

## Impact of insecticide resistance management strategies on sucking pest of cotton in relation to weather parameters in Hisar region

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**ABSTRACT :** A total of 5215 ha area was covered for the implementation of IRM strategies in 15 villages which account for 84.74 per cent area of the total cotton area of these villages. Similarly, 1355 ha area was selected in 3 non IRM villages. The percentage of the farmers which were linked with the IRM strategies was 47.42 per cent (on an average). Four experimental fields of cotton were selected in each village of Hisar district for recording weekly data of sucking pest and to find out the relationship of weather parameters with these pests. The average population of leafhopper, whitefly and thrips through out the season was recorded (2.36, 6.91 and 8.13 respectively) more as compare to IRM villages (1.87, 5.95 and 6.46, respectively). The insecticide usage was recorded more in non IRM villages compared to IRM villages. The average yield obtained was more in IRM villages compared to non IRM villages. Maximum net profit and C: B ratio of IRM farmers were more compared to non IRM farmers. The net profit/ha of IRM farmers was more compared to non IRM farmers of Hisar district.

**Keywords :** IRM, leafhopper, thrips, whitefly

Cotton is being cultivated in 11 districts of Haryana, however 3 districts viz; Sirsa, Hisar and Fatehabad are main cotton growing districts which account for around 73 per cent cotton area of the state. Cotton was sown in an area of about 5.7 lakh ha during the current season whereas in previous year the total area was 4.18 lakh ha in the state with an average 91 per cent area under *Bt* cotton. There was an increase in cotton area in the state by 26.66 per cent as compared to year 2010-2011.

The IRM strategies were disseminated in 18 villages of Hisar including 3 villages as non-IRM. Cotton cultivation in Hisar covered 1, 24,277 ha in which 1, 21,287 i.e. 97 per cent of the total area the farmers opted for *Bt* cotton and remaining 2990, i.e. 3 per cent under *arboreum* cotton and other American cotton varieties. Central Institute for Cotton Research, Regional Station, Sirsa is the nodal agency for implementing this project in Haryana state in Sirsa, and Hisar districts. IRM strategies were reformulated during 2007-2008 crop season in 11<sup>th</sup> plan where the focus was shifted to dissemination and management of resistance in sucking pests in *Bt* cotton. In north zone there was severe incidence of mealybug during 2007-2008 seasons and the special emphasis in this programme were given for the management of

mealybug. Incidence of mealybug was in controlled condition due to the activity of its natural enemies i.e. *Aenasius* sp upto 2011 and this awareness was created through IRM programme among the cotton growing farmers of different villages. So during 2011-2012 emphasis were given on the resistance monitoring in sucking pests against commonly used insecticides.

**IRM strategies/List of technologies disseminated:** The following modified strategies finalized for 2011-2012 season in the light of major area being shifted to *Bt* cotton, focusing on Insect Pest Resistance Management (IRM) were adopted.

### **Window 1 : Early sucking pests: No foliar spary upto 60 DAS**

- Cultivation of sucking pest tolerant genotypes (*Bt* cotton or non *Bt*) to help in delaying the first spray, thereby conserving the initial buildup of natural enemies. The *Bt* cotton hybrids tolerant to sucking pests in north zone were promoted.
- Foliar sprays of chloronicotnyl and broad spectrum organophosphates such as

Monocrotophos, Methyl demeton, Phosphomidon, Acephate etc especially as early season sprays were avoided as these strongly disrupt the natural enemy populations.

- *Neem* oil 2.5 l/ha mixed with 0.1 per cent *Nirma* washing soap powder was promoted for the management of leafhopper and whitefly especially during the earlier part of season.
- *Verticillium lecanii* was tried at few locations for mealy bug control.

**Window 2 : 60-90 DAS: Initial bollworm infestation: mostly eggs and young larvae: biological and biopesticides window**

- Use of Thiodicarb at 5 per cent bollworm infested plants in non *Bt* cottons (plants having flared square with entry hole).
- Spray against minor lepidopteran insects such as the cotton leaf roller, *Sylepta derogata* and cotton semilooper, *Anomis flava* were avoided as the larvae cause negligible damage to cotton but serve as hosts for parasitoids such as *Trichogramma* spp, and *Apanteles* spp that attack *H. armigera*.
- Farmers were advised not to spray formulations on *Bt* cotton to avoid further selection pressure.
- Farmers were advocated during meetings to use spinosad or Emamectin benzoate only on non *Bt* cotton at ETLs of 5 per cent infested plants (plants having flared squares with entry hole). Avoid these insecticides on *Bt* cotton so that the efficacy of these insecticides can be preserved for bollworm control in non *Bt* cotton. Excessive use of these expensive insecticides both on *Bt* and non *Bt* cotton can hasten the development of bollworm resistance to the chemicals.
- Farmers were also informed that Spinosad, Emamectin benzoate and Indoxacarb are highly effective on pyrethroid resistant *H. armigera*. Apart from their toxicity to *H. armigera*, Spinosad and Emamectin benzoate are also effective on *E. vitella* and leaf hopper and hence are preferred first over

