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Validation of eco friendly integrated pest management (IPM) packages in *Bt* cotton at farmer's participatory field

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ABSTRACT: Integrated Pest Management (IPM) module developed for transgenic cotton was compared with Recommended Package of Practices (RPP) on *Bt* cotton (RCH 134) during 2008 and 2009 at farmer's field in Sirsa, district of Haryana. The incidence of leafhopper, (*Amrasca biguttula biguttula* Ishida), Thrip (*Thrip tabaci* Lindeman) as well as mealybug (*Phenacoccus solenopsis* Tinsley) was significantly low in IPM as compared to RPP, except of whitefly (*Bemisia tabaci*, Gennadius). The predator's population was more in IPM modules than RPP. The populations of spider (0.33 and 0.28/plant), lady bird beetle (*Coccinella septumpunctata*, Linnaeus 0.18 and 0.12 /plant) and lacewing (*Chrysoperla carnea*, Stephens 0.29 and 0.23 /plant) in IPM and RPP, respectively were recorded frequently throughout the season. The damaged fruiting bodies, rosette flower, loculi damage, green boll damage were higher in RPP than IPM. On contrary, the number of good opened boll was more in IPM and bad opened bolls were more in RPP. Seed cotton yield was more in IPM (11.90 q/ha) as compared to RPP (11.47 q/ha) with Cost: Benefit ratio of 1:4.29 and 1:3.75 in IPM and RPP, respectively. The better performance of *Bt* cotton was recorded in both IPM modules and RPP but reduced insecticides usage to the 38 per cent in IPM (4.0 sprays in IPM and 6.5 in RPP).

Key words: *Bacillus thuringiensis*, barrier crop, IPM, refugia, RPP

Cotton is the important crop of India generating income through export, supplying raw material to textile industries and providing employment. Approximately 10.0 million ha of cotton is under cultivation in India and the production is second in the world in quantity, but the productivity is very low (494 kg lint/ha, during 2009-2010) as compared to the world average of 582 kg lint/ha. As there is a little possibility to increase the area under cotton, but the productivity has to be improved to meet the local demand.

Among the several factors contributing to low productivity, biotic constraints appear to be very important. Cotton plant is infested by 162 species of insects at various stages of growth, of which 15 are considered to be the key pests. Among these, bollworms and sucking pests are important. The biotic problem has arisen primarily because of the increasing trend on the part of grower to depend mainly on toxic pesticides for pest management. This has exerted a severe impact on natural enemies' fauna of cotton ecosystem. Further, the unwise and indiscriminate use of insecticides as well as synthetic pyrethroids has resulted in development of resistance in insects including bollworms and resurgence of new pests (Kranthi *et al.*, 2002 and Sharma *et al.*, 2000). Increased reliance on pesticides over the years has replaced traditional control methods, though cultural practices, resistance traits and beneficial fauna activity (Wilson *et al.*, 1994) has made it possible to reduce the insect pest damage, the economic sustainability of the crop, is not realized

Transgenic cotton engineered to continuously express delta endotoxin from *Bt* genes, holds great promise for controlling bollworm complex. Host plant resistance provides sound platform for pest management and therefore has been considered as an important component of any IPM module. For sustainable use of transgenic cultivars and maintenance of natural control systems Integrated Pest Management (IPM) packages are essential. The transgenic cotton expressing endotoxin protein of *Bt* as part of an IPM strategy (Lutterell and Herzog, 1994) could reduce the impact of chemical insecticides and create ecologically sound breeding programmes without reducing crop production. In the present study, IPM module developed was evaluated to manage the sucking pest and any bollworm complex to *Bt* toxin as compared with Recommended Package of Practices (RPP).

MATERIALS AND METHODS

The experiment was conducted on one acre plot in farmer's field at village, Bakarianwali (Sirsa) during 2008 and 2009 both under IPM and RPP plots. The soil was sandy loam and loose with poor water retention capacity. Both tube well as well as canal water is used for irrigation. Under cotton wheat cropping system, sowing of cotton are normally done between 15th April to 15th May. RCH 134 *Bt* treated seed with imidacloprid under both the practice but in IPM plot the seed was also dressed with *Trichoderma* @ 4 g/kg seed was sown with a spacing of 100 x 60 cm by dibbling. The non *Bt* crop in the form of refugia was also sown both in IPM plot as well as RPP plots whereas, in IPM a single row of sorghum was also sown as physical barrier for mealybug. The different combinations of treatments applied were as follows:

