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Impact of integrated pest management programme in *Bt* cotton in Faridkot district of Punjab

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ABSTRACT : To manage these insect pests, IPM strategies were developed and disseminated among cotton growing farmers of district Faridkot. The farmers were given training about identification of insect-pests, economic threshold levels, spray technology and natural enemies etc. About 88 villages of district Faridkot were covered under this programme and two were selected under non IPM as to evaluate the impact of strategies during the year 2009-2010. It was observed that the population of cotton jassid remained below ETL in both IPM and non IPM project area. The incidence of sucking pests *viz.,* jassid, whitefly, thrips/ 3 leaves in IPM villages was 1.22, 1.02 and 0.00, respectively as while in non IPM villages it was 2.18, 2.27 and 0.09, respectively. Among sucking pests, mealybug also played important role and the incidence of mealybug/ 2.5 cm in IPM villages was 0.08 and in non IPM villages, it was 0.31. No incidence of any bollworm was recorded from IPM and non IPM villages. Among foliage feeders, the incidence of tobacco caterpillar was 0.08 in IPM villages and 0.24 in non IPM villages. The average number of natural enemies/ plant in different IPM villages was 0.66 as compared to 0.36 in non IPM villages during different metrological weeks. The average number of insecticidal sprays for IPM villages was 4.2 as compared to 5.4 in non IPM villages resulting in 22.22 per cent reduction in number of sprays over non IPM villages. Seed cotton yield was more (2057 kg/ha) in IPM villages as compared to non IPM villages (1966 kg/ha). There was 5.54 per cent increase in yield over non IPM villages. Overall, the average net returns were more (Rs 37899) in IPM villages as compared to non IPM villages (Rs 35319). The additional profit of IPM villages over non IPM villages was Rs 2570/ha. Thus, it is concluded from the above studies that the adoption of IPM strategies will help the farmers to sustain the crop productivity and their prosperity.

Key words : *Bt* cotton, insect pests, integrated pest management, natural enemies

Cotton is an important commercial crop in India and plays a key role in national economy. Cotton crop is grown principally for the fibre and the seed is used as a source of food, feed and oil for humans and animals. India is the only one where all the 4 species of cotton, *viz., Gossypium arboreum* L., *G. hirsutum* L., *G. herbaceum* L. and *G. barbadense* L. along with inter specific hybrids are cultivated. India ranks first in global scenario (about 35 per cent of the world cotton area) but with regard to production, it continued to maintain the second largest producer next to china with 22 per cent of world production. In India, the area under *Bt* cotton was 115.53 lakh ha with production of 375 lac bales and productivity was 552 kg/ha during 2013-2014, while in Punjab, the area under cotton was 5.05 lac ha with total production of 18.50 lakh bales and average lint yield was 707 kg/ha during 2013-2014 (Anonymous, 2014). The insect pests are one of the major constraints in achieving optimum yield potential. Cotton cop harboured 1326 species of insects from sowing to maturity in different cotton growing areas of the world and 162 species have been reported on the crop in India. The insect pest complex of cotton crop broadly divided into three categories, *viz.,* sucking pests, foliage feeders and bollworms causing damage to various plant parts at different growth stages through out the cropping season. Before

introduction of *Bt* cotton, farmers were using more insecticides to control bollworm that resulted in the insecticide resistance, resurgence, secondary pest outbreak and also increasing need for repeated cost of production and environmental pollution (Kranthi *et al.,* 2007). Therefore, for a country that consumes 50 per cent of insecticide alone on cotton crop despite growing on 5 per cent of cropped area, any technology that reduces dependence upon chemicals was an immediate priority, which could not only check the menace of this pest but also help in scaling down the pesticide load for cotton sustainability. Due to non availability of resistant cultivars and effective bio agents along with constraints in adoption of cultural practices, insecticides are the main stay of pest management technology in cotton. There has been a long history of research into integrated pest management (IPM) approaches which might reduce dependence on pesticides with the outcome of introduction of genetically engineered cotton (expressing delta endotoxin genes from *Bacillus thuringiensis* sub sp *kurstaki* (*Bt*)) in 1996 which offered prospects to drastically reduce pesticide application for a sustainable and environmentally acceptable IPM system (Fitt, 2003). Hence, *Bt* cotton has now been playing a major role in effectively protecting the crop from bollworms, especially the *H. armigera*, thus preventing yield losses. The farmers responded positively to *Bt* cotton and strongly supported the technology to the extent that in the history of agriculture, there has never been ever before, an example of such a rapid technology adoption, especially with reference to the spread in area under *Bt* cotton in India. Keeping in view the changing scenario of insect pests on *Bt* cotton, IPM strategies was developed and implemented in different villages of Faridkot districts of Punjab.

