue Management. Therefore, for this study, four videos on crop residue management were chosen in order to measure the farmers' degree of satisfaction. A sample of 180 farmers was selected from the three selected districts Ferozepur, Sangrur and Ludhiana of Punjab. Total 180 respondents (60 as control group and 120 as experimental group) were taken for the study. The results showed that most of the farmers were satisfied with the various aspects of the videos. i.e. mode of video screening, information in videos, language used, timing of videos, intent of motivation, graphics used, completeness of message, latest techniques. Small number of farmers were highly dissatisfied with duration of videos, graphics used. The study's overall satisfaction towards videos showed that over half (56.67 %) of the farmers had medium satisfaction level followed by (22.50%) low level category and (20.83) high satisfaction level category and significant relationship was found between socio-economic characteristics of the respondents and level of satisfaction regarding different aspects of videos.

Key Words: Graphics, Management, Motivation, Sustainability, Satisfaction level, Straw, Technologies, Video screening.

INTRODUCTION

The agricultural business plays an important part in the overall financial growth of the country. Adequate and quality information is necessary for the improvement of all aspects of agriculture. India generates on an average 500 Million tons (Mt) of crop residue per year. The generation of crop residues is highest in Uttar Pradesh (60 Mt), followed by Punjab (51 Mt) and Maharashtra (46 Mt). About 51% of farmers burn paddy straw to save money, 48% for time savings and 48% for lack of machine availability, while 11% of farmers burn paddy straw for other reasons. Adequate and quality information is necessary for the improvement of all aspects of agriculture (Sidhu *et al,* 2009).

There are several ICT tools used in modern day for the dissemination of information. ICTs has the abilities of reaching large number of people simultaneously, therefore have a greater role in the extension work. Extension services are required to improve agricultural productivity by providing farmers with requisite information helping them to optimize use of limited resources (Sharma *et al,* 2014).

ICTs can broadcast the precise and authentic information at right time to the farmers

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so that they can utilize it and get benefits. The decision support system through ICTs facilitate farmers for planning type of crops, practising good agricultural practices by providing timely, user-friendly, and cost-effective access to relevant information, facilitated by the assistance of extension personnel post harvesting and marketing their produce to get better results (Jeewan *et al,* 2021). Integrating ICT into agricultural extension services is seen as crucial to providing the necessary boost to the agricultural sector. The digitalization of communication networks has made information accessible to a large number of people quickly and economically (Shanmuka *et al*, 2022).

There are various communication tools are available, video is the most efficient means of presenting information in an engaging manner and effectively strengthening educational activities. (Rani and Rao, 2014). Identifying the appropriate media source can be assisted by knowledge of consumers' demands, attitudes, emotions, and preferences as well as their preferences for receiving particular types of messages (Webster and Ksiazek, 2012).

Videos, in particular, complement traditional extension tools, especially when extension workers do not have enough resources to perform their duties effectively. The effective use of these tools lies in their ability to encourage social learning (Karubanga *et al*, 2016). Zossou *et al* (2009) proved that videos work more effective training tools than direct face-to-face training approaches and that they can lead to innovation. Extension workers using videos report increased confidence in interacting with experienced farmers

As video joins both the verbal and visual communication which makes it helpful for specialized abilities and offers cost-effective way of delivering information to population (Palakkal and Chinnaiyan 2010). To create effective policies and programs for enhancing service availability and accessibility in rural areas, it is critical to comprehend the degree of satisfaction and accessibility to various services. (Sakthivel *et al*., 2011).

Client satisfaction or discontent is determined by the quality and quantity of services received in all relevant aspects. (Chaturvedani *et al*, 2016). There is a correlation between farmer's expectations and satisfaction. (Salehi and Heydari, 2012). In order to deliver services to farmers more effectively and efficiently, the study will offer helpful suggestions for creating instructive films and an extension strategy. It will also offer feedback for directing future research and system redesign.

METERIALS AND METHODS

The study was conducted in Ferozepur, Sangrur and Ludhiana district of Punjab. In this study multistage sampling was followed in which two blocks have been selected randomly from each district. From these selected blocks, three villages from each block, one as control and two as experimental villages were randomly selected. Thus, a total of eighteen villages were selected for the study. From each selected village, ten (10) paddy growers were selected randomly, thus a total of 180 respondents were selected 120 respondents as experimental and 60 respondents as control group for the study. The study was carried out in the year of 2020 to estimate satisfaction level of informative video of the farmers. Punjab Agricultural University (PAU) in Ludhiana has taken proactive steps to promote agricultural innovation and disseminate vital information among farmers through a variety of video resources. In an effort to measure the satisfaction levels of farmers, a targeted selection process was undertaken, resulting in the identification of four key video topics such as basic crop residue management techniques, in-situ residue management, ex-situ residue management and fertilizer application were selected as treatment to conduct this experimental study. These videos were carefully curated to address critical aspects of crop residue management techniques and to provide practical guidance on best practices and techniques.

To quantify the satisfaction levels, a structured assessment was conducted on a three-point continuum, wherein respondents were categorized as, highly satisfied, satisfied, highly

Table 1. Distribution of respondents according to their level of satisfaction with the different aspects of the informative videos.

Sr.No.	Category	Experimental group (n=120)		
		Highly Satisfied	Satisfied	Highly Dissatisfied
		Frequency (%)	Frequency (%)	Frequency (%)
1.	Mode of video screening	32 (26.67)	76 (63.33)	12(10.00)
2.	Information in videos	46 (38.33)	59 (53.17)	15 (11.90)
3.	Language used	43 (35.83)	64 (53.34)	13 (10.83)
4.	Timing of videos	27 (22.50)	73 (60.83)	20 (16.67)
5.	Duration of videos	18 (15.00)	68 (56.67)	34 (28.33)
6.	Quality	38 (31.67)	61(50.83)	21 (17.50)
7.	Intent of motivation	33 (27.50)	69 (57.50)	18 (15.00)
8.	Graphics used	21 (17.50)	80 (66.67)	19 (15.83)
9.	Practicability	30 (25.00)	73 (60.83)	17 (14.17)
10.	Latest techniques	24 (20.00)	75 (62.50)	21 (17.50)
11.	Sound quality	48 (40.00)	53 (44.17)	19 (15.83)
12.	Completeness of message	23 (19.17)	82 (68.33)	15 (12.50)

dissatisfied corresponding to scores of 2,1 and 0 respectively. Chi-square test was employed to measure relationship of socio-economic characteristics of the respondents and level of satisfaction regarding with different aspects of videos

RESULTS AND DISCUSSION

Mode of video screening

The data (Table 1) revealed that majority of the respondents (63.33%) were found to be satisfied and 26.67 percent were highly satisfied with the mode of video screening whereas, 10 per cent of the respondents were found to be highly dissatisfied with the mode of video screening. In case of information in videos data observed that 53.17 percent respondents were found to be satisfied and 38.33 per cent of the respondents were highly satisfied. However, 11.90 per cent of respondents were found to be highly dissatisfied with the information in videos.

Language used

Further the results indicated that 53.34 per cent of the respondents were satisfied and 35.83 per cent were highly satisfied with the language used in videos. While, rest of the respondents were found to be highly dissatisfied with the language used in videos. Also, it was evident that majority of the respondents (60%) were satisfied and 22.50 percent were highly satisfied with the language used in the videos. However, 16.67 percent of respondents were found to be highly dissatisfied with the language used in the videos.

Duration of the videos

In case duration of the videos more than half of the respondents (56.67%) were found to be satisfied and 15 per cent highly satisfied whereas, 28.33 per cent of the respondents were highly dissatisfied with duration of video. Further, the results indicated that nearly half of the respondents were satisfied and 31.67 per cent were highly satisfied with the quality of videos. However, 17.50 per cent of the respondents were found highly dissatisfied with the quality of videos. Therefore, 57.50 % were satisfied with the intent of motivation in the video followed by

Table 2. Distribution of respondents according to overall satisfaction level regarding the informative videos.

Level of satisfaction	Experimental group (n=120)	
	Frequency	Percentage
Low (= 20)	27	22.50
Medium (21-28)	68	56.67
High (= 29)	25	20.83

Figure 1: Graphical representation regarding level of farmers satisfaction on different aspect of informative videos

27.50 percent were highly satisfied and 15 per cent were highly dissatisfied with the intent of motivation in the videos.

Use of graphics

It was evident that 66.67 per cent of the respondents were found to be satisfied and 17.50 per cent were highly satisfied with the aspect graphics used while, 15.83 per cent of the respondents were highly dissatisfied with graphics used in videos. Thus, 60.83 per cent of the respondents were found to be satisfied and about 25 per cent were found to be highly satisfied with practicability of videos.

About, 14.17 per cent highly dissatisfied that the videos were having practicability. Moreover, about 62.50 per cent respondents were found satisfied with latest techniques in the videos followed by 20 per cent of the respondents were found to be highly satisfied. While, 17.50 per cent were highly dissatisfied with the latest techniques in videos.

Sound quality

The results indicated that 44.17 per cent of the respondents were found to be satisfied and 40 per cent were highly satisfied and 15.83 percent highly dissatisfied with the sound quality of videos. Finally, in case of completeness of message reveals that 68.83 per cent of the respondents were found to be satisfied and 19.17 per cent were highly satisfied with the completeness of message in the videos. However, 12.50 percent highly dissatisfied with the completeness of message in videos.

The data (Table 2) showed that 56.67 per cent of the respondents had high level of overall satisfaction regarding informative videos whereas, 22.5 per cent and 20.85 per cent of the respondents had medium and low level of satisfaction respectively. The results were in line with Kumar (2013) who revealed that most respondents were satisfied with the use of videos as a learning tool.

Relationship of socio-economic characteristics of the respondents and level of satisfaction regarding with different aspects of videos

Association of age with the satisfaction level of respondents towards videos

Table 3. Distribution of respondents according to the association of satisfaction level with the age and education of the respondent.

Level of satisfaction	Age			Total	Chi² test
	Young	Middle	Old		
Low	7(5.84)	13(10.83)	7(5.83)	27(22.50)	14.52*
Medium	16(13.33)	43(35.84)	9(7.50)	68(56.67)	
High	11(9.17)	5(4.16)	9(7.50)	25(20.83)	
Total	34(28.34)	61(50.83)	25(20.83)	120(100.0)	
	Education			**Total**	**Chi² test**
	Up to middle	**10 to 12**	**Graduation and above**		
Low	5(4.17)	7(5.83)	15(12.50)	27(22.50)	17.40*
Medium	14(11.67)	37(30.83)	17(14.17)	68(56.67)	
High	10(8.33)	4(3.34)	11(9.16)	25(20.83)	
Total	29(24.17)	48(40.00)	43(35.83)	120(100.0)	

* Significant at 0.05 level

Table 4. Distribution of respondents according association of satisfaction level with the operational land holding and mass media exposure.

Level of satisfaction	Operational land holding			Total	Chi² test
	Upto marginal	Medium	Larger		
Low	10(8.33)	15(12.50)	2(1.67)	27(22.50)	13.48*
Medium	16(13.34)	46(38.33)	6(5.00)	68(56.67)	
High	2(1.67)	15(12.50)	8(6.66)	25(20.83)	
Total	28(23.34)	76(63.33)	16(13.33)	120(100.0)	
	Mass media exposure			**Total**	**Chi² test**
	Low	**Medium**	**High**		
Low	7(5.83)	7(5.84)	13(10.83)	27(22.50)	19.17*
Medium	17(14.17)	39(32.50)	12(10.00)	68(56.67)	
High	11(9.17)	13(10.83)	1(0.83)	25(20.83)	
Total	35(29.17)	59(49.17)	26(21.66)	120(100.0)	

* Significant at 0.05 level

It was apparent that young age (22-38 yrs) category that 13.33 per cent of the respondents had medium, 9.17 per cent had high and 5.84 per cent had low level of satisfaction; whereas in case of middle age (39-54 yrs) group 35.84 per cent had medium, 10.83 per cent had low and 4.16 per cent had high level of satisfaction. In case of old age (55-70 yrs) group, 7.50 per cent had medium level satisfaction, 7.50 per cent with high and 5.83 per cent had low satisfaction in regards to informative videos.

It was determined that the chi-square value of 14.52 was significant at the 0.05 probability level. Thus, it can be said that there was a strong association between the respondents' age.

Association of education with the satisfaction level of respondents towards videos

It was apparent that among respondents with a middle level of education, 11.67% reported medium satisfaction, 8.33 percent reported poor satisfaction, and 4.17 per cent reported high

satisfaction with videos.; whereas in case of respondents having educational level between 10 to 12 about 30.83 per cent had medium, 5.83 per cent had low and 3.34 per cent had high level of satisfaction. Regarding the informative videos, 14.17 per cent of respondents with graduation or above expressed medium satisfaction, 12.5 per cent expressed strong satisfaction, and 9.16 percent expressed low satisfaction (Table 3). It was determined that the chi-square value of was 17.40 significant at the 0.05 probability level. Thus, it can be said that there was a strong association between the respondents' education.

It was evident (Table 4) that in marginal operational land holding category, 13.34 per cent of the respondents had medium satisfaction, 8.33 per cent low and 1.67 per cent had high satisfaction. Whereas, regarding the category of medium operational land holding, 38.33. per cent reported a medium extent of satisfaction, while 12.50 per cent reported a low and high level of satisfaction, respectively. Regarding the videos, 5.00 per cent of respondents had medium satisfaction, 6.66% had high satisfaction, and 1.67 percent had low satisfaction in the case of the large operational land holding group. It was determined that the chi-square value of was 13.48 significant at the 0.05 probability level. Thus, it can be said that there was a strong association between the respondents' operational land holding.

Association of mass media exposure with the satisfaction level of respondents towards videos

It was cleared (Table 4) that in low mass media exposure category, 14.17 per cent of the respondents had medium satisfaction level, 9.17 per cent had high and 5.83 per cent had high level of satisfaction, whereas in medium mass media exposure, 32.50 per cent had medium, 10.83 per cent had high and 5.84 high level of satisfaction towards the videos. In case high mass media exposure, 10.83 per cent had low satisfaction, 10 per cent had medium and 0.83 per cent had high satisfaction regarding the informative videos. It was determined that the chi-square value of was 19.17 significant at the 0.05 probability level. Thus, it can be said that there was a strong association between the respondents' mass media exposure.

CONCLUSION

Many organizations in Punjab had tried a variety of alternative strategies to reduce straw burning. The study was an attempt to provide and gather information regarding respondents' satisfaction with different aspects on quality informative videos. These findings will provide useful guidance to the University for designing effective informative videos and extension strategy for delivering the services to the farmers in better and efficient way. The videos have the potential to improve awareness, knowledge and technology adoption. It can be concluded that majority of the farmers were expressed satisfaction with mode of screening, graphics used, latest technologies and completion of message. Therefore, continuous efforts should be taken up by the extension agents to disseminate knowledge about recommended scientific farming practices by using information and communication technology tools such as video to educate farmers, maximize profit and improve livelihood.

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Social Audit of Mid-Day Meal Scheme for Sustainable Development

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ABSTRACT

The goal of sustainable development is to ensure a healthy diet for people living in the country. To making development more sustainable, mid-day meal scheme becomes the primary objective. With this backdrop the present study valorize the imperativeness of social audit of Mid-Day Meal (MDMS)/ PM POSHAN for achieving sustainable development. This paper is based on relevant secondary data sources based on Annual Budget 2016-22, (GOI) Global Hunger Index 2020, MDM data, revised guidelines for MDMS, (CMDM) reports, National Family and Health Survey (NFHS) factsheet for various rounds. The Global Hunger Index 2020–22 shows that despite significant financial and human resources being dedicated to MDMS, the majority of school-age children still have "severe" health conditions. Government made every effort to solve the issue, but their implementation was horribly ineffective. The budget for nutrition-related services should be increased by the government and kept constant until malnutrition is reduced. An annual maintenance budget with a specific subsidy provided by government should be set aside for the kitchen sheds. The local group should be tasked with overseeing the program so that teachers may focus on teaching.

Key Words: Budget Allocation, Enrollment, Mid-Day Meal Scheme (MDMS), Retention, Sustainable Development.

INTRODUCTION

Sustainable development is described as the process of extending the variety of opportunities that will eventually allow individuals and communities to realize their full potential. The primary objectives of the programs are to boost registration, continuation and academic achievement among beneficiaries, especially among disadvantaged and poor children. The fundamental purpose of the Mid-Day Meal Scheme (MDMS) is to make development more sustainable (Munasinghe, 2010; Sharma *et al,* 2014; Sharma *et al,* 2018).

The Mid-Day Meal Scheme (MDMS) is known as the biggest school meal program, which comprises the distribution of meals free of charge to school students during all school days for pupils in governments, governmental-aided, local elementary and higher elementary schools, and special training institutions. This has improved over time through sustained engagement by various government departments, civil society, and the judiciary in India (Sahai, 2014; Grover and Kaur, 2015). It is also envisioned that such a lunch will encourage a sense of fraternity and friendship among children who belong to various castes, races, and religions. In order to promote health and avoid sickness, diet is crucial. It also promotes primary education's universalization and enhances children's nutritional status. The program subsequently spread across the nation and is currently regarded as one of the most significant approaches against childhood undernutrition and for academic achievement (Sahoo and Pati, 2018; Kumari and Sinha, 2019). The history of MDMS in India is extensive. The system is being adopted in the majority of states, having initially begun in the Madras Presidency before independence and being later implemented in Delhi and Gujarat, in

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Table1. Status of undernourished in India.

Indicator	1992	2000	2008	2016	2020	2022
GHI Score	46.4	38.8	36.0	28.5	16.3	29.1
GHI Rank	76 (85)	83(119)	102(118)	97(118)	94(107)	107(121)
Proportion of undernourished (As percent of total pop.)	25.0	21.0	19.0	15.2	27.2	16.3

Source: *International Food Policy Research Institute (IFPRI)- various issues*
**Figures in parentheses indicate total number of countries.*

that order, in the post-independence period (Deodhar *et al,* 2007; Kadari and Roy, 2016; Narad, 2016; Singh, 2020).

In September 2004, as per the guidelines of the scheme, elementary schools were required to provide each student with 100 grams of food grains and 20 grams of pulses each day, while upper-primary schools were required to provide each student with 150 grams of rice and 30 grams of dal each day. Children in primary classes receive 450 calories; upper primary children obtain 20 grams of protein and 700 calories a day, compared to lower primary children, who receive 12 grams.

The program benefits around 12 crore children aged between 5 and 11 who attend 11.20 lakh schools nationwide. Of these, 22.6 lakh come from *Balvatika*, 7.2 crore are in primary school, and 4.6 crore are in upper primary. Punjab has been ranked second in the country for executing the MDMS. In the FY 2021–22, about two million pupils were served in the state's schools, compared to 6,656 in upper-primary schools and 13,723 in elementary schools. Under the MDM program, the government has allotted Rs 275.81 crore for the cooking's cost, cereals, and wages for the cook, helper, and managers (Current Affairs News, 2022). With this backdrop, the present study values the imperativeness of the social audit of mid-day meals (PM POSHAN) for achieving sustainable development.

MATERIALS AND METHODS

The literature and relevant information regarding the Mid-Day Meals Program/PM POSHAN Scheme was obtained through relevant secondary data sources based on the annual work plan and Budget 2016–22, the Global Hunger Index 2020, MDM data, updated rules for the MDM Program, Cooked Mid-Day Meal Scheme (CMDM) reports, research gate, Google Scholar, NFHS factsheet for various rounds, research articles, web sites, internet survey reports, etc. Local and national dailies were also referred to. Literature on Mid-Day Meal was piled from a subscription-based database, viz., Web of Science (WoS), for the period 1994–2021. Clarivate Analytics United States administers Web of Science, the scientific citations referencing platform available online with a membership model that offers a comprehensive citations discovery function. It provides access to several databases that contain cross-disciplinary research, enabling a comprehensive review of specialized related fields within a particular discipline.

RESULTS AND DISCUSSION

The different parameters like the Global Hunger Index (GHI), the National Family and Health Survey (NFHS) factsheet, and year-wise budget allocations and expenditures regarding mid-day meals were given in Table 1.

The data highlights the declining trend in the proportion of undernourished people with a score of 29.1, which falls in the serious category of hunger in 2022. In 2000, it recorded an alarming score of 38.8, which was reduced to 28.5 by 2016. The proportion of undernourishment in the population went from 25 in 1992 to 16.3 in 2022. But when it comes to ranking at the international level, India projects a dismal status. Though it improved marginally compared to 2008, when India was ranked 102 among 118 countries. India

Table 2. Nutritional status of children in India: NFHS (various rounds).

Particular	India			
	Rural	Urban	Total	Regional Gap*
Stunned				
NFHS III (Under 3 Years)	47.2	37.4	44.9	-9.8
NFHS IV (Under 5 Years)	41.2	31.2	38.4	-10
NFHS V (Under 5 Years)	37.3	30.1	35.5	-7.2
Wasted				
NFHS III (Under 3 Years)	24.1	19.0	22.9	-5.1
NFHS IV (Under 5 Years)	20.0	21.5	21.0	1.5
NFHS V (Under 5 Years)	19.5	18.5	19.3	-1
Under weight				
NFHS III (Under 3 Years)	43.7	30.1	40.4	-13.6
NFHS IV (Under 5 Years)	38.3	29.1	35.8	-9.2
NFHS V (Under 5 Years)	33.8	27.3	32.1	-6.5
Anemia				
NFHS-III (Under 3 Years)	80.0	80.5	80.1	0.5
NFHS-IV (Under 5 Years)	57.2	55.7	56.6	-1.5
NFHS-V (Under 5 Years)	68.3	64.2	67.1	-4.1

N*ational Family and Health Survey (NFHS-III 2005-06, IV-2015-16, and V-2019-20).*

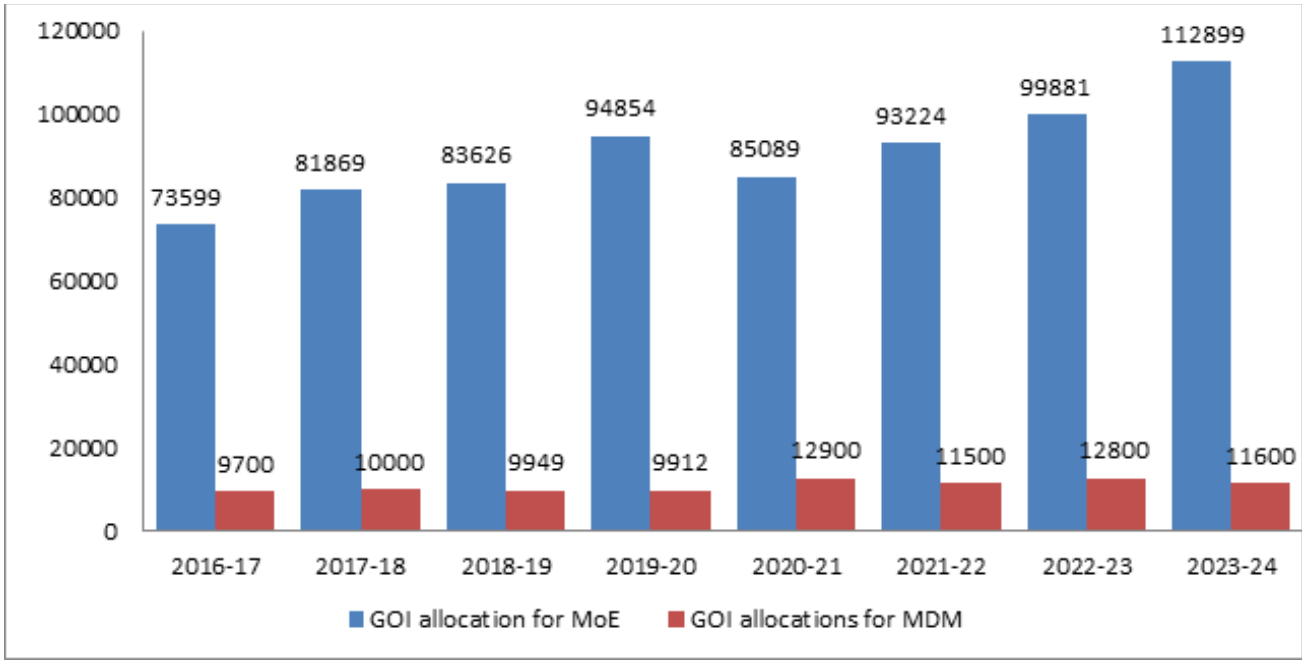
came down to 97th among 118 countries in 2016. Still, it is far behind achieving its Millennium Development Goal of bringing down the proportion of undernourished people to 12.5 percent of the total population.

