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Influence of Weather Parameters on the Incidence of American Bollworm, *Helicoverpa Armigera* (Hubner) on *Bt* and non-*Bt* Varietal Cottons

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ABSTRACT

Studies on impact of weather parameters on the incidence of American bollworm, *Helicoverpa armigera* (Hubner) on *Bt* and non-*Bt* varietal cottons were carried out at Department of Entomology, Agricultural College, Bapatla in collaboration with Regional Agricultural Research Station, Lam, Guntur during two seasons, *kharif* 2009-10 and *kharif* 2010-11. American bollworm larval population was completely absent on stacked *Bt* cotton hybrids (RCH 2 BG II and Mallika BG II) compared to higher larval population (0.04-0.42 larvae/plant) in L 604 non-*Bt* during 40th (Oct.1-7)-52nd (Dec.24-31) std. weeks with its peak (0.42 larvae/plant) during both 45th and 46th std. weeks. The favourable weather parameters that influences the build up of high population of American bollworm (44th to 46th std. weeks) are in the range of maximum and minimum temperatures 29-32 and 21-23^{O}C, morning and evening relative humidities 87-91 and 71-87 per cent, and the rainfall 24-28 mm. Evening relative humidity exerted highly significant positive (r= 0.699**) influence on the American bollworm incidence in L 604 non-*Bt*. All the weather variables *viz.,* maximum and minimum temperatures, morning and evening relative humidities, and rainfall) together contributed to 56.3 per cent variation in American bollworm larval population non-significantly (R^2=0.563) in L 604 non-*Bt*.

Key words : American bollworm, *Bt* and non-*Bt* varietal cottons, Weather parameters.

Cotton is an important cash crop commonly known as 'white gold' cultivated under diverse agro-climatic conditions. India is an important grower of cotton on a global scale. Though India ranks first with regard to aercage in the world, productivity is substantially low. Of the many reasons listed for such a low productivity of cotton, the ravages caused by insect pests are of paramount significance. About 130 different species of insects and mites are reported to cause damage to cotton crop in India (Agarwal *et al*., 1984). Among these, american bollworm, *Helicoverpa armigera* (Hubner) is the dreaded pest which causes severe damage to the economic parts of cotton. Transgenic cottons are designed to be resistant to the lepidopteran target pests *viz*., Spotted bollworm, *Earias vitella* (Fab.); American bollworm, *Helicoverpa armigera* (Hubner) ; Pink bollworm, *Pectinophora gossypiella* (Saunders) and Tobacco caterpillar, *Spodoptera litura* Fab.. These cottons contain *Bt*, a gene toxic to target pest. The performance of *Bt* cotton has been highly efficacious against the bollworms. There is a need to study the factors influencing the pest population density to design effective pest management strategies. To evolve management strategy of *H. armigera* in cotton crop, suitable understanding of the seasonal incidence is important which fluctuates with key abiotic factors. As such the present studies were under taken to find out the correlation between the pest population and key abiotic factors to know the most favourable conditions.

MATERIAL AND METHODS

The investigation was conducted under Department of Entomology, Agricultural College, Bapatla at Regional Agricultural Research Station (RARS), Lam, Guntur during two seasons, *kharif* 2009-10 and *kharif* 2010-11. A bulk crop of two stacked *Bt* cotton hybrids *viz*., RCH 2 BG II and Mallika BG II and non-*Bt* varietal cotton *i.e.* L 604 was raised in an area of 500 m^2 under normal agronomic practices without any insect pest management practices during both the seasons. Larval population of American bollworm (no./plant)

was recorded on a total of 25 plants, which were randomly selected and tagged in bulk plot of each cotton type at weekly interval till pest recession. The meteorological data (*viz.*, maximum and minimum temperatures, morning and evening relative humidities and rainfall) was recorded simultaneously from the observatory of RARS, Lam and used for correlation and multiple linear regression analysis studies.

