Tille: Development and validation of IPM/ IRM strategies for Ht cotton under different ecosystems

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INTRODUCTION

Changes in pest scenario have become more common in the recent times in the rapidly changing cropping systems and environment. Cotton scenario in India is now dominated by Bt cotton. While some pests have been impacted negatively (eg. Helicoverpa bollworm because of Bt cotton), hither to unknown minor pests are emerging as major pests (eg. mealy bug). Integrated Pest Management is a system that emphasizes appropriate decision-making and needs continuous refinement and validation before implementation. Besides the response of the target insects, it also important to study various pest interactions n Bt crop. Since the Bt protein esp. CrylAc does not offer protection against *Spodoptera litura*, focus to determine ETL for the pest was left, The use of insecticides for management of non target pests again need to consider bio safety attributes and effect on natural crop ecosystem.

OBJECTIVES

1. Development of economic threshold levels on Bt cotton against insect pests with focus on Thrips, *Spodoptera litura* and *Helicoverpa armigera* .
2. Resistance monitoring to understand sucking pest and bollworms resistance to new chemistries
3. Software to assess eco-toxicity for insecticides to ensure ecofriendly window placement
4. Influence of biotic and abiotic factors on Cry1Ac expression
5. Integration of all eco friendly strategies and validation of IPM package on Bt cotton

ACTIVITIES

ETL for bollworms:

Experiments were conducted to work out economic threshold levels of insect pests Bt cotton with focus on Thrips, *Spodoptera litura* and *Helicoverpa armigera.* Different insecticides at their recommended dosages viz., Dimethoate, Oxy dementon methyl, triazophos, Imidacloprid, Acetamiprid, Thiomethoxam, Spinosad and Commercial Neem formulation along with water Spray and untreated control were used to create differential population levels of thrips to assess the loss in yield. For *Helicoverpa armigera* and *Spodoptera litura,* study was taken up with Bt Bunny with a plot size of 2.7 X 2.4 m and same sized nylon mosquito nets were used as cages. Cages were installed in the field with the help of poles and each cage covered six plants. Likewise, 18 cages were installed to accommodate 6 treatments which were replicated thrice. *Helicoverpa armigera* and *S./itura* were reared in the laboratory which is required for release of larvae to create differential infestation levels in the field under caged condition. After the installation of cages, a known number of F1 generation,3'd instar larvae of *Helicoverpa armigera* were released on the plants as per above protocol.. While the range of *S.litura* population was five to forty per plant, it was one to five larvae for *H. armigera.* Apart from assessing the damage caused by the larvae, the yield levels obtained were recorded and ETLs were worked out. The management cost was worked out using cost of protection based on insecticide application and cost of host plant resistance of Bt seeds. The market value was considered as Rs. 2400/q of seed cotton.

Estimation of Cry proteins

Cry protein estimation was done by collecting the samples (leaves, squares and bolls) from field at regular intervalS" at 90,105,120,135,150,165 DAS using ELISA method. Study was conducted at CICR, Nagpur, UAS Dharwad and Raichur centres. At the end of the season, analysis of the amount of Cry protein, incidence of boll worm due to soil moisture and plant nutrient variations were assessed. The cultivars varied with the centers.

Validation of IPM:

Integration of eco-friendly strategies of pest management as IPM and their validation against recommended package of practices (RPP) were implemented at farmer fields using the commonly grown Bt cultivar of the region. While ETL /symptom based sucking pest management and need based disease management options were implemented under IPM package the recommended package of practices (RPP) had either the practices of farmers or of the package recommended in that region. IPM practices viz., growing of Non Bt refugia, intercropping and monitoring of bollworms using pheromone traps were common in many centers. The effect of these IPM and RPP on the Bt hybrids under study on key sucking pests and bollworms were studied through weekly observations. The cost of the agronomic practices, inputs, type and time of insecticide applications made and the yield levels were recorded so as to study the economic advantage of the IPM overRPP.

EXECUTIVE SUMMARY

A lot of variation in thrips population on Bt cotton was observed due to application of different insecticides across the locations. Study indicated that ETL forthrips as 16 thrips/leaf on Bt cotton at UAS, Dharwad. The economic losses caused by thrips were negligible and insignificant in other centers.

ETL for *Spodoptera litura* and *Helicoverpa armigera* varied between 8.00 and 12 larvae/ plant, and 0.30 to 0.75 larvae/ plant on Bt cotton, respectively based on the experiments at different locations.

Cry protein toxin expression in Bt cultivars derived between 95-110 DAS and expression levels were lowest in the boll rind, ovary and square bud. Cry protein was higher in bottom leaves compared to middle and top leaves. Concentration of Cry 1Ac protein was found to increase with increase in fertilizer dose in both irrigated and rainfed conditions. Cry protein was high in irrigated conditions up to 130 DAS as compared to rainfed situations.

Study conducted at 15 locations comparing location specific IPM module with recommended package of practices (chemical protection) on Bt cotton clearly indicated the superiority of IPM module on Bt cotton by recording lower sucking pest damage, bollworm incidence and higher seed cotton yield with maximum net profit.. The reduction in the number of insecticidal sprays was 50% in IPM package over the RPP.

