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J Krishi Vigyan 2025, 13(1) : 1-196

TABLE OF CONTENTS

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J Krishi Vigyan 2025, 13(1) : 1-9

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Analysis on Genotypic and Phenotypic Path Coefficients for Major Traits in Okra Germplasm

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ABSTRACT

Okra (*Abelmoschus esculentus)* is the principal crop of family malvaceae prominent cultivated and consumed as vegetable during summer and *Kharif* season in India. The identification of attributes that can facilitate the selection process is a constant requirement in crop breeding. Therefore, the present research was designed during summer season 2019, using 26 different cultivars to examine the direct and indirect effect of several traits under study towards the yield per hectare at the H.N.B.G.U. Srinagar (Garhwal) Department of Horticulture, Uttarakhand, India. Analysis of path coefficient was estimated which indicated that the factors *viz.,* average fruit weight, pedicel diameter, number of primary branches per plant, days to first fruit set, pedicel length, fruit length, petiole length, days to first germination, and petiole diameter had a positive direct association with yield per hectare. Combining the correlation and path analysis showed that days to first germination, number of primary branches per plant, plant height, number of fruits per plant, fruit length, average fruit weight and yield per plot all positively and directly correlated with yield per hectare. Therefore, it is possible to draw the conclusion that when selecting selection indices for okra breeding and advancement programs, decisions based on characteristics such as days to first germination, plant height, number of primary branches per plant, fruit length, average fruit weight, number of fruits per plant and yield per plot may be more advantageous.

Key Words: Genotypic, Okra, Path Coefficient, Vegetable Breeding, Yield.

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] is one of the most widely consumed and farmed vegetable crops worldwide, especially in tropical and warm temperate climates (Jonah and Kwaga, 2019; Kumari *et al,* 2019). Fruits or pods of okra are highly valuable being highly nutritious, rich in vitamins, calcium, potassium, several minerals also having high medicinal, industrial and export potential (Pithiya *et al,* 2017; Joshi *et al,* 2021). Okra fits easily in any sequential cropping system due to its medium duration, fast growing habit, tolerance to heat, variation in rainfall and drought (Reddy *et al,* 2013; Ray *et al,* 2022). Commercial okra cultivars and hybrids are readily accessible in seed markets, but most of them are not appropriate for all of the nation's growing regions, thus farmers struggle to find the right germplasm in each location (Joshi *et al,* 2020; Raval *et al,* 2019). The idea of connections provided by an examination of the correlation between different quantitative traits may be effectively applied to the creation of picking and selection strategies aimed at improving yield and associated qualities (Raval *et al,* 2019; Kumar and Joshi 2024). Correlation studies are useful in

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identifying the yield components, but they do not give a clear picture of the kind and degree to which each of the many independent qualities contributes. Therefore, to provide a clear picture of the relationship between fruit yield and its contributing factors, path analysis was utilized to compute the direct and indirect impacts. Only the magnitude and value of the connection between character pairs are indicated by the correlation values. Effective selection requires separating the genotypic relationship of component traits into direct and indirect effects, which is accomplished by the path coefficient analysis (Prajna *et al,* 2015). Therefore, this investigation was intended to examine the direct and indirect effects of various yield components on fruit yield in the genotypes and cultivars under examination employing path coefficient analysis.

MATERIALS AND METHODS

The present investigation was conducted in the summer of 2019 at the H.R.C, Department of Horticulture, H.N.B.G.U., Srinagar (Garhwal), Uttarakhand, India to study the direct and indirect effects of different traits on the yield characteristics of 25 diverse genotypes of okra viz., Arka Anamika (check), Varsha Uphar, Lucky-666, Punjab-8, Kashi Pragati, Kashi Vibhuti, Chanda, Hisar Naveen, Hisar Unnat, Kashi Kranti, LC-1, Kashi Mohini, LC-3, Kaveri, King Bhindi, LC-6, Parbhani Kranti, Pusa A-4, LC-2, Pusa Sawani, Super Anamika, VL Bhindi-2, LC-5, Vandana-241, LC-4 and Agri Bahar. The experiment was laid out in Randomized Block Design with three replications of each genotype. Five plants from each treatment per replication were randomly selected and tagged for recording the data. The observations noted were plant height (cm), days taken to first germination, internodal length (cm), number of primary branches per plant, stem girth (mm), petiole diameter (mm), petiole length (cm), number of epicalyx segments, leaf length (cm), days taken to first flowering, flower diameter (cm), fruit length (cm), number of nodes at flowering, fruit diameter (mm), number of fruits per plant, average fruit weight (g), number of ridges per fruit, pedicel diameter (mm), pedicel length (cm), days taken to first fruit set, flesh thickness (mm), days taken to first fruit harvest, number of seeds per fruit, seed index, yield per hectare (q), yield per plot (kg), T.S.S (^{0}Brix), chlorophyll content (SPAD), ascorbic acid (mg/100g), ash content, moisture content and physiological loss (days). After collecting data, the mean was calculated, and the mean data was analyzed statistically by various methods. The ANOVA and C.D test at 5% and 1% level of significance was applied as given by Panse and Sukhatme (1967) for the study of the significance of variation among the treatments. Path coefficient analysis (indirect and direct path) was estimated as per Wright (1921) and Dewey & Lu (1957).

RESULTS AND DISCUSSION

Analysis of genotypic and phenotypic path coefficient

A path coefficient study showed how each character contributes differently to the yield per plant. The direct impact of a selected characteristic on yield and its indirect effect on other features are featured in Tables 1 and 2 for the genotypic and phenotypic path coefficient by dividing the phenotypic and genotypic correlations.

Direct effect

At genotypic level, path coefficient analysis showed that positive direct effect with regards to yield per hectare was found for yield per plot (1.0006), plant height (0.0040), pedicel length (0.0035), fruit length (0.0024), days taken to first fruit set (0.0018), number of primary branches per plant (0.0018), pedicel diameter (0.0018), number of epicalyx segments (0.0017), petiole length (0.0016), days taken to first germination (0.0014), petiole diameter (0.0012) and average fruit weight (0.0009). Hence it is suggested that selection should be based on these characters for yield improvement in okra. Adiger *et al* (2011), Kumar *et al* (2012), Reddy *et al* (2013) and Sawant *et al* (2014) in okra also reported similar results in their studies. The negative direct effect towards yield per hectare was observed in stem girth (-0.0015), days taken

to first fruit harvest (-0.0017), fruit diameter (-0.0025) and internodal length (-0.0029). Similar findings were also observed by Adiger *et al* (2011), Sharma and Prasad (2015) and Umrao *et al* (2015) in okra. The phenotypic level, path coefficient analysis showed that positive direct effect with regards to yield per hectare was found for yield per plot (0.9992), days taken to first fruit harvest (0.0018), leaf length (0.0013), and flower diameter (0.0011). Hence, cultivar selection for further breeding process based on these traits will be valuable for yield improvement in okra. The results were in line with the findings of Adiger *et al* (2011), Sawant *et al* (2014), Kerure *et al* (2017) and Pithiya *et al* (2017) in okra. The negative direct effect towards yield per hectare was observed in number of nodes at first flowering (-0.0011) and days taken to first fruit set (-0.0020) the present findings were following the findings of Sharma and Prasad (2015), Thulasiram *et al* (2017), Jonah and Kwaga (2019) and Kumari *et al* (2019) in okra.

Indirect effect

Days taken to first germination

At genotypic level, the positive indirect effect of days to first emergence of seedling towards yield per hectare was observed via internodal length (0.0017) whereas the negative indirect effect was observed through plant height (-0.0015) and yield per plot (-0.0745). Earlier, workers like Kumar *et al* (2012), Prajna and Gasti (2015), Sharma and Prasad (2015) and Jonah and Kwaga (2019) came up with similar findings in okra. while, at phenotypic level, the negative indirect effect was observed through yield per plot (-0.0681). Similar findings were also observed by Sharma and Prasad (2015), Prajna and Gasti (2015), Umrao *et al* (2015) and Kumari *et al* (2019) in okra.

Plant height

At genotypic level, the positive indirect effect of plant height towards yield per hectare was observed through fruit diameter (0.0013), whereas the negative indirect effect was observed via pedicel diameter (-0.0011), fruit length (-0.0012), internodal length (-0.0018) and yield per plot (-0.4282). The present findings are in line with the findings of Adiger *et al* (2011), Kumar *et al* (2012), Reddy *et al* (2013) and Kerure *et al* (2017) in okra. While, at phenotypic level, the negative indirect effect was observed via yield per plot (-0.4153). Prajna and Gasti (2015), Sharma and Prasad (2015), Pithiya *et al* (2017), Thulasiram *et al* (2017) and Jonah and Kwaga (2019) also came up with similar findings in okra.

Number of primary branches per plant

Number of primary branches per plant, at genotypic level imparted positive indirect effect on yield per hectare via days taken to first fruit set (0.0014), pedicel length (0.0014), total soluble solids (0.0010), However, a negative indirect effect of the number of primary branches per plant towards yield per hectare was observed through internodal length (-0.0011), days taken to first fruit harvest (-0.0014) and yield per plot (-0.5932). The present results were in line with the findings of Adiger *et al* (2011), Reddy *et al* (2013), Sharma and Prasad (2015) and Kerure *et al* (2017) in okra. Number of primary branches per plant, at phenotypic level imparted positive indirect effect on yield per hectare via days taken to first fruit harvest (0.0012), However, a negative indirect effect of the number of primary branches per plant towards yield per hectare was observed through days taken to first fruit set (-0.0014) and yield per plot (-0.5655). The present findings were in accordance to the findings of Sharma and Prasad (2015), Pithiya *et al* (2017), Thulasiram *et al* (2017), Jonah and Kwaga (2019) and Raval *et al* (2019) in okra.

Internodal length

At genotypic level, internodal length disclosed positive indirect effect on yield per hectare through plant height (0.0025), fruit diameter (0.0011), fruit length (-0.0015) and yield per plot (-0.5134) which was similar with the findings of Reddy *et al* (2013) and Raval *et al* (2019) in okra. While, at phenotypic level, internodal length disclosed the negative indirect effect was observed via yield per plot (-0.4946) which was following the findings of Reddy *et al* (2013) and Raval *et al* (2019) in okra.

Stem girth

At genotypic level the traits viz., yield per plot (0.1133), pedicel length (0.0022), showed a positive indirect effect on yield per hectare which was following the findings of Sharma and Prasad (2015), Kerure *et al* (2017) and Pithiya *et al* (2017) in okra while, at phenotypic level, the traits viz., yield per plot (0.0932), showed the positive indirect effect on yield per hectare. Pithiya *et al* (2017), Jonah and Kwaga (2019) and Kumari *et al* (2019) also reported similar results in okra.

Leaf length

At genotypic level, pedicel diameter (0.0012) imparted a positive direct effect Similar results were also obtained by Sawant *et al* (2014) and Thulasiram *et al* (2017) in okra while, fruit diameter (-0.0014) and yield per plot (-0.02436), imparted a negative indirect impact on yield per hectare while, at phenotypic level, it imparted negative indirect impact on yield per hectare via yield per plot (-0.1206) which was similar with the findings of Sharma and Prasad (2015) and Thulasiram *et al* (2017) in okra.

Days taken to first flowering

Days taken to first flowering, at genotypic level disclosed positive indirect effect on yield per hectare through days taken to first fruit set (0.0018), pedicel length (0.0017), number of primary branches per plant (0.0014), total soluble solids (0.0009), whereas the negative indirect effect was observed via physiological loss (-0.0010), days taken to first fruit harvest (-0.0018) and yield per plot (-0.6956). Earlier, workers like Adiger *et al* (2011), Kumar *et al* (2012), Reddy *et al* (2013) and Kerure *et al* (2017) also came up with similar results in okra. Days taken to first flowering, at phenotypic level disclosed positive indirect effect on yield per hectare through days taken to first fruit harvest (0.0015), whereas the negative indirect effect was observed via days taken to first fruit set (-0.0017) and yield per plot (-0.5573) which was following the findings of Kumar *et al* (2012), Kerure *et al* (2017) and Kumari *et al* (2019) in okra.

Days taken to first fruit set

Days taken to first fruit set, at genotypic level disclosed positive indirect effect on yield per hectare through pedicel length (0.0016) and number of primary branches per plant (0.0014) similar findings were also made by Koundinya and Dhankhar (2013) and Umrao *et al* (2015) in okra. Days taken to first fruit set, at phenotypic level disclosed positive indirect effect on yield per hectare through days taken to first fruit harvest (0.0017), whereas the negative indirect effect of days taken to first fruit set was observed via yield per plot (-0.6137) which was in close conformity with the findings of Sharma and Prasad (2015) and Raval *et al* (2019) in okra.

Days taken to first fruit harvest

At genotypic level, it imparted positive indirect effect on yield per hectare through days taken to first fruit set (0.0018), pedicel length (0.0017), number of primary branches per plant (0.0015) and total soluble solids (0.0011) which was in close conformity with the findings of Koundinya and Dhankhar (2013), Sharma and Prasad (2015) and Kerure *et al* (2017) in okra. At phenotypic level, it imparted negative indirect effect of days taken to first fruit harvest was observed via days taken to first fruit set (-0.0019) and yield per plot (-0.5659) similar results were also reported by Umrao *et al* (2015) and Raval *et al* (2019) in okra.

Fruit length

It imparted positive indirect effect, at genotypic level on yield per hectare via yield per plot (0.4947) and internodal length (0.0018). However, a negative indirect effect of fruit length towards yield per hectare was observed through fruit diameter (-0.0012) and plant height (-0.0019). Earlier, workers like Kumar *et al* (2012), Reddy *et al* (2013) and Raval *et al* (2019) also recorded similar results in okra. It imparted positive indirect effect, at phenotypic level on yield per hectare via yield per plot (0.3947). Similar findings were also made by Deepanshu and Shamd (2017), Kerure *et al* (2017), Pithiya *et al* (2017) and Thulasiram *et al* (2017) in okra.

Analysis on Genotypic and Phenotypic Path Coefficients

Fruit diameter

At genotypic level, fruit diameter disclosed positive indirect effect on yield per hectare through yield per plot (0.3191), internodal length (0.0013), fruit length (0.0011), pedicel length (0.0011) and pedicel diameter (0.0010), whereas the negative indirect effect was observed via the plant height (-0.0021) which was following the findings of Adiger *et al* (2011), Kumar *et al* (2012) and Kerure *et al* (2017) in okra. While, at phenotypic level, fruit diameter disclosed positive indirect effect on yield per hectare through yield per plot (0.2570) which was supported by the findings of Kumar *et al* (2012), Deepanshu and Shamd (2017) and Raval *et al* (2019) in okra.

Average fruit weight

At genotypic level, the positive indirect effect of average fruit weight towards yield per hectare was observed via yield per plot (0.4964), whereas the negative indirect effect was observed through number of epicalyx segments (-0.0010). Similar findings were also made by Adiger *et al* (2011), Kumar *et al* (2012), Reddy *et al* (2013), Prajna and Gasti (2015) and Raval *et al* (2019) in okra. While, at phenotypic level, the positive indirect effect of average fruit weight towards yield per hectare was observed via yield per plot (0.3117) which was in close conformity with the findings of Kumar *et al* (2012), Sawant *et al* (2014) Sharma and Prasad (2015), Thulasiram *et al* (2017) and Raval *et al* (2019) in okra.

Number of fruits per plant

At genotypic level, the positive indirect effect of plant height towards yield per hectare was observed through yield per plot (0.6497), whereas the negative indirect effect was observed via plant height (-0.0010) the present results are in line with the findings of Adiger *et al* (2011), Kumar *et al* (2012), Reddy *et al* (2013), Prajna and Gasti (2015), Sharma and Prasad (2015) and Thulasiram *et al* (2017) in okra. While, at phenotypic level, the positive indirect effect of plant height towards yield per hectare was observed through yield per plot (0.4821), similar findings were also reported by Sawant *et al* (2014), Umrao *et al* (2015) and Raval *et al* (2019) in okra.

Flesh thickness

At genotypic level, the positive indirect effect of flesh thickness towards yield per hectare was observed via yield per plot (0.0034), internodal length (0.0011) and pedicel length (0.0011), whereas the negative indirect effect was observed through plant height (-0.0016), and fruit diameter (-0.0018) which was following the findings of Adiger *et al* (2011) and Kerure *et al* (2017) in okra. While, at phenotypic level, the negative indirect effect was observed through yield per plot (-0.0127). Similar findings in okra were also recorded by Kumar *et al* (2012), Deepanshu and Shamd (2017) and Raval *et al* (2019) in okra.

Yield per plot

At genotypic level, yield per plot imparted positive indirect effect on yield per hectare through internodal length (0.0015), fruit length (0.0012) and days taken to first fruit harvest (0.0011) which was in line with the findings of Prajna and Gasti (2015), Umrao *et al* (2015) and Thulasiram *et al* (2017) in okra. While, at phenotypic level, yield per plot imparted positive indirect effect on yield per hectare through days taken to first fruit set (0.0012). However, a negative indirect effect of yield per plot towards yield per hectare was observed through days taken to first fruit harvest (-0.0010). Similar results were also obtained by various workers like Reddy *et al* (2013), Sawant *et al* (2014), Sharma and Prasad (2015), Pithiya *et al* (2017) and Kumari *et al* (2019) in okra.

Total soluble solid

Total soluble solid, at genotypic level disclosed the negative indirect effect via yield per plot (-0.1745). Similar results were also observed by Reddy *et al* (2013) and Kumari *et al* (2019) in okra. While, total soluble solid, at phenotypic level total soluble solid disclosed whereas the negative indirect effect of total soluble solid was observed via yield per plot (-0.1573) which was in close conformity with the findings of Kumari *et al* (2019) in okra.

Ascorbic acid

At genotypic level, the positive indirect effect of ascorbic acid towards yield per hectare was observed via plant height (0.0017) and pedicel length (0.0016) whereas its negative indirect effect was observed through pedicel diameter (-0.0010) and yield per plot (-0.3815) similar results were also obtained by Kumari *et al* (2019) in okra. While, at phenotypic level, the negative indirect effect was observed through the yield per plot (-0.2041) which was in close conformity with the findings of Sawant *et al* (2014) in okra.

Chlorophyll content

Chlorophyll content, at genotypic level imparted positive indirect effect on yield per hectare through plant height (0.0019), days taken to first germination (0.0011). However, the negative indirect effect of chlorophyll content towards yield per hectare was observed through fruit length (-0.0010) and yield per plot (-0.09878), which was in close conformity with the findings of Thulasiram *et al* (2017) in okra. While, chlorophyll content, at phenotypic level imparted a negative indirect effect through yield per plot (-0.0645). Sawant *et al* (2014) and Thulasiram *et al* (2017) also came up with similar results in okra.

Ash content (%)

At genotypic level, the positive indirect effect of ash content towards yield per hectare was observed via yield per plot (0.3836), whereas its negative indirect effect was observed through pedicel length (-0.0010) and moisture content (-0.0016) which was in line with the findings of Olivera *et al* (2012), Reddy *et al* (2013) and Sawant *et al* (2014) in okra. While, at phenotypic level, the positive indirect effect of ash content towards yield per hectare was observed via yield per plot (0.2921) which was as per the findings of Olivera *et al* (2012) and Sawant *et al* (2014) in okra.

Moisture content

Moisture content, at genotypic level disclosed positive indirect effect on yield per hectare through yield per plot (0.1798), Physiological loss (0.0026), fruit length (0.0011), internodal length (0.0010), whereas the negative indirect effect of moisture content was observed via pedicel length (-0.0015) which was similar with the findings of Kumar *et al* (2012) and Sawant *et al* (2014) in okra. Moisture content, at phenotypic level disclosed positive indirect effect on yield per hectare through yield per plot (0.1620) which was in line with the findings of Reddy *et al* (2013) and Sharma and Prasad (2015) in okra.

Number of seeds per fruit

Number of seeds per fruit, at genotypic level imparted positive indirect effect on yield per hectare via the number of primary branches per plant (0.0010). However, a negative indirect effect of the number of seeds per fruit towards yield per hectare was observed through yield per plot (-0.1982). Earlier, workers like Kumar *et al* (2012) and Pithiya *et al* (2017) also recorded similar observations in okra. Number of seeds per fruit, at phenotypic level imparted negative indirect effect through yield per plot (-0.1663) which was in accordance with the findings of Kerure *et al* (2017) and Raval *et al* (2019) in okra.

CONCLUSION

Path coefficient analysis based on direct and indirect effects of several traits on yield per hectare revealed that plant height, pedicel length, fruit length, days taken to first fruit set, number of primary branches per plant, pedicel diameter, petiole length, days taken to first germination, petiole diameter and average fruit weight had a positive direct effect on yield per hectare. The correlation and path analysis together indicated that yield per hectare had a positive and direct association with days taken to first germination, plant height, number of primary branches per plant, number of fruits per plant, average fruit weight, fruit length, and yield per plot. Hence, selection of these characters should be taken into consideration in future varietal enhancement programme in okra.

Analysis on Genotypic and Phenotypic Path Coefficients

Table 1: Genotypic and phenotypic path coefficient estimates of direct and indirect effects of different traits on yield per hectare in okra

Characters		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	26
1	G	**0.0014**	-0.0015	-0.0004	0.0017	0.0004	-0.0003	-0.0001	0.0002	0.0005	-0.0001	0.0001	0.0001	-0.0004	-0.0006	-0.0003	0.0000	-0.074
	P	**0.0006**	0.0000	-0.0001	0.0002	0.0000	-0.0002	0.0000	0.0000	0.0000	0.0001	0.0004	0.0003	0.0000	-0.0001	-0.0002	0.0000	-0.067
2	G	-0.0005	**0.0040**	0.0002	-0.0018	-0.0003	-0.0003	0.0000	0.0000	-0.0003	0.0000	-0.0001	0.0000	-0.0012	0.0013	-0.0001	-0.0001	-0.428**
	P	-0.0001	**0.0000**	0.0001	-0.0003	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	-0.0002	-0.0002	0.0001	0.0003	-0.0001	-0.0001	-0.416**
3	G	-0.0003	0.0005	**0.0018**	-0.0011	-0.0004	-0.0008	0.0000	0.0000	0.0001	-0.0004	-0.0003	0.0000	-0.0003	0.0001	-0.0003	-0.0001	-0.594**
	P	-0.0001	0.0000	**0.0006**	-0.0002	0.0000	-0.0003	0.0000	0.0000	0.0000	0.0002	-0.0005	0.0001	0.0000	0.0000	-0.0001	-0.0002	-0.567**
4	G	-0.0008	0.0025	0.0006	**-0.0029**	0.0001	-0.0004	0.0001	0.0000	0.0000	-0.0001	-0.0002	-0.0001	-0.0015	0.0011	-0.0002	0.0000	-0.514**
	P	-0.0002	0.0000	0.0002	**-0.0005**	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0001	-0.0004	-0.0004	0.0001	0.0003	-0.0002	0.0000	-0.496**
5	G	-0.0003	0.0007	0.0005	0.0001	**-0.0015**	0.0003	0.0001	0.0001	-0.0006	-0.0001	-0.0002	0.0001	0.0001	-0.0004	0.0003	0.0000	0.113
	P	-0.0001	0.0000	0.0001	0.0000	**-0.0002**	0.0001	0.0000	0.0000	0.0000	0.0001	-0.0003	0.0004	0.0000	-0.0001	0.0001	0.0000	0.093
6	G	-0.0003	-0.0009	-0.0009	0.0008	-0.0003	**0.0016**	0.0001	0.0000	-0.0002	0.0001	0.0000	0.0000	0.0013	-0.0010	0.0004	0.0001	0.253*
	P	-0.0001	0.0000	-0.0002	0.0001	0.0000	**0.0008**	0.0000	0.0000	0.0000	-0.0001	0.0001	0.0001	-0.0001	-0.0002	0.0002	0.0001	0.194
7	G	-0.0002	-0.0001	0.0000	-0.0003	-0.0001	0.0001	**0.0012**	0.0001	-0.0005	0.0001	0.0000	0.0000	-0.0004	-0.0009	0.0002	0.0000	0.023
	P	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	**-0.0003**	-0.0001	0.0000	0.0000	0.0001	0.0001	0.0000	-0.0001	0.0001	-0.0001	-0.005
8	G	0.0005	-0.0001	0.0001	-0.0002	-0.0003	0.0001	0.0002	**0.0004**	0.0001	-0.0001	0.0000	0.0001	-0.0003	-0.0014	-0.0001	0.0000	-0.244*
	P	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0013**	0.0000	0.0000	-0.0002	0.0001	0.0000	-0.0001	0.0002	-0.0001	-0.120
9	G	0.0004	-0.0007	0.0001	0.0000	0.0005	-0.0001	-0.0003	0.0000	**0.0017**	0.0000	0.0001	0.0000	-0.0006	0.0004	-0.0005	0.0000	-0.242*
	P	0.0001	0.0000	0.0000	0.0000	0.0001	-0.0001	0.0000	0.0000	**0.0001**	0.0000	0.0002	0.0000	0.0001	0.0001	-0.0002	-0.0001	-0.212
10	G	0.0002	0.0002	0.0014	-0.0007	-0.0003	-0.0005	-0.0001	0.0001	0.0000	**-0.0005**	-0.0003	0.0001	-0.0002	0.0002	-0.0001	-0.0001	-0.695**
	P	0.0001	0.0000	0.0003	-0.0001	0.0000	-0.0002	0.0000	0.0001	0.0000	**0.0004**	-0.0005	0.0002	0.0000	0.0001	-0.0001	-0.0001	-0.558**
11	G	-0.0003	0.0011	0.0012	-0.0015	-0.0008	0.0000	0.0000	0.0000	-0.0005	-0.0004	**-0.0004**	0.0000	-0.0008	0.0003	-0.0001	0.0000	-0.450**
	P	-0.0002	0.0000	0.0003	-0.0002	-0.0001	0.0000	0.0000	0.0002	0.0000	0.0002	**-0.0011**	0.0000	0.0000	0.0001	0.0002	0.0000	-0.280*
12	G	0.0005	-0.0009	0.0002	0.0012	-0.0006	0.0002	0.0002	0.0001	0.0000	-0.0001	0.0000	**0.0002**	0.0006	-0.0013	0.0002	0.0000	0.073
	P	0.0001	0.0000	0.0001	0.0002	-0.0001	0.0001	0.0000	0.0002	0.0000	0.0001	0.0000	**0.0011**	0.0000	-0.0003	0.0001	0.0000	0.068
13	G	-0.0002	-0.0019	-0.0002	0.0018	0.0000	0.0008	-0.0002	-0.0001	-0.0004	0.0001	0.0001	0.0001	**0.0024**	-0.0012	0.0002	0.0001	0.494**
	P	-0.0001	0.0000	-0.0001	0.0003	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002	**-0.0002**	-0.0003	0.0001	0.0001	0.395**
14	G	0.0003	-0.0021	-0.0001	0.0013	-0.0003	0.0007	0.0004	0.0002	-0.0003	0.0000	0.0001	0.0001	0.0011	**-0.0025**	0.0002	0.0001	0.319**
	P	0.0000	0.0000	0.0000	0.0002	0.0000	0.0002	0.0000	0.0002	0.0000	0.0000	0.0001	0.0004	-0.0001	**-0.0008**	0.0001	0.0001	0.257*
15	G	-0.0005	-0.0005	-0.0006	0.0007	-0.0005	0.0007	0.0003	-0.0001	-0.0010	0.0001	0.0000	0.0000	0.0006	-0.0007	**0.0009**	0.0000	0.496**
	P	-0.0001	0.0000	-0.0001	0.0001	0.0000	0.0002	0.0000	0.0003	0.0000	0.0000	-0.0002	0.0001	0.0000	-0.0001	**0.0008**	0.0000	0.312**
16	G	0.0001	-0.0010	-0.0008	0.0002	0.0000	0.0006	-0.0002	-0.0001	-0.0003	0.0002	0.0000	0.0000	0.0008	-0.0008	0.0000	**0.0002**	0.649**
	P	0.0000	0.0000	-0.0002	0.0000	0.0000	0.0002	0.0001	-0.0003	0.0000	-0.0001	0.0000	-0.0001	-0.0001	-0.0002	0.0001	**0.0005**	0.482**
17	G	0.0007	-0.0002	0.0011	-0.0001	-0.0004	-0.0006	0.0003	0.0001	0.0000	-0.0004	-0.0001	0.0001	-0.0004	-0.0005	-0.0003	-0.0001	-0.545**
	P	0.0002	0.0000	0.0003	0.0000	0.0000	-0.0002	0.0000	0.0000	0.0000	0.0002	-0.0001	0.0004	0.0000	-0.0002	-0.0002	-0.0002	-0.475**

Characters		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	26
18	G	0.0002	0.0006	0.0007	-0.0006	-0.0010	-0.0002	-0.0001	0.0001	-0.0003	-0.0002	-0.0002	0.0001	-0.0006	-0.0008	-0.0001	0.0000	-0.269*
	P	0.0001	0.0000	0.0002	-0.0001	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0001	-0.0004	0.0003	0.0001	-0.0002	-0.0001	0.0000	-0.244*
19	G	0.0003	-0.0024	-0.0004	0.0009	0.0004	0.0007	0.0004	0.0003	0.0005	0.0000	0.0000	0.0000	0.0001	-0.0014	0.0001	0.0000	0.042
	P	0.0000	0.0000	-0.0001	0.0001	0.0000	0.0002	0.0000	0.0003	0.0000	0.0000	0.0000	0.0001	0.0000	-0.0003	0.0001	0.0000	0.034
20	G	0.0002	0.0005	0.0014	-0.0007	-0.0003	-0.0005	-0.0002	0.0001	0.0002	-0.0005	-0.0002	0.0001	0.0000	0.0003	-0.0002	-0.0001	-0.666**
	P	0.0001	0.0000	0.0004	-0.0001	0.0000	-0.0002	0.0000	0.0001	0.0000	0.0003	-0.0004	0.0003	0.0000	0.0001	-0.0001	-0.0002	-0.614**
21	G	0.0001	0.0003	0.0015	-0.0007	-0.0004	-0.0006	-0.0002	0.0001	0.0002	-0.0005	-0.0003	0.0001	-0.0001	0.0002	-0.0001	-0.0001	-0.654**
	P	0.0001	0.0000	0.0004	-0.0001	0.0000	-0.0002	0.0000	0.0001	0.0000	0.0003	-0.0004	0.0003	0.0000	0.0001	-0.0001	-0.0001	-0.566**
22	G	0.0004	-0.0016	0.0001	0.0011	-0.0002	0.0005	0.0001	0.0001	0.0003	0.0000	0.0001	0.0000	0.0008	-0.0018	-0.0001	0.0000	0.004
	P	0.0001	0.0000	0.0000	0.0001	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	-0.0001	-0.0003	-0.0001	0.0000	-0.013
23	G	-0.0004	-0.0001	0.0010	-0.0004	-0.0005	-0.0001	0.0002	0.0001	0.0001	-0.0002	-0.0002	0.0001	-0.0001	-0.0005	0.0004	-0.0001	-0.198
	P	-0.0001	0.0000	0.0003	-0.0001	-0.0001	0.0000	0.0000	0.0002	0.0000	0.0001	-0.0003	0.0005	0.0000	-0.0001	0.0002	-0.0001	-0.167
24	G	0.0005	0.0000	-0.0009	0.0001	0.0002	0.0002	0.0001	0.0001	-0.0004	0.0001	0.0001	0.0000	0.0002	-0.0008	0.0005	0.0001	0.265*
	P	0.0001	0.0000	-0.0002	0.0000	0.0000	0.0002	0.0000	0.0001	0.0000	-0.0001	0.0001	0.0000	0.0000	-0.0001	0.0003	0.0001	0.252*
25	G	-0.0001	-0.0017	-0.0011	0.0015	-0.0002	0.0004	0.0000	-0.0001	-0.0004	0.0003	0.0002	0.0000	0.0012	-0.0008	0.0004	0.0001	1.000**
	P	0.0000	0.0000	-0.0003	0.0003	0.0000	0.0002	0.0000	-0.0002	0.0000	-0.0002	0.0003	0.0001	-0.0001	-0.0002	0.0003	0.0002	1.000**
27	G	-0.0001	0.0004	0.0009	-0.0008	-0.0003	-0.0009	-0.0004	-0.0002	-0.0002	-0.0002	-0.0002	0.0000	-0.0008	0.0006	0.0002	0.0000	-0.175
	P	0.0000	0.0000	0.0003	-0.0001	0.0000	-0.0003	0.0001	-0.0002	0.0000	0.0002	-0.0004	0.0001	0.0001	0.0001	0.0001	0.0000	-0.157
28	G	0.0001	0.0017	-0.0001	0.0001	-0.0002	0.0004	-0.0004	0.0001	0.0000	0.0001	-0.0001	0.0000	-0.0007	-0.0003	0.0002	0.0000	-0.382**
	P	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	0.0000	0.0000	-0.0001	0.0001	0.0000	0.0000	0.0000	-0.0001	-0.204
29	G	0.0011	0.0019	0.0001	0.0001	-0.0003	-0.0005	-0.0002	0.0002	-0.0005	-0.0001	0.0000	0.0000	-0.0010	0.0002	-0.0004	-0.0001	-0.098
	P	0.0001	0.0000	0.0000	0.0000	0.0000	-0.0001	0.0000	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	-0.0001	-0.064
30	G	0.0002	0.0001	0.0002	0.0009	-0.0004	0.0001	0.0000	0.0000	-0.0001	-0.0001	0.0000	0.0001	0.0007	-0.0006	0.0002	0.0000	0.383**
	P	0.0001	0.0000	0.0001	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001	0.0000	0.0005	0.0000	-0.0001	0.0000	0.0000	0.292**
31	G	-0.0002	0.0001	-0.0002	0.0010	0.0000	-0.0004	-0.0002	0.0000	0.0003	0.0002	0.0002	0.0000	0.0011	-0.0002	0.0003	0.0000	0.180
	P	0.0000	0.0000	-0.0001	0.0001	0.0000	0.0000	0.0001	-0.0001	0.0000	-0.0001	0.0004	0.0001	-0.0001	-0.0001	0.0000	0.0000	0.163
32	G	0.0001	0.0001	-0.0005	-0.0001	0.0005	-0.0004	0.0002	-0.0001	0.0001	0.0002	0.0002	0.0000	-0.0004	0.0008	-0.0002	0.0000	-0.074
	P	0.0000	0.0000	-0.0001	0.0000	0.0000	-0.0001	0.0000	-0.0002	0.0000	-0.0001	0.0004	-0.0001	0.0000	0.0002	-0.0001	0.0000	-0.067

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Table 2: Genotypic and phenotypic path coefficient estimates of direct and indirect effects of different traits on yield per hectare in okra

Characters		17	18	19	20	21	22	23	24	25	27	28	29	30	31	32	R with 26 (yield)
1	G	-0.0004	0.0005	0.0004	0.0003	-0.0001	0.0002	0.0001	0.0001	-0.0745	-0.0001	0.0000	-0.0007	-0.0002	0.0002	0.0001	-0.074
	P	-0.0002	0.0000	0.0000	-0.0003	0.0003	0.0000	0.0002	-0.0001	-0.0681	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.067
2	G	0.0000	0.0005	-0.0011	0.0002	-0.0001	-0.0002	0.0000	0.0000	-0.4282	0.0002	-0.0002	-0.0004	0.0000	0.0000	0.0001	-0.428**
	P	0.0000	0.0000	0.0000	-0.0002	0.0001	0.0000	0.0000	0.0000	-0.4153	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	-0.416**
3	G	-0.0005	0.0014	-0.0004	0.0014	-0.0014	0.0000	-0.0001	-0.0002	-0.5932	0.0010	0.0001	0.0000	-0.0001	0.0002	-0.0007	-0.594**
	P	-0.0004	0.0001	0.0000	-0.0014	0.0012	0.0000	-0.0004	0.0002	-0.5655	0.0000	0.0000	0.0000	0.0000	0.0001	-0.0002	-0.567**
4	G	0.0000	0.0008	-0.0005	0.0004	-0.0004	-0.0002	0.0000	0.0000	-0.5134	0.0006	0.0000	0.0000	0.0002	0.0005	0.0001	-0.514**
	P	0.0000	0.0000	0.0000	-0.0004	0.0003	0.0000	-0.0001	0.0000	-0.4946	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	-0.496**
5	G	-0.0002	0.0022	-0.0005	0.0004	-0.0005	0.0001	-0.0001	0.0000	0.1133	0.0003	-0.0001	-0.0002	-0.0002	0.0000	-0.0008	0.113
	P	-0.0002	0.0001	0.0000	-0.0003	0.0003	0.0000	-0.0002	0.0000	0.0932	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0002	0.093
6	G	0.0003	-0.0004	0.0008	-0.0006	0.0006	0.0002	0.0000	0.0000	0.2521	-0.0011	-0.0001	0.0003	-0.0001	0.0004	-0.0006	0.253*
	P	0.0002	0.0000	0.0000	0.0004	-0.0003	0.0000	0.0000	-0.0001	0.1930	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0001	0.194
7	G	-0.0002	-0.0004	0.0007	-0.0003	0.0003	0.0001	0.0000	0.0000	0.0231	-0.0006	0.0002	0.0002	0.0000	0.0003	0.0005	0.023
	P	-0.0001	0.0000	0.0000	0.0002	-0.0001	0.0000	-0.0001	-0.0001	-0.0055	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	-0.005
8	G	-0.0002	0.0006	0.0012	0.0006	-0.0005	0.0002	-0.0001	0.0001	-0.2436	-0.0007	-0.0002	-0.0004	-0.0001	0.0001	-0.0004	-0.244*
	P	0.0000	0.0000	0.0000	-0.0002	0.0001	0.0000	-0.0001	0.0000	-0.1206	0.0000	0.0000	-0.0001	0.0000	0.0001	-0.0001	-0.120
9	G	0.0000	-0.0007	0.0006	0.0002	-0.0002	0.0001	0.0000	-0.0001	-0.2429	-0.0002	0.0000	0.0002	0.0000	-0.0003	0.0001	-0.242*
	P	0.0000	0.0000	0.0000	-0.0001	0.0001	0.0000	0.0000	0.0001	-0.2124	0.0000	0.0000	0.0001	0.0000	-0.0001	0.0000	-0.212
10	G	-0.0006	0.0017	-0.0001	0.0018	-0.0018	0.0000	-0.0001	-0.0001	-0.6956	0.0009	0.0001	-0.0002	-0.0003	0.0006	-0.0010	-0.695**
	P	-0.0004	0.0001	0.0000	-0.0017	0.0015	0.0000	-0.0002	0.0001	-0.5573	0.0000	0.0000	0.0000	0.0000	0.0002	-0.0002	-0.558**
11	G	-0.0002	0.0017	0.0000	0.0011	-0.0012	-0.0001	-0.0001	-0.0001	-0.4493	0.0011	-0.0001	0.0000	-0.0001	0.0006	-0.0012	-0.450**
	P	-0.0001	0.0001	0.0000	-0.0007	0.0007	0.0000	-0.0002	0.0001	-0.2792	0.0000	0.0000	0.0000	0.0000	0.0002	-0.0003	-0.280*
12	G	-0.0004	0.0011	0.0002	0.0005	-0.0006	0.0001	-0.0001	0.0000	0.0726	0.0002	-0.0001	-0.0001	-0.0005	-0.0002	-0.0001	0.073
	P	-0.0003	0.0001	0.0000	-0.0006	0.0005	0.0000	-0.0004	0.0000	0.0675	0.0000	0.0000	0.0000	0.0000	-0.0001	0.0000	0.068
13	G	0.0001	-0.0008	0.0001	0.0000	0.0001	0.0002	0.0000	0.0000	0.4947	-0.0006	0.0002	0.0004	-0.0002	-0.0007	-0.0004	0.494**
	P	0.0001	0.0000	0.0000	0.0001	-0.0001	0.0000	0.0000	0.0000	0.3947	0.0000	0.0000	0.0001	0.0000	-0.0002	-0.0001	0.395**
14	G	-0.0002	0.0011	0.0010	-0.0002	0.0001	0.0004	0.0000	0.0001	0.3191	-0.0005	-0.0001	0.0001	-0.0002	-0.0001	-0.0009	0.319**
	P	-0.0002	0.0001	0.0000	0.0003	-0.0001	0.0000	-0.0001	-0.0001	0.2570	0.0000	0.0000	0.0000	0.0000	-0.0001	-0.0002	0.257*
15	G	0.0002	-0.0003	0.0003	-0.0003	0.0001	-0.0001	-0.0001	0.0002	0.4964	0.0004	-0.0001	0.0004	-0.0002	-0.0005	-0.0006	0.496**
	P	0.0002	0.0000	0.0000	0.0003	-0.0002	0.0000	-0.0001	-0.0002	0.3117	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0001	0.312**
16	G	0.0004	0.0002	-0.0002	-0.0007	0.0007	0.0000	0.0001	0.0001	0.6497	-0.0002	0.0001	0.0003	0.0000	0.0000	0.0001	0.649**
	P	0.0002	0.0000	0.0000	0.0007	-0.0005	0.0000	0.0001	-0.0001	0.4821	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.482**
17	G	**-0.0008**	0.0021	0.0000	0.0012	-0.0012	0.0001	-0.0001	-0.0001	-0.5453	0.0004	0.0001	-0.0002	-0.0001	0.0007	-0.0006	-0.545**
	P	**-0.0008**	0.0001	0.0000	-0.0011	0.0008	0.0000	-0.0001	0.0001	-0.4739	0.0000	0.0000	0.0000	0.0000	0.0002	-0.0001	-0.475**

Characters		17	18	19	20	21	22	23	24	25	27	28	29	30	31	32	R with 26 (yield)
18	G	-0.0005	**0.0035**	-0.0004	0.0008	-0.0009	0.0002	-0.0001	0.0000	-0.2692	0.0010	-0.0001	-0.0004	-0.0001	0.0004	-0.0011	-0.269*
	P	-0.0004	**0.0002**	0.0000	-0.0008	0.0007	0.0000	-0.0001	0.0000	-0.2433	0.0000	0.0000	-0.0001	0.0000	0.0002	-0.0003	-0.244*
19	G	0.0000	-0.0007	**0.0018**	-0.0005	0.0004	0.0003	0.0000	0.0000	0.0417	-0.0009	0.0000	0.0005	0.0002	0.0005	-0.0006	0.042
	P	0.0000	-0.0001	**0.0000**	0.0003	-0.0002	0.0000	0.0000	0.0000	0.0337	0.0000	0.0000	0.0000	0.0000	0.0001	-0.0001	0.034
20	G	-0.0005	0.0016	-0.0005	**0.0018**	-0.0017	0.0000	-0.0001	-0.0001	-0.6663	0.0008	0.0000	-0.0003	-0.0003	0.0004	-0.0009	-0.666**
	P	-0.0004	0.0001	0.0000	**-0.0020**	0.0017	0.0000	-0.0002	0.0001	-0.6137	0.0000	0.0000	0.0000	0.0000	0.0001	-0.0002	-0.614**
21	G	-0.0005	0.0017	-0.0004	0.0018	**-0.0017**	0.0000	-0.0001	-0.0001	-0.6547	0.0011	0.0000	-0.0003	-0.0003	0.0004	-0.0009	-0.654**
	P	-0.0004	0.0001	0.0000	-0.0019	**0.0018**	0.0000	-0.0003	0.0001	-0.5659	0.0000	0.0000	0.0000	0.0000	0.0001	-0.0002	-0.566**
22	G	-0.0002	0.0011	0.0009	0.0000	0.0000	**0.0006**	0.0000	0.0000	0.0034	-0.0007	0.0000	-0.0001	-0.0002	-0.0005	-0.0005	0.004
	P	-0.0001	0.0001	0.0000	0.0001	0.0000	**0.0000**	-0.0001	0.0000	-0.0127	0.0000	0.0000	0.0000	0.0000	-0.0001	-0.0001	-0.013
23	G	-0.0002	0.0008	0.0000	0.0007	-0.0009	0.0000	**-0.0002**	-0.0001	-0.1982	0.0008	-0.0001	0.0002	-0.0003	-0.0002	0.0000	-0.198
	P	-0.0001	0.0000	0.0000	-0.0007	0.0007	0.0000	**-0.0007**	0.0001	-0.1663	0.0000	0.0000	0.0000	0.0000	-0.0001	0.0000	-0.167
24	G	0.0002	0.0003	0.0000	-0.0004	0.0005	0.0001	0.0001	**0.0004**	0.2651	0.0002	-0.0002	-0.0004	0.0000	-0.0004	-0.0008	0.265*
	P	0.0001	0.0000	0.0000	0.0003	-0.0002	0.0000	0.0001	**-0.0006**	0.2520	0.0000	0.0000	0.0000	0.0000	-0.0001	-0.0001	0.252*
25	G	0.0004	-0.0009	0.0001	-0.0012	0.0011	0.0000	0.0000	0.0001	**1.0006**	-0.0004	0.0001	0.0003	0.0001	-0.0006	0.0005	1.000**
	P	0.0004	-0.0001	0.0000	0.0012	-0.0010	0.0000	0.0001	-0.0001	**0.9992**	0.0000	0.0000	0.0001	0.0000	-0.0002	0.0001	1.000**
27	G	0.0001	0.0008	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	-0.1745	**0.0004**	-0.0006	-0.0007	-0.0002	-0.0005	-0.0003	-0.175
	P	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0001	-0.0001	-0.1573	**0.0000**	-0.0001	-0.0001	0.0000	-0.0001	-0.0001	-0.157
28	G	-0.0002	0.0016	-0.0010	0.0007	-0.0006	0.0000	0.0001	0.0002	-0.3815	0.0003	**-0.0005**	-0.0009	0.0000	0.0000	-0.0003	-0.382**
	P	-0.0001	0.0000	0.0000	-0.0002	0.0001	0.0000	0.0001	-0.0001	-0.2041	0.0000	**0.0000**	-0.0003	0.0000	0.0000	0.0000	-0.204
29	G	-0.0001	0.0005	-0.0003	0.0006	-0.0007	0.0001	-0.0001	0.0000	-0.0978	0.0003	-0.0002	**0.0000**	**-0.0008**	-0.0008	0.0003	-0.098
	P	-0.0001	0.0000	0.0000	-0.0005	0.0004	0.0000	-0.0003	0.0000	-0.0645	0.0000	0.0000	**0.0000**	**-0.0001**	-0.0002	0.0001	-0.064
30	G	0.0003	-0.0010	-0.0006	-0.0005	0.0004	0.0002	0.0000	0.0001	0.3836	0.0001	-0.0002	0.0000	**-0.0004**	-0.0016	0.0002	0.383**
	P	0.0002	-0.0001	0.0000	0.0003	-0.0002	0.0000	-0.0001	-0.0001	0.2921	0.0000	0.0000	0.0000	**0.0000**	-0.0007	0.0000	0.292**
31	G	0.0002	-0.0015	-0.0004	-0.0006	0.0006	-0.0001	0.0000	-0.0001	0.1798	-0.0005	0.0001	0.0001	-0.0001	**-0.0001**	0.0026	0.180
	P	0.0001	-0.0001	0.0000	0.0006	-0.0005	0.0000	0.0000	0.0001	0.1620	0.0000	0.0000	0.0000	0.0000	**0.0000**	0.0007	0.163
32	G	-0.0004	0.0005	0.0004	0.0003	-0.0001	0.0002	0.0001	0.0001	-0.0745	-0.0001	0.0000	-0.0007	-0.0002	0.0002	**0.0001**	-0.074
	P	-0.0002	0.0000	0.0000	-0.0003	0.0003	0.0000	0.0002	-0.0001	-0.0681	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0000**	-0.067

*, ** significant at 5% and 1% level, respectively

1- Days taken to first germination, 2- Plant height, 3- Number of primary branches per plant, 4- Internodal length, 5- Stem girth, 6- Petiole length, 7- Petiole diameter, 8- Leaf length, 9- Number of epicalyx segments, 10- Days taken to first flowering, 11- Number of nodes at first flowering, 12 -flower diameter, 13- Fruit length, 14- Fruit diameter, 15- Average fruit weight, 16- Number of fruits per plant, 17- Number of ridges per fruit, 18- Pedicel length, 19- Pedicel diameter, 20- Days taken to first fruit set, 21- Days taken to first fruit harvest, 22- Flesh thickness, 23- Number of seeds per fruit, 24- Seed index , 25- Yield per plot, 26- Yield per hectare, 27- Total soluble solids, 28- Ascorbic acid, 29- Chlorophyll content, 30- Ash content, 31- Moisture content and 32- Physiological loss.

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Awareness of Meat Safety and Quality among Red Meat Consumers in Kerala

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ABSTRACT

Culinary taste was observed to be important attribute towards consumption of red meat. Among these red meats carabeef and chevon were most accepted among consumers, carabeef being available at less than half of chevon price was widely consumed in Kerala state. With the aim of understanding meat consumers preferences along with their level of awareness on safety and quality of meat, the study was conducted. Socio-demography of consumers revealed that majority of respondents were middle aged group (46.66%), had graduate and above education (41.66%). Majority of carabeef consumers were employed in agriculture and animal husbandry (AH) and from salaried class with the income group of Rs. 1.8 lakh to 4.03 lakh whereas chevon consumers are from salaried class with the income group of 4.03 lakh to 6.26lakh. Fish was the most consumed meat followed by chicken, carabeef, beef and chevon with per capita consumption of 32.46 Kg, 16.5 Kg 7.26 Kg, 4.62 Kg and 3.66 Kg, respectively. Majority of (58.33%) consumers had a medium level of awareness, while studying domain-wise awareness of consumers, optimum storage conditions and consumption period for meat and awareness about hygiene at the meat shop were the domains where consumers have high (Mean score 52.83) and low level of awareness (MS 45.18). Adopting multiple linear regressions on understanding factors influencing consumer's awareness revealed that gender, education, family size, type of family and quantity of meat consumed were the factors prompting at 5 per cent level ($P < 0.05$), whereas total annual income influencing at 1 per cent level ($P < 0.01$).

Key Words: Awareness,Carabeef, Chevon, Per capita consumption, Quality meat, Red Meat.

INTRODUCTION

Red meat is an essential component of human diets, valued for its nutritional richness, including high-quality proteins, vitamins and minerals. However, the safety and quality of red meat have increasingly drawn public health and regulatory attention due to concerns about contamination, improper handling and adulteration (Gracy *et al*, 2009). Meat safety issues, such as microbial contamination, the presence of antibiotic residues and unhygienic slaughtering practices, pose significant risks to consumer health and highlight the need for effective quality control mechanisms (Viegas *et al*, 2021).

Kerala, with its unique dietary preferences and high per capita red meat consumption, presents an interesting case for studying meat safety and consumer awareness. The state's dependence on both organized retail and informal markets creates challenges in maintaining safety and quality standards. Consumer awareness is critical to mitigating health risks associated with unsafe meat practices. Studies have shown that informed consumers are more likely to demand safer, higher-quality products and adopt hygienic meat handling practices (Nagyová *et al*, 2022; Kiran *et al*, 2018). Consumer attitudes and perceptions toward meat safety and quality are shaped by a variety of factors, including cultural practices, education and socio-economic status. Research conducted in Southern India reveals

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Table 1. Distribution of red meat consumers as per their socio-demographic characteristics

n=60

Socio – demographic variable	Consumers		
	Carabeef	Chevon	Total
Age			
Young up to 35	3 (10.00)	4 (13.33)	7 (11.66)
middle aged 36-50	13 (43.33)	15 (50.00)	28 (46.66)
old aged above 50	14 (46.66)	11 (36.66)	25 (41.66)
Gender			
Male	22 (73.33)	25 (83.33)	47 (78.33)
Female	8 (26.66)	5 (16.66)	13 (21.66)
Education			
Illiterate	00	00	00
Primary and secondary	14 (46.66)	11(36.66)	25 (41.66)
Higher secondary	5 (16.66)	2 (6.66)	7 (11.66)
Graduate and above	11 (36.66)	17 (56.66)	28 (46.66)
Family size			
Small (up to 3)	5 (16.66)	2 (6.66)	7 (11.66)
Medium (3 to 6)	24 (80.0)	25 (83.33)	49 (81.66)
Large (Above 6)	1 (3.33)	3 (10.00)	4 (6.66)
Average Family size	4.5	5.23	
Type of Family			
Nuclear	15 (50.00)	13 (43.33)	28 (46.66)
Joint	15 (50.00)	17 (56.66)	32 (53.33)
Occupation			
Agriculture and Animal Husbandry (AH)	9 (30.00)	7 (23.33)	16 (26.66)
Wage employment	6 (20.00)	4 (13.33)	10 (16.66)
Salaried class	9 (30.00)	8 (26.66)	17 (28.33)
Business	3 (10.00)	7 (23.33)	10 (16.66)
Self employed	2 (6.66)	4 (13.33)	6 (10.00)
Others	1 (3.33)	0	1(1.66)
Annual income Rs in lakh			
Rs. 1.80-4.03	24 (80.00)	12 (40.00)	36 (60.00)
Rs. 4.03 - 6.26	2 (6.66)	13 (43.33)	15 (25.00)
Rs. 6.26 - 8.50	4 (13.33)	5 (16.66)	9 (15.00)

significant gaps in consumer knowledge and practices concerning meat safety, highlighting the urgent need for awareness campaigns and policy interventions (Kiran *et al*, 2018). Furthermore, perceptions of quality, hygiene and risks associated with meat often influence consumer behaviour more than actual scientific evidence (Viegas *et al*, 2021).

This study aimed to assess the awareness levels of red meat consumers in Kerala regarding safety and quality issues. By exploring consumer perceptions and attitudes, this research seeks to provide insights into the challenges faced by the state's meat supply chain and offer recommendations for improving public health and food safety.

MATERIALS AND METHODS

A study was conducted among six districts of Kerala; stratified multistage sampling was resorted for selection of the districts, the 14 districts of the state will be considered as three strata *viz.,* southern Kerala, central Kerala and northern Kerala. In the first stage of sampling, the district with the highest buffalo/goat populations as per the twentieth livestock census (DAHD,

Table 2. Distribution of red meat consumer as per their purchasing and consumption behaviour. n=60

Purchasing behaviour	Consumers		
	Carabeef	Chevon	Total
Purchasing source			
Backyard slaughtering	1 (3.33)	5 (16.66)	6 (10.00)
Retail shop	10 (33.33)	12 (40.00)	22 (36.66)
Super market	1 (3.33)	00	1 (1.66)
Hotel and retail shop	16 (53.33)	10 (33.33)	26 (43.33)
Back yard and Retail shop	2 (6.66)	3 (10.00)	5 (8.33)
Offal consumption			
Grey offal	8 (26.66)	13 (43.33)	21 (35.00)
Red offal	4 (13.33)	4 (13.33)	8 (13.33)
Dark offal	00	12 (40.00)	12 (20.00)
Non consumers	20 (66.66)	10 (33.33)	30 (50.00)
Factors considered while purchasing			
Quality	6 (20.00)	5 (16.66)	11 (18.33)
Price	1 (3.33)	1 (3.33)	2 (3.33)
Both	23 (76.66)	24 (80.0)	47 (78.33)

2021) from each stratum would be selected for the study. Thus in the case of carabeef value chains, Malappuram, Thrissur and Kollam districts will be selected, whereas in the case of chevon value chains, Malappuram, Palakkad and Thiruvanathapuram districts will be selected respectively from the northern, central and southern Kerala. In the second stage of sampling from the selected districts of each stratum 10 consumers will be randomly selected (Verma, 2019) with respect to chevon and carabeef so that the study would cover a total of 30 chevon consumers and 30 carabeef consumers. Hence, 60 respondents were interviewed with pretested interview schedule, which was subjected to pilot study at Kannur and Wayanad district. Consumers Awareness on safety and quality of meat was analysed using the adopted scale (Aswathy, 2023). The multiple linear regression analysis was used to find out factors influencing the awareness of consumers about safety and quality of meat and meat products. The collected data was analysed by SPSS version 24.0.

RESULTS AND DISCUSSION

The findings of this study (Table 1) indicated that majority of the respondents were old-aged (43.33%), whereas among chevon consumers majority are from middle aged group (50.00%). Education profile of respondents revealed that majority of carabeef consumers (46.66%) were possess primary and secondary education, whereas majority of chevon consumers (56.66%) had graduate and above education, with respect to family size both carabeef and chevon consumers (80.0% and 83.33%) majorly belongs to medium family size. Studying occupation and annual income of red meat consumers, majority of carabeef consumers employed in agriculture and AH sector and works as salaried employee (30.00% each) and belongs to the income group of Rs. 1.8lakh to 4.03 lakh (80.00%), whereas majority of chevon consumers were belongs to salaried class (26.66%) and falls to the income group of Rs. 4.03 lakh to 6.26 lakh (43.33%). The above results were in consistent with findings of Kiran *et al* (2018) and Chandran *et al* (2024) with respect to studied age group.

Table 3. Per capita meat consumption (Kg.)

n = 60

Meat type	Carabeef Consumers	Chevon Consumers	Average
Fish	32.4	32.52	32.46
Chicken	15.24	17.76	16.5
Carabeef	8.04	6.48	7.26
Beef	4.56	4.68	4.62
Chevon	3.24	4.08	3.66
Others	3.24	0.24	1.74
Total	66.72	65.76	66.24

Table 4. Distribution of consumers based on overall awareness about safety and quality of meat and meat products. n=60

Sr. No.	Scores	Carabeef f (%)	Chevon f (%)	Total f (%)
1	Low (80-89)	8 (23.66)	2 (6.66)	10 (16.66%)
2	Medium (90-98)	19 (63.33)	16 (53.33)	35 (58.33%)
3	High (99-108)	3 (10.00)	12 (40.00)	15 (25.00%)
4	Total	30 (100.00)	30 (100.00)	60 (100.00)

It could be inferred from the study (Table 2) that hotel and retail shop was the most preferred source for carabeef purchase (53.33%), which was followed by retail shop source (33.33%). Among the chevon consumers, retail shop was the most depended source (40.00%) which was followed by hotel and retail shop source (33.33%). Studying the preference for offals revealed that little more than quarter of studied carabeef consumers (26.66%) preferred grey offal whereas only 13.33 per cent of carabeef consumers preferred red offal. With respect to chevon consumers nearly half of the respondents (43.33%) preferred grey offal, followed by this little less consumers (40.00%) preferred dark offal, whereas preference for red offal was meagre (13.33%). Two third (66.66%) of carabeef consumers, don't prefer any kind of offals, whereas it was accounted to be one third (33.33%) among chevon consumers. In contrary study conducted by Ayman *et al* (2020) on offal consumption and documented that dark offals were the least preferred type of offal meat, while grey offals were consumed by only about half of the population. Among the factors quality and price, majority of consumers (78.33%) considered both while purchasing red meat.

The most preferred meat was fish (32.46 Kg) followed by chicken (16.5 Kg), carabeef (7.26 Kg), beef (4.62 Kg) and chevon (3.66 Kg). apart from quantity of consumption there was no significant difference in order of preference among carabeef and chevon consumers towards various meat types. It was observed from the other studies (Kiran *et al,* 2018; Jayanthi *et al,* 2024 and Sivaprasad *et al,* 2024) that chicken was the most preferred among other meats, whereas they haven't considered fish among those meat categories.

From data in Table 4 it can be inferred that with respect to the extent of awareness of consumers about the safety and quality of meat and meat products, 58.33 per cent of consumers had a medium level of awareness while 25.00 per cent of consumers had a high level of awareness only 16.66 per cent consumers had a low level of awareness. Similar study was conducted by Aswathy (2023) and reported that majority of studied consumers had medium level of awareness, followed by low and high level of awareness.

Table 5. Domain-wise awareness of consumers about safety and quality of meat and meat products. n=60

Sr. No.	Domain-wise awareness of consumers	Carabeef		Chevon		Red meat	
		Mean score	Rank	Mean score	Rank	Mean score	Rank
1	Optimum storage conditions and consumption period for meat	52.66	1	53	2	52.83	1
2	Meat quality	52	2	53.45	1	52.73	2
3	Packed meat and meat products	51	3	51	5	51	3
4	Hygiene of the meat handler	50.28	4	50.57	6	50.43	4
5	Hygiene cooking practice	47.33	7	51.66	3	49.49	5
6	Post-buying hygienic meat handling practices for consumers	45	5	51.2	4	48.1	6
7	Meat storage practice for consumer	45	6	48.75	7	46.88	7
8	Awareness about hygiene at the meat shop	44.54	8	45.81	8	45.18	8
	Total	48.43		50.27		49.58	

Table 6. Demographic variables associated factors influencing the awareness of red meat consumers about safety and quality of meat and meat products

X_i	Variables	Carabeef		Chevon	
		Standardized Co-efficients β_i	t-statistic	Standardized Co-efficients β_i	t-statistic
X_1	Age	-.198	-1.244	-.216	-1.298
X_2	Gender	.266*	2.767	.294	1.985
X_3	Education	.405*	2.148	.415*	2.851
X_4	Social category	-.133	-.697	-.035	-.212
X_5	Occupation	.160	.895	.144	1.060
X_6	Total annual income	.397*	2.137	.172**	6.381
X_7	Members of group or association	-.278	-1.525	.315	1.700
X_8	Quantity of meat consumed / month (kg)	.435	1.040	-.479*	-2.653
X_9	Offal consumption	.374*	3.027	.157	1.018
X_{10}	Family size	-.183	-.742	-.217*	-7.832
X_{11}	Type of family	-.050	-.224	.546*	2.819
X_{12}	Locality	.153	.916	-.063	-.489
X_{13}	Frequency of consumption	-.268	-.734	.235	1.187
	a. Dependent Variable: Awareness Score				
		N = 30		N =30	
		F-Value = 12.843*		F-Value = 17.990**	
		R^2 = 0.956, Adjusted R^2 = 0.903		R^2 = 0.971, Adjusted R^2 =0 .908	
		* - P < 0.05 ; ** - P < 0.01		* - P < 0.05 ; ** - P < 0.01	

Results with respect to the domain-wise awareness of about safety and quality of meat and meat products (Table 5), it could be inferred that optimum storage conditions and consumption period for meat was the domain where consumers have more awareness (Mean score 52.83), followed by this domains like meat quality (MS 52.73), packed meat and meat products (MS 51), hygiene of the meat handler (MS 50.43), hygiene cooking practice (MS 49.49), post-buying hygienic meat handling practices for consumers (MS 48.1) were in the rank order. Meat storage practice for consumer (MS 46.88) and awareness about hygiene at the meat shop (MS 45.18) were the domains where consumers have lack of awareness.

Among the 13 independent variables used in the regression analysis, the variable gender, education, total annual income and offal consumption was found to influence positively on the extent of awareness of carabeef consumers about safety and quality of meat and meat products at 5 per cent level ($P < 0.05$). Studying among chevon consumers the variables education and type of family were found to influence positively the extent of awareness of chevon consumers about safety and quality of meat and meat products at 5 per cent level ($P < 0.05$), whereas the variables quantity of meat consumed per month and family size were found to influence negatively at 5 per cent level ($P < 0.05$), it was also observed that total annual income was found to influence positively at 1 per cent level ($P < 0.01$) among chevon consumers.

CONCLUSION

It can be concluded from the present study that the red meats were majorly purchased from retail shop and hotels, whereas found that specifically chevon had additional supply chain from backyard slaughtering. Consumers willing less preferred for carabeef offals in compare with chevon. Majority of consumers considering both quality and price attributes while purchasing red meats. Fish was the most consumed meat among study group followed by chicken, carabeef, beef and chevon, except quantity of consumption there is no much difference in preferred rank order of above mentioned meat. Majority of consumers possess medium level of awareness on quality and safety of meat and meat products. Optimum storage conditions and consumption period for meat and awareness about hygiene at the meat shop were the domains where consumers have difference in awareness level with highest and lowest scores respectively. Total annual income was the factors which contribute majorly to the awareness level of consumers towards hygiene and safety of meat and meat products. The results of present study may provide insights into future strategies that extension educationist and meat scientists can adopt to better recognise consumer needs and address food safety challenges in India. Also it assists in understanding consumer preferences and the factors influencing them are crucial for effectively utilizing marketing tools and developing new strategies.

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Bio-efficacy of Botanicals and Newer Insecticide Molecules against Red spider mite, *Tetranychus urticae* Koch (Tetranychidae: Acarina) in Jasmine (*Jasminum sambac* L.)

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ABSTRACT

Field experiments were conducted to evaluate the efficacy of botanicals and newer insecticide molecules against red spider mite, *Tetranychus urticae* Koch in Jasmine. In the present study, NSKE @ 5.0 per cent was found to be the best followed by *pungam* oil @ 2.0 % against red spider mites in Jasmine. Among the acaricides, Diafenthiuron 50 WP @ 0.80 g/l was effective with a reduction of mite population by 87.58% in Jasmine. The results from the present investigation can provide valuable information towards the development of IPM module in Jasmine and seems to be the most significant pest management tool in IPM programme to increase the flower production in Jasmine.

