Performance of *Bt* and non *Bt* cotton hybrids against American bollworm, *Helicoverpa armigera* (Hubner)

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ABSTRACT

Field trials were conducted in farmers' fields at Warangal district, Andhra Pradesh, India during 2005-06 and 2006-07 to monitor the population and fruiting body damaged caused by *H. armigera* in commercially released *Bt* cotton hybrids under unprotected conditions. In the present study it was found that there was no variability in egg laying among *Bt*, non *Bt* hybrids and Narasimha. However, the larval population and fruiting body damage was significantly lower in *Bt* hybrids than their corresponding non *Bt* hybrids. Seed cotton yield in *Bt* cotton hybrids were more than that of non *Bt* cotton hybrids.

Key words: *Bt* cotton, *Cry*1Ac, *H. armigera*

INTRODUCTION

Bollworms especially, American bollworm, *Helicoverpa armigera* (Hubner) and pink bollworm, *Pectinophora gossypiella* (Saunders), cause considerable damage in India to the cotton crop (Deore *et al.,* 2010). A loss of US $1.0 billion worth cotton has been accounted for the dreaded pest, *H. armigera* every year (Gujar *et al.*, 2000). The indiscriminate use of insecticides has resulted in the development of insecticide resistance in *Helicoverpa*. Growing commercialized *Bt* cotton offers an opportunity to manage the pest problem and increases productivity and provides benefits to farmers, consumers and environment. *Bacillus thuringiensis* (Berliner) is gram positive delta endotoxin producing bacterium. Using biotechnology tools, scientists have introduced genes from *B. thuringiensis* into cotton plant, leading to production of *Cry* protein which provides resistance to bollworm. The first generation transgenic cotton exhibited good level of resistance against the bollworms *viz.*, *H. armigera*, *P. gossypiella* and *Earias vittella* (Fabricius) under laboratory as well as field conditions (Khadi *et al*., 2001; Jeff Whitworth *et al.*, 2010). However, there is a need to monitor the resistance levels in the newly released hybrids. Hence, the present study was undertaken to assess the performance of newly released *Bt* hybrids and non-*Bt* cotton hybrids against *H. armigera.*

MATERIALS AND METHODS

Field experiments were conducted during 2005-06 and 2006-07 in farmers' field at Warangal district, Andhra Pradesh, India to evaluate five *Bt* Cotton hybrids along with their non *Bt* hybrids against *Helicoverpa armigera.* The experiment with 10 test hybrids *viz*., RCH 368 *Bt*, Bunny *Bt*, RCH 20 *Bt*, Mallika *Bt* and RCH-2 *Bt* and their non *Bt* hybrids along with local check variety, Narasimha was laid out with 11 treatments (each hybrid as treatment) replicated four times in a Randomized Block Design. The plot size was 10m x 10m with spacing of 1m x 1m.Cotton crop was raised following the recommended agronomic practices except for plant protection measures. The crop was protected up to 60 DAS from sucking pests by spraying with imidacloprid 17.5 SL (@0.25 mL/L) at 30 DAS and acetamiprid 20 SP (@ 0.2 g/L) at 45 and 60 DAS. Crop was not protected from bollworms with an aim to study the season long incidence of bollworm and its influence on yield of seed cotton.

Observations were recorded on 10 randomly selected plants per replication per plot avoiding border rows. The egg count was recorded on terminal growing shoot of the selected plants an while larval count of *H. armigera* was from the whole plant at weekly intervals. The damage to fruiting structures (squares/flowers/bolls) by *H. armigera* was recorded from whole plant at fortnightly intervals. Seed cotton yield data was recorded. The data were subjected to statistical analysis after suitable transformation.

RESULTS AND DISCUSION

The results of the study are presented in Table 1-4. Oviposition by *H. armigera* was first noticed at 46 DAS on all the cotton cultivars and declined thereafter during both the seasons. However, the cumulative data of 2005-06 and 2006-07 pertaining to seasonal mean oviposition by *H. armigera* reveals that there was no variability in egg laying among *Bt,* non *Bt* hybrids and Narasimha. Earlier studies on oviposition were not consistent. Though some researchers have reported significant differences in egg laying between *Bt* and non *Bt* cotton hybrids, there are other reports which concluded that there were no significant differences in egg laying between *Bt* and non *Bt* cotton hybrids. The results in the present study are in agreement with Kengegowda *et al*. (2005); Basavaraj *et al*. (2007); Li GuoPing *et al*. (2010); Arshad *et al*. (2011) who reported that there was no difference in oviposition between transgenic and non transgenic cotton. However, Wu *et al*. (2003) and Vennila *et al*. (2004) observed significant differences in egg laying.

H. armigera larval population increased slowly from 53 days after sowing to 102 days after sowing across the cotton cultivars and later decreased reaching a minimum at 130 DAS. However, season long larval incidence of American bollworm was very low in all the *Bt* hybrids compared to non *Bt* hybrids and Narasimha. Seasonal mean larval incidence revealed that all the *Bt* hybrids recorded significantly lower population of *H. armigera* than their corresponding non *Bt* hybrids and Narasimha (df=30; F=142.87, P=0.06). The present findings were in agreement with those of Wang and Xia (1997); Cui *et al*. (1998); Zhao *et al*. (1998); Cui and Xia (2000); Anonymous (2002); Srinivasa Rao (2004); Patil *et al*. (2004) and Arshad *et al*. (2011) who reported that the incidence of *H. armigera* larvae was very low on *Bt* cotton cultivars compared to their corresponding non *Bt* cultivars. Further, Srinivasa Rao (2004) reported that the larval population never crossed ETL in *Bt* cotton hybrids. Manjunatha *et al.* (2009) and Vijander *et al*. (2010) reported that larval incidence of American bollworm (*H. armigera*) was nil in all the *Bt* hybrids compared to non *Bt* hybrids.

