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IPM: An eco-friendly approach for the management of sucking pest complex in *Bt* cotton of Mancherial district, Telangana state

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Abstract
A front line demonstration on management of sucking pest complex i.e., jassids, thrips and whitefly in *Bt* cotton has been conducted in different villages in various mandals of Mancherial district in Telangana state during *Kharif* (June - December) season of 2019-20, 2020-21 and 2021-22 respectively to create awareness about the integrated approaches for the management of the pest among the farming community. The adoption of Integrated Pest Management practices like Stem application with Imidacloprid, water @ 1:20 at 45 and 60 DAS for Jassids and other sucking pest, Need based or intermittent spraying of Azadirachtin 1500 ppm @ 5ml with surf (1g) per litre of water, Rotation of insecticidal sprays with different groups and Installation of Yellow sticky traps @ 10/acre etc. were carried out. The results revealed that the superior percent reduction i.e., in the incidence of jassids in the IPM demonstrated plots at 25.69%, 60.70% and 30.35%, in case of thrips @ 32.70%, 59% and 41.77% and in case of whiteflies @ 50.91%, 65.50% and 21.85% over farmers practice with increased yields of 9.98%, 9.03% and 10.97% during corresponding *Kharif* (June - December), 2019-20, 2020-21 and 2021-22. Further, the demonstration plots registered with higher cotton yield of 1785, 1817 and 1608 kgha^{-1} as compared to 1623, 1661 and 1449 kg ha^{-1}under farmers practice. The Cost-Benefit ratio of 1.89, 1.79 and 2.79 respectively in the technology demonstrated plots whereas in farmers practice the recorded Cost - Benefit ratio of 1.64, 1.46 and 1.90 during corresponding *Kharif* (June - December), 2019-20, 2020-21 and 2021-22.

Keywords: Cotton, sucking pest complex, Jassids, thrips, whiteflies, integrated pest management

1. Introduction
Cotton (*Gossypium* spp.) is an important and oldest commercial fiber crop of India as well as in the state of Telangana. Popularly known as white gold, playing a key role in socio economic affairs of the nation. In India, the cotton crop is cultivated in an area of 13.4 mha with a production of 36.5 m bales with a productivity of 460.0 kg ha^{-1}. The area of cotton in Telangana state is 21.2 lakh hectares whereas production is 54.0 lakh bales with a productivity of 432.0 kg ha^{-1} (Anonymus, 2020) [1]. In India, annually Rs. 3,39,660 million worth of yield loss (Dhaliwal *et al*., 2010) [2] instigated by 166 recorded insect pest species on cotton (Puri *et al*., 1999) [3]. After introduction of *Bt* cotton, boll worm incidence and insecticide usage was reduced due to the presence of *Bt* toxins against boll worms to develop resistance but there is no resistance against sucking pest complex (Sharma and Pampathy, 2006) [4]. In addition to this 33.02% yield losses were observed due to this sucking pest complex (Tukaram *et al*., 2017) [5]. Unless extension initiatives to manage sucking pest complex in cotton were implemented on war footing, the situation might have further lead to yield losses and had a surging effect on textile industry and Indian economy. The adoption of Integrated Pest Management helps the farming community in reducing the usage of chemical pesticides there by reducing cost of cultivation as well as increasing yields (Ajanta *et al*., 2019) [10]. Timely implementation of the IPM interventions by educating the farmers helps to reduce the cost of production (Raghava and Punnarao, 2013) [6]. Among all IPM practices against sucking pest complex, the cost effective and eco-friendly method i.e., Stem application with Imidacloprid and water (1:20) at 45 and 60 DAS using with stem applicator at green portion on stem about 6 cm -10 cm for the effective management of leaf hoppers, aphids and thrips in cotton (Gaur *et al*., 1999; Venkanna *et al*., 2019; Ravi *et al*., 2019) [7, 8, 9].

To overcome these gaps Krishi Vigyan Kendras acts as an information and resource Centre at district level to demonstrate the technologies (Sharma *et al*., 2017) [11]. For this IPM technologies need to be practiced in cluster approach to manage the pest (Shankar *et al*., 2022) [12]. Hence, the following integrated pest management module under front line demonstrations has been validated in the field conditions at Mancherial district during *Kharif* (June - December), 2019-20, 2020-21 and 2021-22 to reduce the incidence of sucking pest complex, cost on plant protection practices and to study the yield and economic impact of the technology.