Key Words: Acaricides, Bio-efficacy, Botanicals, Jasmine, Red Spider Mites.

INTRODUCTION

Jasmine (*Jasminum sambac* L.) is important flowering plants which is commercially grown for its fragrant flowers and used for oil production (El-Amir *et al,* 2020). India exports Jasmine flowers to the adjacent countries like Sri Lanka, Singapore, Malaysia and Gulf countries. In South India, huge quantities of Jasmine flowers are used by women folk for beautifying their hairs. Tamil Nadu is the leading state in Jasmine production in the country. The least yield of Jasmine flower production might be due to various reasons, among which the menace by insect pests is of fundamental consequence.

The spider mites generally feed on the lower surface of the leaves as a result the infested leaves initially show speckling and later turn yellowish. The mites spread to all parts of the plants as the population increases especially during day periods and produce webbing over the entire plants. Moderate population may greatly affect crop production and heavy infestation results in death of the plants (Jeppson *et al*, 1975). Farmers depend mostly on acaricides for controlling red spider mites in Jasmine. The decreased efficacy of acaricides and increased concerns over their use in Jasmine ecosystem have emphasized the need for identifying safer, more effective botanicals and newer insecticide molecules for the management of red spider mites in Jasmine. Hence, the present study was carried out to study the efficacy of botanicals and newer insecticide molecules against red spider mites in Jasmine.

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Table 1. Bio-efficacy of botanicals against red spider mites, *T. urticae* in Jasmine.

Treatment	Conc. (%)	Mite population per cm²												Overall Mean	Reduction over untreated check (%)
		1st Spray				2nd Spray				3rd Spray					
		DAS													
		1	3	7	14	1	3	7	14	1	3	7	14		
Notchi (*V. negundo*) leaf extract	5.00	8.56 (2.93)b	8.06 (2.84)b	7.26 (2.69)b	11.59 (3.40)bc	7.59 (2.75)b	7.59 (2.75)c	11.56 (3.40)c	9.42 (3.07)c	11.53 (3.40)b	10.94 (3.31)d	8.43 (2.90)c	12.06 (3.47)bc	9.55 (3.09)a	43.89
NSKE	5.00	7.46 (2.73)a	7.11 (2.67)ab	6.03 (2.46)a	9.06 (3.01)a	6.31 (2.51)ab	5.19 (2.28)a	9.46 (3.08)b	7.06 (2.66)a	10.36 (3.22)a	8.06 (2.84)ab	6.05 (2.46)a	10.59 (3.25)a	7.73 (2.78)b	54.58
Pungam oil	2.00	7.86 (2.80)ab	7.49 (2.74)ab	7.08 (2.66)b	10.32 (3.21)ab	6.98 (2.64)ab	6.25 (2.50)b	10.56 (3.25)c	8.04 (2.84)c	10.59 (3.25)a	9.05 (3.01)bc	7.26 (2.69)b	11.26 (3.36)ab	8.56 (2.93)c	49.70
Sweet flag (A. calamus) rhizome extract	5.00	7.95 (2.82)ab	7.59 (2.75)b	7.43 (2.73)b	10.86 (3.30)b	7.26 (2.69)ab	6.49 (2.55)b	11.04 (3.32)c	8.91 (2.98)c	11.25 (3.35)ab	9.86 (3.14)c	7.38 (2.72)bc	11.86 (3.44)abc	8.99 (3.00)d	47.18
Wildsage (*L. camara*) leaf extract	5.00	9.00 (3.00)ab	7.70 (2.77)b	6.00 (2.45)a	12.60 (3.55)c	9.54 (3.09)c	7.59 (2.75)c	7.25 (2.69)a	12.59 (3.55)d	11.56 (3.40)b	9.59 (3.10)c	8.53 (2.92)c	16.00 (4.00)c	9.61 (3.10)e	43.53
Profenophos 50 EC (Std check)	2.00 ml/lit	7.32 (2.71)	6.51 (2.55)a	5.26 (2.29)a	10.56 (3.25)b	6.25 (2.50)a	4.98 (2.23)a	8.94 (2.99)b	6.80 (2.61)a	10.26 (3.20)a	7.56 (2.75)a	5.49 (2.34)a	12.65 (3.56)bc	7.52 (2.74)a	55.82
Untreated check	-	18.02 (4.25)	17.56 (4.19)c	19.43 (4.41)c	17.53 (4.19)d	16.23 (4.03)d	13.20 (3.63)d	15.43 (3.93)d	16.02 (4.00)e	17.62 (4.20)c	18.46 (4.30)e	16.49 (4.06)d	18.25 (4.27)d	17.02 (4.13)f	0.00
Mean		9.45 (3.07)E	8.86 (2.98)C	8.36 (2.89)B	11.79 (3.43)H	8.59 (2.93)C	7.33 (2.71)A	10.61 (3.26)G	9.83 (3.14)H	11.88 (3.45)H	10.50 (3.24)G	8.52 (2.92)C	13.24 (3.64)I		-

Mean of three replications.
Figures in parentheses are square root transformed values.
In a column/row, means followed by a common letter are not significantly different at 5% level (LSD).

	T	S	D	S x D	T x D x S
Significance	0.01	0.01	0.01	0.01	0.01
CD (P=0.05)	0.02	0.01	0.01	0.02	0.06

Table 2. Bio-efficacy of insecticides against red spider mites, *T. urticae* in Jasmine in Jasmine

Treatment	Dose	Mite population (No./cm²)												Overall Mean	Reduction over untreated check (%)
		1st Spray				2nd Spray				3rd Spray					
		DAS													
		1	3	7	14	1	3	7	14	1	3	7	14		
Emamectin benzoate 5 SC	0.30 g/lit	9.00 (3.00)f	7.70 (2.77)e	6.00 (2.45)e	12.60 (3.55)f	9.54 (3.09)e	7.59 (2.75)f	7.25 (2.69)d	12.59 (3.55)g	11.56 (3.40)e	9.59 (3.10)f	8.53 (2.92)e	16.00 (4.00)f	9.61 (3.10)f	61.70
Diafenthiuron 50 WP	0.80 g/lit	2.11 (1.45)a	2.01 (1.42)a	1.25 (1.12)a	3.50 (1.87)a	4.20 (2.05)a	3.25 (1.80)a	2.10 (1.45)a	4.89 (2.21)a	4.25 (2.06)a	2.03 (1.42)a	3.00 (1.73)a	6.10 (2.47)a	3.12 (1.77)a	87.58
Fenazaquin 10 EC	2.00 ml/lit	6.80 (2.61)d	5.20 (2.28)c	3.60 (1.90)c	8.45 (2.91)d	4.92 (2.22)b	3.66 (1.91)b	7.89 (2.81)e	5.89 (2.43)c	5.57 (2.36)c	5.00 (2.24)d	5.00 (2.24)c	13.56 (3.68)e	6.00 (2.45)d	76.10
Fenpyroximate 5 EC	1.20 ml/lit	4.65 (2.16)b	4.60 (2.14)b	2.54 (1.59)b	6.70 (2.59)b	4.44 (2.11)a	3.56 (1.89)b	2.56 (1.60)b	5.54 (2.35)b	4.20 (2.05)a	2.78 (1.67)b	3.59 (1.89)b	8.30 (2.88)b	4.28 (2.07)b	82.93
Propargite 57 EC	2.50 ml/lit	5.60 (2.37)c	5.00 (2.24)c	2.49 (1.58)b	7.56 (2.75)c	4.96 (2.23)b	3.98 (1.99)c	3.23 (1.80)c	6.23 (2.50)d	4.80 (2.19)b	3.64 (1.91)c	3.56 (1.89)b	9.50 (3.08)c	4.85 (2.20)c	80.67
Spiromesifen 22.9 SC	0.50 ml/lit	7.30 (2.70)e	6.50 (2.55)d	5.20 (2.28)d	10.56 (3.25)e	6.20 (2.49)c	4.98 (2.23)d	8.90 (2.98)f	6.78 (2.60)e	10.25 (3.20)d	7.54 (2.75)e	5.48 (2.34)d	12.64 (3.56)d	7.52 (2.74)e	70.03
Wettable Sulphur 50 WP	2.00 g/lit	11.00 (3.32)g	9.25 (3.04)f	5.23 (2.29)d	10.96 (3.31)e	8.63 (2.94)d	6.55 (2.56)e	7.10 (2.66)d	11.58 (3.40)f	13.10 (3.62)f	20.00 (4.47)g	17.70 (4.21)f	30.45 (5.52)h	12.22 (3.50)g	51.30
Untreated check	-	20.10 (4.48)h	20.80 (4.56)g	22.10 (4.70)f	23.08 (4.80)g	24.11 (4.91)f	25.00 (5.00)g	28.45 (5.33)g	28.33 (5.32)h	27.59 (5.25)g	27.31 (5.23)h	27.22 (5.22)g	27.27 (5.22)g	25.09 (5.01)h	0.00
Mean		8.32 (2.76)E	7.63 (2.63)C	6.05 (2.24)A	10.43 (3.13)J	8.38 (2.75)E	7.32 (2.52)B	8.44 (2.67)D	10.23 (3.05)I	10.17 (3.02)H	9.74 (2.85)G	9.26 (2.80)F	15.48 (3.80)K		-

Mean of three replications.
Figures in parentheses are square root transformed values.
In a column / row, means followed by a common letter are not significantly different at 5% level (LSD).

	T	S	D	S x D	T x S x D
Significance	0.01	0.01	0.01	0.01	0.01

MATERIALS AND METHODS

A field trial was conducted in a farmer's field near village Vallanad, Thoothukudi district, Tamil Nadu, India. The experiment was conducted on existing Jasmine crop of 1.5 years old plants. Three rounds of foliar sprays were given at fortnightly interval using battery operated knapsack sprayer. Pre-treatment observations on the incidence of mites were recorded in each botanicals / synthetic insecticides treated plants. Post treatment counts were recorded on 1st, 3rd, 7th and 14th day after imposing treatment. The population of mites were recorded from twenty randomly selected leaves. In each leaves, one cm^2 area was selected and number of mites were counted and expressed as number of mites per cm^2 (Kiran *et al*, 2017). Randomized Block Design was adopted in each treatment. Three plants per replication and three replications were maintained for each treatment.

To prepare Notchi (*Vitex negundo*) leaf extract, its fresh leaves were collected and dried under room temperature (25±2 °C) and then powdered. A total of 100 gram powdered leaves soaked in 1.0 litre of petroleum ether (boiling range 60–80 °C) was shaken for 24 hours and kept under room temperature for 10 days. After 10 days, the extract was made up to 1000 ml and maintained as standard solution. At the time of spray, 50 ml of standard solution was added in 1000 ml of water and used for spraying (Karunamoorthi *et al*, 2008). Notchi leaf extract was used at a concentration of 5%.

For preparing Neem Seed Kernel Extract (NSKE), a quantity of 50 g dried neem seed kernel was powdered and it was tied in a small muslin cloth bag and dipped in 100 ml of water and kept overnight for 12 hours and the suspension was separated. Then, 900 ml water was added to it and stirred well. The filtrate was used for spraying (Sathyan, 2015). NSKE was used at a concentration of 5%.

Pungam (*Pongamia pinnata*) Oil (Karanj oil) was purchased from the market and sprayed at the rate of 20 ml per litre after thorough mixing with the surfactant. Pungam oil was used at a concentration of 2%.

Sweet flag, *Acorus calamus* (AC 10 % D) rhizome powder of 300 g was added into 1000 ml of distilled water and kept for 24 hours. Then the solvent was filtered. At the time of spray, 50 ml of solvent was used (Shinthiya and Razak, 2017). Sweet flag rhizome powder was used at a concentration of 5%.

Similarly one kg fresh leaves of wild sage, *L. camara* was dried at room temperature and then powdered. One litre of petroleum ether was added to the dried leaves and kept in shaker for 8 hrs. Then, the extract was filtered. The filtrate thus obtained was used for spraying (Deshmukhe *et al*, 2011). Wild sage leaf extract was used at a concentration of 5%. Profenophos 50 EC at a concentration of 2 ml/ lit was used as a standartd check

Similarly newer insecticides like Emamectin benzoate 5 SC @ 0.30 g/l, Diafenthiuron 50 WP @ 0.80 g/ lit, Fenazaquin 10 EC @ 2.00 ml/ li,t Fenpyroximate 5 EC @ 1.20 ml/ lit, Propargite 57 EC @ 2.50 ml/ lit, Spiromesifen 22.9 SC @ 0.50 ml/ lit and Wettable Sulphur 50 WP @ 2.00 g/ lit evaluated against Red spider mites, *Tetranychus urticae* in Jasmine in the field experiments.

RESULTS AND DISCUSSION

Bio-efficacy of botanicals against Red spider mites in Jasmine

Bio-efficacy studies with botanicals against *T. urticae* brought out the variability due to the treatments, spray rounds and period of observations. The influence of interaction was also found significant (Table 1). Overall mean population revealed that all the treatments were able to reduce the mite incidence. Among the botanicals, NSKE @ 5.0 per cent alone was able to reduce the mite population by 54.58 per cent. Though NSKE recorded the least population (7.73 / cm^2), it was inferior to profenophos 50 EC (7.52 /cm^2); profenophos 50 EC recorded the highest reduction of 55.82 per cent. Among the botanicals, *Pungam* oil (8.56/cm^2), sweet flag *(A. calamus)* (8.99 /cm^2), wild sage (L. camara) leaf extract (9.61 /cm^2) and *notchi (V. negundo)* leaf extract (9.55 /cm^2) were better than untreated check recording more than 43 per cent reduction in the mite population, but were inferior to NSKE. Wild sage (L. *camara*) leaf extract and *notchi (V. negundo)* leaf extract were equal between themselves but inferior to all other treatments. The trend was complementary at each spray rounds as well as at each period of observations.

The use of botanical pesticides, an essential component in bio-intensive pest management, helps to reduce the dependence on chemical pesticides and ecological deterioration; and they serve as insecticides, insect repellents and insect feeding deterrents (John *et al*, 2007; Devanand and Rani, 2008). In the present study, wild sage (*L. camara*) leaf extract @ 5.0 per cent and sweet flag (*A. calamus*) rhizome extract were found less effective which may be probably due to the different locations which are influenced differently by different ecological conditions.

Bio-efficacy of insecticides against Red spider mites in Jasmine

The statistical analysis revealed that the variability due to the insecticides, spray rounds and period of observations; their interaction effect was also significant (Table 2). Considering the spray rounds as well as period of observations together the mean population for the treatment ranged from 3.12 (Diafenthiuron 50 WP) to 25.09 (Untreated check) per cm^2. All the treatments were able to reduce the mite population over untreated check. Taking everything into account, diafenthiuron 50 WP shows least population (3.12 / cm^2). Fenpyroximate 5 EC (4.28/ cm^2) stood next and was better than propargite 57 EC (4.85 / cm^2) but inferior to diafenthiuron 50 WP. All other treatments *viz.,* fenazaquin 10 EC (6.00 / cm^2), spiromesifen 22.9 SC (7.52 / cm^2), emamectin benzoate 5 SC (9.61 / cm^2) and wettable sulphur 50 WP (12.22 / cm^2) were found to be less effective than the above three treatments recording less than 80 per cent reduction in mite population over untreated check. Similar was the trend at each spray rounds as well as at each period of observations.

Manju (2013) reported lesser number of mite population on plants treated with diafenthiuron 50 WP followed by fenazaquin 10 EC in carnation. Ramjibhai (2015) has also claimed that fenazaquin 10 EC @ 0.01 per cent is effective against red spider mite, *T. urticae* on okra plants followed by propargite 57 EC @ 0.05 per cent. Diafenthiuron 50 WP was effective in reducing mite population in tomato under polyhouse condition (Pokle, 2015).

Hence, the acaricide application provides an immediate solution to control red spider mites and seems to be the most significant pest management tool in IPM programme to increase the flower production in Jasmine.

CONCLUSION

In the present study, NSKE @ 5.0 per cent found to be the best botanical against red spider mites followed by *Pungam* oil @ 2.0 per cent. Wild sage (*L. camara)* leaf extract @ 5.0 per cent and sweet flag (*A. calamus*) rhizome extract were found less effective against red spider mites in Jasmine. The effectiveness of diafenthiuron 50 WP @ 0.80 g /lit, fenpyroximate 5 EC @ 1.20 ml /l against red spider mites with a reduction of mite population by 87.58 and 82.93 per cent, respectively was brought out by this study. The results from the present study can provide valuable information towards the development of IPM module in Jasmine with special emphasis on selection of acaricides as well as development of pest forecast models.

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Bio-efficacy of Cyanatraniliprole 10.26% OD against Fruit Borer (*Deudorix isocrates* Fab.) infesting Pomegranate.

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ABSTRACT

One of the major pomegranate pests is the fruit borer *Deudorix isocrates* Fab. A comprehensive review of the literature found that ninety-one insects, six mites, and one snail were pests that fed on *Anar* crops in India. The *Anar* butterfly *Deudorix* (*Virachola*) *isocrates* Fab., is the almost annoying foe and can ruin over half of the fruits. Field tests were carried out to assess the effectiveness of cyanatraniliprole 10.26% OD @ 200, 250, 300 and 400 g/ha along with two standard checks *i.e.,* Lamda-cyhalothrin 4.9% CS @ 500 ml/ha and Fipronil 5% SC @ 2.0 l/ha against fruit borer of pomegranate at Krishi Vigyan Kendra, Jhalawar during the years 2021-22 and 2022-23. Cyantraniliprole 10.26% OD showed that test product was evenly effective @ 400 and 300 g/ha to control fruit borer on pomegranate crop and better than other standard treatments. The highest crop yield of *Anar* 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 the respective year in comparison to untreated control.

Key Words: Effectiveness, new chemical molecules, Fruit borer, *Anar*

INTRODUCTION

Pomegranate (*Punica granatum* L.) is grown in arid and semi-arid areas of Tamil Nadu, Gujrat, Maharastra, UP, AP and Karnataka (Balikai *et al,* 2011). One of the main obstacles to producing enough pomegranate fruits of suitable quality and quantity for both domestic and international markets is the *Anar* butterfly/fruit borer, *D. isocrates* (Fab.). With a broad range of host plants, including *Anar*, Citrus spp, Guava, Litchi, Aonla, Wood apples, Apple, Plum, Pear, Peach, Sapota, Ber, Loquat, Tamarind etc. *Anar* fruit borer is the most pervasive, polyphagous, and devastating pest.

About 45 insect species (Butani, 1979), 32 pests (Balikai, 2000), over 50 insect species (Verghese and Jayanthi, 2001), and 33 insect pests (Balikai *et al,* 2003) infest pomegranate trees. In India more than 90 insect pests, mites and snails have been recorded on *Anar* plants causing considerable economic losses, among which the most annoying pest of pomegranate is the pomegranate butterfly, *D. isocrates,* which alone responsible in causing 65-70% losses in yield globally (Kumar *et al,* 2017). Butani (1979 reported more than 45 insects attack pomegranates in India. The primary pest affecting both cultivated and wild pomegranates is the pomegranate fruit borer, *Deudorix epijarbas* (, Dubey *et al,* 1993, Kakar *et al,* 1987, Payal and Nath, 1993, Shevale and Khaire, 1999). Its caterpillars bore into maturing fruit and eat the seeds, making it a direct pest that occurs frequently. Fruit rots and falls because of the secondary infection that the larva's hole encourages. Gupta and Dubey (2005) and Balikai (2000) reported the extent of losses in yield varies in-between 50-90 per cent. Most insecticides used to manage the pest include pyrethroids and organophosphates (Shukla and Prasad, 1983; Kakar *et al,* 1987; Shevale and

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Khaire, 1999; Gupta and Dubey, 2005). Since these pesticides are linked to a number of issues, including resistance, health risks, environmental contamination, etc., it is necessary to look for alternatives in order to control the pest in an environmentally responsible manner. In order to test the efficacy of new insecticide, Cyanatraniliprole 10.26% OD at different doses against pomegranate fruit borer, the present investigation was carried out.

MATERIALS AND METHODS

The experiment to evaluate the bio-efficacy of new insecticide, Cyanatraniliprole 10.26% OD at different doses against fruit borer of pomegranate, was conducted at KVK, Jhalawar on selected plants of 10 year old pomegranate orchard having plantation of variety "Sindhuri" during 2021 and 2022. The experiment was conducted in RBD (Randomized Block Design) with 7 treatments including one untreated control with three replications. Noval insecticide, Cyantraniliprole 10.26% OD was evaluated at different doses, @200, 250, 300 and 400 g/ha along with Lamda-cyhalothrin 4.9% CS and Fipronil 5% SC @ 2000ml/ha as standard checks *i.e.,* against fruit borer infesting pomegranate. Fruit damage caused by *Anar* butterfly was recorded at fruit maturity stage. From each plant 25 fruits were randomly observed to calculate per cent fruit damage by recording healthy and damaged fruits. From each plot 3 plants were randomly selected to record fruit damage. For the recorded data per cent damage reduction over untreated control was calculated. Data recorded on damage were transformed in to arc-sine values for the statistical analysis.

RESULTS AND DISCUSSION

Observation recorded on fruit damage revealed that lowest damage of 4.44 % was recorded in Cyantraniliprole 10.26% OD @ 120 g ai./ha which was at par with cyantraniliprole 10.26% OD @ 90 g a.i./ha (4.89 %) and Cyantraniliprole 10.26% OD @ 75 g a.i./ha (5.33 %). Highest fruit damage was recorded 31.56% in control (untreated) during 2021. Similarly, observation of fruit damage reduction over control (untreated) revealed that highest reduction of fruit damage over untreated control was recorded in Cyantraniliprole 10.26% OD @ 120 g a.i./ha (85.93 %) which was found similar with Cyantraniliprole 10.26% OD @ 90 g a.i./ha (84.51 %) and followed by Cyantraniliprole 10.26% OD @ 75 g a.i./ha (83.11 %) (Table 1) during 2021. Similar results were obtained when the data were recorded during second year of experiment . The observation was recorded on fruit damage revealed that lowest damage of 3.56 % was recorded in Cyantraniliprole 10.26% OD @ 120 g a.i./ha which was at par with Cyantraniliprole 10.26% OD @ 90 g a.i./ha (4.00 %) and Cyantraniliprole 10.26% OD @ 75 g a.i./ha (4.44 %). Highest damage (28.89 %) was recorded in untreated control (Table 1).

Fruit damage reduction over control (untreated) recorded revealed that highest reduction was recorded in Cyantraniliprole 10.26% OD @ 120 g a.i./ha (87.68 %) which was found similar with Cyantraniliprole 10.26% OD @ 90 g a.i./ha (86.15 %) and followed by Cyantraniliprole 10.26% OD @ 75 g a.i./ha (84.63 %) (Table 1).

The yield data revealed that highest yield of 9.82 t/ha was recorded in Cyantraniliprole 10.26% OD @ 120 g a.i./ha which was found at par with Cyantraniliprole 10.26% OD @ 90 g a.i./ha (9.31 t/ha) and followed by Cyantraniliprole 10.26% OD @ 75 g a.i./ha (9.11 t/ha). Lowest yield (3.89 t/ha) was recorded in untreated control during the year 2021. Whereas, during the year 2022 highest yield of 10.92 t/ha was recorded in Cyantraniliprole 10.26% OD @ 120 g a.i./ha which was found at par with Cyantraniliprole 10.26% OD @ 90 g a.i./ha (10.53 t/ha) and followed by Cyantraniliprole 10.26% OD @ 75 g a.i./ha (10.05 t/ha). Lowest yield (4.62 t/ha) was recorded in untreated control.

The outcomes closely match those of Bhut *et al* (2013) who found that the most effective treatments were of Chlorantraniliprole, followed by flubendiamide, novaluron, thiodicarb, endosulfan, and malathion against *Anar* butterflies. According to Kambrekar *et al* (2015), spinosad 45 SC 0.20 ml/l and emamectin benzoate 5 SG @ 0.25 g/l provided the greatest reduction in

Bio-efficacy of Cyanatraniliprole against Fruit Borer

Table 1. Bio-efficacy of Cyantraniloprole 10.26% OD, against *Anar* butterfly in pomegranate.

Tr. No.	Treatments	Dose		Fruit damage (%)		Reduction over control (%)		Fruit Yield (t/ha)	
		(g) a.i./ha	Formulation (ml or g/ha)	Year 2021	Year 2022	Year 2021	Year 2022	Year 2021	Year 2022
T_1	Cyantraniliprole 10.26% OD	60	200	15.11* (22.87)**	13.33* (21.42)**	52.12	53.86	5.76	6.82
T_2	Cyantraniliprole 10.26% OD	75	250	5.33 (13.35)	4.44 (12.14)	83.11	84.63	9.11	10.05
T_3	Cyantraniliprole 10.26% OD	90	300	4.89 (12.75)	4.00 (11.54)	84.51	86.15	9.31	10.53
T_4	Cyantraniliprole 10.26% OD	120	400	4.44 (12.14)	3.56 (10.82)	85.93	87.68	9.82	10.92
T_5	Lambda-cyhalothrin 4.9% CS	25	500	10.22 (18.64)	8.44 (16.88)	67.62	70.79	7.56	8.73
T_6	Fipronil 5% SC	100	2000	10.67 (19.06)	8.89 (17.34)	66.19	69.23	7.14	8.23
T_7	Untreated control	-	-	31.56 (34.17)	28.89 (32.50)	-	-	3.89	4.62
	S. Em±			0.48	0.52	-	-	0.37	0.41
	CD at 5 %			1.47	1.59	-	-	1.13	1.27

*Original values; **Arc sine transformed values; ROC – Reduction Over untreated Control (%)

fruit damage. The most effective sprays against *Anar* butterflies were rynaxypyr, spinosad, emamectin benzoate, and cyazypyr, while flubendiamide was only moderately efficient against fruit damage, according to Kumar and Gupta (2018).

CONCLUSION

In suppressing *Anar* butterflies in pomegranates, the treatment Cyantraniliprole 300 g/L OD @ 120 g a.i./ha, 90 g a.i./ha, and 75 g a.i./ha were found to be superior and comparable. It also recorded higher yield in both years. Cyantraniliprole 300 g/L OD @ 75 g a.i./ha can be suggested to control *Anar* butterflies in pomegranates, based on the present findings.

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Causes of Child Labour in Rural Punjab

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ABSTRACT

Child labour refers to the exploitation of children through work that deprives them of their childhood, education and basic rights. It is a global issue, often driven by poverty, lack of access to education, and economic inequality. The study was conducted using primary data collected from 120 respondents (60 farm and 60 off farm) to analyse factors responsible for the child labour. The findings showed that personal factors *i.e*. economic needs and drunken father were the dominating factors responsible for child labour. Irregular income of the family and family debt forced the children to earn at earlier age. Besides these, migration, which is more common among farm respondents and large family size were contributing factor for increasing child labour. Thus, the study suggested that government should provide avenues of vocational training to provide better employment opportunities to unemployed parents and encourage them to send their wards to school for education.

Key Words: Child labour, Economic, Personal, Social factors

INTRODUCTION

Child labour is a matter of great concern because it has serious consequences and implication for children, parents, families and society at large. Poverty is said to be the main reason for child labour. children join work because they are poor. But in reality, child labour increases poverty rather than reducing it, as it consigns successive generations to its vicious cycle (Singh, 2022; Barman 2014). Child labour is basically cheap and each working child take the place of an adult worker, accentuates adult unemployment and lower the wage structure. The ratio of adult employment to child employment decreases as the child employment rate increases. Beyond employment and income, child labour has a negative impact on children's health. Their education is severely hampered, and it undermines their ability to grow and develop from the ground up.It results in loss of education, mental retardation, physical exhaustion, and deprivation of avenues for support and pleasures, which are crucial for a child's normal growth (Hoque, 2021).

The failure of the educational system has made child labour more prevalent in India. Even though free and compulsory education is offered, the Right of Children to Free and Compulsory Education Act of 2009 states that 50 percent of age school-age children between 6 and 14 years are engaged in work participation. India has one of the highest rates of illiteracy. Even in the state like Punjab, where almost every village has a school, the number of illiterates has risen to 76.48 lakh in 2022 as compared to 63.80 lakh in 2001(Audi *et al,* 2022). Even for the survival of the family, the modest wages earned by adult male labourers are insufficient, compelling the female family members and children to labour. Thus, millions of innocent children are subjected to heartbreakingly severe hardship and exploitation. They have completely lost the fun and thrill of a typical childhood ((Anker, 2000; Maya, 2021).

Run away children occasionally move alone to urban areas. These emotionally neglected children flee from their homes due to a hostile home environment, abusive parenting, a dislike of education, parental abandonment, or the allure of city life (Mishra 2000). Due to low pay and adaptability, business owners prefer to hire

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children, while they claim that this is done out of compassion to help the children's families earn more money. Children often fill the roles of adults in the workforce, though at wages that are half or even lower. It results in joblessness among the key personnel. According to Agarwal and Pathak (2015), an adult worker's bargaining strength is diminished by the abundance of children in India who are willing to offer themselves for employment, with lower pay.

Child labour exists in different forms, including hazardous and non-hazardous jobs, agricultural and non-agricultural work, modern and traditional industry jobs, formal and informal economy occupations, full- and part-time work, wage earners and unpaid family workers. The number and direction of the economic effects of various forms of child labour might vary greatly, making this information crucial. Thus, the present study had been undertaken with specific objective of identifying the factors responsible for child labour in rural Punjab.

MATERIALS AND METHODS

The study was conducted in rural areas of Punjab by using multiple stage random sampling technique. At first, two districts i.e. Ludhiana and Moga were selected from 23 district of Punjab. In the second stage, two blocks from each selected district were selected randomly for the purpose of the study. Similarly at the third stage, two villages from each block were taken randomly for the purpose of present investigation. Thus, four blocks and eight villages were selected from Punjab. At last 120 child labourers were selected, 15 from each village from farm and off farm category. Response from parents, major care taker and acquaintance was also recorded wherever possible to authenticate the responses of child labour. Off farm child labour included domestic labour, labour in cycle/scooter repair shop and village shops (tea stall, dhaba, grocery and vendors etc.). Using comprehensive interpretation and Table construction, a methodical data analysis was carried out with the help of code designing. Data from the schedules were analysed using frequency and percentages and Z-test.

RESULTS AND DISUSSION

The paper analyzed the socio-economic characteristics of selected child laborers to identify the root cause of child labour and also examine the economic, personal and social factors responsible for child labour.

Socio-economic Characteristics

The data (Table1) showed that males constitute a larger proportion of the off-farm sector (58.3%) compared to the farm sector (46.6 %). Conversely, females were more represented in the farm sector (53.3%) than in the off-farm sector (41.7 %). Overall, males make up 52.5 percent of the total sample, while females account for 47.5 per cent. Most of the respondents (38.5 %)) were from the age group of 10-12 yrs. The farm respondents showed a higher proportion of 10 to12 yr-old (33.3%)) compared to off-farm child labour was (20.00%) This suggests that as children grow older, they were increasingly involved in farm activities. It was observed that 20 percent of respondents belonged to the 8 years age group and from off farm sector. The comparison between farm and off farm indicated that half of the off-farm respondents were under the age group of 8-10 years as compared to 26.7 percent farm respondents. Also 40 percent farm respondents were from 12-14 years age group as compared to 10 percent in off farm sector.

The data showed the distribution of respondents according to their education. There was clear differences in education between child labours who worked in the off farms sectors and those who worked in farm sector. Compared to farm respondents (26.7%), the percentage of illiterate respondents was higher among off-farm respondents (33.3%). Thirty per cent of child labours were illiterate pointing towards serious social a problem for both groups. While the number of respondents with a primary education falling between the first and fifth standards was low (13.33%). More than half of respondents were educated upto middle from which 60.00per cent were from farm sector and 53.4per cent from off farm.

Table 1. Distribution of respondents according to their socio-economic characteristics.

Gender	Farm (n=60)	Off farm (n=60)	Total (N=120)
Male	28(46.6)	35(58.3)	63(52.5)
Female	32(53.3)	25(41.7)	57(47.5)
Age (years)			
Below 8	-	12(20.00)	12(10.00)
8-10	16(26.7)	30(50.00)	46(38.34)
10-12	20(33.3)	12(20.00)	32(26.67)
12-14	24(40.00)	6(10.00)	30(25.00)
Caste			
Scheduled Castes (SCs)	38(63.34)	40(66.67)	78(65.00)
Other Backward Castes (OBCs)	22(36.67)	20(33.34)	42(35.00)
Education			
Illiterate	16(26.70)	20(33.3)	36(30.00)
Primary	8(13.33)	8(13.33)	16(13.33)
Middle	36(60.00)	32(53.40)	68(56.67)
Religion			
Hindu	12(20.00)	11(18.30)	23(19.16)
Sikh	40(66.67)	44(77.30)	84(70.00)
Muslim	8(13.33)	5(8.30)	12(10.00)
Native place			
Punjab	35(58.33)	46(76.67)	81(67.50)
Uttar Pradesh	10(16.67)	5(8.33)	15(12.50)
Bihar	15(25.00)	9(15.00)	24(20.00)

The data (Table 1) showed the distribution of respondents across different castes. It was found that 65percent off farm child labourers belonged to the scheduled castes and 35.00 percent belonged to other backward castes. Caste wise not much difference was found among farm and off farm categories. Further, 77.30 percent of respondents from the off-farm sector and 66.67 percent from the agriculture sector were identified as Sikhs. Further, 19.16 percent of the sampled respondent were Hindus. In the farm sector there were 20 percent Hindus and 18.30 percent in off farm sector. It was also found that 67.50 percent were from Punjab state, from which three fourth (76.67 %) off-farm labours. Further, 20.00 percent of the respondents from Bihar followed by 12.50 were from UP state.

Factors responsible for the child labour

Various factors responsible for child labour are categorized under personal ,economic and social factor. Children have to do work due to personal factor such as broken family, economic need, drunken father and orphanage etc. A large number of social factor were responsible for child labour such as large family size, poverty, migration etc. and economic factor compelled the child to do labour such as to supplement family income ,family debt , irregular income etc.

Personal Factors

The data (Table 2) showed the personal factors responsible for child labour. All respondents (100%) consistently reported economic need as the cause of child labour. Another affected factors for child labour was drunken father reported by majority of the respondents i.e 81.67 percent farm and 83.34 off farm respondents .Peer influences was seen among 65.84 percent also additional factor responsible for the child labour as respondents started doing labour under influences of friends or

Table 2. Distribution of respondents according to their personal factors responsible for child labour.

Multiple responses

Personal factor	Farm (n=60)	Off farm (n=60)	Total (N=120)	Z-Value
Broken family	3(5.00)	1(1.67)	4(3.34)	1.07 NS
Economic need	60(100.00)	60(100.00)	120(100.00)	-
Drunken Father	49(81.67)	50(83.34)	99(82.5)	-0.24 NS
Run away from home	1(1.67)	-	1	-
Orphan	-	2(33.34)	2(2.5)	-
Lack of education	48(80.00)	22(20.00)	70(58.34)	4.81*
Peer influences	37(61.67)	42(70.00)	79(65.84)	-0.96 NS
Limited recreational opportunity	49(81.67)	35(58.34)	84(70.00)	2.78*

Note- Figures in the parentheses indicate percentage
*Significant at 5% level of significance

Table 3. Distribution of respondents according to their economic factors.

Economic Factor	Farm (n=60)	Off farm (n=60)	Total (N=120)	Z- value
To supplement family Income	40(66.67)	25(41.67)	65(54.17)	2.74*
No other earning member in family	24(40.00)	27(45.00)	51(42.5)	-0.55 NS
Unemployment	40(66.67)	37(61.67)	77(64.17)	0.57 NS
Irregular Income of Family	47(78.34)	40(66.67)	87(72.5)	1.43 NS
Family Debt	37(61.67)	30(50.00)	67(55.84)	1.28 NS
Limited job opportunity	33(55.00)	40(66.67)	74(61.67)	1.30 NS
Poverty	60(100.00)	60(100.00)	120(100.00)	-

Multiple responses
*Significant at 5% level of significance

attraction towards earning money. Significantly, a difference was seen in the component of lack of education, as more respondents on farms (80.00%) than off farms (20.00%) cited it as a contributing factor. This yielded a statistically significant Z-value of 4.81. Additionally, respondents who lived on farms (81.67%) report having less recreational possibilities than respondents who did not lived on farms (58.34%). This difference was significant, as indicated by the Z-value of 2.78 at 5 percent level of significant.

Economic Factors

The economic factors contributing to child labour highlighted several significant trends. Notably, the need to supplement family income was significantly more common among farm respondents (66.67%) compared to off-farm respondents (41.67%), with a Z-value of 2.74 indicating statistical significance. In terms of family structure, 40 percent of farm workers and 45 percent of off-farm workers indicated that there were no other earning members in the family showing no significant difference (Z-value -0.55 NS). Unemployment was reported similarly by both groups, with 66.67 percent of farm workers and 61.67 percent of off-farm workers, resulting in a total of 64.17 percent Regarding the irregular income of the family, 78.34 percent of farm workers reported this issue, compared to 66.67 percent of off-farm workers, total 72.5 percent. Family debt affected 61.67 percent of farm workers and 50% of off-farm workers, with a total of 55.84 percent, poverty was universally reported, affecting all respondents (100%) from both farm and off-farm categories.

Social Factors

There were notable variations observed among social factors responsible for child labour. It was found that family disputes was the main

Table 4. Distribution of respondents according to their social factors.

Social factors	Farm (n=60)	Off farm (n=60)	Total (N=120)	Z- value
Large family size	18(30.00)	26(43.34)	44(36.64)	-1.51 NS
Family dispute	40(66.67)	52(86.67)	92(76.67)	2.59*
Chronic illness in family	10(16.64)	14(23.34)	24(20.00)	-0.91 NS
Lack of awareness	24(40.00)	37(61.67)	61(67.5)	2.37*
Family occupations	20(33.34)	19(31.67)	39(32.5)	0.19 NS
Migration	25(41.67)	15(25.00)	40(33.34)	1.94**
Orphanage	3(5.00)	2(3.34)	5(4.17)	0.45 NS

Note- Figures in the parentheses indicate percentages
*Significant at 5% level of significance
**Significant at 10% level of significance

problem with a Z-value of 2.59 showing statistical significance. This was significantly more common among off-farm respondents (86.67%) per cent than among farm respondents (66.67 %). Furthermore, the lack of awareness regarding educational and welfare policies and programme etc. was higher among respondents who were not off farm category (61.67%) than among farm respondents (40.00%), as indicated by a Z-value of 2.37, which is also significant. Another significant difference was observed in migration in which is more common among respondents who live on farms (41.67%) than off-farm (25.00%). This difference was found significant with Z-value of 1.94, indicating this trend is growing larger family size is another dominate factors contributing towards increasing child labour, reported by 36.64 per cent total respondents. However, no significant differences was observed regarding social factors in both the categories.

CONCLUSION

In India, child labour has become a major issue. Many children are forced to work at young ages to support their families due to many factors such as unemployment, a large number of family members, poverty and lack of parental education. It affected the psychological and physical growth of child and also minimize the opportunity for getting better education.The findings of this research emphasize the critical issue of child labor in rural Punjab, revealing its deep roots in socio-economic challenges, including poverty, illiteracy, family debt, and limited access to educational opportunities. The study highlights that children are compelled to work due to both economic necessity and systemic gaps in family and societal support. These factors not only deprive children of their right to education and a normal childhood but also perpetuate cycles of poverty and inequality. Thus the study suggested some recommendations to minimize or eradicate the problem child labour:

- Parents should be made aware regarding importance of education and be motivated to send their children to schools.
- Government and NGOs should provide institutional support for orphans and run-away children.
- Migrant parents should also be encouraged to enroll their children in schools.
- Village Panchayat should have dispute redressal mechanism to promptly intervene in the cases of the physical or sexual abuse of child labour.
- NGOs should arrange awareness generation camps to make child labour aware of their rights.

- PHCs should be well equipped to attend to health emergencies of child labour.
- Government should provide avenues of vocational training to provide better employment opportunities to child labour.
- Besides free and compulsory education, government should provide some financial aid at primary education level to curb the menace of child labour.
- Improvement in the working as well as living conditions of child labor through government intervention is urgently needed.

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Chemical Weed Management in Blackgram for Enhancing Productivity

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ABSTRACT

An On-Farm Trial was conducted during the *Rabi* seasons of 2020 and 2021 in Nindra mandal, Chittoor district, Andhra Pradesh and evaluated the efficacy of pre- and post-emergence herbicides on blackgram productivity. The assessment revealed that the most effective treatment, pre-emergence application of Pendimethalin 30% EC (2.5 lt/ha) followed by post-emergence application of Sodium Acifluorfen 16.5% + Cladinofop propargyl 8% EC (1.0 lt/ha) at 15-20 days after sowing (DAS), significantly suppressed weed density (23.30 and 8.80) and weed dry matter (8.95 gm/m² and 8.35 gm/m²) at 20 and 50 DAS, respectively, resulting in high weed control efficiency (71.33% and 27.37%) compared to the farmer's practice of hand weeding at 25-30 DAS. This treatment also led to significantly higher average plant height (31.6 cm), number of pods per plant (52.8), and yield (1020 kg/ha), resulting in a higher net return (Rs. 41,825/ha) and benefit-cost ratio (2.59) with a lower cost of cultivation (Rs.24,877/ha) compared to the farmer's practice. The increased yield was attributed to effective weed control at critical growth stages, promoting better crop growth, development, and ultimately, a good number of pods.

Key Words: Blackgram, Herbicide, Weed density, Weed control efficiency and Yield

INTRODUCTION

India, the world's largest blackgram producer and consumer, accounts for approximately 29% of the nation's total pulse acreage and contributes 10.25% of its pulse production. With an annual production of about 2.84 Mt from 4.76 million ha., India's average blackgram productivity is 596 kg/ha (Crop Outlook Reports of Andhra Pradesh, 2022). In Andhra Pradesh, blackgram is cultivated on 0.345 million hectares, yielding 0.431 million tonnes at an average of 1249 kg/ha. Within the state, Chittoor district cultivates blackgram in 684 ha, producing 586 t with an average yield of 857 kg/ha (Season and Crop Report, Govt of Andhra Pradesh, 2022-23). While Chittoor's productivity slightly exceeds the national average, it remains significantly lower than the state average, highlighting the potential for increased yields through improved practices. A major constraint to blackgram production during the *Rabi* season is weed infestation, exacerbated by the coinciding North East Monsoon and the crop's slow initial growth, compact habit, and early maturity. Traditional weed control methods like hand weeding and inter-cultivation are costly, often delayed by labor shortages, and further hampered by monsoon rains during early growth stages. Therefore, chemical weed management offers a promising approach to enhance blackgram productivity, prompting On-Farm Trials (OFTs) to assess the efficacy of pre- and post-emergence herbicides.

MATERIALS AND METHODS

RASS-Krishi Vigyan Kendra has conducted an On-Farm Trial (OFT) in Agarampeta village, Nindra mandal, Chittoor district, Andhra Pradesh, during the *Rabi* seasons of 2020 and 2021 to evaluate chemical weed management in blackgram. Using a randomized block design across eight locations, the trial compared two

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Table 1. Effect of weed management practices on weed density, weed dry matter and weed control efficiency.

Particulars	weed density (Number/m^2)						weed dry matter (g/m^2)						weed control efficiency (%)					
	20 DAS			50 DAS			20 DAS			50 DAS			20 DAS			50 DAS		
	A	B	X	A	B	X	A	B	X	A	B	X	A	B	X	A	B	X
Trial	21.0	25.7	23.3	9.6	8.0	8.80	8.58	9.33	8.95	8.96	7.75	8.35	73.26	69.4	71.33	25.43	29.32	27.37
FP	39.0	37.6	38.3	16.6	15.0	15.8	32.34	30.52	31.43	12.16	11.12	11.64	-	-	-	-	-	-
t-cal value	8.8**			7.12**			25.6**			4.3**								

A means Year 2020; B means Year 2021; X means Mean Value

treatments: the farmer's practice of hand weeding at 25-30 days after sowing (DAS), and a pre- and post-emergence herbicide application in the trial. The trial treatment consisted of pre-emergence application of Pendimethalin 30% EC (2.5 lt/ha) followed by post-emergence application Sodium Acifluorfen 16.5% + Cladinofop propargyl 8% EC (1.0 lt/ha) at 15-20 DAS, using the Yellow Mosaic Virus resistant variety TBG-104. Both in the farmer's practice and in the trial plots sowing occurred in the last week of October, with harvesting in the first week of January. The trial followed package of practices recommended by Acharya N.G Ranga Agricultural University. Data collected included weed density (number of weeds per square meter), weed biomass (weed dry matter), and weed control efficiency at 20 and 50 DAS, along with yield attributes at crop maturity. Economic analysis was performed using current market prices for inputs and blackgram yield. Statistical analysis of the data was conducted using a two-sample t-test.

RESULTS AND DISCUSSION

The data (Table 1) revealed that the significant impact of chemical weed management on weed parameters. The chemical treatment, consisting of pre-emergence application of Pendimethalin followed by post-emergence application of Sodium Acifluorfen + Cladinofop propargyl at 15-20 DAS, consistently resulted in lower average weed density (23.3 and 8.8) and weed dry matter (8.95 and 8.35) at both 20 and 50 DAS across both years, compared to the farmer's practice. This effective suppression of weed density and dry matter led to high weed control efficiency (71.33% and 27.37%) during both years. This likely stems from the targeted action of both the pre- and post-emergence herbicides at critical crop growth stages, minimizing weed presence and biomass. These results corroborate findings by Jagadesh *et al* (2019), who also observed the lowest weed density (17.3 No/m^2) and biomass (14.4 g/m^2) at 20 and 40 DAS in blackgram with a similar treatment of Pendimethalin (1 kg/ha at 3 DAS) followed by Acifluorfen Sodium (16.5%) + Cladinofop propargyl (8% EC) at 187.5 g/ha at 20 DAS.

The two years' data (Table 2) clearly showed that the chemical weed management, resulted in significantly higher average plant height (31.6 cm), average number of pods per plant (52.8), and average yield (10.20 q/ha) compared to the farmer's practice. This improvement is attributed to the effective weed control achieved through pre- and post-emergence herbicide application at crucial growth stages, promoting increased blackgram growth. This effective weed control facilitated better crop growth and development, leading to a good number of pods and ultimately a higher yield. The trial plot recorded approximately 22.0% yield increase over the farmer's practice. These findings align with those reported by Ram Mohan Reddy *et al* (2023).

The data (Table 3) revealed that the pre-emergence application of Pendimethalin followed by post-emergence application of Sodium Acifluorfen + Cladinofop propargyl at 15-20 DAS

Table 2. Effect of weed management practices on plant height, number of pods and yield of blackgram.

Particular	Plant height (cm)			No of pods per plant			Yield q per ha		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
Trial	29.9	33.3	31.6	47.6	58	52.8	9.85	10.56	10.20
Farmers Practice	29.3	29.0	29.1	27.2	38.3	32.8	8.45	8.28	8.36
t-cal value			2.35**			6.26**			7.92**

***Significant at 0.01 level of probability*

Table 3. Effect of weed management practices on the economics of blackgram.

Particulars	Cost of cultivation (Rs/ha)			Gross returns (Rs/ha)			Net Returns (Rs/ha)			BC Ratio		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
Trial	21882	27872	24877	61195	73967	67581	39213	44432	41825	2.79	2.65	2.59
Farmers' Practice	23793	28809	26301	52390	57960	55175	28597	29150	28874	2.20	2.00	2.10

resulted in significantly higher net returns (Rs. 41,825/ha) and a benefit-cost ratio of 2.59, achieved with a lower cost of cultivation (Rs. 24,877/ha) compared to the farmer's practice. These findings are consistent with Jagadesh *et al* (2019), who also reported greater profitability, in terms of net returns and benefit-cost ratio with lower expenditure, using a similar treatment of pendimethalin (1 kg/ha at 3 DAS) followed by Acifluorfen Sodium (16.5%) + Cladinofop propargyl (8% EC) at 187.5 g/ha at 20 DAS.

CONCLUSION

This study concludes that pre-emergence application of Pendimethalin 30% EC (2.5 lt/ha at 3 DAS) followed by post-emergence application of Sodium Acifluorfen 16.5% + Cladinofop propargyl 8% EC (1.0 lt/ha at 15-20 DAS) effectively controls weeds in blackgram, leading to significant improvements in growth, yield, and economic returns compared to the farmer's practice.

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Classification of Tubewell Waters of Block Ellenabad of Sirsa District for Irrigation

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ABSTRACT

This study test the water quality of 120 samples collected during 2019 to 2021 from Block Ellenabad, district Sirsa Haryana, regarding electrical conductivity (EC), carbonate ion (CO_3^{2-}), bicarbonate ion (HCO_3^-), calcium and magnesium (Ca^{++} and Mg^{++}), and residual sodium carbonate (RSC). The analysis revealed that most samples (50% on average) fell within the 0-2 dS/m EC range, indicating generally good water quality for irrigation. However, higher EC levels (2-8 dSm^{-1}) were present, necessitating careful water management, including mixing with canal water to mitigate potential adverse effects on crops. The study also observed variability in CO_3^{2-} concentrations with a trend toward increasing levels over time particularly in 2021. Bicarbonate concentrations were predominantly in the 4-6 meL^{-1} range, but higher levels (>8 meL^{-1}) increased in 2021, raising concerns about rising alkalinity. The Ca^{++} and Mg^{++} concentrations were mostly within the lower range (0-8 meL^{-1}), but higher concentrations became more prevalent in 2021, indicating a potential increase in mineral content in the water. RSC values, crucial for determining water's suitability for irrigation, showed that 58.18% of samples had values between 2.5 and 4.5 meL^{-1}, suggesting moderate to severe restrictions on their use. The study underscored the importance of regular monitoring and management practices to ensure sustainable agricultural practices in regions where water quality may be compromised.

Key Words: Bicarbonate ion, Calcium, Carbonate ion, Electrical conductivity,Water quality,

INTRODUCTION

Water is one of the most important and abundant compounds of the ecosystem. All living organisms on the earth need water for their survival and growth (Jain *et al*, 2014). The qualities of these water bodies vary widely depending on the location and environmental factors (Pawari and Gavande, 2015). Jakhar *et al* (2024) indicated that 38% of the samples were suitable for all crops, with EC levels between 0-2 dS/m. However, 35% of samples exhibited medium to high salinity (4-8 dS/m), and 11% showed very high salinity (>12 dS/m), which limits crop choices and requires careful management. Ellenabad block in Sirsa district in Haryana, confronts significant challenges related to groundwater quality due to a blend of natural and anthropogenic factors. Located in a semi-arid region characterized by erratic rainfall, the District's reliance on groundwater for agricultural, industrial, and domestic purposes places considerable strain on this critical resource (Jain *et al*, 2021).

The quality of groundwater in Ellenabad is particularly affected by high levels of salinity and elevated total dissolved solids (TDS), primarily resulting from excessive groundwater extraction and the district's underlying geological conditions (Choudhary *et al,* 2020). Furthermore, nitrate

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contamination is a pressing issue, largely attributed to the intensive use of chemical fertilizers in agriculture, which poses severe health risks and impacts water usability (Singh and Singh, 2019). Fluoride concentrations also vary across the district, contributing to public health concerns and influencing water quality (Kumar *et al,* 2022). Industrial activities, combined with inadequate waste management, further exacerbate contamination problems by introducing additional pollutants into the groundwater system (Yadav *et al,* 2023). To address these challenges, a comprehensive approach is needed, involving the adoption of sustainable agricultural practices, improved waste management strategies, and robust monitoring and regulatory frameworks (Rani *et al,* 2021). Effective groundwater management is essential for safeguarding crop production and maintaining ecological balance in this resource-dependent region (Mehta and Kumar, 2021). Singh *et al* (2014) reported that the quality of irrigation water available to the farmers has a considerable impact on which crops can be successfully grown, the productivity of these crops, and water infiltration and other soil physical conditions. Based on EC and RSC values together, it was found that 40 per cent water samples were fit, 40 per cent were marginal and 20 per cent were unfit for irrigation purpose. A large proportion of samples falling in marginal and unfit category indicated the need of water testing for sustainable crop production without deteriorating the soil health. Thus, the present investigation was carried out to assess the quality parameters of underground water being used for irrigation in the block Ellenabad of Sirsa district of Haryana.

MATERIALS AND METHODS

Ellenabad is a region increasingly facing the challenges associated with groundwater quality and sustainability. As an area heavily reliant on agriculture, the groundwater resources of Ellenabad are vital for supporting the local economy, which is predominantly agrarian. However, this reliance on groundwater has brought to light several concerns regarding the quality and safety of water for agriculture purposes. The ground water quality of the district is not good at all locations and the farmers are advised to get their tube-well water tested at regular intervals for safe use in agriculture. A large number of farmers across the district use to bring water samples for testing to the soil and water testing laboratory at Krishi Vigyan Kendra, Sirsa. The present study is based on the analysis of water samples received at KrishiVigyan Kendra, Sirsa during the years 2019, 2020 and 2021. A total of 120 water samples were received representing 55, 28 and 37, during the years 2019, 2020 and 2021, respectively.

The chemical analysis of samples was done using standard procedures for electrical conductivity (EC), carbonate (CO_3^{2-}), bicarbonate (HCO_3^-), calcium and magnesium (Ca^{2+}+Mg^{2+}), chloride (Cl^-) and RSC (Richards, 1954). For the ease of understanding the scenario of ground water quality in the block the values of all the parameters have been expressed in per cent of total samples and average per cent of samples.

RESULTS AND DISCUSSION

The EC of water samples (120) was categorized between 0 and 12 dSm^{-1} irrespective of the years as majority of the water samples fell in these limits (Table 1). The data analysis revealed the distribution of water samples across different Electrical Conductivity (EC) classes from 2019 to 2021, highlighting significant trends in water quality. The 0-2 dSm^{-1} EC class consistently represents the largest proportion of samples in the present study recording 43.64% in 2019 to 64.86% in 2021, with an average of 50% over the three years, indicating that a substantial portion of the water samples fall into this lower EC range, often associated with better water quality. In contrast, the 2-4 dSm^{-1} categories recorded 32.73% in 2019 to 8.11% in 2021, averaging 21.94%, suggesting that samples falling in this particular group water quality cannot be used with freedom and there is restriction over choice of crops. The 4-8 dSm^{-1} range exhibits variability, with proportions fluctuating between 16.36% and 32.14%, and an average of 23.37%, reflecting some inconsistency in water quality in this middle range. In this range it was advised that the tubewell water should be mixed with canal water in cyclic mode so that it may not adversely affect the crops.

Classification of Tubewell Waters of Block Ellenabad

Table 1. Electrical conductivity of samples during the years 2019, 2020 and 2021.

EC Classes dSm^{-1}	No. of water samples			Average of three years (%)
	2019	2020	2021	
0-2	24 (43.64)	12(42.86)	24(64.86)	50
2-4	18(32.73)	7(25.00)	3(8.11)	21.94
4-8	9(16.36)	9(32.14)	8(21.62)	23.37
8-12	3(5.45)	0(0.00)	1(2.70)	2.71
> 12	1(1.82)	0(0.00)	1(2.70)	1.50

Table 2. CO_3^{2-} concentration of samples during the years 2019, 2020 and 2021.

CO_3^{2-} meL^{-1}	Number of water samples			Average of three years (Percent)
	2019	2020	2021	
0 to 0.2	23(41)	6(21)	16(43)	35
0.21 to 0.30	24(43)	17(60)	5(43)	38.66
0.31 to 0.40	8(14)	3(10)	4(10)	11.33
>0.40	0(0.0)	27(7)	12(32)	13
HCO_3^- meL^{-1}				
<2	8(14)	0(4.08)	3(8)	8.69
2 to 4	17(21)	2(34.69)	10(27)	27.56
4 to 6	19(56)	22(38.78)	15(40)	44.92
6 to 8	9(14)	3(18.37)	2(5)	12.45
>8	2(5)	1(4.08)	7(18)	9.09

EC is considered as good criterion to assess water quality (Jakhar *et al,* 1994) and level of salinity is marked accordingly. Based on the present study, only 50% water samples were found of good quality and the water can be used for irrigation in almost all the crops grown on all types of soil. The medium saline water (23.33%) can be utilized in conjunction with canal water for cultivation of semi-tolerant to tolerant crops. In some pockets of the district where water quality was of very high salinity observed in 1.66% water samples, the fields may be kept vacant during rainy season for reclamation and salinity tolerant *rabi* crops should be grown using the water as lifesaving irrigation. Rajput and Polara (2013), Chopra *et al* (2014), Kumar *et al* (2017) and Dhaker *et al* (2020) has also shown variation in electrical conductivity in different samples analysed.

The data analysis on CO_3^{2-} concentration in water samples from 2019 to 2021 revealed significant variations in the distribution across different concentration ranges. For the 0 to 0.2 meL^{-1} range, the proportion of samples fluctuated, starting at 41% in 2019, dropping to 21% in 2020, and rising to 43% in 2021, with a three-year average of 35%. This indicates variability in the concentration of CO_3^{2-}, with a notable prevalence of lower concentrations in the sample set. The 0.21 to 0.30 meL^{-1} range had a high proportion of samples in 2019 (43%) and 2020 (60%), but a sharp decline to 13% in 2021, averaging 38.66% over the three years. This suggests that while this concentration range was predominant in earlier years, it diminished significantly in the most recent year. The 0.31 to 0.40 meL^{-1} range showed relatively low proportions, with 14% in 2019, 10% in 2020, and 11% in 2021, averaging 11.33%, indicating it is a less common concentration range. The >0.40 meL^{-1} category had no samples in 2019 but saw an increase in 2020 (7%) and a significant rise to 32% in 2021, with an average of 13%. This suggests an emerging trend of higher CO_3^{2-} concentrations in more recent samples.

Table 3. $Ca^{++}+Mg^{++}$ of samples during the years 2019, 2020 and 2021.

$Ca^{++}+Mg^{++}$ meL^{-1}	No. of water samples			Average of three years (%)
	2019	2020	2021	
0 to 8	34(68.18)	14(53.85)	15(68.0)	63.34
8 to 16	9(18)	6(23.08)	2(9.09)	16.72
16 to 24	3(6)	3(11.54)	10(27)	14.84
24 to 28	8(14)	4(14)	8(21)	16.33
>28	1(2)	1(3)	2(9)	4.98

Table 4. RSC of samples during the years 2019, 2020 and 2021.

Residual Sodium Carbonate meL^{-1}	Percent of total samples			Percent of total samples
	2019	2020	2021	
2.5 to 3.5	18(56)	8(66)	6(54)	58.18
3.6 to 4.5	4(12)	1(8)	3(27)	14.54
4.6 to 5.5	4(12)	1(8)	0(0)	9.09
5.6 to 6.5	1(3)	0(0)	0(0)	1.81
6.6 to 7.5	2(6)	2(16)	1(9)	9.09
7.6 to 8.5	1(3)	0(0)	0(0)	1.81
8.6 to 9.5	2(6)	0(0)	1(9)	5.45

The distribution of bicarbonate ion (HCO_3-) concentrations in water samples from 2019 to 2021 revealed distinct patterns in concentration ranges. The <2 meL^{-1} range showed low prevalence, with 14% of samples in 2019, 4.08% in 2020, and 8% in 2021, averaging 8.69% over three years. The 2 to 4 meL^{-1} range had moderate representation, with 21% in 2019, increasing to 34.69% in 2020, and then decreasing to 27% in 2021, resulting in a three-year average of 27.56%. The 4 to 6 meL^{-1} range was the most dominant, with a high proportion of 56% in 2019, 38.78% in 2020, and 44% in 2021, averaging 44.92%, indicating it is the most common concentration range across the period. Conversely, the 6 to 8 meL^{-1} range recorded a decrease from 14% in 2019 to 5% in 2021, averaging 12.45%, reflecting a decline in this concentration range over time. The >8 meL^{-1} category had a minimal presence with 5% in 2019 and 4.08% in 2020, but increased notably to 18% in 2021, averaging 9.09%, suggesting a rising trend in higher bicarbonate concentrations. Overall, the data indicates that while the 4 to 6 meL^{-1} range remains prevalent, there is a noticeable increase in higher bicarbonate concentrations, particularly in the most recent year. Similar trend was also observed by Dhaker *et al* (2020).

The distribution of $Ca^{++}+Mg^{++}$ concentrations in water samples from 2019 to 2021 reveals several key trends across different concentration ranges. The 0 to 8 meL^{-1}range consistently represented the largest proportion of samples, with 68.00% in 2019, 53.85% in 2020, and 68.18% in 2021, averaging 63.34% over the three years. This indicates that the majority of samples fall within this lower concentration range, reflecting a common baseline level of these minerals in the water. The 8 to 16 meL^{-1} range showed moderate representation, with 18.00% of samples in 2019, 23.08% in 2020, and a decrease to 9.09% in 2021, resulting in a three-year average of 16.72%. This category demonstrates some fluctuation but remains a notable concentration range. The 16 to 24 meL^{-1} range saw a significant increase in 2021, with 27% of samples compared to 6.00% in 2019 and 11.54% in 2020, averaging 14.84% over the three years. This indicates a rise in higher mineral concentrations in recent years. The 24 to 28 meL^{-1}range had relatively stable proportions, with 14% in 2019, 14% in 2020, and

21% in 2021, averaging 16.33%, suggesting a moderate presence of these higher levels. Finally, the >28 meL^{-1}range was the least common, with only 2.00% of samples in 2019, 3.85% in 2020, and an increase to 9.09% in 2021, averaging 4.98%, reflecting a rare occurrence of very high mineral concentrations. Overall, the data indicates a predominance of lower Ca^{++}+Mg^{++} levels with a noticeable increase in higher concentrations in recent years. Similar results are obtained by Serawat *et al* (2022) while characterising water samples of Balesar tehsil in Rajasthan.

Residual sodium carbonate of water is very important and deciding property for its use in cultivation and selection of specific crops. During three years of study, 56, 66 and 54% of total water samples received during the years 2019, 2020 and 2021, respectively, were found sodic in nature which required moderate to severe restrictions on their use for irrigation purpose. On average basis of three years, out of 32 samples 58.18% samples recorded the RSC in the range of 2.5-3.5 and 3.6-4.5 meL^{-1}each signifying better water quality than rest of the samples (Table 5). The RSC of 5 to 9% samples ranged between 4.6 and 8.5 meL^{-1}. However, exceptional samples (5.45% of total sodic water samples) recorded the RSC of 9.6-13.6 meL^{-1}also during the years 2019 and 2020, whereas samples of very high sodicity were not reported during the year 2021. The higher RSC values above 2.5 $meL^{-1}$are hazardous for the soils particularly that are fine textured while in light textured soils these hazards are comparatively less due to more leaching. Similar results have also been recorded by Kumar *et al* (2017) and Dhaker *et al* (2020).

CONCLUSION

The study highlights significant trends in water quality across 120 samples collected from 2019 to 2021 in Ellenabad block of Sirsa district in Haryana. A substantial proportion of the water samples exhibited low Electrical Conductivity (EC) and moderate CO_3^{2-} and HCO_3^- levels, indicating generally good water quality for irrigation. However, the presence of higher EC, Ca^{++}+Mg^{++}, and Residual Sodium Carbonate (RSC) levels in some samples suggest the need for careful management practices, such as blending with canal water and the application of soil amendments, to mitigate potential risks to crop health and soil quality. Regular monitoring is essential to ensure sustainable agricultural practices.

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Comparative Analysis of Junk Food Consumption Patterns among Adolescent Students in Assam

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ABSTRACT

The increasing trend of junk food consumption among school children become a matter of serious concern as Junk foods severely deficit in micronutrients and high in fat, salt and sugar. Regular consumption of junk food leads to an increased risk of chronic degenerative diseases and many other chronic health conditions. Delicious taste, dazzling presentation, packaging, ready availability and advertisement attracts young children towards junk food. Present study was undertaken to know the consumption pattern of junk food among the adolescent students in Assam. It was found that majority of students irrespective gender consume junk food on regular basis (34.3%) and only a negligible (0.7%) student never consume fast food. Most popular Junk Food item was found to be chips (62.00%) followed by fast food (42.33%), chocolate (39.33%), carbonated drinks (39.00%) for all students irrespective of gender. But significant differences were observed in preferences towards items was recorded among girls and boys. Boys preferred carbonated drinks than girls whereas girls prefer to take ice cream and chocolate than boys. Majority of the students consume junk food due to its taste and flavour (68.67%), followed by availability (39.33%). While boys take junk foods to satisfy hunger too while the girls were found to be more influenced through advertisement and preferred junk food for enjoyments than boys.

Key words: Adolescent, Consumption pattern, Junk food, Students.