***Gaps were worked out on Percentage Points Method.**

Children's nutritional status is described by four physical growth indices: height-for-age (stunting), weight-for-height (wasting), and weight-for-age (underweight), and anemia are the most common micronutrient deficiency among children. The results (Table 2) show that stunting and underweight, which are prevalent among children, have decreased in the last two decades. The percentage of children recorded as stunted declined from 44.9 to 35.5 from 2005–06 to 2019–20. Wasting and underweight also got reduced from 22.9 to 19.3 and 40.4 to 32.1, respectively, for the same period.

The National Family and Health Survey (NFHS) III (2005–06) round recorded the highest percentages of children under 3 years who suffered from anemia. However, the NFHS IV (2015–16) round recorded a healthy trend and had a decrease in the percentage of children under 5 years with anemia (56.6 percent). The percentages of anemic children in rural areas (57.2%) were higher as compared to urban areas (55.7%). The IIIrd and IVth rounds of the NFHS revealed that the percentages of stunted children below the age of 3 and 5 were greater in rural regions of India than in

Figure no. 1: Budget Allocations Year Wise



(Source: Union Budget for Expenditure, Ministry of Education, fiscal years 2016-17 to FY 2023-24)

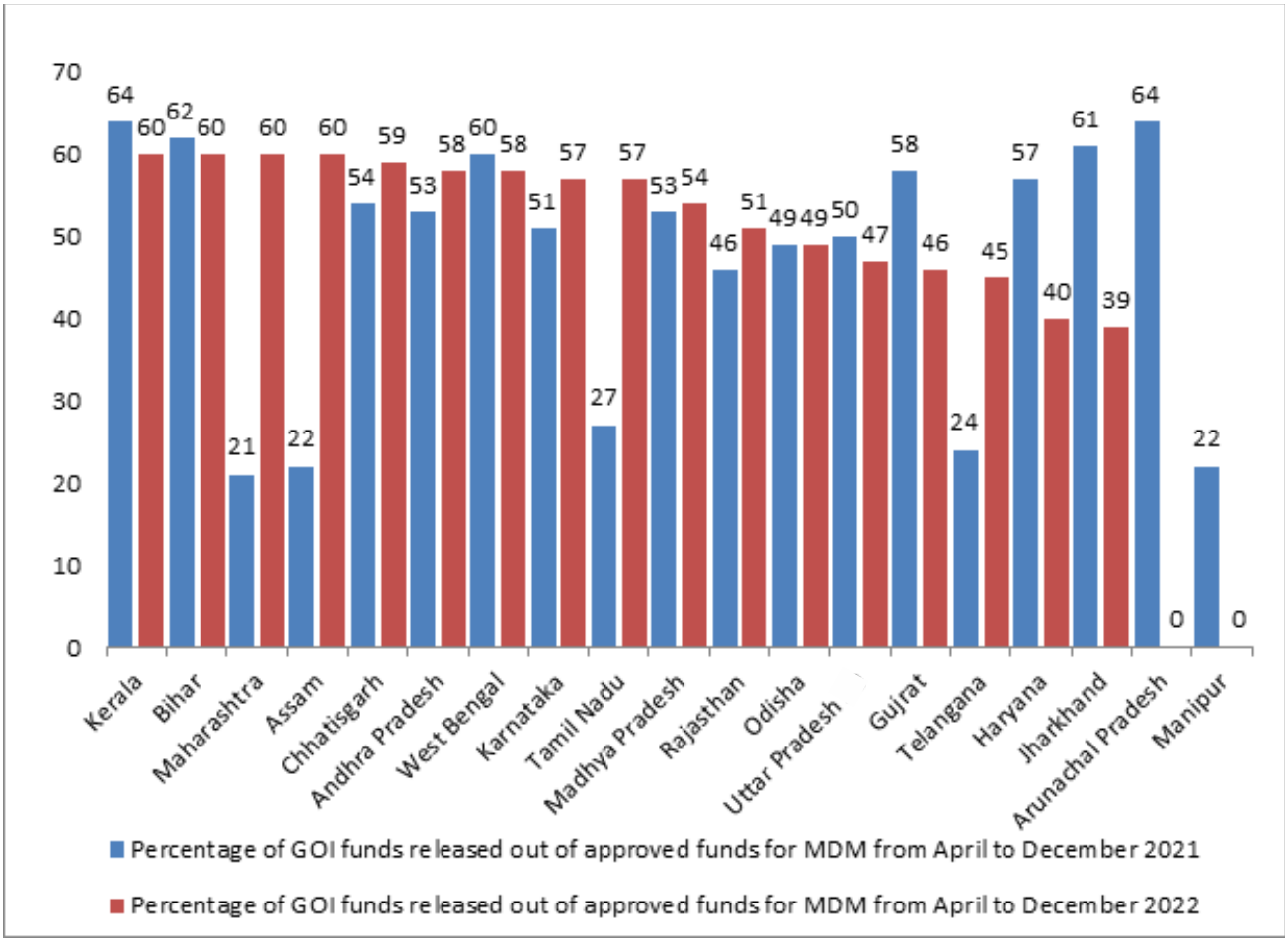
urban regions. NFHS V (2019–20) rounds recorded the highest percentages of anemic children (under 5 years) inside rural regions (68.3%) compared to urban regions (64.2%). In 2019, anemia affected more than two-thirds (68.4%) children below the age of five in India.

The change in the trend was significantly due to the increase in urbanization trends captured during the 2011 census. Due to the stretched boundaries of major cities and towns, slums and squatters mushroomed and border-lined colonies in city after city in the above-mentioned period, contributing to an increase in enumerating malnutrition in urban areas. Hence, the regional gap, which was -9.8 percent during 2005–06, increased to -10 percent in 2015–16 and further showed a tilt towards urban, with a gap of -7.2 percent in 2019–20.

Wasting is a serious problem in India. Whereas India fared well as for stunting and underweight was recorded but performed dismally on account of wasting among children. Study recorded a continuous decreased in the percentages of children with stunting and underweight. The prevalence of underweight children aged 3 to 5 years had decreased in all three rounds of NFHS. It decreased from 40.4 percent in 2005-06 to 35.8 percent in 2015-16 and 32.1 in the year 2019-20. Regional gap of -13.6, -9.2 and -6.5 percentage point pertaining to underweight during IIIrd, IVth and Vth NFHS rounds respectively recorded a continuous decline. Thus the study showed that Punjab had succeeded in bringing down the proportion of stunted and underweight. Ruralities were marginalized compared to their urban counterparts.

Figure 1 shows that Budget Estimates (BEs) for the Ministry of Education (MoE) were 73,599 crore at the beginning of Financial Year (FY) 2016–2017. The Government of India has allotted 9700 crore for MDM in the Union Budget FY 2016–17. This increased to 10,000 crore in FY 2017–18. In fiscal year 2018–19, allocations were reduced even more. The proposal was for 12,147 crore, but the MDM budget for the Ministry of Human Resources was 9,949 crore, 2198 crore less than the requirement. Similarly, the revised allocations for FY 2019–20 were 18 percent less than the 12,054 crore proposal from the Ministry. The allocations for the program have mostly stayed the same from 2018–19 to 2019–20. To provide adequate support during the COVID-19 pandemic, the Government of India (GOI) approved an increase in MDM spending to 13,400 crore for Fiscal Year (FY)

Figure 2: State-wise utilization of released funds



*(**Source:** PAB Meeting for PM POSHAN, FY 2021-22 and FY 2022-23. (2) Central Assistance Released FY 2021-22, and FY 2022-23)*
Available online at: https://pmposhan.education.gov.in/. Last accessed on 3 January 2023

2020–21, up from 11,000 crore in the Budget Estimates (BEs). However, the revised estimates (REs) for the year were 12,900 crore, or 4% less than the announced figure. Budget Estimates (BEs) for MoE were at 93,224 crore at the start of Financial Year (FY) 2021–22, while the GOI allotted 11,500 crore for MDM in the Union Budget 2021–22, and 11 percent decreased from 2020–21 from revised estimates (REs) and 5 percent increase from the Budget Estimates (BEs). This was an improvement of ten percent from the preceding year's revised estimates (REs), but a decrease of 6 percent from the BEs. MDM is MoE's second-largest scheme, accounting for 12 percent of the Ministry's budget in FY 2021–22. The implementation of the plan has been directly impacted by the COVID-19 pandemic. Furthermore, the PM-POSHAN plan is granted an amount of Rs 11,600 crore in the 2023–24 budgets. This is 9 percent less than the revised estimates (REs) but 13 percent greater than the budget estimates (BEs). The allocation of GoI for the PM-POSHAN Scheme also shows an approximate 10 percent lower in 2023–24 as compared to 2022–23.

States wise Performance of the PM-POSHAN Scheme

The program's funding was allocated in the 2004 budget, and it started to be implemented in 2005. The Central government pays 60 percent of the costs associated with running the program, and the State governments pay 40 percent. State budget proposals are approved by the Ministry of

Education's (MOE) Programme Approval Board (PAB) for MDM following deliberations and agreements with respective state governments. Figure 2 shows that just 52 percent of GOI approvals were released until December 2022-23, in contrast to 48% in 2021-22. By December 2022, 60 prcent of the funding has only been distributed to five of the thirty-six states and UTs. Likewise, among the states allocated to GoI in FY 2021–2022, only six states obtained 60 percent or more. The amount of money released for twenty states and union territories was less than the national average in numerous states, including Jharkhand (39%), Haryana (40%), Telangana (45%), Gujarat (46%), UP (47%), Odisha (49%) and Rajasthan (51%), Seven among the twenty states and union territories (including Manipur and Arunachal Pradesh) did not receive any funding.in the first three quarters of FY 2022–2023. There are state variations. In the final quarters of the fiscal year 2021–2022, over 50% of the money allocated to Assam, Manipur, and Sikkim was released. Kerala, Jharkhand, Haryana, and Chhattisgarh, on the other hand, have already received all of their funding prior to the final quarter.

Problems and Challenges

To ensure that the scheme is appropriately implemented, monitoring committees are in place at every level, from the center to the village level. Implementation of the midday meal program at government schools will be hampered by the program's problems with staff shortages, frequent power failures, and poor infrastructure, which are discussed further.

Lack of resources and infrastructure

Rural areas' poor facilities are a result of a lack of resources and inadequate infrastructure, which affects students' ability to clean up after meals and maintain good hygiene. These problems get worse by inadequate midday food staffing and classroom space (Mehta *et al*, 2013; Mishra, 2013; Chhabra and Rao, 2014; Narad, 2016; Sachan and Singh, 2016; Sahoo and Pati, 2018; Sinha, 2019; The Hindustan Times, 2022).

Time lag in the current data flow system

Data manipulation, data corruption, and data distortion are made possible by the delay in data transfer from the school to the state level. The fact that teachers have to devote two or three hours to managing this program is an enormous drawback. Students' study time is hampered by teachers' participation in the system, and educational quality is compromised (Sahai, 2014; Kadari and Roy, 2016; Menezes, 2017).

Cooking costs and honorarium

About 81 percent of head teachers and teachers reported irregular payment of cooking costs, requiring them to buy ingredients on credit or with personal funds. The Allahabad High Court ordered 12 months' salary for MDMS cooks in 2019, but the government only pays 10 months' honorarium. The district magistrates and the state government were ordered by the court to settle the honorarium and arrears within four months (Grover and Kaur, 2014; Narad, 2016; Sahoo and Pati, 2018).

Conservative beliefs

To reduce the deficiency of protein it was proposed that high protein foods like egg, mushroom should be served in MDMS. One of the study discovered that Class 8 girls gained up to 71% more weight than their counterparts who did not receive eggs. Based on a study that involved over 4,500 students in two districts and was commissioned by the Karnataka government. Lingayat and Jain seers in Karnataka have historically strongly opposed schemes to include eggs. The nutritional contradictions religious and personal beliefs Choices about the diet have also been impacted by personal and religious norms that conflict against dietary recommendations (EPW, 2015). Minimizing menu-related disputes like the controversy started by NGO Akshay Patra's unwillingness to add eggs and locally consumed spices in the meals it had been contracted to provide in various states (Yamunan, 2019). All government programs have similar problems, but the Mid-day Meal Program's extensive history can be constructed to reduce their impact on newer programs like the Pradhan Mantri Ujjwala Yojana and the Swachh Bharat Mission (Grover and Kaur, 2015; Kadari and Roy, 2016; Prajavani, 2021).

So it is ironical that after allocating huge human and economic resources towards MDMS, the majority of school-age children's health status is in the "serious" category as is reflected in global hunger index 2020-22. In spite of best intents to address by governments, implementation required flawed and dismally poor.

The PM Poshan Scheme (previously known as Pradhan Mantri Poshan Shakti Nirman Yojna) was approved by the Union Cabinet of India on September 29, 2021, replacing the MDMS program and reorganizing the Mid-Day Meal Program to meet nutritional goals by 2025 and provide hot lunch in govt. and government-funded schools. It was introduced for an initial five-year period (2021-22 to 2025-26). The new programme includes provisions for supplementary nutrients for pregnant women, breastfeeding mothers, teenage females, and adults in addition to schoolchildren. The Education Minister claims that students from Balvatikas, which were ICDS-affiliated pre-primary schools, are now part of the MDM Scheme. The PM Poshan Scheme will be operational from 2021–2022 until 2025–2026 (Gopal and Singh, 2021).

CONCLUSION

The MDMS is the largest school feeding program and helps students who arrive at school and feel hungry in class. The program's objective is to enhance the student enrolment, retention and socialization of students from various castes. Thus, the program offers a way to reduce caste-based inequality by allowing all children to sit and eat together. This program is a significant step in the right direction toward lowering malnutrition and improving the socioeconomic indices of the nation.

It has been suggested by the New Education Policy that the MDMS should include breakfast because a single meal, even during the workday, is insufficient to combat the dangers of malnutrition, the government should provide a healthy breakfast for children in the schools. The PM POSHAN program should be expanded to classes 10+2. To address discrepancies in delivery, coverage, and access, nutrition services within health systems should be assessed and reviewed routinely. Government should increase its budget for nutrition-related services and maintain it until malnutrition is reduced. The kitchen sheds should be maintained annually with a special subsidy provided by government. The local group should be tasked with overseeing the program so that teachers may focus on teaching.

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Social Empowerment of Rural Women through Self Help Groups: A Study in Gujarat State

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ABSTRACT

The present investigation was carried out in Gir Somnath district of Gujarat State. Five talukas of Gir Somnath district were purposively selected where Self-Help Groups (SHGs) formed under Ambuja Cement Foundation and Krishi Vigyan Kendra. A total of 79 SHGs were formed in these five talukas. Villages with more than eight SHGs and those engaging in income-generating activities for more than three years were included. From each village, 25 SHG and 25 non-SHG woman members were selected for the study. Thus, the total sample size of members was 500. The results revealed that the independent sample 'Z' test showed a significant difference in the mean values of SHG members and non-SHG members in case of social status, communication ability, mass media exposure, and extension contact.

Key Words: Rural Women, Self Help Groups, Social empowerment.

INTRODUCTION

Self-help groups play a pivotal role in promoting gender equality by elevating the status of women as active participants, decision-makers, and beneficiaries across democratic, economic, social, and cultural domains. The involvement of women becomes indispensable at every stage of economic and social endeavors. These groups actively encourage women to engage in the socio-economic advancement of our nation. By empowering women to take on active roles, self-help groups unlock the potential for women to shape their communities positively and foster entrepreneurial initiatives among them. Self-help groups (SHGs) provide credit access to the impoverished, which is paramount in alleviating poverty.

Self-Help Groups (SHGs) are also instrumental in driving societal development, particularly in empowering women. They enable women to come together, confront challenges, and tackle various socio-economic issues. With the support of microfinance provided by banks, SHGs attain financial stability and enhance strategic planning. Thus, this study explored that how participation in self-help groups facilitated the social empowerment of rural women.

MATERIALS AND METHODS

The study focused on the Gir Somnath district in Gujarat state. Five out of the district's six talukas were purposively selected, as these areas had Self-Help Groups (SHGs) formed under the Ambuja Cement Foundation and Krishi Vigyan Kendra. In total, SHGs were established in 79 villages across these five talukas. Among these, 10 villages were chosen based on the criterion of having more than eight SHGs actively engaged in livelihood activities for over three years. From each selected village, 25 SHG women members were randomly chosen, along with 25 non-SHG women members, for a comparative study. This resulted in a total sample size of 500 SHG and Non SHG members. Data collections were performed conducted through personal interviews utilizing a pre-tested structured schedule. The data were processed, tabulated, classified, analyzed, and subjected to statistical analysis to assess the impact of self-help groups on the social empowerment of

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women. For measuring social empowerment the scale developed by Bariya (2016) was used as under followed.

Change in social status

The statements regarding change in social status were prepared. The respondents were asked to give their reply in yes or no. The score of 1 and 0 was assigned for yes or no answer to each statement, respectively. The score on each statement was added to obtain final score indicating change in social status of the peasant.

The respondents were grouped into five categories for change in social status as under:

Sr. No.	Category	Score
1	Very less	(0.0 to 1.8 score)
2	Less	(1.9 to 3.6 score)
3	Medium	(3.7 to 5.4 score)
4	High	(5.5 to 7.2 score)
5	Very High	(Above 7.2 score)

Communication ability

Five statements regarding communication ability were included in the study. The respondents were asked to give the answer to each statement. This referred to the frequency of interactions with others by the pleasant. This variable was quantified by assigning score as follows:

Sr. No.	Frequency of communication ability	Score
1	Never	0
2	Occasionally	1
3	Sometime	2
4	Always	3

On the basis of arbitrary method, the respondents were grouped into the following five categories:

Sr. No.	Category	Score
1	Very less	(0.0 to 03.0 score)
2	Less	(3.1 to 06.0 score)
3	Medium	(6.1 to 09.0 score)
4	High	(9.1 to 12.0 score)
5	Very High	(Above 12.0 score)

Mass media exposure

Mass media exposure referred to the frequency of reading news paper, listening to radio broadcast, viewing to television telecast and cinema. To know the mass media exposure of the respondents scale adopted by Kamat (1993) was used. The total score was calculated for each respondent by summing up the score of all statements. The respondents were grouped into five categories for mass media exposure as under:

Sr. No.	Category	Score
1	Very Less	(00.0 to 08.0 score)
2	Less	(08.1 to 16.0 score)
3	Medium	(16.1 to 24.0 score)
4	High	(24.1 to 32.0 score)
5	Very High	(Above 32.0 score)

Extension contact

This referred to the frequency with which women came in contact with the extension agent's *viz*. VLWs, extension officer, taluka development officer, scientists of agriculture University, government officers of different departments, private veterinary doctors, members of cooperative societies and bank officers. The respondents were asked to indicate their frequency of their contact with each extension agent on a five point continuum *viz*. weekly, fortnightly, monthly, half-yearly and never with scores of 4, 3, 2, 1 and 0 respectively. The total score for each respondent was obtained by adding the scores for all the contacts made with the extension agents for getting information. The respondents were categorized in five groups as under.

Sr. No.	Category	Score
1	Very Less	(00.0 to 08.0 score)
2	Less	(08.1 to 16.0 score)
3	Medium	(16.1 to 24.0 score)
4	High	(24.1 to 32.0 score)
5	Very High	(Above 32.0 score)

Table 1. The respondents according to their social status. **(n = 500)**

Sr. No.	Category	SHG members (n = 250)		Non -SHG members (n = 250)	
		Frequency	Per cent	Frequency	Per cent
1.	Very low	43	17.20	58	23.20
2.	Low	57	22.80	105	42.00
3.	Medium	85	34.00	87	34.80
4.	High	44	17.60	00	00.00
5.	Very high	21	08.40	00	00.00
	Total : -	250	100.00	250	100.00
	Mean	3.77		2.85	
	'Z' value	5.092 **			
** Significant at 0.01 level of probability.					

RESULTS AND DISCUSSION

Social status

Social status pertains to the position individuals occupy within a society, which can vary based on different factors. At any given time, individuals typically hold multiple social statuses. These statuses can be categorized into three types: Achieved status, which is earned through personal merit; Ascribed status, which is assigned to individuals by virtue of their birth or inherent characteristics; and Master status, which represents the most significant social status individuals hold.

Table 2. The respondents according to their communication ability. (n = 500)

Sr. No.	Category	SHG members (n = 250)		Non-SHG members (n = 250)	
		Frequency	Per cent	Frequency	Per cent
1.	Very low	00	00.00	00	00.00
2.	Low	84	33.60	101	40.40
3.	Medium	52	20.80	143	57.20
4.	High level	70	28.00	06	02.40
5.	Very high	44	17.60	00	00.00
Total : -		250	100.00	250	100.00
Mean		9.11		6.74	
'Z' value		11.15**			
** Significant at 0.01 level of probability.					

Perusal of Table 1 revealed that 51.60 percent of SHG woman members exhibited a medium to high level of social status, while 22.80 percent had a low level of social status. Furthermore, 17.20 percent were observed with a very low level of social status, and 8.40 percent were categorized with a very high level of social status. Conversely, among non-SHG woman members, it was noted that 42.00 percent had a low level of social status, followed by 34.80 percent with a medium level of social status. Interestingly, none of them were found to have high or very high levels of social status. The mean values regarding social status for both groups of respondents indicate minimal disparity between their social status levels. However, the independent sample 'Z' test revealed a highly significant difference in the mean values of social status between SHG woman members and non-SHG woman members. Findings suggested that the majority of SHG members had medium to low levels of social status, whereas non-SHG women predominantly exhibited low to very low levels of social status. This trend may be attributed to factors such as limited education, modest economic conditions, a moderate to low level of risk orientation and innovativeness, and in both groups, some respondents living below the poverty line. The similar finding were also confirmed by Shambharkar *et al (*2012), Bariya *et al* (2020), Bariya *et al* (2021) and Bariya *et al* (2022).

Communication ability

Particularly, Information and Communication Technology (ICT) plays a pivotal role in bolstering communication and interpersonal skills among women, thereby improving their overall performance across all activities.

There are many successful initiatives for successful use of media one of such initiative is establishment of the community "Lokvani FM radio" station at KVK. This station broadcasts agriculture and allied field programs to surrounding villages within a 15 km radius. Women speakers engage with female villagers, addressing common issues for their upliftment. Furthermore, the utilization of internet facilities plays a crucial role in the rural upliftment, particularly benefiting women who are integral to rural communities.

Table 2 displays data indicating that among SHG woman members, 33.60 per cent had a low level of communication ability, followed by 28.00 per cent with a very high level, 20.80 per cent with a medium level, and 17.60 per cent with a high level of communication ability. Notably, none of them exhibited a very low level of communication ability. Conversely, among non-SHG members, the majority (57.20 per cent) had a medium level of communication ability, with 40.40 per cent displaying a low level and 2.40 per cent showing a high level of ability. Notably, none of the non-SHG members exhibited very low or

Table 3. The respondents according to their mass media exposure. (n = 500)

Sr. No.	Category	SHG members (n = 250)		Non-SHG members (n = 250)	
		Frequency	Per cent	Frequency	Per cent
1.	Very low	108	43.20	231	92.40
2.	Low	91	36.40	19	07.60
3.	Medium	51	20.40	00	00.00
4.	High	00	00.00	00	00.00
5.	Very high	00	00.00	00	00.00
Total :-		250	100.00	250	100.00
Mean		13.93		7.38	
'Z' value		6.55**			
** Significant at 0.01 level of probability.					

Table 4 : The respondents according to their extension contact (n =500)

Sr. No.	Category	SHG members (n = 250)		Non-SHG members (n = 250)	
		Frequency	Per cent	Frequency	Per cent
1.	Very low	101	40.40	207	82.80
2.	Low	40	16.00	43	17.20
3.	Medium	109	43.60	00	00.00
4.	High level	00	00.00	00	00.00
5.	Very high	00	00.00	00	00.00
	Total : -	250	100.00	250	100.00
	Mean	11.2		6.12	
	'Z' value	16.36**			
** Significant at 0.01 level of probability.					

very high levels of communication ability. Mean values for communication ability across both groups highlighted significant differences, indicating a substantial variation in communication ability levels among SHG and non-SHG woman members. An independent sample 'Z' test confirmed a highly significant difference in mean values between the two groups regarding communication ability.

It was concluded that SHG members typically have greater opportunities for engagement with leaders, VLWs, bankers, government officials, political figures, and NGO volunteers compared to non-SHG members. This enhanced interaction enables SHG members to articulate their concerns effectively and enhances their self-confidence. Conversely, non-SHG women members engage in information exchange, albeit their primary aim was to establish connections with others. However, the scope for conversation among non-SHG women is comparatively limited. This finding was supported with Mehta *et al.* (2011), Singh *et al* (2012) Bariya *et al* (2020), Bariya *et al* (2021) and Bariya *et al* (2022).

