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INTEGRATED PEST MANAGEMENT (IPM) IN PUNJAB – REPERCUSSIONS ON INSECT-PEST INCIDENCE, NATURAL ENEMIES AND COTTON YIELD

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ABSTRACT

To manage the problems arising from the excessive use of pesticides for the control of insect-pests on cotton, IPM strategies were disseminated among cotton growers of 8 villages of Punjab during 2008. It included cultivation of recommended tolerant varieties to bollworms, no spray from sowing to first week of July, use of recommended insecticides on ETL from second week of July to first week of August and eradication of weeds for the management of mealy bug. The farmers were trained in identification of insect pests, time of selection of pesticide and insect economic threshold levels. Four cotton growing districts *i.e.* Mansa, Muktsar, Ferozepur and Bathinda were covered under this programme. Non-IPM villages were also kept for ascertaining the impact of adopted strategy. The mean number of jassid nymphs/three leaves and whitely adults/three leaves were low in IPM villages (0.34 and 0.46) as compared to non-IPM villages (0.91 and 0.95) during crop season. The population of natural enemies during early season remained high in cotton crop due to less number of sprays and thus helped in reducing the pest population and ultimately the damage done by these pests. The impact of adoption of IPM strategies resulted in 37.31 per cent reduction in number of sprays in IPM villages over non-IPM villages. The average net profit per hectare was more in IPM villages (Rs. 48402/ha) as compared to non-IPM villages (Rs. 3309/h).

Key words: Cotton, IPM, non-IPM, Insecticides, natural enemies and yield

INTRODUCTION

Cotton has been infested by a multitude of pests as it evolved through various production levels. Of these, jassid, *Amrasca biguttula* (Ishida), whitefly, *Bemisia tabaci* (Gennadius) and bollworm complex *viz.* American bollworm, *Helicoverpa armigera* (Hübner); spotted bollworm, *Earias spp.* and Pink bollworm, *Pectinophora gossypiella* are key pests and pose a serious threat in arresting cotton production in India. The main thrust of Indian cotton growers so far is to depend heavily on unilateral use of insecticides to combat these pests. The development of transgenic cotton has resulted in an increase in the seed-cotton yield and reduction in the insecticidal sprays (Barwale *et al.*, 2004). It helped the farmers to manage the population of bollworm, *H. armigera*, which was the most important pest causing about 31.0 per cent loss in non-transgenic cotton (Grover and Pental, 2003) and more than 80 per cent potential crop losses in cotton (Oerke *et al.*, 2005). However, this technology has also resulted in emergence of new pest complex on Bt cotton such as *Spodoptera litura* Fab., and sucking pests like mealy bug. To overcome these problems, integrated pest management (IPM) arose in the second half of the century as the choice for pest control, and stressed the need to incorporate basic ecological concepts in the implementation of pest control strategies. An attempt has been made to manage the pest incidence below ETL, reduction in number of sprays, cost of cultivation and to increase the net profit by implementing IPM strategies in the adopted villages of Punjab.

MATERIAL AND METHODS

Eight villages from four districts (Mansa, Bathinda, Ferozpur and Muktsar) of Punjab were adopted for dissemination of IPM strategies of cotton during 2008 crop season. About 4486 ha area was covered for implementation of IPM of cotton and about 946 farmers followed the IPM strategies. One village adjoining to IPM villages was kept under observation and this constituted the non-IPM villages in each of our districts. The Bt cotton crop was grown as per recommendations by Punjab Agricultural University, Ludhiana (Anonymous, 2008). The sowing of cotton was completed before first week of May. The IPM strategies include sowing of varieties recommended by PAU, timely sowing, use of recommended seed rate, judicious use of fertilizers, regular monitoring of crop, spraying of crop at ETL with recommended dose and pesticides, weed management and conservation of natural enemies. For successful dissemination and implementation

of these strategies, a Farmer Field School (FFS) was setup in each of the adopted village. In these FFS, the farmers of adopted villages were trained about each and every aspect of cotton IPM by the PAU expert's right from sowing to harvesting. The literature pertaining to agronomic practices, insect-pests, their economic threshold level and their management was distributed among the farmers. One demonstration field was kept in each of adopted village for the on farm training of farmers. The baseline data regarding varieties, sowing time, cost of cultivation and yield were recorded. The weekly data were recorded both from IPM and non-IPM farmer field for sucking pest and number of insecticide application throughout the season.

RESULTS AND DISCUSSION

I. Incidence of insect-pest and natural enemies

Sucking pests: The mean number of jassid nymphs per three leaves during different MWs in IPM villages was 0.34 during the crop season, whereas in non-IPM villages the mean population was 0.91. Similarly, whitefly adults/3 leaves was more in IPM villages (0.46) as compared to non-IPM villages (0.95). Mealy bug population /2.5 cm upper stem varied from 0.6 to 1.6 with the mean of 0.97 in IPM villages; whereas, in non-IPM villages, it was 1.76 (Table 4, Figure 1).