INTRODUCTION

Food is one of the basic human needs and a nutritious diet is a prerequisite to a healthy life. A well-balanced diet is crucial from the earliest stages of life to ensure appropriate growth, development, and to maintain an active lifestyle. Food is made up of essential components—such as carbohydrates, fats, proteins, and water - that are consumed by both humans and animals for nourishment and pleasure, aiding in proper growth and development. Maintaining good health is essential for everyone to lead a vibrant life, necessitating a commitment to a balanced diet and healthy lifestyle choices. India has a rich culinary culture that dates back to ancient times. Indian cuisine encompasses a wide range of regional and traditional dishes originating from the Indian subcontinent. Due to the variations in soil, climate, culture, ethnic groups, and occupations, these cuisines show significant diversity, utilizing spices, herbs, vegetables, and fruits that are locally sourced wholesome and nutritious. Over time, people's food preferences specially the younger generations have shifted from traditional meals to junk food and fast food. However, the rising popularity of junk food is having an increasingly negative effect on younger generations.

Junk foods are characterized by high in calories mainly from macronutrients such as simple carbohydrate and fats, often high in sodium and low in dietary fiber, protein, micronutrients such as vitamins and minerals. Based on their nutrient content these are also known as “high in fat, salt and sugar food” (HFSS food). Regular consumption of junk food leads to intake of excess fat, simple carbohydrates, and increased sodium which contribute to an increased risk of chronic

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Table 1. Frequency of junk food consumption among the adolescent students.

Frequency of Junk foods Consumption	Boys (N=155)	Girls (N=145)	Total (N=300)	Percentage	Chi-square level	P value
Daily	55	48	103	34.3	5.947	<0.400 ns
Alternately	52	45	97	32.3		
4 to 6 days in a week	21	18	39	13.0		
1 to 3 days in a week	11	19	30	10.0		
Once in a Month	9	12	21	7.0		
Rarely	5	3	8	2.7		
Never	2	0	2	0.7		

degenerative diseases and many other chronic health conditions. Delicious taste, dazzling presentation, packaging, ready availability and advertisement attracts young children towards junk food. Rapid urbanization and industrialization with changing lifestyle and advancement in technology has greatly affected the day-to-day life and food habit of majority of population in developing countries. Different age groups exhibit varying affinity for consuming junk food, but some of them displaying more frequent consumption.

Gupta *et al* (2018) suggested that across the age brackets, adolescents and young adults emerge as leading consumers of such food items. Magdalena *et al* (2024) reported that a series of unhealthy trends in the eating and lifestyle habits of the young population, such as a tendency toward sedentary lifestyle, a trend of increased consumption of meat and meat preparations; and an increased preference for some junk food products such as fried potatoes, pastries, snacks, chips, hamburgers, sweetened soft drinks, coffee and even a relatively high consumption of alcoholic drinks. The Economic Survey 2024-25 has proposed the introduction of a higher tax rate on ultra-processed foods (UPFs), suggesting it as a potential health tax aimed specifically at brands and products that actively advertise these items. Therefore, the present study was undertaken to find out the consumption pattern, frequency and reasons for intake of junk food among the adolescent students of Golaghat district of Assam.

MATERIALS AND METHODS

This study was conducted among 300 students from different schools of Golaghat district of Assam out of which, 155 were male, and 145 were female. The samples were selected following stratified sampling and simple random sampling techniques. Data were collected using a questionnaire which contained both closed and open-ended questions. The data gathered were analyzed using descriptive statistics and results presented in tables, percentages and Chi square test were used to analyze the collected data.

RESULTS AND DISCUSSION

Adolescent is one of the critical life spans of human being which is the transition from childhood to adulthood. Many habits form during adolescent generally continued in the adulthood. Sujan *et al* (2021) stated that unhealthy food habit developed during adolescent may become one of the risk factors of CHD, diabetes obesity and hypertension due to consumption of excessive amount of saturated fats and sodium. Table 1 shows the frequency of Junk foods Consumption among adolescent of Golaghat district which depicted that majority of students (34.3%) consume junk food on regular basis followed by alternately (32.3%), 4 to 6 days in a week (13.0%)

Table 2. Preferences of junk food among the adolescent students.

Frequently consumed Junk food	Boys (N=155)	Girls (N=145)	Total	Percentage	Chi-square level	P value
Chips	91	95	186	62.00	53.152	<0.001**
Fast food	68	59	127	42.33		
Bakery products	41	18	59	19.67		
Chocolate	31	87	118	39.33		
Ice cream	35	69	104	34.67		
Carbonated drinks	73	44	117	39.00		

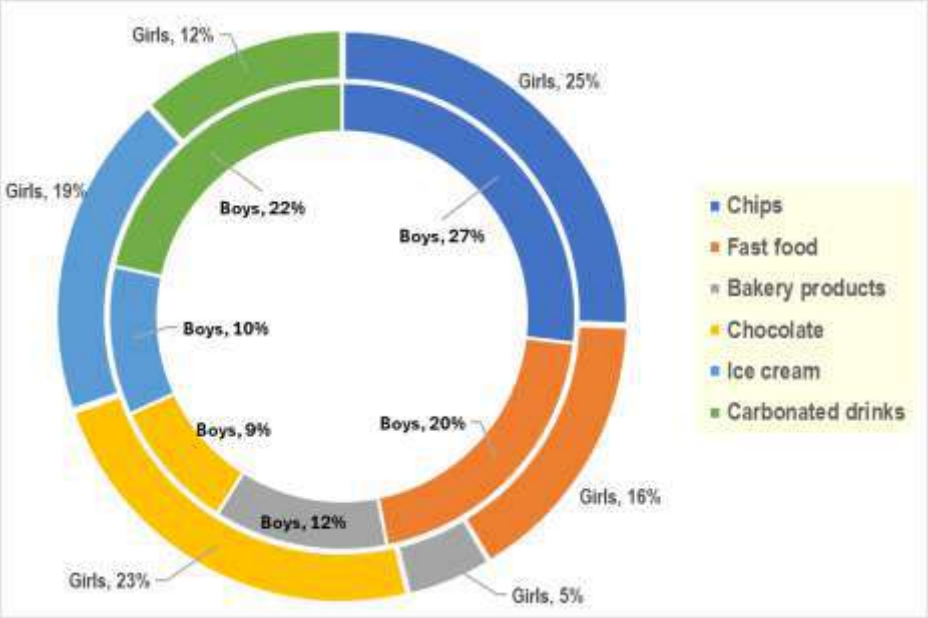

Fig 1. Preferences of junk foods by adolescent boys and girls

and 1 to 3 days in a week (10.0%) only a negligible (0.7%) student never consume fast food. Junk foods often lack essential micronutrients and dietary fiber. Given that many adolescents tend to incline toward these foods, therefore enhancement of nutrition value is very important .We can enhance nutritional value of junk food by incorporating nutrient-rich ingredients into their preparation. In this regard, we can use nutritious cereal millets to partially replace refined flour, as millets are high in micronutrients and serve as a beneficial source of dietary fiber. Furthermore, we can include different nutritious ingredients like antioxidant rich colourful vegetables, uncultivated greens, locally available greens like curry leaf, *moringa* leaf powder to enhance the nutritional quality of our meals. According to Varma and Borkar (2024), the addition of moringa leaf powder has proven to be beneficial in combating anaemia among adolescent girls.

It was observed from the Table 3 that majority of the students consume junk food due to its taste and flavour (68.67%), followed by availability (39.33%) and impact of advertisement (33.67%). Almost 30 percent students consume junk food to satisfy hunger and enjoyment. It is almost similar to the study of Bhabani and Devi (2020) who also reported that the majority of the study participants are influenced by taste (35%), followed by advertisements, easy availability and the appearance of the food. Awareness campaigns should be organized to educate people about the benefits of a balanced diet, the significance of both macro and micronutrients in maintaining good

Table 3. Rationale of junk food consumption by the adolescent students.

Rationale of Consumption	Boys (N=155)	Girls (N=145)	Total (N=300)	Percentage	Chi-square level	P value
Taste and flavour	101	105	206	68.67	23.873	<0.003*
Easily available	63	55	118	39.33		
Attractive	48	37	85	28.33		
Satisfy hunger	61	28	89	29.67		
Party with friends	39	47	86	28.67		
Ready to eat	29	23	52	17.33		
Enjoyment	35	51	86	28.67		
Advertisement	39	62	101	33.67		

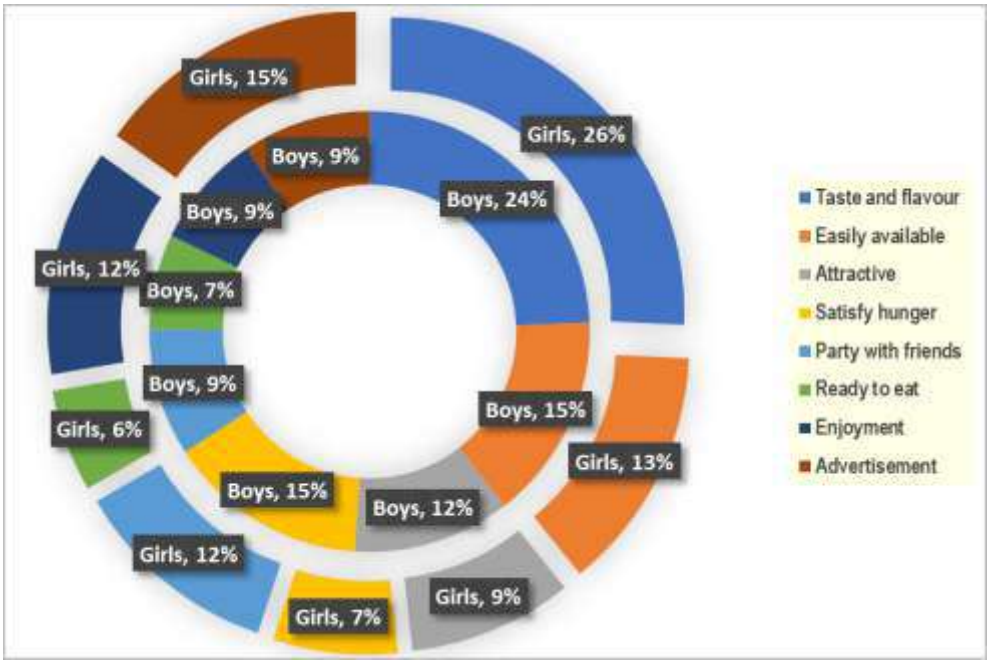

Fig. 2 Pattern of junk food consumption by adolescent boys and girls

health, the impact of dietary fiber in preventing chronic degenerative diseases, the value of traditional foods, and the harmful effects of junk food, particularly its connection to the prevalence of chronic degenerative diseases. This information will aid individuals in making healthier food choices. Additionally, companies producing junk food, which tends to be high in fat, salt, and sugar, should be mandated to disclose the potential side effects of these products on their labels.

It can be challenging to discover healthier substitutes for junk food, but we can enhance nutritional value of junk foods by including nutritious ingredients. In this regard, the Health Star Rating system could prove advantageous for packaged foods, as it serves as an effective tool for assessing a product's healthiness. It offers a clear method to compare similar packaged foods. The system rates items from half a star to five stars according to their overall healthiness. We should very careful in selecting our food products. When assessing the nutritional value of packaged items, it is important to pay close attention to health claims like “low in fat” or “sugar-free,” as these can frequently be misleading. The labels "light" or

"lite" may refer only to the product's appearance or flavor, which does not necessarily indicate that it is low in fat.

Checking the nutrition facts label on the back of the packaging can provide valuable information regarding the actual fat and other nutrients content. Another frequent claim usually seen in the processed product is “sugar-free” or contains “no added sugar”. It may indicate that the product lacks additional sucrose or table sugar, but it might still include other types of sugar. Additionally, the product could contain salt or fat and be high in energy, indicating that even products labeled as sugar-free may fall into the junk food category. It is also observed that certain item labeled and advertised as health foods like certain package fruit juices and muesli bars, can also be unhealthy if they have high amounts of sugar, salt, or fat. In this regard policy makers and government can play a important role by strictly regulating the packaging norms and advertisement.

CONCLUSION

The consumption of junk food is on the rise among young generation. These foods are high in fats, sugars, and excessive salt. Regular consumption of junk food leads to an increased risk of chronic degenerative diseases and many other chronic health conditions. Delicious taste, dazzling presentation, packaging, ready availability and advertisement attracts young children towards junk food. The media and advertising heavily promote these types of foods, which enhances young people's inclination towards them. Poor eating habits are a key factor in the emergence of these diseases, making it essential to educate young people about proper dietary practices. A timely nutritional intervention aimed at adolescents to enhance their eating habits is crucial at this moment. Maintaining the good nutrition and health status of students will contribute to the development of a healthy and productive nation. Kashayap M (2024) stated that, there is an association between level of knowledge regarding fast food with their demographic variables such as age, class of studying, mother's educational qualification and source of information regarding junk food. Various health-promoting departments, such as Social Welfare, Health, and Krishi Vigyan Kendras can make a meaningful impact by organizing awareness programmes that highlight the harmful health effects of consuming junk food and by promoting healthier food choices among the younger generation.

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Comparative Performance of Aseel, *Kadaknath* and Local Breed of Poultry in Mayurbhanj district of Odisha

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ABSTRACT

The present study was carried out to assess the growth performance among local breed, *Aseel* and *Kadaknath* breed of poultry chicks. A total of 400 day old chicks were procured from local hatchery (200 chicks each of Aseel and *Kadaknath* breed) and were provided 10 chicks each of both breeds to 20 farmers for raising under backyard poultry system. Birds of local breeds were procured by the farmers them selves. The body weight, egg production and net return were recorded for 40 weeks duration and found significantly higher in *Aseel* breed as compared to local and *Kadaknath* breed of poultry. Likewise, the acceptability and adaptability of the Aseel breed of poultry was significantly ($P<0.01$) more than that of local breed and *Kadaknath* breed. The incidence of disease in *Aseel* breed of poultry was significantly ($P<0.01$) less than that of Local and *Kadaknath* breed of poultry.

Key Words: Breed, Body weight, Egg, Growth, Performance, Production, Poultry.

INTRODUCTION

The economy of Odisha depends on agriculture, hence government always give primary importance to the development of agriculture sector. In addition to the traditional agriculture, importance is also given to the allied agriculture sectors like animal husbandry, fishery and horticulture. Now a days, poultry rearing in the backyard, goatry, sheep rearing and mushroom cultivation are becoming the ways of different entrepreneurship development. Among all these entrepreneurial activity, poultry rearing is one of the most important entrepreneurial activity. The consumption of poultry meat has been increasing day by day across the world. However, indigenous breeds of poultry are important source of animal proteins and could be a very helpful food group helps in combating the nutritional deficiencies as well as in income generation of the rural and tribal masses.

Mayurbhanj is a tribal dominated district having 58.74% of the different tribal and PVTG (Particularly Vulnerable Tribal Group) people belonged to this district. Areawise Mayurbhanj is the largest district in Odisha. It has more than 39% of the forest and hilly area out of total geographical area (4049 Sq.Km.). It contains most of the natural plants and there is big opportunity for the development of animal sectors. In most of the household anybody can find either poultry or goatry or both. It has been delineated that native chicken are well known for their adaptability to local agro-climatic conditions, hardiness, ability to utilize locally available feed, requiring minimum care and management besides having a unique flavor and taste. The eggs and meat of these birds reared in the family fetches premium price due to high consumer preference even in the urban areas where plenty of eggs and poultry meat from commercial units are available (Thomas *et al,* 2023).

Aseel and Kadaknath are becoming progressively more popular as pure and out-crossed lines for their benefits in production traits and resistance to disease (Arora *et al,* 2011; Haunshi *et al,* 2011). Biswas *et al (*2010) emphasied that inspite of a drastic increase in the import of high yielding strains from across the world, the local breeds are still preferred in their native environment mainly due to its special capabilities

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Table 1. Comparison of body weight among *Aseel* and *Kadaknath* and local breed of poultry.

Trait	Local breed	*Aseel*	*Kadaknath*
Body weight (g)			
1 day	32.0	34.0	29.5
1st week	46.08	48.06	46.89
2nd week	65.06	71.87	60.45
4th week	145.56	149.45	113.89
1.5month	255	267	193
4.5 month	755	1005	945
5 month	849	1235	1124
1 year	925	1459	1410
Age at first egg production (days)	178	175	172
Age at Sexual maturity	208	215	201

Table 2. Comparison of other trait among Local *Aseel* and *Kadaknath* breed of poultry with the traditional poultry breed

Breed	Body weight (kg/ yr/10 birds)	Increase in body weight (%)	Egg prod. (nos/bird)	Increase in egg prod. (%)	Gross cost (Rs/ 10 birds)	Net return (Rs/ 10 birds)	B:C
FP (Local breed)	9.00	-	42	-	1550	990	1.60
T1(*Aseel*)	14.59	62.1	58	38.09	1600	1250	1.81
T2(*Kadaknath*)	14.10	56.6	48	14.2	1610	1100	1.63

i.e., good foraging, less cost and efficient mothers. The *Aseel* and Kadaknath are the two native breeds of India. The *Aseel* breed is known for its stamina, hardy meat and fighting qualities. Most of the people in Mayurbhanj considered *Aseel* breed chicken as their local breed poultry. *Kadaknath* breed of poultry is native to village Jhabua of MP. The meat of this breed is locally known as Kalamashi due to its black colour meat. Therefore, an effort was made to assess comparative performance of *Aseel, Kadaknath* and Local Breed of poultry.

MATERIALS AND METHODS

An assessment of three poultry breeds under semi intensive system at backyard was conducted in four villages namely Kadalibadia, Badakhaladi, Bholagadia and Gundihudi during 2021-22. A total of 400 day old chicks were procured from local hatchery (200 chicks each of Aseel and *Kadaknath* breed) and were provided 10 chicks each of both breeds to 20 farmers for raising under backyard poultry system. Birds of local breeds were procured by the farmers them selves. The various parameters namely body weight, egg laying (days), age at first egg production (days) and sexual maturity (days) were studied. The body weights were recorded at day old, one week, second week, fourth week, 1.5 month, 4.5 month, 5 month and after 1 year and weight gain was calculated. Home made feed mixture was offered by the farmers to all three categories of birds kept under backyard system of rearing. The data were statistically analysed by SPSS, and excel-22. Sensory evaluation of meat was conducted by 5 panelist of Govt. Veterinary Assistant Surgeons of Mayurbhanj district. Five point Likert scale was used for sensory evaluation rating.

Table 3. Sensory evaluation for acceptance of poultry meat.

Sensory trait evaluation	Local breed	*Aseel*	*Kadaknath*
Taste	9.2	8.7	6.8
Colour	8.2	8.6	4.2
Flavour	8.9	8.8	4.3

RESULTS AND DISCUSSION

The mean values of sexual maturity, age at first egg laying, body weight, egg production of these poultry breeds were compared with the traditional practice of local breed chicks (Table 1). The higher body weight was observed in *Aseel* breed as compared with local breed and *Kadaknath* breed of poultry chick.

In the present study, age at first egg laid was 175 d and 172 d in *Aseel* and *Kadaknath* birds, respectively. In contrary to present finding, age at first egg was slightly lower in the study of Haunshi *et al* (2011) and Thangadurai and Shanmugam (2019). However, Ezhil Valavan *et al* (2016) reported age at first egg production was 159 days. This might be due to the genetic potentiality of birds, growing stage of the birds, managemental differences and study location. It has been documented that total egg production determines the success of poultry enterprises and better income to farmers (Vinothraj *et al*, 2020) .

The body weight of the *Aseel* breed at one year of age was1.459kg and was significantly ($P<0.001$) higher than that of local breed (0.9 Kg) and *Kadaknath* breed of poultry (1.410kg). The body weight of the *Aseel* breed and *Kadaknath* breed was 62.1% and 56.6% higher than that of the local poultry breed, respectively . Similarly the egg production of the *Aseel* breed of poultry was 58 numbers and was significantly ($P<0.001$) higher than kadaknath (48 nos) and local breed (42 nos) of poultry. The net return from rearing ten *Aseel* poultry birds was Rs. 1250/- and was significantly higher than rearing of local breed (Rs 990/-) and *Kadaknath* breed of poultry. The benefit cost ratio of *Aseel* breed poultry (1.81) which was also significantly higher than *Kadaknath* breed of poultry chick and local breed of poultry chick. These results were in agreement with Shanmathy *et al* (2018) who concluded that *Aseel* birds had better production performance than the Kadaknath which can be used for crossbreeding. However, Deori *et al* (2024) reported that kadaknath chicken has demonstrated comparable performance to local varieties in terms of production in the hill ecosystem. These results further strengthen the findings of Acharya and Behera (2019) who reported that backyard poultry farming is an effective tool to strengthen the livelihood of resource poor farmers and landless labourers in rural area with low-cost initial investment. It provides eggs and meat for family consumption and additional income to the rural households.

The sensory evaluation traits like taste, colour and flavour were studied for the acceptance of the three breeds by five point Likert scale. The taste and flavour of the local breed was significantly ($P<0.01$) more accepted by the panelist in comparison to the *Aseel* and *Kadaknath* breed of poultry whereas the colour of the meat of the *Aseel* breed was more preferred by the panellist in comparison to the local breed and *Kadaknath*.

CONCLUSION

The result of the present study carried out in Mayurbhanj district of Odisha showed the growth rate, egg production, and net return from *Aseel* breed of poultry chick was significantly higher than local breed and *Kadaknath* breed of poultry. Acceptability and adoptability rate as per sensory evaluation was higher for local poultry breed followed by *Aseel* and *Kadaknath* among the tribal people of this district. Hence, in overall among these three breeds *Aseel* breed was the most accepted and profitable breed for the tribal community.

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Comparative Study of Antimicrobial Activities of *Ocimum* Sps. Against Pathogenic Microorganism

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ABSTRACT

The family Lamiaceae has several significant decorative, therapeutic,aromatic plants, some of which generate economically important essential oils that are utilised in both conventional and contemporary medicines. World-wide distributed plants of family Lamiaceae like *Leonurus, Mentha, Nepeta, Origanum, Leucas, Salvia, Hyssopus and Ziziphora* etc are frequently used to heal wounds, treatment of various types of disorders like gastritis, infections, dermatitis,bronchitis and inflammation. *Ocimum sanctum* and *Ocimum basilicum*, two varieties of the basil herb that are widely available for cultivation, may be a strong contender for usage as a plant with antibacterial properties. *C. freundii* and *M. luteus* bacterial strains were used to test the antibacterial effects of ethanolic extracts from *O. sanctum* and *O. basilicum.* By using agar disc diffusion tests maximum inhibition zones against the pathogenic bacteria *C. freundii* and *M. luteus* were seen in ethanolic leaf and stem extracts of *O. sanctum*. *O. sanctum and O. basilicum* may be suggested as easily accessible and renewable antibacterial agent source rather than manufactured chemicals. The antimicrobial efficiency of *O. sanctum* leaves and stem exhibits significant antimicrobial capabilities.

Key Words : Antimicrobial activity, Lamiaceae, Medicinal herb, *Ocimum sanctum, Ocimum basilicum,* Ethanolic extracts.

INTRODUCTION

One of the primary factors causing a number of diseases is microbial infection. Bacteria that may have an effect on public health is one of the sources of infection. According to the World Health Organization (WHO), 80% of the populace in the developing nations relies on traditional medicines, mostly pharmaceuticals made from the plants (Bahmani et al,2014). Additionally, the current pharmacopoeia continues to include at least 25% of medications that are derived from plants, in addition to a large number of synthetic analogues to plant-derived prototype chemicals. The necessity of medicinal plants is rising in both developed and developing countries as people are becoming more aware of the benefits of natural goods, which are often the only form of healthcare for the poor because they are non-narcotic, have no adverse effects, are readily available, affordable, and easy to obtain. Medicinal plants have long played a significant role in India's rural and tribal communities , spiritual, and medical life. (Awang ,2009).

In ayurveda, medicinal herbs are hugely significant. It is employed to treat a number of disorders. Various types of plant extracts have been utilized for a variety of uses for thousands of years. Antibacterial testing of medicinal plants provides information to create novel medications (Ali et al, 2017) . There is increased interest in medicinal plants as a source of potential antimicrobial medication discoveries since pathogenic microorganisms become resistant to antibiotics employed in modern medicine (Rathnayaka, 2013).

Over 7000 species from 245 genera make up the worldwide family Lamiaceae . They have several uses in medicine, cosmetics, cuisine, and

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Fig : Selected plants (1) ***Ocimum sanctum***
(2) ***Ocimum basilicum***

other fields because of the family members' enduring appeal for having unique essential oil characteristics. Many of the Lamiaceae plants that have been grown and used since antiquity are still in use. Due to the wide range of biological activities of their secondary metabolites, such as antifungal, antimicrobial, antioxidant, anticancer properties and anti-inflammatory, lamiaceae plants are used by the locals according to their inherited empirical skills or as a result of the acquisition and exchange of traditional and/or modern knowledge (Napoli et al,202;Waller et al,2017; Turner et al,2011;Cilliers,2009;Hrisrova et al,2017;Bosi et al, 2020; Ntalli et al, 2020; Ghalkhani et al, 2021; . Dzhambazov et al, 2002; Mladenova et al, 2021).

This family has a variety of species that are high in terpenes and flavonoids, with diterpenoids being the most prevalent. They are also abundant in other medicinally important compounds, have helped with taxonomic classifications. Six most popular spices includes thyme, basil, oregano, rosemary, sage, and lemon balm having fragrant characteristics. Due to the diversity of bioactive chemicals that provide the Lamiaceae family's plants antioxidant, insecticidal, fungicidal, and bactericidal capabilities, there is a possibility that these plants might have significant economic and pharmaceutical significance (Bekut et al,2018; Vieira, et al,2002; Harley et al,2004; . Uritu et al,2018).

Ocimum sanctum is commonly referred to as holy basil, is a fragrant plant which is native to asia and tropics of africa . Majority of plants belongs to family Lamiaceae are most widely utilised as a source of medical plants and valuable essential oils that are used as spices and flavours in a variety of various culinary products. O. sanctum has an upright, 75 cm in height, heavily branched, hairy stem, and simple opposite, green, intensely fragrant leaves, petiole up to 5 cm long, and typically toothed leaves (Jirovetz et al,2002; Malima et al,2013; Kaya et al,2008).

Ocimum basilicum, also known as basil, grows in a variety of habitats. The leaves are utilised as spices in conventional food. Since many years ago, the essential oils of popular culinary herb basil have been used widely to flavour meats and sausages. In addition to being used in a variety of dental and oral treatments, basil oil has also found widespread use in fragrance. Additionally, naturally derived antimicrobial agents like basil are becoming increasingly significant in antimicrobial packaging since they are seen as posing a reduced danger to consumers due to the public's preference for natural food additives nowadays (Sappakul et al, 2003).

The current study set out to assess the possible antibacterial properties of Ocimum sanctum and Ocimum basilicum plants extracted using ethanol and four distinct leaf and stem extract concentrations against Citrobacter freundii and Micrococcus luteus.

Table 1. List of phytochemicals present in *Ocimum sanctum* and *Ocimum basilicum*

Sr. No.	Constituents	*Ocimum sanctum*	*Ocimum basilicum*
1.	Alkaloids	(+ve)	(-ve)
2.	Glycosides	(+ve)	(+ve)
3.	Tannins	(+ve)	(+ve)
4.	Flavonoids	(-ve)	(+ve)
5.	Steroids and Terpenoids	(+ve)	(+ve)
6.	Carbo- hydrate	(+ve)	(+ve)

(Where +ve= presence of bioactive compound , -ve=absence of bioactive compound)

MATERIALS AND METHODS

Vegetative parts of O. sanctum and O. basilicum , collected in the SLS, Khandari, Agra area of Uttar Pradesh (Fig.1). Collected plant parts were placed in poly bags and sealed. The stored plant material were carefully washed in tap water to remove dust particles and transfer to disinfectant then shade dried, grind and packaged (Srinivasan et al, 2004).

Antimicrobial activity assay

The disc diffusion technique was used to assess the in-vitro antibacterial activity of a particular plant extract. For susceptibility testing, extract solutions with different concentrations were made using serial dilution method . On sterile discs (6 mm in diameter), 25 µl of each extract solution was applied. A few colonies from the pure culture were mixed with a nutritional broth. The broth was inoculated across the whole surface of the nutrient agar plate using a cotton swab soaked in culture. The plant extracts containing discs were applied to the contaminated surface of the agar plate with sterile forceps and these plates were incubated at 37 °C for 24 hours . By measuring the width of the zones of inhibition surrounding each disc, the antibacterial activity was determined (millimeter) (Sharma *et al*, 2024).

RESULTS AND DISCUSSION

The Phytochemical analysis of the plant *O. sanctum* extracts was performed the phytoconstituent reported are tannin, phenols, steroids, ,alkaloids, glycosides, steroids and terpenoids a whereas flavonoids are not found while in *O. basilicum* extracts showed the presence of tannin, phenols, steroids ,glycosides, tannins ,steroids and terpenoids but alkaloid was not found in it. The data showing the zone of inhibition of selected bacterial strains viz, *C. freundii* and *M. luteus* due to action of different concentrations of ethanolic extracts of *Ocimum sanctum* and *O. basilicum (*Fig 1 and 2).

Maximum inhibition (20mm) was recorded in 12.5mg ethanolic leaf extracts of *O. sanctum* as compared to 16mm in *O. basilicum* respectively against *C. freundii*. However, inhibition decreased with the decrease in the concentration (fig 1).

This was interesting to note that all the concentration of ethanolic stem extracts were less sensitive as compared to leaf extracts. Maximum inhibition by 12.5mg ethanolic stem extract was 12mm in *O. sanctum* against *Citrobacter freundii* as compared to 10mm in *O. basilicum* (fig 2). Ethanolic leaf extract of *O. sanctum* showed highest inhibition zone (9mm) of *M. luteus.* While 8.5mm diameter and inhibition zone was found in *O. basilicum (*fig 3 and4).

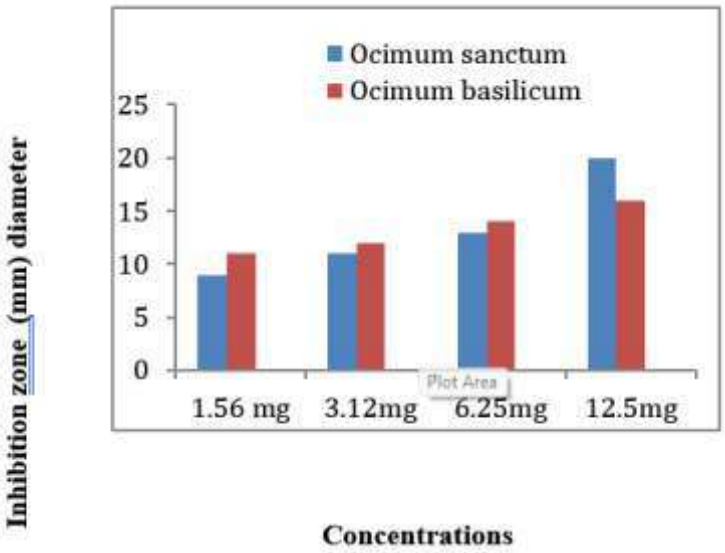

Fig. 1 : Inhibition zone (mm) diameter of *C. freundii* by different concentrations of ethanolic leaf extracts of plants.

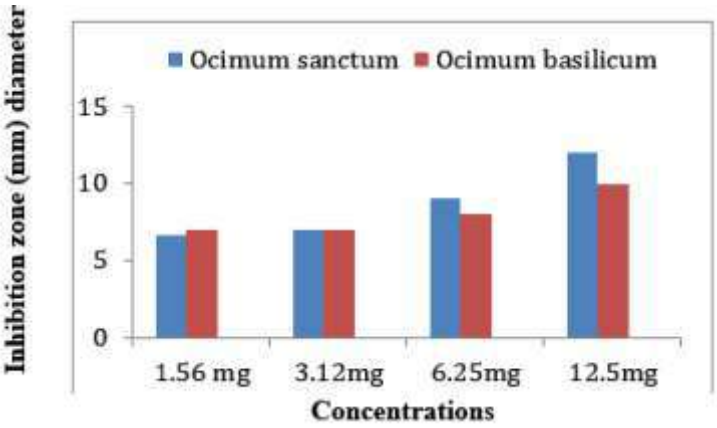

Fig. 2 : Inhibition zone (mm) diameter of *C. freundii* by different concentrations of ethanolic stem extracts of plants.

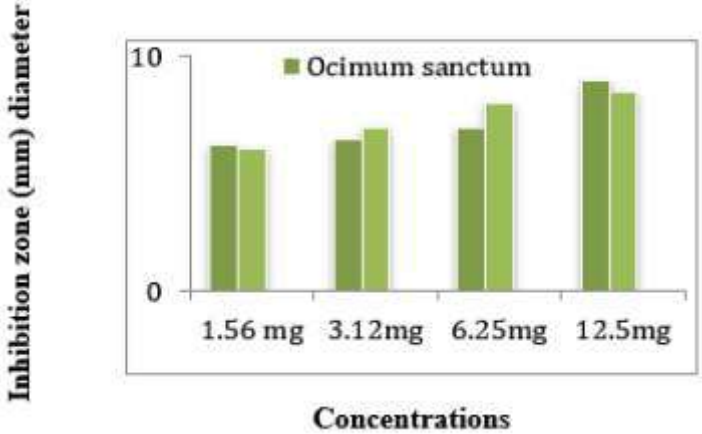

Fig 3. : Inhibition zone (mm) diameter of *M. luteus* by different concentrations of ethanolic leaf extracts of plants.

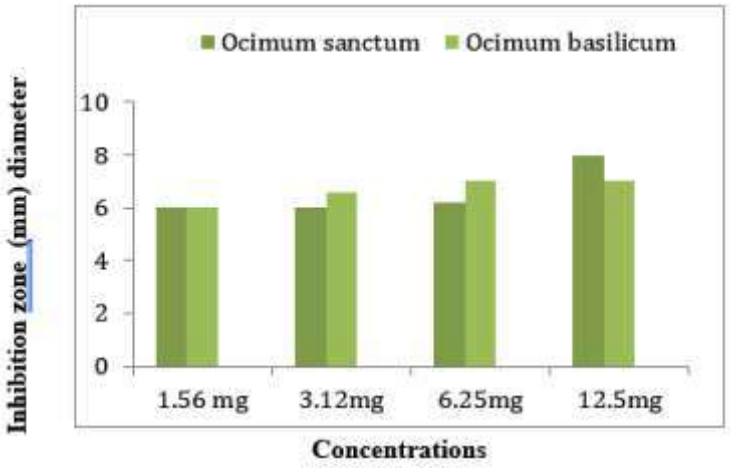

Fig.4: Inhibition zone (mm) diameter of *M. luteus* by different concentrations of ethanolic stem extracts of plants.

CONCLUSION

According to the current study , *O. sanctum* and *O. basilicum* both plants are a rich in various types of phyto-chemical components. *O. sanctum* leaf and stem ethanolic extracts shows more potential to control the growth of both pathogenic bacteria. *O. sanctum* and *O. basilicum* are commonly occurring herb plants, because of its high antibacterial potential , their leaves and stems may be used as an antimicrobial drug instead of manufactured chemicals because they are readily available and renewably.

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Comparison Between Vegetatively Propagated and Seedling Plants in African Marigold (*Tagetes erecta*) Hybrid.

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ABSTRACT

A study was carried out to compare the rooted cuttings and seedlings at regional agriculture research station, Pilicode. Seeds were sown initially to produce seedlings. Rooted cuttings were prepared from seedlings. Seedlings of same age and rooted cuttings were transplanted on prepared beds. Lime and farm yard manure were applied to beds as basal dose along with fertilisers as per package of practices recommended by Kerala Agricultural University. It was observed that seedlings recorded the maximum plant height, number of primary branches and secondary branches. Seedlings also recorded maximum plant fresh weight and dry weight. Yield parameters such as number of flowers per plant (42.05), flower yield per plant (489.85g), flower yield per plot (9.8 Kg), flower yield per hectare (29.02 t/ha) and duration of flowering were significantly more in seedling originated plants. Plants raised from rooted cuttings required less number of days for first flowering (8.65d), 50 per cent flowering (17.90d) and days to first harvest (21.10d) indicating earliness. Shelf life of marigold flowers were also more (7.05) in vegetatively propagated plants compared to that from seedlings (5.45d). Plants raised from rooted cuttings recorded the maximum B:C (5.34 :1) ratio compared to seedlings (3.91:1).

Key Words: Marigold, shelf life, seedlings, cuttings.

INTRODUCTION

Marigold (*Tagetes erecta* L.) holds prominent place among the annual flower crops in India. It is extensively used as loose flower for making garlands in religious and social functions as cut flowers and for garden decoration in landscaping. Marigold has gained popularity among gardeners throughout the world on account of its easy cultivation, wide adaptability and year round flower production. Its free flowering habit, short duration to produce marketable flowers, wide spectrum of attractive colours, shapes, size and good keeping quality has attracted the attention of many amateur and commercial flower growers who utilize them for bedding, edging, herbaceous borders and for pot planting. The availability of seeds in bulk and the prohibitive cost of hybrid seeds in the market are main constraints for expansion of marigold cultivar in Kerala. In order to overcome the constraints of seed cost and hybrid seeds, propagation of marigold by cuttings is a viable option.

The commercial method of cultivating marigold crop is through seed propagation. Plants raised from seeds show a great variability with respect to vigour, precocity and quality. True to type plants cannot be obtained through seed propagation as it is an often cross pollinated crop (Bhatt and Chauhan, 2012). Vegetative propagation through cuttings is the most convenient and cheap method of obtaining a fully developed stronger plants in considerably less time. Propagation through cutting is commonly used in commercial propagation of ornamental plants (Blythe *et al*, 2004). Cuttings required comparatively less time to root and mature for field transplantation than the plants propagated through seeds. Moreover, vegetative propagation method is presumed to result in true to type plants for preservation of all characters of a particular variety (Dawane *et al*, 2015), which can be exploited for planting material production in marigold.

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MATERIALS AND METHODS

The experimental site was located at $12^0$12'N latitude and $75^0$10'E longitude and at an altitude of 15m above mean sea level at RARS, Pilicode. The soil of the site for the experiment was lateritic loam. It was acidic in reaction with a pH of 5.98, organic carbon content 0.48 per cent, available N 225.79 Kg/ha, available P_2O_5 126.47 Kg/ha and available K_2O 431.64 Kg/ha.

Seeds were sown initially to produce seedlings. Rooted cuttings were prepared from seedlings. Seedlings of same age and rooted cuttings were transplanted to prepared beds. For experiment beds of size 2.25 × 1.2 m^2 were prepared by removing stones and weeds. Lime and farm yard manure were applied to beds as basal dose along with fertilisers adopting package of practices recommended by Kerala Agricultural University (KAU, 2016). The rooted cuttings and seedlings were planted at spacing of 30 × 45 cm^2 on beds and distance of 50 cm was maintained between beds. The bacterial wilt was too severe during experiment and copper oxychloride (COC) 50%WP 3g/l was drenched per plant. The control measures like drenching beds with bleaching powder about 10 g/l and copper oxychloride (COC) 50%WP 3g/l was practiced to overcome this. Bacterimycin @ 0.5 g/l was also tried for controlling bacterial wilt.

Plant height (cm), number of primary branches per plant, number of secondary branches per plant, total fresh and dry weight of plants (3MAP), days to first flowering, days to 50% flowering, days to first harvest, number of flowers per plant, mean flower weight (g), flower yield per plant (g), total flower yield / ha (Kg), flower diameter, duration of flowering, vase life, BC ratio were the observations made during comparison study. The data were analysed using t- test analysis

RESULTS AND DISCUSSION

Plant height

Plant height was recorded at 30 d, 60 d and 90 d after planting from both seedlings originated plants and those from cuttings. During all the stages, plant height recorded was correspondingly more in seedlings (T_2) compared to rooted cuttings (T_1). Maximum plant height was recorded by seedling originated plants at 90 DAP (90.40 cm) while the height recorded by rooted cuttings was significantly lesser (67.8 cm). This indicated that plants originated from cuttings tend to be dwarfed irrespective of the stages of growth.

Number of primary branches

Number of primary branches was also recorded at 30 d, 60 d and 90 d after planting from both seedlings originated plants and those from cuttings. A similar trend followed here also where seedling originated plants (T_2) recorded significantly more number of primary branches at all the stages observed compared to cuttings (T_1). Maximum number of primary branches were recorded in seedling originated plants at 90 DAP (10.50) while this was 36 percent lesser in rooted cuttings at the same stage (6.35). However, the increase in the number of primary branches between 60 and 90 days was minimal and most of the development of primary branches occurs within 60 days after planting in both seedlings originated plants and rooted cuttings.

Secondary branches

Production of secondary branches also followed a similar trend to that of primary branches irrespective of the stages observed whether at 30, 60 or 90 days after planting. Seedling originated plants (T_2) documented significantly higher number of secondary branches in all the stages observed compared to plants from rooted cuttings. Here also, the maximum number of secondary branches were recorded in seedling originated plants at 90 days after planting (21.97) compared to rooted cuttings (14.15). The production of secondary branches also were minimal between 60 days and 90 days as there was no significant increase in the number of secondary branches after 60 days both in seedling plants and rooted cuttings.

Plant weight

The data on total fresh and dry weight of plants recorded after the crop were analysed. The

treatments, seedlings and cuttings had shown impact on total plant fresh and dry weight. Seedling plants (T_2) recorded higher total fresh weight (211.51g) and dry weight (47.97g) compared to rooted cuttings. Flower initiation seems to be earlier in rooted cuttings as the number of days required for first flowering was lesser in rooted cuttings. The number of days required for initial flowering in rooted cuttings (T_1) was 8.65 days while this required 13.125 days in seedlings. Hence, this indicated that plants originated cuttings have earliness in flowering

Days to 50 per cent flowering

The observation on days to 50% flowering also followed a similar trend to that of days to first flowering, as the cuttings (T_1) recorded least number of days to complete 50 per cent flowering compared to seedling plants (T_2). The number of days required for cuttings (T_1) was17.9 days for 50 percent flowering while it was significantly longer (22.6) in seedling plants (T_2). For this parameter also, plants from cuttings (T_1) recorded significantly lesser number of days (21.10) to first harvest indicating earliness in this character also. Seedling originated plants required longer days (29.72) for first harvest. A reversal of trend was observed with this parameter as the number of flowers recorded was maximum (42.05) in seedling plants (T_2) compared to cuttings (T_1) where the flower production was 21.75 per cent lesser (37.45).

Flower weight

The maximum mean flower weight (8.32 g) was recorded from cuttings (T_1) which was significantly similar (8.16) to treatment seedling (T_2). The seedlings and cuttings made significant impact on flower diameter. The maximum flower diameter (6.13 cm) was found in treatment cuttings (T_1) which was significantly higher than seedlings (5.96 cm). The treatments significantly influenced the flowering duration as evidenced by the data presented. Seedling originated plants (T_2) recorded longer flowering duration (62.87 days) which was significantly superior to cuttings (T_1) in which the duration was 17.28 per cent lesser (52 days). This indicates the superiority of seedling plants over rooted cuttings for this parameter.

Flower yield

Flower yield per plant was significantly affected by the treatments. The treatment seedlings (T_2) recorded maximum flower yield per plant (489.85 g) which was significantly greater than treatment cuttings (T_1). Individual plants originated from seedling recorded 20.57 per cent higher flower yield compared to rooted cuttings (389.07 g). Flower yield per plot was significantly affected by treatments. The treatment seedlings (T_2) recorded maximum flower yield per plot (9804.8g) which was significantly greater than cuttings(T_1). Flower yield per hectare was significantly affected by the treatments. The treatment seedlings (T_2) recorded maximum flower yield (29t/ha) which was significantly greater than treatment cuttings (T_1). During all the stages, plant height, number of primary and secondary branches recorded was correspondingly more in seedlings (T_2) compared to rooted cuttings (T_1). Maximum plant height, number of primary branches and secondary branches was recorded by seedling originated plants at 90 DAP. This indicated that plants originated from cuttings tend to be dwarf and the production of primary and secondary branches were significantly lesser in them irrespective of the stages of growth compared to seedling originated plants. In both cases however, the increase in the number of primary branches between 60 and 90 days was minimal and most of the development of primary branches occurs within 60 days after planting.

The results were in agreement with the reports by Dawane *et al* (2015) and Naveen (2016) in marigold in which the plant height and number of primary and secondary branches were more in seedling plants than rooted cuttings. The reason for maximum plant height, and production of primary and secondary branches in seedlings might be due their vigorous nature of growth and the taproot system present in seedlings which helps in more absorption of nutrients and water making plants stronger, taller, well branched and well established. Vegetatively propagated plants are less vigorous and usually short in stature and less branching due to the fibrous root system is present in them and low absorption of nutrients from soil.

The propagation methods significantly influenced the total plant fresh weight and dry weight. Seedling plants recorded higher total fresh weight and dry weight compared to rooted cuttings. The results were in line with the findings by Kathiravan *et al* (2007). The dominance of seedling plants for these parameters could be because of more number of primary and secondary branches in them compared to that of cuttings.

Flowering and Yield attributes

Flower initiation seems to be earlier in rooted cuttings as the number of days required for first flowering was lesser in them. The number of days required for initial flowering in rooted cuttings was 32 per cent lesser than seedlings. Similarly, the number of days to complete 50% flowering also was significantly lesser in rooted cuttings compared to seedling plants (T_2). 50% flowering in plants from rooted cuttings completed five days earlier than seedling plants.

Earlier flower initiation and days to 50 percent flowering in rooted cuttings may be due to the reduced juvenile phase in vegetatively propagated plants as reported by Bose *et al* (1986) and early maturity of cuttings to flower (Hartman *et al,* 2002) The present results were also in agreement with reports by Dawane *et al* (2015) in marigold.

Plants from cuttings also recorded significantly lesser number of days to first harvest indicating earliness in this character also. Seedling originated plants required longer days for first harvest. Earliness in harvest might have resulted from the associated factors presented above such as earlier flower bud initiation and days to complete fifty percent flowering as observed in plants originated from rooted cutting.

A reversal of trend was observed in flower production as the number of flowers recorded was maximum in seedling plants compared to cuttings where the flower production was 39 per cent lesser. The results were in conformity with the studies by Dawane *et al* (2015) and Naveen (2016) in marigold. The production of more number of branches might have resulted in more number of flowers in seedlings.

Weight of individual flowers and diameter of flowers was not influenced by the propagation methods. Similar individual flower weight and diameter of flowers recorded by both seedling plants and rooted cuttings substantiates this. These findings were contrary to the findings by Dawane *et al* (2015) and Naveen (2016) in marigold where they reported significantly higher flower weight and flower diameter from seedling plants

Seedling originated plants (T_2) recorded longer flowering duration which the duration was 10 days longer than cuttings. This indicates the superiority of seedling plants over rooted cuttings for this parameter. The reason behind the increased duration of flowering in seedlings might be due to their vigorous and robust nature of seedlings (more number of lateral shoots). The outcomes were in conformity with the work of Dawane *et al* (2015) in marigold.

The flower yield per plant, flower yield per plot and flower yield per hectare were significantly affected by propagation methods. Seedlings plants recorded maximum flower yield per plant as well as per hectare which was significantly superior to cuttings. Individual plants originated from seedling recorded 20.73 per cent higher flower yield compared to rooted cuttings. The cause for improved flower yield per plant in seedlings might be due to more number of branches, leaves and increased assimilates for development of flowers as well as higher duration of flowering, more number of flowers per plant. The results were in conformity with the findings of Dawane *et al* (2015) in marigold. The propagation methods had significant influence on vase life. The maximum vase life was recorded by cuttings which was significantly superior to seedlings. The results were in conformity with the findings of Dawane *et al* (2015) in marigold. The increased vase life might be due to more capacity to tolerate loss in weight because of reduced transpiration and respiration and also increased quantity of antioxidants, antibiotics, phenols hormones.

The B:C ratio was significantly influenced by propagating methods. The maximum B:C was found in cuttings(T_1) which was significantly higher than seedlings (T_2). This was contrary to

Comparison Between Vegetatively Propagated and Seedling Plants

Table1. Effect of propagation methods (Seedlings and cuttings) on plant characters.

Variable	Seedlings	Std.Err.	Cuttings	Std.Err.	CD value at 0.05%	t value
Plant Height at 30 Days (cm)	51.72	0.443	39.31	0.709	1.75	14.839
Plant Height at 60 Days (cm)	87.91	0.296	66.89	0.519	1.25	35.139
Plant Height at 90 days (cm)	90.40	0.215	67.800	0.281	0.59	83.87
Primary Branches at 30 Days (No)	4.65	0.076	2.77	0.087	0.24	16.196
Primary Branches at 60 Days (No)	9.62	0.230	6.15	0.107	0.53	13.681
Primary branches at 90 days (No)	10.50	0.118	6.35	0.125	0.36	24.01
Secondary Branches at 30 Days (No)	10.15	0.155	6.77	0.126	0.41	16.919
Secondary Branches at 60 Days (No)	19.57	0.271	12.12	0.187	0.69	22.591
Secondary Branches at 90 days	21.975	0.095	14.150	0.100	0.28	56.831

Table 2. Effect of propagation methods (Seedlings and Cuttings) on flower yield parameters.

Variable	Seedlings	Std.Err.	Cuttings	Std.Err.	CD value at 0.05%	t value
Days to 1st Flowering	13.12	0.150	8.65	0.242	0.59	15.706
Days to 50% Flowering	22.60	0.371	17.90	0.180	0.86	11.399
Days to 1st Harvest	29.72	0.142	21.10	0.163	0.45	39.896
Number of Flowers/ Plant	42.05	0.44	32.95	0.57	1.52	12.56
Mean Flower Weight	8.16	0.078	8.32	0.097	0.261	2.026
Flower Diameter	5.96	0.093	6.13	0.172	0.41	0.877
Flowering Duration	62.87	0.239	52.00	0.467	1.10	20.725
Flower Yield/ Plant(g)	489.85	2.35	389.07	1.48	5.84	36.22
Flower yield per plot (g)	9804.8	46.04	7781.5	29.68	115.09	36.93
Total flower yield/ha (Kg)	29027.84	139.39	23056.18	87.95	346.28	36.23

Table3. Effect of propagation methods (Seedlings and cuttings) on physiological, qualitative characters and BC ratio.

Variable	Seedlings	Std.Err.	Cuttings	Std.Err.	CD value at 0.05%	t value
Total fresh Weight(g)	211.51	3.504	149.48	1.665	8.15	15.988
Dry Weight(g)	47.976	2.301	33.723	0.941	5.22	5.733
Vase Life(days)	5.450	0.153	7.05	0.170	0.48	7.002
BC ratio	3.91	5.34				

Naveen (2016). The reason for increased B:C ratio in cuttings might be production of more number of plants from single mother plants and high cost of hybrid seeds

CONCLUSION

The results revealed that there was significant difference on various morphological

and yield attributes. Flowering was significantly early in cuttings compared to seedlings. Maximum B:C ratio of 5.34 was obtained when rooted cuttings were used as the planting material while BC ratio was 3.91 when seedlings were used. Propagation and planting through rooted cuttings can be promoted in hybrid marigold as this helps to maintain purity of varieties as well as reduce the cost of seeds. A single mother plant can provide up to shoots amenable for rooting which can be retained as source for planting materials. This practice not only reduce cost of cultivation and ease the burden procuring seeds each season which are not available locally.

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Constraints Faced by Vegetable Growers in Chandel District Manipur

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ABSTRACT

Vegetable farming plays a pivotal role in the agricultural landscape of Chandel district, Manipur, contributing to local consumption, economic activity, and employment. However, vegetable farmers in the region face numerous constraints that impact their productivity, sustainability, and income. This study was conducted in three villages of Chandel district—Lambung, Phunchung, and Lamphou Pasana—to identify the social, economic, production, and marketing challenges encounter by vegetable growers. A sample of 120 respondents was selected to gather primary data through structured questionnaires. The findings revealed that social and economic constraints such as youth disinterest in farming, poor economic conditions, and lack of institutional support were significant. In terms of production, the major challenges included pest infestations, lack of irrigation facilities, and high labour costs. Marketing constraints, such as low marketable surplus, inadequate transportation, and lack of storage facilities, further exacerbate the difficulties faced by farmers. These constraints significantly hinder the growth and sustainability of vegetable farming in the region.

Key Words: Constraints,Marketing, Production, Socio-economic ,Vegetable farming.

INTRODUCTION

Vegetables are a crucial part of Indian agriculture and nutritional security due to their short growing periods, high yields, nutritional value, economic feasibility, and ability to generate both on-farm and off-farm employment. India's diverse agro-climates and distinct seasons allow for the cultivation of a wide variety of vegetables. Manipur, a small landlocked state in north-eastern India, produced about 376569 t of vegetables from the year 2023 to 2024 as reported by Department of Agriculture and Farmers welfare. The data reached an all-time high of 376579 t in 2022 and a record low of 219820 t in 2013 in the last ten years. This represents an increase of approximately 71.3% in vegetable production over the last 10 years, demonstrating a significant rise in productivity during this period. However, the Northeast region presents unique challenges due to its hilly terrain, climatic conditions, and socio-economic factors. Hanglem (2019) indicated that farmer in this region struggle with poor road connectivity, insufficient irrigation facilities, and limited availability of quality seeds. It also highlighted that farmers face significant hurdles such as pest infestations, lack of storage facilities, and fluctuating market prices, which adversely affect their income and sustainability.

Chandel district is one of the hilly districts situated in the south-eastern part of Manipur with an area of 3,313 square kilometers, at approximately 24°40'N latitude and 93°50'E longitude. The district falls under a subtropical agro-climatic zone with exception in some areas. The soil ranges from Clay type to Loamy Red Soil rich in organic matter. However, the hilly regions or the Upland areas are acidic nature. The main river in the area is the Chakpi. The distribution of rainfall widely varies from 343.85mm to 1650.00mm. As per Census 2011, Chandel had population of 133,182 and, the literacy rate is 71.11%. The majority of the population relies on agriculture and its allied activities for sustenance,

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Table 1. Social and Economic constraint (n=120)

Sr.No	Social and Economic constraint	Frequency	Percentage	Rank
1	Less interest shown by upcoming youth in farming	84	70	I
2	Poor economic condition	79	65.83	II
3	Lack of time to attend meetings or trainings	75	62.5	III
4	Lack of institutional credit facilities/loans	69	57.5	IV
5	High burden of farm activities	60	50	V
6	Stray cattles cause lots of damage to vegetable farming	55	45.83	VI
7	Poor communication skills	35	29.16	VII
8	Low literacy rate in area	32	26.66	VIII
9	Lack of self confidence in farmers	32	26.66	IX

with vegetable farming being a vital component. While vegetable farming is crucial for both local consumption and economic activity, Chandel district accounts for only 4.09% of the total area under vegetable cultivation in Manipur (Devi, 2019). This study was conducted to identify and analyze the key constraints faced by vegetable growers in Manipur with a focus on challenges related to production, marketing, and resources, in order to propose effective solutions for improving vegetable farming practices in the region.

MATERIALS AND METHODS

The present study was purposely carried out in three villages of Chandel block under Chandel district, namely Lambung, Phunchung and Lamphou Pasana to assess constraints faced by farmers in growing vegetables. These three villages have a large number of small and marginal vegetable growers. In order to have representative sample, a sample of 40 respondents was drawn randomly from each village, which resulted in 120 respondents. The primary data were collected through pre-tested and structured questionnaire without any biased. The data collected on socio-economic, production and marketing constraints faced by the vegetable growers were tabulated and analyzed to draw conclusion. Frequency, simple percentage and ranked analysis done for analysing the data collected. Rank was assigned to each sub category on the basis of frequency.

RESULTS AND DISCUSSION

Social and Economic constraint

The major social and economic constraint faced by the vegetable grower was less interest shown by upcoming youth in farming. It ranked 1stin rank analysis with 70%. It may be due to youth showing more interest in education and also moving to other cities for work. Kaur and Sharma (2018) also revealed that women, especially the youth were less interested to participate in the farming related activities. Poor economic condition was the second major constraint. Most of the farmers have low income to meet their daily necessity so they were not able to invest in big farms and take risk for any unknown circumstances that may result in crop loss therefore they normally practiced subsistence farming. It came at 2nd in rank analysis with 65.83%. Lack of time to attend meetings or trainings was the 3rd constraint with 62.5%, lack of institutional credit facilities/loans comes in 4th rank with 57.5% and high burden of farm activities comes in 5th with 50%. It is very difficult and time consuming for the vegetable growers to get loan facilities.

The vegetable growers are mostly women so managing their household work along with time consuming farming task is a big problem for them. It was also found that Stray cattle cause lots of damage to vegetable farming, coming 6th in the

Table 2. Production constraints. (n=120)

Sr. No.	Production problem	Frequency	Percentage	Rank
1	Severe pest and diseases infestation	76	63.33	I
2	Lack of irrigation facilities/ monsoon dependant	72	60	II
3	High cost of human labour	70	58.33	III
4	Scarcity of labours	67	55.83	IV
5	Non-availability of quality seeds	55	45.83	V
6	Lack of awareness of cost reduction technologies in vegetable farming	52	43.33	VI
7	Lack of Knowledge in selecting appropriate varieties	50	41.66	VII
8	Non-availability of machines for hiring	47	39.16	VIII
9	Low return from the investment	45	37.5	IX
10	Lack of institutional and government support	32	26.66	X
11.	Fragmentation of land holdings.	15	12.5	XI

rank analysis with 45.83%. Most of the farmers were not able to make proper fencing so, their crops gets damage by the straying cattle resulting in low output. Poor communication skills comes in 7th rank with 29.16%, while low literacy rate ranks 8th with 26.66% and Lack of self confidence in farmers comes in rank 9th with same percentage of 26.66%. There are some barriers when it comes to communication as most of the farmers were less literate so whenever there are training programmes conducted they find it difficult to fully understand. Also, the farmers have less confidence in their farms mainly because of the erratic weather pattern and incidence of pest and diseases.

Production constraints

The major and most felt production constraint faced by the vegetables growers was severity in pest and diseases infestation, ranking 1st in the rank analysis with 63.33%. This was due to the fact that the farmers hardly used inorganic chemical for pest and disease control and mostly depends upon traditional measure. Lack of irrigation facilities/monsoon dependant was at 2nd rank with 60%. Farmers lack irrigation facilities and cultivate their farms under rain-fed conditions depending mostly on monsoon rainfall which is quite erratic in nature due to the changing climatic condition, thereby resulting in crop losses whenever there is irregularity in rainfall. Murry *et al* (2020) also found similar findings. High cost of human labour comes at 3rd rank with 58.33%, followed by scarcity of labours with 55.83% and non-availability of quality seeds with 45.83%. It was found that there is very less availability of labours with very high cost so the total production cost becomes high with less return if they hire labours, so in order to avoid that they themselves do all works therefore, they are not able to invest in bigger farms. Since the village is situated in economically backward area thus, there is a lack of timely availability of quality seeds so the farmers mostly used traditional varieties which are of long duration with lesser yield.

The study also found that there was lack of awareness of cost reduction technologies in vegetable farming. It ranked 6th in the ranking analysis with 43.33%. The farmers mostly practiced traditional method of farming which takes longer period, with lesser yield. Lack of Knowledge in selecting appropriate varieties was at 7th rank with 41.66%, followed by non-availability of machines for hiring with 39.16%. Low return from the investment was at rank 9th with 37.5% and a lack of institutional and

Table 3. Marketing constraints. (n=120)

Sr. No.	Marketing constraint	Frequency	Percentage	Rank
1	Low marketable surplus	80	66.66	I
2	Less risk bearing capacity of farmer	75	62.5	II
3	Lack of proper transportation facilities	63	52.5	III
4	Lack of warehouses / storage facilities in the area	58	48.33	IV
5	Lack of efficient marketing mechanism	40	33.33	V
6	Lack of government support price and pricing policy	35	29.16	VI
7	Lack of marketing co-operative societies	31	25.83	VII

government support ranked 10th with 26.66%. Since specific variety is more suitable in specific environmental or soil condition to have higher returns, it is very important to have knowledge about suitable variety but the farmers are less literate so they have less knowledge about suitable variety and sometimes they grow less suitable variety resulting in lesser return. The village being economically weak have very few machines for hire. The farmers also face low return from their investment due to erratic weather, wildlife or diseases/pest infestation. Haneef *et a*l (2019) also found similar findings. Few farmers were interested in commercial cultivation but there is a problem of fragmentation land holdings which is quite challenging. So fragmentation of land holdings ranked at 11th rank with 12.5%.

Marketing constraints

The data (Table.3) showed that the major marketing constraint faced by vegetable growers was low marketable surplus ranking 1st in the rank analysis with 66.66%. The farmers were mostly subsistence farmers and economically backward so do not have the means to support large cost of production. The farmers were also not willing to take a risk of unknown circumstances like pest and disease infestation, erratic weather pattern that may result in loss of crop thereby loss in profit, hence, less risk bearing capacity of farmer was at 2nd rank with 62.5%. Lack of proper transportation facilities comes in 3rd rank with 52.5%, followed by lack of warehouses / storage facilities in the area with 48.33% and lack of efficient marketing mechanism with 33.33%. Most of the farmers also do not own vehicles to carry their products to the market and very few are available for hire at high cost. Also, the farmers stored their produce in traditional methods due to the lack of storage facilities thereby lesser shelf life. Samantaray *et al* (2009) also found similar findings. Other major constraints face by the vegetable growers includes lack of government support price and pricing policy with 29.16% and lack of marketing co-operative societies with 25.83%.

CONCLUSION

The study highlighted the multi-dimensional challenges faced by vegetable farmers in Chandel district, Manipur. Social and economic constraints, such as youth disinterest in farming and poor economic conditions, contribute to the decline in agricultural participation. Production constraints, including pest infestations, lack of irrigation, and high labor costs, further limit the productivity of vegetable farming. Marketing constraints, such as low marketable surplus and inadequate storage facilities, worsen the financial outcomes for farmers. To address these issues, targeted interventions, including improved access to institutional credit, better pest management solutions, better irrigation facilities, and development of efficient marketing and storage systems, are crucial. Government support and the introduction of modern farming techniques could help mitigate these challenges, improve productivity, and enhance the sustainability of vegetable farming in the region.

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Eco-Friendly Management of Sheath Blight Disease in Barnyard Millet (*Echinochloa crusgalli*) incited by *Rhizoctonia solani* Kuhn

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ABSTRACT

Sheath blight, caused by *Rhizoctonia solani*, threatens barnyard millet (*Echinochloa crusgalli*), a nutrient-rich cereal critical for food security in India. This study evaluates eco-friendly disease management strategies, including seed treatment, seed biopriming, and organic amendments colonized with biocontrol agents (*Trichoderma asperellum, Pseudomonas fluorescens, Bacillus subtilis*), under field conditions in Uttarakhand. The pathogen was identified via morphological and microscopic analyses. Field trials using a Randomized Block Design assessed disease incidence, severity, and control efficacy across 36 plots. Results showed that farm yard manure (FYM) pre-colonized with a consortium of bioagents achieved 100% disease control efficacy, outperforming individual seed treatments. The study highlights the synergistic potential of bioinoculants in reducing disease incidence and severity, offering a sustainable alternative to synthetic fungicides. These findings underscore the role of bioagents in promoting resilient, eco-friendly agriculture in India.

Key Words: biocontrol agents, bioinoculants, disease management, eco-friendly agriculture, organic amendments, sustainable practices.

INTRODUCTION

Millet is the oldest of the cultivated grain crops and a general term for a variety of small-grained cereal grass varieties (Kumar, 2016; Rawat *et al,* 2019). Vital nutrients are found in millets, and their protein content is regarded as being on par with or better than that of rice (*Oryza sativa*), maize (*Zea mays*), and wheat (*Triticum aestivum*). (Kumar et al, 2017). They are considered as Nutri Cereal crops and slowly being rediscovered by the agricultural research and development community (Kumar, 2016; Grovermann *et al*, 2018). Of the 30.73 million tons of millet produced worldwide, 11.42 million tons are produced in India, making up 37% of the total production. In India, millet is grown on about 24 million ha of land. (Sakamma *et al,* 2018).