Mass media exposure

Exposure to communication channels facilitates the acquisition of general awareness and provides access to scientific and technical information, thus playing a pivotal role in enhancing socio-economic standards. Information on mass media exposure was gathered by assessing respondents' interactions with various media platforms such as newspapers,

radio, television, films, the internet, WhatsApp, and the I-kisan portal. Trained personnel could assist rural women in navigating computers and mobile devices through initiatives like Krishi Mobile Seva. Establishing knowledge resource centers or information booths in local languages, focusing on crop-specific issues, and problem-solving at the village level can empower individuals to take initiative. Over the past five years, "Lokvani Radio," operated through KVK at Ambujanagar, has successfully broadcasted programs on agriculture and related subjects, contributing to knowledge dissemination in the community.

Table 3 reveals that slightly over two-fifths (43.20 %) of SHG woman members had a very low level of mass media exposure, followed by more than one-third (36.40 %) with a low level, and 20.40 per cent with a medium level. Notably, none of them reported high or very high levels of mass media exposure. Conversely, among non-SHG members, the majority (92.40 %) had a very low level of exposure, with 7.60 per cent reporting a low level. None of the non-SHG members indicated medium, high, or very high levels of exposure. Mean values for mass media exposure across both groups highlight significant differences, indicating substantial variation between the two categories of woman members. An independent sample 'Z' test confirmed a highly significant difference in mean values between SHG and non-SHG woman members regarding mass media exposure.

It can be inferred (Table 3) that the likely factors contributing to this situation include low to medium levels of education, poor economic conditions, and medium to low levels of self-esteem. Additionally, the limited availability of essential mass media platforms such as radio, newspapers, television, farm magazines, internet, and WhatsApp among both groups may also contribute to the observed differences in mass media exposure. This finding is similar with the finding reported by Verma *et al* (2013), Bariya *et al* (2020), Bariya *et al* (2021) and Bariya *et al* (2022).

Extension contact

Extension contact entails the frequency of interactions initiated by women with various extension agencies or workers, both within and outside their village. These interactions are crucial for gathering and comprehending the latest information pertaining to their profession and new government schemes

The data (Table 4) illustrated that slightly over two-fifths (43.60 %) of SHG woman members reported a medium level of extension contact, followed by 40.40 per cent with a very low level, and 16.00 per cent with a low level. Notably, none of them indicated high or very high levels of extension contact. In contrast, among non-SHG woman members, the majority (82.80 %) reported a very low level of extension contact, with none reporting medium, high, or very high levels. Mean values regarding extension contact for both respondent groups highlighted significant differences, indicating notable variations in extension contact levels between SHG and non-SHG woman members. The independent sample 'Z' test confirms a highly significant difference in mean values between the two groups regarding extension contact.

These findings suggested that SHG members have more opportunities to engage with extension functionaries compared to non-SHG respondents, motivating them to take proactive steps towards their social empowerment. The prevalence of medium-level extension contact among the majority of beneficiaries may be attributed to frequent visits by Ambuja Cement Foundation and Krishi Vigyan Kendra staff to the villages, regular meetings, vocational training sessions, and short-duration training programs. Beneficiaries likely demonstrate interest in gaining knowledge or acquiring new skills, knowing that these extension contacts contribute to their welfare by providing recent information and clarifying doubts. However, some beneficiaries and non-SHG members reported low extension contact, possibly due to lack of interest or ignorance regarding the benefits associated with such interactions. This finding was

somewhat agreement with the findings of Sowjanya (2007), Bariya *et al* (2020), Bariya *et al* (2021) and Bariya *et al* (2022).

CONCLUSION

The findings of this study highlighted a notable disparity between SHG and non-SHG woman members. Consequently, it is crucial for the government to prioritize the establishment of self-help groups within relevant institutions. Furthermore, organizing awareness and training programs is essential to emphasize the importance of this microfinance initiative in rural areas for fostering women's empowerment.

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Socio-economic Status of Fishers along the Coast of Ratnagiri

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ABSTRACT

The present study was carried out to study the socio-economic status of fishers of Ratnagiri, Maharashtra. Three talukas were selected form the district and one hundred fifty two fishers were selected randomly. Information was collected through personal interview with the help of a well-structured interview schedule. The study revealed that majority (29%) fishers were from the age group 50-58 yr. All the participants were male. It was found that 97% were married and 54% were living in joint family. Fishers inherited their house from ancestors (78%). Majority of fishers had bank account (91%) and 11% were indebted.

KeyWords: Age, Department, Fishers, Fisheries, Ratnagiri, Socio-economic , Status.

INTRODUCTION

The second-oldest economic activity in the history of humanity after agriculture is fishing. Over one billion people rely on fishing as a significant part of their diet and as a source of income globally (Kumbhar, 2017). Fisheries sectors play an important role on socio-economic development of fishermen community (Banasure et al, 2023). Besides, fisheries also serve as the valuable and cheap source of protein to the country (Prabhavathi and Krishna, 2017) and important source of foreign exchange.

Maharashtra state has 720 km coastline which includes seven coastal districts: Palghar (74 km), Thane (112 km), Greater Mumbai (114 km), Raigad (132 Km), Ratnagiri (167 Km) and Sindhudurg (121 Km) (Anonymous, 2020). The overall fisher population in Maharashtra is 15, 18,228, including both inland and marine fishers. Among these, there were 1, 97,760 male fishers and 1, 88,499 female fishers are engaged (Anonymous, 2022). In Ratnagiri district, there are forty-six landing centers and ninty-eight fishing villages, serving as integral hubs for the fishing community. There are 71,620 fisher-folks, population in the district of which 35,957 individuals are male and 35,663 are female. There are 15,716 marine fishing boats in operation, of which 13,002 are mechanized (Patilkhede et al, 2017).

The term socio-economic status (SES) refers to a measurement of a person's or a family's economic and social position in relation to others, based on a variety of factors including income, education, occupation, family affluence, physical assets, social position, social participation, caste, physical strength, political influence, etc. (Reza *et al*, 2015). Considering the large number of fisher families involved in fishing along the coast of Ratnagiri, this study was undertaken to understand the social and economic aspects.

MATERIALS AND METHODS

The study was descriptive as well as exploratory in nature. The data were analysed through descriptive statistics. The study was carried out in three taluka of Ratnagiri namely Dapoli, Ratnagiri and Rajapur. The survey was conducted on socio-economic condition of fishers. A total of 152 fishers were interviewed form three taluka of Ratnagiri. Pre-tested interview schedule was used to collect the required information.

The questionnaire was divided into two sections. First section included the socio- personal details such as age distribution, fishing experience, religion and category of the fishers, and the second

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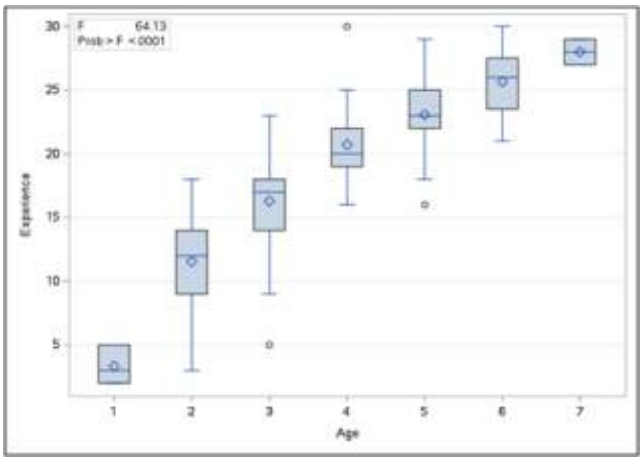

Fig. 2: Distribution of fishers according to fishing experience

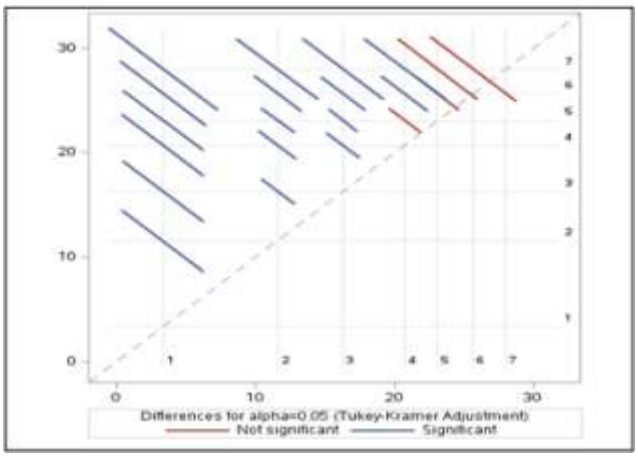

Fig 3: Comparison of experience with age groups

section included economic aspect as bank details, indebtedness and asset holdings. The questionnaire which consisted both open ended and close ended questions. The data were collected during March, 2023 to June, 2023.

The interviews were the primary sources of acquired data. Interviews were conducted at the landing centres and home in the selected area. The data were analysed mainly based on descriptive statistical analysis using MS excel and SAS.

RESULTS AND DISCUSSION

Socio-personal analysis

The socio-personal status of fishers is being presented in Table 1.

Age and fishing experience

The age and fishing experience of an individual tells a lot about their social wellbeing. In the study area majority of fishers were in the age group of 50-58 yr (29%), followed by 34-42 year age group (26%), 26-34 year age group (17%), 42-50 yr age group (16%), 58-66 yr age group (8%), 18-26 age group (2%) and lastly 2% had age between 66-74 yr. Similarly, Banasure *et al* (2023) identified age of trap fisher in Ratnagiri. The highest percentage of trap fisher (50%) were belonged to the 36-50 middle age group, followed by 29.61% fisher were from old age group, while 20.83% fishers from young age group upto 30 yr of age. Gautam *et al* (2020) observed that a significant portion of the respondents, specifically 55.3%, fell within the middle age category of 31 to 45 yr. Patilkhede *et al* (2017) observed the average age of 0-5, 5-10, 10-15, 15-20, 20-25, 25-30, 30-35, 35-40, 40-45, 45-50. Implementing more equitiable fishing policies Regulating the fishing practice Encouraging the collaboration Increasing level of enforcement Increase the presence of police in 12 nauticle mile area Fishers themselves form a vigilare group Increase in satellite/drone monitoring Number of respondents Responses based on location Dapoli Ratnagiri Rajapur fishermen in Ratnagiri was 45 yr and 32.92% fishermen belonged to young age of up to 33 yr, middle age comprised of 52.50% fishers the criteria of middle age ranging from 34-57 yr. The old age was categorised into '58 and above' in which 14.58% were recorded, out of total 240 samples.

The fishing experience was recorded as the majority of fishers (47%), had over 20 yr of fishing experience, followed by 15-20 yr (29%), 0-5 yr (3%), 5-10 yr (6%) and 10-15 yr (15%). Patilkhede *et al* (2017) studied that the average experience of fishers in fishing was 16 yr. There were 1.25% fishers present in this bracket of age group, 21.67% had fishing experience between 6-10 yr, 38.75% had high fishing experience of 11-20 yr. Fishers having very high experience above 20 yr were 38.33%. Kumaran *et al* (2021) studied the socio-economic status of fishermen of Puducherry.

The marine fishing experience of fishers was compared for the different age groups. The result showed that the fishing experience of age

Table 1. Socio-personal status of fishers of Ratnagiri, Maharashtra (N= 152)

Sr. No.	Character	Category	Percentage
1.	Age (Year)	18-26	2
		26-34	17
		34-42	26
		42-50	16
		50-58	29
		58-66	8
		66-74	2
2.	Experience (Year)	0-5	3
		5-10	6
		10-15	15
		15-20	29
		20+	47
3.	Religion	Hindu	57
		Muslim	43
4.	Category	Open	14
		SBC	4
		OBC	81
		SEBC	1
5.	Gender	Male	100
6.	Marital status	Married	97
		Unmarried	3
7.	Educational status	Illiterate	4
		Can only sign	6%
		Primary	44
		Secondary	43
		Higher secondary	3
8.	Family type	Joint	54
		Nuclear	46
9.	House	Ancestor	78
		Constructed	22

groups 18-26, 26-34 and 34-42 yr each was significantly different from the fishing experience of every other age group shown in Fig.4. The experience of (42-50 year) age group was non-significant only with the experience of age group (50-58 year), whereas it was different from every other age group. The older age groups of (50-58 year), (58-66 year) and (66-74 year) were not significantly different from each other with respect to the marine fishing experience.

Religion and category

Data on religious practices followed by respondent fishers was collected and subsequently classified into four distinct categories: Hindu, Muslim, Christian, and Others. It was observed that 57% were Hindu, while 43% were Muslim, while no respondents from Christian or any other religious community were recorded. Similarly

Patilkhede *et al* (2017) revealed that there were 78.75% Hindus and 12.50% fishers belonged to Muslims and Christians. On the contrary Yadav *et al* (2020) studied socio-economic status of fishers of Ratnagiri, revealed that all the 100% respondents were of Hindu religion, whereas Kumar *et al,* (2017) showed that, there were 83.57% Hindus present in 2011-12 in his study. Muslims were 10.80% and remaining 5.63% were Christians. The category-related data were gathered from the fishers, which was then classified into distinct categories including Open, SC (Schedule Caste), ST (Schedule Tribe), OBC (Other Backward Class), NT (Nomadic Tribes), DT (Denotified Tribes), and SEBC (Socially Economically Backward Tribes). It was observed that 81% of the fisher population in the sample belonged to the OBC (Other Backward Class) category, followed by Open (14%), SBC (4%), and SEBC (1%).

Gender

In the study cent percent of the respondent fishers were males. Bhuyan and Islam (2016) reported that involvement of men and women in fishing was 86% and14% respectively in Bangladesh.

Marital status

The marital status of the participants showed that a significant majority (97%) of the respondents were married, while 3% were not married. Yadav *et al* (2020) in his study found that 82.8% were married, 14.1% were unmarried and rest 3.1% were widow.

Educational status

Education is an important aspect as to consider the socio-economic status of a person. The study revealed that 44% of the fishers had successfully attained primary education, while secondary education was done by 43%, followed by some fisher have never gone to school but somehow they had learned to sign only were 6%, whereas 4% were categorized as illiterate. The remaining 3% had successfully completed education up to the level of higher secondary. Patilkhede *et al* (2017) in her study found that 47.08% were illiterate, 3.25% were functionally literate and only 6.67% had education till mediatory. On the contrary, Kumari and Sharma (2022) reported that majority of the fishers were educated up to secondary level followed by primary, higher secondary and graduation.

Family type

Family plays an important role in considering social status. It has a major role in socialisation of an individual. The study has found that 54% were living in a joint family and 46% were living in nuclear family. Patilkhede *et al* (2017) study showed that 48.33% were living in nuclear family similary, Yadav *et al* (2020) found that 62.5% lived in joint family and remaining 37.5% had a joint family.

House

The study revealed that all the individuals had their own house, out of which 78% had got it inherited from their ancestors and rest 22% had purchased or constructed their own house. Based on the year of house construction it was categorised before 2010 (14%), between 2010-2020 (84%) and after 2020 were 2%. Toraskar *et al* (2019) in his study reveals that all the participants were owners of their house.

Economic analysis

Annual income

The results clearly showed that the average annual income of fishers was in between the range of Rs.5.0 - 7.5 lakh. Overall distribution of average annual income showed that 24% of the respondents had an income of 0 - 2.5 lakh, followed by Rs. 2.5 - 5lakh (26%), Rs. 5 - 7.5lakh (28%), Rs. 7.5 - 10 lakh (20%), Rs. 10 - 12.5 lakh (1%), and the remaining 1% earns 12.5 - 15lakh. Notably, none of the respondents could reach beyond an average annual income of 15 lakh.

Bank account

The study revealed that 91% of fishers had bank account while the rest 9% did not had any bank account. Yadav *et al* (2020) in his study found that 84% fishers had bank account and rest 16% did not had any account in bank.

Indebtedness

The information related to indebtedness plays a major role in economic factor for an

Table 2. Economical status of fishers of Ratnagiri, Maharashtra (N=152)

Sr. No.	Character	Category	Percentage
1.	Annual income (lakh)	0-2.5	24%
		2.5-5	26%
		5-7.5	28%
		7.5-10	20%
		10-12.5	1%
		12.5-15	1%
2.	Account in bank	Yes	91%
		No	9%
3.	Indebtedness	Yes	11%
		No	89%
4.	Purpose of loan	Repair and maintenance	70%
		Operating vessel	18%
		Boat construction	12%

individual. It was found that 89% of the fishers were unindebted and remaining 11% were indebted. Salim *et al* (2017) showed a total of 287 respondents had availed loan for different fishing purpose.

Purpose of loan

The reason for which the loan was used is a huge as an economic factor. The study revealed that 70% of the loan was utilized for repair and maintenance, 18% for the operation of the vessel, and 12% for boat construction. Salim *et al* (2017) studied the purpose of loan availed by fishers 49.7% availed loan either for house construction or for to purchase land. People who availed loan for gear purchase were 18% and marriage was the reason for loan by 16%.

CONCLUSION

The fishing practice plays an important role in national economic development of the nation. The study showed that fishers engaged in fishing are mostly males as it requires a lot of physical work. Most of fishers belonged to age group 50-58 yr of age. Mostly these fishers had education only up to primary level this affects the methods of living and the working conditions of the fishers. Therefore, the efforts should be taken such as giving information to them about the need get education. This will help them to develop their mind set to adopt new technologies and follow rules. Priority in providing loans to them at low interest so that the would not be exploited by informal lenders. Different fishing techniques should be implemented in different regions with the help of State Fisheries Department (SFD).

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Socio-economic Status of Gillnet Operators from Ratnagiri Block of Maharashtra State

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ABSTRACT

Gillnetting has been practiced for centuries worldwide and has experienced a remarkable surge in activity in recent times. Gillnets are regarded as highly selective fishing gear, making them one of the most appropriate methods for catching fish from a conservation and stock regulation perspective. In Ratnagiri, gillnet fishing is pivotal in small-scale fisheries and generates employment for the coastal people. Hence, it was necessary to study the socio-economic status of gillnet operators of Ratnagiri, Maharashtra. Therefore, an investigation on socio-economic status of gillnet operators of Ratnagiri, Maharashtra was done. The information was collected randomly from 113 respondents by using an interview schedule. By using descriptive statistics, the data were analysed. The results showed that a majority (69.03%) belonged to the middle age group with secondary education. Most were male (100%), married (95.58%), and owned gill net boats (100%). The study highlighted their housing conditions, family structure, and possession of assets. Gillnet operators faced health issues, and the major constraints included a lack of capital and poor ice supply. The average annual family income was ₹ 2,04,513, with savings at 46.54%. The profit gained from gillnet fishing was ₹ 3,12,092. The constraints faced by gillnet operators were lack of capital, price fluctuation, poor ice supply, spoilage during storage, high transportation cost, unhygienic market place, lack of government assistance. The study suggests targeted training programs for modern fishing techniques, financial education, and income diversification to address challenges and promote overall development in the region. Improved ice supply and storage facilities are also recommended for the fishing community.

Key Words: Block, Gillnet operators, Maharashtra, Ratnagiri, Socio-economic.

INTRODUCTION

The traditional fishing method of gillnetting, practiced for centuries worldwide, has experienced a remarkable surge in activity in recent times. Gillnets can be operated from boats and canoes on inland waters and inshore, decked small vessels in coastal waters, and medium-sized vessels fishing offshore. Gillnets are regarded as highly selective fishing gear, making them one of the most appropriate methods for catching fish from a conservation and stock regulation perspective (Thomas, 2003). The contribution of mechanized gillnet towards fishery in Maharashtra is 8% and had a catch rate of 291.1 kg/unit (CMFRI Annual Report, 2020).

The term socio-economic status (SES) refers to a measurement of a person's or a family's economic and social position in relation to others, based on a variety of factors including income, education, occupation, family affluence, physical assets, social position, social participation, caste, physical strength, political influence, etc (Reza *et al*, 2015).

The collection of socio-economic data focuses on the resources invested, the volume of fish caught, market interactions, and the gains and rewards for individuals involved in these endeavors. These socio-economic data form an integral part of a broader realm of knowledge, encompassing catch and effort data along with

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biological data. The objective of gathering socio-economic data was to evaluate economic effectiveness, cost patterns, livelihoods, employment, profitability, investment levels, financial obligations, subsidies, activity rates, demographic aspects, and ownership arrangements.

Ratnagiri district is one of the important coastal districts of Maharashtra with 167 km of coastline (Yadav *et al*, 2020). There are 46 fish landing centers and one minor fishing harbour is present in this district. Ratnagiri has a 66,685 total fisher folk population. The total number of fishing boats operating in Ratnagiri is 3038 out of which 2267 are mechanized and 771 are non-mechanized. Ratnagiri district has 71,620 fisher folks of which 35,957 are male and 35,663 are female. A total of 14416 active fishermen are residing in Ratnagiri district. The total marine fish production of Ratnagiri district was 65,374 tons during the year 2020-21 (Fish Production Report, Maharashtra; 2020-21). The main objective of the present study was to study the socio-economic status, health status, and constraints faced by the gillnet operators of Ratnagiri Block.

Though gillnet fishing plays pivotal role in Ratnagiri but many constraints were faced by the gillnet operators starting from the economic constraints to the health issues. Hence study of the socio-economic status of fishermen was important because it helps in assessing their income sources and economic contributions, informing sustainable fishing practices and resource conservation, designing targeted policies to address specific needs and challenges, evaluating the impact of fishing practices on the ecosystem. The present study was an attempt to understand the socio-economic status of gillnet operators of Ratnagiri, Maharashtra.

MATERIALS AND METHODS

The study was conducted at the coastal Ratnagiri block, which is located in the Ratnagiri district of Maharashtra on the west coast of India and is situated between 17°18'38.69"N latitude and 73°11'38.14"E longitude and 16°48'24.76"N latitude and 73°18'48.85'E longitude. From the Ratnagiri block, five villages— Kasarveli, Purnagad, Varavade, Mirkarwada, and Rajiwada were chosen for the study.

Random sampling (Snedecor and Cochran, 1967) was used to gather information from each of the study areas. Data related to personal information (Gender, Religion, Category, Age, Education, Marital status, Employment, Occupation, Family size and type, Experience in occupation, Ration card, etc) and constraints was collected by using an interview schedule. The data were collected through face-to-face interviews. The interview schedule was prepared as per McGoodwin (2001) and a formulated interview schedule was used for collecting the socio-economic data of gillnet operators. The present study employed an Interview schedule as the main data collection tool. The respondents for data collection in the present study were the gillnet operators of Ratnagiri block. The data were analyzed by descriptive statistics.

Constraints were analyzed using the weighted average Kant *et al* (2015), Shehrawat *et al* (2016), and Yadav *et al* (2017). Additionally, percentage and frequency distribution were used for the analysis of the data. Statistical analysis was carried out by using Microsoft Excel.

RESULTS AND DISCUSSION

The information related to the profile of gillnet operators was collected and presented in the Table 1. It was observed that the middle age group (40-60 yrs) was dominating with a percentage of 69.03, whereas the young age group (<40 yrs) was 23.89 and the old age group (> 60 yrs) was minimum i.e. 7.07% in the study area. Similar results were found by Baruah and Deka (2016) reported that about 52% of respondents were in the middle age group (31-40 yrs) and a mere 4% were in the old age group (51-60 yrs).

Majumder (2018) studied on socio-economic conditions of fishermen of North-East coastal region of India and Reza *et al* (2015) studied socio-economic and livelihood status of fishermen around the Atrai and Kankra Rivers of Chirirbandar Upazila under Dinajpur District,

Table 1. Profile of gillnet operators along Ratnagiri coast.

Sr. No.	Profile of gillnet operator	Categories	Numbers	Percentage
1	Age(Years)	Young age (<40)	27	23.89
		Middle age(40-60)	78	69.03
		Old age(>60)	8	7.08
2	Education	Illiterate	1	0.88
		Can only sign	3	2.65
		Primary	29	25.66
		Secondary	57	50.44
		SSC	16	14.16
		HSC	5	4.42
		Graduate	1	0.88
		ITI	1	0.88
3	Religion	Hindu	41	36.28
		Muslim	72	63.72
4	Category	OBC	80	70.80
		SBC	33	29.20
5	Marital status	Married	108	95.58
		Unmarried	5	4.42
6	Family type	Nuclear	33	29.20
		Joint	80	70.80
7	Experience inoccupation (years)	< 10 years	17	15.04
		10 to 20 years	70	61.95
		> 20 years	26	23.01
8	House details	Own	111	98.23
		Rental	2	1.77
9	Number of rooms	Two	53	46.90
		Three	48	42.48
		Four	10	8.85
		Five	1	0.88
		Six	1	0.88
10	Extrinsic factors			
	a) Membership	Fishermen cooperative society	99	87.61
		Gram panchayat	6	5.31
		Religious committee	7	6.19
		Bhajani mandal	6	5.31
	b) Indebtedness	Indebted	21	18.58
		Unindebted	92	81.42

Bangladesh and reported that all the respondents (100%) were male. It was observed that cent percent (100%) of the respondents were male.