indoxacarb. Both insecticides have a high selective toxicity towards the target pests while being less toxic to many beneficial insects in the cotton ecosystem. These insecticides are ideally suited in eco-sustainable insecticide resistance management programmes.

**Window 3 : 90-120 DAS: Pink bollworm infestation**

- Use Organophosphates or carbamates only once either on *Bt* or non *Bt* cotton as effective larvicides for bollworm control at ETLs of 5 per cent plants showing flared up squares. Resistance levels against certain organophosphate group of insecticides (Quinalphos, Chlorpyrifos and Profenophos) and carbamates (Thiodicarb and methomyl) have been found to be low in most populations tested. These insecticides are very effective for bollworm control but have low ecological selectivity and can be harmful to beneficial insects. The populations of beneficial insects in cotton ecosystem are generally low in later part of this window and hence the application of organophosphates and carbamates is rational.

**Window 4 : Pink bollworm >120 DAS: Pyrethroids**

- **ETL based spray:** Eight pink bollworm moths/trap/night for 3 consecutive nights. The application of pyrethroids as late season sprays were advocated for pink bollworm management as pyrethroid resistance in *H. armigera* is generally high, but pyrethroids are very effective against pink and spotted bollworms and are ideally suited for the late season window.

**Weather scenario :** The weather remained dry and normal rainfall received during the season in Haryana. The max temp reached upto 43.0 °C in the third week of the May and min temp 1.2 °C in the fourth week of the December, respectively. Total of 543.7 mm

rainfall was received during the year, out of which 486.1 mm was received during the cotton season *i.e.* April to November at Hisar station.

### Varietal / Hybrids spectrum:

**Bt cotton hybrids:** At present, 250 Bt cotton hybrids have been permitted by GEAC for north zone. Almost entire area was covered by Bt hybrids. The following hybrids were grown by majority of farmers: RCH 134, SIGMA Bt, MRC 6301, BIO SEED 6488 BG 1, TULASI 4, BUNNY Bt, ANKUR 2534, KDCHH 9810 Bt, VBCH 1008, JKCH 1947, NCEH 6, MRC 6304, SP 7007, RCH 314, MRC 6025, JAI Bt, BIO SEED 6588, NCS 913, VBCH 1504, BIO SEED 6317 BG I, NCS 950, OLE Bt (COT 33), OM 333, SIGMA Bt BG-II, BIO SEED 6488 BG II, VBCH 1518 BG II, RCH 134 BG II, JAI BG-II, ASSI BG II, VBCH 1516 BG II, BIO SEED 2113 BG II, MRC 7017, and MRC 7031 etc.

**Pest situation :** The observations on the incidence of pest and beneficial insects were recorded from Bt cotton hybrids during the crop season. In the selected villages of the IRM and non IRM only Bt cotton hybrids were grown/prevalent as follows:

**Sucking pests and predators:** In general the incidence of sucking pest was recorded more

in non-IRM fields as compared to IRM fields probably due to adoption of IRM strategies by IRM farmers.

**A) Leafhopper, whitefly and thrips :** The sucking pest population *viz.*, leafhoppers, whitefly and thrips remained below ETL throughout the crop season in both IRM and non IRM villages in Hisar district. The average population of leafhopper through out the season was recorded 1.87/3 leaves but its max population (4.89/3leaves) was noticed in the third week of July in IRM villages while in non IRM villages the average population was 2.36/3 leaves recorded and its max population (4.98/3leaves) was noticed in the fourth week of July in non IRM villages. The average population of whitefly through out the season was recorded 5.95/3 leaves but its max population was noticed in the fourth week of September in IRM (12.24/3leaves) while in non IRM villages the average population was 6.91/3 leaves recorded and its max population was noticed in the fourth week of September (12.36/3leaves) in non IRM villages. The average population of thrips through out the season was recorded 6.46/3 leaves but its max population (9.6/3leaves) was noticed in the Second week of August in IRM villages while in non IRM villages the average population was 8.13/3 leaves recorded and its max population (14.23/3leaves) was noticed in the second week