Madhya Pradesh has the largest state area (84,000 ha,) among all the states that grow small millets, followed by Chhattisgarh (63,370 ha), Uttarakhand (53000 ha,), and Maharashtra (40980 ha,). With a productivity of 1711 kg/ha, Telangana leads the pack, followed by Tamil Nadu (1444 kg/ha) and Uttarakhand (1339 kg/ha). With an average productivity of 1034 kg/ha, India is the world's largest producer of barnyard millet, both in terms of area (0.146 m ha) and production (0.147 mt). One of the smallest and most resilient millets is barnyard millet (*Echinochloa crusgalli*), which is a member of the Poaceae family and the Panicoideae subfamily. It is known by a number of names, including sanwank, sawan, ooda, and oadalu. Indian barnyard millet, or *Echinochloa frumentacea (Roxb.) Link; syn. E. colona var. frumentacea* (allohexaploid, 2n = 6x = 54), is derived from wild *E. colona* (L.). Compared to other millets, barnyard millet has a relatively higher nutritional status. Nearly all of the essential components of a typical human diet are present in greater amounts in it, including protein

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(11.60g/100g), carbohydrates (74.30g/100g), minerals (4.70g/100g), calcium (14.00 mg/100g), crude fiber (14.70g/100g), and phosphorous (121.00 mg/100g). (Anbukkani *et al,* 2017). Similar to this, barnyard millet's alkaloids, steroids, carbohydrates, glycosides, tannins, phenols, and flavonoids have a variety of ethnomedical qualities, including the ability to heal wounds, reduce biliousness, and alleviate diseases linked to constipation. (Sharma *et al,* 2016; Sayani and Chatterjee, 2017).

Rhizoctonia solani-induced sheath blight has become a growing issue in Uttarakhand's hilly regions. (Kumar and Prasad, 2009; Kumar, 2016). The first reports of *Rhizoctonia solani*-caused sheath blight disease in barnyard millet date back to 2009 (Kumar and Prasad, 2009). Oval to irregular and light grey to dark brown lesions are the symptoms that were previously seen on the sheath but are now also seen on the leaves. Lesions initially developed on the leaves close to the soil's surface, but they quickly spread, merged to cover the upper leaves, and resulted in blighting of the foliage (Kumar, 2016). A series of copper and brown bands appeared across the leaf as the disease worsened, with the central parts of the lesions eventually turning white to straw with thin, reddish-brown borders (Kumar, 2016). Attempts to employ a group of bio-control agents to achieve long-term control of plant diseases have also been made in recent years (Chaube and Sharma, 2002; Rawat *et al,* 2011, 2012).

It is commonly known that *Trichoderma* works well as a biological control agent against a variety of plant diseases, including *R. solani*. (Hicks *et al,* 2014). According to several reports, *Trichoderma's* strong antagonistic and mycoparasitic activity effectively inhibits plant pathogens in the soil (Bhattacharjee and Dey, 2014; Rawat *et al,* 2016), in addition to direct impacts on plant roots, boosting the uptake of nutrients, enhancing seed germination, and boosting plant defenses against biotic and abiotic stressors (Hicks *et al,* 2014; Bhattacharjee and Dey, 2014). Among the most popular bacterial biological agents for combating a variety of soil phytopathogens, such as *Rhizoctonia solani*, are *Bacillus subtilis* and *Pseudomonas fluorescens* (Bhattacharjee and Dey, 2014; Kukreti *et al,* 2017). The synthesis of bioactive substances and/or extracellular hydrolytic enzymes may be the cause of *Bacillus subtilis* and *Pseudomonas fluorescens'* antagonistic activity (Saber *et al,* 2015; Kukreti *et al,* 2017). Using combinations of compatible biocontrol agents that have synergistic effects can result in biological control ability (Hicks *et al,* 2014; Ezzat *et al,* 2015). In order to assess the impact of seed treatment, seed biopriming, and the incorporation of organic amendments with bacterial or fungal antagonists used as soil treatment against the sheath blight disease in barnyard millet caused by *Rhizoctonia solani*, the current study was conducted.

MATERIALS AND METHODS

The current study was carried out at the College of Forestry's Plant Pathology Research Block and Laboratory in Ranichauri, Tehri Garhwal, Uttarakhand. A field trial was carried out in 2021 during the *Kharif* season. Randomized block design was used to lay out the field experiment.

Isolation and identification of the pathogen

In order to isolate the blight-inciting pathogen, the infected sheath sample was taken from the Vegetable Research Block and transported to the Plant Pathology Laboratory at the College of Forestry in Ranichauri. Following a thorough cleaning with sterile distilled water, these sheath samples were allowed to air dry. Both the healthy and diseased portions of the samples were then cut into tiny pieces, each measuring around 4 mm. Following surface sterilization with sodium hypochlorite and double-distilled water, these cut portions were allowed to air dry on sterile blotting paper. A laminar airflow chamber was used to create aseptic conditions for the inoculation of these cut portions onto the petri plates that contained the PDA medium. These plates were then incubated at 25±2 ºC in a BOD incubator for about 7-10 d for the fungus to grow. The fungus was then observed under a compound microscope for its identification.

Table 1. Details of treatments used under field conditions.

Sr. No.	Symbol	Treatment detail	Concentration
1.	T_1	Control/Untreated check	-
2.	T_2	Seed treatment with *Trichoderma asperellum*	@10g/kg seed
3.	T_3	Seed treatment with *Pseudomonas fluorescens*	@10g/kg seed
4.	T_4	Seed treatment with *Bacillus subtilis*	@10g/kg seed
5.	T_5	Seed bio-priming with *Trichoderma asperellum*	@10g/kg seed
6.	T_6	Seed bio-priming with *Pseudomonas fluorescens*	@10g/kg seed
7.	T_7	Seed bio-priming with *Bacillus subtilis*	@10g/kg seed
8.	T_8	Soil application of value added FYM (FYM pre-colonized with *Trichoderma asperellum*)	@5kg pre-colonized FYM/plot
9.	T_9	Soil application of value added FYM (FYM pre - colonized with *Pseudomonas fluorescens*)	@ 5kg pre-colonized FYM/plot
10.	T_{10}	Soil application of value added FYM (FYM pre - colonized with *Bacillus subtilis*)	@ 5 kg pre-colonized FYM/plot
11.	T_{11}	Soil application of value added FYM (FYM pre - colonized with *Trichoderma asperellum +Pseudomonas fluorescens +Bacillus subtilis*)	@ 5kg pre-colonized FYM/plot
12.	T_{12}	Seed treatment with Carbendazim	@ 2g/kg of seed

Table 2. Disease Rating scale for sheath blight disease severity (AICRP Small Millets Proceeding, 2020)

Grade	Description	Host reaction
1	<1% of plant area covered by lesion	Highly resistant (HR)
2	1-5% of plant area covered by lesion	Resistant (R)
3	6-10% of plant area covered by lesion	Resistant (R)
4	11-20% of plant area covered by lesion	Moderately resistant (MR)
5	21-30% of plant area covered by lesion	Moderately resistant (MR)
6	31-40% of plant area covered by lesion	Susceptible (S)
7	41-50% of plant area covered by lesion	Susceptible (S)
8	51-75% of plant area covered by lesion	Highly susceptible (HS)
9	>75% of plant area covered by lesion	Highly susceptible (HS)

Evaluation of fungal and bacterial bioagents and fungicide against sheath blight disease in barnyard millet, incited by *Rhizoctonia solani* Kuhn under field conditions.

The Plant Pathology Laboratory, College of Forestry, Ranichauri, Tehri Garhwal, V. C. S. G. Uttarakhand University of Horticulture and Forestry, Uttarakhand, provided the seed material for the current study. It included one variety of barnyard millet (*Echinochloa crusgalli L.*), known as PRJ-1, as well as pure cultures of three biocontrol agents: *Trichoderma asperellum*, *Pseudomonas fluorescens*, and *Bacillus subtilis*. Prior testing revealed that the aforementioned

Table 3. Effect of different treatments on percent disease incidence, percent disease index, host reaction and per cent efficacy of disease control (PEDC).

Sr. No.	Treatment	Percent Disease Incidence	Percent disease index	Grade	Host Reaction	PEDC
1.	T1	43.36±0.15(41.172)	30.29 ±0.38 (33.38)	5	Moderately Resistant (MR)	0.00
2.	T2	22.58*±0.13(28.36)	12.44*±0.11(20.64)	4	Moderately Resistant (MR)	59.93
3.	T3	25.65*±0.06(30.42)	13.16*±0.02(21.26)	4	Moderately Resistant (MR)	56.55
4.	T4	28.40*±0.34(32.19)	16.44*±0.09(23.91)	4	Moderately Resistant (MR)	45.72
5.	T5	15.74*±0.07(23.37)	9.03*±0.14(17.48)	3	Resistant (R)	70.18
6.	T6	18.43*±0.04(25.41)	10.17*±0.21(18.58)	4	Moderately Resistant (MR)	66.42
7.	T7	19.81*±0.18(26.42)	11.10*±0.08(19.45)	4	Moderately Resistant (MR)	63.35
8.	T8	5.35*±0.02 (13.37)	1.21*±0.02(6.31)	2	Resistant (R)	96.00
9.	T9	7.51*±0.04 (15.89)	2.34*±0.01 (8.79)	2	Resistant (R)	92.26
10.	T10	10.85*±0.14(19.22)	6.70*±0.14 (15.00)	3	Resistant (R)	77.88
11.	T11	0.00*±0.00(0.00)	0.00*±0.00(0.00)	1	Highly Resistant (HR)	100
12.	T12	23.86*±0.19(29.22)	8.72*±0.21 (17.16)	3	Resistant (R)	71.21
	S.E (d)	0.17 (0.11)	0.23 (0.19)			-
	C.D. 0.05)	0.35 (0.24)	0.49 (0.41)			-

bioagents were compatible with one another. Before the seeds were planted, the field was prepared by two power tiller ploughings and the addition of the recommended fertilizer dosage (40:20:20) to the soil. Thirty-six plots measuring 2.0 m by 1.35 m were constructed with appropriate drainage channels, a path, and enough space between them to allow for the labeling and tagging of various replications. The details of these treatments are shown in Table 1.

Observations were made for per cent disease incidence, per cent disease severity, per cent disease control. The per cent disease incidence was recorded for the number of plants found infected in the field, and disease severity for the sheath blight disease was recorded by the scale (Table 2) and calculated by the formula given by Mayee and Datar (1986), and per cent efficacy of disease control (PEDC) was calculated by the formula given by Vincent (1927).

RESULTS AND DISCUSSION

Isolation and identification of the pathogen

Based on documented morphological and microscopic observations, the isolated fungus was determined to be *Rhizoctonia solani*. Under a microscope, the pathogen's mycelium appeared hyaline when it was young and turned brown as it matured. Branching was seen at a roughly right angle to the distal septum. The primary characteristic of the fungus *Rhizoctonia solani* is constriction and the formation of the septum in branches close to the point of origin. as shown in Fig. 1 B. The characters were found similar to those described in the literature of Chowdary and

Govindaiah (2007), Mishra *et al* (2011) along with Jain *et al* (2016).

Disease assessment and its control

Percent Disease Incidence

T1 (Control) had the highest disease incidence rate (43.36%), followed by T4 (*Bacillus subtilis* seed treatment) and T3 (*Pseudomonas fluorescens* seed treatment), with 28.40% and 25.65%, respectively. However, the treatment T11 (FYM pre-colonized with *Trichoderma asperellum* + *Pseudomonas fluorescens* + *Bacillus subtilis*) had the lowest disease incidence (0.00%), followed by T8 (FYM pre-colonized with *Trichoderma asperellum*) at 5.35 % and T9 (FYM pre-colonized with *Pseudomonas fluorescens*) at 7.51%.

Disease severity

Treatment T11 (FYM pre-colonized with *Trichoderma asperellum* + *Pseudomonas fluorescens* + *Bacillus subtilis*) had the lowest disease severity (0.00%) with 1G and highly resistant (HR) type of host reaction.T8 (FYM pre-colonized with *Trichoderma asperellum*) had the second-lowest disease severity (1.21%) with 2G scale and resistant (R) host reaction, and T9 (FYM pre-colonized with *Pseudomonas fluorescens*) had the second-highest disease severity (2.34%) with 2G scale and resistant (R) host reaction.The highest disease incidence (30.29%) was recorded in T1 (Control) with 5G and moderately resistant (MR) host reaction.

Per cent Efficacy of disease control (PEDC)

The treatment T11 (FYM pre-colonized with *Trichoderma asperellum* + Pseudomonas fluorescens + *Bacillus subtilis*) had the highest percentage of disease control efficacy (100.00%) of sheath blight, followed by T8 (FYM pre-colonized with *Trichoderma asperellum*) with 96.0 % and T9 (FYM pre-colonized with *Pseudomonas fluorescens*) with 92.26%. The lowest percentage of disease control efficacy (45.72%) was found in T4 (Seed treatment with *Bacillus subtilis*), followed by T3 (Seed treatment with *Pseudomonas fluorescens*) and T2 (Seed treatment with *Trichoderma asperellum*) with 56.55 % and 59.93 %, respectively. T11 (FYM pre-colonized with *Trichoderma asperellum* + *Pseudomonas fluorescens* + *Bacillus subtilis*) had the lowest percentage disease incidence and PDI, followed by T8 (FYM pre-colonized with *Trichoderma asperellum*) and T9 (FYM pre-colonized with *Pseudomonas fluorescens*). T1 (Control) had the highest percentage disease incidence and PDI. According to a number of studies in the literature, siderophores' production sequesters iron in the root environment, reducing its availability to competing harmful microflora and weakening pathogenic populations. This makes it simpler for rhizospheric biocontrol agents to lyse pathogens. (Bholay *et al,* 2012; Deshwal, 2012). Patro *et al,* (2014).

Morsy *et al* (2015 reported that, in field settings, *Pseudomonas fluorescens* significantly decreased the incidence of sheath blight disease caused by *R. solani*. In a similar vein, B. subtilis has also been shown to reduce the prevalence of disease by Morsy *et al* (2015) in rice crop. The present findings also corroborate with the earlier work of Rani *et al* (2013) in maize with lowest disease severity recorded in *Pseudomonas fluorescens* followed by *Trichoderma viride* and carbendazim against banded leaf and sheath blight disease. Patro *et al* (2020) found that the application of *Trichoderma viride* and *Pseudomonas fluorescens* significantly decreased the incidence of *Rhizoctonia solani*-caused sheath blight in little millet. The development of cereals and legumes, the biofortification of mineral nutrients in grains, and the suppression of phytopathogens under biotic and abiotic stressors have all been found to be successfully accomplished by bioinoculants. (Rawat *et al*, 2011, Rawat *et al,* 2013).

CONCLUSION

The current study makes it clear that every treatment was significantly more effective than the control, which was left untreated. The treatment of FYM pre-colonized with *Trichoderma asperellum* + *Pseudomonas fluorescens* + *Bacillus subtilis* was the most successful among seed treatments, seed biopriming, and colonized compost in terms of disease parameters. This was followed by treatment of FYM pre-colonized with

Fig 1: The experimental field for the field evaluation of different treatments against the sheath blight disease of barnyard millet.

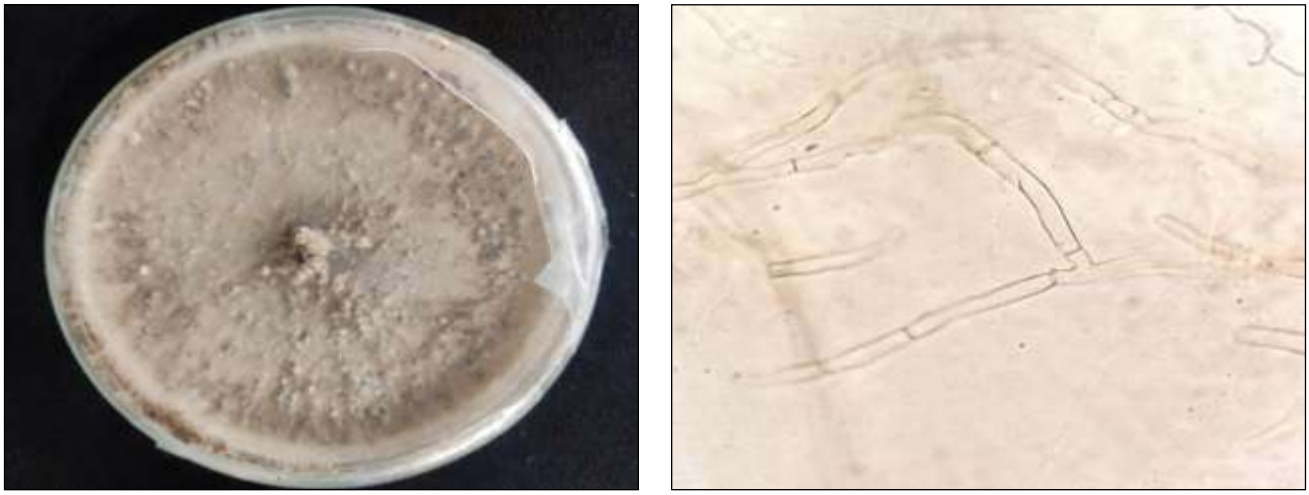

Plate 1 A. Isolated pathogen from infected sheath

Trichoderma asperellum and treatment of FYM pre-colonized with *Pseudomonas fluorescens*. The findings showed that when it came to lowering the incidence and severity of the sheath blight disease, the bioagents were not far behind. Therefore, it can be claimed that bioinoculants can be used in modern agriculture to reduce reliance on synthetic fungicides and can be used in conjunction with various integrated methods to control plant diseases.

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Efficacy of Fungicides for Management of Sheath Blight (*Rhizoctonia solani*) of paddy

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ABSTRACT

Rice sheath blight, caused by *Rhizoctonia solani*, causes significant yield losses in rice crop worldwide by damaging leaf sheaths and reducing grain quality. A field trial was conducted during *kharif* 2023 and 2024 seasons to evaluate the effectiveness of two fungicides namely Glo-it (propiconazole 13.9% + difenconazole 13.9% EC @500 ml/ha) and Pulser (Thifluzamide 24 SC at 1 ml/L) in managing rice sheath blight in variety Sabour Sampann under natural conditions. Out of two fungicides tested, propiconazole 13.9% + difenconazole 13.9% EC @500 ml/ha was found to be the most effective in controlling the disease. The data revealed that the percentage of disease incidence and severity were significantly lower in crop treated with a combination (propiconazole13.9%+difenconazole13.9%EC) at 500ml/ha(63.08%and 40.76%) followed by crop treated with thifluzamide 24 SC at 1 ml/L (66.97% and 43.69%). Significantly higher grain yield (37.72 q/ha) was also observed in the crop treated with combination product (propiconazole 13.9% + difenconazole 13.9% EC) @ 500 ml/ha followed by thifluzamide 24 SC @ 1 ml/ L (36.28 q/ha) and the lowest yield of 34.25 q/ha was recorded in the farmers' practice plot. The benefit cost ratio was also found higher in tested propiconazole 13.9% + difenconazole 13.9% EC(1:2.41) and thifluzamide 24 SC (1:2.32) sprayed plots compared to farmers' practice plots. Hence, it can be concluded that propiconazole13.9%+difenconazole13.9%EC at a rate of 500 ml/ha, followed by thifluzamide 24 SC at 1 ml/L, were effective fungicides in reducing sheath blight severity and increasing grain yield.

Key Words : Disease, Fungicide, Management, Paddy, Sheath blight.

INTRODUCTION

Rice productivity worldwide is influenced by various biotic and abiotic factors. Approximately 50 different biotic factors, including fungi, bacteria, viruses, nematodes, and insects, can contribute to potential yield losses in rice. Sheath blight (*Rhizoctonia solani* Kuhn) is a significant issue in the rice- growing areas worldwide. The disease was first reported in Gurdaspur, Punjab and now found in nearly all rice-growing states of India, leading to yield losses of up to 50%.depending on the stage of the crop at the time of infection, the disease's severity, and the environmental conditions. The disease is becoming more concerning due to the intensive cultivation of modern high-yielding varieties coupled with the heavy use of nitrogenous fertilizers. Sheath blight progression is accelerated by high plant density, a closed canopy, and increased nitrogen fertilizer levels. Additionally, elevated pathogen levels in the soil contribute to greater disease pressure. Symptoms of the disease can be seen in both nursery and transplanted crops. The early symptoms of sheath blight manifest as circular, oblong, or ellipsoid greenish-grey, water-soaked spots approximately 1 cm in length, typically found on leaf sheaths near the water line. When conditions are favorable, the infection swiftly spreads to the upper leaf sheaths and leaf blades of both the same and nearby tillers. Lesions on the upper section so the plant spread quickly from the water level to the flag leaf, covering the entire tiller eventually causing the death of the leaf, tiller, and plant. A 1% rise in sheath blight incidence led to 0.38% reduction in grain yield (Saikia and Baruah,1990). Currently, there are no rice varieties known to be immune to or highly resistant to sheath blight disease. In the lack of appropriate resistant donors, fungicides remain the primary solution to control these diseases. Several

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fungicides, including benomyl, carbendazim, chloroneb, captafol, mancozeb, zineb, edifenphos, iprobenphos, thiophanate, and carboxin, have proven effective in controlling the disease under field conditions.(Singh and Sinha, 2004). Amarajyothi and Chinnam naidu (2020) also reported that preventive measures are more effective in reducing the incidence of rice blast and sheath blight. Although various methods are used to control pests in different pest management systems, yet use of pesticides continue to be the major component of most of the pest control programmes and will probably remain so in the near future (Singh *et al,* 2013).

A variety of new fungicide formulations are now available in the market and farmers are trying to control the disease through 3-4 sprays under field condition.This study aims to assess the effectiveness of two fungicides Glo-it (propiconazole 13.9% + difenconazole 13.9% EC @500 ml/ha). Propiconazole interferes with the production of sterols in cell membranes, preventing the growth of fungi. Whereas Difenoconazole is a sterol demethylation inhibitor that inhibits fungus growth by blocking cell membrane ergosterol biosynthesis. and Pulser (Thifluzamide 24 SC at 1 ml/L) . It is systemic fungicide with protective and curative action. It effectively controls *Rhizoctonia solani* fungus which is major cause sheath blight in paddy. It is rapidly absorbed by roots and leaves and translocated in xylem and apoplast throughout the plant. Both the fungicide sprayed 45 day after transplanting of paddy for controlling rice sheath blight.

MATERIALS AND METHODS

Field trials were carried out during the *Kharif* seasons of 2022 and 2023 using a Randomized Block Design (RBD) across ten farmer plots (10 replications with a plot size of 5.0m x 2.0m, spacing 15cm x 20cm) on the rice variety Sabour Sampann in various villages of Madhepura district in north Bihar. The fungicides Glo-IT (propiconazole 13.9% + Difenconazole 13.9% EC), Pulser (Thifluzamide 24 SC), and Contaf (Hexaconazole 5 EC), commonly used by farmers, were applied according to the recommended formulations. Grain yield was measured and recorded on a per-plot basis, then expressed in quintal per hectare (q/ha).

The percent disease index (PDI) and disease severity of sheath blight were assessed after each spray using the Relative Lesion Height (RLH) method (IRRI, 2002) with the following formula:

RLH=Lesion Height/ Plant Height x100

In each plot, fiverandom sampling units of 1m² were marked. Disease severity was recorded on fifteen plants from each sampling unit. The percentage of disease control over the check was calculated.

RESULTS AND DISCUSSION

The data (Table 3) revealed that the fungicide propiconazole 13.9% + difenconazole13.9% EC @ 500 ml/ha (T2) was highly effective in controlling sheath blight disease in paddy compared to thifluzamide 24 SC @ 1 ml/L (T3) and hexaconazole 5 EC @ 2 ml/L T1. The highest disease incidence and severity were recorded in T1 and T3 treatments as 94.39% and 75.97%, respectively. No significant difference was observed among the treatments concerning sheath blight incidence. The lowest disease incidence was recorded with T2 (propiconazole 13.9% + difenconazole 13.9% EC at 500 ml/ha (63.08%), followed by T3 (Thifluzamide 24 SC at1ml/L (66.97%), which was significantly different from the farmer's practice fungicide, hexaconazole 5% EC at 2.0 L /ha (94.39%). Propiconazole 13.9% + difenconazole 13.9% EC at 500 ml/ha reduced the disease by 31.5% followed by Thifluzamide 24 SC at 1 ml/L, which showed a 29.04% reduction.The highest grain yield and benefit-cost ratio were observed in the plots treated with T2 (propiconazole 13.9% + difenconazole 13.9% EC at a rate of 500 ml/ha). (37.72 q/ha and 1:2.41), T3 thifluzamide 24 SC @ 1 ml/ L (36.28 q/ha and1:2.32) compared to T1 plot (34.25q/ha) (Table3). Maximum grain yield (10.13%) increase over farmers' practice was recorded in crop

Efficacy of Fungicides for Management

Table 1. Treatments including fungicide along with their doses.

Treatment	Treatment Detail
T1 (Farmers' practice)	Spray of hexaconazole 5 EC@ 2 Liter/ ha
T2	Spray of propiconazole 13.9% + difenconazole 13.9% EC @ 500 ml/ha.
T3	Spray of thifluzamide 24 SC @ 1ml/L of water (45 days after transplanting).

Table 2. Effect of fungicides on disease parameters in rice sheath blight.

Treatment		Per cent Diseases Severiy	Per cent Diseases Incidence	Per cent disease control over FP	Yield (q/ha)	Per cent increase in yield over FP (average)
T1 (FP)	Spray of hexaconazole 5 EC @ 2L / ha	75.97	94.39	-	34.25	-
T2	Spray of combind product (propiconazole 13.9% + difenconazole13.9%EC) @500 ml/ha.	40.76	63.08	31.51	37.72	10.13
T3	Spray of thifluzamide 24 SC @ 1 ml/ L of water (45 days after transplanting).	43.69	66.97	29.04	36.28	5.92
CD @ 5%		0.499	1.177	-	0.135	-
SEm (+ -)		0.706	0.393	-	0.04	-

Table 3. Impact of fungicides on yield and economic outcomes in rice.

Technological options		Mean grain yield (q/ha)	Gross	Gross return (₹)	Net return (₹)	BCR
T1 (FP)	Spray of hexaconazole 5 EC@ 2ml / L	34.25	33234	74768	71364	2.24
T2	Spray of propiconazole 13.9% + difenconazole 13.9% EC @ 500 ml/ha.	37.72	34130	82343	98873	2.41
T3	Spray of thifluzamide 24 SC @ 1 ml/ L of water (45 days after transplanting).	36.28	34118	79199	93558	2.32

Support price ₹ 2183

treated with propiconazole 13.9% + difenconazole 13.9% EC @ 500 ml/ha followed by crop treated with thifluzamide 24 SC @ 1 ml/ L (5.92%). Present findings were in accordance with Kandhari (2007) who found Armure 30 EC (propiconazole + defenconazole) best among seven fungicides tested showing a disease severity of 31.3% in comparison to 77.9% in check and Singh *et al* (2015). *Rhizoctonia solani* is a seed- and soil-borne pathogen, which survives through sclerotia and mycelia in infected seeds or soil in tropical environments (Senapati *et al* , 2022).

CONCLUSION

Sheath blight is one of the major concerns in rice with the potential to affect rice production and productivity. The causal agent (*R. solani*) is a dynamic pathogen with a wide host range which enables it to overwinter and survive. Because of its versatility, the pathogen is very difficult to manage. Chemical control has been the most commonly used approach for management, which is not only environmentally unsafe but also leads to the evolution of novel virulent strains of the pathogen. Although there are other approaches such as cultural practices and biological control to reduce the disease severity, utilizing host plant resistance is the most sustainable approach for managing this fungal disease. The current findings revealed that propiconazole 13.9% + difenconazole 13.9% EC at 500 ml/ha, followed by thifluzamide 24 SC at 1 ml/L, were effective fungicides in reducing sheath blight severity and achieving higher grain yield.

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Enhancing Sex Ratio, Yield and its Attributing Traits with Exogenous Application of Phytohormones in Bottle Gourd (*Lagenaria siceraria* L.)

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ABSTRACT

A field experiment was conducted at the Vegetable research farm, Khanaura of Punjab Agricultural University, Ludhiana, Punjab during summer seasons of 2021 and 2022 with three phyto-harmones in varying concentrations *viz.*, Ethrel (100, 200, 300 ppm), Indole acetic acid (100, 150, 200 ppm) and Gibberellic acid (20, 40, 60 ppm) to enhance the production potential and reproductive behavior of bottle gourd (*Lagenaria siceraria* M.) variety Punjab Komal. The experimental results showed that foliar spray of ethrel @ 300 ppm observed to be significantly better than control for reproductive characteristics *viz.,* number of pistillate flowers/vine, days to first fruit harvest, fruit set percentage, lowered sex: ratio, furthermore, the exogenous application of gibberellic acid @ 60 ppm increased vine length at maturity and number of staminate flowers/vine. The yield attributing traits *i.e.,* fruit weight, number of fruits as well as total yield/plant had also improved with ethrel @ 300 ppm. Therefore, it may be concluded that spray of the ethrel @300 ppm at 2 true leaf stage and superimposed at 4 true leaf stage can be recommended to enhance number of female flowers in bottle gourd ultimately producing early and higher fruit yield.

Key Words: Bottle gourd, Growth ,Regulators, Sex ratio, Reproductive traits, Yield.

INTRODUCTION

Bottle gourd (*Lagenaria siceraria* L.) is a significant vegetable crop within the cucurbitaceae family, commonly referred to as white-flowered gourd/calabash gourd. Bottle gourd fruits has been recognized for their high nutritional value, serving as a rich source of carbohydrates, essential vitamins, and minerals (Wamiq *et al,*2022). The fruit pulp act as an antidote for poisons and also helps in curing the constipation, night blindness and coughing (Leghari *et al,* 2014). In India, bottle gourd is grown across 116.9 thousands of hectares, producing an annual yield of 1,428.3 thousand tonnes. In Punjab, cucurbits are grown across 18.01 thousand of hectares, yielding an annual production of 184.27 thousand MT (Anonymous, 2021) in the state of Punjab.

Bottle gourd initiates flowering approximately 40–50 days after sowing based on cultivar and prevailing environmental conditions. Cross-pollination highly favoured a monoecious flowering pattern, with solitary white male as well as female flowers emerging at different nodes on the same plant (Ilyas *et al,* 2017). Staminate flowers emerge earlier than pistillate flowers along the nodal axis of both the main and secondary branches. Usually, most of male flowers occur on main vine (branch), whereas female flowers are borne on secondary branches (Patel *et al,* 2017). The natural tendency of all the cucurbitaceous crops to produce higher male flowers than female flowers proved to be a limitation in crop yield. Generally, the rapid growth of the main vine limits the development of secondary branches, consequently reducing the number of pistillate flowers and leading to a decline in overall yield. Thus, in order to obtain early and higher yield manipulation of sex ratio is mandatory in cucurbits.

The sex modification can be attained through altering the time of flowering as well as sex ratio through manipulating the endogenous

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concentrations of gibberellin, auxin, ethylene as well as ascorbic acid during development . Hence, it could be achieved through the foliar spray of PGRs which modulate plant growth and development through alterations in their physiological homeostasis (Rafeekher *et al,* 2002). Pertinent literature demonstrates that PGRs could alter flowering as well as yield (Gedam *et al,*1998; Damodhar *et al,* 2004), promote initial flowering along with fruit maturation, enhance length of fruit (Ghani *et al,* 2013), and increase both total number of fruits and individual weight of fruit (Hossain *et al,* 2006), fruit yield in cucurbits (Nagamani *et al,* 2015).

Although plant growth regulators have significant potential to enhance the growth and yield of various vegetable crops. However, limited information is available regarding the optimal dosage along with time of application specifically for bottle gourd. The primary aim of this research was to examine effects of PGRs on modulating the sex ratio by promote pistillate flower development, induce femaleness to enhance fruit set along with yield of bottle gourd. The study will enlighten the new path in way of changing sex expression for the research community to utilize phyto-hormones enhancing the production potential of bottle gourds in terms of vegetable and seed crop.

MATERIALS AND METHODS

The field trial had been performed at two different geographical locations of the Punjab Agricultural University, District Ludhiana (Punjab) during the summer seasons of 2021 and repeated during 2022 for the confirmation of the results. The experimental material comprised Punjab Komal variety of Bottle gourd. The field trial was designed using a Completely Randomized Block Design (CRBD) along with three replications. Those treatments comprised of three phytohormones each with three concentrations *i.e.,* Ethrel @ 100, 200, 300ppm, Indole Acetic acid (IAA) @ 100, 150, 200ppm and Gibberellic acid (GA_3) @ 20, 60, 80ppm. The specified amounts of each phytohormone were individually diluted in small amount of 95% absolute alcohol along with stock solutions had been subsequently prepared by solublized with distilled water.

The treatments were applied as foliar sprays at 2 true leaf stage and superimposed at 4 true leaves stage and control plot was sprayed with distilled water in morning hours. Ten plants from each treatment were randomly chosen for observation recording. Data were collected for various morphological parameters *i.e.,* inter-nodal distance, length of vine at maturity, number of branches/vine along with reproductive parameters *i.e.,* days to appearance of first female flower, number of pistillate flowers/vine, fruit weight, number of fruits/plant and total yield/plant. The recorded data from both locations were pooled and analyzed using statistical analysis of variance procedure (Sheoran *et al,*1998). The mean comparisons were conducted using the LSD method at a significance level of 5 per cent.

RESULTS AND DISCUSSION

Vegetative traits

The pooled statistical analysis demonstrated that application of phytohormones with varying concentrations significantly affected the inter-nodal distance and vine length at maturity during both the years (Table 1) . However, the variations in tendril length and number of branches/vine were non-significant. The spray of ethrel @ 300ppm was significantly efficient in reducing inter-nodal distance compared to the control across both years of study. As closely results had reported by (Kumar *et al,* 2020), whom seen a comparable impact of PGRs on the growth of bottle gourd vines. The data recorded for vine length at maturity indicated that spray of GA3 @ 60 ppm increased vine length which was at par with both GA3 @ 40 ppm and 20 ppm. Similarly, the applications of ethrel @ 300ppm, IAA @ 100 ppm and @ 200 ppm significantly improved the vine length than the control treatment. While, the lower concentrations of ethrel both @100 ppm and 200 ppm failed to statistically improve the vine length at maturity. The number of branches/vine were determined as statistically non-significant through various concentration of phytohormones in bottle gourd.

However, foliar spray of ethrel @ 300 ppm resulted in highest number of branches/vines followed by ethrel @ 200 ppm. Therefore, treatment of control observed minimum number of branches/vine. A similar findings were observed by (Kumari *et al,* 2017).

Yield traits

The data for the yield traits *viz.,* fruit weight, diameter, length, number of fruits along with total yield/plant for both locations and years as shown in table 2. The highest fruit weight was observed through foliar spray of ethrel @ 300 ppm and ethrel @ 200ppm afterward IAA @ 100ppm over both locations whereas, control treatment observed the minimum fruit weight in comparable with all other treatments. The results were closely related to earlier study of (Sandra *et al,*2015) who observed that ethrel treatment enhanced fruit weight in cucurbit. The exogenous application of ethrel @ 300 ppm showed significantly maximum fruit diameter followed by the foliar spray of ethrel @ 200 ppm consist the fruit diameter. The lower fruit weight percentage recorded in treatment of control. These results were closely related to Vyas *et al* (2015) who observed that diameter of fruit was significantly increased by application of ethrel @ 300 ppm in cucurbit. The use of ethrel @ 300 ppm subsequently enhanced the length of fruit then ethrel @ 200ppm. The least fruit length percentage reported in treatment control. Results were closely associated to previous study of Barot (2022)) who observed that length of fruit had been maximised through foliar spray of ethrel @ 300 ppm. The application of all the phytohormones at varying concentrations significantly improved the number of fruits/plant. The highest number of fruits was observed by foliar spray of ethrel @ 100, 200 and 300 ppm. While, the lower number of fruits/plant had been observed in control treatment. The results were closely associated with previous study of (Kumar *et al,* 2020). The number of fruits/plant subsequently increased because, ethephon functions as a growth retardant without inhibiting gibberellic biosynthesis. The action of mechanism is to release ethylene, that has been retained within a plant as well as interfere in process of growth. However, ethephon reduces the photosynthesis by enhancing level of ethylene (Ouzounidou *et al,* 2008). The statistical analysis revealed that use of all the phytohormones subsequently enhanced the total fruit yield/plant. As increased in total yield/plant had observed through spray of ethrel @ 300ppm afterward @ 100ppm and 200ppm over both environments. Similar findings have been reported by Jyoti *et al,*(2016). Moreover, the application IAA @ 200 ppm recorded total yield per plant at par with all other remaining treatments with foliar application whereas, the control treatment observed statistically lowest total yield per plant.

Reproductive traits

The pooled data analysis of variance (Table 3) revealed that that induction of staminate flowers was not statistically influenced with exogenous application of phytohormones at various concentrations. Similarly, the non-significant effect of phytohormones on production of staminate flowers cucumber was observed by (Gosai *et al,*2020). The spray of ethrel @ 300ppm maximised number of pistillate flower/vine at par with ethrel @ 200 ppm. Similarly, the treatment with IAA @ 200ppm recorded higher number of pistillate flowers at par with both IAA @150 ppm, IAA @ 100 ppm along with GA3 @ 20 ppm. Control treatment observed minimum number of pistillate flowers at par with GA3 @ 40 ppm, GA3@ 60 ppm. The results were closely associated with previous findings of (Sulochanamma 2001). Ethrel is an essential growth regulator which has been applied to increase the fruit weight, because of its ability to stimulate the gynoecium development, stress induction, ripening of fruit and lateral cell expansion. It also enhances the starch and carbohydrate levels (Rajala *et al,*2001). Moreover, the lower sex: ratio was observed by spray of ethrel @ 300 ppm followed by ethrel @ 200 ppm. This could be possible by increased number of pistillate flowers or suppression of maleness with the application of ethrel. The similar findings were recorded by (Imamsaheb *et al,*2014). The control treatment recorded statistically highest sex: ratio than all the treatments with phytohormones application. The fruit set percentage was increased under application of ethrel @ 300 ppm, ethrel @ 200

Table 1. Impact of application of phyto-harmones on vegetative characteristics of bottle gourd.

Treatment/ Environment (E)		Inter-nodal distance (cm)		Vine length at maturity (cm)		Tendril length (cm)		number of branches/vine	
		2021	2022	2021	2022	2021	2022	2021	2022
Ethrel 100 ppm	(E^1)	7.12*	7.04*	529.6	531*	13.5	12.5	7.0	7.8
	(E^2)	7.06*	7.10*	530.1*	530.5	13.1	12.9	7.5	7.3
Ethrel 200 ppm	(E^1)	6.92*	7.18*	529.5	530.5*	13.9	13.1	8.2	7.4
	(E^2)	7.08*	7.02*	530.1*	529.9	13.4	13.6	7.0	8.6
Ethrel 300 ppm	(E^1)	6.96*	7.04*	535.4*	536.0*	13.9	13.3	7.8	8.4
	(E^2)	7.02*	6.98*	536.3*	535.1*	14.0	13.2	7.5	8.7
IAA 100 ppm	(E^1)	7.10*	7.80	530.0	536.6*	14.2	13.6	7.2	8.0
	(E^2)	7.30*	7.60	531*	535.6*	13.8	14	7.5	7.7
IAA 150 ppm	(E^1)	7.58	7.08*	522.5	523.5	14.1	13.1	8.2	7.2
	(E^2)	7.20*	7.46	524.0	522.0	13.9	13.3	7.9	7.5
IAA 200 ppm	(E^1)	7.52	7.65	532.0*	534.0*	14.2	13.4	7.1	7.7
	(E^2)	7.60	7.57	534.5*	531.5	13.9	13.7	7.6	7.2
$GA_3$20 ppm	(E^1)	7.00*	7.20*	541.0*	540.4*	13.4	13.6	7.9	7.1
	(E^2)	7.11*	7.09*	539.5*	541.9*	13.9	13.1	7.2	7.8
$GA_3$40 ppm	(E^1)	8.06	7.96	543.5*	542.5*	13.3	14.1	8.0	7.2
	(E^2)	8.00	8.02	542.6*	543.4*	14.0	13.0	7.7	7.3
$GA_3$60 ppm	(E^1)	8.26	8.40	547.8*	546.8*	13.3	14.5	8.2	7.2
	(E^2)	8.46	8.20	546.9*	547.7*	14.2	13.6	7.8	7.6
Control	(E^1)	7.86	8.00	522.2	521.2	13.9	13.5	6.8	7.2
	(E^2)	7.96	7.90	520.8	522.9	14.1	13.3	7.4	7.6
CD (5%)		0.48		8.81		NS		NS	
CV		3.78		0.95		2.80		4.19	

* Significant at 5 % level of significance

Table 2. Impact of application of phyto-harmones on the yield and its attributing traits of bottle gourd.

Treatment		Fruit weight (g)		Fruit diameter (cm)		Fruit length (cm)		Number of fruits per plant (number)		Total yield per plant (kg/plant)	
		2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Ethrel 100 ppm	(E^1)	810*	790.46*	40.80*	41.42*	16.82*	17.52*	7.66*	8.36*	6.86*	6.38*
	(E^2)	785.06*	815.40*	41.21*	41.01*	17.06*	17.28*	8.56*	7.46*	6.26*	6.98*
Ethrel 200 ppm	(E^1)	812.25*	837.81*	41.85*	43.25*	17.12*	17.32*	8.18*	7.86*	7.18*	6.40*
	(E^2)	820.25*	829.81*	42.15*	42.95*	17.06*	17.38*	8.00*	8.04*	6.62*	6.96*
Ethrel 300 ppm	(E^1)	857.85*	843.05*	43.15*	42.61*	19.06*	18.28*	7.86*	8.28*	7.22*	7.52*
	(E^2)	860.35*	840.55*	42.05*	43.71*	18.88*	18.46*	8.92*	7.22*	7.12*	7.62*
IAA 100 ppm	(E^1)	810.80*	829.86*	38.06	36.60	16.22*	16.44	6.82*	7.24	5.56*	6.08*
	(E^2)	822.20*	818.46*	37.10	37.56	16.58*	16.08	7.16*	6.90	5.88	5.76*
IAA 150 ppm	(E^1)	790.20*	809.88*	34.84	35.82	17.00*	16.12	6.72	7.34*	6.20*	5.92*
	(E^2)	815.85*	784.23*	35.00	35.66	16.26*	16.86*	7.82*	6.24	5.60	6.52*
IAA 200 ppm	(E^1)	816.24*	804.58*	36.10	36.34	17.12*	16.92*	7.10*	7.06	6.58*	6.06*
	(E^2)	812.66*	808.16*	35.96	36.48	16.76*	17.28*	6.66	7.50*	6.36*	6.28*
$GA_3$20 ppm	(E^1)	795.24*	765.42*	32.12	32.48	15.92*	16.12	7.44*	6.72	5.36*	5.94*
	(E^2)	784.20*	779.46*	32.06	32.54	16.92*	15.12	6.88	7.28*	6.14*	5.16*
$GA_3$40 ppm	(E^1)	815.24*	806.10*	35.16	34.84	16.64*	15.84	7.62*	7.30*	5.86*	6.20*
	(E^2)	812.30*	809.04*	34.12	35.88	15.70	16.78*	7.86*	7.06*	6.16*	5.90*
$GA_3$60 ppm	(E^1)	814.46*	806.92*	36.06	36.60	16.84*	17.26*	7.14*	6.96	6.36*	6.06*
	(E^2)	812.24*	809.14*	36.54	36.12	17.24*	16.86*	7.04	7.06*	6.18*	6.24*
Control	(E^1)	715.60	744.5	35.18	34.38	14.58	15.56	6.52	7.02	4.64	5.06
	(E^2)	718.40	741.7	34.66	34.90	15.04	15.10	6.84	6.70	5.44	4.26
CD (5%)		5.99		3.28		1.01		0.24		0.50	
CV		0.43		5.02		3.52		1.87		4.65	

*** Significant at 5 % level of significance**

ppm and ethrel @ 100 ppm. The control treatment observed lowest fruit set percentage. However, higher concentration of GA3 @ 60 ppm also improved the fruit set percentage at par with the remaining treatments such as GA3@ 40 ppm, IAA @ 100, 150 and 200 ppm, respectively. The results were closely associated summer squash with previous study of (MR *et al,*2016). The use of ethrel @ 300ppm results in maximum fruit retention percentage afterward ethrel @ 200ppm.

Table 3. Impact of foliar application of phyto-harmones on various reproductive traits of bottle gourd.

Treatment		Number of staminate flowers (number/vine)		Number of pistillate flowers (number/vine)		Sex: ratio		Fruit set (%)		Fruit retention (%)	
		2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Ethrel 100 ppm	(E^1)	20.9	21.9	14.3*	13.7*	1.62*	1.68*	42.0*	41.34*	51.6*	50.4*
	(E^2)	21.6	21.2	13.8*	14.2*	1.64*	1.66*	41.84*	41.50*	50.9*	51.1*
Ethrel 200 ppm	(E^1)	21.7	20.9	14.8*	13.8*	1.55*	1.41*	42.67*	41.99*	52.8*	53.2*
	(E^2)	21.1	21.5	14.2*	14.4*	1.45*	1.51*	41.79*	42.87*	52.2*	53.8*
Ethrel 300 ppm	(E^1)	21.2	20.8	15.7*	14.9*	1.23*	1.27*	45.65*	44.35*	54.7*	55.3*
	(E^2)	20.4	21.6	15.1*	15.5*	1.28*	1.22*	44.95*	45.05*	55.4*	54.6*
IAA 100 ppm	(E^1)	21.2	21.4	11.7	12.3*	1.66*	1.62*	39.87	39.79*	49.8*	52.8*
	(E^2)	21.5	21.1	12.3*	11.7	1.72*	1.56*	40.21*	40.45	52.2*	50.4*
IAA 150 ppm	(E^1)	20.8	21.8	11.9	12.7*	1.58*	1.74*	40.79*	41.87*	51.6*	50.4*
	(E^2)	21.0	21.6	12.4*	12.2*	1.64*	1.68*	41.27*	41.39*	51.5*	50.5*
IAA 200 ppm	(E^1)	21.7	21.3	12.8*	13.8*	1.68*	1.78*	41.33*	40.67*	52.8*	51.8*
	(E^2)	21.4	21.6	13.0*	13.6*	1.58*	1.88*	41.45*	40.55	52.2*	52.4*
$GA_3$20 ppm	(E^1)	20.9	21.9	12.7*	11.9*	1.76*	1.72*	39.75	40.25*	50.7*	51.3*
	(E^2)	21.2	21.8	12.5*	12.1*	1.66*	1.82*	40.66*	39.34	51.8*	50.2*
$GA_3$40 ppm	(E^1)	22.2	21.2	10.5	10.9	1.80*	1.94*	40.44	41.56*	51.4*	50.6*
	(E^2)	21.8	21.6	11.0*	10.4	1.90*	1.84*	41.26*	40.74	50.3*	51.7*
$GA_3$60 ppm	(E^1)	22.2	21.4	11.9	11.5	2.10*	2.04*	42.78*	41.22*	52.2*	51.8*
	(E^2)	21.0	22.6	12.0*	11.4	2.0	2.14*	41.34*	42.66*	51.8*	52.2*
Control	(E^1)	21.3	22.1	10.0	10.6	2.38	2.12	38.4	37.6	47.6	46.4

* Significant at 5 % level of significance

Lower fruit retention percentage had been reported in treatment of control. These results were closely related to Banyal *et al* (2015) who observed that fruit retention was significantly enhanced with the application of ethrel in the cucurbits. The maximum number of days to emergence of first male flower was found under the spray of GA3 @ 60 ppm followed by the control treatment. The application of ethrel @ 100 ppm reported least days for appearance of first male flower. However, results of days to appearance of first male flower in bottle gourd plants were statistically found non-significant and hence bears no practical significance. The above results were in close agreement with those of Sabu *et al* (2022) who reported the impact about several PGRs on bottle gourd. The foliar spray of ethrel @ 300 ppm took lower days to emergence of the first female flower at par along with spray of ethrel @ 200ppm, ethrel @ 100 ppm. The similar findings were observed by Ansari *et al*(2018). The earlier formation of female flowers induced by the spraying of ethrel might be due to enhanced starch and carbohydrate levels (Sabu *et al,*2022). Treatment of ethrel @ 300ppm reduced the node/number of the first male flower followed by ethrel @ 200 ppm. Highest number of nodes at which the first male flower emerged was seen in treatment control. However, the results of node/number of the first male flower in bottle gourd plants were statistically non-significant and hence bears no practical significance. The above results were closely related to Thappa *et al* (2011) who reported that lowest number of first male flower had been identified with spray of ethrel @ 300 ppm. The minimum node/number for emergence of first female flower was observed by use of ethrel @ 300ppm then ethrel @ 200ppm. Similar findings have been reported by Shafeek *et al (*2016) who reported that lowest number of nodes for first female flower was found with spray of ethrel @ 300 ppm. The exogenous application of ethrel @ 300 ppm showed subsequently lowest number of days for fruit set afterwards spray of ethrel @ 200 ppm. Maximum number of days to the fruit set was identified in control treatment. The above results were in agreement with Thakur (2022) who reported that foliar spray of ethrel had

Table 3 (Contd..): Impact of foliar application of phyto-harmones on various reproductive traits of bottle gourd.

Treatment		Days to appearance of first male flower		Days to appearance of first female flower		Node/ number of first male flower (number)		Node/ number of first female flower (number)		Days to fruit set	
		2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Ethrel 100 ppm	(E^1)	44.4	46.8	47.8*	48.2*	9.5	9.3	11.2*	10.8*	42.52*	85.34
	(E^2)	45.4	45.8	48.5*	47.5*	9.2	9.6	10.6*	11.4*	42.82*	45.52*
Ethrel 200 ppm	(E^1)	45.0	46.2	47.2*	48.2*	8.9	9.9	11.2*	10.2*	41.88*	42.12*
	(E^2)	45.2	46.0	47.8*	47.6*	9.5	9.3	10.8*	10.6*	42.62*	41.38*
Ethrel 300 ppm	(E^1)	45.5	45.9	46.9*	47.7*	8.7	9.9	9.7*	10.3*	38.78*	39.22*
	(E^2)	46.2	45.2	47.2*	47.4*	9.0	9.6	10.1*	9.9*	39.72*	38.28*
IAA 100 ppm	(E^1)	45.8	45.6	51.2*	50.2*	9.6	9.4	11.7*	10.9*	45.82*	44.84*
	(E^2)	46.3	45.1	49.9*	51.5*	9.2	9.8	10.8*	11.8*	45.24*	45.42*
IAA 150 ppm	(E^1)	45.8	46.4	50.8*	51.2*	10.2	9.2	12.2*	11.2*	48.36	48.30
	(E^2)	45.7	46.5	51.8*	50.2*	9.6	9.8	12.0*	11.4*	48.16	48.50
IAA 200 ppm	(E^1)	45.4	46.8	49.6*	50.4*	9.8	9.0	12.4*	13.0*	46.54*	46.12*
	(E^2)	46.2	46.0	50.8*	49.2*	9.2	9.6	12.9*	12.5*	45.86*	46.80*
$GA_3$20 ppm	(E^1)	45.8	45.6	49.7*	50.9*	9.8	9.4	11.2*	12.2*	47.15*	93.34
	(E^2)	46.2	45.2	51.0*	49.6*	9.2	10.0	12.4*	11.0*	46.25*	47.09*
$GA_3$40 ppm	(E^1)	45.8	46.2	49.2*	50.8*	10.2	9.2	11.1*	12.3*	43.12*	42.22*
	(E^2)	46.2	46.4	50.5*	49.5*	9.8	9.6	11.9*	11.5*	42.62*	42.72*
$GA_3$60 ppm	(E^1)	46.8	45.8	51.4*	52.6*	9.4	10.0	13.2*	12.2*	46.36*	46.30*
	(E^2)	46.2	46.4	52.3*	51.7*	9.8	9.6	12.6*	12.8*	46.44*	46.22*
Control	(E^1)	45.8	46.6	55.8	56.8	10	9.6	15.1	14.3	51.16	50.84
	(E^2)	46.3	46.1	56.0	56.6	9.4	10.2	14.8	14.6	51.24	50.76
CD (5%)		NS		1.91		NS		1.09		3.07	

* Significant at 5 % level of significance

minimum number of days to fruit set in the bottle gourd plants.

CONCLUSION

It may be concluded that spray of the ethrel @300 ppm at 2 true leaf stage and superimposed at 4 true leaf stage can be recommended to enhance number of female flowers in bottle gourd ultimately producing early and higher fruit yield.

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Evaluating Tendu (*Diospyros melanoxylon*) Leaves Production for Sustainable Livelihood of Tribal Communities in Jharkhand.

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ABSTRACT

Non-Wood Forest Products (NWFP) was formerly known as minor forest products, the country has approximately 45,000 species of plants. Nearly 3,000 species have been identified to yield NWFPs but only 126 have good marketability due to their better economic returns. Tribes residing in and around Jharkhand forest area are progressively dependent on NTFPs to sustain their livelihood. Tendu leaf one of the good source of economic as well as sustainable livelihood NTFPs for tribes of Jharkhand. The purpose of this study was to investigate the production of Tendu leaf as a non –farm industry income and employment to Jharkhand Tribes. The experiment was conducted during the Tendu production season of April to June 2020. The data was collected by laying out random sample plots in Kuru beat and Peshrar beat of RR Lohardaga A and B territorial Range respectively. There was Ten (10) sample plot of the size 20m X 20m in each beat and from each sample plot. The data was collected on Total number of Tendu plants and its per hectare density, Total number of leaves per plant and Productivity of Tendu leaves per hectare. The study finding revealed that Tendu plant density was significantly higher in undulating conditions (5430 plants/ha) compared to sloppy conditions (4765 plants/ha). The number of Tendu trees and bushes was also greater in undulating areas. Tendu leaf production per hectare was notably higher in undulating conditions (113495 leaves) than in sloppy conditions (82095 leaves), with a similar trend in leaf bundles and standard bags per hectare.

Key Words: *Diospyrus melanoxylon Roxb* , Leaf Productivity, Minor forest produces,

INTRODUCTION

Tribal societies' socioeconomic and cultural growth is greatly influenced by the forest. It offers every source of large and minor products, making it the repository of vast resources (Kala, 2013). Tendu leaves, which come from Tendu (*Diospyrus melanoxylon Roxb*), are one of the major sources of income for rural groups, particularly tribal people who live close to the forests in Central India and the neighbouring states. About 30–40 million members of the region's underprivileged populations rely on Tendu to gather leaves and make bidi, or traditional cigarettes (Kumar and Choudhary, 2016). Madhya Pradesh, Andhra Pradesh, Bihar, Jharkhand, Maharashtra, Gujarat, Rajasthan, Karnataka, and Uttar Pradesh are the states where Tendu trees are most found growing naturally. India produces over 6 lakh tonnes of Tendu leaves annually. According to Kerketta *et al* (2018), Jharkhand produces 4,74,900 standard bags (One standard bag of Tendu leaves comprises of 1000 bundles of 50 leaves each) of Tendu leaves annually on an average. Additionally, it makes a substantial contribution to the creation of jobs for their respective states' government employees. More importantly, it allows a farmer to make money to spend in the upcoming agricultural campaign and creates jobs in agro-based climates. Jharkhand State Forest Development Corporation (JSFDC) has been nominated as the sole agency for trade in Tendu leaves in the state. It accounts for

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Table 1. Notified Yield of Tendu leaf by Jharkhand State Forest Development Corporation Limited.

Sr. No.	Name of Forest Division	Number of MFP Range	Number of Units	Number of Territorial Range/ Part Territorial Range	Notified Yield (In Standard bags)
1	Dhalbhum	6	95	46	102400
2	Ranchi	7	110	40	105900
3	Daltonganj	5	92	39	116200
4	Garhwa	7	137	36	149125
5	Hazaribagh	11	146	69	205850
6	Giridih	9	106	66	116400
	Total	45	686	296	795875

75. 80% of the total revenue from the forests (Kerketta *et al,* 2018).

MATERIALS AND METHODS

The study was conducted in the Lohardaga district, a small forest produce range with a total area of 1491 sq. km. and comprises approximately 41239.00 ha (37.36%). The predominant forest type is arid Peninsular Sal, interspersed with mixed woodland areas. The Lohardaga hills are home to many Mahua plants. Two territorial units, RR Lohardaga A and RR Lohardaga B, were chosen for investigation out of the four territorial units in this MFP range. Two beats, Kuru Beat 316 k in RR Lohardaga A and Peshrar Beat 317 in RR Lohardaga B territorial range, were chosen further from these territorial units. The experiment was conducted during the Tendu production season of April to June 2020. The data was collected by laying out random sample plots in Kuru beat and Peshrar beat of RR Lohardaga A and B territorial Range respectively. There was Ten (10) sample plot of the size 20m X 20m in each beat and from each sample plot.

The data were collected on Total number of leaves per plant (a count was made manually for total numbers of leaves in a plant in each quadrate were such count was made for all the pants in each quadrate and average was taken) and Productivity of Tendu leaves per hectare (total number of Tendu leaf per quadrate were counted and per/ hectare Tendu leaves) was calculated by following formula

RESULTS AND DESICCATION

Tendu Bushes were observed in different quadrates of Kuru and Peshrar beats of the Minor Forest Produce Range Lohardaga. The maximum number of leaves was recorded in Kuru beat at quadrate number 5 and the minimum number in Peshrar beat at quadrate number 2. The total number of leaves collected from Tendu Bush in both Kuru and Peshrar beats was calculated as 3527.40, which was about 12% less than the mean value of leaves collected in Kuru beat. The leaves productivity of Tendu/ha was calculated as 99195 in Kuru range and 99195 in Peshrar range. The total number of plants in both quadrates was calculated as 88185, which was 12% less than the mean value of average diameter in Kuru beat. Under undulating and sloppy conditions, the maximum number of Tendu Leaf/ha was recorded in Kuru beat under undulating conditions at quadrate number 3. The mean value of Comparative status of Total Tendu Leaf/ha in all five quadrates under undulating conditions was calculated as 113195.

Under sloppy conditions, the maximum number of Tendu Leaf/ha was calculated as 82095, which was 37% more than the mean value under undulating conditions. In conclusion, the study analyzed the total number of Tendu leaves in different quadrates of the Peshrar beat under undulating and sloppy conditions in the Minor Forest Produce Range of Lohardaga. The maximum number of Tendu leaves was recorded

Table 2. Production of leaf collected from Tendu Bush (*Diospyrous melanoxylon*) in different quadrate of Kuru & Peshrar Beats of Minor Forest Produce Range Lohardaga.

Quadrate No.	Name of the Beat							
	Kuru Beat				Peshrar Beat			
	Total Number of leaf / quadrates	Total Number of leaf /ha	Total Number of leaf /ha in bundle	Total Number of standard bags	Total Number of leaf / quadrates	Total Number of leaf /ha	Total Number of leaf /ha in bundle	Total Number of standard bags
1	4461	111525	2144.71	2.14	3920	98000	1884.62	1.88
2	3091	77275	1486.06	1.49	3670	91750	1764.42	1.76
3	3246	81150	1560.58	1.56	3081	77025	1481.25	1.48
4	4140	103500	1990.38	1.99	5032	125800	2419.23	2.42
5	5766	144150	2772.12	2.77	2666	66650	1281.73	1.28
6	3928	98200	1888.46	1.89	4132	103300	1986.54	1.99
7	4344	108600	2088.46	2.09	2615	65375	1257.21	1.26
8	4548	113700	2186.54	2.19	3558	88950	1710.58	1.76
9	3176	79400	1526.92	1.53	4388	109700	2109.62	2.11
10	2978	74450	1431.73	1.43	2212	55300	1063.46	1.06
Mean value	3967.80	99195	1907.60	1.90	3527.40	88185	1695.87	1.70
	t (c) at 5% = 1.1							
	t (t) at 5% = 2.101							
	t (c) at 5% < t (t) at 5%							
	Non - significant difference total No. of leaf							

in quadrate number 3 under undulating conditions, while the minimum number was recorded in quadrate number 2. The mean value of the total number of Tendu leaves in all five quadrates under undulating conditions was calculated as 105710. In contrast, the maximum number of Tendu leaves in all five quadrates under sloppy conditions was calculated as 70660, which was 49% more than the mean value under undulating conditions(Table 4).

The productivity of leaves in terms of bundle/ha was also observed in different quadrates of Kuru and Peshrar beats. The maximum number of leaves in terms of bundle/ha was recorded in quadrate number 5 and the minimum number was recorded in quadrate number 10. The mean value of the productivity of leaves in terms of bundle/ha in all ten quadrates of Kuru range was calculated as 1907.60, while the average diameter of Tendu trees in both quadrates was calculated as 1695.87. The maximum number of Tendu leaves in bundle was observed in Kuru beat under undulating conditions, while the minimum number of plants species was recorded under sloppy conditions. The total number of Tendu leaves in bundle was calculated as 1358.85, which was 49% more than the mean value under undulating conditions. The study analyzed the total number of Tendu leaves in bundles and standard bags in different quadrates of Kuru and Peshrar beats of the Minor Forest Produce Range Lohardaga. A significant difference was observed in the total calculated t-value at 5%, indicating that the maximum number of Tendu leaves in bundles was observed in Peshrar beat under undulating conditions compared to sloppy conditions.

Productivity of leaves in standard bags was also observed in different quadrates of Kuru and Peshrar beats. The mean value of the average diameter of Tendu trees in both the Kuru and Peshrar beats was found to be uniform and not affected by physiographic or anthropogenic factors. The maximum number of Tendu leaves in standard bags was found to be higher in Kuru beat under undulating conditions, while in Peshrar beat, it was found to be higher under sloppy conditions. The collection and processing of Tendu leaves is standardized and used throughout India. The plants are pruned in February and March, and mature leaves are collected after 45 days of pruning. Bundles of 50 leaves are assembled and tied with grass rope or bark fibers, and brought to collection centers for processing.

Table 3. Comparative status of total number of Tendu Leaf (*Diospyrous melanoxylon*) observed in undulating & sloppy conditions at Kuru Beat of Minor Forest Produce Range of Lohardaga.

Quadrate no.	Kuru Beat					
	Undulating conditions			Sloppy conditions		
	Total Number of leaf /ha	Total Number of leaf /ha in bundle	Total Number of leaf/ha in standard bag	Total Number of leaf	Total Number of leaf /ha in bundle	Total Number of leaf/ha in standard bag
1	111525	2144.71	2.14	77275	1486.06	1.49
2	103500	1990.38	1.99	81150	1560.58	1.56
3	144150	2772.12	2.77	98200	1888.46	1.89
4	98200	1888.46	1.89	79400	1526.92	1.53
5	108600	2088.46	2.09	74450	1431.73	1.43
Mean value	113195	2176.83	2.176	82095	1578.75	1.58
	t (c) at 5% = 3.40					
	t (t) at 5% = 2.306					
	t (c) at 5% > t (t) at 5%					
	significant difference in total number of leaf/ha					

Table 4. Comparative status of total number of Tendu leaf (*Diospyrous melanoxylon*) observed in undulating & sloppy conditions at Peshrar Beat of Minor Forest Produce Range of Lohardaga

Quadrate no.	Peshrar Beat					
	Undulating conditions			Sloppy conditions		
	Total Number of leaf/ha	Total Number of leaf /ha in bundle	Total Number of leaf/ha in standard bag	Total Number of leaf /ha	Total Number of leaf /ha in bundle	Total Number of leaf/ha in standard bag
1	98000	1884.62	1.88	77025	1481.25	1.48
2	91750	1764.42	1.76	66650	1281.73	1.28
3	125800	2419.23	2.42	65375	1257.21	1.26
4	103300	1986.54	1.99	88950	1710.58	1.71
5	109700	2109.62	2.11	55300	1063.46	1.06
Mean value	105710	2037.89	2.032	70660	1358.85	1.358
	t (c) at 5% = 4.30					
	t (t) at 5% = 2.306					
	t (c) at 5% > t (t) at 5%					
	significant difference in total number of leaf /ha					

CONCLUSION

The study showed that the density of Tendu plants is highly dependent on topographical conditions and it is significantly superior under undulating conditions than sloppy conditions while, the growth characteristics are not depended on topographical conditions. As regards to the Tendu leaves productivity, in terms of total number of leaves/plant , total number of leaves produced/ha, total number of leaves bundle/ha and standard bag/ha, non-significant difference was observed in both (Kuru beat and for Peshrar beat) the beats. But when the leaves production was analyzed for different topographical conditions in both the beats, significantly superior results was obtained under undulating conditions than the sloppy conditions. It may be concluded that although the leaves production between both the beats showed non-significant difference but under undulating conditions, it was found significantly superior than sloppy conditions, which may be correlated with more nutritional availability to the Tendu bush from the soil under undulating conditions.

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Factor Analysis of Consumer Preferences Towards Online Food Delivery Services

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ABSTRACT

Online food delivery services are increasingly popular among young and urban consumers who appreciate convenience and variety. A total of 150 consumers were selected from different localities of Guntur randomly. The data were collected from various age groups, income groups and gender groups. To examine the factors that influence consumer online food delivery services in the study, a set of nine statements were presented to 150 consumers and the opinions expressed were subjected to factor analysis. Preference factors emerged as the most influential factor obtained the highest mean score of 3.63 and securing the top rank. This suggested that the preferences and choices of consumers play a crucial role in determining the success of the product or service. Convenience factors were ranked second with a mean score of 3.52. These factors likely encompass elements that drive and inspire customers to choose a particular product or service. Motivational factors obtained the lowest mean score of 3.48 ranked third.

