INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES
IJPAES
Volume-6, Issue-1, Jan-Mar-2016 Coden: IJPAJX-CAS-USA, Copyrights@2016 ISSN-2231-4490
Received: 7th Nov-2015 Revised: 19th Dec -2015 Accepted: 23rd Dec-2015
Research article

EVALUATION OF INTEGRATED PEST MANAGEMENT IN BOLLGARD COTTON

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ABSTRACT: Integrated pest management (IPM) module was evaluated in transgenic *Bt* cotton during *kharif* seasons of 2013–14 and 2014–15 at Regional Agricultural Research Station, Warangal, Telangana state. The IPM module comprising of Jowar as border crop, Castor as trap crop, Greengram as intercrop, installation of pheromone and yellow sticky traps, stem application with Monocrotophos: Water in 1:4 ratio and use of need based insecticides, *viz.*, monocrotophos 36 SL, buprofezin or fipronil 5 SC was compared with farmers' practice and untreated control in *Bt* cotton. The results indicated that mean number of aphids, jassids, thrips and whitefly were more in untreated control as compared to IPM and farmers' practice during 2013 and 2014. Adoption of IPM strategies effectively contained population build up of thrips and maintained higher population of spiders and coccinellids than farmers' practice. Due to frequent interventions of insecticidal sprays in farmers' practice, incidence of aphids and jassids was lowest in farmers' practice than IPM. However, adoption of IPM has resulted in higher B: C ratio than farmers' practice and control.
Key words: Evaluation, IPM, *Bt* cotton,

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INTRODUCTION

Cotton accounts for about 40% of the world's natural fibre production and is commercially cultivated in 78 countries from temperate, subtropical, and tropical regions of the world [1]. Though surveys have catalogued >1300 species of herbivorous insects inhabiting cotton, only a fraction of these are considered pests of economic significance. Cotton has historically been one of the largest users of insecticides worldwide [2]. There have been many improvements in the management of insect pests in cotton that had contributed to reduction of insecticide use in this crop in the past two decades [3,4] with perhaps the most notable being advances in biotechnology that have allowed engineering of plants to provide highly effective and selective control of lepidopteran pests, the most significant pest group of cotton globally.

However, with the advent of *Bt* cotton, sucking pests emerged as major pests because the cry toxins present in *Bt* cotton provides protection only for lepidopteran pests. To contain the sucking pests, farmers resort to apply insecticides at least 5 to 6 times even in *Bt* cotton. Indiscriminate use of insecticides would lead to development of resistance, and cause resurgence of insect pests. This necessitates the need for adoption of integrated strategies for sucking pest management. The present study was carried out to evaluate feasibility of adoption of integrated pest management in *Bt* cotton *vis-à-vis* farmers' practice in Warangal district of Telangana state.

MATERIALS AND METHODS

Integrated pest management module was evaluated in *Bt* cotton hybrid "Jaadoo" during *kharif* seasons of 2013 and 2014 at Regional Agricultural Research Station, Warangal Telangana state. The experiment was carried out with three treatments, *viz.*, IPM module, farmers' practice and an untreated control, each in 151 sq. m. area separated with 2m buffer distance. The crop was grown under rainfed conditions in heavy black soil at a spacing of 90 x 60 cm following all recommended agronomic practices except plant protection measures. IPM module included ecofriendly strategies while farmers' practice comprised of chemical insecticide sprays (Table 1) which farmers normally follow in the test location. Sowing was done on 05-7-2013 during 2013 and on 21-7-2014 during 2014. In untreated control plot, no insecticidal sprays were taken up during both the seasons. The pest management interventions were carried out only when the pests crossed economic threshold level. In all the treatments, cotton seed treated with imidacloprid 70 WS were sown in order to manage the early sucking pests.
Each plot was divided into four equal blocks to minimize the error while recording the data. Observations on the incidence of sucking pests were recorded on 20 randomly selected plants in each plot (5 plants per block) at 15 days interval on top three leaves avoiding border rows. Similarly, natural enemy population per plant was also recorded on 20 randomly selected plants in each treatment. Data were averaged to mean number of insects per three leaves for sucking pests and per plant for natural enemies. Mean data of all the observations was pooled to arrive at seasonal means. Cotton yield was recorded from each treatment and the data were presented as seed cotton yield in kg/ha and benefit cost ratio of each treatment was worked out.