Similarly, fruiting body damage also increased slowly from 65 DAS and damage was higher at 95 and 110 DAS and decreased thereafter. At peak activity of *H. armigera*, lowest fruiting damage were recorded in *Bt* hybrids, which are equal among themselves. However, non *Bt* hybrids recorded higher damage differed from their respective *Bt* counter parts but were equal among themselves (df=30; F=1062.19; P=0.10). The present findings are in confirmation with results of Krishnamurthy and Subramanian (2004); Patil *et al.* (2004) and Vennila *et al.* (2004); Thulasi Ram *et al.* (2006); Prasad and Rao (2008); Prasad *et al*. (2008), Manjunatha *et al.* (2009) who reported similar trend of low square damage and green boll damage in different *Bt* cotton cultivars compared to their corresponding non *Bt* cotton counterparts and check hybrid.

Seed cotton yield was equal among the *Bt* hybrids. However, *Bt* versions were superior over their non *Bt* versions and local check, Narasimha (df=30; F=6.17; P=423). The present findings are consistent with the findings of Benedict *et al.* (1996), Surilivelu *et al.* (2004), Khambhampati *et al*. (2006), Kumar (2006), Iyengar and Lalitha (2007), Bheemanna *et al.* (2008) and Manjunatha *et al.* (2009) who reported higher seed cotton yield in *Bt* hybrids compared non *Bt* hybrids. Radhika *et al*. (2006) observed that the yield differences among *Bt* hybrids was not significant, while *Bt* hybrids were significantly superior over their non *Bt* versions and checks. Hence the present study established that *Bt* hybrids recorded lower fruiting body damage and better in yield compared to non *Bt* hybrids.

Table 3. Mean per cent fruiting body damage by *H. armigera* in different cotton cultivars during 2005-2007 (Pooled data of two years)

Cotton Cultivar	Fruiting body damage (%)						
	65 DAS	80 DAS	95 DAS	110 DAS	125 DAS	140 DAS	Mean
RCH 368 *Bt*	0.37±0.15	3.52±1.28	4.39±1.31	3.45±1.86	1.62±1.72	0.52±1.24	1.39±0.04
RCH 368 non *Bt*	4.29±0.77	15.96±3.99	19.83±2.10	19.99±3.13	11.58±2.93	5.75±2.02	15.01±0.04
Bunny *Bt*	0.48±0.47	4.14±1.14	4.61±1.17	3.94±0.85	2.08±0.92	0.66±0.97	2.14±0.03
Bunny non *Bt*	4.51±1.47	18.21±2.89	22.13±3.73	21.57±1.73	12.34±4.34	6.96±3.46	15.95±0.08
RCH 20 *Bt*	0.28±0.45	2.96±0.82	3.96±1.69	2.40±0.79	1.42±0.69	0.45±0.44	1.21±0.02
RCH 20 non *Bt*	5.14±1.78	15.59±4.36	19.39±3.00	19.35±3.04	9.79±3.53	5.37±2.65	9.41±0.03
Mallika *Bt*	0.37±0.44	4.25±1.33	3.61±0.85	3.56±1.74	1.50±1.31	0.43±0.24	0.97±0.01
Mallika non *Bt*	4.99±1.78	16.25±2.84	19.39±1.22	19.41±4.22	9.66±3.80	6.03±1.24	13.40±0.06
RCH 2 *Bt*	0.29±0.29	3.66±0.72	5.38±0.67	2.44±1.14	1.34±2.38	0.35±0.32	1.22±0.03
RCH 2 non *Bt*	4.92±1.95	17.19±3.63	19.11±2.83	19.06±3.49	8.61±2.79	4.64±0.94	10.57±0.06
Narasimha	5.21±2.08	17.52±4.25	21.13±3.13	20.89±4.12	9.42±2.71	6.14±1.56	10.97±0.07
F-test	S	S	S	S	S	S	S
SEm±	1.23	2.56	1.75	2.39	2.62	1.50	0.03
CD (P=0.05)	3.59	7.43	5.08	6.94	7.59	4.37	0.10

DAS – Days after sowing; S – Significant; NS – Non Significant

Table 4. Seed cotton yield in different cotton cultivars

Cotton cultivar	2005-06	2006-07	Mean
	Yield (kg/ha)	Yield (kg/ ha)	Yield (kg/ ha)
RCH 368 *Bt*	2467±405	2517±238	2492±309
RCH 368 non *Bt*	1809±88	1834±91	1821± 89
Bunny *Bt*	2270 ±55	2345±55	2307±41
Bunny non *Bt*	1734±132	1739 ±50	1736±78
RCH 20 *Bt*	2554 ±173	2679±77	2616±119
RCH 20 non *Bt*	1616±131	1914±38	1765±72
Mallika *Bt*	2329±162	2404±88	2366±126
Mallika non *Bt*	1791±127	1886±134	1828±126
RCH 2 *Bt*	2780 ±336	2505 ±180	2643±256
RCH 2 non *Bt*	1824±158	1874±157	1849±156
Narasimha	1950 ±189	1908±124	1929±147
F-test	S	S	S
SEm±	192	115	146
CD (P=0.05)	558	335	423

This is mainly due to ability of *Bt* hybrids to resist infestation from American bollworm as evident from low larval incidence and lower fruiting body damage.

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