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International Journal of Agricultural and Applied Sciences, December 2020, 1(2): 79-81
https://www.agetds.com/ijaas
ISSN: 2582-8053
https://doi.org/10.52804/ijaas2020.1212

Research Article

Participatory analysis and evaluation of IPM practices against sucking pests of *Bt* cotton

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(**Received:** 03/11/2020; **Revised:** 10/11/2020; **Accepted:** 26/11/2020)

ABSTRACT
Farmer's participatory demonstrations were evaluated during *kharif* seasons of 2017-2018 and 2018-2019 at four villages of Panchmahal district, Gujarat to introduce IPM practice and to evaluate their effectiveness through demonstrations. Farmers identified several constraints of which, increased infestation of sucking insect pests *viz*., aphid (*Aphis gossypii* Glover), leaf hopper (*Amrasca biguttula biguttula* Ishida) and whitefly (*Bemisia tabaci* Gennadius) were the most important. IPM practice consisting of one spray application of *Beauveria bassiana* (2 x 10^8cfu) @ 4 g /l water, two spray applications of thiamethoxam 25 WG @ 0.01 per cent (0.4 g /l water) and one spray application of acephate 75 SP @ 0.075 per cent (1 g /l water) following threshold level (5 sucking pests /leaf) was found effective and economical for the management of sucking insect pests without any adverse effect on the natural enemies in *Bt* cotton. The application of this practice also resulted higher seed cotton yield as compared to farmers practice.
Keywords: *Bt* cotton, IPM practices, natural enemies, sucking insect pests.

INTRODUCTION
Cotton (*Gossypium spp.*) is a fiber crop. It is popularly called as friendly fiber because of its versatility, appearance, performance and above all its natural comfort. Cotton pest management has always been an immensely challenging task for entomologists all over the world. About 1326 species of insects have been reported on cotton worldwide. In India around 162 insect pests have been reported to cause damage to the cotton crop (Dhaliwal and Arora, 1998). Among them, only a dozen are major and half of them are key production constraints which cause losses to the extent of 30-80 per cent. Cotton is an excellent reproductive host for many sucking insects such as leafhoppers, *Amrasca devastans* (Distant); aphids, *Aphis gossypii* (Glover) and whiteflies, *Bemisia tabaci* (Gennadius). The avoidable loss due to sucking pests is up to 33.02 % (Nikam *et al.* 2017). Cotton growers depend heavily on synthetic pesticides to combat sucking pests. At least 2-3 sprays are directed against sucking pests. Due to Continuous and indiscriminate use of synthetic insecticides, there is resistance and hence increase in production cost, toxicity to natural enemies. So, potential solution is adoption of IPM strategies plays a key role. Keeping these things in view participatory analysis and evaluation of IPM practices was demonstrated in farmer's fields for the management of sucking pest in *Bt* cotton.

MATERIALS AND METHODS
The field demonstrations were carried out during *Kharif* season of 2017-2018 and 2018-2019 at four villages of Panchmahal district to evaluate the IPM practices against sucking pests of *Bt* cotton under FLD activity of ICAR- Krishi Vigyan Kendra-Panchmahal (Gujarat). In this study, 12 farmers were selected for demonstration. The IPM technology was adopted from AAU, Anand (Gujarat) while farmers' practice comprised of chemical insecticide sprays (Table1). The insecticides were sprayed when the pest attained Economic Threshold Level (ETL). The observations on population of sucking insect pests' *viz*., aphid, leaf hopper and whitefly were made on three plants selected randomly in each sector. From each selected plant, three leaves were selected randomly from top, middle and bottom canopy to record the pest population. The observations were recorded at fortnightly interval right from the germination to last picking of the crop. Cotton yield was recorded and the data were presented as seed

cotton yield in q/ha and benefit cost ratio was also worked out.

Table 1. Details of management practice against sucking pests of cotton

Management practice	Details
Integrated Pest Management Practice (IPM)	IPM practices consisting of ; One need based (5 aphids or leafhoppers or whiteflies/leaf) application of *Beauveria bassiana* (2 x 10^8 cfu/g) @ 4 g/l water followed by two need based applications of thiamethoxam 25 WG 0.01% (0.4 g/l water) (50 g a.i./ha). Need based (5 thrips/ leaf) application of acephate 75 SP 0.075% (1 g/l water) (375 g a.i./ha). The waiting period of thiamethoxam 25 WG 0.01% (50 g a.i./ha) and acephate 75 SP 0.075% (375 g a.i./ha) maintained 21 and 15 days after application, respectively.
Farmer's Practice	Farmers used unsystematic spraying of different insecticides like imidacloprid 17.8 SL @ 200 ml/ha, fipronil 5% SC @ 1500 ml/ha, monocrotophos 36% SL @ 800 ml /ha etc. at different crop stages. The farmers usually tend to give higher than the recommended dose

Statistical analysis

The data collected were transformed into square root values as per the standard requisites. The experiments were subjected to statistical scrutiny following the method of Panse and Sukhatme (1989) and the means were compared with Least Significant Difference (L.S.D.).