Key Words: Analysis, Consumer, Factor, Online Food Delivery, Preferences , Services.

INTRODUCTION

The consumer behaviour is directly involved in obtaining, consuming, and disposing of products and services, including the decision process and follow action. Their expectations towards the buying product change from time to time. In these days, rural marketing is gaining a significant importance because it is one of the fastest growing markets in India. The consumption pattern, lifestyle of the people and the buying behaviour of the people living in rural areas is also changing (Ahuja and Sharma, 2018). Now, more people in India are choosing the convenience and comfort of ordering food online, which made a recent spike in the popularity of online food delivery services. Several businesses are fighting for market supremacy in India, where the market for online food delivery services has expanded dramatically in recent years. In India, well-known online food delivery services are Pizzahut, Dominos, Swiggy, and Zomato. These platforms provide a broad selection of meal alternatives from various restaurants, such as continental, Indian, Chinese, and fast food. Consumers can order, peruse menus, and pay with a variety of options, such as digital wallets, credit/debit cards, and online banking.

Online food delivery services are increasing popularity among young and urban consumers who appreciate convenience and variety. The pandemic has also led to an increase in the popularity of online meal delivery services, as people are choosing to order food online rather than go out to eat. Almost every industry has seen the replacement of old business techniques by technology. Nowadays, people purchase online rather than in-store. Due to the ease of ordering and the removal of time and location constraints provided by the internet, customers are now used to placing meal orders online. (Muthumani, 2017)

A consumer's experience with these services can be positive or negative, depending on

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several criteria such as food quality, customer service, delivery time, and cost. Numerous significant aspects that impact the user experience as a whole impact consumer perception and preferences for online meal delivery services. First and foremost, convenience is clearly a crucial factor, as customers are appreciating the opportunity to have access to a large variety of food alternatives while remaining comfortable in their homes or places of employment. Customer happiness is greatly impacted by how simple it is to place orders, browse menus, and follow deliveries. (Kuriachan, 2014)

Guntur is located in the Coastal Andhra region, near to the state's capital, Amravathi, Andhra Pradesh, India. The district is home to a number of industries, including food processing, pharmaceuticals, textiles and also seen number of colleges and universities. It has a population over 4.8 million people and 5th largest city in Andhra Pradesh. In the Guntur district, online meal delivery services are growing in popularity. This expansion is being driven by several factors, such as the rise in the middle class, the availability of smartphones, and the increasing number of working professionals and educational institutions in the town.

MATERIALS AND METHODS

Guntur is located in the Coastal Andhra region, near to the state's capital, Amravathi. Andhra Pradesh, India. The district is home to a number of industries, including food processing, pharmaceuticals, textiles and also seen number of colleges and universities. Total population of Guntur district is 6,70,073 out of which 3,31,435 are males while 3,38,638 are females as per (2011 census). The Total literacy rate of Guntur is 4,69,263 out of which male literacy is 2,46,906 while female literacy is 2,22,357. Guntur is a district in Andhra Pradesh, India known as the Spice Capital of India and the Chilli City of India.

A total of 150 consumers were selected from 5 different localities of Guntur areas *i.e,* Brindavan Gardens, Arundalpet, Vidyanagar, Brodipet, Lakshmipuram. The data were collected from various age groups, income groups and gender groups. 30 consumers from each area were selected randomly. Based on exhaustive review of literature, interaction with consumers of online food delivery services and by taking expert's opinion, a total of 7 statements were listed and consumers were asked to rank their opinions on these statements *viz.,* Rank 1, Rank 2 and Rank 3 etc., and the statements were prioritized by adopting Garrett's ranking technique.

Factor Analysis

Factor analysis is a multivariate technique which is most commonly employed in marketing applications. The factors are extracted through Principal component and Common factor analysis. The major objective to employ this analysis is to group the various identified information needs of consumers. To identify the underlying factors and to investigate the relationship among the variables that influence consumers towards online food delivery services, factor analysis was applied. For this study, a total of 11 variables on various aspects were selected. The consumers were asked to indicate their responses on a 5-point scale, whether they strongly disagree, disagree, neutral, agree and strongly agree.

The responses of the consumers were recorded and scored for each factor, then scores were added to obtain the total score. To test the sampling adequacy, the Kaiser-Meyer-Olkin measure of sampling adequacy was used. The Bartlett's test of sphericity was employed to test the validity of factor analysis. Principal component analysis was employed for extracting the factors. The Varimax normalized method was used to find a new factor that was easier to interpret. The factors with Eigen- values greater than 1.0 were considered and the analysis was conducted.

RESULTS AND DISCUSSION

Preferences of various attributes towards online food delivery services

The data (Table 1) revealed that the price of the food item was the major attribute preferred by sample consumers towards online food delivery services (Rank 1) followed by discounts and offers (Rank 2) and Delivery time (Rank 3). Other attributes namely quality food,

Table 1. Preferences of consumers towards online food delivery services

Sr. No	Attribute	Total score	Garretts mean score	Rank
1	Price	9390	62.60	1
2	Discounts and offers	9248	61.25	2
3	Delivery time	9002	60.01	3
4	Quality food	8816	58.77	4
5	Customization options to orders	8678	57.83	5
6	Live tracking of orders	8630	57.53	6
7	Variety of restaurants	8534	56.89	7
8	User interface of the app	8506	56.71	8
9	Payment options	8428	56.19	9
10	Customer services	8344	55.63	10

Table 2. Kaiser-Meyer-Olkin and Bartlett's Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.729
Barlett's Test of Sphericity	Approx. chi-Square	250.085
	Degrees of freedom	36
	significance	< 0.001

Table 4.23 Principal Component Analysis

Total Variance Explained									
Component	Initial Eigen values			Extraction sums of Squared Loadings			Rotation sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	2.667	29.632	29.632	2.667	29.632	29.632	1.993	22.148	22.148
2	1.369	15.211	44.863	1.369	15.211	44.843	1.729	19.216	41.364
3	1.105	12.274	57.117	1.105	12.274	57.117	1.418	15.753	57.117
4	0.897	9.967	67.084						
5	0.878	9.758	76.841						
6	0.654	7.262	84.103						
7	0.573	6.363	90.466						
8	0.447	4.969	95.435						
9	0.411	4.565	100.000						
Extraction Method: Principal Component Analysis									

customization options to orders, live tracking of orders and variety of restaurants, were ranked four, five, six, seven by sample consumers with mean scores of 58.77, 57.83, 57.53, 56.89, respectively. The lowest preferred attributes towards online food delivery services by sample consumers were user interface of the app, payment options, and customer services with mean scores of 56.71, 56.19, and 55.63, respectively. These results and rankings provided insights into the consumers preferences in Guntur. This ranking suggested that to meet consumer preferences, online food delivery services should focus on maintaining affordable prices, offering discounts, ensuring timely deliveries, and providing high-quality food. Other aspects like customization, live tracking, and a user-friendly app interface are also important but secondary to cost and speed of delivery. (Karthikeyan, 2016)

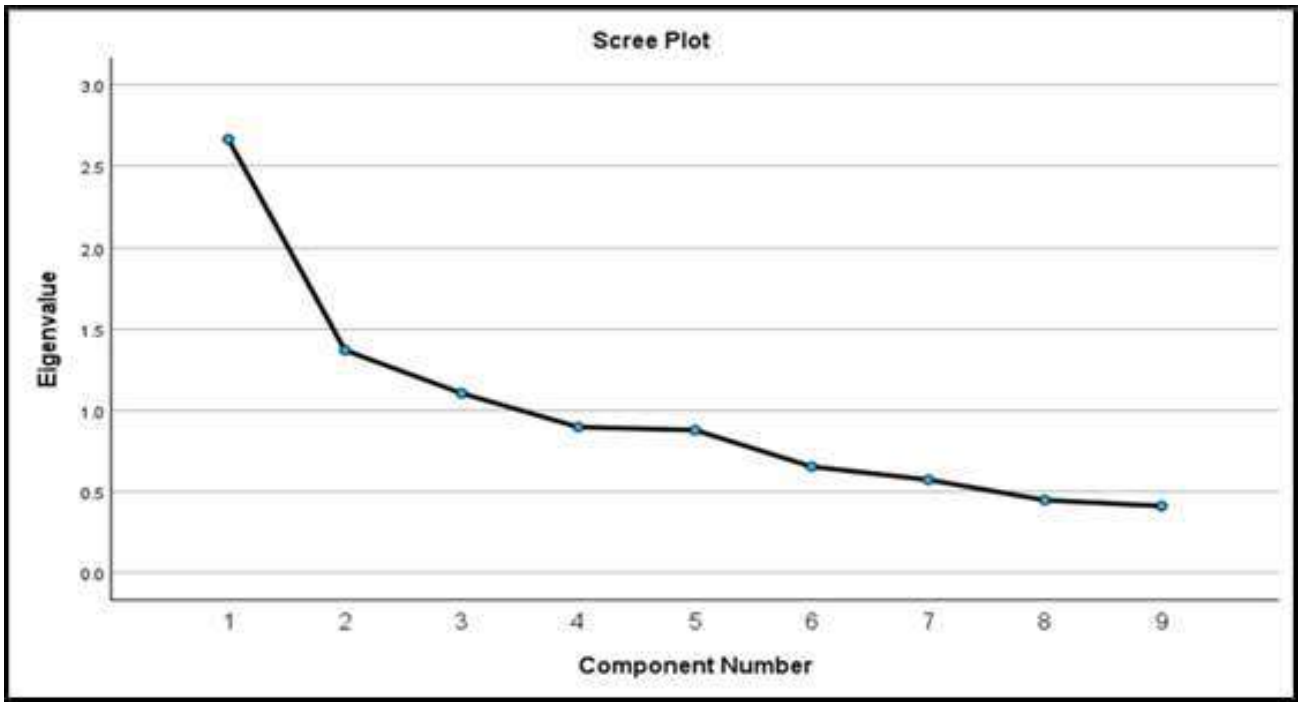

Table 4. Rotated Component Matrix.

Sr. No	Particular	Component		
		1	2	3
1	Ease of getting food from your favourite restaurant	0.849		
2	The accessibility of different payment options influences usage of Online food delivery services	0.695		
3	The convenience of having food delivered to my doorstep	0.691		
4	Helps to save time during busy schedule			
5	Helps to order food at your convenient time	0.665		
6	Helps to prefer wide variety of food items from different restaurants		0.786	
7	The availability of discounts or promotional offers during specific days		0.736	
8	Ease of ordering food based on customer reviews			0.737
9	Positive past experiences play a significant role in building trust and ensuring repeat usage.			

Factors Influencing Consumer Usage Towards Online Food Delivery Services

The Kaiser-Meyer-Olkin- (KMO) measure of sample adequacy and Bartlett's test of sphericity were used to study the relevance of factor analysis and the results were presented (Table 2).

The results of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy indicate a value of 0.729 which suggested that the information set was suitable for factor analysis. The Bartlett's Test of Sphericity yielded an approximate chi- square value of 250.085 with 36 degrees of freedom. The associated p-value for the test was found to be <0.001 indicating statistical significance. Hence factor analysis was valid.

Principal Component Analysis

Using SPSS software principal component analysis was used for extracting the

Table 5. Grouping of Extracted Factors

Sr. No	Factor name	Variables under factor	Factor loadings
1	Convenience factors	Ease of getting food from your favourite restaurant	0.849
		The accessibility of different payment options influences usage of Online food delivery services	0.695
		The convenience of having food delivered to my doorstep	0.691
		Helps to save time during busy schedule	.000
		Helps to order food at your convenient time	0.665
2	Preference factors	Helps to prefer wide variety of food items from different restaurants	0.786
		The availability of discounts or promotional offers during specific days	0.736
3	Motivational factors	Ease of ordering food based on customer reviews	0.737
		Positive past experiences play a significant role in building trust and ensuring repeat usage.	.000

Table 6. Factors impacting the consumer experience in usage of online food delivery services

Sr. No	Factor	Mean score	Rank
1	Preference factors	3.63	1
2	Convenience factors	3.52	2
3	Motivational factors	3.48	3

factors from the following 9 variables taken for the research (Table 3). The initial eigen values indicated that SPSS initially extracted all nine factors from the nine variables analysed in the research. However a criterion was applied where only factors with eigen values greater than one were retained resulting in three factors being extracted. The extraction sum of square loading column showed that the cumulative variance accounted for by these three factors was 57.117%.

The rotation sums of the square loading columns represented the distribution of the variance after the Varimax rotation with Kaiser Normalisation 22.148 % of variance was accounted by factor one and it has the corresponding eigen value of 1.993, 19.216% of variance was accounted by second factor with the eigen value of 1.729, 15.753% of the variance accounted by third factor with the eigen value of 1.418.

Scree plot

The scree plot was used to determine which elements were retained. The scree chart is a graph that showed the eigen values in relation to all components. The point of interest is where the curve begins to flatten, as seen in Fig. below.

Rotated Component Matrix

The factor loadings obtained against each variable and factor retrieved are reshown by the rotated component matrix. The criterion for grouping variables into three factors was chosen so that factor loading for each variable was maximum across row and larger than 0.5. (Table 4).

The results showed that variables like getting food from favourite restaurant, payment options, convenience of having food delivered to my doorstep, order food at convenient time, time savings have the highest factor loadings of 0.849,

0.695, 0.691, 0.665 and 0.000 these variables were represented in factor one. The variables like prefer wide variety of food items and promotional offers have the highest factor loadings of 0.786 and 0.736. These variables were represented in factor two. The variables like customer reviews, positive customer experiences have the factor loadings of 0.737 and .000 these variables were represented in factor three.

Grouping of Extracted Factors

The variables extracted from each column according to their factor loadings were grouped. A specific name was given to those variables under each group and the details were presented (Table 5).

It can be inferred that the factor one variables were categorized as convenience factors, while the second factor variables categorized consumer preference factors. The third factor variable was grouped as motivational factors. (Kohar,2021)

The values (Table 6) presents the mean scores and ranks for different factors affecting the overall performance or popularity of a certain product, service, or offering. These factors have been categorized into three main groups: Motivational factors, Preference factors, and Convenience factors. Preference factors emerged as the most influential factor obtained the highest mean score of 3.63 and securing the top rank one. This suggested that the preferences and choices of customers play a crucial role in determining the success of the product or service. Convenience factors were ranked second with a mean score of 3.52. These factors likely encompass elements that drive and inspire customers to choose a particular product or service. Motivational factors obtained the lowest mean score of 3.48 ranked third. Vanitha (2016)

CONCLUSION

The study provided valuable insights into consumer behaviour and perception factors influencing towards online food delivery services in Guntur. The majority of respondents comprising (69.30 %) of the total sample fell within the age range of 21-40 yrs, indicated that the e-commerce sector successfully attracts consumers across different age groups, particularly the younger demographic. Factor analysis revealed that the primary factors influencing consumers to use online food delivery services include the preference for a wide variety of food items from different restaurants, the ease of obtaining food from their favorite restaurant, and promotional offers as key drivers for using online food delivery services.

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Growth Performance of Amur Carp *(Hungarian Strain)* in Inland Water Resources of Kerala

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ABSTRACT

Common carp is extensively domesticated globally. However, the existing common carp stock has disadvantages of early sexual maturation (< 6 months) and spawning in grow-out ponds at a small size. Hence, the genetic improvement of common carp made by the collaborative actions of the different institutions, which developed a superior Amur carp strain possessing an additional growth rate of 27.3 percent. The species is cultured, and its performance in Kerala was studied using a participatory approach. The study revealed that 30 days of rearing in natural freshwater ponds were required to rear Amur fry from its Spawn. The average fingerling size was 7.5 ±1.0 cm (2.0 ± 0.5g) after 45 days of rearing in nursery ponds. The survival percentage was 18,70 and 90 in the spawn, fry-to-fingerling, and grow-out stages, respectively. Stocking 10000 fingerlings per hectare can produce an average of 9.0 t of fish in 15 months. The production cost per hectare would be Rs. 7.9 lakh. Fifteen months of farming was required for this species to reach the marketable size of 1100 ±200 g.

Key Words: Amur Carp, Common Carp, Fingerling, Freshwater, Hungarian Strain, Span.

INTRODUCTION

Common carp is one of the oldest cultured species of the Cyprinidae family, domesticated extensively in different regions of the world (Flajšhans, 2007). Its natural habitat ranges from Western Europe to China, Korea, Japan, and Southeast Asia, from Siberia at 60°N to the Mediterranean Sea and India (Kohlmann, 2003). The domestication of common carp happened after dozens of natural selections of various strains across the globe (Nedoluzhko *et al*, 2020). It is an omnivorous bottom-dweller that feeds mainly on benthic fauna and decaying matter (Khan *et al*, 2016). Its growth primarily depends upon the underneath fauna, stocking density, and the rate of supplementary feed (Vikas *et al,* 2024). However, the existing common carp stock has disadvantages of early sexual maturation (< 6 months) and spawning in grow-out ponds at a small size (100 g) (Dong *et al,* 2015).

The genetic improvement of common carp was started in Hungary in 1962 at the Fish Culture Research Institute, Szarvas (Bakos, 2001). Selective breeding was undertaken using fifteen fish strains from Hungary and fifteen from other parts of the world, including the strain from Amur River, China (Bakos, 2001). In India, a similar effort was made by the collaborative actions of the University of Stirling, the University of Whales, the UK, the erstwhile University of Agricultural Sciences, Bangalore, and Karnataka Veterinary, Animal and Fisheries Sciences University (KVAFSU), Bidar, Karnataka. In this program, common carp stocks from different geographical origins, viz. Hungary, Vietnam (SV), Indonesia (RJ), and India were brought and studied for superior breed development. As an outcome, a superior Amur carp strain possessing an additional growth rate of 27.3 percent (Das, 2017) was released. This strain possesses characteristics such as late-maturing, accepting artificial feed, having

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similar food habits to existing stock, being less susceptible to diseases, and having a slender body with a smaller belly than existing stock.

The present study evaluated the growth performance of a genetically improved breed of common carp, Amur (Hungarian strain), developed by the Karnataka Veterinary, Animal, and Fisheries Science University, Bengaluru, in the inland water resources of Ernakulam district, Kerala, India. Inland water bodies are plentiful in the area, and there is potential to tap these resources for fish farming using diversified species like improved common Carp strains.

MATERIALS AND METHODS

The Spawn and fingerlings were reared in natural freshwater ponds at Chenkara, Kothamangalam (9.6462° N, 77.0752° E) near Ernakulam, Kerala, India. A pond of dimensions 8.0m×5.0m×1.2m was selected for spawn rearing, and another pond of dimensions 10.0m×20.0m×1.2m was selected as a nursery pond for fingerling rearing. Both ponds were scientifically prepared by eradicating weed fish by applying the biological toxin tea seed cake extract and manually removing all plants and algae. Ponds were filled with filtered fresh water and fertilized using Agriculture lime (2 kg/40 m^2), Ground nut oil cake (300 gm/40m^2), Urea (50 gm/40 m^2), and Triple superphosphate (5 gm/40 m^2) followed by incubation of 7 days to get good phytoplankton bloom.

The spawn, ten lakhs in numbers produced at National Freshwater Fish Brood Bank (NFFBB), Bhubaneswar, Orissa, India, were stocked in the spawn rearing pond during the first week of October 2020 and a water depth of 1m was maintained. The stocking density was 625 numbers/m^2. The spawns were fed using 300 micron-sized formulated dust feed containing 40 percent protein and 8 per cent fat at the rate of 10 percent of body weight five times a day. The feed size was increased to 500-micron size after two weeks. Fertilization was done at intervals of 10 days to keep sufficient phytoplankton levels. The spawn-rearing continued for two months. Subsequently, the frys were shifted to the nursery pond, where a water depth of 1.2 m was maintained—the stocking density was ten numbers/m^2. The formulated feed of 0.8 mm containing protein 36 per cent and fat 5 per cent was fed at 8 per cent of body weight four times a day. The fingerling rearing continued for 60 days.

The grow-out culture was done in ponds of dimensions 50m×50m×1.5m at three locations *viz*., Kothamangalam(10.0603° N, 76.6352° E), Chenkara(9.6462° N, 77.0752° E), and Karukutty(10.2270° N, 76.3749° E), Ernakulam, Kerala. A water depth of 1.5 m was maintained uniformly in all the ponds and fingerlings stocked at one per square meter. The formulated feed of 1.2 mm containing 28 per cent protein and 4 per cent fat was administered twice a day during the first month. Subsequently, feed size successively increased to 1.8, 2.5, 3.0, and 5.0mm till fish attained the harvestable size of 15 months.

RESULTS AND DISCUSSION

The Amur carp spawns to reach the fry stage, which requires 30 days. During this period, the spawns metamorphosed into fry's of average length 1.5 ± 0.5 cm (200 ± 50 mg). The survival percentage during this phase was only 18 (Fig 1). However, Basavaraja (1997) and Hasan (2002) reported a better survival percentage earlier during the Spawn fry phase. The low survival percentage in the present study may be due to cumulative actions of exogenous factors such as predatory organisms, intermittent rain, high stocking density, etc.

During the fry to fingerling phase, a higher survival 70 % was observed, which was on par with the earlier report of Jena *et al* (2020). The high survival percentage may be due to phytoplankton's and zooplanktons in sufficient quantities as supplementary feed. Any larvae rearing depends on the availability of a nutritionally balanced quality starter diet (Vikas *et al*, 2014). No significant differences in sizes were noticed among the fingerlings. The average fingerling size was 7.5 ±1.0 cm (2.0 ± 0.5 g) after 45 days of rearing in nursery ponds. The survival percentage during the grow-out culture phase was 90 (Fig 1). The Amur Carp fingerlings (2.0± 0.5 g) reached the marketable size of 1100 ±200 g in 15 months.

Growth Performance of Amur Carp (*Hungarian Strain*)

Fig.1 Amur Carp Spawn to adult stage-wise survival rate.

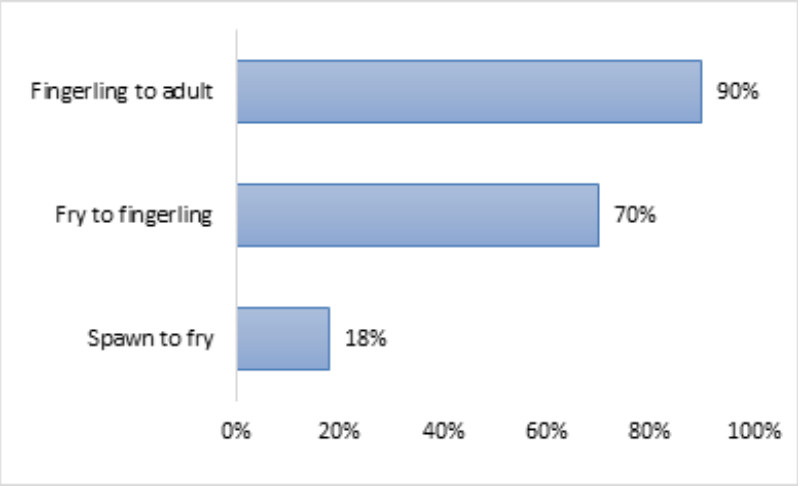

Table 1. Production cost of Amur carp in grow-out ponds

Sr. No.	Particular	Cost (lakh Rs/ha)
I	**Recurring cost**	
1	Cost of seed, 10000 numbers@ Rs.5/-	0.5
2	Cost of feed, 13,500 kg @ Rs.40/ Kg	5.4
3	Miscellaneous expenditure (lease, Labour, etc) LS	2.0
	Total	7.9
II	Fixed cost, Pond lease charges @ Rs.	0.3
III	Gross benefit, Receipt from sale 9000 kg @ Rs.130/-	11.7
IV	Net benefit	3.5
V	BC ratio	1.48

This growth rate is 27 to 50 percent faster than the growth rate of common carp reported by Basavaraju et al (2002). Das (2017) also reported the Amur Carp Hungarian strain's faster growth rate and late maturity behaviour.

The cost economics at the prevailing price was worked out (Table 1). The average production cost per kg was Rs. 87.8/-. Stocking 10000 fingerlings per hectare can produce an average of 9.0 t of fish in 15 months. The production cost per hectare would be Rs. 7.9 lakh.

CONCLUSION

Amur carp (Hungarian strain) is an ideal candidate fish for farming in the inland freshwater resources of Ernakulam district in Kerala, India. Nursery care is essential prior to grow-out farming as the seeds are available as fry's. The survival percentage in the grow-out phase is 90. Fifteen months of farming is required for this species to reach the marketable size of 1100 ±200 g. Amur carp farming is a profitable enterprise with a BC ratio of 1.48.

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Impact of Weather Parameters on Thrips (*Scirtothrips dorsalis* Hood) in Pomegranate

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ABSTRACT

An experiment was conducted during 2022-23 at KVK, Jalore to observe the incidence of thrips in pomegranate orchards and their relationship with weather parameters. A fixed plot survey was conducted at five locations in the Jalore district. Five locations were selected for the fixed plot survey and the weekly incidence of thrips was recorded. The data revealed that the incidence of thrips (*Scirtothrips dorsalis* Hood started in the 25th Standard Meteorological Week (18 June - 22 June) with 0.33/5cm twig/plant whereas the peak incidence of pomegranate thrips was recorded in the third week of September (38th SMW) with 14.66 thrips/5cm twig/plant and last week of March (13th SMW) with 14.33 thrips/5 cm twig/Plant during 2022-23. A simple correlation coefficient was worked out between the incidence of thrips and weather parameters revealed that temperature showed a positive and significant relationship with the population of thrips.

Key Words: Incidence, Pomegranate, Temperature, Thrips.

INTRODUCTION

Pomegranate is a high-value crop with great economic importance. Among all fruit crops pomegranate is the only fruit crop in India and is being cultivated in arid and semiarid regions of Gujarat, Maharashtra, Karnataka, Uttar Pradesh, Andhra Pradesh and Tamil Nadu (Balikai *et al,* 2011) It is a highly adapted crop to the weather fluctuations and different ranges of soil (Pal *et al,* 2014). It is an ideal crop for the sustainability of small holdings, as pomegranate is well suited to the topography and agro-climate of arid and semiarid regions. In addition it provides ample opportunity for livelihood security has a high potential to utilize wastelands widely available in the region and an ideal crop for diversification. used.

Temperature is the key factor in the population build up of the thrips in pomegranate throughout the year . In Rajasthan, it is mainly grown in, Jalore, Barmer, and Jodhpur Bikaner districts and acreage in Thar Desert particularly Barmer, Jodhpur and Jaisalmer is increasing rapidly. Several biotic and abiotic stress have greatly influenced the growth and yield of pomegranate, among biotic factors many species of thrips belonging to the order Thysanoptera are a serious pests of pomegranate (Wang, 1994) and causing considerable losses in quality and quantity.Thrips population remains throughout the year in pomegranate orchards in different ranges (Roopa and Kumar, 2014). Temperature is the key factor in the population build-up and has been observed to slightly impact the incidence of thrips population (Ananda, 2007)

MATERIALS AND METHODS

The experiment was conducted during 2022-23 at different locations in Jalore district to record the impact of weather parameters on the thrips population under natural conditions in pomegranate orchards without spraying any insecticides and variety used was Bhagva. The field survey was conducted at farmer's field at different locations and the population of Thrips (*Scritothrips dorsalis* Hood) was recorded at weekly intervals during morning hours between 8.00 am to 9.00 am on five randomly selected and tagged on three leaves in each plot (5m x 5m) by

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using a sampling technique given by Satpathy (1973). Tender shoots of five tagged plants up to 10 cm were selected randomly and tapped gently on a black paper board (40cm x10 cm).The number of thrips (both nymph and adult) was recorded with the help of a hand lens. Weekly weather parameters viz., maximum temperature, minimum temperature, relative humidity, and total rainfall were collected from the meteorological observatory, KVK, Jalore-I. The mean numbers of thrips were correlated with the meteorological data and a regression equation developed and correlation coefficient was worked out.

RESULTS AND DISCUSSION

Seasonal incidence

The data (Table 1) and in (Figure 1&2) indicated that the thrips population in pomegranate orchards appeared during the 25th standard meteorological week (SMW) *i.e.,* 18th June-24 June (3rd week) with a mean population of 0.33 thrips/ 5cm twig/plant. The population increased gradually and attained the peak in the third week of September (38th SMW) with a mean population of 14.66 thrips/5cm twig/plant. Later on, the population of thrips declined and reached a minimum level of 1.00 thrips/5cm twig/plant during the 5th SMW *i.e.,* 29th January -4th February and the population again attends its peak in the last month of March (13th SMW) with 14.33 thrips/5 cm twig/plant.

Correlation with weather parameters

Thrips exhibited a non-significant and positive correlation (r1 = 0.07986) with average temperature and a non-significant negative correlation with relative humidity (r2 = -0.06468). Jadhav *et al* (2019) studied the seasonal incidence of major sucking pests of pomegranate and reported that the thrips infestation was close conformity to the present study. Similar results were also reported by Elango and Sridharan (2017) and Bagle (1993) the high-density plantation is more favorable for the thrips population built up and exhibited a positive significant relation with average temperature. Mishra and Kumar (2023) reported that thrips exhibited a non-significant positive correlation with maximum temperature and population of thrips in chilli crop and Asma and Hanumantharaya (2015) reported a positive correlation between the population of thrips and maximum temperature. Lakshmi *et al* (2024) reported that the reproductive activity of thrips was increased due to temperature and sunshine hours. Rizwana *et al* (2024) reported that the higher humidity levels decrease the thrips population but temperature increases the pest population in chilli.

CONCLUSION

Thrips are the significant insects that remain throughout the crop season in the pomegranate orchards and are majorly influenced by weather parameters, especially minimum and maximum temperature. Population in pomegranate orchards appeared during the 3rd week of June with a mean population of 0.33 thrips/ 5cm twig/plant and remained up to the last month of March with 14.33 thrips/5 cm twig/plant and showed a non-significant and positive correlation with average temperature.

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Impact of Weather Parameters on Thrips

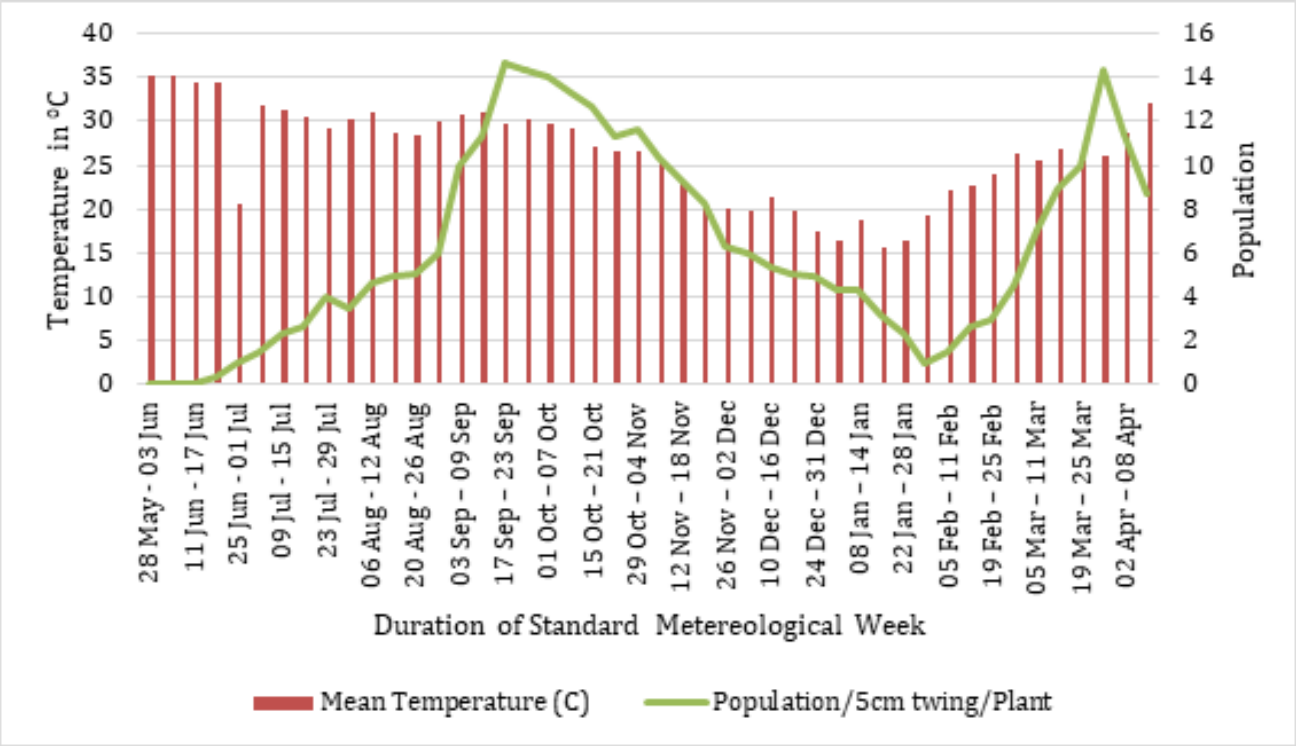

Fig: 1 Effects of temperature on thrips population in pomegranate.

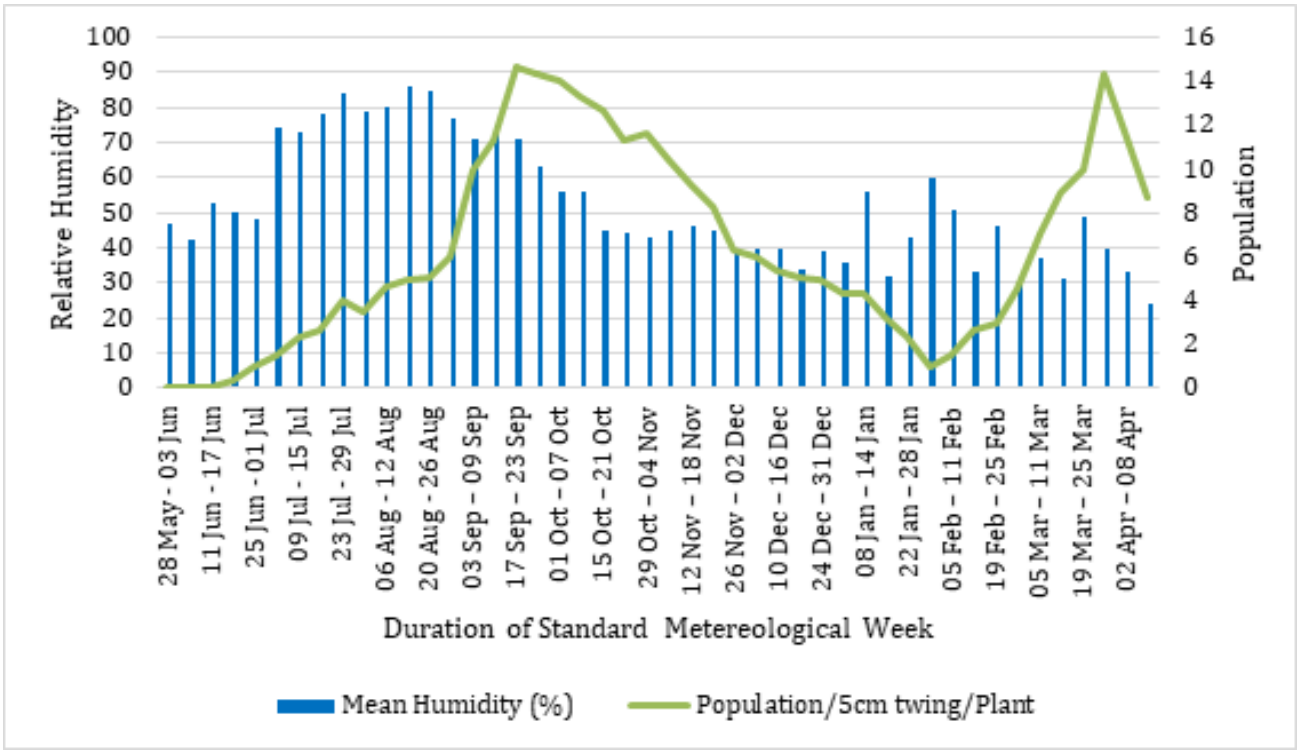

Fig: 2 Effects of relative humidity on thrips population in pomegranate.

Table 1. Incidence of thrips (*Scritothrips dorsalis* Hood) in pomegranate.

SMW	Date	Population/5cm wing/Plant 2022-23	Mean Temperature (ºC)	Mean Humidity (%)
22	28 May - 03 Jun	0.00	35.20	47.00
23	04 Jun - 10 Jun	0.00	35.20	42.00
24	11 Jun - 17 Jun	0.00	34.40	53.00
25	18 Jun - 24 Jun	0.33	34.30	50.00
26	25 Jun - 01 Jul	1.00	20.70	48.00
27	02 Jul - 08 Jul	1.50	31.80	74.00
28	09 Jul - 15 Jul	2.33	31.30	73.00
29	16 Jul - 22 Jul	2.66	30.50	78.00
30	23 Jul - 29 Jul	3.99	29.10	84.00
31	30 Jul - 05 Aug	3.50	30.20	79.00
32	06 Aug - 12 Aug	4.66	31.00	80.00
33	13 Aug - 19 Aug	4.99	28.60	86.00
34	20 Aug - 26 Aug	5.00	28.40	85.00
35	27 Aug - 02 Sep	5.99	30.10	77.00
36	03 Sep – 09 Sep	9.99	30.70	71.00
37	10 Sep – 16 Sep	11.33	31.00	75.00
38	17 Sep – 23 Sep	**14.66**	**29.80**	**71.00**
39	24 Sep – 30 Oct	14.33	30.20	63.00
40	01 Oct – 07 Oct	13.99	29.70	56.00
41	08 Oct – 14 Oct	13.33	29.10	56.00
42	15 Oct – 21 Oct	12.66	27.00	45.00
43	22 Oct – 28 Oct	11.33	26.50	44.00
44	29 Oct – 04 Nov	11.66	26.50	43.00
45	05 Nov – 11 Nov	10.33	25.80	45.00
46	12 Nov – 18 Nov	9.33	22.90	46.00
47	19 Nov – 25 Nov	8.33	20.70	45.00
48	26 Nov – 02 Dec	6.33	20.10	40.00
49	03 Dec – 09 Dec	6.00	19.70	40.00
50	10 Dec – 16 Dec	5.33	21.40	40.00
51	17 Dec – 23 Dec	5.00	19.90	34.00
52	24 Dec – 31 Dec	4.99	17.50	39.00
1	01 Jan – 07 Jan	4.33	16.40	36.00
2	08 Jan – 14 Jan	4.33	18.80	56.00
3	15 Jan – 21 Jan	3.20	15.70	32.00
4	22 Jan – 28 Jan	2.33	16.50	43.00
5	29 Jan – 04 Feb	1.00	19.20	60.00
6	05 Feb – 11 Feb	1.50	22.10	51.00
7	12 Feb – 18 Feb	2.60	22.60	33.00
8	19 Feb – 25 Feb	2.99	24.10	46.00
9	26 Feb – 04 Mar	4.50	26.40	31.00
10	05 Mar – 11 Mar	7.00	25.50	37.00
11	12 Mar – 18 Mar	8.90	26.80	31.00
12	19 Mar – 25 Mar	10.00	25.50	49.00
13	26 Mar – 01 Apr	**14.33**	**26.00**	**40.00**
14	02 Apr – 08 Apr	11.40	28.60	33.00
15	09 Apr – 15 Apr	8.66	32.10	24.00
Correlation coefficient between population of thrips and abiotic factors				
Mean Temperature (ºC)				0.07986
Mean relative humidity (%)				-0.06468

*SMW: Standard Meteorological Wee*k

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Investigating Bioactive Compounds from Medicinal Plants for Targeting Nonstructural Proteins of the Chikungunya Virus

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ABSTRACT

Chikungunya virus (CHIKV) is a major public health problem because it is widely transmitted by Aedes mosquitos and can cause devastating symptoms such as fever, joint pain, and rash. Currently, no particular antiviral medications or vaccines are available for the treatment or prevention of CHIKV infection, highlighting the critical need for alternative therapeutic methods. Medicinal herbs have long been known as rich sources of bioactive chemicals with a wide range of pharmacological activities, including antiviral activity. This study will look into bioactive chemicals derived from medicinal plants and their ability to target nonstructural proteins of the Chikungunya virus, including nsP1, nsP2, nsP3, and nsP4 (Mainly nsP2). A comprehensive literature study and bioinformatics analysis were used to identify medicinal plants renowned for their antiviral activities. The bioactive chemicals found in these plants were tested for their capacity to interact with and inhibit the function of CHIKV nonstructural proteins using molecular docking and molecular dynamics simulations.

Preliminary results showed that some intriguing bioactive chemicals can bind to particular areas of CHIKV nonstructural proteins, potentially affecting the enzymatic activity required for viral replication and propagation. These compounds have high binding affinities and stable interactions with target proteins, indicating that they could be used as lead compounds to create novel antiviral medicines against CHIKV. This study provided insights into the use of bioactive chemicals from medicinal plants as prospective candidates for targeting CHIKV nonstructural proteins, paving the way for the development of efficient antiviral medicines to battle Chikungunya virus infection.

Key Words: Bio active chemical, Medicinal plants, Proteins, Virus.

INTRODUCTION

The tropical disease chikungunya, which is spread by mosquitoes is currently a threat. More than a million people encounter this illness each year, which results in severe joint pain. Kimakonda language which means that which bind up is where the word Chikungunya originates (Zhang et al, 2016). The Chik V virus bears a striking resemblance to the O'nyong-nyong virus, which was discovered in Uganda in 1959 in a patient exhibiting joint pain, fever, and itchy rashes. The virus is spread by 'Anopheles' mosquitoes (Mao et al, 2019). Chikungunya fever is brought on by the Chikungunya virus (CHIKV), which is a member of the Tongoviridae family and genus Alphavirus. This comprises more than thirty species of alphaviruses carried by arthropods. Each of these has seven distinct antigenic complexes in common (Ruiz-Moreno et al, 2012). A few additional alphaviruses, such as the Rose River virus, O'nyong-nyong virus, Bannah Forest virus, and Mayaro virus, are also closely related to CHIKV. This virus group is known to cause

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arthritis. There are three genotypes of CHIKV: West African, East Central South African, and Asian(Lopresti, 2018).

Chikv Virus Genome

The Chikungunya virus is a positive single-stranded ribonucleic acid virus that is spherical, enveloped, and has icosahedral symmetry. Its diameter is around 60–70 nm. length of around 11.7 kb, encoding ORF1 and ORF2, two open responding frames. These two open reading frames, which have nucleotide sequences of 7422 and 3744, encode structural and non-structural proteins, respectively. They are linked to a common area (J), which functions as a promoter for the synthesis of sub-genomic RNA. Both proteins were produced as precursors of polyproteins. The four non-structural proteins are encoded by ORF1. At the 5' end of the genome are the non-structural proteins, nsPl, nsP2, nsP3, and nsP4 (Ahola and Merits, 2016). The structural polyprotein, which cleaves into five structural proteins, is encoded by ORF2. At the 3' end of the genome are the genes for the structural protein CP, E3, E2, 6K, and El(Subudhi et al, 2018).

Medicinal Plants and their Bioactive Compounds

Curcuma longa (curcumin)- Its effectiveness against CHIKV has recently been demonstrated(Mounce et al, 2017). Curcumin, the primary active component of the rhizome of turmeric (Curcuma longa), exhibits antiviral properties against many viruses (Mathew and Hsu, 2018). Its IC50 against CHIKV was 3.89 m. With a CC50 of 11.6 m, the safety index, however, was insufficient. However, demethoxy curcumin, a derivative of it, was more effective and had a better safety record. Because of its lipophilic properties, demethoxy curcumin has the ability to disrupt the CHIKV membrane, which enhances its antiviral efficacy. Because demethoxy curcumin is lipophilic, it can obstruct the CHIKV membrane, which enhances its antiviral properties. Despite curcumin has been demonstrated to be effective in vitro against a range of viral illnesses, its limited water solubility and absorption have mostly prevented the effects from being translated in vivo(Von Rhein et al, 2016). Therefore, before curcumin compounds are employed any further, their in vivo efficacy needs to be confirmed. However, it is possible to derivatized it in order to improve its pharmacokinetics and anti-CHIKV properties.

`*Zingiber officinale* (6-gingerol)- A plant whose rhizome is widely used as a spice and a component of traditional herbal medicine in Asia has been shown to offer numerous health benefits (Akinyemi et al, 2015). Several investigations have documented biological effects, including anti-inflammatory, antibacterial, anticancer, and antioxidant qualities (Ahebwa et al, 2023). Additionally, ginger has been associated with the management and prevention of diabetes, respiratory issues, neurological disorders, and cardiovascular disease(Wahid et al, 2017). [6]-gingerol is one of the components of ginger that has the highest pharmacological activity(Hwu et al, 2015). Fresh ginger has a distinct flavor due to the aromatic ketones that are present in its chemical composition(Abu Bakar and Ng, 2018). This nonvolatile substance possesses a broad spectrum of biological effects, such as anti-oxidation, anticancer, analgesic, and anti-inflammatory abilities, along with a low toxicity profile . It has also been found that [6]-gingerol inhibits the replication of CHIKV once it has infiltrated the host cell(Citronberg et al, 2013).

MATERIALS AND METHODS

The docking of *Curcuma longa* (turmeric) and *Zingiber officinale* (ginger) derived composites against the nsp2 protein of the chikungunya virus is the focus of this work. Docking was performed using the CB-Dock (Cavity-detection guided Blind Docking) software program.

Preparation of Chikv Nsp2 Protein

Utilizing the Protein Data Bank (PDB), the macromolecule's three-dimensional structure was discovered. This investigation used the Chikv nsp2 protein. Using PDB ID: 4ZTB, the Nsp2 protein structure was obtained from PDB. The PDB format was used to store the three-dimensional structure. The Py-Mol viewer was used to view the downloaded protein.

Table 1. Chemical and physical properties of various compounds from turmeric (*Curcuma longa*) and ginger (*Zingiber officinale*).

Sr.No	Ligand name	Pub chem ID	Molecular wt. (g/mol)	Hydrogen bond	Hydrogen bond donor	Log p	Binding energy ligand +target(nsP2)
1	α-Pinene	6654	136.23	0	0	2.8	-6.2
2	β-Pinene	14896	136.23	0	0	3.1	-6
3	Myrcene	31253	136.23	0	0	4.3	-5.7
4	α-Phellandrene	443160	136.23	0	0	3.2	-6.4
5	α-Terpinene	7462	136.23	0	0	2.8	-6.4
6	p-Cymene	7463	134.22	0	0	4.1	-6.4
7	Terpinolene	11463	136.23	0	0	2.8	-6.6
8	Curcuphenol	360253	218.33	1	1	5.3	-7.5
9	Tricyclene	79035	136.23	0	0	3.2	-6.2
10	Camphene	6616	136.23	0	0	3.3	-5.7
11	Hexanal	6184	100.16	1	0	1.8	-4.1
12	n-octane	356	114.23	0	0	3.9	-4.6
13	n-decane	15600	142.28	0	0	5	-5.1

Preparation of Ligands

For this investigation, ligands from *Zingiber officinale* (ginger) and *Curcuma longa* (turmeric) were used. Downloads of ligand chemical structures are available from the MAPS Database, PubMed, Pubmed Central, Pubchem, Zinc Database, and ChEMBL. These ligands' three-dimensional structure was obtained from PubChem.

Docking

The software CB-Dock (Cavity- detection guided Blind Docking) was used to conduct docking investigations. For post-analysis and docking, CB-Dock was employed. The protein and ligand structures were uploaded, and the docking procedure was started. The outcome of the docking was examined.

RESULTS AND DISCUSSION

A technique named molecular docking, sometimes referred to as molecular anchoring, gives researchers estimates of the free energy binding between a protein and ligand in several spatial conformations. Every spatial conformation has its free energies of binding (between the binder and its target) computed, and the conformation with the lowest energy is deemed to be the most advantageous or best-fitted conformation. The RSCB Protein Data Bank repository, which is associated with PDB Id 4ZTB and has X-Diffraction 2.59 A, is where the NsP2 structure was discovered. The structures of the ligands were obtained from a variety of software programs, including MAPS Database, Pubchem, Zinc Database, Pubmed Central, and ChEMBL.

13 ligands were used in the docking studies, and the target protein was nsP2. The ligands such as α-Phellandrene, α-Terpinene, p-Cymene, Terpinolene, and Curcuphenol exhibit increased affinity for the nsP2 protein in their binding conformation modes. The ligand binding site predicted by the docking approach was examined while examining the binding interaction and location of ligands with the nsP2 protein. Every ligand molecule's binding position to the chikv virus nsP2 protein was examined, and the pose with the lowest binding energy was

produced. In comparison to greater energy scores, the lowest energy score indicated better target protein-ligand binding affinity (best protein-ligand complex). Out of the thirteen ligands, it was discovered that α-Phellandrene, α-Terpinene, p-Cymene, Terpinolene, and Curcuphenol had ligand binding energy values that were lower than those of the other ligands. Ligand Curcuphenol has the lowest binding energy value (-7.5 kcal/mol) when it's bound to the chikv virus nsP2 protein, followed by ligand Terpinolene (-6.6 kcal/mol) and ligands α-Phellandrene, α-Terpinene, and p-Cymene (-6.4 kcal/mol).

CONCLUSION

Using molecular docking, this work examined the potential of bioactive compounds from Zingiber officinale and Curcuma longa to inhibit the Chikungunya virus's (CHIKV) nsP2 protein. Curcuphenol had the highest binding affinity (-7.5 kcal/mol) among the 13 ligands that were examined. Terpinolene came in second (-6.6 kcal/mol), followed by α-Phellandrene, α-Terpinene, and p-Cymene (-6.4 kcal/mol). These findings imply that these substances may interfere with the enzymatic activity of nsP2, which is necessary for viral replication. The results set the stage for additional experimental validation and medication development by identifying the potential of natural chemicals as antiviral options against CHIKV. This research advances the investigation of plant-based treatments for viral diseases.

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In-vitro Analysis of Inhibitory Potential of Fungicides and Biocontrol Agents against Vascular Wilt Pathogen, *Fusarium oxysporum* f. sp. *vasinfectum* infecting Cotton in Western U.P.

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ABSTRACT

Cotton yield production and productivity is significantly suppressed due to vascular wilt incited by *Fusarium oxysporum* f. sp. *vasinfectum* (FOV). The management of the wilt pathogen can be achieved by using various biocontrol agents, such as *Trichoderma* spp., *Pseudomonas* spp., and *Bacillus* spp., and fungicides, such as carbendazim, copper oxychloride, CM75% (carbendazim + mancozeb), propineb, mancozeb, vitavex, propiconazole and Amistar top. Among all the biocontrol agents, *T. harzianum, P. fluorescens*, *T. viride* and *T. atroviride* resulted highest inhibition (60-74%) of the mycelium growth of FOV was observed *in vitro*. The complete reduction (100%) in the mycelial growth of Fov was recorded with carbendazim, CM75%, propineb and mancozeb even at their used lowest concentration of 50 ppm among all the tested eight fungicides. The most significant biocontrol agents, including *T. harzianum, P. fluorescens*, *T. viride* and *T. atroviride* and fungicides, such as carbendazim, CM75%, propineb and mancozeb can be utilized in integrated disease management module for the best control of vascular wilt disease in cotton.

Key Words: Biocontrol agents, Cotton, Culture, Fungicides, *Fusarium* spp. Management.

INTRODUCTION

Cotton is one of the most significant fibre crops which is cultivating throughout the world (Cusser *et al,* 2016; Voora *et al,* 2020). The crop is mainly used for its natural fibre, oilseed, and animal feed (Chen *et al,* 2015; Zhang *et al,* 2019). The fibre production and productivity of the crop is hampered by numerous abiotic, biotic factors, and weeds which are causing significant suppression in the cotton yield (Pegg and Brady, 2002; Halpren *et al,* 2018; Hussain *et al,* 2024). Biotic factors includes; fungi, bacteria, virus and nematodes etc. (Kamburova *et al,* 2018; Tarazi *et al,* 2020), and all these pathogens are responsible for up to 30% losses in fibre yield (Tarazi *et al,* 2020). The most common soil borne, and foliar diseases of cotton are blackarm (*Xanthomonas campestris* pv. *malvacearum*), anthracnose (*Colletotrichum gossypii* or *C. capsica*), wilt (*Fusarium oxysporum* f. sp. *vasinfectum*), grey mildew (*Ramularia areola*), root-rots (*Rhizoctonia bataticola*), leaf curl (*Cotton leaf curl virus*), verticillium wilt (*Verticillium dahliae*), and leaf blight (*Alternaria macrospora*) (Ramod, 2016; Patel *et al,* 2021).

Among all these diseases, *Fusarium oxysporum* f. sp. *vasinfectum* (FOV) is one of the most significant soil and seed borne pathogen that limits the fibre production and productivity of the crop (Armstrong and Armstrong, 1981; Atkinson 1892; Hillocks 1992; Sanogo and Zhang 2016; Zhu *et al,* 2022). The typical symptoms of wilt infected plants include cholorosis, yellowing, which is followed by leaf shedding, slow wilting, and in case of severe infection plant may die. One characteristic indication that is specific to fusarium

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wilt is a reddish-brown discoloration can be seen when cutting sections of stem and roots of the plant (Ayubov *et al,* 2024). Like other soil-borne pathogens, FOV can live in soil for many years without finding a suitable host plant, making it difficult to eradicate (Bani *et al*, 2018). Between 1953 and 2012, the wilt disease caused fiber yield losses that ranged from 0.19 to 1.36% (Blasingame and Patel, 2013) and in the United States, the National Cotton Disease Council had calculated an estimated 109,000 bales (227 kg or 500 lb) yield reduction was recorded in the year 2004 (Blasingame and Patel, 2005). Due to economic importance of the cotton crop and to reduce the yield losses caused by the wilt fungi, an experiment was conducted to evaluate the antagonistic or inhibitory effect of various biocontrol agents (fungal and bacterial) and fungicide on the mycelial growth of FOV.

MATERIALS AND METHODS

Isolation of *Fusarium oxysporum* f. sp. *vasinfectum*

Ten plants of cotton showing wilt disease symptoms were collected from the cotton fields. Sterilized poly bags were used to collect the plant samples and taken to the laboratory. To isolate wilt fungus, FOV, the small pieces (2-5mm) were cut from the stem and root of sample plant. After being surface sterilized for 30 seconds in 2.5% NaOCl (vol/vol), the pieces were rinsed two or three times with distilled water. The parts were put in a Petri plate with solidified potato dextrose agar (PDA) after being soaked on sterilized tissue paper. The inoculated plates were kept at 25±2°C in a BOD incubator. To identify *F. oxysporum* f. sp. *vasinfectum*, the fungal colonies that had grown on the plates were examined under a microscope (Updhayay and Rai, 1992; Gilman, 2001).

Dual culture test of biocontrol agents and wilt fungus

Antagonistic activity of nine isolates of bio-agents *viz*., *T. virens* ITC-477, *T. viride* AMUTVRD-13, *Trichoderma harzianum* AMUTHZM-21, *T. atroviride* AMUTATVRD-27, *T. longibrachiatum* AMUTLNG-23, *T. asperellum* AMUTA-1, *T. hamatum* AMUTHMT-19, *Pseudomonas fluorescens* AMUPF-7 and *B. subtilis* AMURBS-7 against *F. oxysporum* f. sp. *vasinfectum* (FOV7) was evaluated using the dual culture technique (Zivkovic *et al,* 2009). Two mycelial discs (5 mm dia.) of each FOV7 and biocontrol fungi were placed on the solidified PDA, 3 cm apart from each other in a Petri plate. The plates inoculated with *F. oxysporum* f. sp. *vasinfectum* FOV7 without BCAs served as control. Every treatment was kept in five replicated plates. After inoculation, the plates were kept at 25±2 °C for two weeks. On PDA-containing Petri plates, the bacterial antagonists were streaked 3 cm from the pathogen's mycelial disc. The plates were then incubated for 7 days at 35±2 °C and monitored. The radial growth of the biocontrol agents and *Fusarium* colonies and inhibition zone were measured.

Calculating the minimum inhibitory concentration (MIC) of fungicides against mycelial growth of *Fusarium oxysporum* f. sp. *vasinfectum*

Eight fungicides, enlisted in Table 2 were evaluated by poisoned food technique against *Fusarium oxysporum* f. sp. *vasinfectum* (FOV7) (Dhingra and Sinclair, 1985). The sterilised medium was mixed with stock solutions of the fungicides in a liquid state until the concentration of active ingredients reached 50, 100, 150, and 200 ppm. The mediums were poured in Petri plates (20 ml/ plate). After allowing the PDA in the plates to solidify, a mycelial disc of FOV7 (9 mm diameter) was positioned in the middle. A control (without fungicides) was maintained. Each treatment was maintained with five replicate plates. The plates were incubated at 25±2 °C. On the seventh day, the colonies' diameter was measured, and the following formula was used to determine the percentage of fungal growth inhibition:

$$PI = \{(C - T)/C\} x100$$

Where,

C = the test pathogen's growth (mm) in control;

T = the test pathogen's growth (mm) in the amended medium.

Table 1. *In vitro* efficacy of biocontrol agents in inhibiting of radial growth of *Fusarium oxysporum* f. sp. *Vasinfectum.*

Treatment	Radial growth (mm)		Percent inhibition over control (%)
	F. oxysporum* f. sp. *vasinfectum	**Biocontrol agents**	
Control (FOV7 alone)	90[a]	--	--
T. harzianum AMUTHZM-21	24.1[c]	65.9[a]	73.3[a]
T. virens ITC-477	31.1[b]	58.9[b]	65.5[bc]
T. viride AMUTVRD-13	28.4[bc]	61.6[b]	68.4[ab]
T. hamatum AMUTHMT-19	34.6[b]	55.4[c]	61.6[cd]
T. longibrachiatum AMUTLNG-23	34.7[b]	54.3[c]	60.4[d]
T. asperellum AMUTA-1	30.9[b]	59.1[b]	65.7[bc]
T. atroviride AMUTATRVD-27	29.5[bc]	60.5[b]	67.2[b]
*P. fluorescens*AMUPF-7	28.4[bc]	61.6[b]	68.5[ab]
*B. subtilis*AMUBS-7	29.7[bc]	60.3[b]	66.7[b]
LSD at P≤ 0.05	3.746[*]	2.044[*]	2.908[*]
F values of Treatments (df=8)	227.9[*]	212.9[*]	466.5[*]

Each value is a mean of five replicates. Values within a column followed by different alphabets are significantly different at P≤0.05 according to Tukey's test

RESULTS AND DISCUSSION

The nine biocontrol agents (fungi and bacteria) and eight fungicides were screened *in vitro* conditions to evaluate their effectiveness against *F. oxysporum* f. sp. *vasinfectum* (FOV7).

Effect of biocontrol agents on the colonization of *Fusarium oxysporum* f. sp. *vasinfectum*

Antagonistic activity of nine BCAs isolates *viz., T. virens* ITC-477, *Trichoderma harzianum* AMUTHZM-21, *T. viride* AMUTVRD-13, *T. longibrachiatum* AMUTLNG-23, *T. atroviride* AMUTATVRD-27, *T. hamatum* AMUTHMT-19, *T. asperellum* AMUTA-1, *B. subtilis* AMURBS-7 and *Pseudomonas fluorescens* AMUPF-7 against *F. oxysporum* f. sp. *vasinfectum* AMURFOV7 was evaluated using dual culture technique. The biocontrol agents inhibited the colonization of *F. oxysporum* f. sp. *vasinfectum*, *in vitro*. However, substantial variation in the degree of inhibition was observed among the BCAs (60-74%). *T. harzianum* AMUTHZM-21, *P. fluorescens* AMUPF-7, *T. viride* AMUTVRD-13 and *T. atroviride* AMUTATVRD-27 were recorded highest effective and suppressed the growth of mycelial of wilt fungus by 73-69% (P≤0.05), followed by *B. subtilis* AMUBS-7 (67%), *T. asperellum* AMUTA-1 (66%), *T. virens* ITC-477 (65%), *T. hamatum* AMUTHMT-19 (62%) and *T. longibrachiatum* AMUTLNG-23 (60%) over control (Table 1).

In vitro effectiveness of fungicides against *Fusarium oxysporum* f. sp. *vasinfectum*

Eight fungicides *viz*., carbendazim, copper oxychloride, CM75% (carbendazim + mancozeb), propineb, mancozeb, vitavex, propiconazole and Amistar top were evaluated against *F. oxysporum* f. sp. *vasinfectum* (FOV7) at various concentrations (50, 100, 150 and 200 ppm) using poisoned food method to find the minimum inhibitory concentration (MIC) of each fungicide. As fungicide concentrations increased, resulting in the inhibition of fungal colonization usually. The cent percent reduction in the mycelial growth was recorded at 50 ppm of the carbendazim,

Table 2. Analysis of minimum inhibitory concentration (MIC) of various fungicides using poisoned food technique *in vitro*

Fungicide	Percent inhibition of *Fusarium oxysporum* f. sp. *vasinfectum*			
	50 ppm	100 ppm	150 ppm	200 ppm
Control (FOV7 alone)	00	00	00	00
Mancozeb	100[a]	100[a]	100[a]	100[a]
Copper oxychloride	69.39[b]	73.87[c]	76.89[c]	83.59[b]
Amistar Top	65.68[b]	69.40[c]	76.87[c]	78.35[c]
CM75% (Carbendazim+Mancozeb)	100[a]	100[a]	100[a]	100[a]
Vitavex	67.16[b]	88.80[b]	91.78[b]	97.02[a]
Carbendazim	100[a]	100[a]	100[a]	100[a]
Propiconazole	62.68[c]	72.39[c]	86.67[b]	73.14[d]
Propineb	100[a]	100[a]	100[a]	100[a]
LSD at P≤ 0.05	4.851	4.044	3.559	2.426
F values of Treatments (df=7)	395.9*	557.4*	713.5*	1563*

Each value is a mean of five replicates. Values within a column followed by different alphabets are significantly different at P≤0.01 and P≤0.05 according to Tukey's test. Significant at P≤0.01.

CM75%, propineb and mancozeb. The vitavex, copper oxychloride, Amistar top and propiconazole induced significant inhibition in the colonization of the fungus (Table 2).

CONCLUSION

The experiment has demonstrated that among nine isolates of BCAs, *T. harzianum AMUTHZM-21, P. fluorescens* AMUPF-7, *T. viride* AMUTVRD-13 and *T. atroviride* AMUTATRVD-27 showed highest antagonism against *F. oxysporum* f. sp. *vasinfectum* FOV7. Whereas *T. virens* ITC-477, *T. hamatum* AMUTHMT-19 and *T. longibrachiatum* AMUTLNG-23 were found relatively less suppressive to the wilt fungus. Among eight fungicides tested *in vitro* against FOV7, carbendazim, CM75%, propineb and mancozeb proved to be the most effective inducing 100% suppression of the wilt fungus at 50 ppm concentration and other four fungicides like Copper oxychloride, Amistar Top, Propiconazole and Vitavex are lesser effective at lower concentration.

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Low Cost Feed Formulation for Semi-Intensive Poultry Farming During Brooding Period

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ABSTRACT

The study was conducted at different locations of Angul district by Krishi Vigyan Kendra, Angul, Odisha. In the trial four groups were made and total 10 replications were done for each group and each group contained 25 birds under each replication. Under treatment group $T_{1,}$ birds were supplemented with broken rice and T_2 birds were supplemented with crumbled broiler starter feed (market feed). T_3 feed contained ground maize 35%, groundnut cake 23%, fish meal 10%, wheat bran 15%, broken rice 15%, mineral mixture and salt 2%. T_4 feed contained ground maize 30%, groundnut cake 23%, fish meal 10%, wheat bran 15%, broken rice 20%, mineral mixture and salt 2%. It was observed that the treatment T_1 supplemented with broken rice showed lowest average weight gain of 553.12g at 60 d, whereas, T_4 supplemented with formulated feed material showed highest weight gain 770.12g in 60 d. There was minimal mortality in T_2. It was observed that the CP content of T_2 (Broiler starter) was more or less similar to that of T_3 and T_4. Hence, the formulated feeds can be a substitute for commercial starter feed.

Key Words: Body weight, Low cost feed, Poultry, Proximate value.