RESULTS AND DISCUSSION

In the present investigation incidence of sucking pests remained low when integrated pest management was adopted as compared to untreated control plot during both the years. The mean number of aphids, jassids, thrips and whitefly were more in untreated control plot as compared to IPM and farmers' practice during 2013 and 2014 (Table 2). Adoption of integrated pest management strategies resulted in 38.4, 32.4, 20.7 and 42.8 per cent reduction in aphids, jassids, thrips and whitefly population over untreated control plot during 2013-14 and 15.9, 36.6, 43.3 and 10.5 per cent reduction over untreated control during 2014-15, respectively. The number of aphids was low in farmers' practice (2.84/3leaves) as compared to IPM (3.03/3leaves) and untreated control (4.58/3leaves) during 2013-14. Similarly low number of aphids were recorded in farmers' practice (4.16/3leaves) as compared to IPM (4.87/3leaves) and untreated control (5.44/3leaves) during 2014-15 indicating the influence of insecticidal interventions over IPM practices. The population of jassids was low in farmers' practice (1.46/3leaves) when compared to IPM (1.61/3leaves) and untreated control (2.30/3leaves) during 2013-14 while it was low in IPM (1.07/3leaves) as compared to farmers' practice (1.18/3leaves) and untreated control (1.65/3leaves) during 2014-15. However, thrips incidence was low in IPM (2.26 - 8.81/3leaves) compared to farmers' practice (2.52 - 10.78/3leaves) and untreated control (2.75 - 12.70/3leaves) where IPM practices played a major role in suppressing thrips population. The incidence of whitefly was low in IPM (1.87/3leaves) when compared to farmers' practice (2.00/3leaves) and untreated control (3.10/3leaves) during 2013-14 while it was low in farmers' practice (1.44/3leaves) as compared to IPM (1.6/3leaves) and untreated control (1.75/3leaves) during 2014-15. In general, the population of all sucking pests was high in untreated control compared to IPM module and farmers' practice. Though farmers' practice recorded lower incidence of aphids, jassids mainly due to frequent insecticidal interventions, adoption of IPM practices such as Jowar as border crop, Castor as trap crop, Green gram as inter crop, installation of pheromone traps for monitoring and yellow sticky traps, stem application with monocrotophos : water @ 1:4 ratio and coupled with only two need based insecticide sprays also effectively reduced sucking pest population. The present findings are in conformity with reports of Patil *et al.,* [5] who reported low population of sucking pests in *Bt* integrated pest management, followed by non-*Bt* and *Bt* recommended plant protection. Rama Rao *et al.* [6] reported that stem application with imidacloprid 200 SL at 1:20 ratio dilution at 20, 40 and 60 days after sowing was highly effective in controlling aphids, leafhoppers and mealy bugs. Venkatesan *et al.* [7] observed low incidence of leafhoppers when intercropped with green gram and black gram, while Rao and Chari [8] reported that the cotton crop bordered by sorghum showed significantly lower aleyrodid populations. Sohi *et al.* [9] reported that the incidence of leafhoppers and whiteflies per leaf were low in IPM fields.

