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Impact of Weather Parameters on the Incidence of Pink Bollworm, *Pectinophora gossypiella* (Saunders) on *Bt* and non-*Bt* Varietal Cottons

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ABSTRACT

Studies on impact of weather parameters on the incidence of pink bollworm, *Pectinophora gossypiella* (Saunders) on *Bt* and non-*Bt* varietal cottons were carried out under Department of Entomology, Agricultural College, Bapatla at Regional Agricultural Research Station, Lam, Guntur during two seasons, *kharif* 2009-10 and *kharif* 2010-11. Pink bollworm larval population and their damage to locules was completely absent on stacked *Bt* cotton hybrids (RCH 2 BG II and Mallika BG II) compared to high larval population (0.50-11.50 larvae/25 green bolls) and locule damage (0.51-18.59% /25 green bolls) in non-*Bt* (L 604) during 49th (Dec. 3-9)- 8th (Feb.19-25) std. weeks with its peak (11.50 larvae and 18.59 per cent) during 8th std. week. The favourable weather parameters that influences the build up of high population of pink bollworm (6th to 8th std. weeks) are in the range of maximum and minimum temperatures 31-33 and 17-19^{O}C, morning and evening relative humidities 82-92 and 42-56 per cent, and the rainfall 0-4 mm. Maximum temperature and evening relative humidity exerted significant positive (r= 0.673**) and significant negative influence (r= -600*) on the pink bollworm incidence in L 604 non-*Bt,* respectively. All the weather variables (*viz.,* maximum and minimum temperatures, morning and evening relative humidities, and rainfall) together contributed to 68.7 per cent variation in pink bollworm larval population significantly (R^2=0.687*) in L 604 non-*Bt*. Of the five variables, minimum temperature was found to have significant influence on variation of larval population.

Key words :*Bt* and non-*Bt* varietal cottons, Pink bollworm, 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 acerage in the world, productivity was 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, bollworms are the dreaded pests which cause severe damage to the economic parts of cotton. Among bollworms, pink bollworm *Pectinophora gossypiella* (Saunders) is one of the serious pests of cotton worldwide causing losses in both yield and quality of cotton. In Andhra Pradesh, pink bollworm activity has become more pronounced during recent past and pose greater threat to cotton production. 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. The knowledge about incidence of a pest in the cropping season and existing weather conditions help in designing pest management strategies. Hence, the present investigation was therefore, undertaken to study the influence of weather parameters on pink bollworm incidence on *Bt* and varietal cottons.

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 years. Incidence of pink bollworm was recorded through destructive sampling of green bolls *i.e.* 25 green bolls/plot were collected randomly from each cotton type before every picking and were cut open carefully along ridges of the locules with the help of sharp cutter in the laboratory and the number of larvae/boll and per cent locule damage was recorded. 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

Mean incidence of pink bollworm and its damage to locule during both *kharifs* of 2009-10 and 2010-11from the common standard weeks indicated that in stacked *Bt* hybrids (RCH 2 BG II and Mallika BG II) the incidence and locule damage was nil compared to 0.50-11.50 larvae and 0.51-18.59 per cent locule damage per 25 green bolls in non-*Bt* (L 604) during 49th (Dec. 3-9)-8th (Feb.19-25) std. weeks. The larval population and locule damage almost increased gradually from 49th to 8th std. week with its peak (11.50 larvae and 18.59 per cent locule damage) during 8th std. week when maximum and minimum temperatures were 31.56 and 18.57^{0}C, morning and evening relative humidities were 91.27 and 55.93 per cent and rainfall was 3.85 mm (Table 1).

Favourable weather factors that influences the build up of high population of pink bollworm (8.00-11.50 larvae per 25 green bolls during 6th-8th std. weeks in L 604) during the study are in the range of maximum and minimum temperatures 31-33 and 17-19^{O}C, morning and evening relative humidities 82-92 and 42-56 per cent, and rainfall 0-4 mm. The results are in agreement with Srinivasa Rao (2004), Lakshmi Soujanya (2008) and Sandhya Rani *et al*. (2010) who reported the range of favourable maximum and minimum temperatures 29-33 and 14-21^{O}C, morning and evening relative humidities 74-97 and 38-72 per cent and rainfall 0-9 mm in Guntur district of Andhra Pradesh. However, the present findings are contradict with those of Gosalwad *et al*. (2009) who reported the range of maximum and minimum temperatures 27-30 and 6-13^{O}C and evening relative humidities 76-81 and 31-46 for build up of high population of *P. gossypiella* (2-2 and 4-6 larvae/10 green bolls in 2004-05 and 2005-06, respectively) on PHH 316 (Ganga) cotton variety at Parbhani, Maharastra during both seasons of 2004-05 and 2005-06.