INTRODUCTION

Poultry rearing plays an important role for improving the nutritional security of the rural poor by providing meat and egg (Banja *et al*, 2017, Sivadasan and Subramannian, 2022). In any livestock rearing nutrition plays a pivotal role because it directly affects the profitability in terms of survivability, growth and production (Mishra *et al,* 2023). The livestock development depends on various factors viz., feed quality, water, breeds, environmental conditions, management and the farming practices (Ofori *et al,* 2019). Among all these factors feed is the most important one. In the rearing process the feed constitutes 60-80 % of the total cost of production; any attempt to reduce the feed cost may lead to a significant reduction in the total cost of production (Wagh *et al,* 2021). Incorporation of commercial feed during brooding period that comprises crude protein up to 18-20% leads to increase in total cost of production and simultaneously reduced marginal profit. However, feeding management during brooding is an important aspect that needs to be addressed for better production in grower and layers. Attempts to utilize locally available cheap non conventional feed sources may benefit the small poultry farmers in reducing the feed cost which in turn can reduce the total cost of production of meat and egg and making them easily available at affordable cost in rural area (Wagh *et al,* 2021). Multiple energy and protein feedstuffs will not only reduce the feed cost, but also improve the feed quality and reduce the mycotoxin level; compared to maize and soya combination only. If conventional feedstuffs like maize, soya and fish are costly /scarce / poor quality, alternate feedstuffs like jowar, millets, rice polish, broken rice /wheat, cheaper oil cakes, guar meal, BSF larvae meal, meat-cum-bone meal etc. can be selected (Nayak *et al,* 2023).

Hence, the study was undertaken with the objective to reduce feed cost and to formulate a balanced diet that will provide appropriate

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Table 1. Different treatment groups and their feed supplement.

Treatment	Number of birds	Feed supplement
T_1	250	Broken rice
T_2	250	Broiler starter
T_3	250	Ground maize 35%, groundnut cake 23%, Fish meal 10%, wheat bran 15%, Broken rice 15%, Mineral mix and salt 2%
T_4	250	Ground maize 30%, groundnut cake 23%, Fish meal 10%, wheat bran 15%, Broken rice 20%, Mineral mix and salt 2%

quantities of biologically available nutrients required by the bird. In present study, locally available ingredients like fish meal, wheat bran, maize flour and broken rice were used for feed formulation with nutritional similarity as that of starter poultry feed. This formulated feed will also help in case of non availability of commercial starter feed in local market.

MATERIALS AND METHODS

The study was undertaken at multiple locations of Angul district during the year 2023-24. Ten farmers were selected for conducting experimental trial. The poultry chicks under this trial were of Kaveri breed. Four treatment groups were made and each treatment consisted of 25 birds. Under T_1 birds were fed with broken rice and T_2 birds were fed with crumbled broiler starter feed (market feed). Two different type of low cost feed materials were developed in T_3 and T_4 (Table 1). T_3 contained ground maize 35%, groundnut oil cake 23%, fish meal 10%, wheat bran 15%, broken rice 15%, mineral mix and salt 2%. T_4 contained ground maize 30%, groundnut oil cake 23%, fish meal 10%, wheat bran 15%, broken rice 20%, mineral mixture and salt 2%. All the groups were provided with clean drinking water, brooder, vaccination etc. The chicks were vaccinated for Ranikhet disease vaccine (F strain/ Lasota strain) on 7th day and booster dose on 21th day of age and infectious bursal disease on 14th day. Multivitamin suspensions were given to all chicks during first 15 days. During the initial 3 days chicks were fed with coarse wheat flour followed by trial feeds upto 35d. Weight gain was recorded on 0 day, 15th day, 30th day and 60th day on digital weighing balance. The proximate analysis of poultry feed samples were also done as per AOAC (2002).

Statistical analysis

The average body weight of chicks at different age groups were measured and the data analyzed statistically by one way ANOVA for comparison within groups.

RESULTS AND DISCUSSION

Gain in body weight

It was observed that the T_1 group fed with broken rice showed lowest average weight gain of 553.12g at 60d whereas, T_4 fed with formulated feed material showed highest weight gain 770.12 g in 60d and T_2 and T_3 showed average body weight of 754.4 g and 744.8 g, respectively. The weight gain in the four groups differed significantly at 15, 30, and 60d. At 60 d, the average weight gain of T_1 significantly different from all four treatments. However, the weight gain performance in T_2 showed no significant difference from that of T_3 and T_4 (Table 2). The weight gain performances were partially in agreement to that of Wagh *et al* (2021) where the food grain of rice, wheat and sorghum showed lowest average weight gain.

Cumulative feed consumption and FCR

The cumulative feed consumption at 60 day and feed conversion ratio (FCR) of all the four treatments were presented in Table 3. It was observed that the FCR value of T_4 was lowest (1.75) indicating higher efficiency where as that of T_1 was highest (2.39) suggesting lowest efficiency.

Mortality

The mortality percentage was 12, 0, 4 and 4 per cent in T_1, T_2, T_3 and T_4, respectively. The minimal mortality in T_2 suggesting more hygienic feed processing than other three groups.

Table 2. Average body weight of chicks at different age groups.

Treatment	Body weight (g)			
	0 day	15 day	30 day	60 day
T_1	38.36±0.74	70.12^{a}±1.84	162.88^{a}±1.91	553.12^{a}±8.76
T_2	39.02±0.56	104.56^{bc}±2.11	238.70^{b}±5.64	754.41^{bc}±3.04
T_3	36.73±0.49	100.38^{b}±2.31	201.66^{c}±2.36	744.75^{b}±3.47
T_4	38.11±0.56	112.72^{c}±2.11	289.28^{d}±5.64	770.12^{c}±3.04

Values differ significantly between the groups, if contain different superscripts within the same column at the specific day of observation ($P < 0{\cdot}05$).

Table 3. Cumulative feed consumption and feed convertion ratio (FCR) .

Sr. No.	Treatment	Cummulative feed consumption/bird (60 d)	Average Weight gain at 60 d/ bird	FCR
1	T_1	1325.4±3.52	553.12a±8.76	2.39
2	T_2	1350.2±5.28	754.41bc±3.04	1.79
3	T_3	1335.6±3.99	744.75b±3.47	1.79
4	T_4	1348.4±6.84	770.12c±3.04	1.75

Poultry nutrition plays important role in maintenance, growth, breeding, health and egg production. Poultry birds need rations which should be enriched with amino acids, vitamins, minerals and other nutrients (Singh *et al,* 2019 and Halima *et al*, 2007). As feed cost is one of the major expenditure consisting around 70% of the production cost in poultry farming, low cost feed preparation is very much appropriate for making this enterprise profitable. Energy and protein concentrations in the diet play an important role in livestock productivity and are critical in the evaluation of poultry performance (Dairo *et al,* 2010). The nutrient concentration is important both in the nutritional aspect and practical application in terms of its economics, thus, feed formulation with lower protein or energy concentration enables the decrease of feed cost (Kamran *et al*, 2011). In present study, four different feed samples were used to feed four treatment groups of birds. Total cost of T_1 feed was Rs.1800/q. Total expenditure for preparation of low cost feed under T_3 and T_4 was Rs.3247/q and Rs.3217/q respectively. The broiler starter under T_2 was Rs. 4300/q. The cost of broiler starter was high compared to all other feed samples. The proximate analysis of all the feed samples was carried out in order to evaluate the nutritive value. The details of the proximate analysis of the samples were presented in the Table 4. Moisture content (%) in the different treatment feed ranged from 10.21 to 11.96. The higher moisture content was observed in T_1 (Broken rice), whereas, lower moisture content was observed in T_2 (Commercial broiler starter). However, the moisture content in T_3 and T_4 were in the range as per Ofori *et al* (2019). The moisture content in the feed sample is an indicator of quality. As per NRI (1995) high moisture content in feed predisposes feed to mycotoxins and spoilage in presence of high environmental temperature and poor ventilation, which can affect health of birds when fed. In the present study there was high moisture content in T_1 (Broken rice) leading to more mortality of 12% in this treatment group indicating poor quality feed. According to GSA (2007) the minimum requirement of Crude Protein (CP) for layer starter, layer grower, layer, broiler starter and broiler finisher were respectively 18.0%, 17%, 17%, 22% and 20%. In the present study the lowest CP was found in T_1 (6.29%) which was below the recommended minimum of 17% and the

Table 4. Proximate analysis of feed samples in different groups.

Sr. No.	Parameters (% as on dry matter basis)						
	Feed sample	Moisture	Crude Protein	Ether Extract	Crude Fibre	Total Ash	Acid insoluble Ash
1	T_1	11.96	6.29	0.10	0.60	1.81	0.27
2	T_2	10.21	18.47	5.10	2.66	5.54	0.40
3	T_3	10.48	18.65	4.04	5.74	7.49	0.63
4	T_4	10.73	18.83	4.07	5.22	7.05	0.58

Table 5. Expenditure, weight gain and mortality % in different groups.

Sr. No.	Particular	T_1	T_2	T_3	T_4
1	Total Expenditure	1125	1671	1439	1433
2	Average weight gain (g)	553	754	744	770
3	Mortality % in 60 days	12 %	0 %	4 %	4 %

highest was found in T_4 (18.83%) which matches with that of layer starter as per GSA (2007). CP in the feed provides essential amino-acids. According to Kuashalendra *et al* (2016) increased crude protein in diet of birds results in improvement in egg size and weight. A feed sample of lower CP content will affect development of carcass and eggs production (NRC, 1994). Hence, the formulated feed in the study can be a substitute for commercial starter feed with a low cost and better production. In the present study, the crude fibre % ranged from 0.60 to 5.74. According to Reddy (2016) roughage feedstuffs possess more than 18% crude fibre while concentrate possess less than 18% crude fibre. Hence, in the formulated low cost feed CF% were within the range.

CONCLUSION

Feed with the composition of ground maize 30%, GNOC 23%, fish meal 10%, wheat bran 15%, broken rice 20%, mineral mix and salt 2% could the best combination for low cost rearing of poultry bird during brooding period. This will help to reduce the overall cost of feed and significantly increase economy of marginal farmer. For successful poultry farming, the quality of the feed is an important factor for growth and production of birds and every attempt must be put in place to ensure that feed prepared should contain all the essential nutrients at the right amount for the sustenance of the poultry industry. The selection of feed ingredients for formulation of poultry feed should not be compromised in order to reduce mortality.

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Onion Variety Bhima Super Enhances Profitability of Onion (*Allium cepa*) Growers

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ABSTRACT

The study was conducted in farmer's field in Bagalkote district for three consecutive years during *kharif* season to assess the performance of Bhima Super over local variety. It was noticed that the onion variety (Bhima Super) recorded average yield of 19.56 t/ha with net return of Rs. 93266/-ha as compared to farmers' practice, which produced average yield of 16.23 t/ha with net return of Rs. 60958/- ha. Timely plant protection measures reduced the average bulb rotting incidence (11.8%) in Bhima super compared to local check (21.8%), average thrips incidence was also low in Bhima super (13.5 thrips no./plant) and in local check (19.90 thrips no./plant). There was less incidence of purple blotch disease (21.9%) but disease incidence was high in local variety (29.23%). The average extension gap, technology gap and technology index were 5.67, 2.53 and 11.50 per cent, respectively. The average benefit cost ratio was high in Bhima Super onion (3.12) compared to local variety (2.35). On an average, 19.4% yield increase was observe in demonstration plots over farmers' practice.

Key Words: Bhima Super, Demonstration, Extension gap, Front line, *Kharif* onion.

INTRODUCTION

Onion is one of the most important spice and vegetable bulb crop throughout the world and commercially cultivated in more than hundred countries. India ranks second in the world in area and production after China and third in export after Netherland and Spain. India is producing 17,511.10 thousand MT of onion from an area of 1,087.26 thousand hectares with an average productivity 16.10 t/ha. In Karnataka, it is grown about 177.20 thousand Mha with an average production of 2,451.20 thousand MT and productivity 13.83 t/ha (NHB data base 2016-17). In India, Maharashtra, Gujarat, Karnataka, Orissa, Uttar Pradesh, Madhya Pradesh, Rajasthan and Andhra Pradesh are major onion growing states. Because of its high export potential it comes under cash crop apart from vegetables.

In Bagalkot, onion is cultivated in an area of 18064.4 ha with the production of 298335 tons and productivity of 13.2 t/ha, which is below the average national productivity (14.21 t/ha). In Bagalkot area, the major constraints for lower productivity in onion were non availability of quality seeds, use of local cultivars, weed menace during early stages of crop accompanied by insects (thrips, aphids, leaf eating caterpillar) and disease problems (bulb rot, fungal rot, damping off, purple blotch and twisting disease). Most of the onion varieties grown were from private sector lines which are costlier and farmers uses self produced onion seeds which are susceptible for pest and disease. Hence, there was need for introducing new promising onion variety with good yielding potential and thus conducted front line demonstrations (FLD's) to show the worth of high yielding Onion variety Bhima super to the 30 selected onion growers each year during 2018-19, 2019-2020 and 2020-2021 on cluster villages concept basis in the district.

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Table 1. Details of *Kharif* onion growing under demonstrations and existing practices.

Sr. No.	Operation	Existing/ farmers' practice	Improve practice demonstrated
1	Variety used	Use of local/own seeds	Bhima Super, an improved variety from DOGR, recommended for *kharif* season.
2	Seed treatment	No seed treatment	Seed treatment with *Trichoderma* @ 10 g/ kg.
3	Nursery Rising	Flat bed or direct seed sowing without shade	Raised bed (3 m x 1 m size, raised up to 20- 25 cm.) covered with green shade net
4	Method of sowing	Broadcasting	Line sowing
5	Fertilizer application	Imbalanced application of fertilizer FYM,10 t/ha N:P:K @ 60:30:00 kg/ ha	Application of recommended dose of fertilizers along with foliar spray of micronutrients
6	Sucking pest management	Non-adoption of IPM practices	Adoption of integrated pest and disease management as recommended in Package of Practice

MATERIALS AND METHODS

The soil samples of selected farmers' fields were analyzed and based on the results, improved agronomic practices *viz.,* recommended quantity of manures (FYM-25t/ha) and correct dosage of fertilizers (125:75:125 kg NPK/ha) were demonstrated. Soil application of farm yard manure (FYM) enriched with *Trichoderma viridae* was demonstrated to combat soil borne diseases. For the purpose of FLD's, a high yielding onion variety Bhima Super was introduced to the selected farmers in the district. Bhima Super which is a new red onion variety with big bulb size developed by Directorate of Onion and Garlic Research, Rajgurunagar, Maharashtra which has been identified for release for *kharif* season in Chhattisgarh, Delhi, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan and Tamil Nadu. Normally farmers grew local onion varieties and the same varieties were used as check during front line demonstrations. To supplement micro nutrients, foliar sprays of vegetable special developed by IIHR, Bengaluru @ 4 g/l of water was demonstrated. For every 20 liters of water 80 g of vegetable special + one lemon juice + 1 sachet shampoo were mixed and sprays were taken. As part of integrated pest management practices, yellow and blue sticky traps @ 25 per hectare were erected (farmer share) for monitoring thrips and aphids infestation.

Front line Demonstration were conducted for consecutive 3 years during *kharif* season from 2018-19 to 2020-21 at Bagalkot, Bilagi, Hunagund and Badami clusters to assess the performance of Bhima Super over local variety. In order to reach more number of onion growers to disseminate improved technologies, the farmers of these area were provided with scientific knowledge about crop cultivation and processing through on and off campus training, method demonstration, field visits and exhibitions as part of capacity building activities.

Before conducting the demonstrations, training to the framers of respective villages was imparted with respect to envisaged technology interventions, site selection, farmer's selection, layout of demonstration, and farmer's participation etc. were followed. The data were carefully recorded regarding plant characters, pest and diseases incidence, yield, production cost and returns were collected with frequent field visits from demonstration fields and farmers' practice

Table 2. Impact of improved production technology on plant growth, pest and disease parameters of Onion variety Bhima Super.

Crop	Demonstration (Onion-Bhima Super)				Check (Farmers practice)			
Parameter	2018-2019	2019-2020	2020-2021	Average	2018-2019	2019-2020	2020-2021	Average
No. of leaves at grand growth	8.10	9.20	8.40	8.53	6.76	7.40	7.60	7.25
S.Em±	0.86	0.94	0.95	-	0.24	0.34	0.28	-
CD (0.05)	2.65	2.90	2.93		0.75	0.94	0.87	
Thrips/ plant(no.)	12.24	14.58	13.52	13.5	13.76	19.86	17.46	17.0
S.Em±	0.59	0.72	0.57	-	0.45	0.69	0.74	-
CD (0.05)	1.80	2.23	1.78		1.39	2.13	2.29	
PDI (%) for Purple blotch	28.5	22.2	21.0	23.90	35.1	28.6	24.0	29.23
S.Em±	1.01	0.83	0.65	-	0.88	0.45	0.52	-
CD (0.05)	3.10	2.58	2.01		2.72	1.40	1.62	
Bulb rotting (%)	3.2	18.5	5.1	11.80	6.8	37.4	6.3	21.85
S.Em±	0.42	0.61	0.21	-	0.22	1.13	0.28	-
CD (0.05)	1.26	1.90	0.64		0.68	3.48	0.88	
Bulb weight (g)	116	136.3	128.5	126.93	127.8	122.6	115.3	121.90
S.Em±	0.82	2.24	0.96	-	0.70	0.71	1.01	-
CD (0.05)	2.54	6.90	2.95		2.18	2.20	3.08	

fields (control) and finally extension gap, technology gap and technology index were calculated as given by (Singh and Sharma, 2017).

RESULTS AND DISCUSSION

The results of the pooled data for three years (2018-19, 2019-2020 and 2020-21) were given in Table 2. The bulb rotting and purple blotch incidence was expressed in percentage and thrips damage by number of insects per plant. It was observed that in Bhima super , average bulb rotting incidence was low (11.8%) compared to local check (21.8%), average thrips incidence was also low in Bhima super (13.5 thrips no./plant) than in local check (19.90 thrips no./plant). There

Table 2. Impact of improved production technology on plant growth, pest and disease parameters of Onion variety Bhima Super.

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No. of leaves at grand growth	8.10	9.20	8.40	8.53	6.76	7.40	7.60	7.25
S.Em±	0.86	0.94	0.95	-	0.24	0.34	0.28	-
CD (0.05)	2.65	2.90	2.93		0.75	0.94	0.87	
Thrips/ plant(no.)	12.24	14.58	13.52	13.5	13.76	19.86	17.46	17.0
S.Em±	0.59	0.72	0.57	-	0.45	0.69	0.74	-
CD (0.05)	1.80	2.23	1.78		1.39	2.13	2.29	
PDI (%) for Purple blotch	28.5	22.2	21.0	23.90	35.1	28.6	24.0	29.23
S.Em±	1.01	0.83	0.65	-	0.88	0.45	0.52	-
CD (0.05)	3.10	2.58	2.01		2.72	1.40	1.62	
Bulb rotting (%)	3.2	18.5	5.1	11.80	6.8	37.4	6.3	21.85
S.Em±	0.42	0.61	0.21	-	0.22	1.13	0.28	-
CD (0.05)	1.26	1.90	0.64		0.68	3.48	0.88	
Bulb weight (g)	116	136.3	128.5	126.93	127.8	122.6	115.3	121.90
S.Em±	0.82	2.24	0.96	-	0.70	0.71	1.01	-
CD (0.05)	2.54	6.90	2.95		2.18	2.20	3.08	

was less incidence of purple blotch disease (21.9%) but disease incidence was high in local variety (29.23%). These results were in line with the findings of Chaudary *et al* (2021) in *kharif* onion.

It was evident that under the demonstrations, performance of *Kharif* onion was sustainable higher than that in the farmer's practices (local check) during three years of the study. The data (Table 3) revealed that, monetary returns were directly influenced by the market price of onion bulbs and cost of production during the successive years of demonstrations. During all the years of demonstrations, the increased gross monetary return, net monetary returns and benefit: cost ration were obtained in the demonstrated technology over local check of farmers. The variety Bhima super variety recorded average yield of 19.56 t/ha with net return of Rs. 93266/ha as compared to farmers practice, which produced average yield of 16.23 t/ha with net return of Rs. 60958/-ha. Hence, the average benefit cost ratio was high in Bhima Super onion (3.12) compared to local variety (2.35). The higher average onion yield in demonstration fields compared to farmer's field was due to superior varietal characters of Bhima Super and integrated crop management practices. These results were in line with the findings of Hiremath *et al* (2012), Hirave *et al* (2015), Meena *et al* (2016), Dubey *et al* (2019), and Bhoi *et al* (2020), Chaudary *et al* (2021) in

Table 3. Impact of improved production technology on yield and economics of Onion variety Bhima Super.

Crop	Demonstration (Onion-Bhima Super)				Check (Farmers practice)			
Parameter	2018-2019	2019-2020	2020-2021	Average	2018-2019	2019-2020	2020-2021	Average
Yield (t/ha)	18.5	20.3	19.90	19.56	15.6	17.8	15.28	16.23
% increase	15.67	12.31	30.23	19.40	-	-	-	-
Cost of Cultivation	32900	31250	59500	41216.67	33975	31250	59500	41575
Gross Income (Rs/ha)	116550	68000	218900	134483.33	82530	56960	168080	102523.3
Net Income (Rs/ha)	83650	36750	159400	93266.67	48555	25740	108580	60958.33
Benefit Cost Ratio	3.5	2.17	3.68	3.12	2.4	1.82	2.82	2.35

Table 4. Technological gap, Extension gap and Technology Index of Onion (Bhima Super).

Year	Potential yield (t/ha)	Average yield (t/ha)		Increase in yield over farmers practice (%)	Extension Gap (t/ha)	Technology Gap (t/ha)	Technology Index (%)
		Farmers practice (Check)	Demo plot (FLD)				
2018-19	22	15.6	18.5	15.67	2.9	3.5	15.90
2019-2020	22	17.8	20.3	12.31	9.5	1.7	7.72
2020-21	22	15.28	19.9	30.23	4.62	2.4	10.90
Mean	22	16.23	19.56	19.40	5.67	2.53	11.50

kharif onion. Fluctuations in yield observed over the years were mainly on account of variation in temperature, rainfall, sowing time and pest and disease management.

Technology gap

The technology gap is the difference between the demonstration yield and potential yield. It was recorded 3.5 t/ha in the first year (2018-19) and later on decreased 1.7 t/ha and 2.4 t/ha in next two years, respectively, due to technology received from KVK scientists time to time. It was found an average 2.53 t/ha. This could be due to the lack of awareness about the improved crop management technologies of *kharif* onion. The technology gap observed might be attributing to the dissimilarity in soil fertility status and weather conditions. Therefore, variety wise location specific recommendation appears to be necessary to minimize the technology gap for yield level in different situations. Hence, to narrow down the technology gap awareness about the improved variety appears necessary to educate the farmers and seed production activities for further multiplication. These findings were similar to the findings of Hiremath and Hill (2012) in *kharif* onion.

Extension gap

The difference between demonstrated yield and yield under existing farmers practice is extension gap. It was recorded as 5.67 t//ha in this study and it should be filled by various extension methods. Information on improved practices need to be disseminated through training, awareness programmes, communication through print and electronic media, etc. extension personnel intervention to reduce this gap is required. The new technologies will eventually lead to the farmers to discontinue old verities with the new high yielding varieties. These results were in line with the findings of Ojha and Singh (2013) and Rajput *et al* (2018) in *kharif* onion.

Technology index

The technology index showed the feasibility of the evolved technology at the farmer's fields. The ratio between technology gap and potential yield expressed as percentage is technology index. It was 11.50 per cent in this study. This has increased as a result of technology gap. With adoption of improved practices the technology gap can be reduced as a result technology index also will be minimized. Similar results were also reported by Singh and Singh (2018), Ojha and Singh (2013) in *kharif* onion.

CONCLUSION

It can be concluded that improved technology reduce technology gap to a considerable extent, thus leading to increased production of *kharif* onion in Bagalkot district of Karnataka. FLD is an effective extension mean to disseminate the proven technology at village level and to bridge the extension gap that increase the crop yield, monetary returns and livelihood status of the farming community. This also improved linkages between farmers and scientists, and built confidence for adoption of the improved technology. However, the technology needs to be popularized to decrease the extension gaps, technology gap, technology index and thereby yield gap so as to increase the income of farmers. The economic details of the demonstrations give us a insight to further popularize them among the farming community for large scale adoption.

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Performance of Stionic Combination on Vegetative Growth and Flowering of Exotic Mandarin Germplasm under Sub-Tropical Plains of Punjab

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ABSTRACT

Different exotic mandarin cultivars imported from Israel and budded on various root stocks were evaluated from 2017 to 2019. Kinnow scion grafted over Rough Lemon plant reached its maximum height (3.50 m). Fairchild budded on Volkamer lemon (3.19 m) was found to be promising in terms of average plant spread. Fairchild and Michal budded over Volkamer Lemon and X 639 produced the largest plant volume (13.30 m^3). Similarly, Michal grafted on Volkamer lemon achieved the scion girth (26.8 m) and root stock girth (33.7 m). Pearl Tangelo grafted on Rough lemon produced earliest bloom initiation while there was a lot of heterogeneity among the best cultivar and root stock combinations. Daisy x Rough lemon combination proved to be the best in terms of earliest maturity with the shortest number of days from fruit set to maturity (222.3 d). Volkamer lemon and X-639 outperformed the other stionic combinations in most of the criteria, indicating that they have the potential to replace the current leader Rough lemon. Thus, it can be said that these combinations can best replace the existing Kinnow budded over Rough lemon monoculture with nearly identical features.

Key Words: Citrus, Flowering, Kinnow, Rotstock, Scion, Vegetative.

INTRODUCTION

Rootstock and scion girth is considered very important to determine the degree compatibility of stionic relationship between stock and scion. Sometime rootstock shows incompatibility with scion leading to unbalancing in physiological functions, plant vigor, productivity as well as fruit quality. The information about the behaviour of a scion cultivar on a particular rootstock in terms of vigour and other characters cannot be extended to other cultivars as these rootstocks behave differently with different scions and with same scion under varying soil and climatic conditions. The majority of the harvest is made up of citrus fruits such mandarins, sweet oranges, lime, lemons, and grapefruits. Sweet oranges account for 61.18 percent of the crop, mandarins for 22.12 percent, lime and lemons for 11.4 percent, and grapefruit and other citrus fruits for the remaining 5.5 percent. With an annual citrus production of 146.8 Mmt, there are roughly 140 major citrus-producing nations worldwide. India, with a production of 13.20 Mmt ranks in third (Annonymous,2019) and provides 8.99 percent of the world's citrus production from 0.43 million ha of land with a yield of 12.31 MT per hectare. States like Punjab, Haryana, and Rajasthan have experienced substantial growth in the citrus sector. The overall area under fruit crops in Punjab is over 66.0 per cent, while citrus has 57288 ha, of which more than 92.59 percent is under Kinnow mandarin, a hybrid of C. Nobilis and C. deliciosa.

Due to the genetic pool being reduced due to this type's dominance in citrus, disease and pest outbreaks are a potential problem. Citrus fruit supply is short-lived due to the late maturing cultivar (Kinnow). Similar to how there is an oversupply on the market due to the monoculture

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of this particular citrus type. It has been demonstrated that root stocks have a significant impact on tree growth output and fruiting quality (Hussain *et al,* 2013). Citrus cultivars imported from other countries may exhibit differences in vegetative and fruit characteristics due to differences in soil and climate. As a result, these experiments were conducted to assess the effects of exotic cultivars on several root stocks that could perform well in the Punjab subtropics.

MATERIALS AND METHODS

Location of experiment and plant material

The current research was conducted between 2017 and 2019 in the Centre of Excellence for Fruits (Citrus), hamlet Khanaura, District Hoshiarpur (Punjab), which is located at 31.4041550 (31024'15.0"N) and 75.83505650 (75050'06.2"E). Eight exotic cultivars (Daisy, Michal, Murcott, Fairchild, Fremont, Pearl Tangelo, W Murcott, and Kinnow) were budded on four different rootstocks (Volkamer Lemon, Rangpur Lime, X-639, and Rough Lemon) and compared to the local commercial variety Kinnow for vegetative growth, flowering, and fruiting behaviour.

Layout of experiment

The experiment was set up in a randomised block design (RBD), with four plants chosen for each treatment and planted in September/October 2014 on raised beds with a height of 1.5 feet and a width of 6 feet, with a gap between row and plant of 6 and 3 metre, respectively, and drip irrigation. There were 32 stionic combinations in total, with three replications each including four plants. A total of 384 plants were tested during the study.

Observations recorded

Plant height (measured with a measuring pole from the ground up to the highest point of growth) and plant spread N-S and E-W were measured with a measuring tape and stated in metre. Using the following formula, the average plant sprea

d was obtained by combining both:

$$\text{Average plant spread} = \frac{\text{Plant spread in N-S} + \text{Plant spread in E-W}}{2}$$

To record plant volume, the plant was considered to be one half of a prolate spheroid, and the volume was computed using the formula:

$$\text{Plant volume} = \frac{0.524 \times \text{height} \times \text{spread}}{2}$$

Scion girth was measured 20 cm above the grafting union using Mitutoyo Inc.'s Digital Vernier Caliper. The same tool was used to measure rootstock girth 20 cm below the grafting union. Bloom initiation (the moment when roughly 5-10 percent of the flower opened) and the date was recorded during the flowering stage. When more than 80-90 percent of the flowers had opened and 75-80 percent anthesis had occurred, observatioin was recorded. In turn, a period of full bloom was seen when more than 75% of the flowers had anthesis. Only 5% of buds were left to open at the end of the flowering cycle and 95% of flowers were shed. Fruit set (when 95 % flowers shed and turned into berries) and days to maturity (when 80-95 percent of fruits have reached the right size and appealing colour) were both recorded.

RESULTS AND DISCUSSION

Plant height (m)

Among various scion cultivars the maximum height (3.13 m) was observed in Kinnow which was at par with Michal followed by Pearl Tangelo (2.60 m) and Fairchild (2.50 m). However, the minimum plant height (2.10 m) was recorded in cultivar Fremont. For all these cultivars Volkamer lemon was used as rootstock (Table 1). Kinnow budded on Rangpur lime (rootstock) attained a height of only 3.00m and was found at par with Fremont and Fairchild followed by Daisy (2.45 m), Michal (2.35 m), and Pearl Tangelo (2.30 m). On the contrary, when different exotic citrus cultivars were budded on X-639 (rootstock), maximum plant height was noted in Michal (2.73 m) and found at par with Fairchild, and Kinnow, significantly followed by Pearl Tangelo (2.76 m). In case of Rough lemon

(rootstock), maximum plant height was recorded in Kinnow tree (3.50 m) followed by Daisy (2.60 m), Michal, and Freemont. The increase in plant height may be due to better compatibility between scion and rootstock (Singh *et al*, 2019). Present findings were corroborated with the results of (Ahmed *et al,* 2006) who claimed better plant height in case Kinnow mandarin budded on Rough lemon rootstock followed by Volkamer lemon as compared to other rootstocks like Citrumelo 4475 and Brazilian sour orange. Maximum plant height in Kinnow plants grafted on Rough lemon followed by Kinnow stock was also reported (Nasir *et al,* 2011).

Average plant spread (m)

The data about plant spread disclosed that maximum spread was recorded in cv. Fairchild budded on Volkamer lemon (3.19 m) which was at par Pearl Tangelo followed by Michal (2.92 m), Kinnow (2.91 m) along with Murcott (2.86 m). On the other hand, when Rangpur lime was used as rootstock, the maximum spread was noted in Kinnow (2.78 m) and was at par with Pearl Tangelo (2.62 m) along with Fairchild (2.52 m) followed by Daisy and W Murcott (2.44 m and 2.41 m, respectively). The least plant spread was documented in Murcott (1.64 m). Use of X-639 as rootstock revealed that spread was the highest in the case of Michal cultivar (2.95 m) and was at par with Fairchild and Pearl Tangelo (2.77 m) followed by Daisy and Fremont cultivars. The lowest values were observed in W Murcott cv. where it was only 2.17 m. In the case of Rough lemon (rootstock) highest values were obtained in the case Fairchid (2.77 m), at par with Daisy and Murcott, followed by W Murcott (2.40 m), at par with other citrus cultivars *viz*., Pearl Tangelo (2.39 m) and W. Murcott (2.40 m). The cultivars like Kinnow, Fairchild, and Fremont also gained promising plant spread in the N-S direction (Josan and Kaur, 2006). Better plant spread in Rangpur lime and Volkamer lemon rootstocks resulted when budded over with Oneco mandarin (Gonzatto *et al,* 2011)

Plant volume (m^3)

A significant variation was revealed in plant volume (Table 1). Maximum plant volume (14.69 m^3) was recorded in Kinnow followed by cv. Michal (12.50 m^3), which was at par with cv. Fairchild and Murcott. Significant lowest plant volume was recorded in case of Freemont when budded on Volkamer lemon. However, Kinnow exhibited the highest values (12.6 m^3) when budded over Rangpur lime rootstock followed by Fairchild (9.0 m^3). When all these cultivars were budded over X-639 (rootstock), significant results were obtained. The highest values were recorded in the case of Michal (13.3 m^3) followed by Pearl Tangelo. While budding on Rough lemon, best results were observed in Kinnow to the tune of 11.7 m^3, followed by Fairchild and Daisy cultivars. The results of the present investigations were corroborated with the observations where it was found maximum canopy volume in Sour orange followed by Rough lemon and Volkamer lemon while reviewing Nova mandarin on eleven rootstocks in Cyprus (Georgiou, 2010). A better canopy volume in Oneco mandarin budded on Caipira orange followed by Swingle citrumelo, Troyer citrange, Volkamer lemon, and Rangpur lime whereas, minimum in Flying Dragon trifoliate orange rootstock (Josan and Kaur, 2006; Gonzatto *et al,* 2011).

Scion girth (cm)

The data (Table 2) significantly divulged the differences in scion girth of budded cultivars over rootstocks. When Michal was budded over Volkamer lemon rootstock, the scion girth had exhibited the highest value of 26.8 cm followed by W Murcott (24.3 cm). It was interesting to note that Kinnow had a scion girth of 20.9 cm. But when Rangpur lime was used as rootstock maximum girth was noted in the case of the Kinnow cultivar to the tune of 21.0 cm. This value was at par with Michal, Freemont, and Fairchild (19.6, 19.5, and 19.0, respectively). While in another experiment, Pearl Tangelo (19.9) showed the highest values for the same when budded on X-639 followed by W Murcott but Kinnow displayed less value (18.9 cm) for the same. Rough lemon proved to be the best rootstock for Michal (22.5 cm) while at par with Murcott, trailed by Pearl Tangelo with 19.3 cm. In

a related study , Rough lemon and Vlokamer lemon had the greatest increases in scion girth (Ahmed *et al,* 2006). Additionally, Olinda Valencia budded at its highest scion girth on Benton rootstock, while Hamlin budded at its lowest scion girth on Benton rootstock research (Chahal and Gill, 2015)). Similarly, it has been reported that several rootstocks had displayed varied growth response on the diverse scion kinds, which may have occurred due to the rootstocks' innate genetic potential (Singh *et al,* 2018)).

Rootstock girth (cm)

Various mandarin cultivars did not significantly affect the rootstock circumference of the plant (Table 2). However, maximum rootstock girth was recorded in Michal (33.7) followed by W Murcott (31.9 cm) when budded over Volkamer lemon rootstock. The least girth was recorded in the case of Freemont to the tune of 27.2 cm. Similarly, rootstock girth was not affected significantly by any cultivar used in the study. But when Rangpur lime was used as rootstock, cv. Kinnow and Michal showed maximum value for stock girth (24.8) while Daisy was next to it (23.9 cm). Results were non-significant in the case of X-639 and Rough Lemon (both rootstocks) budded with different cultivars, during study. It was interesting to note that Kinnow exhibited improved performance regarding rootstock girth while using Rough lemon rootstock. In a similar experiment, maximum rootstock girth increment in Rough lemon followed by Volkamer lemon (Ahmed *et al,* 2006). The findings also demonstrated the variance in growth response of the rootstocks which might be due to the inherent genetic potential (Singh *et al,* 2018). They concluded that Rangpur lime trailed by rough lemon exhibited its dominance concerning spread tree volume of Sathgudi sweet orange upon other rootstocks, demonstrating their well-adapted nature to soil circumstances with good root system that might lead to higher buildup of nutrients. Similar in the case of sweet orange on various rootstocks (Yildiz *et al,* 2013; Ghosh *et al*, 2012).

Flowering and Fruit setting parameters

Several variations had been noted in different cultivars and rootstocks under investigation concerning flower initiation, flower duration, days required for fruit set, and maturity (February –March). Although the flowering was limited to these two months, variability has been seen concerning the time.

Date of flower initiation

The data concerning the date of flower initiation of different mandarin cultivars and rootstocks are presented in table3. The date of flower initiation varied between 4th February to 7th March among different cultivars of mandarin and different rootstocks used. The earliest flower commencement was seen in Pearl Tangelo (9th Feb) followed by Fremont (14thFeb) when budded over Volkamer Lemon rootstock. In case of Pearl Tangelo budded over Rangpur lime (rootstock) flower initiation occurred by 5th Feb while in cultivar Kinnow, it was by 1st March. Similarly, Pearl Tangelo budded over rootstock X-639 showed flower initiation by 6th Feb while Kinnow showed late flowering initiation (2ndMar). Pearl Tangelo budded over Rangpur lime and had initiated flowering by 4th Feb. Kinnow mandarin budded on different rootstock did not show much variation in commencement of flowering (13). An early start of flowering on 11th March in Pink Pummelo and late on 17th March in NRCC Pummelo 4 (14). However, Kinnow had shown early flowering by 13th March in all eight rootstocks expect the latest by 14th March in NRCC-1 and NRCC-5 rootstocks. Rattanpal *et al* (2019) also reported variation in the initiation of flowering, where earliest flowering commenced on 15th February in Schaub and Chase whereas, late flower initiation was on 26th March in Florida both rough lemon strains.

Flower duration

The data regarding different flower-related activities revealed that Freemont exhibited a flowering duration of 34 d when budded over Volkamer lemon rootstock. This was significantly followed by Fairchild (33.0 d). The least days were taken by Daisy cultivar to the tune of 18 d. While in Kinnow cultivar this duration was recorded only 27 d. Similarly, in another experiment, Rangpur lime was used as rootstock, cultivar W Murcott showed the longest flower

Table 1. Plant height, plant spread and plant volume of various scion cvs. of mandarin budded over different rootstocks.

Cultivar	Name of Root stock											
	Volkamer Lemon			Rangpur Lime			X-639			Rough Lemon		
	Plant Height	Plant Spread	Plant Volume	Plant Height	Plant Spread	Plant Volume	Plant Height	Plant Spread	Plant Volume	Plant Height	Plant Spread	Plant Volume
Daisy	2.40	2.59	8.40^{c}	2.45^{b}	2.44	7.7^{c}	2.45^{b}	2.59	9.4^{c}	2.60^{b}	2.68	9.8^{b}
Michal	2.80^{a}	2.92	12.50^{b}	2.35^{b}	2.34	7.0^{c}	2.73^{a}	2.95	13.3^{a}	2.55^{b}	2.26	6.8^{c}
Murcott	2.53	2.86	10.80^{b}	1.80	1.64	2.7	2.10^{c}	2.33	6.5	2.10^{c}	2.60	7.5^{c}
Fairchild	2.50^{c}	3.19	13.30^{a}	2.50^{a}	2.57	9.0^{b}	2.19^{c}	2.77	9.6^{c}	2.45^{b}	2.77	9.8^{b}
Fremont	2.10	2.24	5.50^{c}	2.60^{a}	1.80	4.6^{c}	2.50^{b}	2.56	9.3^{c}	1.85^{c}	2.26	4.90
Pearl Tangelo	2.60^{b}	3.09	13.00^{a}	2.30^{b}	2.62	8.6^{b}	2.60^{a}	2.77	11.3^{b}	2.18^{c}	2.39	6.50^{c}
W Murcott	2.55	2.63	9.20^{c}	2.28^{c}	2.41	7.2^{c}	2.05^{c}	2.17	5.8	2.29^{b}	2.40	6.9^{c}
Kinnow	3.13^{a}	2.91	14.6^{a}	3.00^{a}	2.78	12.6^{a}	2.68^{a}	2.38	8.6^{c}	3.50^{a}	2.52	11.7^{a}
C.D. ($p \geq 0.05$) Interaction	0.38	0.17	1.79									

Table 2. Scion girth, stock girth and stock/scion ratio of various scion cvs. of mandarin budded over diff. rootstocks.

Cultivars	Name of Root stock											
	Volkamer Lemon			Rangpur Lime			X-639			Rough Lemon		
	Scion girth	Rootstock girth	Stock/Scion ratio	Scion girth	Rootstock girth	Stock/Scion ratio	Scion girth	Rootstock girth	Stock/ Scion ratio	Scion girth	Rootstock girth	Stock/ Scion ratio
Daisy	21.1^{b}	28.8	1.4	18.8^{a}	23.9	1.3	18.6^{a}	21.5	1.2	19.9^{b}	25.7	1.3
Michal	26.8^{a}	33.7	1.3	19.6^{a}	24.8	1.3	21.6^{a}	27.5	1.3	22.5^{a}	29.5	1.3
Murcott	21.2^{b}	31.2	1.5	18.0^{b}	21.3	1.2	18.7^{a}	21.1	1.1	20.6^{a}	25.6	1.3
Fairchild	19.8^{c}	30.3	1.5	19.0^{a}	21.2	1.1	19.9^{a}	21.7	1.1	18.9^{c}	24.3	1.3
Fremont	21.1^{b}	27.2	1.3	19.5^{a}	21.4	1.1	19.5^{a}	25.2	1.3	20.7^{a}	28.6	1.4
Pearl Tangelo	21.8	27.4	1.3	18.2^{b}	22.4	1.2	19.9^{a}	23.8	1.2	19.3^{b}	26.6	1.4
W Murcott	24.3^{b}	31.9	1.3	19.5^{a}	23.9	1.3	19.8^{a}	26.0	1.3	17.9^{c}	25.2	1.4
Kinnow	20.9^{b}	28.6	1.4	21.0a	24.8	1.2	18.9^{a}	25.5	1.3	21.4^{a}	30.4	1.4
C.D. ($p \geq 0.05$) Interaction	2.3	NS	NS									

duration (28 d) whereas it was at par with Fremont. It was significantly followed next to Pearl Tangelo (26 d). Minimum flower duration was noted in the case of Daisy (19 d). W Murcott showed 31 d when budded over X-639 rootstock which is significantly followed by other cultivars under investigation viz. Fairchild, Fremont and Pearl Tangelo. Minimum days were recorded in the case of Michal (22 d). In the case of Michal, budded over Rough lemon showed the significantly highest duration (36 d) was followed by other cultivars like W Murcott, Pearl Tangelo, and Murcott (each with 33, 33, and 34, respectively) whereas, Daisy recorded the least flower duration of 22 d. A study also reported variation concerning flower initiation to cessation (18 to 25 d) in different Pummelo cultivars under subtropics of Punjab (Baswal *et al,* 2018). Whereas, flowering duration varied from 14 to 28 d in seventeen rough lemon strains under sub-tropical conditions of Punjab (15).

Days required for fruit set

The data revealed the days required for the fruit set. A non-significant results were recorded in case of various rootstocks, during the course of study. However, Pearl Tangelo took the least days (6 d) for the fruit set. Next to it, Murcott (7 d) while in Kinnow it was observed as 8 d when budded over Volkamer lemon (rootstock). Likewise, when

Table 3. Flower initiation (particular point of time) of various scion cvs. of mandarin budded over different rootstocks

Cultivar	Name of Root stock			
	Volkamer Lemon	Rangpur Lime	X-639	Rough Lemon
	Flower initiation	Flower initiation	Flower initiation	Flower initiation
Daisy	7th March	26thFeb	25th Feb	20th Feb
Michal	24th Feb	24th Feb	19th Feb	19th Feb
Murcott	25th Feb	23rd Feb	23rd Feb	17th Feb
Fairchild	18th Feb	22nd Feb	19th Feb	17th Feb
Fremont	14th Feb	17th Feb	17th Feb	9th Feb
Pearl Tangelo	9th Feb	5th Feb	6th Feb	4th Feb
W/Murcott	22nd Feb	21st Feb	23rd Feb	18th Feb
Kinnow	1st March	1st March	2ndMarch	26th Feb

Table 4. Flower duration, days required for fruit setting and setting to maturity of various scion cvs. of mandarin budded over different rootstocks

Cultivars	Name of Root stock											
	Volkamer Lemon			Rangpur Lime			X-639			Rough Lemon		
	Flower duration (d)	Fruit setting (d)	Setting to maturity (d)	Flower duration (d)	Fruit setting (d)	Setting to maturity (d)	Flower duration (d)	Fruit setting (d)	Setting to maturity (d)	Flower duration (d)	Fruit setting (d)	Setting to maturity (d)
Daisy	18.0	8.00	225.3	19.0	9.00	235.3	24.0c	10.0	232.7	22.0	7.00	222.3
Michal	26.0	10.0	260.3	25.0[c]	8.00	267.7	22.0	14.0	275.7	36.0[a]	7.30	253.7
Murcott	27.0	7.00	319.7	25.0[c]	9.30	321.7	26.0[b]	12.0	330.3	33.0[b]	8.30	317.7
Fairchild	33.0[b]	12.0	269.3	25.0[c]	9.00	278.0	27.0[b]	7.30	283.0	32.0[c]	8.00	271.3
Fremont	34.0[a]	10.0	281.7	28.0[a]	10.0	294.7	27.0[b]	9.00	304.7	31.0	10.0	284.3
Pearl Tangelo	29.0	6.00	333.3	26.0[b]	6.00	340.7	27.0[b]	7.30	346.7	34.0[b]	8.30	327.7
W Murcott	31.0[c]	8.00	327.0	28.0[a]	9.00	325.3	31.0[a]	9.00	332.3	33.0[b]	9.30	318.3
Kinnow	27.0	8.00	310.3	25.0[c]	9.00	316.0	24.0[c]	5.00	323.3	26.0	12.0	313.0
C.D. (p≥0.05) Interaction	1.40	NS	NS									

Rangpur lime was used as rootstock, minimum days were noted in the case of Pearl Tangelo (6 d) followed by Michal (8 d). However, the highest number of days were recorded in Michal (14 d), and minimum days in Kinnow (5 d) budded over X-639. Days were maximum in the case of Kinnow (12 d, longest time) when budded over Rough lemon while time was least in Daisy (7 d), followed by Michal (7.30 d). Overall, Daisy took minimum days in fruit setting.

Days taken for fruit maturity

Among various rootstocks, significant differences were seen regarding the number of days taken from fruit set to maturity. When Daisy cultivar was budded over Volkamer lemon rootstock showed that minimum days (225.3 d) for fruit maturity followed by Michal. At the same time when Rangpur lime was budded over with the same cultivar (Daisy), it exhibited a minimum

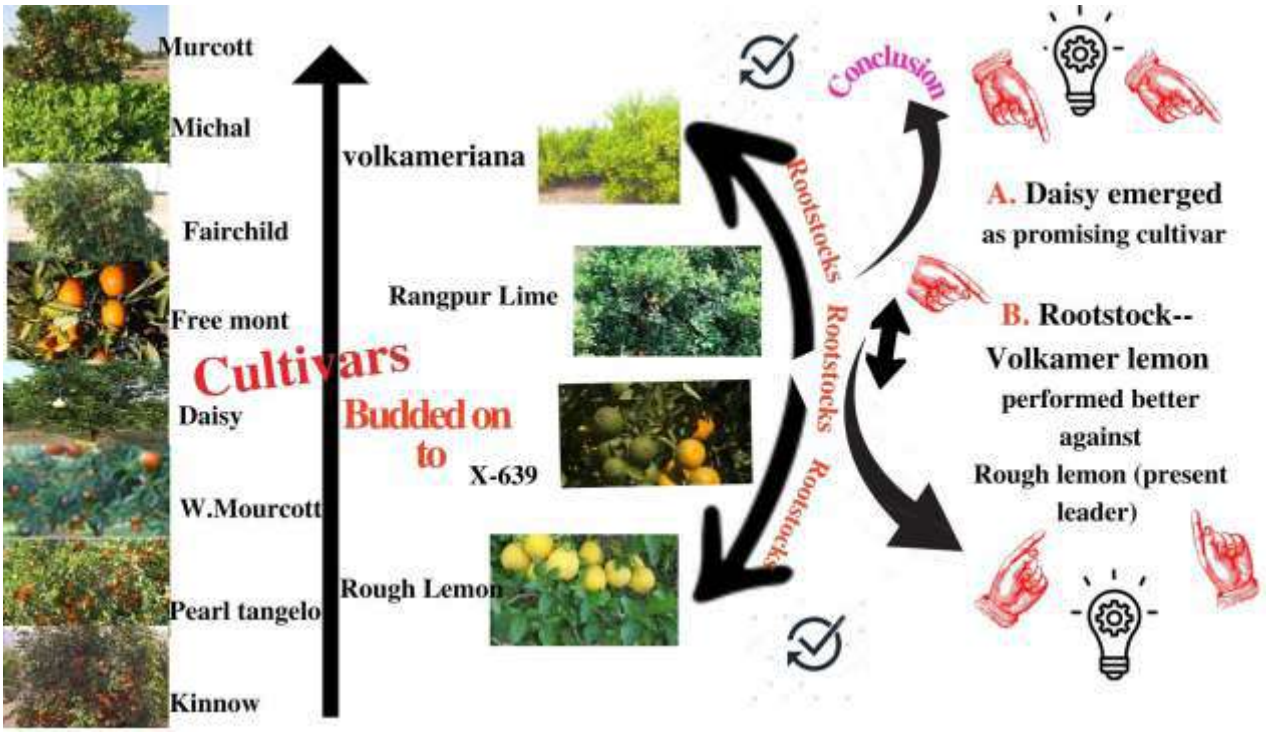

Fig 1. Summary and conclusion of research experiment

number of days for fruit maturity *i.e.,* 235.3 while it was followed by Michal (267.7 d). But this cultivar took the least number of days for fruit maturity when budded over X-639 and Rough lemon rootstock (232.7 and 222.3 d, respectively). A study assessed performance of Fremont mandarin on different rootstocks under Indian conditions and revealed that fruit maturity of Fremont was earliest on Pectinifera rootstock, while it was deferred on other rootstocks like Rough lemon and Karna khatta (16).

CONCLUSO N

It was concluded that for vegetative, blooming, and fruit setting behavior, Daisy, Murcott, and W Murcott emerged as promising cultivars for the climatic conditions of Punjab and may be utilized as an alternative to Kinnow mandarin and to break monoculture in the future. Volkamer lemon and X-639 performed best among rootstocks and can replace the existing rootstock, Rough lemon. Above all, there was a lot of variation in the pairings of cultivars and rootstocks. Daisy and Murcott cultivars budded on Volkamer lemon rootstock, followed by X-639 rootstock, produced the best stionic combinations (Fig 1). These combinations have the potential to replace the existing Kinnow and Rough lemon monoculture. This included study on evaluating the performance of other systems. This envisages research on evaluating the performance of other citrus species to diversify varietal wealth along with increasing productivity, variety diversity for fruit maturity, and quality etc. will be the crucial concerns of variety improvement and breeding in the future. Many potential exotic citrus species/varieties have been introduced in India and some of them have been well adapted, having good potential to be cultivated on a larger scale. But initial screening, characterization of germplasm, evaluation, and potential against biotic and abiotic stresses for future utilization for improvement is recommended.

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Physico-chemical Analytic Comparison between Normal Compost, Swift Compost and PSN Compost at Lawngtlai district, Mizoram

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ABSTRACT

The present study was taken to compare the physical and chemical characteristics of three composts namely normal compost, swift compost and Phospho-sulpho-nitro (PSN) enriched compost during *Rabi* of 2023 at Krishi Vigyan Kendra Research farm, Lawngtlai district, Mizoram. The treatments consisted of T_0 Control (normal compost), T_1 (Swift compost) and T_3 (PSN enriched compost). The design followed was RBD and replicated thrice. The result revealed that there is no much physical difference among the three composting processes, however, the nutrients nitrogen and phosphorus content in PSN enriched compost was significantly higher than the other treatments with least CN ratio. Therefore, enriching compost by following Phospho-Sulpho-Nitro composting method could be recommended for farmer's practice.

Key Words: Cow dung, Mineral, Pit, *Pseudomonas*, *Trichoderma*

INTRODUCTION

Composting in India started under Sir Albert Howard's Indore method of composting, sparking interest among agriculturists to come up with improved method thereafter. The main focus of the composting processes has also since gradually shifted to quick multi-nutrient enriched methods as compared to old methods of composting which focused on aerobic of anaerobic decomposition with passive aeration accompanied with infrequent and little turning (Bordoloi *et al,* 2020). Multi nutrient fortification to obtain highly nutritional superior compost is the main goal of today's compost, producing superior quality compost.

In order for plants to thrive and produce good yield, they should have effective access to multiple nutrients and micronutrients from the available pool of nutrients in the soil. These essential elements can be grouped into primary (NPK), secondary (Ca, Mg, S) and micro-nutrients (Cl, Fe, B, Mn, Zn, Cu, Ni and Mo). These nutrients have been heavily supplemented through chemical fertilizers, however application in large quantity alone does not guarantee adequacy for the crops. Instead they could be present in large amount in the soil, leading to unwanted residual effect in the long run disrupting soil equilibrium (Sanchez *et al,* 2017). There should exist a balanced chemical, physical and biological activity in the soil. Soil microbes play a pivotal role in nutrient transformation and assimilation by crops. A fertile soil is a soil rich in soil microbes. Compost provides an ideal environment for the optimum activity of effective microbes. It also supply all the elements required for a fertile soil, a healthy crop, in the right proportion although may not be adequate.

Compost have the capability to improve soil aggregates, increases the water holding capacity for soil, acts as natural reservoirs of essential nutrients and micro nutrients, produces organic acids that help in making or transforming unavailable form of nutrients such as potassium, phosphorus and micro nutrients in the soil to available form. Compost serves as source of energy and home for soil microbes and small

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animals like earthworms and ants which facilitate soil friability. Enriching the compost by incorporating not only multiple nutrients but also through addition of bacteria and other beneficial micro-organism is an important strategy to enhance the nutrient supplying capacity of the compost to crops.

The microorganism are shown to be involved in the transformation of organic matter substrates to inorganic compounds through mineralization and solubilization processes. Inoculation of *Trichoderma* and *Pseudomonas* in compost and its application has shown to significantly increase fruit weight (40%) and increase fruit per meter square (22%) in strawberry yield (Huasasquiche *et al* 2024). Similar findings has also been reported in wheat crop by Kumar and Mahapatra (2014). Bellini *et al* (2023) also reported that using *Trichoderma* statistically reduced disease severity caused by Fusarium wilt from 50 to 70% on lettuce.

So, it is important that we supplement the compost using minerals and beneficial microbes to contain proper proportion of the essential nutrient in the compost. Several reports under ICAR co-ordinated research projects have shown that enriched compost meets nutrient requirement of various crops and the cost incurred for fertilizers has markedly reduced, making compost partially able to replace conventional chemical fertilizers. Keeping this in view, the present research has been undertaken to compare Normal compost, Swift compost and PSN enriched compost in Lawngtlai district.

MATERIALS AND METHODS

The study was conducted at Compost Demonstration unit at Krishi Vigyan Kendra Lawngtlai district, Mizoram during rabi 2023. Swift compost was prepared using cow dung as sole substrate without incorporation of any other substrate to the compost. A pit of 10 x 3 x 2.5 ft was dug which can accommodate approximately 0.5 MT of cow dung. The pit was filled with fresh cow dung until the pit is full at day 1, then a mixture of 250 ml of *Trichoderma spp* mixed with 40 liters of water is sprinkled and mixed well with the cow dung and was left covered for four days. On the fourth day a mixture of 250ml of *Pseudomonas spp* mixed with 25 liters of water was incorporated to the compost pit and was again covered undisturbed for four days. The above steps were repeated on the 8th and 12th day respectively. On the 15th day the silpauline cover was removed and the compost pit was properly turned. This was followed with proper turning and mixing on day 19th. The top 15cm was collected and dried on alternate days since day 21 until it reach day 30 where the entire compost from the pit was collected and dried. These collected and partially dried compost were sprayed with NPK capsule dissolved in 15 liters of water. The finished compost was allowed to shade dry maintaining moisture of 20-25 % and sieved and stored for future use.

Phospho-sulpho-nitro (PSN) enriched compost was prepared by mixing commonly found weed substrate with dry biomass from crop residue. A pit of 10 x 3 x 2.5 ft was dug, this can fit approximately 300 kg of mixed substrate. The base and side of the pit was plastered with mixture of cow dung: soil: compost (1:1:0.5) slurry. The compost was enriched using mineral additives such as Nitrogen @0.5% as urea, phosphorus @1.5% as DAP and Sulphur @0.5% as elemental sulphur. Care was taken to properly fill the pit with the right amount of substrate to bring the CN ratio to optimum level. About 20cm thick substrate was filled at the base of the pit, followed by uniform spreading of the mineral mix and sprinkled with cow dung slurry. Pit was properly filled and moistened approximately 70 %. The top of the pit is plastered using the slurry to prevent water to seep through as well as to increase temperature inside the pit. The pit was opened and turned every 20 days interval for best and fast compost process and then plastered again with the slurry till 100days. The finished compost was collected and dried under shade, it was then sieved through 1 inch mesh and stored in a cool dry place for analysis and further use.

Normal compost was prepared using substrates that are easily available on the farm like weeds and crop residue incorporated with saw dust as carbon source, followed by thin layer of finished compost to hasten the composting

process. Proper layering of substrates was established. The compost layers were sufficiently moistened with water so that microbial decomposition could progress quickly. It took two months for the compost to mature and complete.

The data had been statistically analyzed using ANOVA under randomized block design using one factor OPSTAT analysis designed by Sheoran *et al* (1998) and Statistical Error Mean (SEm±) and critical differences were computed.

RESULTS AND DISCUSSION

Physical analytic comparison

The maturity of compost can be physically assessed through color. The color of the finished composed in all the three treatments turned black from dark brown/brown. This indicates that the composting process is complete and can either used or stored for enhancing crop production. Another very important parameter to analyze for a good compost is the odor the compost emits. Unfinished compost will reek of certain unpleasant smell like the smell of decomposing animal dung or decomposing weed. The finished and good compost will have no foul odor in fact it will possess an earthy smell. All the three compared compost exhibit musty odorless smell after the compost is finished. Good compost should not be completely dry, as it will be dusty and irritating to work with, there should be at least 25-50 per cent moisture content. When the compost is too dry, it takes much more time for releasing nutrients to the soil when it is applied to unirrigated soil. The compost should not be too wet either as it will be difficult to handle and will be lumpy and heavy. The moisture assessment in Swift compost shows almost dry compost with moisture content of 25 percent, while the PSN enriched compost exhibit dry and friable compost with moisture content of 30 percent. The moisture content in normal compost is 20-25 percent as compared to 80 per cent moisture content in its initial condition. Swift compost has little to no distinguishable original substrate, as the substrate used here was solely cow dung without other crop residue or weed substrate. PSN enriched compost also possess little to no presence of original substrate at the finished compost. Normal composting however has some left over hard substrate that was not completely decomposed and can be incorporated to the next batch of composting. Both the composting processes viz. Swift compost and PSN enriched compost show full decomposition at 30 days and 100 days respectively. Normal composting duration is 60 days where approximately 98 per cent is achieved. The compost duration in normal composting was lesser than enriched method because it followed aerobic composting, while the quick composting in swift compost was due to usage of only cow dung as substrate (Chowbey and Tiwari 2022, Chakravarty *et al* 2023). The initial volume of substrate in Normal compost, Swift compost and PSN enriched compost were 500 kg each. After the compost has matured Normal compost production is 150 kg, Swift compost production is 300-400 kg while PSN enriched compost production is 160 kg. The high production in Swift compost can be attributed to the substrate which is cow dung alone. Both Normal and Enriched compost produces 30 per cent and 32 per cent of the initial substrate.

Chemical analytic comparison:

The value of pH in the three compared compost ranged between 6.6 – 7.7 at compost maturity. The pH of normal compost lies in neutral range at 6.6pH, the pH of Swift compost is 7.7 pH which is slightly alkaline, and the pH of PSN enriched compost is 7.2 pH which lies in the range of neutral. The rise in pH can be attributed to higher pH of cow dung the main substrate used for preparing the compost. The neutral to alkaline compost is beneficial and recommended to be used in acidic soil like soil of North East India for reclamation of acidity.

The total carbon content of Normal compost (39.8%) is significantly higher than Swift compost (18.6%) and PSN enriched compost (24.2%) respectively, probably owing to the inclusion of sawdust as dry substrate. These findings were in line with the finding of Qureshi *et al* (2014).

The total nitrogen content of Normal compost, Swift compost and PSN enriched compost were 0.91%, 1.1% and 2.3 %

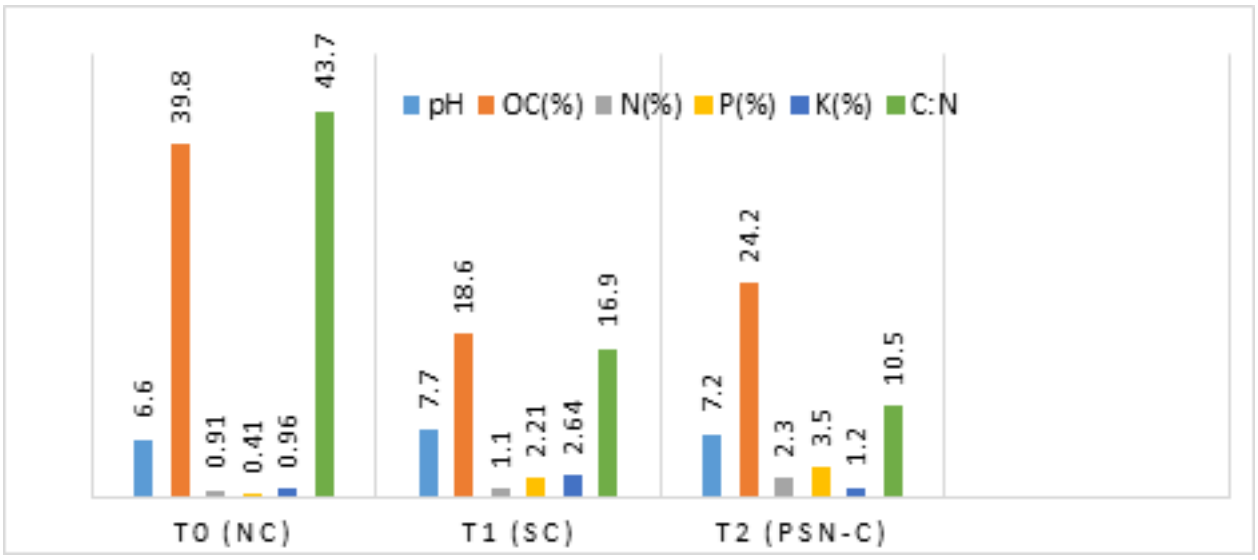

Fig.1. Chemical parameters of Normal compost, swift compost and PSN compost

Table 1. Nutritional variability of Normal compost, Swift compost and PSN compost

Treatment	pH	C (%)	N (%)	C:N	P (%)	K (%)
T0 (Normal compost)	6.6	39.8	0.91	43.7	0.41	0.96
T1 (Swift Compost)	7.7	18.6	1.1	16.9	2.21	2.64
T2 (PSN Compost)	7.2	24.2	2.3	10.5	3.5	1.2
SEm±	0.29	3.43	0.28	3.85	0.44	0.30
CD@5%	NS	13.83	1.15	15.53	1.82	1.22

Table 2. Physical analysis of Normal compost, Swift compost and PSN compost

Parameters	Initial	Normal Compost	Swift Compost	PSN Compost
Color	Brown	Brown to black	Brown to black	Black color
Odor	Present	Absent	Absent	Absent
Moisture	Wet	Almost dry	Almost dry	Dry and friable
Original substrate	Distinguishable	Coarse and large fragment remaining	Non distinguishable	Non distinguishable
Composting (%)	NA	98	100	100
Duration of composting (days)	NA	60	30	100
Compost production (kg)	NA	150	300-400	160

respectively. It showed that the total nitrogen content in PSN enriched compost was highest and this could be due to nitrogen enrichment (Tognetti *et al* 2005; Singh and Ganguly, 2005).

The carbon nitrogen ratio determines the quality of compost. The carbon nitrogen ratio of PSN enriched compost was lowest which was 10.5, followed by Swift compost (16.9). The highest carbon nitrogen ratio was recorded in Normal compost which was 43.7, this finding corroborated the finding of Sharma *et al* (2004).

The total phosphorus content ranged from 0.41-3.5% (NC-0.41 %, SC- 2.21 %, PSN-3.5 %). The total phosphorus content in PSN enriched

compost was highest, this could be attributed to enrichment of compost using di-ammonium phosphate. Similar results were reported by Singh and Ganguly (2005) and Biswas and Narayanasamy (2006).

The total potassium content of Normal compost was lowest at 0.96%, while the content was 1.2 % at PSN compost. The highest total potassium content was 2.64% in Swift compost which was due to pure utilization of cow dung as substrate. Cow dung has high content of potassium. Similar findings has been reported by Kalemewala *et al* (2012) and Jayapal *et al* (2021).