Table 1. Treatments details applied under IPM and RPP

Particulars	IPM plot	RPP plot
Hybrid	Popular hybrid of the locality (RCH 134 *Bt*)	Popular hybrid of the locality (RCH 134 *Bt*)
Size	1 acre	1 acre
Seed treatment		
a) Imidacloprid	Yes	Yes
b) *Trichoderma*	Yes	No
Refugia	5 rows of non *Bt* with one border row of sorghum	5 rows of non *Bt* cotton
For whitefly	20 yellow sticky traps and *neem* oil spray	Triazophos and Acetamiprid spray
For mealybug	Spot spray of Profenophos	Profenophos and Acephate
For mechanical collection	i) Grownup *Helicoverpa* larvae ii) Egg mass	Lambda Cyhalothrin and spinosad
For management of bollworms	Thiodicarb insecticide spray on refugia only	Pyridalyl 10 EC and quinalphos insecticide spray on refugia

Weekly observations were recorded for insect pest's viz., leafhopper thrips and whiteflies from three leaves each of 20 randomly selected plants/plot. Infestation of bollworms was recorded by examining all green bolls and opened bolls from 20 plants/plot. The mean number of mealybug was recorded/plant. For pink bollworm, 20 bolls/plot was picked randomly at 90 and 120 DAS intervals and number of damaged locules and pink bollworm larvae were recorded. The weekly counts of predators like spider, ladybird beetle and green lacewing were taken on 20 plants/pot. The damage to squares, flowers and green bolls was recorded. Seed cotton yield of each field was recorded.

Data on insect pests, natural enemies, boll damage, yield, etc were analyzed using pair "t" test.

RESULTS AND DISCUSSION

The incidence of sucking pests in IPM module was in decreasing order as compared to RPP (Table 2). Significant differences in IPM over RPP for leafhopper/3 leaves (1.1 and 1.28 mean population of IPM and RPP, respectively), for thrips/3 leaves (5.47 and 6.52), mealybug/plant (0.36 and 0.55) except for whitefly/3leaves where mean population was 3.56 and 3.46 under IPM and RPP, respectively with non significant "p" value and "t" value.

Seed treatment under both modules kept the population of sucking pests below and the installation of 20 yellow sticky traps and neem oil spray helped in reducing the whitefly and leafhopper population throughout the crop season. During the present investigation the efficacy of seed treatment was recorded up to 45 DAS. On similar pattern others have also reported that seed treatment with imidacloprid reduced the sucking pest population below economic threshold level upto 40 DAS (Patil *et al.*, 2003 and Kannan *et al.*,2004) and even proved effective against leaf hopper population upto 60 DAS (Dandale *et al.*, 2004).

The populations of natural enemies were more in IPM plot over RPP (Table 3). The population of spider/plant (seasonal weekly mean

Table 2. Mean population of sucking pests under IPM and RPP

	Leafhopper/ 3 leaves		Whitefly/ 3 leaves		Thrips/ 3 leaves		Mealybug/ plant	
	IPM	RPP	IPM	RPP	IPM	RPP	IPM	RPP
Mean *	1.1	1.28	3.56	3.40	5.47	6.52	0.3617	0.5594
SE of diff	0.061		0.178		0.462		0.053	
SD	0.6367	0.692	2.38	2.18	6.18	6.31	0.2656	0.411
SE of Mean	0.1501	0.1631	0.5619	0.5155	1.457	1.487	0.0626	0.0969
t value	2.8742		0.5765		2.2622		3.7278	
P value	Significant		NS		Significant		very significant	

* Mean of 18 weekly observations from 20 plants

0.33 and 0.28) and *C. septumpunctata* (seasonal weekly mean 0.18 and 0.12) were recorded significantly different whereas the population of *Chrysopa* was non-significant under IPM and RPP. Kannan *et al.*, (2004) and Satpute *et al.*, (2002) concluded that imidacloprid seed treatment attracted the coccinellids and lacewings. The reason for low population of predators (spiders and *C. septumpunctata*) under RPP is because of the spray of acetamiprid and triazophos for whitefly.

