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Integrated Crop Management Practices Resulted in Higher Yield in Sorghum (*Sorghum bicolor* L.)

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ABSTRACT

ICAR-Krishi Vigyan Kendra, Kalaburagi-II conducted cluster demonstrations programmes during the year 2018 to 2021 to demonstrate scientific cultivation of sorghum through improved crop management at farmers field in the villages namely, Rasanagi (Jewargi Taluka), Beeranahalli village (Sedum Taluka) and Malaga (K) Chittapur Taluka of Kalaburagi district. The results showed the low incidence of shootfly, *Atherigona soccata* (Rondani) (3.18 %), fall army worm, *Spodoptera fruziperda* (1.10 No.larvae /plant), stem borer, *Chilo partillus* (2.63 %), Mirid bugs, *Perigranus maidis* (2.30), aphids, *Rhopalosiphum maidis* (8.03) and smut diseases (1.20 %) in the demonstration plots as compared to the farmers' practice which were recorded the 10.35 per cent, 3.53, 10.50, 8.52, 22.92 and 6.82 per cent in 2018-19, 2019-20 and 2020-21 successive years, respectively. The average grain yield was higher in the demonstration plot (10.06 q/ha) than the farmers' practice (8.37 q/ha) it means 19.39 per cent yield increase over farmers' practices. Further, it was recorded that, higher gross return, net return and B: C ratio of the scientific improved technology as compared to farmers practices.

Key Words: Sorghum, Insect Pests, Improved Practice, Fall Armyworm, Smut Diseases.

INTRODUCTION

Sorghum, *Sorghum bicolor* (L) chiefly used as a forage crop for feeding dairy animals and also a principle feed ingredient in poultry and dairy industry (Singh *et al*, 2002).. Sorghum is mostly widely grown in rabi season under rainfed condition in kalyan Karnataka region. In India, nearly 32 per cent of sorghum crop is lost due to insect pests both under storage and field conditions. It also attacked by over 150 insect species from sowing till harvest. The shoot fly, *Atherigona soccata* (Rondani) is one of the serious pests and attacks sorghum seedlings during initial one to four weeks during the rainy season. Pawar *et al.* (1984) reported maximum yield losses of 75.6 per cent in grain and 68.6 per cent in fodder. The larva of this pest attacks on central whorl of the plant and causes dead heart formation. The damaged seedling is generally killed and plant grows side tillers which are further attacked under high pest population leading to considerable loss. The incidence increases as the sowing is delayed and early sowing escapes the shootfly damage on sorghum. At the boot stage, twisting of top leaves and emergence of panicles is prevented in case of severe infestation (Subbarayudu *et al*, 2002). Apart from shootfly other stem borer, *chilo patrtillus*, fall army worm, *Spodoptera fruziperda*, and sucking pest, soot bug and aphids becoming more problematic. In view of effects caused by insect pests and improper agronomic practices, to avoid losses in grain yield, considerable research efforts have been made to develop strategies for its management. Plant protection during early stage of crop is very much essential, as losses through early season pest could be minimized by seed treatment of insecticides against shootfly and sucking pest and also seed borne diseases. The consolidated strategy to manage insect pest, deficiency of nutrients and diseases were the combination of cultural practices, natural enemies, insecticides and host plant resistance in integrated without harming any others. Therefore, ICM approach was evaluvated to increase production and productivity of sorghum by adopting improved agronomic practices to reduce

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loss caused by both biotic and abiotic factors on sorghum.

MATERIALS AND METHODS

The Integrated crop management (ICM) of Sorghum FLD was conducted at ten farmers' sorghum fields under Rainfed farming *Rabi* season in an area of 0.40 ha each. The observations on important insect pest (for aphids, and merid bugs no. of insects per plant and for per dead hearts for shoot fly. Whereas for fall armyworm number larvae per plant and also per cent defoliation) and diseases (only the per cent smut incidence) incidence occurring on sorghum crop were recorded after the treatment imposition of spray schedule in ICM demonstration plots and simultaneously in farmer's Practice was followed. Inputs were used as per prescribed package and practices for integrated crop management of sorghum crop (Table 1). The yield, cost of input, net return and additional gain parameters including insect pest and diseases were documented (Table 2 and 3).

