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Impact of integrated pest management practices on pest complex and economics in *Bt* cotton

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ABSTRACT : The study was conducted to control insect-pests of *Bt* cotton by implementing Integrated Pest Management (IPM) practices at village level in Sirsa district (Haryana) to manage the problems arising due to excessive use of pesticides for control of insect- pests of *Bt* cotton. IPM practices in cotton were implemented at farmer's fields during 2007-2008 to 2009-2010 crop seasons. The impact of adoption of IPM practices resulted in 37.5 per cent reduction in number of sprays in IPM in comparison to non IPM practices. Recommended doses of pesticides were used in IPM as compared to over dosages in non IPM fields. Removal of congress grass and other weeds was found effective to manage the mealybug. Population of natural enemies/plant (*Chrysoperla*, Spiders and Coccinellids) was higher in IPM fields (1.14, 2.54 and 0.91), respectively than in non IPM programme (0.93, 2.34 and 0.74). Spray cost and cost of cultivation (Rs./ha) were higher in non IPM fields (Rs.5150 and 25466), respectively, as compared with IPM fields (Rs.3333 and 24583), B:C ratio in IPM fields was 1:2.83 as compared with 1:2.44 in non IPM fields. Net profit was also higher in IPM (Rs.46083/ha) than non IPM fields (38000/ha). Additional profit to the farmers was Rs.8083/ ha in IPM fields over the non IPM fields.

Key words: *Bacillus thuringiensis*, cotton, ecological, IPM

Cotton (*Gossypium* spp.) is the most important commercial fibre crop in India and plays a vital role as cash crop. With the introduction of *Bt* cotton hybrids, the pest scenario has changed, bollworms attained secondary pest status and sucking pests (jassids, thrips and whitefly) remains as such. The development of transgenic cotton has resulted in an immense increase in the seed cotton yield and reduction in the insecticidal sprays (Barwale *et al.,* 2004). However this technology has also resulted in emergence of new pests complex on *Bt* cotton such as *Spodopetera litura, S. exigua* and sucking pests like mealy bug etc. Moreover, sucking pests may be aggravated due to large scale use of high yielding *Bt* hybrids, replacement of conventional varieties and hybrids having high adaptability, intensive cultivation, lack of crop rotation and intercropping, changes in planting and pesticides use pattern etc. Now a day's, introduction of several new *Bt* cotton hybrids which are highly susceptible to pests resulted in increase of damage of sucking pests like leafhoppers, thrips and whitefly. The indiscriminate use of chemical insecticides though foliar sprays is also a major concern. Due to effectiveness of neonicontinoides (imidacloprid 17.8 SL, acetamiprid 20 SP and thi amithoxam 25WG), they are largely used against sucking pests. As a result of indiscriminate use of insecticides sucking pests have developed resistance to almost all major groups of insecticides and recent field study showed that repeated use of these chemicals caused resurgence in major sucking insect-pests (Gawande, 2012).

Attempts are being made to find alternative methods for management of insect pests. Therefore, the study was undertaken to manage the problems arising due to excessive use of pesticides and control of insect pests, in *Bt* cotton by implementing integrated pest

management (IPM) practices at village level in Sirsa district of Haryana state.

MATERIALS AND METHODS

Three villages from Sirsa district namely Panihari, Bharokhan and Nuhinawali of Haryana were selected for adoption of IPM practices of *Bt* cotton during 2007-2008, 2008-2009 and 2009-2010 crop seasons, respectively. An area of 25 ha was covered under this programme in each village in every crop season involving 66 farmers for adoption of IPM practices. An area of 25 ha adjoining to IPM programme was kept under observations and this constituted the non IPM programme. For successful dissemination and implementation of IPM programme regular training on IPM in *Bt* cotton were organized in the adopted villages. In these trainings, the farmers of adopted villages were trained about each and every aspect of IPM practices of *Bt* cotton by the CCSHAU Krishi Vigyan Kindra expert's right from sowing to picking. The data regarding population of natural enemies, cost of cultivation, cost of sprays, yield, B:C ratio and number of sprays of insecticides applied was recorded throughout the crop season.