Materials and Methods

The present study was carried out in the different villages of various mandals in Mancherial district during *Kharif* (June - December), 2019-20, 2020-21 and 2021-22 by the Krishi Vigyan Kendra, Bellampalli, Mancherial, PJTSAU. In this study, 10 farmers were selected for the demonstration of the technology in the each year the three consecutive years. The improved technology were imposed, consisting Stem application with Imidacloprid, water @ 1:20 at 45 and 60 DAS for Jassids and other sucking pest, Need based or intermittent spraying of Azadirachtin 1500 ppm @ 5ml with surf (1g) per litre of water, Rotation of insecticidal sprays with different groups and Installation of Yellow sticky traps @10/acre etc. were carried out. Whereas the farmers practice includes indiscriminate spraying/excessive dosages of different insecticides like Acephate 75SP @ 400 - 500 gacre^{-1}), Imidachloprid 17.8 SC (150-250 mlacre^{-1}), Acetamiprid (100 gacre^{-1}) and Flonicamid 50 WDG (100 - 150 gacre^{-1}) during the cropping period from vegetative stage to end of the crop growth period. The regular field visits were taken up for recording the data on the following observations such as percent incidence and percent reduction of jassids, thrips and whiteflies, cotton yield, yield attributes and cost benefit ratio etc. These studies also provide information about the favourable periods for pest build-up that help in the management of the pest. The weather parameters *viz*., Maximum and Minimum Temperatures (ºC) and Rainfall (mm) were recorded on regular basis from August to December during 2019-20, 2020-21 and 2021-22 respectively for the careful examination of sucking pest complex incidence and damage. During the cropping period frontline demonstrations, training programs, diagnostic field visits by scientists and departmental officials from time to time, guiding farmers through phone in live programmes, farmer-scientist interaction meetings, print and electronic media etc. were organized to create awareness on upgraded technologies among the farmers. Recorded the data from all the demonstrated plots as well as practicing farmers on pest incidence i.e. number of jassids, thrips and whiteflies per 3 leaves, yield and economic parameters i.e., gross returns, cost of cultivation, net returns with benefit - cost ratio.

Results and Discussion

The observations were recorded on the intensity of sucking pest complex i.e., jassids, thrips and whiteflies per 3 leaves consequently in three years during *Kharif* (June - December), 2019-20, 2020-21 and 2021-22.

Jassids

Average number of jassids 2.34, 1.66 and 4.07 in number per 3 leaves respectively in the IPM demonstrated plot whereas in farmers practice the average no. of jassids 3.16, 4.08 and 6.1 and the percent reduction in the incidence of jassids in the demonstrated plot over farmer's practice 25.69%, 60.70% and 30.35% during *kharif* (June-December), 2019-20, 2020-21 and 2021-22 respectively (Table 1 & 2).

Thrips

Average number of thrips 4.93, 5.53 and 6.03 in number per 3 leaves respectively in the IPM demonstrated plot whereas in farmers practice the average no. of thrips 6.36, 10.70 and 9.98 and the percent reduction in the incidence of thrips in the demonstrated plot over farmer's practice 32.70%, 59.0% and 41.77% during *kharif* (June-December), 2019-20, 2020-21 and 2021-22 respectively (Table 1 & 2).

Whiteflies

Average number of whiteflies 2.02, 1.77 and 2.75 in number per 3 leaves respectively in the IPM demonstrated plot whereas in farmers practice the average no. of whiteflies 4.13, 4.41 and 3.16 and the percent reduction in the incidence of whiteflies in the demonstrated plot over farmer's practice 50.91%, 65.50% and 21.85% during *kharif* (June-December), 2019-20, 2020-21 and 2021-22 respectively (Table 1 & 2).

The data revealed from the three consecutive years that, the incidence of sucking pests was declined due to stem application in demonstrated plots as compared to farmers practice. The yield increase in demonstrations was due to the adoption of IPM practices i.e., stem application Imidacloprid, water @ 1:20 at 45 and 60 DAS for controlling jassids and other sucking pests. The stem application in cotton reduced 2 sprayings for management of sucking pests and an amount of Rs. 2075 ha^{-1} was saved on insecticides and safe to natural enemies. Adoption of IPM approaches in cotton reduced the occurrence of sucking pests and preserved the natural enemies (Anjanta *et al*., 2019). Similar findings were reported Undhad *et al*, 2018 [13], Venkanna *et al*. (2019) [8], Ravi *et al*. (2019) [9], Anjanta *et al*., 2021 and Shankar *et al*., 2022 [12].