It was also observed that most gillnet operators (50.44%) had received education up to the secondary level followed by primary level education (25.66%). Similar results were found by Asif and Habib (2017) studied socio-economic condition of fishermen of Jhikargachha upazila in Jessore district, Bangladesh and reported that 42% had secondary level education and 36% had primary level education. Kumari and Sharma (2022) also reported that majority of the fishers were educated up to secondary level followed by primary, higher secondary and graduation.

A majority of gillnet operators (63.71%) in Ratnagiri block were Muslim and 36.28% were

Hindus. Similarly, Haque *et al* (2019) studied socio-economic conditions of Atrai River Jolkor fishermen community in Naogaon district of Bangladesh and reported that 86% were Muslims and 14% were Hindus.

The present study indicated that OBCs were dominating with a percentage of 70.80%, whereas SBCs were around 29.20% in the study area. Similar results found by Devi *et al* (2012) studied socioeconomic and cultural profile of fishers around the Loktak lake of Manipur, India and reported that 66% were under OBC.

The study revealed that 95.58% of gillnet operators were married and about 4.42% of gillnet operators were unmarried in the study area and similar results were reported by Bera and Maity (2023) and Arefin (2015).

The results revealed that about 70.80% of the family of gillnet operators were joint type and 29.20% were nuclear type in the study area. Similar observations were found by Bhendarkar *et al* (2017) in his study the profile of the socio-economic condition of fishermen in selected villages in Kabirdham district, Chhattisgarh state, India observed that 64% of fishermen had joint families and 36% of fishermen had nuclear families. Barua *et al* (2022) studied socio-economic condition of the indigenous fishermen in and around an artificial lake for Bangladesh and observed that 21% of tribal fishermen had nuclear families and 79% had joint families.

It was observed that 61.54% of the gillnet operators had 10-20 years of experience in fishing, followed by 23.01% of gillnet operators were having >20 years of experience and 15.04% of gillnet operators having < 10 years of experience. Similarly, Patilkhede *et al* (2017) studied socio-economic profile of fishermen in coastal Konkan region of Maharashtra and observed that 38.85% of fishermen had 11 to 20 years of experience, 38.33% had more than 20 years of experience, 21.67% had 6 to 10 years of experience and 1.25% had less than 5 years 50 of experience.

The proportion of gillnet operators who had their own house were 98%, while those who had rented houses were 2%. The results of the present study are similar to the results obtained by Khode (2018). In the present study, a greater proportion of the respondents were residing in their own pucca houses, which indicates their better earning from the occupation over the period.

Further, percentage of gillnet operators had two rooms (46.90%). About 42.48% of gillnet operators had three rooms and 8.85% had four rooms. Very few gillnet operators had five (0.88%) and six (0.88%) rooms. Similar observations were found by Waskar (2008) and Khode (2018).

Membership in societies

Majority of the gillnet operators (87.61%) had membership in the fishermen's cooperative society in the present study. Some were having membership in gram panchayat and bhajani mandal. The percentage recorded for Gram panchayat and Bhajani mandal was 5.31%. Gillnet operators having membership in religious committees were 6.19%. similar results found by Toraskar *et al* (2020) studied socio-economic status of rampan operators of Sindhudurg district of Maharashtra and observed that 56.63% of rampan operators were affiliated with the fishermen co-operative society, while 0.82% were associated with the Gram-panchayat and 0.27% were affiliated with the Gram vikas mandal.

In the present study, most of the gillnet operators were indebted and the percentage for this was 81.42% similar results observed by Waskar (2008) and Toraskar *et al* (2020). Reza *et al* (2015) studied socioeconomic and livelihood status of fishermen around the Atrai and Kankra Rivers of Chirirbandar Upazila under Dinajpur District, Bangladesh and have reported that a substantial proportion of the fishers, precisely 64%, have acquired loans from various non-governmental organizations, whereas 36% of them have relied on their credit.

Economic Status

The economic analysis of gillnet operators was presented in the Table 2. The capital cost includes the vessel cost, cost of engine, net, rope, indicator buoys, floats, sinkers, crates and anchors. It was found that percentage investment on vessel was 71.75% while the cost of net was 10.33%, cost of engine was 9.72%, 2.32% sinkers,

Table 2 Economic analysis of gillnet operators.

Sr. No.	Particular	Amount	Percentage
A	**Capital cost**		
1	Vessel	2,03,540	71.75
2	Cost of engine	27,566	9.72
3	Net	29,292	10.33
4	Rope	3,204	1.13
5	Indicator buoys	1,080	0.38
6	Floats	3,876	1.37
7	Sinkers	6,540	2.31
8	Crates	3,655	1.29
9	Anchors	4,920	1.73
	Total capital cost	2,83,673	100.00
B	**Variable cost**		
1	Basket	1,073	1.95
2	Paint	1,345	1.61
3	Maintenance of gillnet	611	0.73
4	Maintenance of engine	3,584	4.28
5	License fee	3,690	4.41
6	Custom pass	500	0.60
7	Fuel	3,372	4.03
8	Ice	12,142	14.51
9	Oil	2,345	2.80
10	Crew salary	55,044	65.76
	Total variable cost	83,706	100.00
C	**Total project cost (A+B)**	3,98,706	
D	**Fixed cost**		
1	Depreciation on capital cost@ 10%	28,367	
2	Interest on capital cost@ 12%	34,041	
3	Interest on variable cost@ 12%	10,045	
	Total fixed cost	68,229	
E	Total cost(B+D)	1,51,936	
F	Revenue	4,64,028	
G	Profit or loss(F -E)	3,12,092	

1.73% anchors, 1.13% rope, 1.37% floats, 1.29% crates 0.38% indicator buoys. Total variable costs included the cost for basket (1.95%), paint (1.61%), maintenance of gillnet (0.73%), maintenance of engine (4.28%), license fee (4.41%), custom pass (0.60%), fuel (4.03%), ice (14.51%), oil (2.80%), crew salary (65.75%). The total fixed cost included the depreciation on capital cost @ 10%, interest on capital cost @ 12%, and interest on variable cost @ 12%. The total fixed cost was found to be ₹65,105. The total cost was found to be ₹1,51,936. The revenue calculated was ₹4,64,028. The profit gained was ₹3,12,096. Analysis of cost and return showed that the operation of gillnet operators was profitable for gillnet operators along the Ratnagiri coast. Similar results were reported by Wasave *et al* (2018) and Gautam *et al* (2020) while studying the socio-economics of fish retailers of Ratnagiri area of Maharashtra and fish farmers of Uttar Pradesh, respectively and stated that they were earning around 1,50,000/- as profit per annum. Guguloth *et al* (2018) reported that over 85% of the respondents reported that they save annually from their income, while the remaining 15% indicated that they do not engage in any annual savings. Dar *et al* (2017) studied the Economics of OBM Gill Netters along the Jaleshwar Coast, Veraval, Gujarat, India and revealed that the capital cost of a single OBM gillnetter was ₹3,33,379 and the

Table 3. Constraints faced by gillnet operators.

Sr. No	Constraint	Weighted average	Rank
1	Lack of capital	1.49	1
2	Price fluctuation	1.43	2
3	Poor ice supply	1.42	3
4	Spoilage during storage	1.31	4
5	High transportation cost	1.19	5
6	Unhygienic market place	1.13	6
7	Lack of government assistance	0.94	7

variable cost was ₹ 1,07,568. Fixed cost inclusive of depreciation was Rs. 59,848. revenue of OBM gillnetter was ₹1,52,778.43 respectively. The annual loss found to be ₹ -14,638. But the researcher also stated that this was incurred considering the initial investment in terms of capital cost at the end of first year, however second year onwards the OBM gillnetters were profitable.

CONSTRAINTS

Major constraints faced by gillnet operators were lack of capital (weighted average score 1.49), price fluctuation (weighted average score 1.43), poor ice supply (weighted average score 1.42), spoilage during storage (weighted average score 1.31), high transportation cost (weighted average score 1.19), unhygienic market place (weighted average score 1.13), lack of government assistance (weighted average score 0.94). Similarly, Reza *et al* (2015) observed that the main problems faced by the fishermen were depletion of fish stock and catch, lack of financial ability, inadequate credit facilities and financial support, lack of training facilities, vandalism i.e. theft of boats, and nets, low fish price etc.

CONCLUSION

The study on the socio-economic status of gillnet operators from Ratnagiri block of Maharashtra showed that as most of the gillnet operators were educated up to secondary level education there is a need for targeted training programs to give knowledge about modern fishing techniques and sustainable practices. This training program should also include financial literacy as a major constraint observed was a lack of capital. This training program will help them to manage their credit and finance. The gillnet operators should diversify their income sources this will help them during the low catch and market fluctuations. The ice supply infrastructure should be improved to avoid spoilage during storage and cold storage facilities should be enhanced to maintain the freshness of fish. There is need to plan certain schemes to uplift the socio-economic status of gillnet operators by minimizing the constraints faced by them.

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Soil Nutrient Status Prediction Using Machine Learning Algorithms

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Soil nutrients play a pivotal role in facilitating optimal plant development and enhancing agricultural yield. The precise assessment of soil nutrient levels is paramount for making informed agricultural choices, encompassing crop selection, land preparation, and fertilizer application. This study incorporates diverse supervised machine learning approaches, including K-Nearest Neighbour, Decision Tree, Random Forest, Support Vector Machine and Naive Bayes, to analyse soil nutrient profiles. A total of 12 soil parameters were employed to categorize soil nutrients into low, medium, and high classifications. Post pre-processing, the dataset underwent a division into training and testing datasets. Algorithms were applied to the training collection and then assessed with the test dataset, using Python for coding. The random forest model achieved the highest accuracy, reaching 99%, thus surpassing alternative methodologies. The research highlights that the application of machine learning strategies, notably the random forest method, can greatly advance the accuracy of soil nutrient forecasts, allowing farmers to make wiser decisions that increase productivity and optimize land management.

Key Words: K-Nearest Neighbour, Machine Learning, Naive Bayes, Prediction, Random Forest, Soil Nutrients, Support Vector Machine,

INTRODUCTION

Soil nutrients are vital for the healthy growth of plants. Maintaining adequate nutrient levels ensures optimal plant growth, high yields, and resilience against diseases and pests. Deficiencies or excesses in soil nutrients can compromise plant health and reduce agricultural output (Kumar, 2020). Prediction of soil nutrient status is the foundation of all input-based agricultural production systems. It is the initial and most crucial step, influencing several key agricultural decisions. These include the selection of suitable crops, the preparation of land, the choice of seeds, anticipated crop yields, and the appropriate application of fertilizers or manure (Sharma *et al,* 2020; Pandith *et al,* 2020). Farmers can make informed decisions that enhance crop production, conserve resources, and protect the environment by accurately assessing soil nutrient status.

Machine learning (ML) utilizes algorithms to analyse data, detect patterns, and make decisions, enabling systems to perform tasks similar to human activities. These systems learn and improve autonomously from experience without needing explicit programming. (Sarker, 2021; Abraham *et al,* 2024). With recent advancements in machine learning, the use of ML models is likely to become more widespread. Effectively used in support and decision-making, ML algorithms have the potential to revolutionize fields, enhancing efficiency and effectiveness (Folorunso Olusegun *et al,* 2023). Machine learning algorithms are primarily classified into supervised, unsupervised, and reinforcement learning paradigms. Supervised learning uses labelled datasets where each input has a corresponding output. These algorithms learn from this data to establish relationships and generalize predictions for new inputs. When applied to predict categorical values, they are known as classification algorithms (Sharma *et al,* 2020). It involves a two-step process: analysing dataset attributes to build a model with predetermined class labels, and estimating the model's accuracy. Before applying classification techniques, data cleaning, transformation, and

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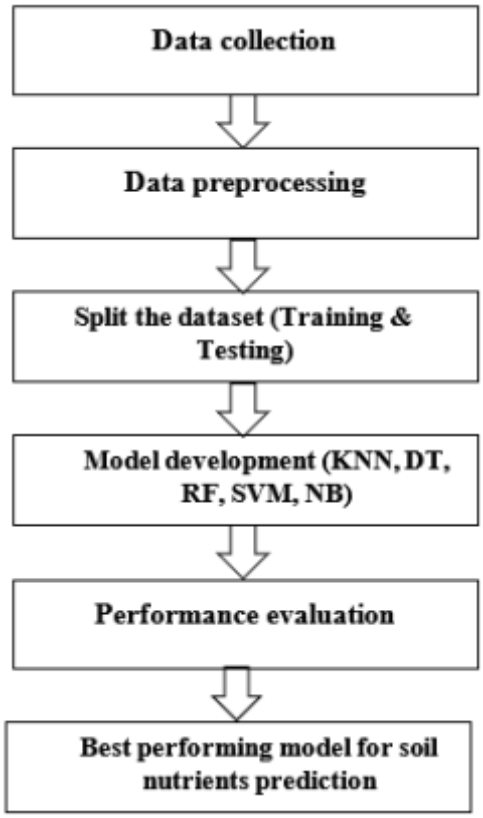

relevance analysis are essential to refine the dataset for optimal model training and prediction. Classification model results are evaluated based on scalability, speed, predictive accuracy, robustness, and interpretability (Awasthi and Bansal, 2017).

Using machine learning techniques for soil nutrient assessment can optimize fertilizer application, predict pest and disease outbreaks, and suggest precise irrigation strategies. This enhances agricultural productivity and efficient land resource management (Folorunso Olusegun *et al*, 2023). Classification can be used for the prediction of soil nutrient status (Oumnia Ennaji *et al,* 2023). The main classification algorithms identified for soil nutrient prediction are k-Nearest Neighbours (KNN), Decision Trees (DT), Random Forest (RF), Support Vector Machine (SVM) and Naive Bayes (NB) (Oumnia Ennaji *et al,* 2023; Sharma *et al,* 2020).

MATERIALS AND METHODS

The dataset was collected from the soil testing laboratory at Krishi Vigyan Kendra in Jabalpur. It includes readings of 12 parameters, pH (soil pH value), EC (electrical conductivity), OC (organic carbon), N (nitrogen), P (phosphorus), K (potassium), S (sulphur), Zn (zinc), B (boron), Fe (iron), Mn (manganese), and Cu (copper) and corresponding labels indicating nutrient status categories, low, medium, high. After data collection, pre-processing was performed to eliminate duplicates, handle outliers, standardize attribute values, and substitute missing data. The dataset of 1000 soil samples has been divided into training and testing data in the ratio 70: 30. The proposed methodology is presented in Fig 1.

Classification algorithms suitable for soil nutrient status prediction are follows (Folorunso Olusegun *et al,* 2023; Oumnia Ennaji *et al,* 2023).

K-Nearest Neighbours (KNN)

The KNN algorithm is a flexible and easy-to-understand method that can be applied to both classification and regression problems. It works by selecting a parameter, k, that represents the number of nearest neighbours to consider. For classification tasks, KNN assigns a new data point to the category most common among its k-nearest neighbours, while a larger k tends to enhance stability. As a non-parametric algorithm, KNN uses the training data to group new points without

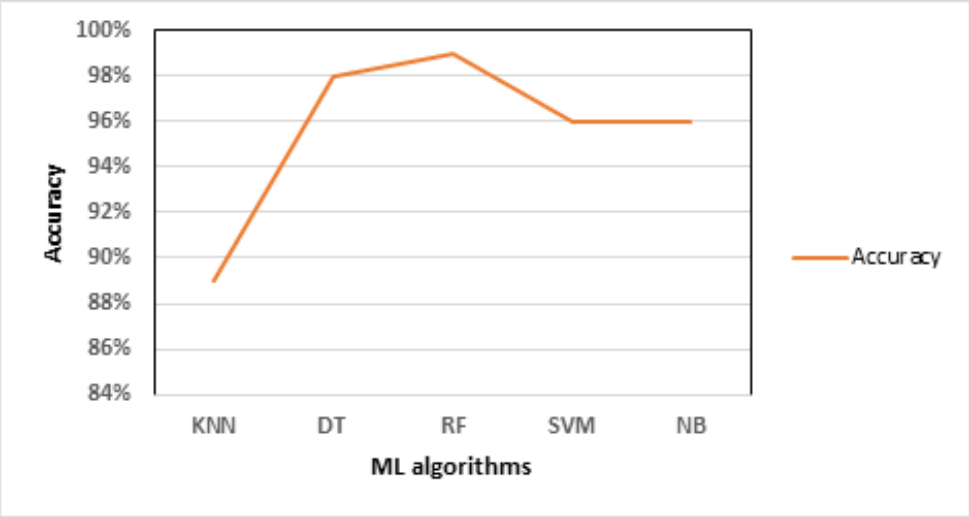

Fig 2: Evaluation for finding better accuracy

assuming any specific data distribution. It is effective for capturing both linear and non-linear patterns, adjusting to local data variations, and handling outliers well, making it suitable for predicting soil nutrient levels based on nearby data characteristics.

Decision Trees (DT)

DTs are versatile algorithms suitable for both classification and regression tasks, with a preference for classification problems. In a tree-structured classifier, internal nodes represent dataset features, branches symbolize decision rules, and leaf nodes signify outcomes. Decision Trees offer excellent clarity and interpretability, highlighting feature importance and handling non-linear relationships effectively. They work well with mixed data types (categorical and numerical), have low computational complexity, and manage outliers efficiently, making them ideal for predicting soil nutrient status based on various soil parameters.

Random Forest (RF)

RF is a powerful and very easy-to-use supervised learning algorithm known for its high accuracy. It creates a forest of decision trees, on various subsets of the given dataset. Even without fine-tuning, it often produces good results. RF is effective in dealing with outliers and noisy data, works well with large numbers of categories, highlights important variables, and avoids overfitting, making it a great option for predicting soil nutrient levels.

Support Vector Machines (SVM)

SVMs are powerful and flexible supervised learning algorithms used for both classification and regression tasks. They are popular because they can work with both categorical and continuous variables. SVMs separate data by creating a decision boundary, or hyperplane, between two classes. This hyperplane is adjusted to minimize errors and maximize the margin, which helps improve generalization. SVMs perform well in high-dimensional spaces, are less likely to over fit, and can use different kernel functions. They also work effectively with small to medium datasets and are not affected by irrelevant features, making them a good choice for predicting soil nutrient levels.

Naive Bayes (NB)

NB is a simple but powerful classification algorithm that builds fast machine learning models for quick predictions. It works as a probabilistic classifier, making predictions based on the likelihood of an object, using Bayes' theorem and assuming that features are independent. The algorithm estimates class labels by calculating the probability for each instance and requires only a small amount of training data. NBs is especially useful for datasets with multiple classes. It efficiently handles large datasets, scales well, and manages irrelevant features. It also works with limited training data and is easy to

interpret, making it a good option for predicting soil nutrient levels.

RESULTS AND DISCUSSION

A comparative analysis was conducted to determine the most accurate technique among machine learning algorithms for prediction of soil nutrient status. Machine learning models were implemented using Python's scikit-learn library. The performance of each model was evaluated on pre-processed soil datasets with feature scaling applied where necessary. Fig 2 provides a summary of the evaluation results of each algorithm. Various machine learning methods were employed to determine the most accurate model based on soil data sets. The following machine learning methods were employed: K-Nearest Neighbour, Decision Tree, Random Forest, Support Vector Machine and Naive Bayes. The models were trained using soil nutrient data, with the data split into training and testing sets in a way that made sure all categories were fairly represented.

Classification tasks and evaluation performance metrics were used to test the accuracy of each machine learning model, yielding the following results: 89% for KNN, 98% for decision tree, 99% for random forest, 96% for support vector machine, and 96% for Naive Bayes. The random forest method achieved the highest accuracy. The random forest technique outperformed all other machine learning methods in predicting soil nutrients status, enabling farmers to make more informed decisions to increase productivity.

CONCLUSION

This study demonstrates the effectiveness of machine learning algorithms in predicting soil nutrient status. By utilizing a dataset of soil samples with 12 parameters were used to classify soil nutrients as low, medium and high and implementing supervised learning algorithms using Python, the research achieved a high accuracy rate of 99% with the random forest model. Accurate soil nutrient prediction can significantly aid farmers in making informed decisions regarding crop selection, land preparation, and fertilizer application, ultimately enhancing agricultural productivity and resource management. The success of the random forest algorithm underscores its robustness and reliability, making it a valuable tool for optimizing soil nutrient management practices.

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Survey of Antihypertensive Drugs Sold from Different Pharmacy Shops of Selected Areas of Varanasi District of Uttar Pradesh

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The present study was based on shop to shop survey for the availability of different antihypertensive medicines which are being used in therapy of hypertension in Varanasi district of Uttar Pradesh. A total of 124 pharmacy shops including both allopathic and homeopathic were contacted during the survey. The results revealed that antihypertensive medicines from class calcium antagonists, angiotensin converting enzyme inhibitors, angiotensin receptor blockers and beta-blockers were present in all (100%) the pharmacy shops, followed by diuretics (94.50%), aldosterone antagonist (69.72%), alpha blockers (55.96%) and vasodilators (21.10%). Ayurvedic medicines were present in few of the pharmacy shops which were surveyed while homeopathic preparation of various makes was present in each of the homeopathic pharmacy shops which were used for treatment of hypertension.

Key Words: Antihypertensive, Hypertension, Medicine, Pharmacy, Varanasi.

INTRODUCTION

In India hypertension (HTN) is one of the most common disease which causes a significant burden on the health care system. Risk factors involved in the development of hypertension includes age, smoking, alcohol intake, increased body mass index (BMI), decreased consumption of vegetables/fruits, increase in consumption of fat and salt in diet, and an inactive life style. Hypertension contributes a significant risk factor for diseases like cardiovascular disease, cognitive impairment, chronic kidney disease, causes mortality and disability. Cardiovascular diseases are affecting around 1.39 billion adults and causing around 10.4 million deaths annually, among these diseases, hypertension is one of the major contributors (Unger *et al*, 2020). Cardiovascular diseases are responsible for one-third of total deaths taking place in India (Patel *et al*, 2011). The low and middle income countries are experiencing a significant raise in the occurrence of hypertension in contrast with the high income countries (Mills *et al*, 2020). As per data by Zhou *et al*, 2021 the sum total of people affected with hypertension around the world has increased by twofold in the previous 30 years. Despite global to increase in the access to different classes of extremely potent antihypertensive drugs (Neal *et al*, 2000), only one women out of four and one men out of five having hypertension have achieve the treatment targets (Zhou *et al*, 2021). In India hypertension is most prevailing disease, affecting 25.3% adult (18+ years) population (Gupta *et al*, 2018). The estimated value of adults having hypertension in India is at least one among four (Geldsetzer *et al*, 2018) and, among them only about 12% have their blood pressure under control range (Prenissl *et al*, 2019). Persistent high blood pressure can lead to development various cardiovascular diseases including stroke, coronary artery disease, and peripheral vascular

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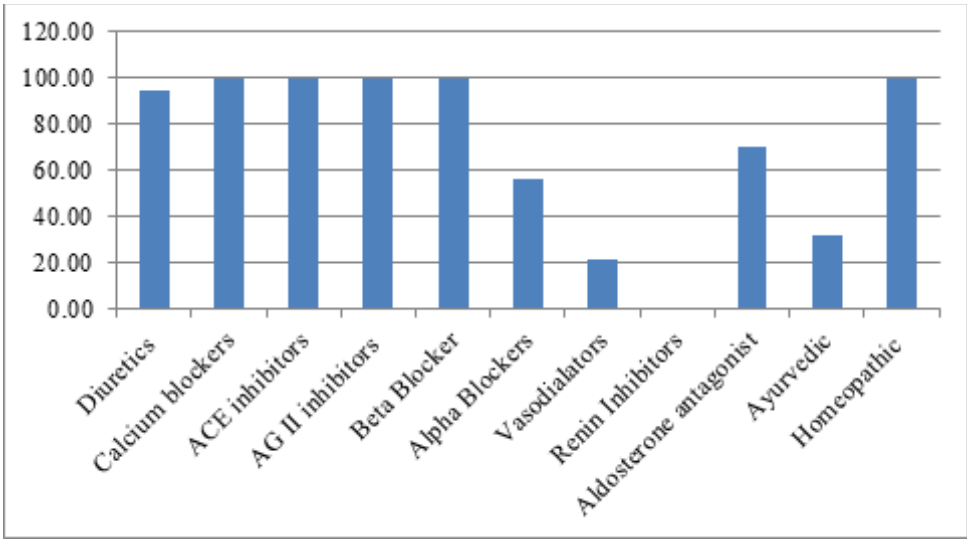

Fig.1: Antihypertensive drugs present (%) in pharmacy shops.

disease, retinopathy, nephropathy and possibly neuropathy (Arauz-Pacheco *et al*, 2003).

