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STUDIES ON DEVELOPMENT AND SURVIVAL OF *SPODOPTERA LITURA* ON BT COTTON (CRY 1 AC) UNDER LABORATORY AND FIELD CONDITIONS

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ABSTRACT

Seven cotton genotypes including four *Bt* cotton hybrids (RCH-134, RCH-317, MRC-6301 and MRC-6304) and three non-*Bt* cotton hybrids (RCH-134, RCH-317 and LHH-144) were screened for feeding preference by *Spodoptera litura* (Fabricius) studies under laboratory and field conditions. Weight gain in larvae of *S. litura* was more when fed on RCH-134 bt (101.45 mg /larva) with relative growth rate (RGR) of 4.29 / larva as compared to its non-*Bt* counterpart (53.71 mg /larva and RGR 2.51/larva) under laboratory conditions. In the field, incidence of *S. litura* showed an increasing trend and reached maximum (0.80 larvae/plant) in RCH-317 *Bt* cotton on the 41st Standard Meteorological Week (SMW). The pooled data indicated that the population of *S. litura* ranged from 0.06 to 0.40 larva per plant in all the *Bt* cotton hybrids as against 0.05 to 0.12 larva per plant in non-*Bt* hybrids.

Key words: ***Spodoptera litura*****,** *Bt* cotton hybrids, Cry 1AC.

INTRODUCTION

Spodoptera litura (Fabricius) is a polyphagous pest affecting about 150 host plants and is widely distributed in India. *Bt* cotton (Bollgard-I with Cry 1 Ac protein), commercialized in India since 2002, is rapidly being adopted by farmers. *Bt* cotton has demonstrated remarkable control of *Helicoverpa armigera* (Hubner), *Earias* spp. and *Pectinophora gossypiella* Saunders (Bagade *et al.*,2005). However, the common lepidopteran pests like fall armyworm, *Spodoptera frugiperda*; beet armyworm, *Spodoptera exigua* (Hubner); and soybean looper, *Pseudoplusia includens* (W) are reported to be tolerant to Cry I Ac (Luttrell *et al*., 1998).

Though Bollgard I manages the bollworms effectively, it does not provide any protection against *S. litura*. It was reported on cotton from North India (Arora, 1993), though cotton is not the most preferred host for the development and survival of this pest (Singh and Byas, 1975); however, severe incidence of this pest on cotton was not noticed in North zone throughout the last decade (1993-2003). In the recent past the insect has caused widespread epidemic on soybean in central India during August- September, 2004; and was also noticed on cotton during *kharif* 2003, in north zone (Anon., 2004). Keeping this in view the feeding preference experiments and field experiments were conducted with *Bt* cotton hybrids during *kharif 2006.*

MATERIALS AND METHODS

(a) Laboratory Experiment : Field-collected second instar larvae of *S. litura* were starved for six hours, weighed (initial weight) and put individually into separate cylindrical glass vials (5x2 cm) of known weight and again weighed to know exact weight of the larvae after consumption under laboratory conditions. These larvae were fed with the terminal leaves plucked from 90 day-old *Bt* (4) and non-*Bt* (3) hybrids. After five days of feeding the larvae were again weighed (final weight). The difference in weight between *Bt* and non-*Bt* hybrids was calculated by using standard procedure and the relative growth rate (RGR) was calculated by following the procedure of Farrar *et.al*. (1989) as mentioned below.

Relative Growth Rate (RGR) = ΔB / (BI) (T)

ΔB = change in body weight.

BI = initial weight of the insect

T = feeding period in days

(b) Field experiment: Field evaluation was done in randomized complete block design (RBD) with seven treatments comprising of four *Bt* cotton hybrids (RCH-134, 317, MRC-6301 and MRC-6304) and three non-*Bt* cotton hybrids (RCH-134, 317 and LHH-144) and replicated thrice with each plot measuring 500 m^2 in village Randhawa (Sirsa-Haryana) during *kharif* 2006. All the recommended agronomic practices for *Bt* cotton hybrids were followed.

The larval population of *S. litura* was observed at weekly intervals starting from the first appearance of *S. litura* incidence from 25 randomly selected plants in both *Bt* and non-*Bt* hybrids. The data was subject to transformation (square root transformation for population count) and analyzed statistically.

RESULTS AND DISCUSSION

(a) Laboratory Experiment on feeding studies : The weight gain by S. *litura* larva was more in RCH-134 *Bt* (101.45mg /larva with RGR value of 4.29/larva) and RCH- 317 *Bt* (72.80 mg/larva and RGR, 3.37/larva) compared to that of its non-*Bt* counterpart RCH -134 (53.71mg/larva and RGR, 2.51/ larva) and RCH-317 (35.50 mg /larva and RGR, 2.10/larva). However, the statistical analysis revealed that the weight gain was not significant between *Bt* and non-*Bt* hybrids. Adamczyk *et al*. (1998) observed no significant difference in larval survival of *S. frugiperda* between the normal (variety DP-5415) and *Bt* cotton (variety NuCOTN-33B) at 2, 4, 6, 8, 10 and 12 days after exposure.