CONCLUSION

It can be concluded from the present study that there were not much distinguishable difference amongst the three compost methods considering physical parameters. However, apart from all the chemical parameters taken under study being higher than normal compost, the nutrients- nitrogen and phosphorus content in Phospho-sulpho-nitro enriched compost was comparatively higher than the swift and normal compost. The CN ratio was also lowest at PSN enriched compost and therefore could be recommended to farmer.

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Preferential Analysis on Occupation of the Tribals in Mayurbhanj District of Odisha

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ABSTRACT

Agriculture being the primary occupation of the tribal of Mayurbhanj district in Odisha state still belongs to main livelihood option. But they prefer for other profitable vocations due to the reason that most of them 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. The present study has been carried out with the objectives to study the present status of the occupation of the tribal people and preferences on vocations along with the extension support required for checking the occupational mobility from the agriculture to non-agricultural activities. On the basis of the finding it was suggested the development of infrastructure in agriculture and allied fields must be emphasized for checking mobility to non-agriculture sector. The extension officials must be pro-active to suitable extension strategies and implementation of the different development programme in the field of agriculture and allied sectors to make it more profitable and attractive through intermediary monitoring and evaluation.

Key Words: Agriculture, Choice, Hereditary, Occupation, Primary, Secondary, Tribal,Vocation.

INTRODUCTION

Agriculture is the main vocation among the large section of population in Odisha state. Although the primary occupation of the tribal of Mayurbhanj district is cultivation, but now they are deviating from this occupation to other profitable vocations due to lack of sufficient scope for livelihood. The most of tribal 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. In spite of various agencies in the field of tribal development, the food security problem is not solved. The tribals therefore go for other vocations particularly to work in non agricultural sectors and work as unskilled labourers. Even they do not hesitate to leave their house including all other resources and migrated to other districts and continue to work as labourer.

Karade (2009) describes occupation is one of the best indicators of class, because people tend to agree on the relative prestige they attach to similar jobs. 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. Reddy (2012) observed that majority

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Table 1. Distribution of the respondents according to their category/caste of tribal. (n=180)

Sr. No.	Parameter	Number	Percentage
A.	**Caste**		
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
B.	**Qualification**		
9.	Illiterate	36	20.00
10.	Primary Level	40	22.22
11.	Middle school Level	33	18.33
12.	Matriculation	40	22.22
13.	Higher secondary	18	10.00
14.	Graduation	06	03.33
15.	Post-Graduation and above	04	02.22
16.	Any technical degree	03	01.66
C.	**Land holding**		
17.	Less than 0.4 ha	67	37.22
18.	Within 0.4-0.8 ha	56	31.12
19.	Within 0.8-2 ha	42	23.33
20.	More than 2 ha	15	08.33
D.	**Farming experience**		
21.	Less than 5 years	74	41.11
22.	5-10 years	47	26.11
23.	11-15 years	09	05.00
24.	16-20 years	19	10.55
25.	More than 20 years	31	17.22

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. Rai *et al* (2023) emphasizes that in India extension activities are important tools for dissemination of agricultural based technologies for increase the production productivity of a piece of land. He conducted the study in Lucknow district of Uttar Pradesh in which he stated as the maximum visits of farmers was 93.5 per cent at KVK which denotes it first among different agricultural agencies, those were working for knowledge up-gradation. Majority of farmers participated in farmers fair (80.5%) albeit relative credibility index was found highest for demonstration activity (1.14). It means demonstrations were most effective method of transfer of technologies. Purnima *et al* (2022) explored on the study of tribal of Andhra Pradesh that majority of the participants (58%) preferred to engage in locally suitable and traditional enterprises while 42 per cent want to take up new enterprises. Major motivating factor was expressed as Govt support (44%) followed by family support (27%), availability of inputs (19%) and training (10%). The findings of this study also highlighted the potential constraints for tribal youth to take up entrepreneurship as financial followed by technological, social and personal constraints.

Table 2. Distribution of respondents according to their traditional hereditary occupation (n=180)

Sr. No.	Occupation	Primary occupation		Secondary occupation	
		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 3. Distribution of respondents according to their present occupation. (n=180)

Sr. No.	Sector	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

The present study has been carried out with the objectives of to study the present status of the occupation of the tribal people and preferences on vocations along with the extension support required for checking the occupational mobility from the agriculture to non-agricultural activities.

MATERIALS AND METHODS

The study was conducted in Mayurbhanj district of Odisha purposefully as the district enriched with the tribal people those occupy 58.72 % of the total population. The sub divisions, blocks, villages and respondents were selected through random sampling technique,. Four blocks were selected randomly one each 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 comprising twelve villages in total. Fifteen tribal people were selected from each village thus makes a sample size of 180. The data was collected through a pre tested structured interview schedule and the results were analysed by using frequency, percentage and t-test. The extent of satisfaction was studied by assigning scores as 1, 2 and 3 for not satisfactory, satisfactory and highly satisfactory, respectively and then mean value was calculated.

RESULTS AND DISCUSSION

The data (Table 1) revealed 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 % each to Ho, Munda and Sabar. It was in confirmation to the

Table.4 Source of income and extent of satisfaction from the income of the respondents during the last years. (n=180)

Sr. No.	Source	Extent of Satisfaction		
		Highly satisfactory	Satisfactory	Not satisfactory
		Mean score	Mean score	Mean score
1	Crop production	19.25	56.48	37.08
2	Animal Husbandry	16.31	26.00	44.98
3	Fishery	5.49	25.66	28.03
4	Minor Forest produce Collection	0	4.66	14.0
5	House hold value added products	0	36.43	27.06
6	Wage Earning	8.69	67.5	23.97

Table 5. Comparative analysis of facilities available as perceived by the respondents. (n=180)

Sr. No.	Facility	Facilities available during last three year		Present facility		Comparison
		Mean score	SD	Mean score	SD	"t" value
1	Soil condition	2.37	0.61	2.3	0.50	1.84 NS
2	Water Availability	2.25	0.57	2.3	0.50	
3	Manures	2.72	0.49	1.92	0.40	
4	Fertilizers	2.24	0.68	2.78	0.61	
5	Seeds	2.22	0.65	2.93	0.68	
6	Labour Availability	2.75	0.48	2.02	0.52	
7	Market	1.96	0.33	2.45	0.54	
8	Technical Support	1.96	0.55	2.73	0.63	
9	Finance	1.67	0.66	2.48	0.58	
10	Cold Storage/Storage facility	0.53	0.50	1.13	0.46	
11	Access to farm implements	1.58	0.66	2.63	0.58	
12	Transport Facility	1.88	0.60	2.26	0.48	

demographic figure about the distribution of the tribal in the district where Santal and Bhumij caste are predominant. Majority of the respondents studied up to primary 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 %). From the observation it was evident that most of the respondents had very poor educational background. Further, farmers' holding were in the marginal category (37.22 %) followed by 31.12 % having land holding in between 0.4 to 0.8 ha and 23.33 % in between 0.8 to 2.0 ha. This clearly justifies as most of the tribal people were marginal and small farmers. Majority of farming were having farming experience of less than 5 years which indicated that either most of the respondents were young farmers or engaged in other vocations.

It was observed (Table 2) 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 percent.

The data (Table 3) indicated that majority of the respondents had farming (35.0 %) as their primary occupation followed by wage earner (20.55 %). Only 7.22 % respondents had government service. It was also noted that majority of the respondents had animal husbandry as secondary occupation which constituted 35.0 %t followed by farming (23.88 %). The finding

Preferential Analysis on Occupation of the Tribals

Table 6. Preference regarding vocations of the tribal people. (n=180)

Sr. No.	Vocation	Mean score	Rank
1	Crop production	4.94	I
2	Poultry farming	5.61	II
3	Goat rearing	6.11	III
4	Dairy management	6.16	IV
5	Fishery	6.27	V
6	Business	6.63	VI
7	Mushroom cultivation	6.77	VII
8	Horticultural crops	6.88	VIII
9	Job work	8.72	IX
10	Industrial work	9.05	X
11	Skilled job	9.66	XI
12	Sabai grass rope making	10.16	XII
13	Rural handicrafts	10.38	XIII
14	Bee keeping	10.83	XIV
15	Collection of non-timber forest produce	11.55	XV

**Scores ranges from 1-15*

Table.7 Extent of need for management support as perceived by the respondents. (n=180)

Sr. No.	Facility	Extent of management support			Mean score	Rank order
		Very much essential	Essential	Not essential		
		Number	Number	Number		
1	Water supply and electricity	79	45	47	1.19	I
2	Infrastructure support	64	37	79	0.97	II
3	Community approach	73	12	95	0.88	III
4	Team work	73	09	98	0.86	IV
5	Communication	60	35	85	0.86	IV
6	Asset creation	33	65	82	0.73	V

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.

It was observed that extent of satisfaction from different sources, which gave impression that the respondents had received most satisfaction from crop production followed by wage earning whereas least number of respondents had satisfaction from minor forest product (Table 4).

The data revealed no significant difference between the facilities available today and three years back.

It was inferred that crop production was the most preferred vocation followed by poultry farming, goat rearing, dairy farming, and fishery. It signified as most of the respondents had choice for the traditional occupation which requires being improved and more remunerative.

Management support is very much essential for successful implementation of a programme. The extent of management support for the tribal people under study was analysed

which shows that water supply and electricity was the most needed by the respondents followed by infrastructural development.

CONCLUSION

It was imperative that as most of the tribal people of Mayurbhanj district of Odisha have cultivation and livestock rearing is the primary occupation and largely depend on those sectors for livelihood, still due ti changing scenario they are shifting to other profitable vocations for more earning. On the basis of the finding it was suggested the development of infrastructure in agriculture and allied fields must be emphasized for checking mobility to non-agriculture sector. The extension officials must be pro-active to suitable extension strategies and implementation of the different development programme in the field of agriculture and allied sectors to make it more profitable and attractive through intermediary monitoring and evaluation.

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Purpose and Motive of Farmers Visiting Krishi Vigyan Kendra

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ABSTRACT

The role of Krishi Vigyan Kendras (KVKs) on dissemination and adoption of technologies for remunerative and sustainable farming is becoming increasingly important. The farmers visiting the KVKs benefitted in different aspects and empowered by receiving appropriate technological advisory or inventory. A study was conceptualized with an objective to to know the time and purpose of farmers visits to KVK. The respondents of the present study were sampled purposely of all the farmers visiting the KVK, Srikakulam. The majority of farmers (16.54%) visited the KVK during the November month with the objective to get seeds, seedlings and planting material (39.09%). It was evident from the observation that KVK are effectively creating impact on the livelihoods of farmers and farm families. It gained the trust of farmers and maintaining the data on frequency, time and purpose of their visits help the KVKs to forecast the demands of inputs and advisory needs.

Key Words: Adoption, Advisory,Dissemination,Technology.

INTRODUCTION

The Krishi Vigyan Kendra (KVK) Amadalavalasa is 12 km away from Srikakulam, the district head-quarter. The KVK is specialized in skill and entrepreneurship development of the farmers on value addition of millets, mushroom cultivation, handicrafts, vegetable seedling production, pine apple value addition and jute products. Apart form women empowerment programmes, demonstration of technologies and linkages with line departments to address farmers localized problems with the subject matter specialists of all disciplines. It has facilities of extension corner with display of latest information and new programmes launched by Governments. Farmers can visit KVKs for crop advisory, entrepreneurship and for best quality seed. With the existing strengths and areas of operations it was planned to study the frequency of farmers visits during different months and their purpose of their visit.

The KVKs beneficiaries had improved the knowledge on agricultural technologies compared to the non-beneficiaries (Chaudhari *et al*, 2015; Chhodvadia *et al*, 2016). Further, the farmers knowledge on topics covered by KVKs had significantly positive impact over non trained technologies (Meena and Singh, 2010). In addition to it, trainings at KVKs improved the adoption more than 30 per cent (Bharath *et al*, 2023). Therefore, knowledge followed by adoption of agricultural technologies had significantly increased among farmers due to KVKs activities (Katole *et al*, 2017). The operational villages are selected by KVKs to conduct the mandated activities such as OFTs, FLDs, fairs, special

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occasions etc. rigorously and these villages have improved the yield by 30 percent and technologies that reduces the cost of cultivation significantly (Gorfad *et al*, 2018). The technologies demonstrated were also found to be feasible and reduced the technology gap in the area than the other areas of district (Malathi *et al*, 2018). The technologies that are minimal skill oriented, less costly and easy to adopt are fully adopted (Sunil and Manjula, 2009). The trainings given by KVK enhanced the employment opportunities to rural youth (Acharya *et al*, 2024) Overall, the KVKs positively impacted on profitability of farmers in agriculture and allied sectors (Jena *et al,* 2022).

The present study intended to focus on the purpose of farmers visiting the KVKs and how it is helping the farmers to address the problems of farmers in the field. The study area KVK Amadalavalasa, Srikakulam district covers the jurisdiction of 38 mandals with major crops paddy, maize, sugarcane, black gram, green gram, sesame and allied sectors are horticulture, Animal Husbandry, fisheries, Sericulture.

MATERIALS AND METHODS

The impact of KVKs reviewed with the existing literature. KVK Amadalavalasa of Srikakulam district of Andhra Pradesh is purposively selected for the study. A register was maintained at KVK Amadalavalasa to note the farmers visits and their purpose of their visit. The data maintained of this kind at KVKs help to analyze the picture of focused areas of KVKs and overcome the lacuna in technology or dissemination models existing the farmers prefers. A total of two hundred and sixty-six farmers visited the KVK Amadalavalasa during 2019-20 inspite of the COVID 19 pandemic year.

RESULTS AND DISCUSSION

The monthly distribution of the farmers visiting the KVKs showed that majority of the farmers (16.54 %) visited in the month of November, 2019 due to the peak pest and disease surveillance and scientist of KVK recommended some eco friendly remedies at the initial stages of controlling them. In addition to it, seedling material for *rabi* crops and sale of inputs also falls in the month. Equal number (12.40%) of farmers visiting KVK in the months of July and December as the July month is known for seedling material and organic inputs for the *kharif* season. However, the first week of December late *rabi* crops and horticultural planting material were taken from the KVK. The frequency of majority farmers visiting the KVKs to get advisory along with quality inputs than merely for advisory. The months September (10.52%) and August (10.15%) occupied the next two places as the farmers visited for training, enterprise development and advisory during this month

The month of April has less frequency of farmers visited as summer crops are very minimal in the area due to less water availability expect horticultural crops like mango and cashew, so the visit to KVKs was comparatively very low. January month also less visited by farmers as there is less scope except the specialized trainings if planned. In the March month harvesting of *rabi* crops and horticultural crops takes place and harvesting implements are of great demand in this month. However, KVK has minimal role in the harvesting, so the visitors were less.

The majority of the (39.09 %) farmers visits KVK for inputs such as seeds, seedlings and planting material might be due to the farmers trust the quality of seeds sold by university than the seeds of private agencies. The pest and disease control advisory was the second most considered (18.04%) aspect for receiving the advisory from the KVKs as the subject matter specialists of KVKs were most experienced as well as qualified to give advisory in the district. On the other hand, 13.90 per cent farmers visiting KVK weed to get advice from KVKs on weed management as the Scientists were not profit oriented to recommend the extra doses of herbicide to control the weeds and to reduce the input costs. It is also found that, 9.39 per cent of the farmers were attracted to receive information relayed to poultry birds from the subject expert, one of the major allied sector business in the area. The farmers frequently visitng KVKs for different purposes had positive attitude on KVKs and less knowledge gap (Jiyawan *et al,* 2012).

Purpose and Motive of Farmers Visiting Krishi Vigyan Kendra

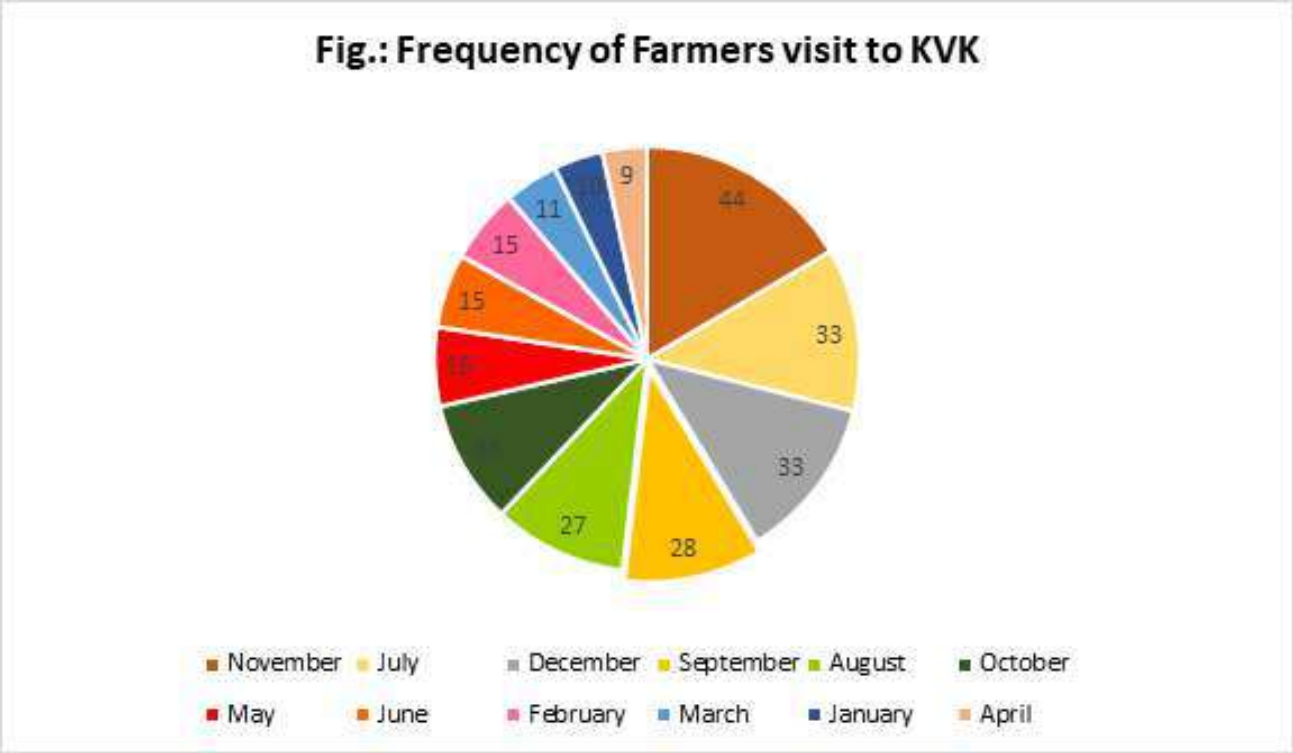

Table 1. Visit of farmers to KVK, Amadalavalasa-2019-2020.

Sr.No.	Purpose	Number of farmers visited	Ranking
1.	Seeds , Seedlings, Planting material	104	I
2.	Pest and disease Management	48	II
3.	Weed Management	37	III
4.	Poultry birds	25	IV
5.	Others(Vyavasaya Panchangam, Vermi compost, Waste decomposer, Visit to KVK farm, Package of practices, Fisheries, Literature etc)	13	V
6.	Training on Coconut climbing	10	VI
7.	Training on Mushroom cultivation	9	VII
8.	Azolla, Liquid Bio fertilizers, Yellow Sticky traps	6	IX
9.	Soil testing	8	VIII
10.	Agricultural implements	6	IX

CONCLUSION

The trust gained on KVK among various sections of farmers in agriculture and allied fields was due to the all-round service provided by them. The study reiterate the importance of maintaining the minute data at KVKs on farmers to plan the programmes for them. Moreover, it also facilitated the KVKs to know the demands of various inputs and services provided by KVK and more focus should be on it. Awareness can be created on the less demanded areas from KVK and also need for necessary changes in those relatively weaker areas in KVK management.

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Resource Utilization and Economic Analysis of Cotton Farming in Northern India

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ABSTRACT

The present study was conducted in the northern cotton-growing zone of India, comprising the states of Punjab, Haryana, and Rajasthan, to evaluate resource utilization and the economics of cotton cultivation. It also examined the challenges faced by cotton growers in production and marketing. Primary data for the year 2021-22 were collected from a sample of 120 farmers. The recommended doses of nitrogen and phosphorus was followed by only 40.83 and 22.50 per cent of farmers, respectively. Overuse of potash in Rajasthan highlights inefficiencies in fertilizer application. The average profitability of cotton cultivation has been worked out at Rs. 45087 per ha. Among the states, the profitability of cotton cultivation was Rs. 40153/ha, Rs. 47771/ha and Rs. 47329/ha, in Rajasthan, Haryana and Punjab, respectively. Major issues confronted by cotton growers include poor-quality inputs, price fluctuations, unstable productivity, contamination of cotton, shortage of skilled labour, and limited technical knowledge. Addressing these issues through the supply of high-quality cotton seeds, development of pest-resistant varieties, integrated pest management strategies, and strict regulation of oil mills and ginneries to control the hibernating pink bollworm in seed cotton could significantly enhance cotton cultivation and increase the area under production.

Key Words: Cotton**,** Cultivation, Input use, Northern Zone, Returns, Operational costs, Profitability

INTRODUCTION

The cotton-growing regions of India are primarily divided into three zones: Northern (Punjab, Haryana, and Rajasthan), Central (Gujarat, Maharashtra, and Madhya Pradesh), and Southern (Andhra Pradesh, Tamil Nadu, and Karnataka). In the Northern zone, cotton is typically planted from mid-April to the last week of May, whereas in the Central and Southern zones, planting begins in June and July, extending into August. In Tamil Nadu, part of the Southern zone, cotton planting occurs twice annually: in January/February for the summer crop and in June/July for the winter crop. Harvesting generally takes place from October to February across the country. The Northern zone contributes about 18% of India's total cotton production, from approximately 13% of the total cotton-growing area (GoI 2021). During 2019-20, Punjab had 248 thousand hectares under cotton cultivation, yielding 1206 thousand bales with an average productivity of 827 kg/ha. The major cotton-growing districts in Punjab—Bathinda, Fazilka, Mansa, and Sri Muktsar Sahib—account for 97.4% of the cotton area and 98% of its production in the state (GoP, 2021). In Rajasthan, 760 thousand hectares were under cotton cultivation, producing 2787 thousand bales with an average yield of 623 kg/ha. The primary cotton-growing districts—Sri Ganganagar, Hanumangarh, Alwar, and Nagaur—contributed about 71% of the total cotton area and 70% of production in the state (GoR, 2021). Similarly, in Haryana, cotton was cultivated on 723 thousand hectares, yielding 2484 thousand bales with an average productivity of 584 kg/ha. The major cotton-producing

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Table 1. Land holding of sample farmers in the selected cotton growing states. (Area in ha.)

Particulars	Rajasthan	Haryana	Punjab	Overall
Owned land (a)	4.90	4.19	4.23	4.78
Leased in (b)	0.14	0.04	0.07	0.08
Leased out (c)	0.26	0.36	0.16	0.26
Total operational holding (a+b-c)	4.77	4.88	4.14	4.59

districts—Hisar, Sirsa, Bhiwani, Fatehabad, and Jind—accounted for around 80% of the state's cotton-growing area and 82% of production (GoH, 2021). Cotton production is influenced by a variety of factors, including climatic conditions, rainfall patterns, insect-pest infestations, weed growth, and diseases. In Northern India, pests such as the American bollworm, pink bollworm, whitefly, and aphids have significantly impacted cotton yields. Despite its relatively small share of 5% in India's total cultivable land, cotton accounts for over 50% of the country's insecticide use (Singh *et al*, 2013). Farmers face numerous challenges in cotton production, such as losses from insect and pest attacks, excessive rainfall, unavailability of quality seeds, inadequate quality inputs, and limited technical knowledge. Productivity in the Northern zone is significantly influenced by factors such as climatic conditions, rainfall variability, insect-pest infestations, weed growth, and disease prevalence. Pests like the American bollworm, pink bollworm, whitefly, and aphids have caused substantial yield losses. Additionally, resource use efficiency remains a concern. This study aims to analyze the input use pattern and economics of cotton cultivation in the Northern India along with identification of the key challenges faced by cotton growers to suggest actionable solutions.

MATERIALS AND METHODS

The present study was conducted during the 2021-22 cropping season in the northern cotton growing states of India, encompassing Punjab, Haryana, and Rajasthan. To ensure robust and representative data collection, a multi-stage sampling technique was employed. In the first stage, the two highest cotton-producing districts from each selected state were identified. At the second stage, two villages were randomly chosen from each of these districts. Finally, from each selected village, a sample of 10 cotton growers was drawn, resulting in a total of 40 farmers surveyed per state. In this way, the overall sample comprises 120 cotton growers. Comprehensive primary data were collected from the sampled farmers, covering various aspects of cotton cultivation. These included details on operational land holding, cropping pattern, agronomic practices adopted in cotton cultivation, input usage (such as fertilizers and pesticides), labor and machinery utilization, and the associated costs. Additionally, the study explored various challenges faced by cotton growers, particularly issues related to production and marketing. These insights provide a valuable basis for understanding the economics of cotton farming and addressing the key constraints affecting productivity and profitability in the region.

RESULTS AND DISCUSSION

Operational land holding

The average operational holding of the sampled farmers in north cotton zone of India was 4.59 ha (Table 1). The operational land holding of the sample cotton growers in Haryana was 4.88 ha while in Rajasthan and Punjab, it was estimated at 4.77 ha and 4.14 ha, respectively. The prevailing average land rent was highest in Punjab ranging from Rs. 128079/ha to Rs. 134669/ha and lowest in Rajasthan (ranging from Rs. 66717/ha to Rs. 76601/ha). The reason behind this is higher productivity (hence, higher returns) of crops in Punjab as compared to other two states.

Depth of water table

The depth of water table varies across states and it also varies in different seasons. At overall, the depth of water table was in the range of 31-40 feet at about 40 per cent farms, while at 38.3 per cent farms, the water table was in the range of

Table 2. Depth of water table, source of irrigation and draft power in the selected cotton growing states.

Water table depth (ft.)	Rajasthan (n=40)	Haryana (n=40)	Punjab (n=40)	Overall (N=120)
21-30	-	13 (32.50)	33 (82.50)	46 (38.33)
31-40	17 (42.50)	24 (60.00)	7 (17.50)	48 (40.00)
41-50	3 (7.50)	3 (7.50)	-	6 (5.00)
> 50	20 (50.00)	-	-	20 (16.67)
Source of irrigation				
Canal only	1 (2.5)	3 (7.50)	-	4 (3.33)
Both canal and electric motor	31 (77.50)	26 (65.00)	30 (75.00)	87 (72.50)
Canal, electric motor and diesel engine	8 (20.00)	11 (27.50)	10 (25.00)	29 (24.17)
Source of draft power				
Owned tractor	35 (87.50)	36 (85.00)	33 (82.50)	104 (86.67)
Hired tractor	5 (5.00)	6 (15.00)	7 (17.50)	18 (15.00)
Bullock	-	2 (5.00)	4 (10.00)	6 (5.00)
Camel	3 (7.50)	-	-	3 (2.50)

Figures in parentheses indicate percentages to their respective totals.

21-30 feet (Table 2). Among the states, the deepest water table was observed in Rajasthan where the water level depth was more than 50 feet at about half of the sample farms. At the majority of farms (82.50%) in cotton growing belt of Punjab, the water table depth was in the range of 21-30 feet. In Haryana, the water table depth was 31-40 feet at about 60 per cent of sample farms.

Source of irrigation

Irrigation plays an important and crucial role in production of crops at farm level. At overall level, majority of the farmers (72.50%) were using both canal and electric motor as the source of irrigation (Table 2) followed by the farmers that were using electric motor and diesel engine in addition to canal water (24.17%). Similar trend was being followed by the farmers of Punjab, Haryana and Rajasthan states. The farmers who were using both canal and electric motor were found to be highest in Rajasthan (77.50%) followed by Punjab (75%) and Haryana (65%).

Source of draft power

Farmers use a variety of draught power sources for their various farming operations. It was found that at overall, 86.67 per cent of respondents owned tractors, whereas 15.00 per cent of farmers were using tractors on custom hiring basis for performing farm activities (Table 2). In Rajasthan, 87.50 per cent of farmers were having own tractors, while just 5 per cent were using custom hired tractors. Similarly, the 85.00 and 82.50 per cent of farmers in Haryana and Punjab, respectively were possessing tractors. In Rajasthan, 7.50 per cent of farmers also kept camels for performing farm operations.

Cropping pattern

The cropping patterns followed in the states under consideration (Table 3) revealed that the area under wheat was having highest share (38.42%) in the total cropped area followed by cotton crop (29.70%). The allocation of area under wheat in Punjab, Haryana and Rajasthan was 43.79, 36.55 and 34.92 per cent, respectively to their respective total cropped areas. As far as cotton crop is concerned, Haryana was the leading state amongst the selected states comprising 31.73 per cent of total cropped area followed by Rajasthan (29.10%) and Punjab (27.51%). The share of area under paddy and mustard in the total

Table 3. Cropping pattern at sample farms in the selected cotton growing states (ha/farm)

Crop	Rajasthan	Haryana	Punjab	Overall
***Kharif* season**				
Cotton	1.10 (29.10)	1.25 (31.73)	0.93 (27.51)	1.09 (29.70)
Paddy	-	0.12 (3.05)	0.65 (19.23)	0.26 (7.08)
Cluster bean	0.56 (14.81)	0.46 (11.68)	-	0.34 (9.26)
Maize	0.02 (0.53)	0.03 (0.76)	0.01 (0.30)	0.02 (0.54)
Moong	0.14 (3.70)	-	-	0.04 (1.09)
Sorghum fodder	0.05 (1.32)	0.10 (2.54)	0.07 (2.07)	0.07 (1.91)
Bajra fodder	0.05 (1.32)	-	-	0.02 (0.54)
***Rabi* season**				
Wheat	1.32 (34.92)	1.44 (36.55)	1.48 (43.79)	1.41 (38.42)
Mustard	0.37 (9.79)	0.32 (8.12)	0.10 (2.96)	0.26 (7.08)
Barley	-	0.08 (2.03)	-	0.02 (0.54)
Berseem fodder	-	0.06 (1.52)	0.04 (1.18)	0.03 (0.82)
Oats	0.08 (2.12)	0.06 (1.52)	0.04 (1.18)	0.06 (1.63)
Gram	0.12 (3.17)	-	-	0.04 (1.05)
Maize	0.02 (0.47)	-	-	0.01 (1.09)
***Zaid* season**				
Summer moong	-	0.02 (0.51)	0.06 (1.78)	0.02 (0.54)
Total cropped area	3.78 (100.00)	3.94 (100.00)	3.38 (100.00)	3.67 (100.00)

Figures in parentheses indicate percentages to their respective total cropped area.

cropped area was about seven per cent each. The cluster bean was being cultivated in Haryana (11.68%) and Rajasthan (14.81%) which comprised about 9.3 per cent area in total cropped area at the overall level. However, some other crops were also being cultivated in the study area like sorghum fodder having 1.91 per cent area followed by oats (1.63%), moong (1.09%), gram (1.09%), berseem fodder (0.82%), maize (0.54%), bajra fodder (0.54%), barley (0.54%) and summer moong (0.54%).

Seed rate

The study revealed significant variations in the quantity of cotton seed used per hectare across the sampled respondents. At the overall level, 49.17 per cent of farmers were using seed @2.25Kg/ha, while 45 per cent were using 2.812 Kg/ha(Table 4). The state-wise analysis showed distinct differences in seed usage patterns. In Punjab, 90 per cent of farmers adhered to the recommended seed rate of 2250 grams/ha, compared to 52.5 per cent in Haryana and only 5 per cent in Rajasthan. Conversely, the higher seed rate of 2.812 Kg/ha was predominantly used by 95 per cent of farmers in Rajasthan and 40 per cent in Haryana. Additionally, a small proportion of farmers (10%) used significantly higher quantities of seed in Punjab and 7.5 per cent farmers in Haryana were applying 3375 grams/ha. This overuse of seed may indicate a lack of awareness about optimal seeding rates or a response to perceived issues such as poor seed germination or pest susceptibility. Promoting education on recommended seed rates, alongside ensuring the availability of high-quality seeds, is essential for optimizing resource use, reducing cultivation costs, and improving productivity.

Irrigation applied to cotton crop

Cotton is a long duration crop which matures in 160-170 days which requires 5 to 6 irrigations. At the overall, five to six irrigations were applied to cotton crop by 53.33 per cent of sampled famers while 23.83 and 25 per cent of the farmers have applied seven to eight and three to four irrigations, respectively (Table 4). In Punjab, Haryana and Rajasthan, mostly five to six

Table 4. Cotton seed rate and number of irrigation applied by the sample farmers. (No. of farmers)

Seed rate (Kg/ha)	Rajasthan (n=40)	Haryana (n=40)	Punjab (n=40)	Overall (N=120)
2.250	2 (5.00)	21 (52.50)	36 (90.00)	59 (49.17)
2.812	38 (95.00)	16 (40.00)	-	54 (45.00)
3.375	-	3 (7.50)	4 (10.00)	7 (5.83)
Number of irrigation applied				
3-4	12 (30.00)	12 (30.00)	6 (15.00)	30 (25.00)
5-6	17 (42.50)	26 (65.00)	21 (52.50)	64 (53.33)
7-8	14 (35.00)	2 (5.00)	15 (37.50)	31 (25.83)

Figures in parentheses indicate percentages to their respective totals.

Table 5. Recommended application of nitrogen, phosphorus and potash to cotton.

Fertilizers (in nutrient form)	Rajasthan (n=40)	Haryana (n=40)	Punjab (n=40)	Overall (N=120)
Nitrogen	52.50	40.00	30.00	40.83
Phosphorous	15.00	20.00	32.50	22.50
Dose of potash (kg/ha)				
Nil	22.50	50.00	47.50	40.00
<25	2.50	-	-	0.83
25-50	35.00	27.50	25.00	29.17
50-75	32.50	-	5.00	12.50
75-100	7.50	22.50	22.50	17.50

irrigations were being applied by 42.5. 65 and 52.5 per cent of the farmers, respectively. Due to the issue of brackish water in some parts of Haryana, the farmers have to use canal water alone or by mixing the canal and tube well water. In Rajasthan, due to lesser irrigation facilities, about 40 per cent farmers applied four to five irrigations.

Fertilizer application

Nitrogen and phosphorous

Nitrogen is an important component for the plant growth. As per recommendations of agricultural scientists, the recommended dose of nitrogen for cotton crops is 103.8 kg per ha (PAU 2021), whereas for Rajasthan it is 148.3 kg/ha as there is problem of nitrogen leach down in sandy soils. It was observed that at overall level only 36.67 per cent cotton growers were applying recommended dose of nitrogen (Table 5). In Rajasthan, 50.00 per cent of the sampled farmers have applied recommended dose of nitrogen, followed by Haryana (35.00%) and Punjab (25.00%). Phosphorous plays crucial role in plant's reproductive growth. According to the agricultural scientists, if phosphorous is applied in *rabi* season, then its application may be skipped in the following *kharif* season. The recommended quantities of phosphorus in cotton in Punjab and Haryana are same (30 kg/ha) while in Rajasthan its recommended dose is higher (40 kg/ha). There is no need to apply phosphorous to cotton crop in *kharif* season. It was observed that only 22.50 per cent of sampled farmers have applied the recommended dose of phosphorus to cotton crop.

Table 6. Application of zinc and pesticide spray to cotton crop at the sample farms
(Per cent farmers)

Dose (kg/ha)	Rajasthan (n=40)	Haryana (n=40)	Punjab (n=40)	Overall (N=120)
Not applied	77.50	97.50	90.00	88.33
Applied by	22.50	2.50	10.00	11.67
Number of pesticide sprays				
1-2	7.50	15.00	5.00	9.17
3-4	92.50	67.50	87.50	82.50
5-6	-	17.50	7.50	8.33

Potash

The agriculture experts advocate that potash application in cotton crop should be based on soil test results. Potash is necessary only if the soil is deficient in this nutrient. However, the adoption of this practice varies across regions. At the overall level, 40 per cent of the sampled farmers did not apply potash to their cotton crop (Table 5). The highest proportion of non-application was observed in Haryana, where 50 per cent of farmers did not use potash, followed by Punjab (47.5%) and Rajasthan (22.5%). In Rajasthan, approximately 35 per cent of farmers were observed applying 25 to 50 kg of potash per hectare, likely reflecting the region's specific soil characteristics and fertility needs. This relatively higher adoption rate may be attributed to awareness of soil potash deficiency and its impact on crop productivity in the region. Encouraging farmers to adopt soil test-based nutrient management practices can enhance resource efficiency, reduce input costs, and improve cotton yields. Providing access to affordable soil testing services and creating awareness about the critical role of potash in plant nutrition are essential steps to bridge the gap between recommendations and field practices.

Zinc

It was observed that in the selected cotton growing states, 88.33 per cent of the sampled farmers did not apply zinc fertilizer to their cotton crop (Table 6). State-level analysis revealed significant variation in zinc application practices. In Rajasthan, Punjab and Haryana, around 77.50, 90.00 and 97.5 per cent of farmers, respectively, avoided the use of zinc. The relatively higher adoption of zinc fertilization in Rajasthan, where 22.5 per cent of farmers applied zinc, can be attributed to the region's sandy soil texture, which is often deficient in zinc. Zinc deficiency in soil negatively affects plant growth and yields, as zinc is a critical micronutrient for enzymatic and physiological processes in plants. Recognizing this, a subset of farmers in Rajasthan incorporated zinc into their fertilization practices to address the nutrient deficit and improve crop productivity. The widespread avoidance of zinc fertilization in Punjab, Haryana, and by most farmers in Rajasthan is due to the fact that these farmers think that their lands are not zinc deficient. To address this issue, agricultural extension services should focus on educating farmers about soil testing and the role of micronutrients in optimizing cotton yields.

Pesticides use in cotton crop

Cotton cultivation is highly vulnerable to various insect pests, which can cause significant damage to the crop if not managed effectively. To combat these pests, farmers in the cotton-growing regions of northern India rely heavily on chemical insecticides and pesticides. However, this intensive use of chemicals poses challenges related to cost, environmental impact, and pest resistance. In Punjab and Haryana, approximately 87.5 and 67.5 per cent of farmers, respectively, reported applying pesticides to their cotton crops three to four times (Table 6). In contrast, 92.50 per cent of farmers in Rajasthan applied pesticides three to four times. These application patterns

Table 7. Profitability of cotton cultivation in the selected states **(Rs./ha)**

Particulars	Rajasthan	Haryana	Punjab	Overall
A. Total operational costs	62711	58392	53687	58263
Average cotton yield (q/ha)	17.75	18.36	17.34	17.82
i) Value of main product	98335	101476	96150	98657
ii) Value of by product	4529	4687	4865	4694
B. Gross returns (i+ii)	102864	106163	101015	103350
Profitability (B-A)	40153	47771	47329	45087

Table 8. Cotton production and marketing related issues confronted by the sample farmers

(Mean values)

Issue	Rajasthan	Haryana	Punjab
Poor quality seed	3.93***	4.15***	4.30***
Poor quality pesticides/fertilizer	4.28***	4.20***	4.25***
Insect/pest incidence	4.05***	4.08***	4.18***
Productivity instability	3.83***	3.90***	4.08***
Rainfall at harvesting	2.83NS	3.78***	3.50***
Costly labour	3.30**	2.85NS	3.05NS
Lack of skilled labour availability	2.85NS	2.65***	2.60***
Inadequate technical know-how	3.07NS	2.53***	2.40***
Price fluctuations	3.85***	3.98***	3.90***
Contamination in cotton produce	2.80*	2.70**	3.83***
Long distance market access	2.47***	2.50***	3.49NS
High transportation cost	2.42***	3.20NS	3.48***
Delay in payment	3.03NS	2.65***	2.73**
Lack of storage facility	2.90NS	2.43***	2.65***
Market fees	2.95NS	2.48***	2.09NS

***, ** and *: Statistically significant at 1, 5 and 10 per cent probability level, respectively.
NS: Non-significant

reflect differences in pest pressure, climatic conditions, and agricultural practices across the states. The frequent use of chemical pesticides highlights the high susceptibility of cotton to pests such as bollworms, whiteflies, etc. While chemical interventions provide immediate control, over-reliance on these methods can lead to several issues, including the resurgence of secondary pests, resistance development among target pests, and contamination of soil and water resources. To mitigate these challenges, it is crucial to promote Integrated Pest Management (IPM) strategies so that the use of chemicals may be minimized. IPM practices, such as monitoring pest populations, using pheromone traps, and introducing natural predators, can help reduce pesticide dependence while maintaining productivity. Moreover, educating farmers about the judicious and targeted application of pesticides can prevent overuse and ensure sustainable cotton production. Awareness campaigns and training sessions by state agriculture departments can play a vital role in this regard. This comprehensive approach is essential to safeguard the environment, improve the economic viability of cotton farming, and ensure long-term pest management effectiveness.

Profitability of cotton cultivation

To work out the profitability of cotton cultivation, a detailed analysis of operational costs

and gross returns was conducted. The overall operational costs incurred in cotton cultivation were estimated at Rs. 58263 per hectare (Table 7). It includes the cost of seed, fertilizers, irrigation, plant protection, use of human labour, use of tractor use, transportation and marketing. The results revealed that Rajasthan had the highest expenditure at Rs. 62711/ha, followed by Haryana (Rs. 58392/ha), and Punjab (Rs. 53687/ha). The average productivity of cotton in the region was 17.82 quintals/ha. The gross returns and returns over variable costs were calculated at Rs. 103350/ha and Rs. 45087/ha, respectively. Profitability of cotton cultivation in Haryana was Rs. 47771/ha, followed by Punjab (Rs. 47329/ha), and Rajasthan (Rs. 40153/ha).

Production and marketing challenges in cotton cultivation

The cotton growers face multiple challenges that affect economic returns, including price volatility, input quality issues, unstable productivity, labour shortages, and contamination during production and processing. The results revealed that the poor quality seed and other inputs (like pesticides, fertilizers), insect/pest incidences and instability in cotton productivity were the major problems faced by cotton growers (Table 14). In Punjab and Haryana, the problems of rainfall at the time of harvesting, lack of skilled labour availability and lack of technical knowledge were found statistically significant. However, the problems of price fluctuations and contamination in produce were reported by the all the sampled cotton growers of all three states. In Rajasthan, the respondents expressed the constraint of higher labour cost. The difficulty in accessing the remunerative markets due to long-distance was reported by Haryana and Rajasthan farmers whereas lack of storage facilities and the issue of payment delays was noticed in Punjab and Haryana states. By addressing these challenges, the Northern zone can optimize resource use and increase cotton production and profitability.

CONCLUSION AND POLICY IMPLICATIONS

To enhance resource efficiency and economic returns, the following measures are recommended:

1. The supply of high-quality seeds, fertilizers, and pesticides should be ensured at affordable prices to make cotton cultivation a more profitable enterprise.

2. To prevent the sale of substandard inputs by private dealers, the government must implement stringent regulations and take strong action against such malpractices to protect cotton growers.

3. A significant portion of cotton seeds is produced and distributed by the Central and Southern states. These seeds should be thoroughly checked for approved hybrids and pest infestations to maintain quality standards.

4. Encouraging farmers to apply fertilizers based on soil testing can enhance resource efficiency, reduce input costs, and improve cotton yields. State agriculture departments should conduct awareness campaigns and training programs to educate cotton growers on the judicious application of fertilizers and pesticides.

5. Research efforts should focus on developing cotton cultivars that can tolerate the insect-pest attack and diseases. This can help increase cotton acreage and sustainability across the country.

6. State Departments of Agriculture and Agricultural Universities should jointly promote the Integrated Pest Management (IPM) approach, particularly in major cotton-growing regions, to reduce dependency on chemical pesticides and mitigate pest infestations.

7. Pink bollworm infestation often originates from seed cotton stored at oil mills and ginneries, where the pest hibernates. These facilities should be kept under strict surveillance throughout the year, as they are major sources of infestation.

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Socio-Economic Dynamics of Left-Behind Wives of Farmers Who Committed Suicide in Punjab

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ABSTRACT

Agricultural distress has been a major cause of farmer suicide in several nations, including India, the United States, Australia, and France. The National Crime Records Bureau (NCRB) reports that 11,290 farmers committed suicide in 2022 across the country. One of the most neglected and vulnerable populations in rural communities are the left-behind wives of farmers who committed suicide. A number of variables, including demographics, social inclusion, and financial stability, affect their economic status. These widows frequently find themselves forced into informal labour or dependent on insufficient government compensation due to their economic struggles, which include debt burden, limited access to credit, restricted ownership of property rights, and loss of household income. The present study was undertaken with specific objective of understanding the socio-economic characteristics of left-behind wives of farmer who committed suicide. This study explores the socio-economic and psychological distress of farmer widows in Punjab, based on a primary survey in **Bathinda, Mansa, and Sangrur**. Using **snowball sampling**, data were collected from **240 households across 77 villages** through structured interviews and case studies. The study highlights the socio-economic distress of farmers' widows in Punjab, with 42.08 per cent illiteracy, 79.17 per cent from *Jat Sikh,* the majority of respondents belonged to the marginal (50.42%) and small (36.67%) farming households. Early marriages were more common among the respondents. Over 55.83 per cent became household heads, and 87.09 per cent belonged to marginal and small farming families with an average of 1.06 ha operational land holding. Agriculture (62.28%) remained the primary source of income. The findings underscored the need for financial stability, land security, and income diversification to support these left-behind wives of farmers.

Key Words: Agricultural distress, Debt burden, Farmer suicides, Household income, Left-behind wives, Psychological distress, Socio-economic distress.

INTRODUCTION

The deliberate and intentional taking of one's own life, known as suicide, is often impacted by socioeconomic crises. Agricultural distress has been a major cause of farmer suicide in several nations, including India, the United States, Australia, and France. Financial burdens, climate change, decreased farm revenues, and a lack of institutional assistance have all been highlighted as major contributors to suicides. The World Health Organization (WHO) and other researchers have found that agricultural laborers are more likely to commit suicide due to financial instability and issues with mental health, specifically in developing countries' agrarian economies. Farmer suicides in India continue to be a serious concern, with thousands of farmers killing themselves each year as a result of financial insecurity and agrarian crisis. Despite government-sponsored relief efforts, the crisis continues to impact rural agricultural communities. According to FAO 2020, 82 per cent of farmers are small and marginal farmers, while seventy per cent of rural

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families depend on agriculture as their major source of income. Agricultural productivity is directly related to the economic prosperity of the Indian population. But the agrarian crisis has grown exacerbated due to increasing input costs, decreasing crop prices, and the widening gap between the agricultural and non-agricultural sectors (Sangalad 2012; Kale *et al,* 2014; Singh and Singh ,2016; Bodke and Deshmukh, 2018; WHO, 2019; FAO, 2020; Patil and Hasalkar, 2020).

The National Crime Records Bureau (NCRB) reports that 11,290 farmers committed suicide in 2022 across the country. Between 2000 and 2015, more than 16,000 farmers and agricultural workers in Punjab, formerly known as the Granary of India, committed suicide. Significant debt, diminishing farm incomes, and a lack of alternative work options are major causes of these suicides. One of the most neglected and vulnerable populations in rural communities are the left-behind wives of farmers who committed suicide. These women suffer from great psychological and socio-economic challenges following the death of their husbands, who frequently were their primary breadwinners.

Farmer suicides in Punjab have a significant socio-economic impact on women who are left behind. A number of variables, including demographics, social inclusion, and financial stability, affect their economic status. These widows frequently find themselves forced into informal labour or dependent on insufficient government compensation due to their economic struggles, which include debt burden, limited access to credit, restricted ownership of property rights, and loss of household income. Across the country, women are still fighting for the right to live a dignified life. In every aspect of life, including work, health care, and property rights, women face obstacles. The problems that affect this segment of the population are still not receiving the necessary attention. In terms of demographics, caste, religion, and differences between rural and urban areas further influence their mobility, inheritance rights, and access to resources. Developing strategies that address their financial instability, social marginalization, and long-term well-being requires a thorough understanding of these socio-economic issues. (Padhi, 2009, 2012; Vasavi, 2012; Rao, 2014; Ghunnar and Hakhu, 2018; Jadhav *et al,* 2019; Sharma, 2019; Falnikar and Dutta, 2019; Mann and Chauhan, 2020; NCRB, 2020; Sahoo, 2020 Singh *et al,* 2021; Sharma and Jain, 2023). Hence, with this the present study was undertaken with specific objective of understanding the socio-economic characteristics of left-behind wives of farmer who committed suicide.

MATERIALS AND METHODS

The present study was based on primary data collected from rural Punjab during year 2023-24.The span of farmers' suicide considered under the study was from year 2015 till July, 2024. Government of Punjab entrusted three universities *viz.,* Punjab agricultural university, Ludhiana; Punjabi university Patiala; and Guru Nanak Dev university, Amritsar to conduct studies on farmer suicide between year 2000 till 2018 in the state. Based upon the data reported in these studies on number of farmer suicide committed in each district, three districts i.e. Bathinda, Mansa and Sangrur were purposively selected that from where the highest incidence of farmer suicides was reported. A snowball sampling technique was employed, with information on suicide cases obtained from village sarpanches, panchayat members, chowkidaars, and ASHA workers. The data were collected from total of 77 villages (29 in Bathinda, 27 in Mansa, and 21 in Sangrur) of three blocks from each district were selected. A proportionate random sample of 80 households from each district were undertaken to meet total sample size 240 requirements of the study. The widows of the farmers were the main respondents, data were also collected from farmers household using a structured interview schedule designed to assess socio-economic status of left behind. This paper includes the determinants related to the socio-economic profile of selected households of farmer who committed suicide viz. age, caste, education, headship, source of income, main occupation, type of house, type of family, size of family, number of dependents, working members, land ownership and operational holdings etc with

Table 1. Distribution of left behind wives according to their socio-economic characteristics.

Age at marriage (years)	Bathinda (n_1=80)	Mansa (n_2=80)	Sangrur (n_3=80)	Overall (n=240)
<18	16 (20.00)	13 (16.25)	20 (25.00)	49 (20.41)
18-20	48 (60.00)	41(51.25)	42 (52.50)	131 (54.58)
> 20	16 (20.00)	26 (32.50)	18 (22.50)	60 (25.00)
Age at widowhood (years)				
<=20	6 (7.50)	4 (5.00)	4 (5.00)	14 (5.83)
21-40	22 (27.50)	21(26.25)	20 (25.00)	63 (26.25)
41-60	16 (20.00)	33 (41.25)	27 (33.75)	76 (31.67)
>60	36 (45.00)	22 (27.50)	29 (36.25)	87 (36.25)
Literacy level				
Cannot read and write	36 (45.00)	31 (38.75)	34 (42.50)	101 (42.08)
Primary	12 (15.00)	16 (20.00)	10 (12.5)	38 (15.83)
Middle	20 (25.00)	14 (17.50)	14 (17.50)	48 (20.00)
Matric	6 (7.50)	14 (17.50)	15 (18.75)	35 (14.58)
Senior Secondary	5 (6.25)	3 (3.75)	6 (7.50)	14 (5.83)
Graduation	1 (1.25)	2 (2.50)	1 (1.25)	4 (1.66)
Caste				
Jat sikh	52 (65.00)	70 (87.50)	68 (85.00)	190 (79.17)
Scheduled Castes (SCs)*	13 (16.25)	6 (7.50)	8 (10.00)	27 (11.25)
Other Backward castes (OBCs)**	11 (13.75)	2 (2.50)	1 (1.25)	14 (5.83)
Others***	4 (5.00)	2 (2.50)	3 (3.75)	9 (3.75)
Type of family				
Nuclear	40 (50.00)	44 (55.00)	40 (50.00)	124 (51.67)
Joint	40 (50.00)	36 (45.00)	40 (50.00)	116 (48.33)
Type of house				
Kaccha	10 (12.5)	6 (7.5)	10 (12.5)	26 (10.83)
Pacca	42 (52.5)	37 (46.25)	39 (48.75)	118 (49.17)
Mixed	28 (35.00)	37 (46.25)	31 (38.75)	96 (40.00)
Land ownership				
Marginal Farmer (<2.5 acre)	45 (56.25)	36 (45.00)	40 (50.00)	121 (50.42)
Small Farmer (2.5-5 acre)	29 (36.25)	30 (37.50)	29 (36.25)	88 (36.67)
Semi medium and above (>5 acre)	6 (7.50)	14 (17.50)	11 (13.75)	31 (12.92)
Size of family				
Up to 3	27 (33.75)	35 (43.75)	29 (36.25)	91 (37.91)
4-6	47 (58.75)	43 (53.75)	48 (60.00)	138 (57.50)
More than 6	6 (7.50)	2 (2.50)	3 (3.75)	11 (4.58)

Working member in the family				
0	3 (3.75)	0 (0.00)	1 (1.25)	4 (1.67)
1	35 (43.75)	42 (52.5)	39 (48.75)	116(48.33)
2	34 (42.5)	28 (35.00)	34 (42.5)	96 (40.00)
3	7 (8.75)	9 (11.25)	4 (5.00)	20 (8.33)
4	1 (1.25)	1 (1.25)	2 (2.50)	4 (1.67)

Figures in parentheses indicate percentages
Note: SCs included Majabi Sikh, Ravidasiya, Ramdasiya, Sahota.*
*OBCs** included Bhaghu, Daheer, Dhimaan, Ghumiar, kharadhiya, Kurba.*
*Others*** included Khan, Khatri, Meghwal, Menre and Sharma*

an objective to understand the changing dynamics of left-behind wives and their households.

RESULTS AND DISCUSSION

The paper analyzed the socio-economic characteristics of left-behind wives of farmers who committed suicide in Punjab. The economic and social characteristics contains information of left-behind wives and other family members of farmers who committed suicide in Punjab which included age, education of respondent, religion, caste, head of household, family occupation, family annual income, family type, family size, ownership of house, type of house, land holdings, gender based dependency etc. The details of socio-economic characteristics are discussed in following tables.

Age at marriage

The data (Table 1) revealed that one-fifth (20.41%) of the respondents got married before they attained the age of 18 years, with the highest percentage in Sangrur (25%) followed by Bathinda (20%) and Mansa (16.25%). More than half (54.58%) of the respondents got married between the age of 18 years to 20 years, with three fifths (60%) proportion of Bathinda. Another one fifth of respondents got married after 20 years of their age.

Age at widowhood

Widows of farmers who committed suicide often belonged to a wide age range, from young women in their 20s to elderly women in their 60s or beyond. It was unfortunate to reveal that 5.83 per cent of the respondents got widowed up to 20 yrs of their age. Another one fourth (26.25%) got widowed between the age of 21-40 yrs followed by another 31.67 per cent who got widowed between 41-60 yrs of their age. Thirty-six per cent of the women's husbands committed suicide after they attained 60 yrs of their age. Not much district wise difference was found as for age at widowhood was concerned.

Literacy level

Education influences social structures, rules, regulations, and interactions, which help shape society. The data revealed that significant majority (42.08%) of left behind farmers' widows were illiterate; they were unable to read or write, putting them in vulnerable position. Another one fifth (20%) were educated up to middle only. Data further revealed that just 5.83 per cent and 1.66 per cent of the women were educated up to senior secondary and graduation level respectively. Hence, it could be said that literacy level of left behind wives of farmers of these three districts was quite low.

Caste

Caste refers to the system that classifies people into groups based on their birth. Caste is a type of social stratification in which individuals are classified into hierarchical groups based on cultural, economic, and social characteristics. The caste-wise distribution of respondents was taken in to account found that the majority of the farmers who committed the suicide were *Jat Sikhs* (79.17%) followed by Scheduled Castes (11.25%) and Backward Castes (5.83%) across all the three districts. This data indicated a large percentage of

Table 2. Distribution of households according to their headship, dependents, operational land holding and family income.

Head of household	Bathinda (n_1=80)	Mansa (n_2=80)	Sangrur (n_3=80)	Overall (n=240)
Self	37 (46.25)	49 (61.25)	48 (60.00)	134 (55.83)
Father in-law	15 (18.75)	13 (16.25)	16 (20.00)	44 (18.33)
Mother in-law	2 (2.50)	4 (5.00)	8 (10.00)	14 (5.83)
Second husband	5 (6.25)	9 (11.25)	4 (5.00)	18 (7.50)
Son	19 (23.75)	5 (6.25)	2 (2.50)	26 (10.83)
Father	1 (1.25)	0 (0.00)	1 (1.25)	2 (0.83)
Brother in-law	1 (1.25)	0 (0.00)	1 (1.25)	2 (0.83)
Dependents				
Total dependents	2.46 (59.70)	2.08 (54.43)	2.34 (59.18)	2.29 (57.83)
Male dependents	0.94 (38.07)	0.89 (42.77)	0.88 (37.43)	0.90 (39.27)
Female dependents	1.53 (61.93)	1.19 (57.23)	1.46 (62.57)	1.39 (60.73)
Average family size	4.13 (100.00)	3.81 (100.00)	3.95 (100.00)	3.96 (100.00)
Operational land holdings (Average number)				
Owned land (in acres)	2.97 (100.59)	3.38 (129.74)	2.99 (123.45)	3.11 (117.06)
Leased in	1.29 (43.64)	0.74 (28.54)	0.88 (36.34)	0.97 (36.49)
Leased out	1.31 (44.24)	1.52 (58.27)	1.45 (59.79)	1.42 (53.55)
Operational land	2.95 (100.00)	2.61 (100.00)	2.43 (100.00)	2.66 (100.00)
Family income (Rupees)				
Agriculture	281637 (67.00)	267112 (62.64)	235050 (57.10)	261266 (62.28)
Dairy	29437 (7.00)	32950 (7.73)	43800 (10.64)	35395.83 (8.44)
Services*	81000 (19.27)	69150 (16.22)	94950 (23.06)	81700 (19.48)
Self employed	5100 (1.21)	32100 (7.53)	11850 (2.88)	16350 (3.90)
Income from other sources**	23175 (5.51)	25125 (5.89)	26025 (6.32)	24775 (5.91)
Family income	420350 (100.00)	426437 (100.00)	411675 (100.00)	419487 (100.00)

Figures in parentheses indicate percentages

**Services included anganwadi workers, asha workers, conductors and job in schools*

***Income from other sources (rent from leased out land + Pension)*

victims' households among *Jat Sikhs* farmers, with substantially fewer cases among Scheduled Castes, OBCs, and other general castes.

Family type

The type of family has a significant impact on social dynamics, roles, and connections within a community. Overall, nearly half (51.67%) of the farmers' households in Punjab had nuclear family structure. Another half (48.33%) of farmers had joint families structure. In Mansa, the nuclear family system was more prevalent (55%) than the joint family (45%) as compared to Bathinda and Sangrur, whereas the trend of joint family and nuclear family accounted for equal proportions of 50 per cent. This suggests that both joint and nuclear family were prevalent across three districts, reflecting traditional family arrangements in Punjab.

Type of house

The study further highlights the type of houses of the farmers' households. Houses were classified into three categories, viz. *kaccha* (temporary or less durable buildings), *pacca* (permanent or substantial structures), or mixed (a combination of both types). Nearly half (49.17%) of the farmers' families resided in *pucca* houses; Bathinda had the highest proportion of families living in pucca houses (52.50%), while the Mansa had the lowest proportion (46.255%). It is surprising to reveal that still 10.83 per cent of households of farmers had *kaccha* houses, with Bathinda and Sangrur accounting for 12.50 per

cent each. Another 40 per cent had mixed houses. This suggested that some households continue to live in more unstable or temporary conditions, most likely due to economic challenges. The mixed and *Kaccha* houses revealed regional economic disparities.

Land ownership

The data based on land ownership reveal that the majority of respondents belonged to the marginal (50.42%) and small (36.67%) farming households. However, 12.92 per cent also belonged to semi medium and above farming category. This substantiated the fact, that majority of farmer who committed suicide belonged to marginal and small farming category.

Family size

Family size refers to the total number of family members living together in a household. The data present the distribution of households in Bathinda, Mansa, and Sangrur based on family size and the number of working members. The data indicated that nearly forty per cent (37.91%) of farmer households had a small family size (up to three members), with Mansa had a slightly higher percentage of smaller families, accounting for 43.75 per cent. The most common family structure in the area consisted of four to six members, making up 58 percent of households, with the highest proportion in Sangrur (60%). Larger families, consisting of more than six members, relatively few, comprised only 4.58 per cent of the total sample, with Bathinda showing the highest percentage (7.50%). In terms of working members in the family, half of the households (48.33%) had just one earning member in the study area with the highest proportion in Mansa (52.5%). Another forty per cent of households had two earning members. Study further found another 8.33 per cent of households had 3 earning members. Not much district wise difference was found as for earning member per households was concerned. Another nearly 2 per cent (1.67%) were the households who did not have a single working member left after farmer committed suicide, with Bathinda recorded the highest proportion (3.75%).

Headship

The term head of household refers to the person or individual in charge of the household's finances, decision-making, and sustaining dependents. Data (Table 2) highlighted that more than half (55.83%) of the widowed women were themselves the head of households after their husbands committed suicide. In other cases father in-law (18.33%), mother in-law (5.83%) and son (10.83%) headed the households after farmer committed suicide. For another 7.50 per cent of widowed women who got remarried, their second husband headed the household. Mansa had the greatest percentage (11.25%) of headship by the second husband, also indicating a stronger acceptance of remarriage in Mansa across three districts of Punjab. The data thus revealed the complex relationship between gender norms and traditional family systems in the Punjab.

Dependents

The data (Table 2) further revealed that the average family size was 3.96. The overall dependency ratio was high with an average of 2.29 dependents per household, including 1.39 of females and 0.90 of male dependents. Dependents formed a significant portion of the household structure, particularly in Bathinda (59.70%) and Sangrur (59.18%), indicating an economic burden on earning members. Moreover, the proportion of dependent females was higher across all districts, with the highest proportion (62.57%) in Sangrur and lowest (57.23%) in Mansa. In Contrast, dependent males were highest (42.77%) in Mansa and lowest (37.43%) in Sangrur.

Operational holdings

The average size of owned land among the sampled households was 3.11 acres. A district-wise comparison reveals that Mansa (3.38) had a comparatively larger size of owned land compared to Sangrur (2.99) and Bathinda (2.97). A paradoxical situation was observed the sampled households as for operational land holdings were concerned. While, the majority of the studies revealed greater operational land holdings compared to owned land, an opposite trend was observed in the study area. Here average

operational land holding was (2.66 acres) with Bathinda (3.95 acres) having larger operational land holdings compare to Mansa (2.61 acres) and Sangrur (2.43 acres). In absence of working members due to farmer suicide, households had leased-out (1.42 acres) their land in greater proportion than the one who opted for leasing-in (0.97 acres) land. It was found that due to absence of male member in the family, leased-out land was greater than leased-in land across all districts among the sampled households.

Family Income

In the context of farmers, income typically stems from the sale of crops, livestock or other agricultural products. It directly influences their ability to sustain their livelihoods, invest in better farming practices, and cope with challenges such as crop failure, debt, or economic crises. A lack of income can lead to a downward spiral of poverty and increased vulnerability to external shocks, often contributing to mental health struggles and, in extreme cases, suicides. The values (Table 2) revealed the average total annual income of households of farmers across three districts were ₹4,19,487 per year. Mansa had the highest total income of ₹4,26,437**,** while Sangrur had the lowest share, i.e. ₹4,11,675. Agriculture was main source (contributing 62.28% of the total income) of income, with ₹2,61,266 of family income across all districts. Bathinda had the highest proportion at ₹281637 (67%). Services provided the second largest share (19.48%) with average annual income of ₹81700. Sangrur had the highest proportion at ₹94950 (23.06%). This was followed by dairy farming, accounting for ₹35395 (8.44%). Additionally, self-employment income was relatively low at ₹16350 (3.90%). Mansa had the highest proportion (7.53%), where it stood at ₹32100. The remaining 5.91 per cent income came from other sources, which included rental income from leased-out land and pensions played a smaller but steady role in overall household earnings, averaging ₹24,775 across three districts. This data reflected the economic diversity and reliance on agriculture while highlighting the smaller yet significant roles of dairy, services, and other supplementary income sources in these areas.

CONCLUSION

The socio-economic profile of left-behind wives of farmers who committed suicide reveals an intensely vulnerable position of these widows who were struggling with financial insecurity and were solely (55.83%) carrying family responsibilities. Economic distress, primarily driven by agricultural debt, low households income pushes these women into fragile living conditions. The significant majority (77.91%) being either illiterate or lowly educated, got married even before attaining legal age at marriage (20.41%) were left alone to fend for themselves and their families after farmers' suicide. The majority being marginal (50.42%) and small (36.67%) farmers from *Jat Sikhs* (79.17%) caste with primary source of income (62.28%) from agriculture alone placed their women folk at doubly disadvantaged position with the suicide of their primary bread winner. Policy interventions for left-behind wives of farmers who committed suicide should focus on financial stability, land security and income diversification to support. Livelihood support through skill development programs, self-help groups, and employment under government schemes can enhance their financial independence.