RESULTS AND DISCUSSIONS

The per cent dead heart due to shoot fly damage were less in recommended practices during 2018-19, 2019-20 and 2020-21 was 3.15, 2.75 and 3.65 compared to 10.25, 11.50 and 9.30 found in farmers' practice, respectively. This may be due to early sowing of the crop to escape from the shootfly damage and seed treatment with Imidacloprid 60 WP @ 5gm/kg or Thiamethoxam 30 FS 10ml/kg of seeds before sowing (Table 2) by seed treatment of above mentioned chemicals. The result was in conformity with findings of Singh (2021) who reported seed treatment with thiamethoxam 30 FS @ 10 ml/kg seed was found better than spraying of malathion @ 625 ml/ha and control. Seed treatment with thiamethoxam 30 FS @ 5 ml/ kg by Sandhu (2016) and again with thiamethoxam 70 WS @ 3 g/ kg seed was found very effective against sorghum shoot fly (Daware *et al*, 2012). Khandare *et al* (2014) suggested that sorghum seed treatment with thiamethoxam 35 FS @ 5 ml/ kg provided highest germination percentage (92%) and minimum number of dead hearts (9.56%) as compared to control (51.28%). Kumar and Tiwana (2018) also reported per cent dead heart count superiority in seed treatment with thiamethoxam 30 FS @ 10 ml per kg seed. Economic analysis of different treatments revealed that protection against shoot fly damage lead to yield advantage of 93-153 q/ha and promising treatment yielded net return of Rs. 19370/ha.

Lower incidence of Fall army worm (no. of larvae) and Stem borer damage ((% dead heart) were recorded with average of 1.10 and 2.63 per cent in demonstrated or recommended practices as compared to 3.53 and 10.53 in farmers practices (Table 2). This might be due to installation of Pheramone trap (10-12 no./ha) for monitoring of fall armyworm, spraying of 0.2ml of Chlorantriniliprole 18.5SC or 0.4gm of Emamectin benzoate 5% SG in one lit one water. Use of *Metarazhizum anisoplea* at 4g/l of water to cause higher larval mortality under field condition. Similar results have been reported by Sisay *et al* (2019) were in laboratory study of Radiant, Tracer, Karate, and Ampligo caused over 90 per cent larval mortality 72 hr after application. In the greenhouse experiment, all synthetic insecticides reduced foliar damage to maize compared to control. In the field, control plants showed extensive leaf injury compared to the synthetic insecticide- and botanical-treated plants. The synthetic insecticides and botanicals that showed high efficacy against FAW larvae can be used as components for integrated pest management (IPM) plans for FAW under smallholder farmer's conditions in Ethiopia and elsewhere in Africa.

The average incidence or population of Mirid bug and Aphids were less in recommended practices *i.e.,* 2.32, 1.32 and 3.25 No./ plants and 11.00, 6.80 and 6.30 No. / plants as compared to 8.56, 7.56 and 9.45 No./ plants and 35.00, 14.25 and 19.620 No./ plants in farmers' practices in 2018-19, 2019-20 and 2020-21 respectively. Similar findings were reported by Tiwari and Bhamare (2006)

Table 1.Technological gap between integrated crop management technology and farmers' practices in Sorghum crop.