When the larval weight gain was compared individually between different hybrids it was found that the weight gain in RCH-134 *Bt* (101.45 mg / larva) was higher than that of RCH-317 *Bt* (72.80 mg / larva), MRC-6301 *Bt* (44.50 mg / larva) and RCH-317 non-*Bt* (35.50 mg / larva) (Table 1). Sumerford (2002) observed that the *S .exigua* individuals pupated earliest when fed with the Cry 1 Ac diet, which produced offspring that develops significantly faster on Cry 1 Ac diet than the parental control strain. Mohammad *et al*. (2000) recorded that larval mortality in *Spodoptera exigua* fed on *Bt* cotton was low for all the instars compared to that of other bollworms.

(b) Field Experiment : In the field, incidence of *S. litura* on *Bt* cotton initiated in the 38th Standard Meteorological Week (SMW); thereafter, the population showed an increasing trend and reached to a maximum of 0.80 larvae per plant in RCH-317 *Bt* in 41st SMW during 2006 (Table-2). The pooled data of 2006 indicated that the population of *S. litura* ranged from 0.06 to 0.40 larva per plant in all the *Bt* cotton hybrids against 0.05 to 0.12 larva per plant in non-*Bt* hybrids, with a maximum of 0.40 larva per plant in RCH-317

Table 1. Feeding of *S. litura* on *Bt* and non-*Bt* cotton under laboratory conditions

Name of the entry	Initial weight of larva (mg)	Final weight of larva (mg) $\sqrt{x+1.0}$	Difference (mg)	Relative growth rate (RGR)
RCH-134 *Bt*	118.22	219.67	101.45	4.29
RCH-317 *Bt*	108.00	180.80	72.80	3.37
MRC-6301 *Bt*	66.25	110.75	44.50	3.36
MRC-6304 *Bt*	105.50	177.17	71.67	3.40
RCH-134 Non-*Bt*	106.86	160.57	53.71	2.51
RCH-317 Non -*Bt*	84.50	120.00	35.50	2.10
LHH-144 Non-*Bt*	165.00	235.25	70.25	2.13

Table 2. Incidence of *Spodoptera litura* (F.) on *Bt* and Non-*Bt* cotton during 2006

Bt Cotton	Larvae per plant in different meteorological standard weeks				
	38	39	40	41	Pooled Mean
RCH-134	0 (1.0)	0.05 (1.02)	0.45 (1.19)	0.30 (1.15)	0.20 (1.09)
RCH-317	0 (1.0)	0.40 (1.18)	0.40 (1.18)	0.80 (1.34)	0.40 (1.18)
MRC-6301	0.1 (1.04)	0.05 (1.02)	0.10 (1.04)	0.10 (1.04)	0.06 (1.04)
MRC-6304	0 (1.0)	0.20 (1.09)	0.40 (1.18)	0.50 (1.22)	0.28 (1.12)
		Non-*Bt* Cotton			
RCH-134	0 (1.0)	0.05 (1.02)	0.05 (1.02)	0.40 (1.18)	0.12 (1.05)
RCH-317	0 (1.0)	0 (1.0)	0.11 (1.08)	0.11 (1.05)	0.10 (1.03)
LHH-144	0.05 (1.02)	1.10 (1.04)	0.05 (1.02)	0 (1.0)	0.05 (1.02)
S. Em. ±	—	0.032	0.048	0.064	0.04
CD (P = 0.05)	NS	0.08	0.12	0.16	0.10

Note: Figures in parentheses are transformation.

Bt, which was significantly higher than other *Bt* as well as non-*Bt* hybrids (Table 2). In general the population of *S. litura* was more on *Bt* cotton (0.24 larva/plant) as compared to that of non-*Bt* cotton (0.09 larva/plant).

During this investigation higher population of *S. litura* could be due to the absence of other bollworms in *Bt* cotton; especially, *H. armigera*. This observation is further supported by the finding of Bagade *et al.* (2005), who reported that the *Bt* cotton was effective against all the three bollworms (*H. armigera*, *Earias* spp and *P. gossypiella*), as well as the report of Luttrell *et al*. (1998) about the more tolerance found in *S. frugiperda* against Cry 1 Ac than other bollworms. After the introduction of *Bt* cotton regular incidence of *S. litura* is being observed in cotton, late in the season in north zone. A heavy incidence of this pest on cotton was noticed during *kharif* 1993 in north India (Arora, 1993). Further, an outbreak of *Spodoptera* spp. was observed during October in the cotton growing belt of Haryana by Saini *et al*., (2005).

The heavy incidence of *S. litura* could be due to large scale cultivation of illegal *Bt* cotton (Boll gard-I Cry 1 Ac). However, it was interesting to note that these cotton fields with high population of *S. litura*, had a good population of the common weed, *Trianthema monogyna*. This weed is reported to be the most preferred alternate host for *S. litura* and has been observed to harbour high larval populations during the early phase of cotton; hence regular monitoring for the pest becomes necessary.

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