SALIENT FINDINGS

Economic threshold levels on Bt cotton against insect pests

A lot of variation in thrips population on Bt cotton was observed due to application of different insecticides across the locations. Study indicated that ETL forthrips as 16 thrips/leaf on Bt cotton at UAS, Dharwad. In centres of Akola and Nagpur, although there was one peak incidence around 50 DAS, the yield levels did not show any significant differences in relation to unprotected conditions. The economic losses caused by thrips

were negligible and insignificant.. ETI experiments had shown that ETI for *Spodoptera litura* varied from 8.00 to 12 larvae/ plant on Bt cotton in different locations. Different larval population levels released on Bt cotton in enclosed / caged conditions led to differential defoliation. With regard to *Helicoverpa armigera,* studies indicated that ETI for Helicoverpa varied from 0.30 to 0.75 larvae/ plant on Bt cotton in different locations. Different larval population levels released on Bt cotton in caged condition caused different degree of fruiting bodies damage on Bt cotton. Summary of ETIs deduced for the selected insect pests on Bt cotton is furnished in table 1.

Table 1: Development of ETL for insect pests in Bt cotton

Insect! pest	Locations			
	Coimbatore	Dharwad	Raichur	Nagpur
Thrips *	-	16.00*	-	-
Spodoptera litura **	-	8.00**	6.10**	12.0**
Helicoverpa armigera **	0.70**	0.75**	0.30**	-

*Number of thrips/ leaf; ** Number of larvae/ plant

Influence of biotic pests and abiotic factors on Cry 1 AC expression

Study conducted at CICR, Nagpur, UAS Dharwad and Raichur centres revealed decline in Cry IAc expression with crop age. At Nagpur, Cry protein toxin expression declined between 95-110 DAS and expression levels were lowest in the boll rind, ovary and square bud. At UAS, Dharwad and Raichur, the results indicated the concentration of Cry 1Ac protein to increase with increase in fertilizer dose in both irrigated and rainfed conditions. Cry protein was higher in bottom leaves compared to middle and top leaves. Cry protein was high in irrigated conditions up to 130 DAS as compared to rainfed situations. The relationship between the quantity of Cry protein and yield parameters (good open bolls and seed cotton yield) was found to be positive.

Integration of eco friendly strategies and validation of IPM packages for Bt cotton

In all 15 locations study was conducted and location specific IPM module for Bt cotton and compared with recommended package of practices (chemical protection) on Bt cotton. At Dharwad IPM package significantly reduced the sucking pests over the RPP where the cultivar was RCH 2 Bt. At Guntur, the mealy bug infestation was seen with severity of 1-5% of plants per field and there were three insecticidal sprays cum two stem applications under IPM in comparison with the eight insecticidal applications under RPP At Raichur the sucking pest population was low in IPM as well as RPP fields. However, bollworm incidence was less (9.7%) in IPM farms overthe RPP fields (21.5%).The number of insecticidal sprays were two in IPM and eight in RPP fields at Parbhani and Akola. On the other hand, the number of insecticidal sprays was seven and 13 under IPM and RPP mode, respectivel at Surat. At Nagpur, IPM validations had symptom based sucking pest management.. With no bollworm management and management of grey mildew in either of the farms, the difference in pest management interventions between IPM and RPP farms was in relation to sucking pest management.. While the IPM had one contact insecticide (Endosulfan) against sucking pests during mid season, the RPP farm had an early (Imidacloprid) as well as mid season (Triazophos) insecticidal sprays. The differences were significant only for jassid adult population (beil;lg high on IPM over RPP) and square damage due to Helicoverpa armigera (high on RPP over IPM farms). With the estimates of fruiting structures shed, harvested open bolls and the damage levels non significant between the two packages within and between yield differences between first and second pickings of IPM and RPP farms signify the phenological differences in crop growth and development in relation to the pest management interventions resulting in the variations in yield and harvest times. Management of sucking pests based on the symptoms using contact insecticides esp. during the pre flowering season was found to be the best option towards judicious and economical management of sucking pests on Bt cotton. Such a recommendation not only accounts the tolerance mechanism of cultivars to sucking pests but also allows the innate crop response to exhibit its potential for higher yields. The economics of IPM on Bt cotton was also determined (Table2).

Table 2: Economics of IPM module on Bt cotton in different locations

Location	Cotton yield (qj ha)		Net profit (Rs)	
	IPM	RPP	IPM	RPP
UAS, Raichur	36.90	37.13	74020	71074
UAS, Dharwad	31.32	30.63	69970	67676
TNAU, Coimbatore	21.00	19.00	45350	37900
ANGRAU, Nandyal	24.20	23.50	38760	33845
Lam, Guntur	13.20	13.00	11915	9955
PDKV, Akola	25.00	22.50	33305	27585
MAU, Parabhani	22,45	1*9.20	27135	19390
CICR, Nagpur	17.63	14.37	27815	19687
JAU, Junagarh	29,45	22.68	43655	32250
NAU, Surat	35.94	29.25	90593	71359
CICR,Sirsa	30.00	26.00	60732	46854
PAU, Faridkot	23.18	15.40	33088	19682

Overall, studies clearly indicated the superiority of IPM module on Bt cotton by recording lower sucking pest damage, bollworm incidence and higher seed cotton yield with maximum net profit as furnished in the table above.

Cheilomenes sexmaculata