Incidence of pink bollworm and its damage to locule in green bolls was completely absent in stacked *Bt* hybrids (RCH 2 BG II and Mallika BG II) compared to higher population (11.50 larvae/25 bolls) and per cent locule damage (18.59 /25bolls) was recorded in non-*Bt*(L 604). The present findings are in accordance with that of Lakshmi Soujanya (2008) who reported that the incidence of pink bollworm larvae and per cent locule damage in green bolls was nil in stacked *Bt* hybrids (TCH 4 and 117) compared to higher incidence (up to 18.50 larvae/10 bolls) and locule damage (up to 39.28%) in non-*Bt* hybrids (TCH 4 and 117) at RARS, Lam, Guntur, Andhra Pradesh. Similarly Channakeshava and Patil (2009) stated that MECH 184 *Bt* was completely free from the incidence of pink bollworms compared to 0.25±0.17 - 2.25±0.34 in non-*Bt* (NCS-145) between 49th to 3rd std. weeks. The absence of pink bollworm larvae on stacked *Bt* hybrids due to stacking with *Cry* 1 Ac and 2Ab genes that had 10-fold advantage over Cry 1Ac genotypes (Marchosky *et al*., 2001). 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 *Cry*1Ac+*Cry*2Ab was found better than DP 50 B (*Cry*1Ac) with enhanced efficacy over wide range of lepidopteraon pests.

Peak occurrence of pink bollworm with reference to std. weeks can as well vary depending up on the favourable weather parameters. During present study, larval population (8.00-11.50 larvae/25 green bolls) and locule damage (14.80-18.59 %) in green bolls by pink bollworm was high at the end of the crop growth period *i.e.* 6th to 8th std. weeks in non-*Bt* (L 604). Similarly Nadaf and Goud (2007) who stated peak incidence of pink bollworm larvae in green bolls attained during 6th std. week. (37.25 larvae/50 green bolls) in RCH 2 non-*Bt* under unprotected rainfed conditions at Main Agricultural Research Station, Dharwad during 2004-05 and 2005-06. While Channakeshava and Patil (2009) who stated that incidence of pink bollworm was high (2.00 larvae/boll) during 2nd std. week on

Table 1. Seasonal incidence of pink bollworm, *Pectinophora gossypiella* (Saunders) on *Bt* and non-*Bt* varietal cottons (Mean of *kharif* 2009 and 2010-11)

Std. week.	Period	Number of larvae/25 bolls			% locule damge/25 bolls			Max. temp. (°C)	Min. temp. (°C)	Morning R.H. (%)	Evening R.H. (%)	Rainfall (mm)
		RCH 2 BG II	Mallika BG II	L 604 non-*Bt*	RCH 2 BG II	Mallika BG II	L 604 non-*Bt*					
46	12 to 18	0.00	0.00	0.00	0.00	0.00	0.00	29.85	22.10	90.05	86.35	28.00
47	19 to 25	0.00	0.00	0.00	0.00	0.00	0.00	30.60	21.30	90.80	72.90	40.00
48	26 to Dec. 2	0.00	0.00	0.00	0.00	0.00	0.00	31.40	19.10	88.00	59.30	5.40
49	3 to 9	0.00	0.00	0.50	0.00	0.00	0.51	28.20	18.90	89.10	64.45	57.65
50	10 to 16	0.00	0.00	0.00	0.00	0.00	0.00	29.95	19.35	89.40	57.40	0.00
51	17 to 23	0.00	0.00	1.00	0.00	0.00	1.06	28.65	16.80	86.65	52.25	4.70
52	24 to 31	0.00	0.00	2.00	0.00	0.00	2.15	30.70	18.55	91.25	55.90	0.00
1	Jan. 1 to 7	0.00	0.00	1.50	0.00	0.00	1.53	29.45	16.90	87.50	53.40	0.00
2	8 to 14	0.00	0.00	4.00	0.00	0.00	4.33	29.85	15.75	83.20	52.45	0.00
3	15 to 21	0.00	0.00	5.50	0.00	0.00	6.46	30.30	16.30	90.55	44.95	0.98
4	22 to 28	0.00	0.00	6.00	0.00	0.00	7.01	30.45	15.40	90.60	45.40	0.00
5	29 to Feb. 4	0.00	0.00	5.00	0.00	0.00	9.78	31.17	16.27	89.15	44.88	0.00
6	5 to 11	0.00	0.00	8.00	0.00	0.00	15.23	32.19	17.17	90.93	42.45	0.00
7	12 to 18	0.00	0.00	10.00	0.00	0.00	14.80	32.81	17.01	82.72	46.14	0.00
8	19 to 25	0.00	0.00	11.50	0.00	0.00	18.59	31.56	18.57	91.27	55.93	3.85
Mean		0.00	0.00	3.67	0.00	0.00	5.43	30.47	17.96	88.74	55.61	9.37