For the dissemination of IPM technology, 88 villages were adopted in district Faridkot of Punjab during the year 2009-2010. Two villages adjoining to IPM villages were also selected which are known as non IPM villages for comparison. Twenty farmers from each village were selected as a target group for dissemination of IPM strategy. The training regarding identification of insects-pests and natural enemies was given to the scouts and farmers. They were trained for spraying the insecticides *i.e.* when to spray, what to spray and where to spray. Literature pertaining to identification of insect pests, their economic threshold level (ETL) and their control was distributed among farmers. The insecticides of different groups were sprayed at ETL and without repetition of same insecticides. The information regarding cultivation of crop from sowing upto yield was also recorded in the form of questionnaire to study the impact of dissemination of IPM strategies. The data on the incidence of sucking pests (jassid, whitefly and mealybug) and bollworm complex (American bollworm and spotted bollworm) damage were recorded at weekly interval from 32nd to 40th standard metrological weeks (SMWs). The number and cost of insecticides sprays and seed cotton yield were also recorded and mean of different villages was worked out. IPM strategies including cultivation of recommended genotypes, completion of sowing upto 15 May eradication of weeds in or around the cotton fields, use of neo-nicotinoids on ETL basis against sucking pests, use of pheromone traps for monitoring of bollworm's moths, no spray against minor lepidopteran, need based use of novaluron as first spray for the control of tobacco caterpillar and buprofezin for the control of mealybug as spot treatment

Selection of villages and agronomic practices: In Faridkot district, 88 villages were adopted for IPM strategy and 2 were kept as check villages. Data on agronomic practices such as cultivar sown and date of sowing was collected from the adopted farmers. The area under recommended time of sowing (in April) was 51.0 percent. The area under sowing from 1-15 May

was 45.6 percent. The delayed sowing area (after May 15) was 3.4 per cent. Area under recommended varieties (PAU and GEAC) was 81.06 per cent in the adopted villages (Table 1).

Sucking pests, bollworm complex and foliage feeders: The population of cotton jassid, *Amrasca biguttula* (Ishida) on cotton in different IPM and non IPM project area remained below the economic threshold level. The average population of jassid during different meteorological week (MW) varied from 0.9 to 2.0 per three leaves in different IPM villages. In non IPM villages also, the mean population of jassid nymphs was 0.8 to 4.4 per three leaves. However, it was higher than IPM villages in corresponding MW. The mean population of jassid was 1.22 in IPM villages as compared to 2.18 in the non IPM villages. The population of whitefly, *Bemisia tabaci* (Gennadius) adult varied from 0.9 to 1.2/3 leaves in different MW in IPM villages. While in non IPM villages, it varied from 1.3 to 3.7/3 leaves, being higher than IPM villages. In case of non IPM villages, the population was maximum 3.7 adults/3 leaves during 33rd and 34th MW. The mean population of whitefly/3 leaves was 1.02 in IPM villages as compared to 2.27 in non IPM villages. In case of IPM villages mealy bug varied from 0.0 to 0.2/2.5 cm during different MW. In non IPM villages, the average population of mealy bug remained 0.0 to 1.6/2.5 cm during different MW. The average population of mealybug was more in non IPM (0.31) as compared to IPM villages (0.08). In case of IPM villages, no incidence of thrips was observed during different MW. In non IPM villages, the average population of thrips remained 0.0 to 0.8/3 leaves during different MW. The average population of thrips was 0.09 in non IPM villages (Table 2). There was no incidence of spotted bollworm and american bollworm. The incidence of tobacco caterpillar was observed 0.1 during 37th, 38th, 39th and 0.4 in 40th MW in IPM villages. The average population of tobacco caterpillar in IPM villages was 0.08/ plant. However, it was 0.24/plant in non IPM villages.

Natural enemies: The average number of natural enemies in different IPM villages varied from 0.5 to 0.8/plant, which was relatively higher than the non IPM villages (0.0 to 0.8/ plant). The population was maximum (0.8/plant) during 34th MW in IPM villages. The average number of natural enemies in different IPM villages was 0.66/plant as compared to 0.36 in non IPM villages during different MW (Table 2).

Impact of IPM strategies: The impact of dissemination and adoption of IPM strategies resulted in the reduction in the number of insecticidal spray, cost of spray and increase in seed cotton yield.