Table 1. Details of components in different treatments

Treatment	IPM		Farmers' Practice		Untreated control	
Year/Season	**2013-14**	**2014-15**	**2013-14**	**2014-15**	**2013-14**	**2014-15**
Components	Pheromone traps @ 20/ha	Pheromone traps @ 20/ha	Monocrotophos @ 800 ml/ha	Acephate @ 750 g/ha	-	-
	Erection of bird perches @ 20/ha	Erection of bird perches @ 20	Fipronil @ 1000 ml/ha	Acetamiprid @100 g/ha	-	-
	Yellow sticky traps @ 25/ha	Yellow sticky traps @ 25/ha	Imidacloprid @ 200 ml/ha	Monocrotophos @ 800 ml/ha	-	-
	Cotton: Green gram (1:2) ratio	Cotton: Green gram (1:2) ratio	Acetamiprid @100 g/ha	Fipronil @ 1000 ml/ha	-	-
	Stem application with Monocrotophos (3 times)	Stem application with Monocrotophos (3 times)	Diafenthiuron @ 625 g/ha	Thiamethoxam @ 100 g/ha	-	-
	Buprofezin @ 800 ml/ha	Monocrotophos @ 800 ml/ha	Thiamethoxam @ 100 g/ha	Flonicamid @ 150 g/ha	-	-
	Monocrotophos @ 800 ml/ha	Fipronil @ 1000 ml/ha	Acephate @ 750 g/ha	-	-	-
	Buprofezin @ 800 ml/ha	-	-	-	-	-

Table 2. Incidence of sucking pests in Integrated pest management module adopted in *Bt* cotton at RARS, Warangal during 2013-15.

Treatment	Mean no. of Aphid/3 leaves		Mean no. of Jassids/3 leaves		Mean no. of Thrips/3 leaves		Mean no. of Whiteflies/3 leaves	
	2013-14	**2014-15**	**2013-14**	**2014-15**	**2013-14**	**2014-15**	**2013-14**	**2014-15**
IPM	3.03	4.87	1.61	1.07	2.26	8.81	1.87	1.60
Farmers' practice	2.84	4.16	1.46	1.18	2.52	10.78	2.00	1.44
Untreated control	4.58	5.44	2.30	1.65	2.75	12.70	3.10	1.75

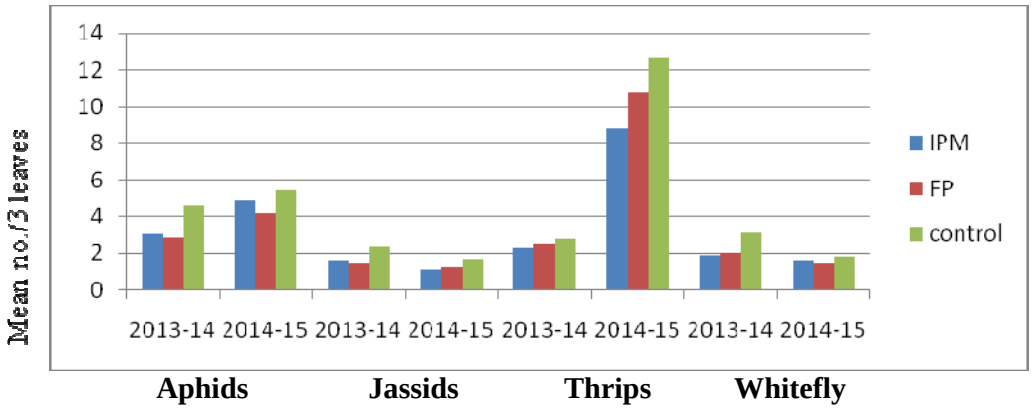

Figure 1. Mean incidence of sucking pests in Integrated pest management module

Table 3. Prevalence of natural enemies in Integrated pest management module adopted in *Bt* cotton at RARS, Warangal during 2013-15

Treatment	Mean no. of Spiders/plant*		Mean no. of Coccinellids/plant*	
	2013-14	2014-15	2013-14	2014-15
IPM module	0.70	0.84	0.12	0.20
Farmers practice	0.66	0.73	0.09	0.10
Untreated control	0.76	0.73	0.14	0.12