RESULTS AND DISCUSSION

Seasonal incidence

The *H. armigera* larval population was completely absent in stacked *Bt* hybrids (RCH 2 BG II and Mallika BG II) during the entire crop period. Whereas in L 604 non-*Bt* the *H. armigera* larval population initiated from 40th std. week (Oct. 1-7) and continued up to 52nd std. week (Dec. 24-31) with larval population ranged between 0.04-0.42 larvae per plant. The *H. armigera* larval population in L 604 non-*Bt* did not cross ETL (1 larvae /plant) at any stage of crop period. The *H. armigera* larval population gradually increased from 40th std. week with more than 0.35 no. per plant was recorded between 44th (Oct.29-Nov.4)-46th (Nov.12-18) std. weeks. This has indicated that 44th-46th std. weeks are the most favourable for *H. armigera* larval incidence. The highest *H. armigera* larval population (0.42 larvae/plant) was recorded in both 45th (Nov.5-11) and 46th (Nov.12-18) std. weeks in L 604 (Table 1).

In general the preferred weather parameters for high population of *H. armigera* (*i.e.* between 44th to 46th std. weeks with population ranged between 0.40-0.42 larvae per plant in L 604 non-*Bt*) in the range of maximum and minimum temperature 29-32 and 21-23^{O}C, morning and evening relative humidities 87-91 and 71-87 per cent, and rainfall 24-28 mm. The observations of the present study are in agreement with Srinivasa Rao (2004), Purohit *et al.* (2006), Lakshmi Soujanya (2008) and Pratheepa *et al*. (2010) who reported the range of favourable maximum and minimum temperatures 29-34 and 16-24^{0}C, morning and evening relative humidities 67-93 and 42-79 per cent and rainfall up to 90.00 mm.

Incidence of *H. armigera* was completely absent on stacked *Bt* hybrids (RCH 2 BG II and Mallika BG II) during both seasons of *kharif* 2009-10 and 2010-11. The results of the present study are in accordance with the results of Bheemanna *et al*. (2008) who reported that the incidence of *H. armigera* was completely absent on MRC 7201 BG II during 2006-07 season at two different locations of Raichur, Karnataka. Similarly Lakshmi Soujanya (2008) who also reported that the incidence of *H. armigera* was nil in the stacked *Bt* hybrids (TCH 4 BG II and TCH 117 BG II) at RARS, Lam, Guntur, Andhra Pradesh during both seasons of *kharif* 2006-07 and 2007-08. The absence of *H. armigera* larvae on stacked *Bt* hybrids due to stacking with Cry 1 Ac and Cry 2Ab genes that had 10-fold advantage over Cry 1Ac genotypes (Marchosky *et al*., 2001). *Bt* cottons were highly resistant to *H. armigera* and the larval population was significantly lower than in non-*Bt* cotton in china (Cui and Xia, 2000). The advantage of *Bt* genotypes with two genes has been reported by Adamczyk *et al*. (2003) and Jackson *et al*. (2003). They reported that DP 50 BG II, the genotype with Cry1Ac+Cry2Ab was found better than DP 50 BG I (Cry1Ac) with enhanced efficacy over wide range of lepidopteran pests.

Peak occurrence of *H. armigera* with reference to std. weeks can vary depending up on the favourable weather parameters. The highest populations of *H. armigera* (0.40-0.42 larvae/plant) in the present study was recorded during 44th-46th std. weeks in L 604 non-*Bt*. The present results are in agreement with Lakshmi Soujanya (2008) who reported high *H. armigera* larval population during 45th and 46th std. weeks with population ranged from 0.68 to 0.88 larvae per plant on non-*Bt* hybrids of TCH 4 and 117 at RARS, Lam, Guntur, Andhra Pradesh during 2006-08. Similarly Prasad *et al*. (2008) who reported the peak incidence of *H. armigera* adults per trap per week was from 36th to 48th std. weeks in cotton during 2001-06. However, Channakeshava and Patil (2009) reported peak occurrence of *H. armigera* (more than 0.90 larvae/plant) during 36th, 38th, 39th, 41st-44th and 46th std. week on Mallika non-*Bt* at Nelahal village of Raichur, Karnataka during 2005-06. Thus it could be concluded that the coincidence of peak incidence of *H. armigera* in different std. weeks in different studies indicate the occurrence of favourable weather during those respective std. weeks.