**Table 1.** Pest/ Predator/ Parasitoid status in the IRM (P) and Non IRM (NP) villages during 2011-12

MSW	Date of observation	Leafhopper nymphs / 3 leaves		Whitefly adults/ 3 leaves		Thrips/ 3 leaves		Spider		Natural enemies/plant				Others	
		P	NP	P	NP	P	NP	P	NP	Lace-wing		Lady bird beetle		P	NP
										P	NP	P	NP		
<b>29</b>	16.07.11	2.68	4.12	0.74	1.78	6.32	7.45	0.56	0.18	0.28	0.25	0.29	0.05	0.46	0.74
<b>30</b>	23.07.11	4.89	3.78	0.96	1.89	7.23	8.56	0.89	0.25	0.37	0.12	0.32	0.02	1.02	2.56
<b>31</b>	30.07.11	2.84	4.98	2.96	2.78	8.69	10.23	0.69	0.3	0.4	0.29	0.26	0.00	1.56	3.22
<b>32</b>	06.08.11	1.96	3.78	1.63	3.10	8.95	10.37	0.56	0.14	0.23	0.23	0.34	0.04	2.35	3.18
<b>33</b>	13.08.11	1.25	2.65	5.32	6.89	9.60	14.23	0.58	0.23	0.42	0.11	0.47	0.10	1.45	3.41
<b>34</b>	20.08.11	4.01	3.89	6.12	9.36	8.46	13.12	0.64	0.10	0.62	0.08	0.31	0.12	2.56	1.12
<b>35</b>	27.08.11	3.24	2.69	4.95	8.52	8.45	10.34	0.42	0.41	0.42	0.31	0.28	0.06	1.01	2.56
<b>36</b>	03.09.11	1.10	1.75	9.20	6.01	7.23	9.10	0.76	0.52	0.36	0.11	0.21	0.08	1.64	3.74
<b>37</b>	10.09.11	0.89	1.63	8.23	11.23	6.40	8.63	0.46	0.10	0.42	0.14	0.30	0.03	1.63	2.45
<b>38</b>	17.09.11	0.79	1.56	9.34	12.36	4.56	4.65	0.41	0.25	0.38	0.19	0.39	0.01	1.96	1.89
<b>39</b>	24.09.11	0.59	0.54	12.24	10.56	4.23	5.38	0.86	0.18	0.52	0.42	0.43	0.06	1.12	1.01
<b>40</b>	01.10.11	0.76	0.63	8.56	9.01	4.10	6.14	0.59	0.32	0.26	0.31	0.24	0.02	2.01	1.92
<b>41</b>	08.10.11	0.68	0.42	5.69	5.32	3.29	3.45	0.43	0.12	0.65	0.32	0.32	0.03	0.34	1.02
<b>42</b>	15.10.11	0.53	0.68	7.36	7.98	2.89	2.14	0.62	0.28	0.53	0.21	0.18	0.01	0.18	1.46
<b>Average</b>	<b>1.87</b>	<b>2.36</b>	<b>5.95</b>	<b>6.91</b>	<b>6.46</b>	<b>8.13</b>	<b>0.61</b>	<b>0.24</b>	<b>0.42</b>	<b>0.22</b>	<b>0.31</b>	<b>0.05</b>	<b>1.38</b>	<b>2.16</b>	

MSW: Meteorological standard week

**Table 2.** Correlation coefficient between weather parameters and sucking pest population

Weather parameters	Leafhopper whitefly		Thrips
TEMP <sub>Max</sub>	0.63	-0.75	0.15
TEMP <sub>Min</sub>	0.71	-0.55	0.87
RH <sub>M</sub>	-0.31	0.49	0.10
RH <sub>E</sub>	0.30	-0.11	0.78
Rainfall	0.16	0.08	0.28

TEMP<sub>Max</sub>: Max tempTEMP<sub>Min</sub>: Min tempRH<sub>M</sub>: Relative humidity (morning)RH<sub>E</sub>: Relative humidity (Evening)

of August in non IRM villages Dhawan *et al.*, (2011) also reported that the population of leafhopper and whitefly was more (1.83 and 2.24, respectively) compared to IRM villages (0.68 and 0.83, respectively)(Table1).