Sr. No	Practice	Recommended Practice	Farmer's practice	Gap
1	Preparation of field	Summer ploughing with mould board plough	No summer ploughing	Full gap
2	Cultivars	SPV-2217, M-35-1 and Muguti	Local Chittapur maldandi (M-35-1) and Gundu theni	Partial gap
3	Time of sowing	September 15th to October 15th	September 15th to October 15th	Nil
4	Spacing	45cm X 15cm	Improper spacing between plants and thick sowing	Partial gap
5	Seed rate	7.5-10/ha	12.5kg/ha	Partial gap
6	Seed treatment	Calcium chloride 30gm in 1.5 lit of water for 1kg of seed or soaking of seeds for 8 hr in cow urine (25%) will get uniform germination nd good crop growth in field Imidacloprid 60 WP @ 5g/kg or Thiamethoxam 0.5g/lit sucking pest and 2gm sulpher or thiram 75 WP or capton 80WP for 1kg of seeds for smut diseases control	No seed treatment	Full gap
7	Fertilizer application	NPK applied in 24kg:16kg:16kg Trichoderma- 12g, Azospirullum-200g Sulpher- 6g, Calcium chloride- 12g	Use of imbalance fertilizer	Full gap
8	Weed management	Intercalation operations - 2-3 times at 10-12 intervals after 30 DAS	2-3 times at 10-12 intervals after 30 DAS	Nil
9	Plant protection measures	dimethoate 30 EC @ 0.03% or 2 ml of Cypermethrin 10 EC after 25 DAS for aphids Installation Pheramone trap for monitoring of Fall armyworm Application of 0.2ml of Chlorantriniliprole 18.5SC or 0.4gm of Emamectin benzoate 5% SG in one lit one water Use of *M. anisoplea* at 4g/l of water metalaxyl (4%)+ mancizeb (64%) @ 3g/l of water	Injudicious use of insecticides and fungicides	Partial gap

Table 2. Effect of integrated crop management on major insect pests and diseases and yield of sorghum.

Year	Shootfly damage (% dead heart)		Reduction in damage (% dead heart)	Fall army worm (No. of larvae / plant)		Stem borer damage (% dead heart)		Reduction in damage (% dead heart)	Mirid bug (No./ plants)		Aphids (No. / plants)		Smut diseases (%)		Reduction in disease incidence (%)
	RP	FP		RP	FP	RP	FP		RP	FP	RP	FP	RP	FP	
2018-19	3.15	10.25	69.26	1.10	2.75	2.10	8.75	76.00	2.32	8.56	11.00	35.00	0.90	6.45	86.04
2019-20	2.75	11.50	76.08	0.80	3.25	2.25	12.45	81.92	1.32	7.56	6.80	14.25	1.50	7.25	79.31
2020-21	3.65	9.30	60.75	1.40	4.60	3.55	10.30	65.35	3.25	9.45	6.30	19.50	1.48	6.75	78.07
Avg.	3.18	10.35	68.69	1.10	3.53	2.63	10.50	74.95	2.30	8.52	8.03	22.92	1.29	6.82	81.22

RP = Recommended Practice; FP= Farmer's Practice; BCR= Benefit Cost Ratio; Avg.= Average

Table 3. Economic performance of sorghum crop with recommended practices and farmers' practices.

Year	Yield (qt/ha.)		Yield increase over FP (%)	Gross cost (Rs/ha)		Gross return (Rs/ha)		Net returns (Rs/ha)		Additional gain (Rs/ha)	BCR	
	RP	FP		**RP**	**FP**	**RP**	**FP**	**RP**	**FP**		**RP**	**FP**
2018-19	7.56	6.65	13.68	9,350/-	8,400/-	19,656/-	17,290/-	10,306/-	8,890/-	2,366/-	1.10	1.05
2019-20	11.60	9.20	26.08	15,310/-	13,275/-	41,760/-	33,275/-	26,450/-	19,845/-	8,485/-	2.73	2.49
2020-21	11.02	9.26	19.00	15,229/-	13,715/-	39,672/-	33,332/-	24,443/-	19,617	6,340/-	2.61	2.44
Avg.	10.06	8.37	19.59	13,296/-	11,797/-	33,696/-	27,966/-	20,400/-	16,117/-	5730.33/-	2.15	1.99