In the present study, the low incidence of bollworms was recorded both under IPM and RPP as *Bt* cotton is resistant to bollworm. As per the record of fruiting bodies retained, the number of square and flower were statistically non significant under IPM and RPP, whereas retained bolls were significantly more in IPM (56.09), than RPP (52.72). Similarly, the number of fallen fruiting bodies, damaged fruiting bodies and rosette flower were not significant under IPM and RPP (Table 4).The numbers of good open boll/plant were higher under IPM (114.41) than RPP (109.24). The damage to green boll after 90 and 120 DAS was almost similar (Table 5). Very low incidence of PBW was recorded on refugia under both the practices. In IPM, because of proper sanitation and weed management very less infestation of tobacco caterpillar (0.25 egg mass/ plot) was observed whereas in RPP (2.0 egg mass/ plant) were recorded. In IPM available egg masses were hand picked and destroyed.

A very low incidence of mealybug was recorded in IPM over RPP. In IPM, only spot spray of profenophos 40 EC@ 1250 ml/ac was given while under RPP, a blanket application of the insecticides was applied to the whole field for management of mealybug. A very low incidence (0 to 0.5) of PBW larvae was recorded in Bt cotton RCH 2, RCH 20, RCH 144 and MECH 162. Hennyberry and Jech, (2000) reported that *Bt* cotton bolls (NUCOTN 33 and DPL 5415) developing on plants 180 days after planting, were also toxic to PBW. The incidence of *H. armigera* was not noticed during the period of study on *Bt* cotton hybrid RCH 134 but during 2008-2009 its infestation on refugia was recorded and the larvae were mechanically picked from the refugia in IPM plot but in RPP lambda cyhalothrin and spinosad were applied for management.

Though the differences for yield of seed cotton under IPM (11.90 q/ac) and RPP (11.47 q/ ac) were non significant but the number of sprays under IPM were only 4.0 in comparison to 6.5 in RPP and the total reduction in cost of spray was

Table 3. Mean population of predators under IPM and RPP

	Spider /plant		*Chrysoperla carnea* /plant		*Coccinella septumpunctata* /plant	
	IPM	RPP	IPM	RPP	IPM	RPP
Mean *	0.334	0.2861	0.29	0.23	0.1833	0.115
SE of diff	0.022		0.038		0.026	
SD	0.1263	0.1189	0.1768	0.1618	0.0944	0.0846
SE of Mean	0.0298	0.028	0.0417	0.0381	0.0222	0.0199
t value	2.2001		1.6389		2.6606	
P value	Significant		NS		Significant	

* Mean of 18 weekly observations from 20 plants

Table 4. Fruiting bodies retained (square, flower and boll), fallen/damaged fruiting bodies and rosette flower under IPM and RPP

	Fruiting bodies retained						Fallen/damaged fruiting bodies					
	Square		Flower		Boll		Fallen fruiting bodies		Damage fruiting bodies		Rosette flower	
	IPM	RPP	IPM	RPP	IPM	RPP	IPM	RPP	IPM	RPP	IPM	RPP
Mean*	18.67	18.38	2.19	2.41	56.09	52.72	0.5	0.56	0.494	0.4707	0.09	0.11
SE of diff	0.682		0.145		1.252		0.047		0.027		0.011	
SD	18.67	18.34	1.7373	1.7756	54.22	49.91	0.5179	0.6326	0.3362	0.3223	0.1515	0.1272
SE of Mean	4.82	4.73	0.4486	0.4585	14.00	12.88	0.1337	0.1633	0.0868	0.0832	0.0391	0.328
t value	0.3501		1.5015		2.6904		1.1931		0.8727		2.0823	
P value	NS		NS		Significant		NS		NS		NS	

* Mean of 15 weekly observations from 20 plants

Table 5. Mean green boll damage, good open boll (GOB), bad open boll (BOB) and locull damage in *Bt* cotton (RCH 134) at farmer's fields. (Pooled, 2008 and 2009)

Details	At last picking stage/plant			Green boll damage (DAS)		No of *Spodoptera* Egg Masses***
	GOB	BOB	Locull damage	90	120	
IPM	114.41*	2.04	4.14	0.14**	0.21	0.35
RPP	109.24	2.30	4.46	0.21	0.27	2.0

* Mean of 25 plants; ** Mean of 25 bolls; *** Mean of 4 weekly observations

Table 6. Details of spray, yield, C: B ratio and Net profit in *Bt* Cotton (RCH-134) at farmer fields (Pooled Mean 2008 and 2009).