* Figures are seasonal means

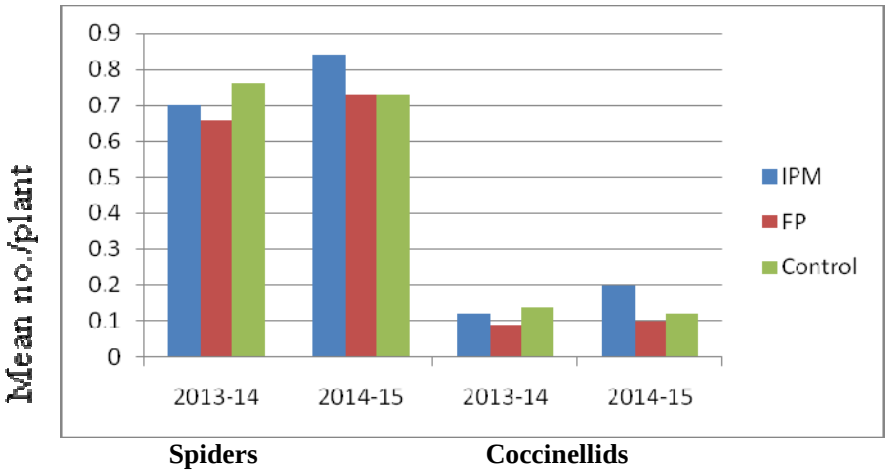

Figure 2 : Mean incidence of natural enemies in Integrated pest management module vis-à-vis farmers' practice

Table 4. Yield and economics of *Bt* cotton in IPM module vis-à-vis farmers' practice at RARS, Warangal during 2013-15

Particular	2013-14			2014-15		
	IPM	Farmers' Practice	Untreated control	IPM	Farmers' Practice	Untreated control
Yield (Kg/ha)	1337	1275	861	1898	2381	1619
Yield from intercrop (Kg/ha)	168	-	-	225	-	-
Income from inter crop (Rs./ha)	10,080	-	-	15,525	-	-
Income from main crop (Rs./ha)	56,154	53,550	36,162	85,790	96,414	56,647
Gross income (Rs./ha)	66,234	53,550	36,162	1,01,315	96,414	56,647
Total Cost of cultivation (Rs./ha)	49,181	47,404	35,965	54,170	55,315	37,612
Benefit: Cost ratio	**1.35**	1.13	1.00	**1.87**	1.74	1.50

Prevailing market price of Kapas per quintal : Rs.4200/- (March, 2014); Rs.4050/- (March, 2015)
Prevailing market price of Greengram per quintal : Rs. 6000/- (March, 2014); Rs.6900/- (March, 2015)

Population of natural enemies like spiders and coccinellids are in abundant in IPM as compared to farmers' practice throughout the crop period during the experimental seasons (Table 3). There was 6.06-15.07 per cent increase in spider population in IPM plot as compared to farmers' practice. Similarly, coccinellid population increased by 33.30 – 100.0 per cent in IPM module as compared to chemical interventions. This could be due to build up of natural enemies in IPM plot because of presence of intercrop and stem application in the initial stages. The increase in natural enemies due to intercropping with green gram or black gram had been well documented [7]. Kulkarni *et al.* [10] reported that natural enemies population was significantly higher *i.e.*, 9.93/plant in *Bt* cotton IPM when compared to 7.87/plant in *Bt* cotton with insecticidal sprayings. The population of coccinellids and chrysopids increased by 45.5 and 38.7%, respectively in *Bt* cotton IPM plots over control [11].

Higher seed cotton yield (1337kg/ha) was received through integrated pest management during 2013-14 compared to farmers' practice and untreated control while during 2014-15, the highest seed cotton yield (2381kg/ha) was received through farmers' practice followed by IPM and untreated control. Rao *et al.* [12] reported that the seed cotton yield from IPM plots was high which resulted in a higher cost benefit ratio (1:5.3) in comparison with conventional farming practice (1:2.5). Highest gross income 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 and untreated control (Table 4). The compatibility of *Bt* cotton with the integrated pest management approach was already recorded by Yuan *et al.*, [13]. The results clearly indicated that integrated pest management strategies needs to be adopted even in *Bt* cotton to have higher net returns and better benefit cost ratios. Thus, integration of *Bt* with other components of integrated pest management augments usefulness and sustenance of *Bt* technology.

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INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES

ISSN 2231-4490

International Journal of Plant, Animal and Environmental Sciences