In India the patient accesses the medicines by mainly two ways either from government health facilities or through private facilities. Government either purchases the drugs or manufactures and distributes to the patient through government health facility centers. A large percentage of patients search for private sector for health care. In India, private sector is visited by the 70% of out-patient (NSSO, 2016). The private pharmacies are more commonly utilized by the patients than government services, because of easy approach, less waiting times, convenient opening times, availability of medicines and availability of medicines on credit (Basak and Sathyanarayana, 2010).

The different groups of drugs prescribed for decreasing blood pressure which are currently available in the market are diuretics, beta-blockers, calcium antagonists, angiotensin-converting enzyme inhibitors and angiotensin receptor blockers these entire groups of drugs are appropriate for the control of high blood pressure and these drugs can be used as a single drug therapy or in different mixtures of selected drugs (Mancia *et al*, 2013). Along with these ayurvedic medicines and homeopathic medicines are also used for the management of hypertension. Choice of antihypertensive drugs should be on the basis of availability of drug and information of drug's capacity to decrease blood pressure (BP) values, which is the first objective to evade cardiovascular problems in patients. As different drugs belonging to the same group does not contain equal antihypertensive strength and the choice of drug can definitely influence the possibility of attaining BP control.

India is a home to a large drug manufacturing units, producing allopathic, ayurvedic and homeopathic medicines. Hence, the present survey was carried out in order to establish the drug availability for treatment hypertension, in different Pharmacy shops of selected areas of Varanasi district of Uttar Pradesh.

MATERIALS AND METHODS

For this observational survey, a random sample from different Pharmacy shops in selected areas of Varanasi district of Uttar Pradesh were contacted to participate, during the period of two months from December 2022 to January 2023. Survey forms were filled out manually with existing drugs data available in the pharmacy shops.

RESULTS AND DISCUSSION

Antihypertensive drugs available from different groups in pharmacy shops

A total of 124 pharmacy shops (109

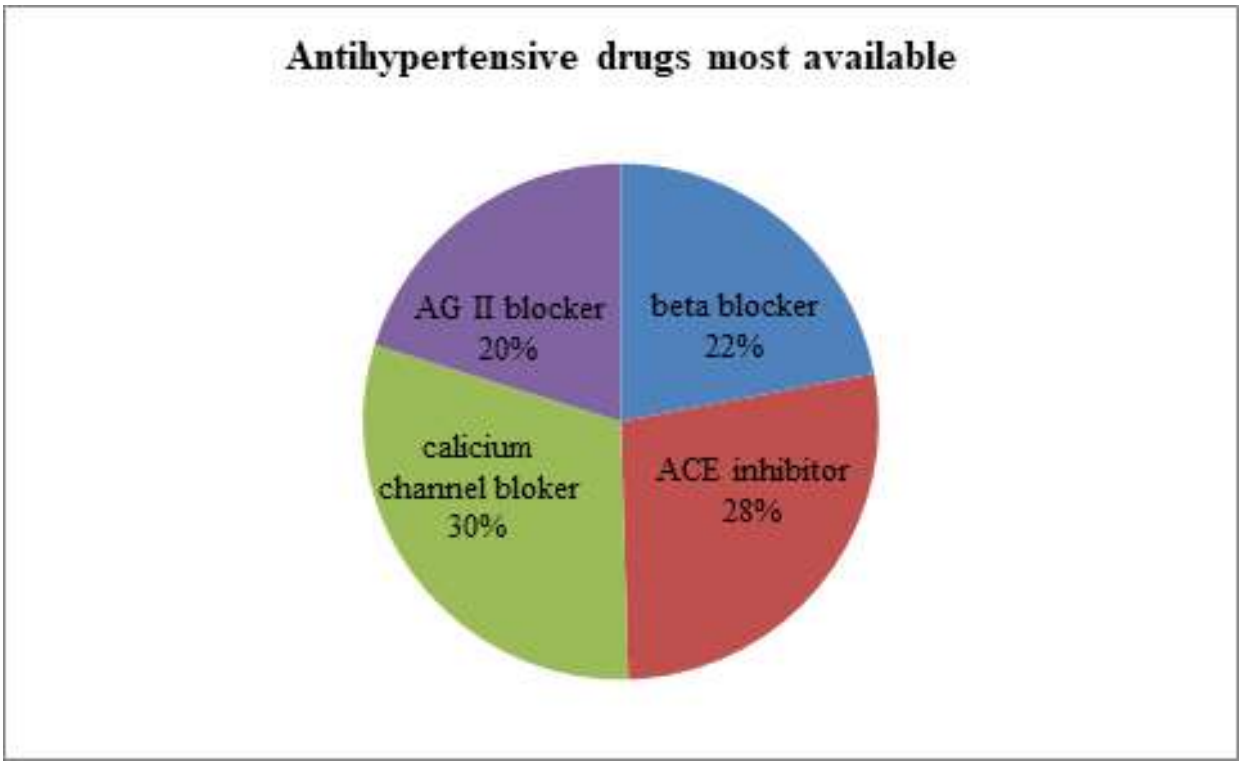

Fig.2: Antihypertensive medicines mostly present in pharmacy shops

allopathic + 15 homeopathic) were contacted during the survey. It was observed that antihypertensive drugs from calcium antagonists, angiotensin converting enzyme (ACE) inhibitors, angiotensin receptor blockers and beta-blockers were present in all (100%) the pharmacy shops, followed by diuretics (94.50%), aldosterone antagonist (69.72%), alpha blockers (55.96%) and vasodilators (21.10%). Renin inhibitors were not found in any of the pharmacy shops. Ayurvedic drugs were present in 32% of the pharmacy shops which were surveyed (fig. 1). Homeopathic preparation of various makes was present in all (100%) of the homeopathic pharmacy shop for treatment of hypertension.

Antihypertensive drugs most available in pharmacy shops

The proportion of different antihypertensive drug in pharmacy was, in 30% pharmacy shop calcium antagonists was mostly available, angiotensin-converting enzyme inhibitors were mostly present in 28% shops, in 22% shops beta-blockers and in 20% shops angiotensin receptor blockers were mostly present in comparison to other antihypertensive drugs (fig.2).

Antihypertensive drugs least available in pharmacy shops

The antihypertensive drugs which was present in the least quantity in comparison with other drug in pharmacy shops were diuretics in 8.26% shops, beta-blockers in 15.60% shops, angiotensin-converting enzyme inhibitors in 19.27% shops, calcium channel blockers in 11.93% shops, AG II blocker in 13.76% shops, alpha blockers in 12.84% shops, vasodilators in 10.09% and aldosterone antagonist in 8.26% shops (fig. 3).

Antihypertensive drugs most affordable in pharmacy shops

According to pharmacy shop owner the most affordable drugs in their shops were beta-blockers in 22.94% shop, ACE inhibitors in 33.03% shop, calcium channel blockers in 31.19% shop, AG II blocker in 6.42% shop, diuretics in 4.59% shop, ayurvedic medicines in 0.92% shop and vasodilators in 0.92% shop (fig. 4).

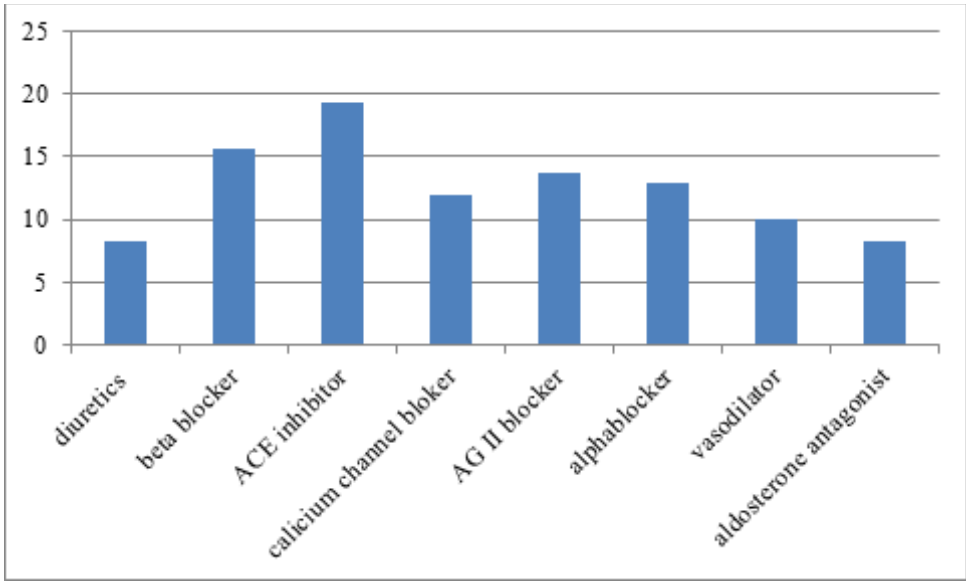

Fig.3: Antihypertensive drug least present in pharmacy shops

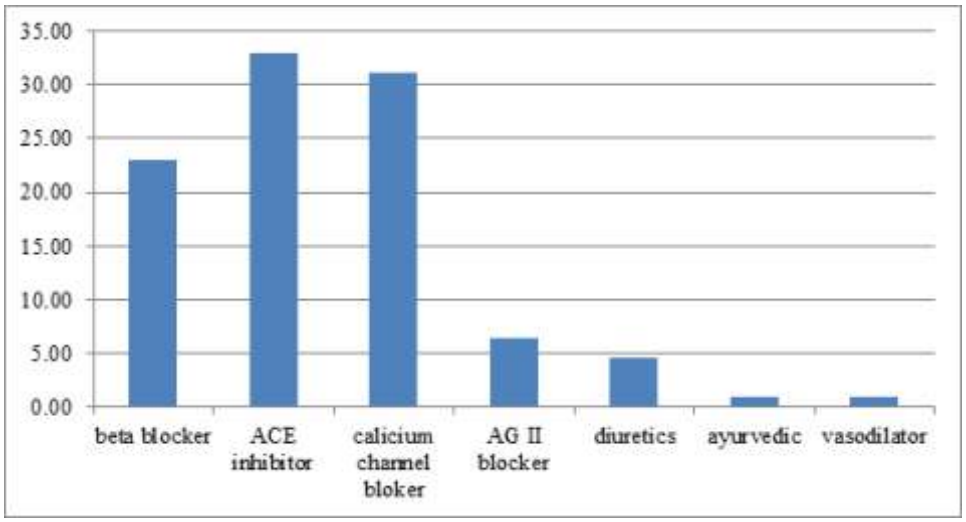

Fig.4: Antihypertensive drugs most affordable

Antihypertensive drugs sold over the counter in pharmacy shops

The list of drugs groups which are sold over the counter (without prescription) are beta-blockers in 18.35% shops, AG II blocker in 12.84% shops, calcium channel blockers in 37.61% shops, ACE inhibitors in 12.84% shops, diuretics in 2.75% shops, ayurvedic in 1.83% shops, while 13.76% shopkeeper replied can't say (fig.5).

It was found that antihypertensive drugs were sold in mostly in form of pills. In none of the pharmacy shops a drug was found which is used for IV administration. The antihypertensive drugs were used for long period of time or throughout whole life. Further it was found that antihypertensive drugs were purchased through both prescription and without prescription. The antihypertensive drugs were maximally used in case of adult and old age groups.

A high percentage of population with hypertension needs a combination of two or more antihypertensive drugs to control blood pressure (DiPette *et al*, 2019). There was presence of drugs which were used in single pill combination, while in India's recent national essential medicines list (EML) the single pill combinations drugs (SPCs)

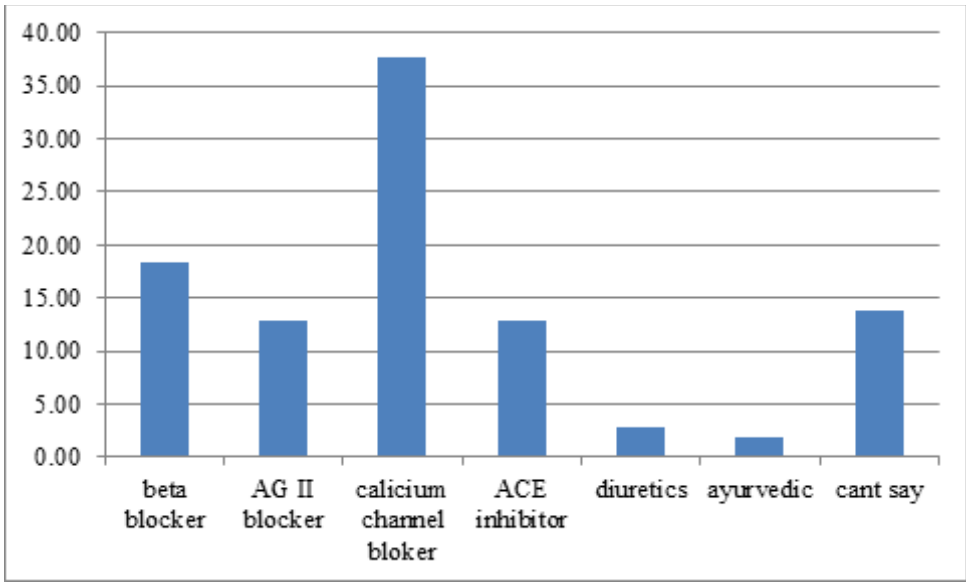

Fig.4: Antihypertensive drug most affordable

are not added (Anonymous, 2015), which highlights the trend of use of single pill combinations in the private health sector. Although The World Health Organization (WHO) had included SPCs had for management of hypertension in its EML (WHO, 2019). The prices of drugs used for SPCs are lower when compared with the prices of the individual drug, under the Government of India's flagship generic drug scheme (BPPI, 2020). Negi *et al*, 2021 was found that the prices of SPCs in India's private sector are not more than individual drug components.

CONCLUSION

It was concluded that calcium antagonists, ACE inhibitors, angiotensin receptor blockers and beta-blockers were present in all (100%) the pharmacy shops

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Sustainable Yard Long Bean Production through Introduction of High Yielding New Variety Arka Managala

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Yard long bean is one of the important vegetable crop rich in proteins and fibers, grown for fresh vegetable market majorly in south India and which plays a vital role in supplementing the income of small and marginal farmers of Mysuru district of Karnataka. One of the major constrain of traditional Yard long bean farming in Mysore district is low productivity due to non-adaption of advanced technologies like use of improved varieties. The present study Sustainable Yard Long Bean production through introduction of high yielding new variety Arka Managala was carried out at Hunsur Taluk of Mysore district during *Kharif* 2023. The improved technologies such as introduction of high yielding variety (Arka Mangala), balanced manures, fertilizers application and integrated pest and disease management etc. The present study revealed that introduced variety Arka managla gave highest yield per ha (14.1 t/ha) compared to farmers practice (8.9 t/ha) i.e. traditional varieties used by the farmers. The Arka mangala registered 36.87 per cent increased yield over the farmer's practice variety. The introduced variety Arka Mangala gave higher B:C ratio 1:3.10 with beneficial/market preference characters like long pods (80 cm), light green, stringless, round, tender with crisp texture and early maturity in 60 days along with minimum pest and disease incidence. Present study clearly showed that the yield and economics of Yard long bean can be improved by adapting high yielding variety with recommended scientific technologies.

Key Words: Arka Mangala, Crisp, Stringless, Texture, Yard long bean.

INTRODUCTION

IYard long bean (*Vigna unguiculata* sp. *sesquipedalis*) is a climbing member of the family Fabaceaeand sub family – Papilionaceae. The Yard long bean is one of the most significant leguminous vegetables in Asia, it is also known as the asparagus bean, string bean, snake bean, or snake pea. The ideal growing temperature for Yard long bean ranges between 27° to 30°C, and it is better able to withstand heat and dryness than other common beans (Quamruzzaman *et al,* 2022). Usually, the Yard long bean is harvested while still young and consumed as a green vegetable. Yard long beans, as the name suggests, the crop is differed from other leguminous vegetables in their very slender long green beans, indeterminate in growth habit, leaves are trifoliate and green in color. Flowers are of papilionaceous type with violet color. Pods are long, slender and pendent with sparely arranged bold seeds.

The Yard long bean is frequently known as poor man's meat as the pods are high not only in protein but also in lysine, tryptophan and a significant number of critical vitamins and minerals including folic acid and vitamin B (Chinma *et al,* 2008). Fresh Yard long beans are very high in folates which are necessary for pregnant women to prevent neural tube defects in babies. To optimize the health benefits associated with yard-long beans, consumption of about 1.5 cups of beans weekly is recommended (Peyrano *et al,* 2016). Yard long bean can be grown with an optimum average temperature of 20ºC to 30ºC. It prefers full sunshine during growth and development, whereas cloudy and rainy weather cause low yield due to poor fruit set and dropping of young pods. It can be grown in various soil types from sandy loam to clay, but loam and sandy loam with pH 6.2-7.0 are the best for yard long bean production. Although it is a highly nutritive legume vegetable, commercial cultivation of yard

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Table 1. Technology gap between two practices

Sr. No.	Package of practices (Technology demonstrated)	Introduction of new variety (Recommended package of practices)	Farmers practice (Local/check)	Technology Gap
01.	Varietal selection	Improved variety (Arka Mangala)	Local old variety	Partial gap
02.	Testing of soil	Have been done in all the demonstrated plot	Not followed	Full gap
03.	Seed treatment	Rhizobium treated	Not treated	Full gap
04.	Spacing followed	60 cm x 45 cm	70 cm x 20 cm	Partial gap
05.	Nutrient management	93 kg N + 75 kg P_2O5 + 105 kg K_2O per ha (50% N+ 100% P K at the time of planting and remaining 50% N applied at 30 days and 60 days after sowing)	Imbalance and inadequate	Partial gap
06.	Correction of deficiency by using micronutrients	2 times Foliar spray of vegetable special 2g/ltr + 1lemon + 1 shampoo sachet	Not used micronutrient	Full gap
07.	Irrigation	Drip irrigation depend upon soil condition	Flood irrigation twice in a week	Partial gap
08.	Weed control	Post emergent herbicide Imajamox @ 40 gram /ha, followed by hand weeding depend upon weed intensity.	Weeding is not common and did by hand weeding	Partial gap
9.	Plant protection measures for control of insect pest and diseases	Followed IPDM: practices and need based spray	Not properly done by using IPDM	Partial gap
10.	Harvesting	Manual	Manual	No gap

long bean for vegetable purpose is relatively low in India. The production and productivity of yard long bean is mainly constrained by due to low yield, use of local varieties and non-adoption of advanced technologies (Noorjehan *et al,* 2023 and Sarutayophat *et al,* 2007). To achieve this, selection of suitable varieties is an important step for successful and profitable cultivation of the

Table 2. Yield characteristics and economics of introduction of Yard long bean high yielding variety Arka Mangala in Mysore District

Particulars	Days taken for first harvest	Pods per plant (No.)	Pod length (cm)	Pod girth (cm)	Pods yield per plant (gm)	Yield (t/ha)	Cost of Cultivation (Rs./ha)	Gross Return (Rs./ha)	Net Return (Rs./ha)	B:C Ratio
Arka Mangala	56	42	76	3.20	790	14.1	181500	564000	382500	3.1
Local variety	71	32	62	2.60	570	8.9	186800	356000	169200	1.9

Table 3. Yield technology gap and technology index of introduction of new high yielding variety of Yard long bean Arka Mangala in Mysore District

Variables	Yield (t/ha)	Yield Increase (%) over farmers Practice	Technology gap (t/ha)	Extension gap (t/ha)	Technology index (%)
Arka Mangala	14.1	36.87	10.9	5.2	43.60
Local variety	8.9	-	-	-	-


ಮೀಟರ್ ಅಲಸಂದೆ ಬೆಳೆಯ
ಹೊಸ ತಳಿ ಅರ್ಕ ಮಂಗಳ

Fig.1 Farmers training programme and Arka Mangala seed distribution

Fig.2 General view of the Arka Mangala plot at farmers field

Fig.3 Farmers with high quality Arka Mangala pods

Fig.4 Organized field day to spread the technology

crop. In view of its nutritive value and being consumed as legume vegetable plays key role in sustainable crop management programme (Nagarajappa *et al,* 2018). At this juncture, identification and promotion of highyielding varieties in Yard long bean will play an essential role in crop improvement. Arka Mangala is an improved variety of Yard long bean with higher yield and better pod quality has released by Indian Institute of Horticultural Research, Bengaluru. Yard long is an important vegetable crop of the district and has been considered as productively potential region of Yard long bean due to assured irrigation facilities and favorable soil and climate conditions. Hence, promotion of this variety in Mysuru district of Karnataka will certainly improve the soil fertility, nutritive status and also increase the farmer's economy.

MATERIALS AND METHODS

Introduction of high yielding variety Arka Mangala was applied approach to dissemination of proven technologies at farmer's fields along with the package of practice and new technologies with better use of locally available resources to increase the productivity, production and income and also construct the bridge between gap in the productivity (Sarada and Hari Prasad, 2020). The variety Arka Mangala which was released from ICAR- Indian Institute of Horticulture Research (ICAR-IIHR), Bangalore was taken for study. To mitigate the problems faced by farmers in cultivation of Yard long bean crop, integrated crop production approach could be followed in Yard long bean and was conducted by ICAR JSS KVK, Mysuru during Kharif 2023, in ten farmer's field of Mysuru district. The variety was grown in 0.5 ha area each farmer with integrated management practices and the farmers practices i.e. traditionally grown in 0.5 ha area for comparison. The integrated management practices consisting ofseed treatment with *Rhizobium*, use of FYM 25 t/ha along with recommended fertilizers 93:75:105 NPK Kg/ha and foliar spray of Arka vegetable special micronutrient formulation (5 g/L) along with one shampoo sachet and two medium sized lemons, was sprayed uniformly on entire crop canopy at 30 and 60 days after sowing (*Anonymous*. 2022).The details of the experiments are given in Table 1. The experiment was evaluated by considering the parameters like days taken to first harvest from sowing, pod length, pod girth, number of pods per plant, pod yield per plant, yield per hector and cost incurred in the production.

At the time of harvest, data were collected from both treatments and practices. At the end, cost of cultivation, net income and cost benefit ratio were calculated. An average of cost of cultivation, yield and net returns of different farmers was analyzed by below mentioned formula.

$$\text{Average} = \frac{(F1+F2+F3+F4+F5+F6+F7+F8+F9+F10)}{N}$$

Where,

F= Farmer

N= Number of farmers

In the present study, technology index was defined as the technical feasibility obtained due to introduction on high yielding Yard long bean variety. To calculate the technology gap, extension gap and technology index following formula used as given by Samui *et al* (2000); Kamal *et al* (2020).

RESULTS AND DISCUSSION

The results showed that there was a significant effect of introduction of new variety over the local variety in increasing the yield of Yard long bean in farmer fields. Adapting new variety, use of balanced fertilizers, proper irrigation methods, weeding and by following integrated pest and disease management farmers can easily get higher yield with good quality.

Days taken to maturity

Maturity days are one of the important criteria in acceptance and cultivation of vegetable crops. The days taken for first harvest from sowing was lower in Arka Mangala (56 days) compared to local variety (71 days), this due to the genetic character of the variety and the same results was found by Nagarajappa *et al* (2018), Ancy *et al* (2024) and Jessy *et al* (2022). This varietal character will help the farmers to get good return within a short period and hence this variety can be consider as early variety of Yard long bean which highly suitable for Mysore District (Table 2).

Pod characteristics

The data related to yield and its attributes were presented in Table 2. The pod quality attributes in relation to yield like pod length, pod girth and number of pods per plants were considered for the evaluation. With respect to pod length, the highest pod length (76 cm) was recorded in the variety Arka Mangala compare to local variety (62 cm). The maximum pod girth (3.2 cm) and highest number of pods per plant (42) were observed in Arka Mangala when compared with local variety 2.6 cm and 32 respectively. The similar results were recorded with respect to variation in pod length and girth was reported by Saurabh *et al* (2018), Sarada and HariPrasad (2020).