Table 1. Population dynamics of American bollworm, *Helicoverpa armigera* (Hubner) (Mean of two crop seasons of 2009-10 and 2010-11).

Std. week.	Period	Number of larvae/plant			Max. temp. (°C)	Min. temp. (°C)	Morning R.H. (%)	Evening R.H. (%)	Rainfall (mm)
		RCH 2 BG	Mallika BG II	L 604 non-*Bt*					
40	Oct. 1 to 7	0.00	0.00	0.04	31.15	23.30	86.80	74.10	37.00
41	8 to 14	0.00	0.00	0.06	34.60	23.40	77.40	55.85	3.50
42	15 to 21	0.00	0.00	0.16	32.70	22.75	85.20	68.65	15.80
43	22 to 28	0.00	0.00	0.20	32.85	22.40	85.75	59.60	31.15
44	29 to Nov. 4	0.00	0.00	0.40	31.25	21.65	87.45	71.10	24.40
45	5 to 11	0.00	0.00	0.42	29.50	21.55	90.85	75.15	25.20
46	12 to 18	0.00	0.00	0.42	29.85	22.10	90.05	86.35	28.00
47	19 to 25	0.00	0.00	0.28	30.60	21.30	90.80	72.90	40.00
48	26 to Dec. 2	0.00	0.00	0.22	31.40	19.10	88.00	59.30	5.40
49	3 to 9	0.00	0.00	0.14	28.20	18.90	89.10	64.45	57.65
50	10 to 16	0.00	0.00	0.14	29.95	19.35	89.40	57.40	0.00
51	17 to 23	0.00	0.00	0.08	28.65	16.80	86.65	52.25	4.70
52	24 to 31	0.00	0.00	0.05	30.70	18.55	91.25	55.90	0.00
Mean±S.E.		**0.00**	**0.00**	**0.20±0.04**	**30.88±0.49**	**20.86±0.58**	**87.59±1.01**	**65.62±2.77**	**20.98±4.94**

Influence of weather parameters

The correlation analysis (Table 2) of mean larval population of *H. armigera* during both *kharif* seasons of 2009-10 and 2010-11 with weather parameters showed that maximum temperature exerted non-significant negative influence (r= -0.200) on the incidence of *H. armigera* larvae. Similar observations were also reported by Lakshmi Soujanya (2008) and Sesha Mahalakshmi (2007) who reported non-significant negative correlation between *H. armigera* larvae and maximum temperature in different cotton hybrids at Regional Agricultural Research Station (RARS), Lam, Guntur, Andhra Pradesh during 2006-08 and 2004-06, respectively.

The relationship between the larval population of *H. armigera* and evening relative humidity was strongly positive and significant (r= 0.699**) which is in accordance with the findings of Sesha Mahalakshmi (2007) who reported that evening relative humidity had highly significant positive (r= 0.569** and 0.587** in MECH 12 non-*Bt* and RCH 2 non-*Bt*, respectively) impact on *H. armigera* larvae in Andhra Pradesh region.

The larval population of *H. armigera* had non-significant positive association with minimum temperature (r= 0.229), morning relative humidity (r= 0.409) and rainfall (r= 0.286). The results of the present investigation are in parallel with the reports of Lakshmi Soujanya (2008).

All the weather variables together contributed to 56.3 per cent variation in *H. armigera* larval

Table 2. Correlation and multiple linear regression analysis between weather parameters and incidence of American bollworm, *Helicoverpa armigera* (Hubner) on L 604 non-*Bt.*

Weather parameter	Correlation coefficient (r)
Maximum temperature (^{O}C) (X_1)	-0.200
Minimum temperature (^{O}C) (X_2)	0.229
Morning relative humidity (%) (X_3)	0.409
Evening relative humidity (%) (X_4)	0.699**
Rainfall (mm) (X_5)	0.286
Regression equation	**R^2**
$= -1.365 + 0.034X_1 - 0.039X_2 + 0.004X_3 + 0.015X_4 - 0.001X_5$	0.563

** Significant at 1% level

population non-significantly (R^2=0.563). However none of these variables exerted significant influence on the variation of *H. armigera* larval population independently. The results of the present study are in partial agreement with the reports of Sesha Mahalakshmi (2007) who reported that multiple linear regression analysis showed that the total variation in *H. armigera* larval population contributed by all the weather factors was very high and significant in non-*Bt* cotton hybrids (55.7, 58.0 and 56.7 per cent in MECH 12, RCH 2 and Bunny, respectively).