**B) Natural enemies :** The population of natural enemies like spider, lace wing and lady bird beetle did not differ much from IRM villages to non IRM villages. In case of spider the population / plant was 0.61 in IRM villages and in non IRM villages it was 0.24. The lace wing population was 0.42 and 0.22/plant and lady bird beetle was 0.31 and 0.05/plant and other (Miridbug, Mealy bug, Leaf roller, Dusty cotton bug etc.) 1.38 and 2.16/ plant in IRM and non IRM villages, respectively. Dhawan *et al.* (2009) observed that the population of natural enemies per plant was significantly more in IRM (0.83 and 0.38 respectively) compared to non IRM (0.40 and 0.19 respectively) (Table1).

**Relationship of weather parameters with sucking pest :** The leafhopper shows the positive relationship with max and min temp, relative humidity (E) and rainfall and negative relationship with relative humidity (M). whitefly population showed positive relationship with relative humidity (M) and rainfall and negative relationship with max and min temp and relative humidity( E).Thrips shows the positive relationship with all weather parameters *viz.*, max and min temp, relative humidity (E), relative humidity (M) and rainfall. A significant positive association of leafhopper was reported with temp in cotton crop by Singh *et al.*, (2005) also reported similar findings in cotton crop. Kavita *et al.* (2003) and Singh *et al.*, (2004) reported

significant positive influence of temp on leafhopper population. Prasad *et al.*, (2008) reported that leafhopper population showed significant positive correlation with evening relative humidity in cotton crop. Singh *et al.*, (2004) reported significant negative correlation of whitefly population with max and min temps. Maximum and min temps exerted significant negative influence on whitefly population (Prasad *et al.*, 2008) (Table 3)

**Decline in insecticide sprays/ insecticide load :** The average number of spays in IRM villages in Hisar were 2.38 where as it was 3.82, in case of non IRM villages. The sprays were mainly given against sucking pest. Kranthi *et al.*, (2000) also reported that there was 90 per cent reduction in sprays and seed cotton yield increased up to 59 per cent and plant protection cost reduced by 25-60 per cent due to impact of IRM strategy.

In Hisar there was 31.4 per cent reduction in insecticides consumption in IRM over non-IRM villages. The cost of spray was Rs 1588 in IRM and in non IRM it was Rs 2706 in Hisar. By following the IRM strategies there was reduction cost of spray over non IRM to the tune of Rs 1118. The results are also in tune with the work of Dhawan *et al.*, (2009) who reported that adoption of IRM strategies resulted 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 compared to non adopted villages. The insecticide consumption was 2.31 l/ha in IRM villages at Hisar as compared to 3.37 l/ha in non IRM villages (Table 3).

**Yield levels in IRM v/s non IRM and net profitability :** The average yield obtained was 25.63 q/ha as compared to 21.33 q/ha in IRM and non IRM villages. Maximum net profit of Rs 83718 and C: B ratio of IRM farmers were 1:3.65 compared to 1: 2.93 for non IRM farmers. The net profit/ha of IRM farmers over non IRM was 20453 Rs (Table 3). Dhawan *et al.* (2004) reported that due to impact of IRM strategy, the overall increase in yield and net profit in adopted villages was 26.58 and 28.73 per cent, respectively. With the adoption of IRM strategies, there was

**Table 3.** Economics of cotton (*Bt*) production in the IRM and non IRM dissemination programme during 2011-2012 of Hisar district

S. No.	Details	IRM	Non IRM
1	Number of farmers	1650	330
2	Farmers category (Gen: Women: SC)	1224:356:390	-
3	Total area covered (ha)	5215	1355
4	Average yield (q/ha)	25.63	21.33
5	Number of sprays	2.38	3.82
6	Per cent decrease in sprays over non IRM villages	37.7	-
7	Insecticides consumption (l/ha)	2.31	3.37
8	Per cent reduced insecticides consumption over non IRM villages	31.4	-
9	Cost of spray (Rs/ ha)	1588	2706
10	Reduced cost of spray over non IRM villages (Rs/ha)	1118	-
11	Per cent increase in yield over non IRM	16.78	-
12	C : B ratio	1:3.65	1:2.93
13	Net profit (Rs/ha)	83718	63265
14	Net profit over non IRM villages (Rs/ha)	20453	-

Price of *Bt* seed cotton Rs. 4500/q.

Net profit=Total income - (Cost of spray + Rs.29, 000/ha as other costs)

C: B ratio: Gross profit/Cost of cultivation (cost of spray +Rs. 29,000/ ha as other costs)

negligible damage of bollworms and also less incidence of sucking pests and foliage feeders, higher number of natural enemies (viz, spider, coccinellid, *Chrysoperla* and Assassin bug) in IRM villages compared to non IRM villages.

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