Foliage Feeders: The tobacco caterpillar population varied from 0.0 to 0.2 per plant during different MWs with the mean of 0.09 per plant in IPM villages whereas in non-IPM villages mean tobacco caterpillar population was higher (0.32/ plant) during different MWs (Table 4, Figure 1).

Bollworm Complex: The per cent boll damage in fruiting bodies due to bollworms was low being 0.05 in IPM villages and 0.08 in non-IPM villages (Table 4, Figure 1).

Natural Enemies: In IPM villages, the number of natural enemies *viz.* spiders, green lace wing and lady bird beetles was 0.48, 0.07 and 0.12 per plants respectively, in Punjab during different MWs. In non-IPM, it was very low *i.e.* 0.14, 0.03 and 0.04 (Table 4, Figure 1).

II. Impact of dissemination of IPM strategies

The impact of dissemination of IPM strategies on number of sprays, cost of spray, cost of inputs, and cost of cultivation, seed cotton yield and net profit in cotton is given below:

Number of sprays: Mean number of insecticide sprays were more in non-IPM villages than IPM villages. It was highest in Bhagu (Ferozepur) *i.e.* 5.8 sprays followed by 4.4 sprays in Ghurkani village of Mansa district in IPM villages. In non-IPM village, maximum numbers of sprays were 7.2 in Phulomithi of Bathinda district. It was 4.3, 4.2, 4.6 and 4.0 in IPM villages of Mansa, Bathinda, Ferozepur and Muktsar, respectively. However, it was 6.9, 7.3, 6.1 and 6.5 in non-IPM villages of Mansa, Bathinda, Ferozepur and Muktsar, respectively. The per cent reduction in number of sprays was highest in IPM villages of Mansa (43.29%) and lowest in Ferozepur (24.50%) over non-IPM villages. The average sprays were 4.2 in IPM villages against 6.7 sprays in non-IPM villages. Mean reduction in number of spray was 37.31 per cent (Table 2).

Spray Cost: Spray cost was higher in non-IPM villages as compared to IPM villages (Table 1). Among the IPM villages, it was highest in Ghurkani village of Mansa district (Rs. 1787) and lowest in Rajpura (Rs. 1030) of Ferozepur district. However, in non-IPM villages it was Rs. 4688 in Mahabaddar village of Muktsar district. Spray cost/ ha was Rs. 1708, 1552, 1229 and 1252 in IPM villages of Mansa, Bathinda, Ferozepur and Muktsar, respectively. It was higher in non-IPM villages varied from Rs. 3802 to 4688. Mean reduction in spray cost was highest in Ferozepur (73.60%) and lowest in Mansa (55.07%). The mean spray cost of IPM village was Rs. 1435/ ha as compared to Rs. 4282 in non-IPM. Mean reduction in spray cost in IPM over non-IPM was 65.73 per cent.

Cost of inputs: Cost of inputs was also higher in non-IPM villages as compared to IPM villages (Table 1). It was Rs. 5610 in Daula (Muktsar) of IPM villages as compared to Rs. 8946 in Mahabaddar (Muktsar) of non-IPM villages. Mean cost of inputs was Rs. 5033 in IPM villages as compared to Rs. 8162 in non-IPM villages.

Cost of cultivation: The cost of cultivation was higher in non-IPM villages than IPM villages. In Punjab, it was Rs. 20430/ha in IPM villages as compared to Rs. 25658/ha in non-IPM. The mean reduction in cost of cultivation in IPM over non-IPM was 9.67 per cent (Table 1 and 2).

Seed cotton yield: Seed cotton yield was highest in Bhagu village (2580 kg/ha) of Ferozepur district under IPM villages. However, it was as lowest in Mahabaddar village (1920kg/ha) of Muktsar district under non-IPM villages (Table 1). It was highest in Mansa district (2491 Kg/ha) followed by Bathinda, Ferozepur and Muktsar (Table 3). Per cent increase in yield of IPM villages over non-IPM villages was highest in Muktsar district (25.31%). It was lowest in Mansa district (20.39). The mean yield of IPM farmers was 2443 Kg/ha as compared to 1991 Kg/ha of non-IPM farmers. The per cent increase in seed cotton yield in IPM fields over non-IPM fields in Punjab was 22.76 (Table 2).