LITERATURE CITED

Adamczyk J J, Hardee D D, Adams L C and Sumerford D V 2003 Correlating differences in larval survival and development of bollworms (Lepidoptera: Noctuidae) and fall armyworms (Lepidoptera: Ncotuidae) to differential expression of Cry1Ac 6-endotoxin in various plant parts among commercial cultivars of transgenic *Bacillus thuringiensis* cotton. *Journal of Economic Entomology.* 94: 284-90.

Agarwal R A, Gupta A P and Garg D O 1984 Cotton Pest Management, Research Co-publications, East Azad Nagar, Delhi. Pp.91.

Bheemanna M, Patil B V, Hanchina S G, Hosamani A C and Bansi A B 2008 Comparative performance and economics of Bollgard-II *Bt* cotton under irrigated conditions. *Journal of Cotton Research and Development*. 22(1): 118-121.

Channakeshava R and Patil B V 2009 Seasonal incidence and management of bollworm complex in *Bt* cotton under irrigated ecosystem. *Annals of Plant Protection Sciences*. 17(2): 275-278.

Cui J J and Xia J Y 2000 Effects of *Bt* (*Bacillus thuringensis*) transgenic cotton on the dynamics of pest population and their enemies. *Acta Phytophylacica Sinica*. 27(2): 141-145.

Jackson E V, Bradley J R and Van duyn W K 2003 Field performance of transgenic cotton expressing one or two *Bacillus thuringiensis* endotoxins against bollworm, Helicoverpa zea (Boddie). *The Journal of Cotton Science.* 7: 57 - 64.

Lakshmi Soujanya P 2008 Effect of *Bt* toxins (Cry1Ac & Cry1Ac+Cry2Ab) on the development & management of bollworm complex with special reference to *Pectinophora gossypiella* (Saunders) & *Spodoptera litura* (Fabracius) on cotton. Ph.D. thesis submitted to Acharya N.G Ranga Agricultural University, Rajendranagar, Hyderabad.

Marchosky R, Ellsworth P C, Moser H and Henneberry T J 2001 Bollgard I and Bollgard II efficacy in near isogenic lines of DP 50 upland cotton in Arizona. Arizona Cotton Report, Department of Entomology, University of Arizona, Maricopa, AZ & USDA – ARS, WCRL, Phoenix, Arizona, USA, pp. 236-240.

Prasad N V V S D, Mahalakshmi M S and Rao N H P 2008 Monitoring of cotton bollworms through pheromone traps and impact of abiotic factors on trap catch. *Journal of Entomological Research.* 32 (3): 187-192.

Pratheepa M, Meena K, Subramaniam K R, Venugopalan R and Bheemanna H 2010 Seasonal population fluctuations of cotton bollworm, *Helicoverpa armigera* (Hubner) in relation to biotic and abiotic environmental factors at Raichur, Karnataka, India. *Journal of Biological Control*, 24(1): 47-50.

Purohit D, Ameta O P and Sarangdevot S S 2006 Seasonal incidence of major insect pests of cotton and their natural enemies. *Pestology*, 30(12): 24-33.

Sesha Mahalakshmi M 2007 Impact of *Bt* cotton on the incidence and management of bollworm complex. Ph.D. thesis submitted to Acharya N G Ranga Agricultural University, Rajendranagar, Hyderabad.

Srinivasa Rao N 2004 Performance of transgenic *Bt* cotton on the seasonal incidence and management of bollworms compared to local bunny through the joint toxic action of novaluron, a new chitin inhibitor. Ph.D. thesis submitted to Acharya N G Ranga Agricultural University, Rajendranagar, Hyderabad.

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