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Impact of Bt cotton on pink bollworm, *Pectinophora gossypiella* (Saunders) infestation*

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Abstract : Studies on population dynamics of pink bollworm *Pectinophora gossypiella* (Saunders) in interspecific Bt and non-Bt cotton hybrids was carried out at Agricultural Research Station, Dharwad farm, Dharwad, during 2007-08. The Bt cotton hybrid recorded significantly low percentage of rosette flowers, per cent green boll, locule damage and lesser number of pink bollworm larvae compared to non-Bt cotton. During the peak flowering stage, the percentage of rosette flowers recorded in Bt cotton and non-Bt cotton was 3.33 and 10.86 per cent, respectively. Whereas, 66.60 per cent reduction in pink bollworm larval incidence in and 61.50 per cent reduction boll damage was recorded in Bt cotton over non-Bt cotton hybrid.

Key words : Bt cotton, *Pectinophora gossypiella*, population dynamics, interspecific hybrid

Introduction

Cotton *Gossypium hirsutum* L., is one of the principal commercial crops playing a key role in economic, social, and political affairs of the country. By far, cotton is the most important natural fibre or vegetable wool has been in the cultivation commercially for domestic consumption and export needs in about 111 countries worldwide and hence called "King of fibres" or "White gold. India is an important grower of cotton on a global scale. In India, cotton is cultivated in an area of 95.30 lakh ha with a production 310 lakh bales of seed cotton. The average productivity of cotton in India is 553 kg/ha (Anonymous, 2007). The cotton production remained stagnant over the years due to many biotic and abiotic constraints. Among the biotic problems, insect pests are major in India.The insect pests spectrum of cotton is quite complex and as many as 1326 species of insect pests have been reported on this crop throughout the world. bout 130 different species of insects and mites found to devour cotton at different stages of crop growth in India. Among these, bollworms *viz*., *Helicoverpa armigera* (Hubner) the American bollworm, *Earias vittella* (Fabricius), the spotted bollworms and *Pectinophora gossypiella* (Saunders) the pink bollworm pose greater threat to cotton production (Agarwal *et al*., 1984).

Among the bollworms, the pink bollworm assumed major pest status in recent past (Ghosh, 2001). World over, Pink bollworm *Pectinophora gossypiella* (Saunders) has become economically the most destructive pest of cotton and has known to cause 2.8 to 61.9 per cent loss in seed cotton yield, 2.1 to 47.10 per cent loss in oil content and 10.70 to 59.20 per cent loss in normal opening of bolls (Patil, 2003).

Insecticidal crystal protein found in a soil bacterium, *B. thureingiensis* forms an important part of an arsenal, which offers better control than insecticides and is ecofriendly. Although plenty of Bt formulation are available, the most effective way to deliver the toxin to the target pest is through transgenic plant system (Kumar, 2002). In the world scenario Bt cotton (Bollgard®) offered high level of resistance against cotton bollworm complex ie., *Helicoverpa armigera* (Hubner), *Earias vittella* (Fabricius) and *Pectinophora gossypiella* (Saunders) both under laboratory as well as field conditions (Ghosh, 2002., Kranthi., 2002. and Kranthi and Kranthi., 2004)

The knowledge about incidence of pest during the cropping season and its possible dynamics help in designing pest management strategies. Hence, the studies on population dynamics of the pink bollworm both in interspecific Bt as well as non Bt cotton hybrids were undertaken during the year 2007-08.

Material and methods

Field experiment was carried out at Agricultural Research Station, Dharwad farm, Dharwad, during 2007-08. The Bt cotton hybrid, DBTHB-05 Bt,an inter-specific hybrid developed at Agricultural Research Station, Dharwad (Hebballi) farm, University of Agricultural Sciences, Dharwad, Karnataka which carries the Bollgard gene *Cry 1Ac* along with a popular inter-specific non-Bt hybrid, DCH-32 were sown under unprotected rainfed conditions. Sowing was done on 27th June 2007 with a spacing of 90 cm between rows and 60 cm between plants by following all standard agronomical practices for hybrid cotton under rainfed conditions except plant protection measures for bollworms.

The plant protection measures for entire experimental setup were uniform against sucking pests. Before sowing the

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seeds were treated with Imidacloprid 70 WS @ 10.0 g /kg to check the incidence of sucking pests. Later on, one application of acetamiprid 20 SP @ 10 g ai/ha was given between 55-60 DAS to check the buildup of thrips and also to take care of trace incidence of leaf hoppers and aphids in both the plots based on ETL. There was absolutely no protection measures rendered against bollworms for any genotype with an aim to know the season long incidence and damage due to pink bollworm.