RESULTS AND DISCUSSION

1. Incidence of insect pests

a) Leafhopper : The data presented in Table 1 indicate that the population of leafhopper remained below economic threshold with mean numbers of 1.34, 1.83 and 1.76 nymphs/leaf in Panihari, Bharokhan and Nuhianwali, respectively in IPM fields, while in non IPM fields it was 2.42, 2.10 and 1.92 in respective villeges.

b) Whitefly : The population of whitefly adults/leaf remained below economic threshold *i.e.* 3.80, 4.84 and 5.20 adults/leaf in Panihari, Bharokhan and Nuhinanwali villages, respectively in IPM fields, while in non IPM fields it was 6.42, 8.90 and 6.54 adults/leaf (above economic threshold) for the corresponding villages.

c) Thrips : Average thrips population /leaf in IPM fields was recorded 1.62, 1.26 and 0.86 in villages Panihari, Bharkhan and Nuhianwali, respectively as agasint 1.84, 1.80 and 1.62 thrips/leaf in non IPM fields for corresponding villages.

d) Mealybug and tobacco caterpillar : A very low incidence of mealy bug and tobacco caterpillar was recorded in IPM fields over non IPM fields. Mean population of mealybug/plant in IPM fields was recorded 0.42, 0.38 and 0.40 in villages Panihari, Bharokhan and Nuhianwali, respectively as against 0.56, 0.62 and 0.52 mealybugs/plant in non IPM fields for respective villages. The population of tabacco caterpillar/ plant was 0.15, 0.25 and 0.10 in villages Panihari, Bhorokhan and Nahianwali, respectively while it was 0.35, 0.40 and 0.36/plant for non IPM fields for respective villages.

e) Natural enemies : The number of spiders, *Chrysoperla* and coccinellids beetles/ plant during the crop season (2007-2008) at village Panihari was 2.47, 1.06, 0.87 respectively in IPM fields, where as it figured 2.13, 0.95 and 0.61, respectively in non IPM fields. These figures at village Bharokhan during the year 2008-2009 were 2.53, 1.24 and 0.97 in IPM fields as compared to 2.46, 0.98 and 0.84, respectively in non IPM fields. Population of natural enemies/plant (Spiders, *Chrysoperla* and Coccinellids) at village Nuhianwali during 2009-2010 crop season were 2.61, 1.12, 0.89 in IPM fields as compared to 2.43, 0.87 and 0.76, respectively in non IPM fields. The average population of spiders, *Chrysoperla*, and coccinellids beetles/plant was 2.54. 1.14 and 0.91, respectively in IPM fields where as it figured 2.34, 0.93 and 0.74, respectively in non IPM fields.

Table 1. Mean population of sucking pests (Leafhopper, whitefly thrips and mealybug) and tobacco caterpillar on cotton in IPM and non IPM fields

Village	Year	Leafhoper /leaf*		Whitefly /leaf*		Thrips /leaf*		Mealybug /plant**		Tabacco caterpillar /leaf**	
		IPM	Non IPM	IPM	Non IPM	IPM	Non IPM	IPM	Non IPM	IPM	Non IPM
Panihari	2007-2008	1.34	2.42	3.80	6.42	1.62	1.84	0.42	0.56	0.15	0.35
Bharokhan	2008-2009	1.83	2.10	4.84	8.90	1.26	1.80	0.38	0.62	0.25	0.40
Nuhianwali	2009-2010	1.76	1.92	5.20	6.54	0.86	1.62	0.40	0.52	0.10	0.36

* Population of leafhopper, whitefly and thirps-observations and based on three leaves on 10 plants during months of June of October.