Table 2. Correlation between weather parameters and incidence of pink bollworm, *Pectinophora gossypiella* (Saunders) on L 604 non-*Bt.*

Weather parameter	Correlation coefficient (r)
Maximum temperature	0.673**
Minimum temperature	-0.488
Morning relative humidity	-0.078
Evening relative humidity	-0.600*
Rainfall	-0.448

*Significant at 5% level ** Significant at 1% level

Table 3. Multiple linear regression analysis between weather parameters and incidence of pink bollworm, *Pectinophora gossypiella* (Saunders) on L 604 non-*Bt* variety

Regression equation	R^2
$= -68.328 + 2.574X_1* - 1.810X_2 + 0.221X_3 + 0.107X_4 + 0.053X_5$	0.687*

Mallika non-*Bt* at farmer field in Nelahal village of Raichur, Karnataka during 2005-06 season. Even during 51st to 1st std. weeks high population of pink bollworm (15.00-18.50 larvae/10 green bolls) and its locule damage in green bolls (28.29-39.28 %) was recorded on non-*Bt* hybrids of TCH 4 and 117 during both seasons of *kharif* 2006-07 and 2007-08 (Lakshmi Soujanya, 2008). Thus, it could be concluded that the coincidence of peak incidence of pink bollworm in different std. weeks in different studies indicate the occurrence of favourable weather during those respective std. weeks.

Influence of weather parameters

The correlation analysis (Table 2) of mean larval population of pink bollworm during both *kharifs* of 2009-10 and 2010-11 with weather parameters showed that maximum temperature exerted highly significant positive influence (r= 0.673**) on the incidence of pink bollworm. Similar observations were also reported by Nadaf and Goud (2007) who computed positive significant correlation between pink bollworm and maximum temperature in Dharwad district of Karnataka during 2004-05 and 2005-06. The present results differed with those of Prasad *et al*. (2008) who reported that maximum temperature had strong negative influence on moth catches of pink bollworm in 2001-06 at RARS, Lam, Guntur, Andhra Pradesh.

The relationship between the pink bollworm population and evening relative humidity was negative and significant (r= -0.600*) which is in accordance with that of Lakshmi Soujanya (2008) who reported evening relative humidity had significant negative influence on pink bollworm larvae in 2006-08 at RARS, Lam, Guntur. Similarly, Nadaf and Goud (2007) and Prasad *et al*. (2008) reported that evening relative humidity had significant negative impact on pink bollworm in Maharastra and Andhra Pradesh region, respectively.

The population of pink bollworm had non-significant negative association with minimum temperature (r= -0.488), morning relative humidity (r= -0.0.78) and rainfall (r= -0.448). The results of the present investigation are in parallel with Dhaka and Pareek (2008) who reported that morning relative humidity and rainfall had non-significant negative influence on pink bollworm on RST-9 cotton variety at Agricultural Research Sub Station, Diggi, Rajasthan in 2001-03. Similarly, Sesha Mahalakshmi (2007) reported that the association between minimum temperature and pink bollworm was non-significant negative in different cotton hybrids at RARS, Lam in 2004-06. The present findings are not in agreement with those of Dhaka and Pareek (2008), Lakshmi Soujanya (2008), Prasad *et al*. (2008) and Srinivasa Rao (2004) who reported minimum temperature, rainfall and morning relative humidity exerted significant negative influence on the pink bollworm incidence.

The multiple linear regression analysis (Table 3) indicated that all the weather variables

together contributed to 68.7 per cent variation in pink bollworm larval population significantly (R^2=0.687*). Of the five variables, minimum temperature was found to have significant influence on variation of larval population. One degree raise in minimum temperature is expected to increase pink bollworm population by 2.574 when all other variables are at their mean level. The present findings are in accordance with that of Sesha Mahalakshmi (2007), Lakshmi Soujanya (2008) and Tomar (2009) who reported the per cent population variability due to all the weather factors in different cotton hybrids was up to 89.00 in different cotton hybrids.

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