RESULTS AND DISCUSSION

A comparison of frontline demonstrations based on IPM practices (recommended technology) and farmer's practices were analyzed as presented in Table 2. Of the two practices, IPM practice (recommended technology) for the management of sucking pests in *Bt* cotton was found to be more effective over farmer's practice. During 2017-18, IPM practice revealed lower mean infestation of aphids (0.92/3 leaves), leafhoppers (0.54/3 leaves) and whiteflies (0.20/3 leaves) Farmer's practice showed higher mean infestation of aphids (15.37/3 leaves), leafhoppers (5.10/3 leaves) and whiteflies (3.02/3 leaves). Highest yield of 27.63 q/ha was recorded in IPM practice as compared to farmer's practice (20.50 q/ha) resulting higher C:B ratio of 1:2.60 in IPM practice. During 2018-19 at all the locations of demonstrations, mean aphids, leafhoppers and whiteflies were observed lower in IPM practice as compared to higher in farmer practice. The lower infestation of aphids, leafhoppers and whiteflies in IPM demonstrations were (1.90, 0.60 & 0.27/3 leaves) as compared to farmer practice (14.20, 4.16 & 2.70/3 leaves) respectively, where it was significantly higher. Highest yield of 25.70 q/ha was recorded in IPM practice whereas 18.50 q/ha were recorded in farmers practice. The Cost: Benefit ratio was also high in the IPM practice 1:2.45 as compared to farmer's practice (1:1.94).

The data over two years 2017-18 and 2018-19 of demonstration (Table 2) indicated that IPM practice (recommended technology) was better than the farmer's practice under local conditions.

Table 2. Impact of IPM practices against sucking pests of *Bt* cotton

	Aphids		Leafhoppers		Whiteflies		Yield (q/ ha)		Cost: Benefit ratio	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
IPM Practice	0.92 (1.40)	1.90 (1.69)	0.54 (1.25)	0.60 (1.27)	0.20 (1.10)	0.27 (1.13)	27.63	25.70	2.60	2.45
Farmer Practice	15.37 (4.07)	14.20 (3.88)	5.10 (2.45)	4.16 (2.24)	3.02 (2.10)	2.70 (1.94)	20.50	18.50	2.00	1.94
S.E±	(0.03)	(0.06)	(0.04)	(0.91)	(0.80)	(0.61)				
CV	(3.71)	(4.62)	(3.13)	(5.93)	(6.74)	(5.21)				
LSD (5%)	(0.08)*	(0.12)*	(1.06)*	(2.02)*	(2.40)*	(1.37)*				

Figures in parenthesis are transformed values of √x+1 * Significant at 5%

Thus, IPM strategy kept the population of sucking insect pests *viz.*, aphid, leaf hopper and whitefly below their threshold level (5/leaf). Khajuria *et al.,* (2017) reported that *Beauveria bassiana* reduced the infestation of aphids on potato crop. Srinivasan *et al.*, (2004) have reported higher effectiveness of thiamethoxam for the control of sucking pests in cotton. Bharpoda *et al.* (2016) also reported that IPM module, fungal bio-agent and thiamethoxam were successful in managing the cotton pests. During present study also, *Beauveria bassiana*, a fungal bio-agent and thiamethoxam, a neonicotinoid are also found effective in management of sucking pests in cotton. Birah *et al.*, (2019) and Khajuria *et al.,* (2016) have reported that the seed cotton yield from IPM plots was high which resulted in a higher cost benefit ratio in comparison with farmer's practice. These results are in accordance with our study as in the present study highest yield was obtained in IPM during both the years of investigation. Over all, the benefit cost ratio was high in IPM as compared to farmers' practice.

CONCLUSION

IPM practices were found effective in comparison to farmer practice of indiscriminate use of pesticides. The results clearly indicated that integrated pest management strategies needs to be adopted even in *Bt* cotton to have higher yield and better benefit cost ratios. So, the above said management practices must be followed by the cotton growing farmers. It is concluded that IPM strategy can be recommended to the farmers for management of sucking pests effectively and economically in cotton.

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