** Population of mealy bug and tobacco caterpillar observations based on 30 plants/ac during months of June to October.

2. Impact of dissemination of IPM practices : The impact of dissemination of IPM practices on number of sprays, cost of sprays, cost of cultivation, yield of seed cotton, gross return, net profit and B:C ratio is presented in Tables 2 and 3.

a) Number of sprays, cost of sprays and cost of cultivation : Average number of sprays of insecticides for control of cotton pests was 5 in IPM fields as compared to 8 in non IPM fields and percent reduction in number of sprays was observed 37.5 per cent in IPM fields. Per cent reduction in number of sprays was highest at (50.0%) at village Panihari during the crop season 2007-2008 and lowest (28.6%) at village Nuhianwali during the crop season 2009-2010. Spray cost was also higher (Rs.5150/ha) in non IPM field as compared to IPM fields (Rs. 3333/ha) (Table 3). Cost of sprays was highest (Rs. 5800/ ha) at village Bharokhan during 2008-2009 crop season where as it was lowest (Rs. 4700/ha) at village Panihari during 2007-2008 crop season. Per cent reduction (35.4%) in cost of sprays was highest at village Nuhaianwali during 2009-2010 crop season where as average reduction in cost of sprays figured 35.3 per cent.

Total cost of cultivation was higher in non IPM fields (average Rs. 25466/ha) as compared to IPM fields (Rs. 24583/ha). Highest cost of cultivation (Rs. 27550/ha) was recorded in village Nuhianwali during 2009-2010 crop season in non IPM fields as compared to Rs. 26750/ha in IPM fields. Per cent reduction (4.5%) in cost of cultivation was highest at village Panihari during 2007-2008 crop season as compared to 2.9 per cent in village Nuhianwali during 2009-2010 crop season in IPM fields. However average reduction in cost of cultivation figured 3.5 per cent.

b) Seed cotton yield, gross return, net profit and B:C ratio : Seed cotton yields was higher in IPM fields (average 2716:6 kg/ha) as compared to non IPM fields (average 2373.3 kg/ ha). Seed cotton yield was highest in Bharokhan village (3300 kg/ha) in IPM fields during 2008-09 crop season as compared to 3000kg/ha in non IPM fields. Per cent increase in yield of IPM fields was highest (33.7%) in village Panihari and lowest (6.2%) in village Nuhianwali. However, average percent increase in yield of seed cotton figured 16.6 per cent.

Average gross return (Rs. 70666.6/ha) was recorded in IPM fields as compared to non IPM fields (Rs. 63466.6/ha). Net profit was also higher in IPM fields as compared to non IPM fields (Table 4). It was highest in village Bharokhan (Rs. 63100/ha) and lowest (Rs. 25400/ha) in village Panihari in IPM fields as compared to Rs. 54150/ha in village Bharokhan and Rs. 15400/

Table 2. Population of natural enemies (Spiders, *Chrysoperla* and coccinellids) on cotton in IPM and non IPM fields

Village	Year	Population of natural enemies/plants					
		Spiders		*Chrysoperla*		Coccinellids	
		IPM	Non IPM	IPM	Non IPM	IPM	Non IPM
Panihari	2007-2008	2.47	2.13	1.06	0.95	0.87	0.61
Bharokhan	2008-2009	2.53	2.46	1.24	0.98	0.97	0.84
Nuhianwali	2009-2010	2.61	2.43	1.12	0.87	0.89	0.76
Average		**2.54**	**2.34**	**1.14**	**0.93**	**0.91**	**0.74**

ha in village Panihari in non IPM fields. Overall net profit was Rs. 46083/ha in IPM fields as compared to Rs. 38000/ha in non IPM fields. Per cent increase in net profit was on an average 31.1 percent in IPM fields. Average additional profit was recorded 8083 in IPM fields. B:C ratio in IPM fields was on an average 1:2.83 as compared to 1:2.44 in non IPM fields. Maximum B:C ratio was observed (1:3.43) in village Bharokhan during 2008-2009 crop season in IPM fields as comaped to 1:3.02 in non IPM fields.