Net profit: Net profit was highest in Bhagwangarh village of Bathinda district followed by Bhagu (Ferozepur district). In non-IPM villages it was as low as Rs. 29824/ ha in Mahabaddar (Muktsar district). The data presented in table 3 showed that per cent increase in net profit was highest

Table 1. Impact of cotton IPM technology on the economics and net returns

District	Village	Total area under cotton (ha)	No. of sprays/ ha				Total no. of sprays	Cost of sprays (Rs./ha)	Cost of inputs (Rs./ha)	Cost of farm operations (Rs./ha)	Cost of cultivation (Rs./ha)	Seed cotton yield (Kg/ha)	Net profit (Rs./ha)
			SP	TC	BW	MB*							
IPM													
Mansa	Saharna	190	2.1	0.6	0.0	1.4	4.1	1629	5475	15775	21250	2455	47490
	Ghurkani	280	2.2	0.7	0.0	1.5	4.4	1787	5515	16015	21530	2528	49254
Bathinda	Bhagwangarh	680	2.0	0.4	0.0	1.7	4.2	1391	5165	15129	20295	2514	50097
	Pakka Khurd	461	2.1	0.6	0.0	1.6	4.3	1713	5470	15192	20662	2415	46958
Ferozepur	Rajpura	690	2.0	0.0	0.1	1.0	3.4	1030	3110	15070	18180	2245	44680
	Bhagu	935	2.0	0.0	1.0	2.0	5.8	1428	4489	17740	22229	2580	50011
Muktsar	Daula	610	2.0	0.0	0.0	2.0	4.3	1184	5610	12122	17732	2422	50084
	Bodiwala	640	2.0	0.0	0.0	1.0	3.8	1320	5432	16129	21561	2390	45359
Total mean		4486	2.0	0.30	0.1	1.5	4.3	1435	5033	15397	20430	2444	47992
Non IPM													
Mansa	Ramdittewala	282	3.1	1.4	0.0	2.4	6.9	3802	8457	14432	22889	2069	35043
Bathinda	Phulo mithi	650	3.0	1.3	0.0	2.8	7.2	3976	8315	14016	22331	2039	34761
Ferozepur	Gobindgarh	160	2.1	0.8	0.0	3.1	6.1	4663	6929	14548	21477	1937	32759
Muktsar	Mahabaddar	193	2.1	0.4	0.5	3.3	6.5	4688	8946	14990	23936	1920	29824
Total mean		1285	2.6	1.0	0.1	2.9	6.7	4282	8162	14497	22658	1991	33097

* Only spot treatment was given for mealy bug, SP–sucking pests, TC–Tobacco caterpillar, BW–bollworms and MB–mealy bug

Table 2. Economics and cost of cultivation in IPM and non–IPM fields

District	Number of sprays			Spray cost (Rs./ha)			Cost of cultivation (Rs./ha)		
	IPM	NIPM*	% reduction	IPM	NIPM	% reduction	IPM	NIPM	% reduction
Mansa	4.3	6.9	43.29	1708	3802	55.07	21390	22889	6.54
Bathinda	4.2	7.3	41.32	1552	3976	60.96	20478	22331	8.29
Ferozepur	4.6	6.1	24.50	1229	4663	73.60	20204	21477	5.92
Muktsar	4.0	6.5	40.00	1252	4688	73.29	19646	23936	17.92
Punjab	4.2	6.7	37.31	1435	4282	65.73	20430	22658	9.67

Table 3. Increase in seed cotton yield and net profit in IPM over non–IPM

District	Yield (Kg/ha)			Net profit (Rs./ha)			
	IPM	NIPM	% increase	IPM	NIPM	Additional profit (Rs./ha)	Additional Profit (%)
Mansa	2491	2069	20.39	48372	35043	13329	38.03
Bathinda	2464	2039	20.84	48527	34761	13766	39.52
Ferozepur	2412	1937	24.52	47195	32759	14436	44.06
Muktsar	2406	1920	25.31	49515	29824	19691	66.02
Punjab	2443	1991	22.76	48402	33097	15306	46.91

Table 4. Incidence of insect pests and natural enemies in different adopted villages during standard meteorological week (SMW)