The average number of insecticide sprays for IPM villages was 4.2 However; it was 5.4 in non IPM. There was 22.22 per cent reduction in number of sprays over non IPM. The mean cost of sprays was more in non IPM villages (Rs 2906/ ha) as compared to IPM villages (Rs 2273/ha). However, per cent reduction in cost of sprays was 21.78 per cent over non IPM (Table 3). The mean number of sprays for sucking pests was 4.0 and 5.2 in IPM and non IPM villages, respectively. In

Table 1. Information regarding agronomic practices adopted in IPM villages of district Faridkot

Villages (centre)	Number of farmers	Area (ha)		Common cultivars (%)		Areas under different dates of sowing (%)		
		Total	Under cotton	Recom-mended *Bt*	Undiscript *Bt*/ non *Bt*	Before April 30	May 1-15	After May 15
88(9)	1213	7348	2450	81.06	18.81	51.0	45.6	3.4

Table 2. Population of arthropod fauna in IPM and non IPM villages

Village	Population of insect pest and natural enemies during different meteorological week									
	32nd	33rd	34th	35th	36th	37th	38th	39th	40th	**Mean**
Jassid nymphs/3 leaves										
IPM	1.1	1.3	1.2	1.2	1.1	1.3	0.9	0.9	2.0	**1.22**
Non IPM	2.9	4.0	4.4	1.3	1.9	1.8	1.6	0.9	0.8	**2.18**
Whitefly adults/3 leaves										
IPM	1.0	1.0	1.2	1.1	1.1	1.0	0.9	0.9	1.0	**1.02**
Non IPM	1.3	3.7	3.7	1.7	3.5	1.7	1.8	1.6	1.4	**2.27**
Mealybug/ 2.5 cm in infested plants										
IPM	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.2	**0.08**
Non IPM	0.2	0.0	0.0	0.3	1.6	0.0	0.3	0.0	0.4	**0.31**
Thrips/ 3 leaves										
IPM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.00**
Non IPM	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.09**
Tobacco caterpillar/plant										
IPM	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.4	**0.08**
Non IPM	0.0	0.0	0.0	0.2	0.0	0.4	0.3	0.6	0.7	**0.24**
Number of natural enemies/plant										
IPM	0.6	0.7	0.8	0.7	0.6	0.6	0.7	0.7	0.5	**0.66**
Non IPM	0.2	0.8	0.8	0.0	0.5	0.2	0.1	0.4	0.2	**0.36**

IPM villages, maximum numbers of sprays were for the control of sucking pest (4.0) followed by tobacco caterpillar (0.2). In non IPM villages, number of insecticide sprays was maximum for control of sucking pest (5.2) followed by tobacco caterpillar (0.2) (Table 3). Cost of cultivation was more (Rs 25876/ha) in IPM villages as compared to non IPM villages (Rs 25625/ha). Seed cotton yield was more (2057 kg/ha) in IPM villages as compared to non IPM villages (1966 kg/ha). There was 5.54 per cent increase in yield over non IPM villages. So the average net profit was more (Rs 37889) in IPM villages as compared to non IPM villages (Rs 35319). The additional profit of IPM villages over non IPM villages was Rs 2570/ha (Table 3).

The present findings corroborate the result of Dhawan *et al.,* (2011), where IRM villages received 4.19 and 3.93 number of sprays compared to 7.75 and 5.57 number of sprays in non IRM villages during the year 2008 and 2009, respectively. There was reduction in number of sprays, cost of sprays and increase in seed cotton yield in IRM villages over non IRM villages. Similarly, 90 per cent reduction in sprays, 25-60 per cent reduction in plant protection cost and 59 per cent increase in seed cotton yield due to adoption of IRM strategies (Kranthi *et al.,* 2000). Similarly, Dhawan *et al.,* (2006) also reported reduction in number of sprays, cost of sprays (Rs/ha) and increase in seed cotton yield in IPM villages over non IPM villages during 2002 and 2003. Surulivelu *et al.,* (2004) also reported 63 per cent reduction in number of sprays in Coimbatore and Theni districts, with the mean of 2.7 in project village as compared to 7.3 in control villages. Similarly, in present study reduction in cost of spray, number of sprays and increase in seed cotton yield was 21.78, 22.22 and 5.54 per cent, respectively. The increase in net profit/ha in IPM villages over non IPM villages was Rs 2570. With the adoption of IPM strategy, there was no damage due to bollworms and incidence of sucking pests and foliage feeders was also less. Higher number of natural enemies in IPM villages as compared to non IPM villages were also observed.

Table 3. Dissemination of IPM strategy on cotton in KVK, Faridkot

Observations	IPM villages	Non IPM villages
Number of villages	88	2
Number of farmers	1213	62
Total area (ha)	2450	210
Total number of spray	4.2	5.4
For jassid and whitefly	4	5.2
For mealybug	0	0
For thrips	0	0
For tobacco caterpillar	0.2	0.2
Cost of spray (Rs/ha)	2273	2906
Cost of cultivation (Rs/ha)	25876	25625
Net profit (Rs/ha)	37889	35319
Yield (kg/ha)	2057	1966
Impact of IRM strategies :		
a. Reduction in insecticide sprays (%)	22.22	-
b. Reduction in cost of sprays		
c. Farmer participation	80%	37889
d. Net profit (Rs/ha)	21.78%	-
e. Additional profit due to IPM (Rs/ha)	2570	35319

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