The present findings are in conformity with the earlier result of Kumar *et al.,* (2011) who reported that incidence of leafhopper, thrips as well as mealybug was significantly low in IPM as compared to recommended package of practices (RPP). The predators' population was more in IPM fields than non IPM fields in the present investigations. Similar results has been reported by Kumar *et al.,* (2011) who reported that population of spider (0.33 and 0.28/plant), lady bird beetle (0.18 and 0.12/plant) and lace wing (0.29 and 0.23/plant) in IPM and RPP. The present findings are in conformity with the earlier results of Kranthi *et al.,* (2000) who estimated 90 per cent reduction in number of sprays and seed cotton yield increased upto 59 per cent due to adoption of IRM strategies. Dhawan *et al.,* (2006) also reported reduction in number of sprays, cost of sprays Rs./ha and increase in seed cotton yield in IRM over non IRM villages support the present findings. The cost benefit ratio increased in IPM fields over non IPM fields in the present findings and

Table 3. Reduction in number of sprays, cost of sprays, cost of cultivation in IPM over non IPM fields

Village	Year	Number of sprays/ ha		Reduction in number of sprays (%)	Cost of sprays (Rs/ha)		Reduction in cost of sprays (%)	Cost of cultivation (Rs/ha)		Reduction in cost of cultivation (%)
		IPM	Non IPM		IPM	Non IPM		IPM	Non IPM	
Panihari	2007-2008	4	8	50.0	3050	4700	35.1	21000	22000	4.5
Bharokhan	2008-2009	6	9	33.3	3750	5800	35.3	26000	26850	3.2
Nuhianwali	2009-2010	5	7	28.6	3200	4950	35.4	26750	27550	2.9
Average		**5**	**8**	**37.5**	**3333**	**5150**	**35.3**	**24583**	**25466**	**3.5**

increase in yield in IPM fields was reported upto 33.7 per cent. Kumar *et al.,* (2011) repeated that number of sprays, cost of spray and cost of cultivation, decreased in IPM modules as compared to recommend package of practices while gross income, net profit and B:C ratio increased in IPM modules support the result of present findings. Patil *et al.,* (2011) also reported that low population of sucking pests in *Bt* cotton where integrated pest management practices were adopted during the year 2007 and 2008 are comparable with the present finding. These workers also reported that population of natural enemies was more in *Bt* cotton where Integrated

Table 4. Seed cotton yield, gross return, net profit and B:C ratio in IPM over non IPM

Village	Year	Yield (kg/ha)			Gross return (Rs/ha)			Net profit (Rs/ha)			B:C Ratio		
		IPM	Non IPM	Increase (%)	IPM	Non IPM	Increase (%)	IPM	Non IPM	Increase (%)	IPM	Non IPM	Increase (%)
Panihari	2007-2008	2300	1720	33.7	46400	37400	24.1	25400	15400	64.9	1000	2.21	1.70
Bharokhan	2008-2009	3300	3000	10.0	89100	81000	10.0	63100	54150	16.5	8950	3.43	3.02
Nuhianwali	2009-2010	2550	2400	6.2	76500	72000	6.3	49750	44450	11.9	5300	2.86	2.61
Average		**2716.6**	**2373.3**	**16.6**	**70666.6**	**63466.6**	**13.5**	**46083**	**38000**	**31.1**	**8083.3**	**2.83**	**2.44**

Pest Management was adopted are in conformity with present findings.

In the present investigations, an effort was made to evaluate the performance of adoption IPM practices over non IPM practices. With the adoption of IPM practices, incidence of sucking pests and *Spodoptera litura* was decreased and population of natural enemies was higher in IPM fields, as compared to non IPM fields. Reduction in number of sprays in IPM fields, decrease in cost of sprays and increase in seed cotton yield, net profit and B:C ratio in IPM fields.

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