SMW	Jassid/3 leaves	Whitefly/3 leaves	Mealy bug/2.5 cm	Natural enemies/ plant			Boll damage due to bollworms (%)	Tobacco caterpillar/ plant
				Spiders	Chrysopa	Coccinellids		
IPM villages								
29	0.3	0.3	0.6	0.5	0.1	0.2	0.0	0.04
30	0.3	0.4	0.7	0.5	0.1	0.2	0.0	0.0
31	0.3	0.5	0.6	0.5	0.1	0.2	0.0	0.0
32	0.3	0.3	0.7	0.4	0.1	0.1	0.1	0.0
33	0.4	0.7	0.7	0.4	0.1	0.1	0.0	0.1
34	0.4	0.5	0.8	0.5	0.1	0.1	0.1	0.1
35	0.4	0.5	1.3	0.4	0.1	0.1	0.1	0.1
36	0.3	0.5	1.2	0.5	0.0	0.1	0.1	0.2
37	0.4	0.5	1.5	0.5	0.0	0.1	0.1	0.2
38	0.3	0.4	1.6	0.6	0.0	0.0	0.0	0.2
Average	0.34	0.46	0.97	0.48	0.07	0.12	0.05	0.09
Non–IPM villages								
29	0.5	0.4	0.8	0.2	0.0	0.1	0.0	0.0
30	0.7	0.6	1.0	0.2	0.1	0.1	0.1	0.1
31	0.7	0.7	1.0	0.2	0.1	0.1	0.1	0.2
32	0.8	0.9	1.2	0.1	0.1	0.1	0.1	0.1
33	1.0	1.2	1.6	0.2	0.0	0.0	0.1	0.2
34	1.2	1.3	1.9	0.1	0.0	0.0	0.0	0.3
35	1.2	1.1	2.2	0.2	0.0	0.0	0.1	0.5
36	1.1	1.1	2.7	0.1	0.0	0.0	0.1	0.6
37	1.0	1.2	2.7	0.1	0.0	0.0	0.1	0.6
38	0.9	1.0	2.5	0.0	0.0	0.0	0.1	0.6
Average	0.91	0.95	1.76	0.14	0.03	0.04	0.08	0.32

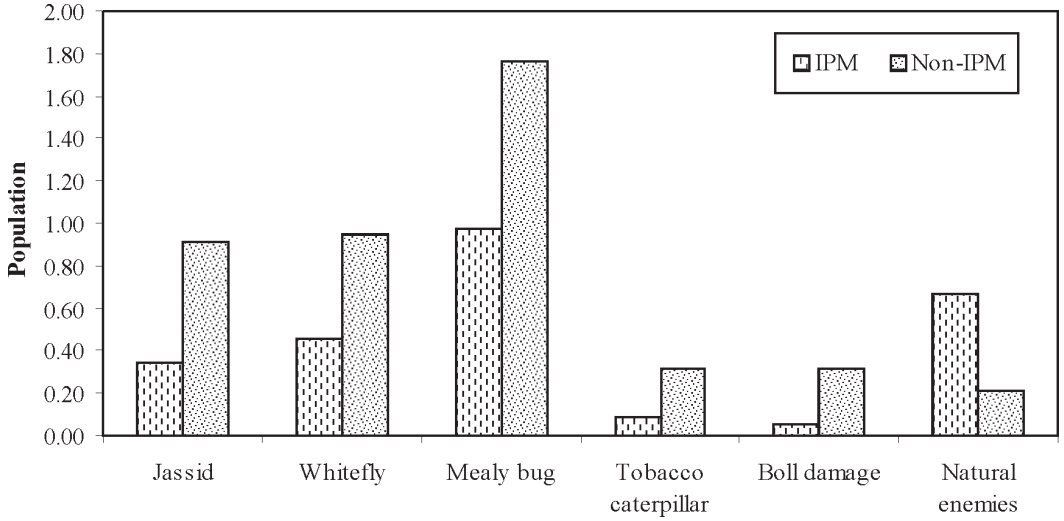


Figure 1. Abundance of insect pests and population of natural enemies on cotton during 2008 in Punjab

in Muktsar district (66.02%) and lowest in Mansa district (38.03%). The overall net profit was Rs. 48402/ ha in IPM villages as compared to Rs. 33097/ ha in non-IPM villages. Addition profit was Rs. 15306/ ha. The per cent increase in additional profit in Punjab was 46.91 (Table 4).

The present findings are in conformity with that of Suruli Velu *et al.* (2004), who also reported 63 per cent reduction in number of sprays at Coimbatore and Theni district, with the mean of 2.7 in project village as compared to 7.3 in control villages. Kranthi *et al.* (2000) reported that number of sprays used for the control sucking pests and bollworm complex varied from 2-20 in North India, and there was 90 per cent reduction in spray, seed cotton yield increased in some cases up to 59 per cent and plant protection cost reduced by 2-60% due to impact of IRM strategy. Similar reports were also given by Rajak *et al.* (1997) with 30-50 per cent reduction in pesticides consumption in IRM adopted fields and 21-27 per cent increase in yield. In the present investigation, the overall increase in yield and additional profit in adopted villages was 22.76 per cent and 46.91 per cent, respectively due to adoption of IPM strategy. Results of present investigations conform also with Dhawan *et al.* (2009) who reported that adoption of IRM strategies helped in reduction of cost of spray up to Rs. 1217/ha, cost of cultivation up to Rs. 1620/ ha and overall additional profit of Rs. 5435/ha in adopted villages as compare to other.

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