Details	IPM	RPP
Average yield (q/ ac)	11.90	11.47
No. of spray	4.00	6.50
Cost of spray (RS)	891.00	1696.50
Reduced cost over RPP	805.50	
Total income(gross profit) (RS)	33915	32689.50
Cost of cultivation (RS)	7891.00	8696.50
Net profit (RS)	26024	23993
*C : B ratio	1: 4.29	1 : 3.75
Per cent increase in net profit over RPP	8.46	

*Price of seed cotton hybrids : Rs 2700 and Rs.3000 during 2008 and 2009, respectively, average price Rs 2850 for both years
Net profit = Total income – (Cost of spray + Rs. 6000 and 8000 / ac for seed and other costs for 2008 and 2009, respectively).
Cost of spray: Includes the cost of insecticides + Machine and labour charges. C: B ratio = Gross profit/ Cost of cultivation

Rs 805.50. The C: B ratio was 1:4.29 and 1:1.375 in IPM and RPP, respectively. (Table 6)

The per cent increase in net profit in IPM over RPP was 8.46 (Cumulative for both the years 2008-2009). The compatibility of *Bt* cotton with IPM approaches was already reported by Yuan *et al.*, (1999). The results clearly indicated the better performance of RCH 134 in both modules but the eco friendly IPM module reduces the insecticide usages. Though *Bt* cotton itself is a component of IPM (Vennila *et al.*, 2004) but IPM approach in Bt cotton is essential as its take care of varying pest situation.

REFERENCES

Dandale, H. G., Thakare, A. Y., Tikar, S. N., Rao, N. G. V. and Nimbalkar, S. N. 2004. Effect of seed treatment on sucking pests of cotton and yield of seed cotton. *Pestology* **25**: 20-23.

Hennyberry, T. J. and Jech, L. F. 2000. Seasonal pink bollworm, *Pectinophora gossypiella*, infestation of transgenic and non transgenic cottons. *South West. Ent.* **25** : 273-86.

Kannan, M., Uthamasamy, S. and Mohan, S. 2004. Impact of insecticides on sucking pests and natural enemy complex of transgenic cotton. *Curr. Sci.*, **86**: 726-29.

Kranthi, K. R., Jadhav, D. R., Wanjari, R. R., Shaher, A. S. and Russel, D. 2002. Insecticide resistance in five major insect pests of cotton in India. *Crop Protec.*, **21**: 449-60.

Lutterell, R. G. and Herzog, G. A. 1994. Potential effect of transgenic cotton expressing *Bt* on cotton IPM programme. In: *Proceedings of "Beltwide Cotton Conference"* **5**: 806-09.

Patil, B. C., Patil, S. B., Udikeri, S. S. and Khadi, B. M. 2003. Effect of imidaclprid seed treatment on growth, yield, seedling vigour and biophysical parameters in cotton (*Gossypium* spp) genotypes. In: Proceeding *"World Cotton Research Conference-3"*. March., 9-13, 2003 Capetown, South Africa.

Satpute, N. S., Katole, S. R., Nimbalkar, S. N. and Satpute, U. S. 2002. Attraction of seed treatment of imidacloprid and thiomethoam to populations of *Chellomenus sexmaculatus* (Fabr.) and *Chrysoperla carnea* on cotton. *J. Biol. Control.* **1**: 81-83.

Sharma, H. C., Sharma, K. K., Seetharama, N. and Ortiz, N. 2000. Prospects for using transgenics to insects in crop improvement. *Electr. Jour. of Biotech.* **3** : 76-95.

Vennila, S., Biradar, V. K., Gadapayle, J. G. and Panchbhai, P. K. 2004. Field evaluation of *Bt* transgenic cotton hybrids against sucking pests and bollworms. *Indian J. Pl. Prot.* **32**: 1-10.

Wilson, F. D., Flint, H. M., Deaton, W. R. and Robert, E. B. 1994. Yield, yield components and fibre properties of insect resistant cotton lines containing a *Bacillus thuringiensis* toxin gene. *Crop Sci.* **34** : 38-41.

Yuan, X. J., Tie, C. J., Li-hua, M., Shuang-ring, D. and Fen, C. X. 1999. The role of transgenic *Bt* cotton in integrated insect management. *Acta Gossypii Sinica*, **11**: 37-64.

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