Yield characteristics

Varietal yield is the most important character to be considered for selection and cultivation of any crops specific to a particular region. In the present study, The maximum yield per plant (790 g) and per ha (14.1 t) were recorded in Arka Mangal compared to local variety 570 g/plant and 8.9 t/ha (Table 2). The maximum yield observed in Arka Mangala is may be due to more number of pods per plant, maximum length of the pod, pod girth and pod weight. The results are in agreed with the findings of Varghese and Celine (2015) and Sarada and Hari Prasad (2020). The percentage increase in the yield of introduced variety of Yard long bean was 36.87 % more than local variety due to adaption of improved cultivation practices and integrated pest and diseases management. Mean while, the cost of cultivation was found more under farmers practices i.e. Rs.1,86,800/ha when compared to Arka Mangala (Rs. 1,81,500/ha). The gross return, net return and benefit cost ratio was found the maximum in Arka Mangala Rs 5,64,000 /ha, Rs 3,82,500 /ha and 1:3.10 respectively, lower in gross return, net return and benefit cost ratio was found in farmers practice Rs 3,56,000 /ha, Rs 1,69,200 /ha and 1:1.90 respectively. The introduction of new technologies along with crop specific scientific package of practices will help to increase the yield and net returns of the farmers. The similar results with respect to superiority of package of practices under introduction of new variety over farmer's practice was reported by Rambabau *et al* (2016) and Saurabh *et al* (2018).

Technological gap

Further we evaluated the technology gap among the farmers in cultivation of yard long bean. The results in relation to technology gap were showed in table 3.Technology gap in the improved variety yield versus potential yield was10.9 t/ha. The technology gap observed in the results may be due to associated with dissimilarity in soil fertility status in farmers field and climatic conditions prevailing during the growing season. In the present experiment the extension gap related yield was5.20 t/ha that indicates there is need to educate the farmers for adaption of improved production technologies to mitigate or reduce the extension gap (Meena *et al,* 2016; Nagarajappa *et al,* 2018).

CONCLUSION

It can be concluded that use of improved method of Yard long bean cultivation can reduced the technology gap to a substantial extent thus leading to increased productivity of Yard long bean in the area.. Cultivation of Yard long bean by following improved technologies has been found more productive and yield might be average increased up to 36.87 per cent. Technology and extension gap extended which can be bridges by popularity package of practices with emphasis of improved variety. Replacement of variety with newly released improved variety will increase the production and net income. Recommended technology was found to be suitable since it fits well to the existing farming situation and also it had been appreciated by the farmers.

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Urine Characterization of Indigenous and Exotic Cows in Rainy, Winter and Summer Season

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An investigation was conducted to characterize the urine of indigenous and exotic cow breeds for various chemical and bio-chemical properties. The study was undertaken in College of Agriculture, Pune, Maharashtra. There were eleven indigenous cow breeds (*Gir, Sahiwal, Red Sindhi, Red Kandhari, Khillar, Konkan Kapila, Tharparkar, Gaolao, Rathi, Deoni* and *Dangi*) and two exotic breeds (*Cross breeds* and *Phule Triveni*) under study. Fresh urine samples during rainy, winter and summer season in 2022-23 were collected and analyzed. The average pH and electrical conductivity was lower by 5.91 and 29.32% in urine of indigenous breeds compared to exotic breeds. The nitrogen in urine varied from 0.37 to 0.46 %.It was higher by 10.86 % in indigenous breeds over exotic breeds. Potassium of urine varied from 0.30 to 0.76% which was higher by 69.24%indigenous breeds over exotic cow breeds. The magnesium content in urine of indigenous cow breeds was lower (7.01 %) over exotic breeds. The sodium in cow urine varied from 1045 to 1503 mg/kg in both breeds. The iron was higher (44.30 %) in urine of indigenous over exotic cow breeds. The manganese, copper and zinc in cow urine ranged from 4.80 to 19.20 mg/kg, 1.53 to 2.42 mg/kg and 2.25 to 3.06 mg/kg, respectively. The average urease activity varied from 16.28 to 19.02 %.

Key Words: Biochemical properties, Chemical properties, Exotic cow, Indigenous cow, Season, Urine.

INTRODUCTION

Cow rising is one of the traditions in Indian culture. From this cow, various products are derived *viz.* milk, ghee, curd, urine dung etc. which are frequently employed in a variety of Ayurvedic compositions. The beneficial effects of cow urine and dung are numerous. They both contribute to the production of insecticides, fungicides, and pesticides. Out of these two, one important product with several applications is 'cow urine'. There are several advantages to cow urine, especially in the field of agriculture. It is notable for its numerous applications, ease of usage, and eco-friendliness. In India, the practice of using cow urine has long been recognized. It has been said that cow pee has countless medicinal benefits and can heal both plants and human so favorite of terminal illnesses.

The urine of cows has long been thought to be a highly helpful bio pesticide and fertilizer in agricultural operations. Its abundance of macro- and micro-nutrients, bactericidal, and preventive qualities help to cleanse the air and increase soil fertility. It is regarded as an option for plant nutrition, metabolic stimulation, and pest and disease management since it is thought to give nutrients to plants at a cheap cost. (Ambigalakshmi *et al,* 2023). Among different organic sources, cow urine is good source of nitrogen, besides, it contains sulphur, phosphate, potassium, sodium, manganese, carbolic acid, iron, silicon, chlorine, salt, enzyme and hormones. It strengthens the fact that cow's urine is not a toxic effluent as 95% of its content being water, 2.5% urea and the remaining 2.5% a mixture of minerals, salts, hormones and enzymes. (Vala and Desai, 2021). Considering the importance of cow

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Table 1. Urine pH and electrical conductivity of indigenous and exotic cows during rainy, winter and summer season.

Sr. No.	Breed	pH				Electrical conductivity (dSm $^{-1}$)			
		Rainy	Winter	Summer	Average	Rainy	Winter	Summer	Average
1	Gir	7.86	8.20	8.42	8.16	22.36	29.54	26.38	26.09
2	Sahiwal	7.43	7.24	7.88	7.52	19.50	20.40	25.85	21.92
3	Red Sindhi	8.56	8.67	8.85	8.69	20.56	27.80	26.70	25.02
4	Red Kandhari	7.68	7.80	8.20	7.89	24.36	28.70	33.60	28.89
5	Khillar	7.61	7.55	7.75	7.64	22.58	25.80	26.60	24.99
6	Konkankapila	7.58	7.85	8.07	7.83	28.36	30.50	34.25	31.04
7	Tharparkar	7.95	8.43	8.75	8.38	23.60	22.40	25.55	23.85
8	Gaolao	7.96	8.74	8.50	8.40	20.60	22.50	24.65	22.58
9	Rathi	7.95	8.05	8.22	8.07	24.30	28.40	27.30	26.67
10	Deoni	8.20	8.68	9.15	8.68	20.36	21.50	24.20	22.02
11	Dangi	7.20	7.53	7.90	7.54	28.90	33.40	28.45	30.25
	Average	7.82	8.07	8.34	-	23.23	26.45	27.59	-
12	Cross Breed	8.69	8.70	9.00	8.80	34.30	33.50	41.25	36.35
13	PhuleTriveni	7.84	8.40	8.85	8.36	35.60	33.80	40.20	36.53
	Average	8.27	8.55	8.93	-	34.95	33.65	40.73	-
	SE (m) $\pm$	0.26	0.36	0.16	-	0.56	0.82	1.92	-
	CD (5%)	0.76	1.04	0.49	-	1.64	2.41	5.61	-

urine especially urine of indigenous cows, the present investigation was planned to evaluate chemical and bio-chemical properties of cow urine.

MATERIALS AND METHODS

The investigation was conducted to characterize the indigenous and exotic cow urine for various chemical and biological properties at Division of Soil Science and Animal Husbandry and Dairy Science, College of Agriculture, Pune (MS) during rainy, winter and summer season of 2022-23.For this purpose, thirteen cow breeds including eleven indigenous (*Gir, Sahiwal, Red Sindhi, Red Kandhari, Khillar, Konkan Kapila, Tharparkar, Gaolao, Rathi, Deoni* and *Dangi*) and two exotic (*Cross breeds* and *Phule Triveni*) breeds were selected.

Fresh cow urine of theses breeds was collected from Division of Animal Husbandry and Dairy Science, College of Agriculture, Pune early in the morning from herd of healthy Indigenous and exotic cows. After wiping faecal matter from the vulva, the cows was stimulated to urinate by stroking the side of the vulva and mid-stream urine was collected from each breed of animal in clean containers. After that it was transferred into well sterile labeled bottles and used for analysis. Urine was collected from same age group of lactating cows and with same feed

RESULTS AND DISCUSSION

The data on pH of cow urine revealed that average pH ranged from 7.20 to 9.15. The pH of indigenous cow ranged from 7.82 to 8.34 while for exotic cows it was 8.27 to 8.93.The significantly higher pH (8.80) was observed for the cross breed. The increasing trend of pH was observed from rainy to summer season. The average electrical conductivity EC of indigenous cows was 23.23 to 27.59 dSm^{-1} while in exotic cows it was 34.95 to 40.73 dSm^{-1}. Lower EC was observed in Sahiwal breed (19.50 dSm^{-1}) while higher was in exotic breed of Phule Triveni (35.60 dSm^{-1}). The

Table 2. Nitrogen and phosphorus in urine of indigenous and exotic cows during rainy, winter and summer season.

Sr. No.	Breed	Nitrogen (%)				Phosphorus (%)			
		Rainy	Winter	Summer	Average	Rainy	Winter	Summer	Average
1	Gir	0.52	0.59	0.62	0.58	0.050	0.038	0.037	0.042
2	Sahiwal	0.48	0.53	0.51	0.51	0.035	0.025	0.023	0.028
3	Red Sindhi	0.45	0.52	0.54	0.50	0.043	0.031	0.033	0.036
4	Red Kandhari	0.39	0.44	0.51	0.45	0.029	0.019	0.023	0.023
5	Khillar	0.35	0.41	0.44	0.40	0.026	0.021	0.022	0.023
6	Konkankapila	0.33	0.37	0.35	0.35	0.083	0.068	0.068	0.073
7	Tharparkar	0.44	0.49	0.48	0.47	0.022	0.014	0.022	0.019
8	Gaolao	0.38	0.42	0.48	0.43	0.026	0.021	0.020	0.022
9	Rathi	0.27	0.34	0.41	0.34	0.116	0.089	0.071	0.092
10	Deoni	0.33	0.37	0.39	0.36	0.038	0.025	0.033	0.032
11	Dangi	0.24	0.28	0.30	0.27	0.034	0.028	0.023	0.028
	Average	0.38	0.43	0.46	-	0.046	0.034	0.034	-
12	Cross Breed	0.34	0.35	0.33	0.34	0.025	0.020	0.018	0.021
13	PhuleTriveni	0.39	0.45	0.43	0.42	0.065	0.052	0.048	0.055
	Average	0.37	0.40	0.38	-	0.045	0.036	0.033	-
	SE (m) $\pm$	0.02	0.023	0.14	-	0.004	0.009	0.006	-
	CD (5%)	0.06	0.067	0.41	-	0.013	0.026	0.019	-

increased electrical conductivity of the cow urine in the summer season may be due to higher accumulation of salts in cow urine due to higher body evaporation. Khushboo *et al* (2021) observed that EC level in the cow urine was significantly lower in winter season than in the summer season. Sakhare *et al* (2022) observed that higher electrical conductivity (20 dS m^{-1}) in cattle urine. The findings in close confirmation to this were also reported by Veeresha *et al* (2013) and Jadhav *et al* (2020).

The nitrogen of indigenous breeds varied from 0.38 to 0.46 % while in exotic breeds, it ranged from 0.37 to 0.40 %. The nitrogen in the cow urine was affected due to season and also breed wise. It was higher in the Gir breed during summer season. This was higher than exotic breeds across the seasons. Variation in the nitrogen content of cow urine may be due to the protein in the diet and rate of metabolism in different breeds varies as per climatic conditions. Jadhav *et al* (2020) reported that nitrogen content in cow urine ranged from 0.55 to 0.83 %. Sakhare *et al* (2022) observed that nitrogen content of cattle urine was 0.50% during application of urine in soil. Sharma *et al* (2020) observed that urea nitrogen and total nitrogen varies from 23-28 ml/kg/day and 40-45 ml/kg/day.

The phosphorus in the cow urine ranged from 0.014 to 0.116 %. Across the season, higher P (0.092 %) was observed in the urine of Rathi breed compared to others. This was recorded higher during rainy season in both indigenous and exotic breeds. Cow urine source of macro micro and has disinfectant properties to purify the atmosphere and improve soil fertility. Cow urine therefore could be an effective tool to address multi nutrient deficiency in most of the soils (Pathak and Ram 2013).The potassium in cow urine varied from 0.14 to 1.33 %. Significantly higher potassium (0.91%) was observed in Gir cow which was at par with Sahiwal (0.82%) and Deoni (0.80 %).

Table 3. Potassium and sodium in urine of indigenous and exotic cows during rainy, winter and summer season.

Sr. No.	Breed	Potassium (%)				Sodium (mg/kg)			
		Rainy	Winter	Summer	Average	Rainy	Winter	Summer	Average
1	Gir	0.91	1.15	1.33	1.13	1750	1240	1740	1577
2	Sahiwal	0.82	1.05	0.84	0.90	1422	1647	1795	1621
3	Red Sindhi	0.44	0.55	0.86	0.62	1415	1536	1848	1600
4	Red Kandhari	0.36	0.48	0.45	0.43	1004	1142	1234	1127
5	Khillar	0.58	0.78	0.40	0.59	806	1000	1100	969
6	Konkankapila	0.34	0.42	0.24	0.33	398	405	521	441
7	Tharparkar	0.55	0.77	0.38	0.57	724	856	850	810
8	Gaolao	0.56	0.72	0.44	0.57	1134	1402	1521	1352
9	Rathi	0.46	0.57	0.38	0.47	1700	1954	1968	1874
10	Deoni	0.80	1.02	0.45	0.76	435	504	614	518
11	Dangi	0.61	0.79	0.51	0.64	703	769	805	759
	Average	0.58	0.76	0.57	-	1045	1132	1272	-
12	Cross Breed	0.14	0.20	0.20	0.18	1205	1341	1570	1372
13	PhuleTriveni	0.58	0.74	0.39	0.57	1319	1245	1435	1333
	Average	0.36	0.47	0.30	-	1262	1293	1503	-
	SE (m) ±	0.04	0.035	0.06	-	84.83	39.54	56.01	-
	CD (5%)	0.12	0.101	0.172	-	247.13	115.20	163.14	-

Table 4. Per cent high or lowcontent in chemical properties and nutrients of indigenous cows over exotic cow urine.

Sr No	Parameter	Low/High (%)
1	pH	-5.91
2	EC	-29.32
3	Nitrogen	10.86
4	Phosphorus	0.25
5	Potassium	69.24
6	Calcium	49.98
7	Magnesium	-7.01
8	Sodium	14.93
9	Iron	44.30
10	Manganese	15.73
11	Copper	1.27
12	Zinc	25.22

Table 5. Calcium and magnesium in urine of indigenous and exotic cows during rainy, winter and summer season.

Sr. No.	Breed	Calcium (mg/kg)				Magnesium (mg/kg)			
		Rainy	Winter	Summer	Average	Rainy	Winter	Summer	Average
1	Gir	521	407	240	389	220	140	154	171
2	Sahiwal	594	400	150	381	320	310	235	288
3	Red Sindhi	550	486	504	513	110	205	311	209
4	Red Kandhari	430	321	341	364	206	Traces	115	161
5	Khillar	220	204	110	178	306	115	143	188
6	Konkan kapila	304	333	Traces	319	Traces	416	317	367
7	Tharparkar	360	200	Traces	280	102	207	234	181
8	Gaolao	198	257	364	273	106	Traces	Traces	106
9	Rathi	403	300	Traces	352	211	105	314	210
10	Deoni	399	Traces	Traces	399	217	136	115	156
11	Dangi	200	364	300	288	Traces	123	152	138
	Average	379	327	287	-	200	195	209	-
12	Cross Breed	111	310	170	194	123	245	287	218
13	Phule Triveni	204	308	110	205	113	304	227	215
	Average	157	309	140	-	118	275	257	-
	SE (m) $\pm$	3.12	2.68	1.82		4.52	3.59	2.71	
	CD (5%)	10.59	6.94	3.51		12.91	10.20	6.05	

Ramani *et al* (2012) reported potassium 7.55 g/L and sodium 1.06 g/L in milch cow urine. Across the season, average sodium was observed from 441 mg/kg (*Konkan Kapila*) to 1874 mg/kg (Rathi). Higher sodium (1272 mg/kg) was recorded in the summer season over other seasons. These findings are in close confirmatory to the finding reported by Saunders (1982), Ramani *et al* (2012), Gulhane *et al* (2017) and Sharma and Kumar (2020).

From the overall study of urine characterization of indigenous and exotic cow revealed that the pH, electrical conductivity and magnesium were lower by 5.91, 2932 and 7.01 per cent, respectively. While nitrogen, phosphorus, potassium, calcium, sodium, iron, manganese, copper and zinc were higher by 10.86, 0.25, 69.24, 49.98, 14.93, 44.30, 15.73, 1.27 and 25.22 percent compared to exotic breeds of cow. Therefore, the use of indigenous cow urine in agriculture is having prime importance.

The data revealed that the calcium in the cow urine varied from traces to 594 mg/kg. High calcium was reported in the urine of Red Sindhi breed over other. Average calcium varied from traces to 513 mg/kg. Across the seasons, higher calcium was observed in rainy season (379 mg/kg). Parihar *et al* (2004) reported that higher level of calcium in non-descript cows urine compared to crossbreed cow. The magnesium in various cow breeds ranged from 106 to 367 mg/kg.

Table 6. Iron and Manganese in urine of indigenous and exotic cows during rainy, winter and summer season.

Sr. No.	Breed	Iron (mg/kg)				Manganese (mg/kg)			
		Rainy	Winter	Summer	Average	Rainy	Winter	Summer	Average
1	Gir	30.00	29.71	43.65	34.45	10.30	12.30	19.20	13.93
2	Sahiwal	17.67	16.66	31.45	21.93	9.50	10.00	15.30	11.60
3	Red Sindhi	24.33	23.77	20.44	22.85	11.04	12.40	11.07	11.50
4	Red Kandhari	10.00	9.21	12.58	10.60	8.70	8.00	9.10	8.60
5	Khillar	8.00	7.78	7.55	7.78	7.80	9.51	14.30	10.54
6	Konkan kapila	34.67	33.34	44.10	37.37	10.55	13.02	17.30	13.62
7	Tharparkar	24.00	23.39	26.06	24.48	7.80	8.00	10.40	8.73
8	Gaolao	25.00	24.60	20.44	23.35	10.09	14.33	13.20	12.54
9	Rathi	24.00	23.86	26.30	24.72	5.90	7.00	11.37	8.09
10	Deoni	9.67	9.21	9.30	9.39	6.50	7.49	8.94	7.64
11	Dangi	10.67	11.28	13.16	11.70	4.80	5.61	10.06	6.82
	Average	19.82	19.35	23.18	-	8.45	9.79	12.75	-
12	Cross Breed	12.67	12.21	14.30	13.06	7.70	9.21	10.70	9.20
13	Phule Triveni	16.67	15.87	14.70	15.75	8.50	8.00	9.44	8.65
	Average	14.67	14.04	14.50	-	8.10	8.61	10.07	-
	SE (m) $\pm$	1.42	1.55	1.77	-	0.42	0.71	0.66	-
	CD (5%)	4.08	4.53	5.17	-	1.25	2.09	1.95	-

The study on the iron of cow urine indicated variation from 7.55 to 44.10 mg/kg. Average iron in the urine of indigenous cows was 19.82 mg/kg while in urine of exotic cows was 14.67mg/kg. In Konkan kapila, iron was higher in all the three seasons under study compared to other breeds. The range of manganese varied from 4.80 to 19.20 mg/kg. The results are in close confirmatory to Ramani *et al* (2012) and Sakhare *et al* (2022).

The copper content across the seasons, varied from 1.44 to 2.40 mg/kg. Among all the breeds, Dangi urine recorded higher copper (3.17 mg/kg) over other breeds. During all the three seasons, higher copper was observed in summer season and higher in exotic breeds. The average zinc in cow urine ranged from 2.00 to 4.05 mg/kg. The average zinc in indigenous and exotic breeds was 2.96 and 2.37 mg/kg. Parihar *et al* (2004) also reported higher levels of zinc, magnesium, potassium and calcium in non-descript cow urine compared to crossbred cows.

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Table 7. Copper and zinc in urine of indigenous and exotic cows during rainy, winter and summer season.

Sr. No.	Breed	Copper (mg/kg)				Zinc (mg/kg)			
		Rainy	Winter	Summer	Average	Rainy	Winter	Summer	Average
1	Gir	1.74	1.40	1.54	1.56	3.56	3.75	4.05	3.79
2	Sahiwal	1.33	1.20	2.00	1.51	2.57	3.20	3.44	3.07
3	Red Sindhi	2.01	2.08	2.11	2.07	2.70	2.90	3.05	2.88
4	Red Kandhari	1.90	1.83	1.94	1.89	2.43	2.80	2.56	2.60
5	Khillar	1.46	1.60	2.00	1.69	2.57	2.70	2.48	2.58
6	Konkan kapila	1.60	1.90	2.46	1.99	2.70	2.90	3.04	2.88
7	Tharparkar	1.70	2.00	3.50	2.40	2.37	2.10	2.55	2.34
8	Gaolao	1.07	1.27	2.00	1.44	2.43	2.77	2.94	2.71
9	Rathi	1.23	1.80	2.44	1.82	2.60	2.73	2.00	2.44
10	Deoni	1.29	1.60	2.00	1.63	2.67	3.70	3.60	3.32
11	Dangi	3.10	3.40	3.00	3.17	3.25	4.05	4.00	3.77
	Average	1.68	1.83	2.27	-	2.71	3.05	3.06	-
12	Cross Breed	1.33	1.50	2.00	1.61	2.53	2.40	2.44	2.46
13	Phule Triveni	1.73	2.00	2.84	2.19	2.33	2.10	2.30	2.24
	Average	1.53	1.75	2.42	-	2.43	2.25	2.37	-
	SE (m) ±	0.10	0.09	0.16	-	0.22	0.13	0.20	-
	CD (5%)	0.27	0.23	0.46	-	0.65	0.39	0.58	-

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Working Environment of Employees of Dairy Cooperative Society of Wayanad

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The study conducted in the Wayanad district of Kerala in 2023-24 focused on the working environment of employees of the dairy cooperative society (DCS). The sample consisted of 120 employees from 30 DCSs. The working environment was evaluated based on factors like people's participation, teamwork, job satisfaction, workload, and job stress. The findings revealed that over 60.837 of respondents were satisfied with the farmers' efforts in implementing extension programs, their interest in extension work, acceptance of technology, and local responses. Regarding teamwork, most respondents felt confident in the delegated authority, mutual desire to give and take, appreciated their colleagues' attitudes, and found the procedural design conducive to working together. In terms of job satisfaction, the majority were content with their professional social prestige, followed by the facilities provided by DCS, job authority, leave facilities, service security and overall job facilities. Job stress sources such as helping others, crowded work areas, subpar working conditions compared to others, and the job being too easy were not significant stressors for most respondents. Significant positive relationships were observed between satisfaction with people's participation and teamwork, teamwork, and job satisfaction, as well as between job stress and workload.

Key Words: Dairy cooperative society, Employees, Job Satisfaction, Job stress, Teamwork, Working environment, Workload.

INTRODUCTION

The organization has a responsibility to create a supportive and fulfilling environment where employees can achieve overall job satisfaction and contribute to the organization's goals. Key factors influencing employee motivation include job characteristics, management practices, employee traits, and broader environmental conditions (Devadass, 2011). The working environment refers to the setting in which individuals perform their jobs. It includes the physical surroundings, the nature of the job itself (such as workload and task complexity), broader organizational characteristics, and external business factors (Jain and Kaur, 2014).

Dairy cooperative societies exemplify a distinctive and influential model within the agricultural and dairy industries. These cooperatives were created to enhance the dairy sector and meet local demand. In a dairy cooperative, local farmers combine their resources, including milk production and expertise, to create a unified organization. This collaborative approach enables them to address individual challenges and jointly invest in infrastructure, technology, and marketing initiatives. The cooperative model prioritizes community-driven decision-making, ensuring that the farmers' interests are paramount (Kujur and Bashir, 2024). In India, the dairy industry is expanding not only to increase milk production but also to provide stable employment opportunities for rural communities (Sonkamble *et al*, 2021). Key aspects of dairy cooperative societies encompass joint ownership, equitable profit sharing, and a focus on improving the overall well-being of member farmers, particularly women (Asha *et al*, 2021).