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Status and Screening of Brown Leaf Spot of Rice in Districts of Madhya Pradesh

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ABSTRACT

Rice (*Oryza sativa* L.) is a staple food for nearly half of the world's population. Its production is significantly affected by various biotic stresses, with fungal diseases causing major economic losses. One such disease is brown spot, caused by the Deuteromycetes fungus *Bipolaris oryzae* (teleomorph *Cochliobolus miyabeanus*), which is a significant challenge in all rice-growing regions. Given the significance of brown spot disease in rice, the current investigations aimed to: know the status of the disease and screen various rice varieties for their resistance to brown spot. A roving survey was conducted to determine the incidence and severity of brown leaf spot disease of Madhya Pradesh. The survey studied revealed that the disease was present in most of the areas, with incidences ranging from 6.52 to 32.51 per cent and severity from 7.14 to 39.54 per cent. One hundred rice varieties were screened to determine their response to the brown spot pathogen. The results indicated that only one variety, JRH-19, was highly resistant. Sixty varieties were moderately resistant, with 5.1 to 25 percent of the leaf area affected. One variety, Kranti, was found to be highly susceptible to brown leaf spot disease.

Key Words: Brown leaf spot, Incidence, Rice, Severity, Screening.

INTRODUCTION

Rice (*Oryza sativa* L.) is a second most staple food cereal crop that feeds approximately half of the global population. India is the world's second largest producer of rice in terms of both area and production, after China. (Gharde *et al,*2018). Rice has a significant role in both life support and economic development around the world. The year 2004 was declared as the "International Year of Rice," with the theme of "Rice is Life," which demonstrates the importance of rice to be the main source of food and results from a recognition that rice-based structures are required for food safety, alleviation of poverty, and enhanced living.

Rice serves as a primary host for *Bipolaris oryzae*. Approximately 23 grass genera and 20 Oryza species have been identified as vulnerable to *B. oryzae* infection in controlled inoculation conditions. However, instances of natural infection in non-rice hosts are uncommon, with the exception of *Zizania aquatica* (wild rice) (Bean and Schwartz in 1961), *Leersia hexandra* (southern cut grass), and *Setaria italica* (German millet) (CPC, 2001). Brown leaf spot of rice caused by *Bipolaris oryzae* (*Breda de Haan*) Shoemaker (= *Helminthosporium oryzae* teleomorph = *Cochliobolus miyabeanus*) has been observed in Japan since 1900. Brown spot leads to reductions in both the quantity and quality of rice crop. The disease has been observed in all rice-growing countries, including Japan, China, Myanmar, Sri Lanka, Bangladesh, Iran, Africa, South America, Russia, North America, and the Philippines (Khalili *et al,* 2012).

In India, brown leaf spot of rice is prevalent in most of the rice-growing states. It was first discovered in Madras (1919) by Sundararaman (1922). This disease is widespread across rice-

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Table 1. Brown spot disease rating scale .

Disease Score	Affected leaf area
0	Spot are not present
1	Small brown speaks of pin point size on lower leaves.
3	Small roundish necrotic brown spots, about 1 -2 mm in diameter, with a distinct brown margin, significant numbers of spots on the upper leaves
5	Typical susceptible brown spot, 3 mm or larger infecting 4-25 percent of the leaf area.
7	Typical susceptible brown spot, 3 mm or larger infecting 26 -50 per cent of the leaf area.
9	Typical susceptible brown spot, 3 mm or larger infecting more than 75 percent of the leaf area.

Samples were taken from the surveyed region, and the Percent Disease Index (PDI) was computed utilizing the formula of Wheeler (1969)

$$PDI = \frac{Sum\ of\ all\ disease\ ratting}{Total\ no.\ of\ leaves\ observed\ x\ Maximum\ grade} x100$$

growing regions worldwide. It tends to be particularly problematic in areas with heavy rainfall, such as Himachal Pradesh, Jammu and Kashmir, Uttarakhand, the coastal regions of Kerala and Karnataka, the Brahmaputra valley of Assam, and West Bengal. The disease tends to be more severe in regions where dry or direct-seeded rice cultivation practices are common, notably in the states of Bihar, Chhattisgarh, and Madhya Pradesh. The disease is critical in many places, resulting in significant grain output losses (up to 90%) when leaf spotting becomes epiphytic, as seen during the Great Bengal famine of 1942 (Ghose *et al,* 1960; Safdar and Rais 2024).

Bengal faced a devastating famine in 1943, killing 2 million people due to malnutrition, and many of them moved to other place as the rice crop was damaged by the fungus *Helminthosporium oryzae*, which caused brown spot (Padmanabham, 1973). This is also known as the disease of poor farmers, who are unable to supply all the requirements of crop. The disease arises especially when water availability is limited, and associated with nutritional imbalances, particularly a deficiency of nitrogen.

The pathogen, *Bipolaris oryzae*, infects various parts of the rice plant including the coleoptiles, leaf sheath, leaves, panicle, branches, glumes, and spikelets. This disease induces seedling blight characterized by small, circular lesions that are yellow or brown in colour. These lesions have the potential to encircle the coleoptiles, leading to distortion of primary and secondary leaves, (Webster and Gunnel in 1992). The current research aims to achieve the documentation and screening of different varieties of rice for their response against *Helminthosporium oryzae* causing brown leaf spot of rice in different districts of Madhya Pradesh.

MATERIALS AND METHODS

The study was carried out during 2023-24 for screening at Jawaharlal Nehru Krishi Vishwavidyalaya in Jabalpur, Madhya Pradesh, specifically at the Breeder Seed Production Unit, College of Agriculture, JNKVV, Jabalpur where rice germplasm was cultivated. The investigation details include the materials used and the methodology adopted, outlined under the following headings.

Survey of brown spot of rice in different districts of Madhya Pradesh

A survey was conducted during the 2022-23 kharif season in the primary rice-growing districts of Jabalpur division of Madhya Pradesh. The aim was to assess the severity of brown leaf spot disease in paddy fields. During the investigation, paddy plants displaying symptoms of brown spot disease were identified and selected

Table 2. Details of 0-9 scale used to determine the severity of brown spot disease.

Disease score	Disease severity (affected leaf area %)	Host reaction
0	No incidence	Immune (I)
1	[illegible]	Highly Resistant (HR)
3	1.1-5	Resistant (R)
5	5.1-25	Moderately Resistant (MR)
7	25.1-75	Susceptible (S)
9	[illegible]	Highly Susceptible (HS)

Table 3. Disease incidence and severity of brown spot of rice in Jabalpur division of Madhya Pradesh during *Kharif* 2023.

District	Tehsil/Taluk	Village	Variety	Disease incidence	Disease severity
Jabalpur	Jabalpur	Gwarighat	MTU-1010	18.64	15.63
		Bamhori	1121	11.69	10.94
	Panagar	Keolari	PS-4	12.59	14.63
		Pipariya	Mahamaya	21.64	17.51
	Sihora	Ghatsemirya	Kranti	27.51	21.89
		Majhgawan	Swarna	19.16	21.61
	Patan	Nunsar	Kranti	28.57	26.95
		Pakariya	MTU-1010	17.69	16.61
Mean				19.68	18.22
Katni	Badwara	Majhgawan	PS-5	12.13	13.12
		Bijori	PS-4	11.64	11.31
	Barhi	Kanwara	Kranti	14.51	13.16
		Karmore	MTU-1010	17.67	16.74
	Murwara	Pipraundh	Chatri	13.51	18.94
		Banda	Chatri	12.89	14.53
	Rithi	Kharkhari	MTU-1010	17.14	18.61
		Barkheda	PS-4	19.76	18.16
				14.90	15.57
Narsinghpur	Gadarwara	Sahpur	PS-5	9.54	11.51
		Vijanpur	PS-5	11.14	9.64
	Gotegaon	Karakbel	MTU-1010	10.16	9.52
		Belkheda	MTU-1010	9.19	8.63
	Kareli	Gobargaon	PS-4	8.74	10.97
		Manegaon	PS-4	13.73	11.89
	Narsimhapur	Jhirikala	Swarna	12.54	12.79
		Bhesapala	Mahamaya	11.33	13.84

for sampling. The severity of the disease was assessed using the Standard Evaluation System (SES) for rice, which utilizes a scale ranging from 0 to 9 as given table-1.

Screening of different varieties of rice for their response against pathogen

The investigation aimed to identify resistant sources against brown spot disease at the Experimental Breeder Seed Production, Unit, JNKVV, Jabalpur during the Kharif season of 2023-24.

One hundred different varieties of rice were collected from the Breeder Seed production unit, JNKVV-Jabalpur. These rice varieties were screened using the Standard Evaluation System (SES) scale for brown spot disease of rice**.** The

District	Tehsil/Taluk	Village	Variety	Disease incidence	Disease severity
		Vijanpur	PS-5	11.14	9.64
	Gotegaon	Karakbel	MTU-1010	10.16	9.52
		Belkheda	MTU-1010	9.19	8.63
	Kareli	Gobargaon	PS-4	8.74	10.97
		Manegaon	PS-4	13.73	11.89
	Narsimhapur	Jhirikala	Swarna	12.54	12.79
		Bhesapala	Mahamaya	11.33	13.84
Mean				10.79	11.09
Seoni	Seoni	Alonia	Kranti	6.52	7.14
		Bamodhi	PS-4	8.92	10.57
	Barghat	Kasmi	PS-4	11.74	10.64
		Dhapara	Swarna	13.14	11.51
	Kurai	Arjuni	Mahamaya	9.53	10.13
		Dungariya	PS-5	10.11	10.74
	Dhanora	Amoli	Swarna	11.59	12.59
		Balpura	Kranti	13.79	12.78
Mean				10.66	10.76
Chhindwara	Amarwara	Badegaon	PS-5	13.74	12.84
		Kekda	PS-5	16.19	15.64
	Bichhua	Chicholi	MTU-1010	18.59	17.12
		Jaitpur	MTU-1010	17.71	16.56
	Chaurai	Bari	PS-4	12.54	18.74
		Dhaulpur	PS-4	18.14	16.63
	Chindwara	Gadhmari	Swarna	17.32	16.13
		Dewardha	Mahamaya	15.15	16.68
Mean				16.17	16.29
Mandla	Nainpur	Hirapur	Kranti	29.16	30.54
		Dithori	PS-4	27.84	32.64
	Niwas	Harduli	PS-4	19.99	38.74
		Kohani	Swarna	20.87	39.54
	Mandla	Amangaon	Mahamaya	26.74	19.98
		Dehra	PS-5	28.64	25.64
	Bichhiya	Dilwara	Swarna	27.54	31.59
		Khamtipur	Kranti	30.64	33.63
Mean				26.42	31.53
Balaghat	Katangi	Nandora	MTU-1010	25.44	30.71
		Khamariya	Swarna	27.84	31.52
	Kiranpur	Amagaon	PS-4	29.54	30.74
		Hatta	MTU-1010	28.74	33.39
	Balaghat	Rajegaon	Kranti	25.94	30.13
		Changotola	MTU-1010	28.14	31.59
	Lanji	Chicholi	Swarna	30.74	36.96
		Biranpur	Swarna	28.56	33.74
Mean				28.11	32.34
Dindori	Dindori	Deopada	MTU-1010	22.14	30.61
		Chandikapur	Swarna	12.94	16.16
	Amarpur	Karanpura	PS-4	30.64	28.94
		Lalpur	MTU-1010	28.59	30.14
	Samnapur	Atariya	Kranti	26.43	31.59
Mean				26.05	28.64

Table 4. District wise data of incidence and severity of brown leaf spot of rice in Madhya Pradesh (Jabalpur division).

Districts	Disease incidence (DI)	Disease severity (DS)
Jabalpur	19.68	18.22
Katni	14.90	15.57
Narsinghpur	10.79	11.09
Seoni	**10.66**	**10.76**
Chhindwara	16.17	16.29
Mandla	26.42	31.53
Balaghat	**28.11**	**32.34**
Dindori	26.05	28.64

Table 5. Field evaluation of rice varieties against brown spot caused by *H. oryzae*

Sr. No.	Rice varieties	Disease severity % (65 Days after transplanting)	Host reaction	Score
1	JRH-19	1.00	HR	1
2	NPT-83	4.44	R	3
3	PB-1121	2.22	R	3
4	JRH-8	2.22	R	3
5	JRH-5	3.33	R	3
6	JR-81	2.22	R	3
7	PUSA JRH -56	2.22	R	3
8	PB-5	4.44	R	3
9	JR-21	3.33	R	3
10	JR-4	2.22	R	3
11	JNPT-10-17	2.22	R	3
12	JRB-1	2.22	R	3
13	JNPT-581-64	3.33	R	3
14	JR-10	6.66	MR	5
15	Kalli Mooch	7.77	MR	5
16	Londi	12.22	MR	5
17	JRH-141	10.00	MR	5
18	JNPT-14-7	8.88	MR	5
19	JR-206	17.17	MR	5
20	Naveen	13.13	MR	5
21	MTU-1010	14.14	MR	5
22	Kalli Kumol	8.88	MR	5
23	PB-1637	23.33	MR	5
24	IR-64	16.66	MR	5
25	Assam Koti	12.12	MR	5
26	PS-4	16.16	MR	5
27	JNPT-1058	12.12	MR	5
28	JRH-139	10.00	MR	5
29	JNPT-19	16.66	MR	5
30	Sonam	14.44	MR	5
31	JNPT-828	18.88	MR	5
32	JNPT-124-64	8.88	MR	5
33	JNPT-822	15.55	MR	5
34	Dubraj	20.00	MR	5

Sr. No.	Rice varieties	Disease severity % (65 Days after transplanting)	Host reaction	Score
35	PB-1509	22.22	MR	5
36	JNPT-827	15.55	MR	5
37	JNPT-505-53	6.66	MR	5
38	JNPT-831	14.44	MR	5
39	DR-199-5	16.16	MR	5
40	JNPT-517-85	17.17	MR	5
41	Pusa Sambha-1853	15.55	MR	5
42	JRH-142	8.88	MR	5
43	Kalli Namak	6.66	MR	5
44	PB-1460	23.33	MR	5
45	Bhaisan	13.33	MR	5
46	DRR-45	7.77	MR	5
47	PB-1718	23.33	MR	5
48	JNPT-105	17.17	MR	5
49	JNPT-14-5	13.33	MR	5
50	Sonam Surbhi	14.44	MR	5
51	JR-33	10.00	MR	5
52	JNPT-832	15.55	MR	5
53	Kshatriya	16.66	MR	5
54	PRH-60	22.22	MR	5
55	Mahamaya	8.64	MR	5
56	Dhanteswari	17.17	MR	5
57	DRR-48	10.10	MR	5
58	MTU-1080	14.14	MR	5
59	PB-1	21.11	MR	5
60	JGL-1928	18.18	MR	5
61	JNPT-570-64	11.11	MR	5
62	BJR-11	15.55	MR	5
63	JRH-138	12.22	MR	5
64	PB-1847	7.77	MR	5
65	PB-1885	11.11	MR	5
66	WGL-14	30.00	MR	5
67	PB-1886	48.48	MR	5
68	JR-201	16.16	MR	5
69	JR-81	7.77	MR	5
70	JNPT-829	17.77	MR	5
71	Pusa Sambha-1850	20.00	MR	5
72	JNPT-8116	22.22	MR	5
73	JNPT-14-6	10.00	MR	5
74	Madurai	16.66	MR	5
75	JNPT-10-17	23.33	MR	5
76	DRR-49	54.44	S	7
77	MR-219	41.11	S	7
78	MTU-1081	44.44	S	7
79	JGL-3228	42.22	S	7
80	PUSA-4	51.11	S	7
81	JNPT-14-4	31.11	S	7
82	OR-1985	51.11	S	7
83	JR-137	28.88	S	7

Sr. No.	Rice varieties	Disease severity % (65 Days after transplanting)	Host reaction	Score
84	PB-7	46.46	S	7
85	Swarna	55.55	S	7
86	Pusa-1460	48.88	S	7
87	PB-1692	27.77	S	7
88	JRH-140	30.00	S	7
89	JNPT-1059-9	26.66	S	7
90	JRH-143	31.11	S	7
91	WGL-32183	31.11	S	7
92	Falguni	38.88	S	7
93	PB 1121	42.32	S	7
94	MR-220	51.11	S	7
95	PB-1401	37.77	S	7
96	Chatri	46.66	S	7
97	WGL-32100	30.00	S	7
98	JNPT-14-3	35.55	S	7
99	WGL-23985	37.77	S	7
100	Kranti	77.77	HS	9

Table 6. Field evaluation of rice varieties against brown spot caused by *H. oryzae*

Disease Score	Affected leaf area	Host Response	Varieties	Total no. of varieties/host response
0	0	Immune (I)	0	0
1	Less than 1%	Highly Resistant (HR)	JRH-19	1
3	1.1-5%	Resistant (R)	NPT-83, PB -1121, JR21, JR -4, PB -5, JRH -5, JRH -8, JR -21, JRB-1, PUSA JRH-56, JNPT-581-64, JNPT-10-17	12
5	5.1-25%	Moderately Resistant (MR)	JR-206, MTU -1010, Naveen, PB -1885, PB -1847, JR -10, PS -4, JRH-138, Kalli kumol, PB -1718, Londi, JR -201, JNPT -505-53, JRH-141, Kshatriya, JNPT -1017, JNPT -822, JNPT -124-64, Sonam, Dubraj, JNPT-14-7, PB-1509, IR-64, JNPT-14-6, JNPT-828, JNPT -827, Assam kot i, PB -1637, JNPT -15-5, Sonam, Surbhi, JNPT -831, JNPT -832, Kalli -namak, Mahamaya, JNPT -8116, JNPT -1058, JR81, Pusasambha1850, Madu rai, JNPT -19, JR-33, JNPT-829, JRH-142, Pusasambha-1853, JRH-139, JNPT-105, PB -1, PRH -60, PB -1460, BJR -11, JGL -1928, DRR -45, Bhaisan, DR199 -5, JNPT -570-64, Dhanteswari, JNPT -517-85, MTU-1080, DRR-48, Kalli mooch.	60
7	25.1-75%	Susceptible (S)	MTU-108, JR -137, Chatri, PB -1692, JNPT -14-3, WGL -14, JNPT-1059-9, PB -1886, JGL -3228, JRH -140, Pusa -4, DRR -49, PB-7, MR-219, Falguni, PB -1121, Swarna, JR H -143, MR-220, PB-1401, WGL-32100, Pusa-1460, OR-1985, JNPT-14-4, WGL-23 985, WGL-32183.	26
9	>75%	Highly Susceptible (HS)	Kranti	1

screening was conducted under field conditions at 65 days after transplanting at the BSP Unit, JNKVV Jabalpur (Table 2).

RESULTS AND DISCUSSION

An survey was carried out in the major rice-growing areas of Madhya Pradesh. The survey covered thirty-two taluks across eight districts: Jabalpur, Katni, Narsinghpur, Seoni, Chhindwara, Balaghat, Mandla, and Dindori, during the Kharif season of 2023. During the survey scoring of the leaves was done as per 0-9 scale (table 1) mentioned in material and methods and data presented in table 3 disease incidence (DI) and disease severity (DS).

The perusal of the data (Table 3) revealed that the brown leaf spot was observed in all areas of the Jabalpur division of Madhya Pradesh. Disease incidence ranged from 6.52 to 32.51 per cent and disease severity ranged from 7.14 to 39.54 per cent.

Scenario of the disease at village level

Among the different villages surveyed, the maximum mean disease incidence (32.51%) was recorded in Amadongri village of Dindori district while the minimum (6.52%) was recorded in Alonia village of Seoni district. Whereas the maximum mean disease severity (39.54%) was recorded in Kohani village of Mandla district while the minimum severity (7.14%) was recorded in Alonia village of Seoni district.

Scenario of the disease at district level

Among the different districts surveyed, the maximum mean disease incidence (28.11%) was recorded in Balaghat district, followed by Mandla (26.42%), Dindori (26.05%), Jabalpur (19.68%), Chhindwara (16.17%), Katni (14.90%) and Narsinghpur (10.79%) in descending order. The minimum disease incidence (10.66) was recorded in Seoni district (Table 4). Further, similar trend was observed for disease severity which was maximum (32.34%) in Balaghat district, followed by Mandla (31.53%), Dindori (28.64%), Jabalpur (18.22%), Chhindwara (16.29%), Katni (15.57%) and Narsinghpur (11.09%). The minimum disease severity (10.76%) was recorded in Seoni district (Table 4).

Screening of different varieties of rice for their response against *Helminthosporium oryzae*

Out of 100 varieties evaluated, one variety (JRH-19) was shown to be highly resistant to brown leaf spot disease, with less than 1% of the leaf area affected, and twelve varieties (NPT-83, PB-1121, JR21, JR-4, PB-5, JRH-5, JRH-8, JR-21, JRB-1, PUSA JRH-56, JNPT-581-64, and JNPT-10-17) were resistant having 1.1 to 5% leaf area affected, (Table 5 & 6).

Sixty varieties were found to be moderately resistant with 5.1 to 25 percent of the leaf area affected whereas One variety (Kranti) was shown to be found highly susceptible to brown leaf spot disease, with more than 75% of the leaf area affected, Table 06.

CONCLUSION

Given the significance of brown spot disease in rice, the current investigations aimed to screen various rice varieties for their resistance to brown spot. A survey of farmers' fields in the major rice-growing regions of the Jabalpur division of Madhya Pradesh revealed that brown leaf spot incidence and severity varied from one location to the next due to varying environmental conditions, cropping patterns, and inoculum buildup. During the survey, disease incidences ranged from 6.52% to 32.51%, and disease severity ranged from 7.14% to 39.54%. Screening of 100 rice varieties indicated that only one variety, JRH-19, was highly resistant to brown leaf spot disease. Sixty varieties were moderately resistant, with 5.1 to 25 percent of the leaf area affected. One variety, Kranti, was found to be highly susceptible to brown leaf spot disease.

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Studies on Biology of Mulberry Silkworm (*Bombyx Mori* L.) Feeding on Mulberry

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ABSTRACT

The studies on biology of mulberry silkworm on V1 variety of mulberry were carried out under laboratory conditions from March 2024 to April 2024. The durations of life stages were recorded from egg hatching till emergence of adults . Female laid eggs singly, that were round, ellipsoidal, with a flat ventral side and a tiny depression in the centre that consist of sticky substance with 164±43.18 eggs per female. First instar larvae known as chawki worms have yellowish-brown body coloration and no markings on their bodies. The second to fifth abdominal segments were marked with two circular brown spots on both second and third instar larvae. The larvae in their fifth and fourth stages were entirely white. After four moults, the larva reached full maturity in 23.5±2.08 days. After that, the pupal stage lasts for 9.75±1.70 days. Before emerging as an adult, the pupa secretes an alkaline fluid that is brown in colour. This fluid softens the end of the cocoon and causes the silk strands to break down. Female moth lived longer as compared to male moth. The dimensions for length and breadth of the male and female moths were 1.412± 0.21cm and 1.846± 0.21cm and 0.532± 0.12cm and 0.592± 0.06cm, respectively. Thus, this study helps to understand the biology and economic benefits of rearing silkworm in the South-Western Punjab.

Key Words: *Bombyx mori,* Biology , Lifecycle, Sericulture, Silkworm.

INTRODUCTION

Sericulture is a rural agro-based industry that combines aspects of farming and village industry (Gurjar *et al,*2018). It is a long-standing land-based practise in India that provides agrarian families with economic benefits and the opportunity for significant employment (Shewale, 2023; Kallamannavar *et al* , 2024). It is notable for its quick and minimal investment strong profits, which make it a perfect sector or business and fit in well with India's socioeconomic structure. It is appropriately referred to be the Kalpvriksha or Kamdhenu of the poor farmers (Sharnagat *et al,* 1994).

The four distinct types of silk *i.e.* Mulberry, Eri, Muga and Tasar silk are uniquely produced in India. According to Anitha (2011), India has the highest possibility of being the only nation in the world to grow all four economically viable varieties of silk: mulberry, tasar, eri, and muga (Bhattarcharjya *et al*, 2020). Mulberry silkworm *(Bombyx mori*) belongs to the order Lepidoptera and family Bombycidae. The monophagous silkworm, only eats mulberry leaves (Saha *et al*, 2022). It is raised carefully in regulated captivity for the manufacturing of commercial silk thread in rural agro industries in tropical and subtropical areas (Soumya *et al*, 2017; Zhang *et al,* 2019).

As per Kim *et al* (2010) the sericulture industry is essential for improving the rural poor community's social and economic conditions. Unfortunately, Punjab state does not prioritise India's sericulture business as a cottage industry. For India's silkworm rearing efforts to be improved and enhanced, there is a dearth of trained personnel and cutting-edge research. While sericulture has thrived in various parts of India, the same cannot be said for Punjab, a state known for its agricultural prowess. To address these challenges

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and promote the growth of sericulture in Punjab, it is crucial to bridge the research gap and gather scientific insights into the biology and cultivation practices of mulberry silkworms. The current study was conducted at Guru Kashi University in Bathinda ,Punjab, to examine the biology of mulberry silkworms on the V1 type of mulberry plant. By studying various aspects of the silkworm's life cycle, including egg characteristics, larval stages, pupal period, cocoon morphology and the characteristics of adult moths, the purpose of this study is to close the current research gap and provide insightful information to Punjab's sericulture sector. The creation of focused policies and interventions to assist the expansion and sustainability of sericulture, which will eventually benefit rural people and economy as a whole, will be made easier with an understanding of the biology and unique difficulties faced by mulberry silkworms in this area.

MATERIALS AND METHODS

A trail was carried out at Sericulture Laboratory, Department of Entomology, Guru Kashi University, Talwandi Sabo, Punjab during March 2024 to April 2024. The disease-free immature larvae of Mulberry silkworm (*B. mori*) were acquired from Regional Sericultural Research Station, Sujanpur, Punjab and were maintained under the laboratory conditions at 25±2.58^{O}C and 53.75±11.08 % RH.

The mulberry leaves were collected from mulberry plants of V1 variety (Table 1) grown in Research Farm Area. The collected leaves were cleaned with the distilled water cut into small pieces (0.5 to 1.0 sq.cm) and given to the newly emerging larvae as food. These larvae were fed each day with mulberry leaves under hygienic conditions. Every day, four feedings of chopped mulberry leaves were provided at 8 a.m., 11 a.m., 3 p.m., and 6 p.m. The size of the chopped leaves was adjusted according on the larval instars. The larvae were not fed during their moulting period. The supply of food was increased in accordance with the silkworm's growth. The fully developed larvae were recognised as mature when they stopped feeding and become translucent with a creamy tint.

Hand-selected mature larvae were housed on mountages to make cocoons. After the adult emergence from cocoons, they were transferred onto the glossy paper sheets smeared with starch (it helps in easy separation of eggs from the sheet) for mating and egg laying. After the egg laying, the sheets containing eggs were kept in distilled water for removal of eggs in loose form and further stored under frozen conditions. The newly hatched larvae after each moult were moved into and kept separately in the 110 mm plastic petri plates while being fed on mulberry leaves. Ocular and stage micrometres were used to measure the size of each instar of the larva under a microscope. The entire period of the larval stages was calculated.

The time taken between pupal formation and the adult emergence was considered as pupal period. The cocoon's length as well as width was measured with a vernier calliper after the cocoon formation. When adults emerged from pupae, their colour and longevity were studied. Shape and the abdominal part were observed to distinguish between male and female adults. Female eggs were collected and counted every morning from 8:00am to 10:00am. Fecundity refers to the total number of eggs laid by an adult female in her lifespan. From the date of emergence to the time of adult mortality, the length of time for male and female moths was estimated individually.

RESULTS AND DISCUSSION

The female's newly deposited eggs were round, ellipsoidal, with a flat ventral side and a tiny depression in the centre. Eggs were pale white having a smooth chorion. Prior to hatching, it was entirely black during the time of oviposition. The reported results were consistent with Patel *et al* (2013).

Chawki worms have yellowish- brown body coloration and no markings on their bodies. The head was clearly apparent; it had a dark black colour with a glittering head capsule. The body was lengthy and covered in hairs in a dense pattern. The hairs were on the complete larvae body in a "C" shape. Two circular brown spots were present on both second and third instar larvae on the second to fifth abdominal segments. Eight abdominal segments were having o horn like

Table 1. Description of mulberry variety used in the study.

Variety	Characteristics
Victory1 (V1) Selection from a hybrid of S-30 and Ber	Erect branched, Ovate and truncate base, thick, succulent, smooth, glossy, good rooting ability and higher yield.

Table 2. Data on Morphometries of adults and cocoon of *B. mori.* *N= 40.*

Sr. No	Characteristic	Male			Female		
		Min.	Max.	Av.+ S.D.	Min.	Max.	Av.+ S.D.
1.	Adults length	1.18	1.73	1.412±0.21	1.60	2.10	1.846±0.21
2.	Adults breadth	0.36	0.68	0.532±0.12	0.48	0.72	0.592±0.06
3.	Adults wing span	3.20	3.50	3.33±0.12	3.68	4.15	3.946±0.20
4.	Cocoon	3.00	3.23	3.106±0.10	3.15	3.40	3.254±0.10

Table 3: Data on Biology of mulberry silkworm, *B. mori* on its host *M. alba*

Sr. No.	Particular	Number of larvae observed	Larval Period (days)		
			Min.	Max.	Mean± S.D.
A	Larval Stages				
	1^{st} instar	80	3	4	3.5±0.57s
	2^{nd} instar	80	3	4	3.75±0.50
	3^{rd} instar	80	4	5	4.5±0.57
	4^{th} instar	80	5	6	5.5±0.57
	5^{th} instar	80	6	7	6.5±0.57
	Total larval period (days)	80	21	26	23.5±2.08
B.	Pupal period (days)	80	8	12	9.75±1.70
C.	Oviposition Period (hrs)	80	12	24	17.75±4.92
D.	Adult longevity (days)				
	Male	80	4	5	4.75±0.50
	Female	80	5	6	5.5±0.57
E.	Fecundity (Number of eggs)	80	110	213	164±43.18
F.	Temperature (°C)		22	28	25±2.58
G.	Relative humidity (%)		40	65	53.75±11.08

projections. A last segment of mature larvae were wider than the others and also consists of a hairy edge. The larvae in their fifth and fourth stages were entirely white and had the same markings as the second and third instar, but they were more obvious. Throughout their life cycle, the larvae had four moults and passed through five distinct instars.

The mean larval duration observed was 3.5±0.57, 3.75±0.50, 4.5±0.57, 5.5±0.57 and 6.5±0.57 d for first, second, third, fourth, and fifth instar larvae, accordingly. The total period of developmental stages of larvae was 23.5±2.08 d (Table 3). When the larva in its last instar reached full maturity, it ceased feeding, displayed anxiousness, grew sluggish, gradually changed colour from white to light yellow, and raised its head to look for assistance in order to be able to begin spinning the cocoon, a sign that the larva was prepared for mounting on mountages. When a pupa first emerged, it was a bright yellow-brown coloration that subsequently turned dark brown. The average pupal period recorded was 9.75±1.70 days. A tough, one-threaded dirty white, oval in shape cocoon with one or two layers of hard, elastic protein was detected. The cocoon's length and width varied between 3.106± 0.10 and 3.254±

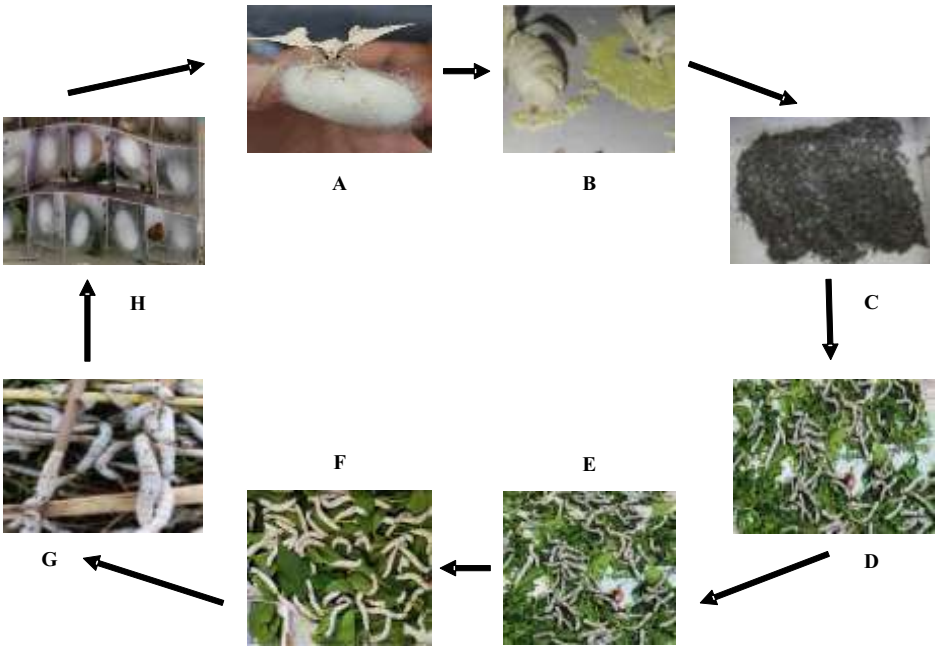

Fig. 1 A. Adult, B. Egg C. 1st instar larvae, D. 2nd instar larvae, E. 3rd instar larvae, F. 4th instar larvae, G. 5th instar larvae, H. Pupal stage of silkworm.

0.10 for male and female respectively. The reported results were consistent with Gurjar *et al* (2018).

Before emerging as an adult, the pupa secretes an alkaline fluid that is brown in colour. This fluid softens the end of the cocoon and causes the silk strands to break down, allowing the frail, crumpled adult to squeeze its way out. The male was a dirty white colour moth with bi-pectinate antennae, no ocelli, and present black compound eyes. Males were smaller than females and could be identified by their size of abdomen and black patterns on their fore and hind wings. The female moth had bi-pectinate antennae and had a dull white tint. The entire body and wings of adults were dirty, dull, white coloured, covered in a thin layer of scales, a tiny, hypognathous head, and a well-developed, coil-like proboscis. Male and female moths had wingspan measurements of 3.33± 0.12cm and 3.946± 0.20cm respectively. The dimensions for length and breadth of the male and female moths were 1.412± 0.21cm and 1.846± 0.21cm and 0.532± 0.12cm and 0.592± 0.06cm, respectively (Table 2). Similar type of results have been reported by Sangle *et al* (2022).

Fecundity data showed that the female laid 164±43.18 eggs during the course of the full ovipositional phase (Table 3). The total oviposition period was 17.75±4.92 hr. Male and female average ages at death were 4.75±0.50 and 5.5±0.57 d, respectively. These were in accordance with results obtained by Gurjar *et al,* (2018). The research highlighted India's potential to grow all four economically viable silk varieties, including mulberry silk, tasar silk, eri silk, and muga silk. The study revealed that *Bombyx mori,* which feeds on mulberry leaves, is a monophagous species that plays a vital role in commercial silk thread production. The findings call for increased investment and research in the sericulture industry to improve social and economic conditions in rural communities. It was found that the average larval period was 23.5±2.08 d while the pupal period lasted for 9.75±1.70d. The study also reported on the dimensions of adult moths, such as length, breadth, and wingspan, as well as the measurements of male and female cocoons. It was observed that female moths laid an average of 164±43.18 eggs during their oviposition phase, which lasted for 17.75±4.92 hr.

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Transforming Okra (*Abelmoschus esculentus L.*) Waste in to Wealth: Empowering Farmers Through Sustainable Handicrafts

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ABSTRACT

Okra (*Abelmoschus esculentus L.*), belonging to the family Malvaceae, is commonly known as Lady's finger, as well as by several vernacular names, bhindi, okura, quimgombo, bamia, gombo, and lai long ma, in the different geographical regions of its cultivation. Keeping in mind the importance of Handicraft and large production of Okra in the plains of Uttarkhand ,the indigenous technologies of making handicraft products was blend with okra fiber and beautiful products were made. One hundred and fifty women from different villages namely Charba, Atenbag, Sherpur, Bhood and Dhalipur from two blocks of Dehradun district who were already exposed to indigenous technology of handicraft products making of other fibers like Rambaans, Bheemal and Nettle, were given training about the extraction and making of handicraft products of okra fiber. The okra plants were bundled comprising of 70-100 plants. Each of these bundles was immersed in a concrete tank containing soft water and the stalks of the plant were tapped slightly with wooden hammer for removal of soft pulp, the fibers were separated thoroughly from the pulp, washed, combed and exposed to sunlight for two days until the odor was removed from fibers and used for handicraft making. Different parameters for acceptance and further adoption were studied so that further strategies could be planned to popularize among the farming communities. and it was observed that majority of the respondents learned this craft from elder family member (52.00%). Interest in craft and also to utilize free time were the two common reason for learning the craft of handicraft product making. Quality and fineness of okra fiber as fully accepted by majority of the respondents. The obstacle faced while adopting handicraft as occupation were also studied so that future strategies could be made after rectifying the problems.

Key Words: Fiber, Handicraft, Okra, Processing, Sustainable.

INTRODUCTION

Okra (*Abelmoschus esculentus L.*) of the family Malvaceae, known as Lady's finger, goes by numerous vernacular names such as okra, bhindi, okura, quimgombo, bamia, gombo, and lai long ma, depending on the geographical region where it is cultivated. The benefits of cultivating okra can be beneficial in dual way, as after harvesting the pods the whole plant may be utilized for fiber processing. After going through retting, washing, carding, fiber making the ultimately weaving to a fabric, this can be utilized in textile industry.

Handicraft making in Uttarakhand harnesses the rich bounty of natural fibers endemic to its terrain, such as Sisal, Agave, Bhimal, Jute, hemp, wool, and nettle. These fibers are sustainably harvested from the region's diverse flora, supporting local communities and preserving traditional craftsmanship. Uttarakhand's artisans skillfully weave these fibers into a myriad of products, including intricately

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patterned shawls, durable rugs, and sturdy baskets. Each piece not only reflects the natural beauty of the Himalayan foothills but also embodies a commitment to eco-friendly practices and cultural heritage. By promoting the use of natural fibers, Uttarakhand's handicraft industry not only sustains livelihoods but also contributes to global efforts in sustainable development and environmental stewardship. Keeping in mind the importance of Handicraft and large production of Okra in the plains of Uttarkhand ,the indigenous technologies of making handicraft products was blend with okra fiber and beautiful products were made.

MATERIALS AND METHODS

This unique work of making handicraft products from okra fiber was done in Dehradun district. As this was a new initiative taken by Krishi Vigyan Kendra Dehradun ,a limited number of rural community was aware about this. Hence, seven trainings were conducted during the year 2021-2023 to create awareness among the rural community regarding this new concept.One hundred and fifty women from Charba, Bhood, Sherpur Atenbag and Dhalipur of Vikasnagar and Sahaspur blocks of Dehradun district who were already exposed to indigenous technology of handicraft products making of other fibers like Rambaans, Bheemal and Nettle, were given training about the extraction and making of handicraft products of okra fiber. Twenty one days exhaustive training programme at Charba was also conducted on designing and making fiber products along with an NGO. Purposive sampling technique was followed to select the villages as well as the respondents and only those respondents who were practicing this craft were selected for the study. The data was gathered with the help of an interview schedule and by observation methods. The data were collected through personal interview method using structural schedule. The entire data were transformed into normal score and the findings were assessed to identify the performance of okra fiber craft among the rural women by using the percentage .

RESULTS AND DISCUSSION

Globalization and internet marketing has opened excellent avenues for the resurgence of traditional crafts of India. The need is to provide enough incentives to the artisans so that they are motivated enough to adopt the skills they have inherited and adopt it as occupation which provides them substantial financial benefits Bains *et al,* 2019.

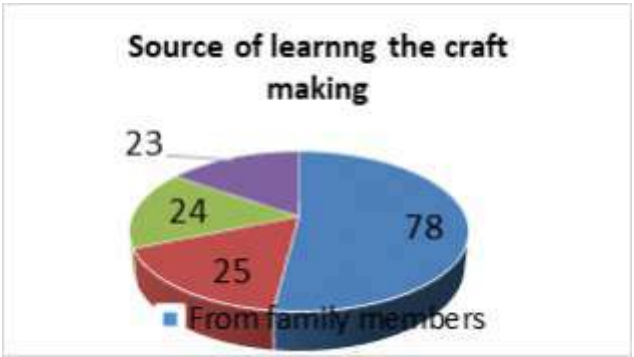

Table 1. Source of learning the Craft making. (n=150)

Sr. No.	Source of learning	No. of respondents	Percentage of respondents
1	From family members	78	52.00
2	From friends	25	16.67
3	Other organizations	24	20.00
4	Self Help Group	23	19.67

Table2:Reasons behind adopting the handicraft as occupation . (n=150)

Sr. No.	Reasons behind adopting the handicraft as occupation	No. of respondents	Percentage of respondents
1	Family profession	29	19.33
2	Interest in craft	47	31.33
3	To utilize free time	46	30.67
4	Generate subsidiary income	28	18.67

From family membersCreating handicraft products is primarily a family-based activity, typically pursued during leisure hours and in communal spaces. However, in recent times, the globalization of markets has proven advantageous for rural artisans, enabling them to secure competitive prices for their products and commercialize their traditional knowledge effectively. The respondents were asked about the source (Table 1) from where they received the knowledge regarding making of different types of handicraft of fiber and it was observed that majority of the respondents learned this craft from elder family member(52.00%). Moreover, the majority of families still practicing this craft were those who had previously received monetary benefits from it.

The artisans were asked aboutreasons behind adopting the handicraft as occupation (Table2).

The data reveals that almost equal number found it as because they have "Interest in craft "and also "To utilize free time"(31.33 and 30.67 percentage simultaneously),while family profession and "To Generate subsidiary income" were two reasons which were observed by19.33 and 18.67 percentage of respondents as reasons behind adopting the handicraft as occupation. As the study was conducted on those artisans who were already engaged in fiber handicraft, Krishi Vigyan Kendra introduced a new technology of Okra fiber, acceptance towards adoption of new ideas/Innovations was also a criteria which was studied. After introducing the okra fiber the products were made on the similar pattern as by other fiber which the respondents were using since a long time.

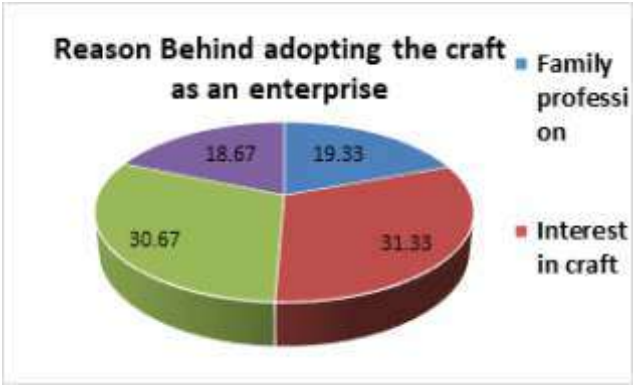

Table 3: Acceptance towards adoption of new ideas/Innovations

Sr. No.	Acceptance towards new idea/	Percentage of respondents		
		Fully	Partially	Not
1	Modification in designs	78 (52.00)	53 (35.33)	19 (12.67)
2	Use of Different Fiber (Okra)	73 (48.67)	41 (27.33)	36 (24.00)
3	Quality and fineness of okra fiber	99 (66.00)	48 (32.00)	3 (2.00)
4	New packaging and presentation ideas	78 (52.00)	67 (44.67)	5 (3.33)

Level of Acceptance towards adoption of new ideas/Innovations was studied to find out the acceptability of new technology and different criteria were kept on mind (Table 3). Highest percentage of artisans (66.00 %)reported "Quality and fineness of okra fiber" as fully accepted and while "Modification in designs" and"New packaging and presentation ideas were observed"by equal percentage of respondents as fully acceptable (52.00 %).Use of different fiber(Okra)was accepted by 48.67 percent of artisans . As this was the first time when the farming community was introduced to okra fiber for making of handicraft products. The fear of acceptance and marketing may be reason behind lessacceptance.

The obstacle faced while adopting handicraft as occupation were also studied (Table 4) so that future strategies could be made after rectifying the problems. "Lesser Know how of modern market trends" "Low wages" " Lack of availability of raw material "were the top three ranked as 1'st, 2'nd and at 3'rd priorities by 88.00,82.00 and 78.00 percent of respondents. "Lesser recognition on traditional values", "Exploitation by the Middlemen", "Lack of cooperation among the artisans". "Decreasing demand due to change inThe taste & interest of people" and "Lesser Know how of Marketing system" were the obstacles prioritized level (4'th to 8'th priority levels simultaneously) perceived by the respondents

Plant and Its Fiber

Okra plant is one of the plentiful sources of natural fibers. Generally, the huge amount of okra plant stem is discarded on the field after collecting vegetable, without proper utilization and a large volume of okra plant stem is thrown away in the field each year The only use of these waste material is that as fuel. However, this biomass from the okra plant is a renewable, biodegradable, cost efficient and low-density source for production of fibers. The fibers can be extracted from the plant's stems or other parts and processed to create a usable textile material. These okra fibers can be used to make fabrics, twine, or other handicraft materials. However, it's important to note that the use of okra fibers in textiles is not as common or widely established as other natural fibers like cotton, hemp, or flax. The okra fiber is bright, shiny, and strong, similar to the bark fibers

Table 4. Obstacles faced by the artisans.

Sr. No.	Obstacles Encountered by the artisans.	Prioritization of problem		
		Frequency	percentage	Priority
1	Lesser Know how of modern market trends	88	58.67	1
2	Low wages	82	54.67	2
3	Lack of availability of raw material	78	52.00	3
4	Lesser recognition on traditional values	72	48.00	4
5	Exploitation by the Middlemen	69	46.00	5
6	Lack of cooperation among the artisans.	67	44.67	6
7	Decreasing demand due to change in The taste & interest of people.	65	43.33	7
8	Lesser Know how of Marketing system	55	36.67	8

of jute, flax, and hemp fibers, and it can be spun into a yarn (Md. Rafiqul Islam). The exploration of okra fibers for textiles may be driven by factors such as sustainability and the search for alternative, renewable fiber sources. These are relatively easy to grow, and using their fibers for textiles could be a way to reduce the environmental impact associated with traditional textile production. The characteristics of okra plant fibers can vary based on factors such as the age of the plant, the part of the plant used (stems or other parts), and the processing methods employed. Additionally, the use of okra fibers in commercial applications is not as widespread or well-established as some other natural fibers like cotton or flax.

Traditional Steps in Processing of okra fiber: The okra is used for handicraft and textile purposes is found at the outer side of the plant core. The fiber from the bark of okra plant is bright, shiny and strong and very much similar to the other conventional bark fibers of jute, Bheemal, flax and hemp fibers. The fiber can be separated from pectin and plant core by various retting or degumming processes. In a retting process, the chemical bonds which hold the stem together are broken and separation of the bark fibers from the woody core takes place due to microbial activity or chemical effect. The traditional method which is used very commonly in hilly areas of Uttarakhand is retting, which removes the waxy epidermal tissue, adhesive pectin and hemicelluloses that bind the fiber bundles to each other. The okra plants were bundled comprising of 30- 40 plants. Each of these bundles was immersed in a concrete tank containing soft water for fifteen days. Later the stalks of the plant were tapped slightly with wooden hammer for removal of soft pulp. This was once again immersed and left in the tank for five days. Then the fibers were separated thoroughly from the pulp, washed, combed and exposed to sunlight for two days until the odor was removed from fibers. Afterword the dried fiber was kept safely in a dried place.

Handicraft Products of Fiber

Procurement of Raw Material/ Harvesting: The okra plants were harvested when the stems were mature enough to contain strong fibers. The Okra plants were procured from field in green condition, and the stems were separated from plant. Then these were bbundled (30-35 plants in a bundle) for retting process.

Retting: Retting is a key step in fiber processing, where the stalks were soaked in water to loosen the fibers. The method used for retting was stagnant water retting which removed the epidermal tissue, adhesive pectin and hemicelluloses that bind the fiber bundles to each other. The okra plants were bundled comprising of 40-50 plants, and were immersed in a concrete tank containing soft water for 10-14 days. Later the stalks of the plant were tapped slightly with wooden hammer for removal of soft pulp.

Decortication: After retting, the fibers were manually separated from the stalks through decortication, where the woody core was removed, leaving the outer fibrous material.

Washing: The separated fibers were washed to remove any remaining impurities such as pectin, dirt, or microbes. Clean water was used with mild chemicals to enhance the cleaning process.

Drying: The fiber was dried in bright sunlight for about 48 hours.

Chemical treatment: The fiber was treated to remove excess lignin. This was done using a bath system with NaOH, Na2CO3, H2O2, sequestering agent, and wetting agent.

Carding and Spinning: After drying, the fibers were combed (carded) to straighten them and align the individual strands. Afterward, the fibers were spun into yarn.

The indigenous method of making okra fiber was to make handicraft items such as baskets, flower vase, coasters, footwear and other house hold items with the raw fiber so many times carding was not required.

CONCLUSION

Natural fibers are of vital importance due to their sustainability, biodegradability, and versatility. Unlike synthetic fibers, which often contribute to environmental pollution and resource depletion, natural fibers like cotton, wool, silk, jute and okra are renewable resources that have a significantly lower environmental impact. They support local economies by providing livelihoods to farmers and artisans while preserving traditional craftsmanship and cultural heritage. Additionally, natural fibers offer superior comfort, breathability, and aesthetic appeal in various applications, ranging from textiles and clothing to home furnishings and handicrafts. Their role in promoting sustainable practices and reducing the ecological footprint of consumer goods underscores their critical importance in today's global push towards environmental conservation and responsible consumption. By integrating indigenous knowledge with modern market opportunities, this initiative can drive economic empowerment while preserving traditional crafts and fostering environmental sustainability.

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Short Communication

Management of Sheath Blight of Rice Using Microbial Formulations under i*n vivo* Condition

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ABSTRACT

An effort was made to explore the efficacy of microbial formulations against sheath blight (*Rhizoctonia solani*) of rice. Efficacy of nine microbial formulations *viz.*, Jawahar *Azotobacter*, Jawahar Phosphorus Solubilizing Bacteria (PSB), Jawahar Blue Green Algae (BGA), Jawahar *Mycorrhiza*, Jawahar *Azospirillum*, Jawahar *Acetobacter*, Jawahar *Tricoderma*, Jawahar *Pseudomonas*, Jawahar consortia were tested. The Jawahar *Pseudomonas* microbial formulations was recorded minimum disease incidence in both years and were found very effective as compared to control. The maximum disease incidence was observed in Jawahar Blue Green Algae (BGA)

Key Word- Management, Microbial formulations, Rice, Sheath blight,

INTRODUCTION

Rice (*Oryzae sativa* L.) is a cereal crop belonging to the family Poaceae. As a tropical crop, it can be grown during the two distinct seasons (dry and wet) of the year provided that sufficient water is made available (Kawure *et al,* 2022). Sheath blight is a soil borne disease caused by the fungus *Rhizoctonia solani* Kuhn AG1-IA. The fungus affects the crop from tillering to heading stage. Initial symptoms are noticed on leaf sheaths near water level on the leaf sheath oval or elliptical or irregular greenish grey spots are formed. As the spots enlarge, the centre becomes greyish white with an irregular blackish brown or purple brown border. The pathogen *Rhizoctonia solani* Kunh AG1-IA (Anamorph), *Thanatephorus cucumeris* (Frank) Donk (Teleomorph) is a soil-dwelling saprotroph and facultative parasite. The pathogen causes lesions on the sheath affecting grain filling and yield in rice (Wu *et al*,-2012). As sclerotia is a secondary inoculum of *Rhizoctonia solani* their studies on sclerotial viability are needed so as to effectively manage the pathogen under field conditions. The fungus spreads rapidly via contact between plant parts such as tillers and leaves, and also via sclerotia (secondary inoculum) present in surface water (Tsiboe *et al*, -2017). Under favorable conditions, the sclerotia germinate to form mycelia, which on establishing contact with the rice plant surface grows and produces infection structures such as infection cushions and lobate appressoria.

Biological control through microbial formulations has been suggested as a very promising strategy to manage neurotropic fungus (Gupta and Tomar, 2017; Tiwari *et al*, 2023). Modern farming systems affect soil health, it is important of developing long-term, eco-friendly, and environmentally sound alternative agricultural approaches like microbial formulations based on Jawahar *Azotobacter*, Jawahar Phosphorus Solubilizing Bacteria (PSB), Jawahar Blue Green Algae (BGA), Jawahar *Mycorrhiza*, Jawahar *Azospirillum*, Jawahar *Acetobacter*, Jawahar *Tricoderma*, Jawahar *Pseudomonas*, Jawahar consortia.

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Table 1. Treatment details of microbial formulation.

Treatment	Treatment details	Dose/ha	Treatment	Treatment details	Dose /ha
T_1	Jawahar *Azotobacter*	3.5 kg	T_6	Jawahar *Acetobactor*	3.5 kg
T_2	Jawahar Phosphorus Solubilizing Bacteria (PSB)	3.5 kg	T_7	Jawahar *Tricoderma*	2.5 l
T_3	Jawahar Blue Green Algae (BGA)	3.5 kg	T_8	Jawahar *Pseudomonas*	2.5 l
T_4	Jawahar *Mycorrhiza*	10 kg	T_9	Jawahar consortia	3.5 l
T_5	Jawahar *Azospirillum*	3.5 kg	T_{10}	Control	

MATERIALS AND METHODS

Two field trials were conducted during 2023 and 2024 at Breeder Seed Production unit JNKVV Jabalpur Madhya Pradesh in a randomized block design (RBD) with 10 treatments including control with 3 replications. The treatments consisted of microbial formulations. The experimental field was ploughed twice and soil was brought to a fine tilth and plots of size 1X1m were prepared. On completion of field preparation 25-day old Kranti seedlings were transplanted in the plots at a spacing 20x15cm. Controlled irrigation was given uniformly throughout the cropping season. Plots were given irrigation at an interval of 20 days. All the microbial formulations as par recommended dose were sprayed in respective plots after 65 and 85 days after planting.

The disease severity was recorded with the help of randomly selected five hills in a plot. The selected hills were tagged for identification. These tagged hills were taken for recording observations on disease severity with the help of 0 to 9 rating scale of standard evaluation system (SES) for rice (IRRI, 2002). The per cent disease incidence was calculated.

RESULTS AND DISCUSSION

Evaluation of different microbial formulation against sheath blight of rice

The results obtained from the present investigation as well as relevant discussion have been summarized. During both the crop season it was observed that all treatments (Table 2) showed significant reduction in disease incidence over the untreated control. Among the various approaches assessed against sheath blight of rice. At before spray in 2023, disease incidence was recorded from 7.51% to 9.60% whereas, after first spraying the minimum disease incidence (11.84%) was recorded in T_8 - Jawahar *Pseudomonas* which was at par with T_2 - Jawahar Phosphorus Solubilizing Bacteria (PSB) (12.59 %) , T_1 - Jawahar *Azotobacter* (12.69%), T_6 - Jawahar *Acetobactor* (13.62%), T_7 - Jawahar *Tricoderma* (14.24%), T_5 - Jawahar *Azospirillum* (15.96%) followed by T_4 - Jawahar *Mycorrhiza* (17.90%), T_9 - Jawahar consortia (18.11%). The maximum disease incidence (20.52 %) was recorded in T_3 - Jawahar Blue Green Algae (BGA) as compared to control (24.88%). After second spray the minimum disease incidence (14.80%) was recorded in T_8 - Jawahar *Pseudomonas* which was at par with T_2 - Jawahar Phosphorus Solubilizing Bacteria (PSB) (15.61 %) , T_1 - Jawahar *Azotobacter* (17.90%), T_6 - Jawahar *Acetobactor* (19.17%) followed by T_7 - Jawahar *Tricoderma* (20.19%), T_5 - Jawahar *Azospirillum* (21.66%) T_4 - Jawahar *Mycorrhiza* (23.52%), T_9 - Jawahar consortia (25.73%). The maximum disease incidence (27.34 %) was recorded in T_3 - Jawahar Blue Green Algae (BGA) as compared to control (36.25%). According to (Singh and Sinha, 2005) *Trichoderma harzianum* and *Pseudomonas fluorescens* as soil application for managing rice sheath blight, and all the methods of application significantly reduced disease severity and incidence as compared to control.

Table 2. Evaluation of microbial formulation on *R. solani* of rice in field.

Treatment	Percent Disease Incidence 2023			Percent Disease Incidence 2024			Percent Disease Incidence Pooled		
	Before Spray	After first spray	After second spray	Before Spray	After first spray	After second spray	Before Spray	After first spray	After second spray
T_1 - Jawahar *Azotobacter*	7.51	12.69	17.90	10.77	15.71	19.12	9.14	14.20	18.51
T_2 - Jawahar Phosphorus Solubilizing Bacteria (PSB)	9.60	12.59	15.61	12.25	14.62	18.80	10.92	13.26	17.20
T_3 - Jawahar Blue Green Algae (BGA)	8.88	20.52	27.34	11.00	24.91	30.31	9.94	22.68	28.83
T_4 - Jawahar *Mycorrhiza*	8.98	17.90	23.52	11.00	20.22	26.43	9.99	18.57	24.97
T_5 - Jawahar *Azospirillum*	8.51	15.96	21.66	10.22	19.87	25.56	9.36	17.57	23.61
T_6 - Jawahar *Acetobactor*	8.01	13.62	19.17	9.94	16.25	21.81	8.97	14.78	20.49
T_7 - Jawahar *Tricoderma*	9.23	14.24	20.19	11.34	18.32	23.03	10.28	14.46	21.61
T_8 - Jawahar *Pseudomonas*	7.57	11.84	14.80	9.82	12.70	16.44	8.69	11.92	15.62
T_9 - Jawahar consortia	8.23	18.11	25.73	10.33	22.26	28.67	9.28	19.76	27.20
Control	9.46	24.88	36.25	11.37	29.54	39.01	10.42	25.54	37.63
C. D. at 5 %	N/A	4.92	4.71	N/A	6.41	5.29	N/A	4.90	3.77
SE(m)±1	1.22	1.64	1.57	1.29	2.14	1.77	1.23	1.63	1.26

As before spray in 2024, disease incidence was recorded from 9.82% to 12.25% whereas, after first spraying the minimum disease incidence (12.70%) was recorded in T_8 - Jawahar *Pseudomonas* which was at par with T_2 - Jawahar Phosphorus Solubilizing Bacteria (PSB) (14.62 %) , T_1 - Jawahar *Azotobacter* (15.71%), T_6 - Jawahar *Acetobactor* (16.25%), T_7 - Jawahar *Tricoderma* (18.32%) followed by T_5 - Jawahar *Azospirillum* (19.87%), T_4 - Jawahar *Mycorrhiza* (20.22%), T_9 - Jawahar consortia (22.26%). The maximum disease incidence (24.91 %) was recorded in T_3 - Jawahar Blue Green Algae (BGA) as compared to control (29.54%). After second spray the maximum disease incidence (16.44%) was recorded in T_8 - Jawahar *Pseudomonas* which was at par with T_2 - Jawahar Phosphorus Solubilizing Bacteria (PSB) (18.80 %) , T_1 - Jawahar *Azotobacter* (19.12%) followed by T_6 - Jawahar *Acetobactor* (21.81%) T_7 - Jawahar *Tricoderma* (23.03%), T_5 - Jawahar *Azospirillum* (25.56%) T_4 - Jawahar *Mycorrhiza* (26.43%), T_9 - Jawahar consortia (28.67%). The maximum disease incidence (30.31 %) was recorded in T_3 - Jawahar Blue Green Algae (BGA) as compared to control (39.01%).

The pooled data of 2023 and 2024 at before spray disease incidence was recorded from 8.69% to 10.92% whereas, after first spraying the minimum disease incidence (11.92%) was recorded in T_8 - Jawahar *Pseudomonas* which was at par with T_2 - Jawahar Phosphorus Solubilizing Bacteria (PSB) (13.26 %) , T_1 - Jawahar *Azotobacter* (14.20%), T_7 - Jawahar *Tricoderma* (14.46%) T_6 - Jawahar *Acetobactor* (14.78%), followed by T_5 - Jawahar *Azospirillum* (17.57%), T_4 - Jawahar *Mycorrhiza* (18.57%), T_9 -

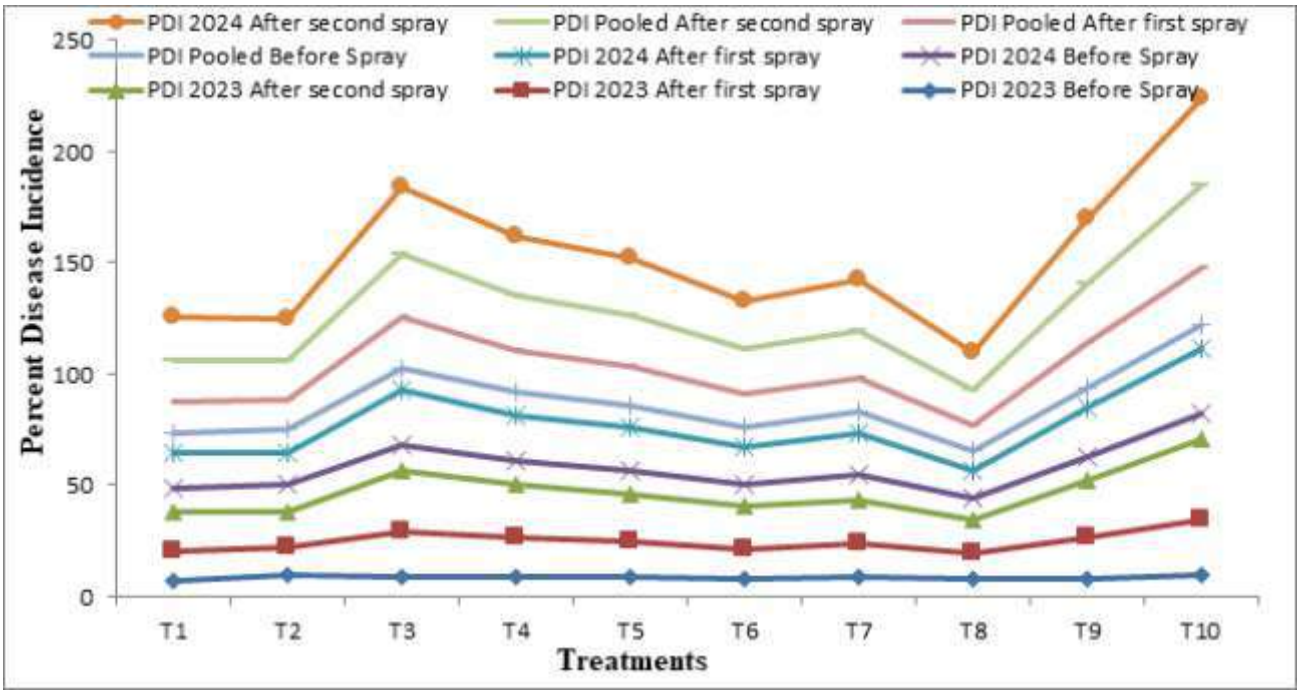

Fig.1- Graphical representation of Percent disease incidence of Sheath Blight of rice
T1- Jawahar Azotobacter, T2-Jawahar Phosphorus Solubilizing Bacteria (PSB),
T3-Jawahar Blue Green Algae (BGA), T4-Jawahar Mycorrhiza, T5-Jawahar Azospirillum,
T6-Jawahar Acetobacter, T7-Jawahar Tricoderma, T8-Jawahar Pseudomonas,
T9-Jawahar consortia, T10- Control

Jawahar consortia (19.76%). The maximum disease incidence (22.68 %) was recorded in T_3 - Jawahar Blue Green Algae (BGA) as compared to control (25.54%). After second spray the minimum disease incidence (15.62%) was recorded in T_8 - Jawahar *Pseudomonas* which was at par with T_2 - Jawahar Phosphorus Solubilizing Bacteria (PSB) (17.20 %), T_1 - Jawahar *Azotobacter* (18.51%) followed by T_6 - Jawahar *Acetobactor* (20.49%), T_7 - Jawahar *Tricoderma* (21.61%), T_5 - Jawahar *Azospirillum* (23.61%) T_4 - Jawahar *Mycorrhiza* (24.97%), T_9 - Jawahar consortia (27.20%). The maximum disease incidence (28.83 %) was recorded in T_3 - Jawahar Blue Green Algae (BGA) as compared to control (37.63%). According to Durga Prasad and Ramji Singh (2018) treatments where *Trichoderma harzianum* (Th) and *Pseudomonas fluorescens* (Pf) was applied to field soil effective in reducing the incidence of sheath blight rice.

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