RP = Recommended Practice; FP= Farmer's Practice; BCR= Benefit Cost Ratio; Avg.= Average

that among the various insecticides, dimethoate 30 EC @ 0.03% and imidacloprid 17.8 SC @ 0.009% were recorded highly effective in reducing aphid population to 1.17 and 1.84 aphid/leaf/cm2, respectively. However, the smut diseases also recorded fewer incidences with average of 1.29 per cent in demonstrated fields as compared to 6.82 per cent in farmers practice in all three years average with 81.22 per cent reduction in disease incidence (Table 2). Similar results were obtained by Gwary *et al* (2007) who reported the Metalaxyl (Apron star) treated sorghum plants recorded the lowest mean smut incidence of 4.8% with severity of 0.9%, while un-treated plants recorded the highest mean smut incidence of 11.25% with mean severity of 5.2% representing disease reduction of 57% and 83%, respectively. Ashok *et al* (2011) reviewed the seeds treated with carboxin+thiram (Vitavax power) followed by sulphur @ 3.0 g kg-1 just before sowing recorded significantly higher seed yield and lesser smut incidence and better seed quality parameters.

Grain Yield

Results showed that the average grain yield was higher in demonstration as compare to farmers' field in all adopted DFI villages of Kalaburagi district. The average yield of sorghum under frontline demonstrations in 2018-19, 2019-20 and 2020-21 were 7.56, 11.60 and 11.02 q ha-1 as compared to 6.65, 9.20 and 9.26 q/ha recorded in farmer's practice with average grain yield increase of 13.68, 26.08 and 19.00. per cent, and additional return of 2,366, 8,485 and 6,34 q/ha, respectively. The better yield of FLD's field may be due to awareness and adoption of package and practices accordingly (Table 1) follow up visits and continues suggestion to adopt recommended package of practices. Similarly by Tiwari and Bhamare (2006) were dimethoate treated plots recorded highest grain yield (2205.75 kg/ha) and fodder yield (56.79 q/ha) of sorghum. These results were in agreement with findings of Kumar and Tiwana (2018) who recorded economic analysis of different treatments revealed that protection against shoot fly damage lead to yield advantage of 93-153 q/ha and promising treatment yielded net return of Rs. 19370/ha. The about yield were similar with finding of Khandalkar (2006), Balikai (2011) and Daware (2011) who recorded grain yield of 19.77, 22.05 and 30.71 q/ha with thiamethoxam as seed treatment in maize.

Economics analysis

The results revealed that higher total return from recommended practice (FLD's) in 2018-19, 2019-20 and 2020-21 were 19,656, 41,760 and 39,672 Rs./ha as compared to 17,290, 33,275 and 33,332 Rs./ha in farmer's practice, respectively. The average net return was 20,400 Rs./ha in demonstration in comparison to 16,117 Rs/ha in farmer's practice. Finally, higher cost benefit ratio (B:C ratio) was recorded *i.e.,* 1.10, 2.73 and 2.61 in demonstrated farmers' fields as compared to 1.05, 2.49 and 2.44 in farmer's practice, respectively in consecutive years. It was observed that additional income ranged from 2,366-6,340 Rs./ha in recommended practice proved beneficial in respect of yield and economics of sorghum in successive years of Kalaburagi District in kalyan Karnataka region. The results were in conformity with Kumar and Tiwana (2018) who opined less number of dead hearts has also yielded highest net return of Rs. 19,370/ha. Balakai and Bhagwat (2009) also supported the superiority of thiamethoxam 70 FS @ 3g/ kg combined with endosulfan spray at 45 days after emergence recorded highest net return of Rs.6,954/-ha. Furthermore, Balakai (2011) supported the effectiveness of thiamethoxam 70 WS (3g/kg seed) for achieving higher yield and net returns in comparison to imidacloprid 70 WS (5g/kg seed). Therefore, it advised for seed treatment before sowing is a useful option to control sorghum shoot fly, especially in case the crop is grown for fodder purpose as there is reduction of 31.67 to 54.85 per cent dead heart in comparison to untreated control.

CONCLUSION

The present findings showed that the ICM practices brought down the insect pest damage and diseases incidence significantly and enhanced productivity of sorghum with 19.59% as compared to farmers practices. It was revealed that the present study on ICM of sorghum has immense potential in increasing productivity by adopting suitable advanced package of practice in each and every stage of the crop growth developed by University of Agriculture Sciences, Raichur which is a boon to sorghum growers in *rabi* season.

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