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Table 1. Satisfaction with people's participation.

Sr. No.	Statement	Satisfied		Somewhat satisfied		Not satisfied	
		F	%	F	%	F	%
1.	Efforts in implementation of extension programs for the farmers	62	51.67	44	36.67	14	11.67
2.	Interest of farmers in extension work	49	40.83	59	49.17	12	10.00
3.	Farmers acceptance of technology	37	30.83	68	56.67	15	12.50
4.	Availability of local response	45	37.50	63	52.00	12	10.00
5.	Voluntary participation of farmers	46	38.33	66	55.00	8	6.67
6.	Financial and other help for farmers	43	35.83	73	60.83	4	3.33

Table 2. Satisfaction with team work.

Sr. No.	Statement	Satisfied		Somewhat satisfied		Not satisfied	
		F	%	F	%	F	%
1.	Confidence in delegated authority	81	67.50	32	26.67	7	5.83
2.	Mutual desire to give and take	73	60.83	42	35.00	5	4.17
3.	Appreciative attitude of colleagues	72	60.00	43	35.83	5	4.17
4.	Procedural design to work together	70	58.33	46	38.33	4	3.33
5.	Proper incentive for team work	67	55.83	41	34.17	12	10.00

MATERIALS AND METHODS

The study was conducted in DCSs of Wayanad district of Kerala in the year 2023-24. Wayanad, a picturesque district in Kerala, is renowned for its lush landscapes and vibrant agricultural activities. Among its diverse agricultural practices, dairy farming holds a significant place, with dairy cooperative societies playing a crucial role in the sector's development. Out of 57 DCSs, 30 DCSs were randomly selected for the study. From each 30 DCSs, four employees were selected using stratified sampling methods for the study. A total of 120 employees formed the sample for the study. The working environment of employees at DCS was evaluated through factors such as people's participation, teamwork, job satisfaction, workload, and job stress. Data collection was conducted using a well-structured and pre-tested interview schedule.

RESULTS AND DISCUSSION

The level of satisfaction in people's participation was examined and found that more than 40.00 per cent of the respondents were satisfied with the effort in the implementation of extension programme for the farmers and the interest of farmers in extension work. 60.83 per cent of the respondents were somewhat satisfied with the financial and other help from farmers and farmers' acceptance of technology (56.67 %). Most of the employees of DCS were somewhat satisfied with the peoples' participation which shows that employees have somewhat better support from the farmers and can do their duties satisfactorily. The employees have somewhat better working environment as far as people's participation is concerned.

Most of the respondents were satisfied with confidence in delegated authority (67.50 %), mutual desire to give and take (60.83 %), an appreciative attitude of colleagues (60 %) and procedural design to work together (58.33 %) as mentioned in Table 2.

Team Work

According to the European Foundation (2007), team performance exceeds individual

Table 3. Work load.

Sr. No.	Sub-components of work load	Heavy		Optimum		Light	
		F	%	F	%	F	%
1.	Fieldwork	10	8.33	51	42.50	59	49.17
2.	Office and clerical work	8	6.67	58	48.44	54	45.00

Table 4. Job Satisfaction.

Sr. No.	Statements	Satisfied		Somewhat satisfied		Not satisfied	
		F	%	F	%	F	%
1.	Professional social prestige	85	70.83	31	25.83	4	3.33
2.	Promotion	66	55.00	40	33.33	14	11.67
3.	Salary	47	39.17	39	32.50	34	28.33
4.	Incentives and rewards	45	37.50	62	51.67	13	10.83
5.	Facilities provided by DCS	75	62.50	39	32.50	6	5.00
6.	Job authority	74	61.67	39	32.50	7	5.83
7.	Service security	73	60.83	39	32.50	8	6.67
8.	Work distribution	63	52.50	50	41.67	7	5.83
9.	Service rules	66	55.00	45	37.50	9	7.50
10.	Allowances like PF, pension etc.	72	60.00	38	31.67	10	8.33
11.	Leave facility	73	60.83	40	33.33	7	5.83

performance, particularly in tasks that demand extensive knowledge, judgment, and varied perspectives. Additionally, teamwork fosters notable increases in productivity in fields that necessitate creative problem-solving, high adaptability, and effective operational management. It also fosters an environment conducive to knowledge and information exchange, often referred to as knowledge sharing. Ralea (2011) suggested that teamwork can lead to greater individual success within an organization and emphasized the importance of effective leadership in fostering strong teamwork.

The value of job satisfaction of employees of DCS indicated that more than 50.00 per cent of respondents were satisfied almost in all aspects except incentives rewards and salary. It was seen that 70.83 per cent of respondents were satisfied with professional social prestige followed by facilities provided by DCS (62.50 %), 61.67 per cent with job authority, and 60.83 per cent with leave facilities. This shows the working environment of DCS and job satisfaction is good among the employees of DCS. It was also found that more than 30.00 per cent of employees were somewhat satisfied with their job satisfaction and it was also found that 28. 33 per cent of employees were not satisfied with their salary.

Job Satisfaction

Job satisfaction refers to the extent to which an individual is content with their current employment (Berber et al, 2022). It refers to the emotional state that results from an employee's belief that their work is meaningful (Erarslan, 2020). Alkahtani *et al* (2021) Indicated that employees with high job satisfaction levels demonstrate a greater degree of organizational commitment and dedication to their work. Job satisfaction plays a crucial role in long-term productivity. It is imperative to implement strategies that include appropriate rewards and enhanced opportunities for promotion. These measures are essential for enabling employees to fulfil their duties with optimal job satisfaction (Meena and Singh, 2003).

Table 5. Job Stress.

Sr. No.	Statement	Not a source of stress		Sometimes a source of stress		Always a source of stress	
		F	%	F	%	F	%
1	I work on my unnecessary job activities	69	57.50	45	37.50	6	5.00
2.	My job activities are unclear to me	96	80.00	23	19.17	1	0.83
3.	To keep up with my job, I usually take home, work with me.	100	83.33	16	13.33	4	3.33
4.	My job is boring	101	84.17	16	13.33	3	2.50
5.	I am responsible for people	99	82.50	18	15.00	3	2.50
6.	My work area (office) is too crowded	86	71.67	24	20.00	10	8.33
7.	I do not have the authority to do my job well	104	86.67	15	12.50	1	0.83
8.	My job is too difficult	95	79.17	18	15.00	7	5.83
9.	My job has become too routine	83	69.17	31	25.83	6	5.00
10.	There is not enough time in the day to do my job	89	74.17	22	18.33	9	7.50
11.	Work condition of my job is below satisfactory	81	67.50	28	23.33	11	9.17
12..	I received conflicting requests from two or more people	84	70.00	30	25.00	6	5.00
13..	I am not sure what is expected of me	86	71.67	31	25.83	3	2.50
14.	I am responsible for too many jobs	75	62.50	40	33.33	5	4.17
15.	My job is too easy	76	63.33	33	27.50	11	9.17
16.	I am responsible for helping others	99	82.50	13	10.83	8	6.67
17.	I do not have time to take an occasional break from the job	78	65.00	30	25.00	12	10.00
18.	My working conditions are not as good as the working conditions of others	76	63.33	33	27.50	11	9.17

Job Stress

In assessing job stress among the employees' various factors were considered. These included workload perceptions such as taking work home, clarity of job activities, the perception of job difficulty and routine, and environmental factors like crowded workspaces. The study found that more than 60.00 per cent of respondents did not find their job as a source of stress. 37.50 per cent of respondents found unnecessary job activities as sometimes a source of stress. Less than 7.00 per cent of respondents found their working environment as always, a source of stress (Table 5).

Interrelationship between factors of working environment of employees of DCS

The interrelationships between various factors of the working environment among employees of DCS were analysed using correlation coefficients. The findings revealed significant positive correlations between satisfaction with people's participation and both team work ($r = 0.5447$, $p < 0.001$) and job satisfaction ($r = 0.4855$, $p < 0.001$). Additionally, team work showed a strong positive correlation with job satisfaction ($r = 0.6363$, $p < 0.001$).

Table 6. Interrelationship between factors of working environment.

Factors of working environment	Satisfaction with people's participation	Team Work	Satisfaction with job	Job stress	Work Load
Satisfaction with people's participation	1.0000				
Team Work	0.5447***	1.0000			
Satisfaction with job	0.4855***	0.6363***	1,0000		
Job stress	-0.0035^{NS}	-0.0669^{NS}	-0.2619**	1.0000	
Work Load	-0.1193^{NS}	-0.2081*	-0.4579***	0.1852*	1.0000

In contrast, job stress did not show significant correlations with satisfaction with people's participation ($r = -0.0035$, $p > 0.05$) or team work ($r = -0.0669$, $p > 0.05$). However, it exhibited a moderate negative correlation with job satisfaction ($r = -0.2619$, $p < 0.01$), indicating that higher job stress levels were associated with lower job satisfaction.

Furthermore, work load demonstrated a significant negative correlation with job satisfaction ($r = -0.4579$, $p < 0.001$) and a weak positive correlation with job stress ($r = 0.1852$, $p < 0.05$), suggesting that higher workloads were linked to lower job satisfaction and slightly elevated job stress levels.

These results underscored the complex interplay between different aspects of the working environment and their impact on job satisfaction and stress levels among subject matter specialists in the agricultural sector.

CONCLUSION

The study revealed that DCS employees generally experience a supportive working environment, with significant satisfaction in extension program efforts (51.67 %), teamwork (67.50 % confidence in delegated authority), and optimal workload perception (48.44 % office, 42.50 % field). Over 50 per cent are satisfied with job aspects like professional prestige (70.83 %) and facilities (62.50 %), though incentives (37.50 %) and salary (39.17 %) satisfaction are lower. More than 60 per cent do not find their job stressful, though some stress is noted from unclear activities (19.17 %) and taking work home (13.33 %). Positive correlations exist between people's participation, teamwork, and job satisfaction, while job stress and workload negatively impact job satisfaction.

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Yield and Economics of Brahmi Crop under Natural Farming

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An experiment was carried out in Medicinal Plants Research and Development Centre (MRDC) of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, District Udham Singh Nagar, India, during *Kharif* season to study the response of *Jeevamrit* on yield and economics of brahmi crop (*Bacopa monneri* L. var. CIM- Jagriti). The soil of experimental plot was sandy clay loam in texture, having pH 6.9, and medium in organic carbon (0.64%. The available nitrogen, phosphorus and potassium are 180.78 kg N/ha, 20.14 kg P_2O_5/ha, and 200.64 kg K_2O/ha,respectively. The experiment was laid out in randomized block design (RBD) having ten treatments with three replications. The treatments comprises with different rates of *Jeevamrit*, Farmyard manure (FYM) and vermicompost. Among all the treatments*, treatment comprises with Jeevamrit @* 5000 l/ha gave maximum return on investment as compared to other treatments.

Key Words: Brahmi, Economics, Farmyard manure, *Jeevamrit*, Vermicompost.

INTRODUCTION

Brahmi (Bacopa monnieri L.) which is also known as jalnimba or water hyssop belongs to family Scrophulariaceae. The genus has great diversity and found in warmer region of the world which includes more than 100 aquatic species. Brahmi *have great medicinal value and* used in various pharmacological/ Ayurvedic preparations for the treatment of bronchitis, diarrhea, joint pain relive and mostly as memory enhancer. The crop is used as raw in many herbal preparations, so the chemical residue free production of brahmi is very important for the health point of view. But the production under organic nutrient management is very costly, thus we need to develop low cost investment production under organic farming system. The agro chemicals used in modern agriculture like fertilizers, herbicides and pesticides are so expensive and cause ill effects on soil and human health. Presently, the sustainability of agriculture system is worldwide concern and there is a need to develop practices which are eco friendly, less expensive and easy to use. Under organic farming *Jeevamrit* is one of the emerging organic bio enhancer which is now a day's called natural farming component. *Jeevamrit* is the consortia of micro organism which multiply in soil and convert unavailable nutrients to available form. Large number of farmers doing farming using *Jeevamrit* as it is easy to prepare and use. According to Reddy (2008) *Jeevamrit* can be used as bio enhancer as it supplement the essential plant nutrients and maintain soil fertility in economically and eco-friendly manner. Therefore, keeping these facts in view, an experiment was conducted to study the effect of *jeevamit* on yield and economics of Brahmi crop under tarai region of Uttarakhand.

MATERIAL AND METHODS

The experiment was carried out in research centre of medicinal plant at G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India. The experiment was consisting of 10 treatments replicated thrice in Randomized Block Design (RBD). Each plot of experiment was 4 m long and 3 m wide having 12 m^2 area. The buffer channel of 120 cm was kept after each replication which was also used as irrigation channel. For one hectare land 375 kg cuttings of brahmi variety CIM- Jagriti were used.

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Treatment	Detail of treatment
T_1	RDF (100:60:40) kg/ha
T_2	*Jeevamrit* 500 l/ha
T_3	*Jeevamrit* 1000 l/ha
T_4	*Jeevamrit* 2000 l/ha
T_5	*Jeevamrit* 3000 l/ha
T_6	*Jeevamrit* 4000 l/ha
T_7	*Jeevamrit* 5000 l/ha
T_8	Vermicompost (VC) 10 t/ha
T_9	Farmyard manure (FYM)20 t/ha
T_{10}	VC 5 t + FYM 10 t/ha

5 cm long cuttings having 2-3 nodes were planted at a spacing of 20 × 10 cm row to row and plant to plant respectively, at 5 cm depth. In morning hours' planting was done manually and after planting water was applied for proper establishment of crop.

In plots where FYM and vermicompost was treatments, FYM and Vermicompost was applied fifteen days before planting of cuttings and calculations of dose was based on recommended dose of fertilizers. The interpretation and calculations of data was done using standard procedures of statistics (Snedecor and Cochran, 1967). The details of treatments were as follow.

Prepration of *Jeevamrit* and its application

For the prepration of 200 l *Jeevamrit*, used 10 kg fresh desi cow dung, 5 l desi cow urine, 2 kg jiggery, 2 kg mxed dal flour and 200 g forest virgin soil where no chemical was applied before. All the ingredients were mixed in 200 l water and stir morning and evening hours with wooden stick in clockwise direction. After stir container was covered with gunny bag so that after fermentation, gasses may escape easily. As the fermentation proceeds, within 3-4 days pungent gasses formed in the container we filtered the *Jeevamrit* and sprayed on crop after irrigation at 30 days interval. First spray was applied third day after planting. Total four sprays were provided during the crop growth period up to harvest.

RESULTS AND DISCUSSION

Yield

The treatment T_7gave highest fresh biomass yield (216.69 q/ha) followed by treatment T_8 (207.84 q/ha). Significantly highest yield was observed in treatment T_7 over all the treatments T_6 and T_8, which was otherwise *on a par*. Treatment T_2 gave lowest fresh biomass yield. In case of dry biomass yield, similar trend was observed as of fresh biomass yield. Treatment T_7 had significantly highest dry biomass (43.89 q/ha) compared to all the treatments except treatment T_6, T_8 and T_{10} which was otherwise *on a par*. Treatment, T_8 and T_6 were equally effective and gave similar results, both the treatments were performed better over lower rates of *Jeevamrit* except RDF which were otherwise *on a par*. Combine application of vermicompost and FYM gave better results compared to RDF, FYM alone and lower rates of *Jeevamrit*.

Economics

The lowest cost of production was recorded in treatment T_2, followed by T_3 and T_4. While the highest cost of production was recorded with treatment T_8, where vermicompost was used followed by T_{10} and T_9, respectively. In general the gross return was higher in *Jeevamrit* treatments and maximum gross return was found in treatment T_7 (Rs. 94.39 lakh), followed by T_8 (Rs. 41.97 lakh). Treatment T_{10} also gave good gross return as compare to lower rates of *Jeevamrit*. In case of net return, treatment T_7 gave highest net return (Rs. 31.70 lakh), followed by T_6 (Fig.1). The lowest net return was received in minimum rate of *Jeevamrit* (T_2). The treatment consist of *Jeevamrit* 5000 l/ha gave highest benefit-cost ratio (2.60), followed by *Jeevamrit* 4000 l/ha (2.43) and RDF (2.20). Among organic treatments the treatment consist of VC 10 t/ha gave highest benefit cost ratio (1.61) followed by vermicompost 5 t/ha + FYM 10 t/ha

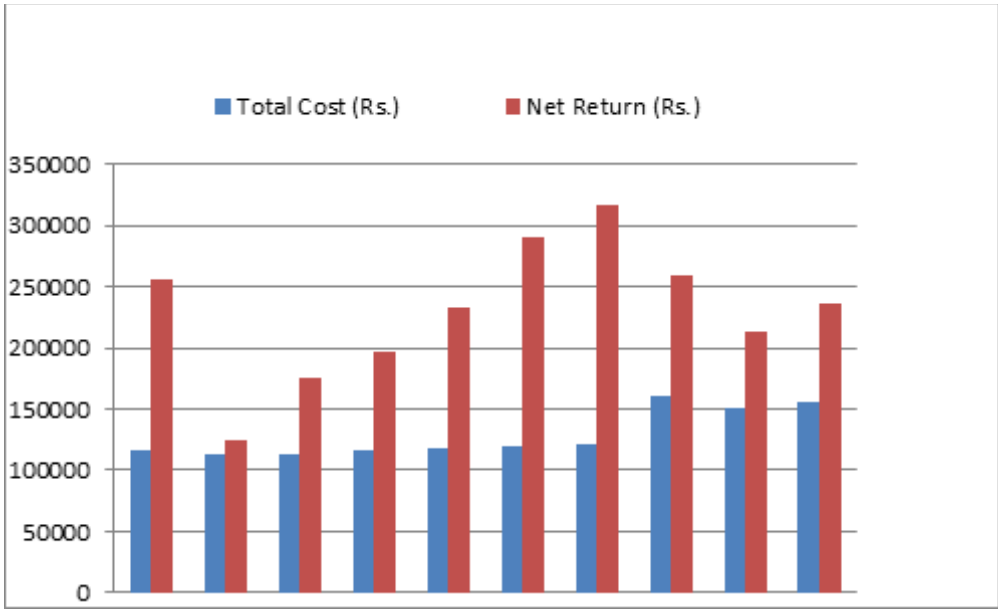

Fig. 1 Total cost and Net return as influenced by the different treatments

Table 1 Yield and economics of brahmi under natural farming

Treatment	Fresh biomass yield (q/ha)	Dry biomass yield (q/ha)	Total cost (Rs. in lakh)	Gross return (Rs. in lakh)	Net return (Rs. in lakh)	B-C Ratios
T_1: RDF (100:60:40) kg/ha	186.10	37.25	11.65	37.25	25.60	2.20
T_2: *Jeevamrit* 500 l/ha	126.68	23.80	11.30	23.79	12.50	1.11
T_3: *Jeevamrit* 1000 l/ha	148.93	28.94	11.39	28.94	17.55	1.54
T_4: *Jeevamrit* 2000 l/ha	157.00	31.31	11.59	31.31	19.72	1.70
T_5 : *Jeevamrit* 3000 l/ha	169.69	35.05	11.79	35.05	23.26	1.97
T_6 : *Jeevamrit* 4000 l/ha	205.31	41.07	11.99	41.06	29.08	2.43
T_7: *Jeevamrit* 5000 l/ha	216.69	43.89	12.18	43.88	31.70	2.60
T_8 : Vermicompost (VC)10 t/ha	207.84	41.98	16.06	41.97	25.91	1.61
T_9 : Farmyard manure (FYM)20 t/ha	185.25	36.44	15.06	36.44	21.38	1.42
T_{10} : VC 5 t/ha + FYM 10 t/ha	195.30	39.12	15.56	39.12	23.56	1.51
S.Em±	4.76	2.00	-	-	-	-
CD $_{(5\%)}$	14.16	5.95	-	-	-	-

(1.51) and FYM 20 t/ha (1.42). The lowest benefit-cost ratio was recorded with treatments consisting of lower rates of *Jeevamrit* application.

With the increase in *Jeevamrit* rate the fresh biomass yield of the crop was also increased. Similarly Vermicompost also perform better and produce equal harvest as higher rate of *Jeevamrit* application. According to Sundararaman *et al (*2001) cow products have capacity to revert the flow of cosmic energy into revitalize growth process. *Jeevamrit* has the capacity to increase the microbial population which converts the unavailable form of nutrients to available form which help in plant growth and development. *Jeevamrit* also contain many vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms (Devakumar *et al*, 2008 and Tharmaraj *et al*, 2011) which ultimately promote plant growth. Better plant growth leads to more photosynthesis area and more photosynthesis leads to more dry matter accumulation which ultimately leads to more

biomass production. Similar findings were also reported by Kumawat *et al* (2010) and Sharma *et al* (2010).

The organic sources were more costly, consequently the net returns obtained from them were very less as compare to *Jeevamrit* and RDF. The preparation cost of *Jeevamrit* was negligible as a result, the total cost of the *Jeevamrit* treatments was much lower than the other treatments which lead to increase in net return and consequently benefits- cost ratio was increased. On the other hand, chemical fertilizers gave good amount of gross return which also gave higher benefits- cost ratio.

CONCLUSION

Organic sources are costly and bulky in nature whose availability is neither feasible nor possible. On the other hand bio-enhancer like *Jeevamrit* are prepared by using locally available resources which make them cost efficient, moreover *Jeevamrit* is eco-friendly and increase soil biodiversity by multiplying soil micro flora. *Jeevamrit* also gave good amount of return on as compare to fertilizer and organic manures. Thus by the use of *Jeevamrit* @ 4000 l/ha farmer can earn good amount of money.

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Yield and Quality Improvement of Fodder Cowpea through Zinc Foliar Nutrition

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A field experiment was conducted with the objective of assessing yield and quality of fodder cowpea by supplementing zinc through foliar nutrition in randomized block design with eight treatments and three replications. The treatments were T_1 (100% RDF), T_2 (75% RDF), T_3 (T_1 + zinc @ 0.25% as foliar spray at 20 DAS), T_4 (T_1 + boron @ 0.25% as foliar spray at 20 DAS), T_5 (T_1 + boron @ 0.125% + zinc @ 0.125% as foliar spray at 20 DAS), T_6 (T_2 + zinc @ 0.25% as foliar spray @ 20 DAS), T_7 (T_2 + boron @ 0.25% as foliar spray @ 20 DAS) and T_8 (T_2 + boron @ 0.125% + zinc @ 0.125% as foliar spray at 20 DAS). The results revealed that for augmented yield and quality of fodder cowpea in sandy loam soils has to be supplied with FYM @ 10 t/ha as basal dose along with N, P_2O_5 and K_2O @ 25:60:30 kg/ha along with foliar application of zinc sulphate heptahydrate @ 0.25 percent at 20 days after sowing.

Key Words: Foliar, Green fodder yield, Quality, Sandy loam, Yield.

INTRODUCTION

Good quality fodder is mandatory for the development of livestock sector. During summer, the quantity and quality of herbage available is very low. Introducing a fodder legume in the low lands during summer can improve fodder production and also enhance the productivity of rice-based cropping system. Fodder cowpea is the most widely cultivated fodder in areas where the soil is sandy and relatively infertile (Singh and Tarawali, 2011). Nutrient availability to crops is one of the limiting factors in crop production. Raising leguminous crops like fodder cowpea, fixes nitrogen from the atmosphere in their root nodules and thus enrich the soil. These legumes will serve as green fodder, dry fodder and also as silage during the lean summer months. Boron and zinc are essential plant micronutrients and their importance to crop productivity is similar to that of major nutrients (Rattan *et al*, 2009; Padbhushan and Kumar, 2014). Onattukara region has a cropping system of two crops of rice followed by sesame/pulses/vegetables which are raised during the summer. The sandy loam soils of Onattukara are low in nutrient contents (Mini and Mathew, 2015) and hence the fertilizer recommendation for each crop has to be followed strictly to obtain satisfactory yield. During summer, there is immense potential to raise fodder cowpea. Hence, the present study was undertaken with the objective of yield and quality in fodder cowpea through foliar nutrition of boron and zinc in the sandy loam soils of Onattukara.