Table 1: Average No. of incidence of sucking pest complex in *Bt* cotton during *Kharif* (June - December), 2019-20, 2020-21 and 2021-22

Particulars	2019-20			2020-21			2021-22		
	Jassids / 3 leaves	Thrips / 3 leaves	Whiteflies/ 3 leaves	Jassids / 3 leaves	Thrips / 3 leaves	Whiteflies/ 3 leaves	Jassids / 3 leaves	Thrips / 3 leaves	Whiteflies/ 3 leaves
IPM Module	2.34	4.93	2.02	1.66	5.53	1.77	4.07	6.03	2.75
Farmer Practice	3.16	6.36	4.13	4.08	10.70	4.41	6.10	9.98	3.16

Table 2: Percent Reduction in the incidence of sucking pest complex in *Bt* cotton during *Kharif* (June - December), 2019-20, 2020-21 and 2021-22

Particulars	2019-20	2020-21	2021-22
Reduction of Jassids (%)	25.69	60.70	30.35
Reduction of Thrips (%)	32.70	59.00	41.77
Reduction of Whiteflies (%)	50.91	65.50	21.85

Yield impact

The information regarding the impact of technology demonstrated in terms of escalation in yield have been presented in table 3. The data revealed that, the cotton yield improved by 9.98%, 9.03% and 10.97% in the demonstrated plots as compared to farmer's practice. In all the three years, the demonstration plots showed significant differences in the yields against farmers practice.

Economic impact

The economic parameters like total cost of cultivation, gross returns, net returns and B:C ratio were to assessed to study the economic impact of integrated pest management practices and farmer practice. The data (table 3) revealed that the yield of IPM module demonstrated field was 1785, 1811 and 1608 kgha^{-1}whereas in the farmer practice, the yield was 1623, 1661 and 1449 kgha^{-1} during *Kharif* (June - December), 2019-20, 2020-21 and 2021-22 respectively. The economic analysis results revealed that the cotton crop recorded higher returns from demonstration as 93713, 89645 and 144720 Rs ha^{-1}as compared to 85208, 82220 and 130410 Rs ha^{-1} in farmers practice during *Kharif* (June - December2019-20, 2020-21 and 2021-22 respectively. The B:C Ratio in IPM module was high 1.89, 1.79 and 2.79 when compared to farmer practice 1.64, 1.46 and 1.90 during *Kharif* (June - December), 2019-20, 2020-21 and 2021-22 respectively. IPM module showned positive results with respect to yield and economics of cotton. It was marked from the results that B:C Ratio of cotton crop in IPM module was higher as compared to farmer practice in all the years. Because of non-adoption of IPM module for the management of sucking pest complex in *Bt* cotton crop resulted in lower B:C Ratio in farmer practice. Thus, promising B:C Ratio and higher net returns in IPM module showed the economic sustainability of the demonstrated technology and influenced the farmers on the utility of technology provided at actual farming situation.

Table 3: Economic analysis of front line demonstration on management of sucking pest complex in cotton during *Kharif* (June - December), 2019-20, 2020-21 and 2021-22

Particulars	Yield (kgha^{-1})			Percent increase in yield over check			Cost of cultivation (Rs. ha^{-1})			Gross returns (Rs. ha^{-1})			B:C Ratio		
	2019-20	2020-21	2021-22	2019-20	2020-21	2021-22	2019-20	2020-21	2021-22	2019-20	2020-21	2021-22	2019-20	2020-21	2021-22
IPM module	1785	1811	1608	9.98	9.03	10.97	49723	50101	51925	93713	89645	144720	1.89	1.79	2.79
Farmer practice	1623	1661	1449	-	-	-	52048	56453	68809	85208	82220	130410	1.64	1.46	1.90

4. Conclusion

In IPM module, documented higher cotton yield with net returns of 43990, 39543 and 92795 Rs ha^{-1} which was about 9.98%, 9.03% and 10.97% higher than the non IPM module with 33160, 25767 and 61601 Rs ha-^{1} during *kharif*, 2019-20, 2020-21 and 2021-22 respectively. From the above study, it can be concluded that by adopting IPM based sucking pest complex management strategies in *Bt* cotton can be efficiently managed instead of practicing chemical control measures.

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