MATERIALS AND METHODS

An investigation for yield and quality enhancement in fodder cowpea was undertaken during December 2022 to February 2023 at Onattukara Regional Agricultural Research Station, Kayamkulam. The field experiment was laid out in randomized block design with eight treatments and three replications. The treatments were T_1 (100% RDF), T_2 (75% RDF), T_3 (T_1 + zinc @ 0.25% as foliar spray at 20 DAS), T_4 (T_1 + boron @ 0.25% as foliar spray at 20 DAS), T_5 (T_1 + boron @ 0.125% + zinc @ 0.125% as foliar spray at 20 DAS), T_6 (T_2 + zinc @ 0.25% as foliar spray @ 20 DAS), T_7 (T_2 + boron @ 0.25% as foliar spray @ 20 DAS) and T_8 (T_2 + boron @ 0.125% + zinc @ 0.125% as foliar spray at 20 DAS). Dolomite @ 1 t/ha was applied uniformly in the experimental area and incorporated into soil along with tillage. Well decomposed farm yard manure was applied

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to all the plots as per treatments at the time of land preparation. The recommended dose of fertilizers was 25:60:30 kg N: P_2O_5:K_2O/ha and was given in split dose as half N, full P, half K as basal and the remaining half N and half K were given as top dressing at 15 days after sowing (KAU, 2016). Foliar nutrition of zinc was supplied as zinc sulphate heptahydrate @ 0.25 % and boron was applied as solubor @ 0.25%. Fodder cowpea var. Aiswarya released from ICAR-AICRP on Fodder Crops, College of Agriculture, Vellayani, Kerala was used for the study. It has a potential yield of 30 t/ha. The seeds of fodder cowpea were sown directly in lines in raised beds at a spacing of 30 cm x 15 cm. Interculture, weeding and earthing up for fodder cowpea were done at 10 days after sowing and at one month after sowing.

The yield characters *viz*., green fodder yield per plant, green fodder yield per hectare, dry fodder yield per plant and dry fodder yield per hectare were recorded at harvest. The fresh weight of observational plants from the respective treatments were recorded and the average was worked out for green fodder yield per plant. The plants in the net plot were harvested at the base and were weighed and expressed in t/ha for green fodder yield per hectare. The observational plants harvested separately were first shade dried and then oven dried at 65° C till constant weight was achieved. The dry weights of these samples were taken and total dry fodder yield per plant was calculated and expressed as g per plant. For dry fodder yield per hectare, the observational plants dried to constant weight were taken and calculated.

The quality characters like leaf: stem ratio, crude protein content and crude fibre content were also analyzed. To assess the quality parameters of fodder cowpea, composite samples were collected from each treatment plot and dried in the hot air oven at 65°C. The N content of fodder cowpea was determined by adopting standard procedures. Crude protein content of the fodder cowpea was determined by multiplying the N content of the sample with a factor 6.25, as prescribed by Simpson *et al* (1965). The content was then presented as percentage on dry weight basis. Plant crude fibre content at harvest was analyzed using AOAC method and expressed in percentage (A O A C, 1975). To assess leaf: stem ratio, the leaves and the main stem were separated from the observational plants. They were shade dried followed by oven drying at 65° C till the attainment of constant weight. The dry weight of leaves and stem of each plant was estimated and the ratio of leaves to stem was calculated. The data were statistically analyzed in GRAPES software (Gopinath *et al*, 2020) and the treatment means were compared at 5 per cent probability level.

RESULTS AND DISCUSSION

Yield and Yield Attributes

The green fodder yield per plant was significantly influenced by the treatment T_3 (106.72 g) followed by the treatment T_5 (101.69 g). There was a yield increase of 10.03 per cent compared to the treatment T_1 (control). The increase in green fodder yield might be due to the increase in growth parameters due to application of zinc foliar spray. Zinc also has an active role auxin synthesis and cell division Safak *et al.* (2009), which might have improved the yield of fodder cowpea. This was in agreement with the findings of Weldua *et al* (2012) who reported an increased yield and above ground biomass for *faba* beans due to zinc application. In general, the reduction in nutrient dosage brought down the green fodder yield per plant. The treatment t_7 registered the lowest green fodder yield per plant (78.45 g). The combined spray of boron and zinc along with the recommended dose of nutrients (T_5) produced a green fodder yield of 101.69 g per plant. This is in agreement with the findings of Debnath *et al* (2018) who reported an increased yield of cowpea with the application of boron and zinc.

The green fodder yield per hectare was significantly influenced by the treatment T_3 (23.74 t) and was 11.77 per cent higher than the control treatment (T_1). Since zinc is a co-factor of over 300 enzymes and also an important element in nucleic acid metabolism (Marschner, 1986), the application of zinc might have favoured a higher yield. Zinc is required for the biosynthesis of IAA and gibberellins (Taliee and Sayadian, 2000; Mousavi *et al.*, 2012) which might be the reason

Table1. Effect of treatments on yield of fodder cowpea.

Treatment	Green fodder yield /plant (g)	Green fodder yield/ ha (t)	Dry fodder yield/plant (g)	Dry fodder yield/ha (t)
T_1 – 100% RDF	96.53	21.24	8.52	1.90
T_2 – 75% RDF	86.89	19.95	8.38	1.86
T_3 – T_1 + zinc @ 0.25%	106.72	23.74	10.12	2.25
T_4 – T_1 + boron @ 0.25%	85.77	19.16	7.83	1.74
T_5 – T_1 + boron @ 0.125% + zinc @ 0.125%	101.69	22.45	9.74	2.17
T_6 – T_2 + zinc @ 0.25%	96.21	20.94	8.47	1.88
T_7 – T_2 + boron @ 0.25%	78.45	17.50	7.24	1.61
T_8 – T_2 + boron @ 0.125% + zinc @ 0.125%	79.33	17.95	7.43	1.65
SEm (±)	1.59	0.32	0.37	0.08
CD (0.05)	4.823	0.966	1.115	0.246

RDF - Recommended dose of fertilizers NS - Not significant

Table 2. Effect of treatments on quality characters of fodder cowpea.

Treatment	Leaf: stem ratio	Crude protein (%)	Crude fibre (%)
T_1 – 100% RDF	1.04	12.83	19.77
T_2 – 75% RDF	0.97	12.25	19.38
T_3 – T_1 + zinc @ 0.25%	1.26	13.42	19.55
T_4 – T_1 + boron @ 0.25%	0.91	13.42	19.75
T_5 – T_1 + boron @ 0.125% + zinc @ 0.125%	1.15	14.00	19.56
T_6 – T_2 + zinc @ 0.25%	1.00	13.42	19.96
T_7 – T_2 + boron @ 0.25%	0.81	11.67	19.34
T_8 – T_2 + boron @ 0.125% + zinc @ 0.125%	0.83	13.42	19.33
SEm (±)	0.02	0.60	0.25
CD (0.05)	0.053	NS	NS

dw -Dry wight RDF - Recommended dose of fertilizers NS - Not significant

for the vigorous growth and yield of fodder cowpea. Pandya and Bhat (2007) and Narayan *et al* (2008) had also observed that the application of sulphur and zinc along with the recommended dose of NPK could improve the green fodder yield of cowpea. Dhaliwal *et al* (2023) also opined that the productivity in fodder crops can be improved through the application of zinc. The treatment t_7 recorded the lowest green fodder yield per hectare. Close examination of data indicated that the plants that received zinc and boron exhibited a synergic effect on yield compared to boron alone.

The dry fodder yield per plant was significantly higher for the treatment T_3 (100 per cent RDF + zinc @ 0.25per cent @ 20 DAS) and was found to be on a par with the treatment T_5. Overall, there was an increase of 18.78 per cent compared to the control. The increase in dry fodder yield per plant might be due to the increase in growth parameters. The lowest dry fodder yield per plant was observed for the treatment T_7. The trend in dry fodder yield per ha was found similar to green fodder yield per ha. The dry fodder yield per hectare was also found significantly higher for

the treatment T_3 (2.25 t) and remained at par with the treatment T_5 (2.17 t). The lowest dry fodder yield per hectare was observed for T_7.

Quality Parameters

Significantly higher leaf: stem ratio was recorded for the treatment T_3 (1.26) followed by T_5 (1.15). The lowest leaf: stem ratio was observed for T_7. The profound increase in number of leaves per plant in the treatment T_3 in response to foliar application of zinc might be the reason for the increased leaf: stem ratio in the treatment t_3. Similar results were also obtained by Kumar *et al* (2016) who reported that the application of $ZnSO_4$ significantly increased the leaf: stem ratio of cowpea. Earlier Singh (2001) had also reported a significant increase in leaf to stem ratio in alfalfa plants. There was no significant effect due to treatments on crude protein content and crude fibre content of fodder cowpea.

CONCLUSION

It could be concluded from the results that for augmented yield and quality of fodder cowpea in *Onattukara* sandy loam soils of Kerala, the crop has to be supplied with FYM @ 10 t/ha, N, P_2O_5 and K_2O @ 25:60:30 kg/ha (KAU POP) along with foliar application of zinc sulphate heptahydrate @ 0.25 percent at 20 days after sowing.

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Short Communication

Assessment of Integrated Approaches for the Management of Sesame Diseases

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Field experiments were conducted for three years to manage soil and foliar diseases of sesame by integrated approaches using bioagents and fungicides. The experiment was conducted in different seasons for the management of Macrophomina root rot, stem blight and Alternaria capsule blight. Seed treatment with biocontrol agent *Pseudomonas fluorescens* (Pf1) followed by foliar spray with Difenconazole @ 0.05% on 30 and 45 DAS reduced the root rot from 19.03 to 5.73%, stem blight from 48.67% to 20.68% and capsule blight from 41.33% to 16.41% and increased yield from 376 to 640.05 kg/ha with a B:C ratio of 2.13 in sesame. Thus, seed treatment with *Pseudomonas fluorescens* (Pf1) followed by foliar spray with Difenconazole @ 0.05% on 30 and 45 DAS provided maximum protection from foliar and soil borne diseases in sesame with higher seed yield and B:C ratio, so that this may be recommended for the management of diseases in sesame

Key Words: Biocontrol agents, Blight, Capsule, Fungicides, Macrophomina, Root Rot, Stem Blight.

INTRODUCTION

Sesame tolerates drought but suffers from poor yield due to susceptibility to many pests and diseases. In Tamil Nadu sesame is grown over an area of 65,118 ha with the production of 30,772 t The average productivity of this crop is 469 kg/ha. However there is a potential of 1000kg/ha under irrigated condition. Though sesame has great potentiality for increasing the productivity, it faces several bottlenecks which hinder the yield potential of the crop. The major bottlenecks in sesame cultivation are 90% of the area under sesame is under rainfed and the area under sole cropping is very limited. The maturity is not uniform and the shattering of the capsules causes higher yield loss. Macrophomina stem blight and root rot, Phyllody and *Alternaria* blight are the major diseases where the yield loss accounts up to 100% depending upon the stage of infection and susceptibility of the crop (Kumaraswamy *et al,* 2015). The literature survey explains the association of *Alternaria sesami* and *A. alternate* to be associated with pod, leaf and stem blight (Rao and Vijayalakshmi, 2000). The other limiting factors include the attack of insect pests like shoot webber and pod bug. However, in recent days the farmers are facing heavy yield loss due to the outbreak of root rot, capsule blight and stem blight.

Integrated disease management plays a vital role in increasing the productivity. Seed treatment with Thiram (0.2%) + Carbendazim (0.1%) was effective for the management of Macrophomina stem and root rot of sesame (Rajpurohit *et al,* 2005). Rajpurohit and Bishnoi, 2006 reported that the integrated disease management module consisting of seed treatment with Thiram (0.2%) + Carbendazim 50WP (0.1%) + spray of Mancozeb (0.2%) + Endosulfan (0.07%) at 30-40 DAS and 45-55 DAS reduced Macrophomina stem and root rot, Alternaria leaf spot, phyllody and leaf curl (Nicotinia virus 10) and increased seed yield.

On the basis of results from the different studies efforts have been made to combine of seed treatment with biocontrol agents and foliar sprays of fungicides as an integrated disease management

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package for the management of Macrophomina root rot, stem blight, and Alternaria capsule blight diseases under field conditions in the present study.

MATERIALS AND METHODS

Field trials were conducted at the Oilseeds Research Station, Tindivanam, Villupuram (Tamil Nadu) to evaluate the efficacy of an integrated disease management strategies with 14 treatments and three replication in randomized block design in sesame cultivar TMV (Sv) 7. The treatment details is as follows: T1:Seed treatment with *Pseudomonas fluorescens* (Pf1) @10g/kg of seed + soil application of *Pseudomonas fluorescens* (Pf1) @2.5kg/ha, T2: Seed treatment with *P. fluorescens* (Pf1) @10g/kg of seed+ foliar spray of *P. fluorescens* (Pf1) @0.2% on 30 and 45DAS, T3: Seed treatment with *P. fluorescens* (Pf1) @10g/kg of seed+ foliar spray of Difenconazole (0.05%) on 30 and 45DAS, T4: Seed treatment with *P. fluorescens* (Pf1) @10g/kg of seed+ foliar spray of Carbendazim+ Mancozeb (SAFF-0.2%) on 30 and 45DAS, T5: Seed treatment with *P. fluorescens* (Pf1) @10g/kg of seed+ foliar spray of Mancozeb (0.2%) on 30 and 45DAS, T6: Seed treatment with *P. fluorescens* (Pf1) @10g/kg of seed+ foliar spray of Propiconazole (0.2%) on 30 and 45DAS, T7: Seed treatment with *Trichoderma viride* (Tv1) @4g/kg of seed + soil application of *T. viride* (Tv1) @2.5kg/ha, T8: Seed treatment with *T. viride* (Tv1) @4g/kg of seed+ foliar spray of *T. viride* (Tv1) @0.2% on 30 and 45DAS, T9: Seed treatment with *T. viride* (Tv1) @4g/kg of seed of seed+ foliar spray of Difenconazole (0.05%) on 30 and 45DAS, T10: Seed treatment with *T. viride* (Tv1) @4g/kg of seed of seed+ foliar spray of Carbendazim+ Mancozeb (SAFF-0.2%) on 30 and 45DAS, T11: Seed treatment with *T. viride* (Tv1) @4g/kg of seed + foliar spray of Mancozeb (0.2%) on 30 and 45DAS, T12: Seed treatment with *T. viride* (Tv1) @4g/kg of seed + foliar spray of Propiconazole (0.2%) on 30 and 45DAS, T13: Seed treatment with Carbendazim 0.2% and T14- Untreated control

Seed treatment with *P. fluorescens, T. viride,* and fungicides were done individually 24 hrs prior to sowing. *P. fluorescens* and *T. viride* (TNAU commercial talc formulation) were applied to the soil individually a week before sowing. The crop was raised as per the agronomic practices given in the Crop Production Guide and observations of disease incidence were recorded one week after the last foliar spray. A 0-5 scale was used for scoring Alternaria Capsule blight and Macrophomina stem blight (Anonymous, 2008) and Percent Disease Index (PDI) was calculated. The incidence of *Macrophomina* root rot was recorded individually by counting the number of affected and healthy plants at random quadrate selection in each plot and the Percent Incidence (PI) was calculated. The grain yield was recorded and C:B ratio was calculated. The experimental data were tabulated and analyzed by ANOVA using Agres statistical software package version 3.01 (Agres, 1994). Least significant differences (LSD) were applied to assess differences between treatments and to identify statistical differences between means , respectively

RESULTS AND DISCUSSION

The experiment was conducted for three years in three different season's and pooled analysis of different season data revealed that seed treatment with *P. fluorescens* Pf1 followed by foliar spray with Difenconazole @ 0.05% (T3) on 30 and 45 DAS recorded the least incidence of Root rot (5.73%), stem blight (20.68%) capsule blight (16.41%) with maximum yield of 640.05kg/ha and BCR of 2.13. This was statistically on par with treatment T9 i.e seed treatment with *T.viride* (Tv1) + foliar spray of Difenconazole (0.05%) on 30 and 45DAS (Table 1). The untreated control (T14) recorded the highest incidence of root rot of 19.03%, stem blight (48.67%) and capsule blight (41.33%) with lowest yield of 495.97kg/ha (Table 1). Rajpurohit (2004) reported that foliar spray of 0.2% Mancozeb in combination with insecticide was effective for the management of Alternaria blight, Phyllody and leaf curl diseases of sesame. Applications of FYM + NPK @ 60:30:30 was found to be significantly reduced incidence of Alternaria leaf spot and Cercospora leaf spot coupled with maximum yield with higher cost benefit (C:B) ratio (Nayankishor and Roy, 2019). Seed treatment with Thiram (0.2%) + Carbendazim (0.1%) was effective for the

Table: 1 Pooled analysis of the effect of biocontrol agents and fungicides on Root rot, stem blight, capsule blight and yield of sesame

Sr.No	Treatment	Root rot (%)	stem blight (PDI)	capsule blight (PDI)	Yield (Kg/ha)	BCR
T1	ST (Pf1) + SA (Pf1)	9.81	36.66	32.67	592.43	1.97
T2	ST (Pf1) + FS (Pf1)	11.07	39.60	24.39	583.50	1.94
T3	ST (Pf1) + FS Difenconazole (0.05%)	5.73	20.68	16.41	640.05	2.13
T4	ST (Pf1) + FS Carbendazim+ Mancozeb (SAFF-0.2%)	8.21	25.21	25.33	600.93	2.00
T5	ST (Pf1) + FS Mancozeb (0.2%) (30 and 45DAS)	13.50	36.27	32.79	570.41	1.90
T6	ST (Pf1) + FS Propiconazole (0.2%)	8.56	29.59	27.06	605.08	2.02
T7	ST (Tv) + SA (Tv)	8.67	31.73	34.93	607.00	2.02
T8	ST (Tv) + FS (Tv)-30 and 45 DAS	10.47	35.61	32.41	596.70	1.99
T9	ST (Tv) + FS Difenconazole (0.05%)	6.27	25.87	17.33	637.08	2.12
T10	ST (Tv) + FS Carbendazim+ Mancozeb (SAFF-0.2%)	8.67	22.79	23.73	609.31	2.03
T11	ST (Tv) + FS Mancozeb (0.2%)	11.79	40.01	35.61	586.15	1.95
T12	ST (Tv) + FS Propiconazole (0.2%)	9.17	34.01	23.53	602.72	2.01
T13	ST - Carbendazim 0.2%	12.73	39.60	33.81	576.01	1.92
T14	Untreated control	19.03	48.67	41.33	495.97	1.65
	SEd	1.13	3.14	2.71	18.97	
	CD(.05%)	2.32	6.46	5.66	39.00	

management of Macrophomina stem and root rot of sesame (Rajpurohit *et al* 2005). *Trichoderma viride* is found to be effective against Macrophomina stem and root rot of sesame (Rajpurohit, 2004). Jeyalakshmi *et al* (2013) observed that soil application of neem cake (250 kg/ha) along with seed treatment and soil application (2.5 kg/ha) of *Trichoderma viride* followed by foliar spray of azadirachtin @ 3 ml/L on 30 and 45 DAS was found to be superior in reducing the root rot, leaf blight and powdery mildew disease of sesame. Meena (2020) reported that stem and root rot disease of sesame can be managed effectively using the integration of bioagent, *T. asperellum* (seed treatment and furrow application) and foliar application of fungicides (Trifloxystrobin + Tebuconazole @ 0.5 g/l at capsule initiation and second spray after 15 days interval. Seed treatment with *T. asperellum* @ 4g/kg + *P. fluorescens* @10g /kg + soil application of *P. fluorescens* @ 2.5kg/ha + 2.5 kg/ha enriched in 100 kg of FYM + neem cake @ 250 kg/ha was found effective in controlling the root rot and it's seem to be promising for practical disease management in farmer's field (Mahalakshmi and Ahila Devi ,2021). Integrated disease management (IDM) has emerged as the promising approach for management of root rot of sesame (Nayankishor and Roy, 2019)

CONCLUSION

From the present study, it was revealed that seed treatment with *Pseudomonas fluorescens* (Pf1) or *Trichoderma viride* followed by foliar spray with Difenconazole @ 0.05% on 30 and 45 DAS provided maximum protection of *Macrophomina* root rot , stem blight and *Alternaria* capsule blight diseases in sesame with higher seed yield and B:C ratio, so that this may be recommended for the integrated management of Macrophomina Root rot, stem blight and Alternaria capsule blight diseases of sesame.

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Short Communication

Therapeutic Management of Generalized Scabies in a Dog: A Case Report

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This report reveals the successful treatment of generalized scabies in a dog in Ranchi, using oral ivermectin at 50, 100, 150, 200, and 300 µg/kg b.wt respectively from day-1 to day-5. After the priming of the dog, Ivermectin @ 300 µg/kg b.wt was continued at weekly intervals for four weeks, until the resolution of scabies.

INTRODUCTION

Canine scabies caused by *Sarcoptes scabiei* is one of the most common skin diseases encountered in veterinary practices, and may be in localized or generalized form. Animals affected with five or more local lesions or having two or more body regions are considered as generalized form of scabies. A 3-year-old male non-descript dog, weighing 20 kg with a repeated history of recurrent scabies was presented at the clinical complex RVC. The dog was treated previously with ivermectin injection, but the condition relapsed every time, whenever the therapy was stopped.

Fig. I. Showing scabies-infested dog

On physical examination, severe alopecia was observed, especially on the legs and belly with darkening and thickening of the skin. The animal showed intense pruritis with crusty lesions and scales all over the body. For the treatment of generalized scabies, ivermectin is the drug of choice. Although the recommended dose of ivermectin in generalized scabies in dogs is 300-600 µg/kg b.wt (Plumb, 2005, Mueller, 2004).

Fig. 2. Showing *Sarcoptes scabiei* (10X)

MATERIALS AND METHODS

Multiple skin scrapping was taken using a scalpel blade. A portion of the skin samples was boiled with 10 percent KOH solution and Sediment was examined under the microscope (10X) which revealed *Sarcoptes scabiei* Soulsby

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(1982) while another portion was stained with Gram's stain in which skin samples were initially stained with crystal violet which imparts a purple color to all cells. Iodine is then added as a mordant forming a crystal violet iodine complex within the cell. Alcohol or acetone is used as a decolorising agent. Gram positive bacteria retain the crystal violet iodine complex due to their thick peptidoglycan layer while gram negative bacteria lose the stain because of their thiner peptidoglycan layer and outer lipid membrane. After decolorisation the cells are couterstained with safranin which stains gram negative bacteria pink or red while gram positive bacteria remain purple. which revealed several cocci bacteria.

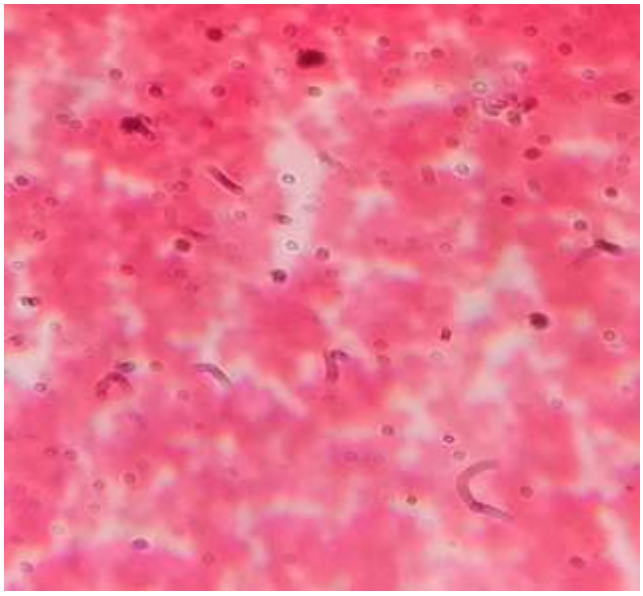

Fig. 3. Showing Gram –ve cocci (100X)

RESULTS AND DISCUSSION

Treatment was carried out for four weeks with oral Ivermectin (Neomec^{R}, INTAS) @ 300 µg/kg b.wt, Cephalexin (Cephalexin^{R}, VIRBAC) @ 300 mg bid every alternate day for seven days, and vitamin E (Evion, Mark) @ 200mg, once daily for two weeks with topical application of Benzyle benzoate. Skin scraping and the vital parameters of the dog were monitored at intervals of 2 weeks.

Marked improvement was observed after one-week treatment schedule, whereas complete resolution was noted after 6 weeks of therapy.

Generalized scabies was confirmed when *Sarcoptes scabiei* was spotted in the microscopic evaluation (10x) of skin scraping of the affected dog. Since secondary pyoderma is a concurrent problem in generalized scabies, antibiotics (e.g., cephalexin, enrofloxacin, or marbofloxacin and skin supplements such as vitamin E may be needed depending on the individual case (Nesbit and Ackerman,1998). Here, the secondary bacterial infection was observed, and hence Cephalexin with vitamin E was included for the purpose.

CONCLUSION

Recurrent generalized scabies in a non-descript dog was treated with oral ivermectin (along with supportive therapy) with complete recovery in 6 weeks.

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