Each treatment was sown on an area of 8.0m x 6.0 m and separated by 1.5 m apart. Each plot was divided into three subplots to serve as replications. From each replication, five plants were selected randomly for recording observations. All the observations were made at weekly intervals avoiding boarder rows starting from 75 DAS till completion of all pickings of cotton.

The observation on rosette flowers due to pink bollworm infestation was made starting from 75 DAS and continued upto 130 DAS at weekly intervals. In each genotype, after initiation of flowering, total of number of flowers and number of rosette flowers per plant was counted and the per cent rosette flowers was worked out. Observations on the incidence of pink bollworm in unopened bolls were made at weekly intervals. For this purpose, 30 unopened bolls of three-week age, were plucked randomly from the subplots and brought to the laboratory for further observations. In laboratory, each green boll was cut opened along with ridges of the locules with help of sharp cutter carefully and counting the number of live PBW larvae in each boll was observed. Then total number of pink bollworm larvae per 30 bolls was worked out. During the observations on larval counts, the number of bolls damaged by pink bollworm was counted and expressed them in terms of per cent green boll damage. At the time of each cotton picking, 50 fully opened bolls were sampled randomly from each field, total number locules and damaged locules due to PBW larval infestation were counted and expressed in terms of per cent locule damage. All the observations were analyzed by 't' test after suitable transformation.

Results and discussion

The incidence of pink bollworm on cotton flowers began second week of September (37th standard week) and increased gradually reaching its peak during last week of October (43rd standard week). During the peak incidence period, the rosette flowers recorded in DBTHB-05 Bt and DCH-32 was 3.33 and 10.86 per cent, respectively. Later on the incidence of pink bollworm declined gradually with a minimum of 0.84 and 3.95 per cent rosette flowers in Bt and non-Bt cotton respectively (Table-1). The mean rosette flowers in Bt cotton was 1.69 per cent significantly less compared to non-Bt cotton which registered 6.24 per cent. The Bt cotton hybrid had a convincing effect on rosette flower damage due to pink bollworm, which resulted in reduction of rosette flower damage to an extent of 72.91 per cent over non-Bt.

The present findings on rosette flowers corroborate with the result of Suresh (2001) and Lavekar *et al.* (2004), who reported that, early in the season before bolls are available, the number of rosette flowers were 95 per cent lower in Bt cotton than non-Bt cotton. Rathod *et al.* (2003) and Nadaf and Basavanagoud (2006) also opined significantly lesser percentage of rosette flowers in Bt cotton compared to non-Bt cotton hybrid.

In Bt cotton (DBTHB-05 Bt), the pink bollworm larval incidence was noticed starting from November second week (45th standard week) (0.74 larvae/30 bolls) and it was minimum

Table 1. Per cent rosette flowers in Bt and non-Bt cotton hybrids

		Per cent rosette flowers	
Month	Standard Weeks	DBTHB-05 Bt	DCH-32
September	37	0.00	3.13
2007		(1.16)	(10.14)
	38	0.00	3.28
		(1.16)	(10.43)
October	39	0.94	3.73
2007		(5.56)	(11.09)
	40	1.51	5.55
		(7.06)	(13.56)
	41	2.05	6.10
		(8.23)	(14.29)
	42	2.38	8.16
		(8.87)	(16.59)
	43	3.33	10.86
		(10.51)	(19.23)
November	44	3.18	10.43
2007		(10.27)	(18.83)
	45	2.70	8.28
		(9.45)	(16.72)
	46	2.43	9.10
		(8.96)	(17.55)
	47	1.94	6.07
		(8.00)	(14.26)
December	48	1.78	5.57
2007		(7.66)	(13.65)
	49	1.21	4.86
		(6.31)	(12.73)
	50	1.05	4.66
		(5.88)	(12.46)
	51	0.84	3.95
		(5.26)	(11.46)
Seasonal Mean		1.69	6.24
		(6.80)	(14.20)
't' value		7.10	
% reduction over non-Bt		72.91	

Table t value at 16 df – 2.048

Figures in parenthesis are arc sine transformed values

upto December second week (49th standard week) and later on the larval population increased gradually with a peak of 10.87 larvae per 30 green bolls during January last week (4th standard week). Whereas, in non-Bt cotton (DCH-32), a gradual increase in the larval population was noticed from October third week (42nd standard week) and reached its peak of 23.43 larvae/30 bolls during last week of January (4th standard week). The seasonal mean of pink bollworm larval population in bolls evidently indicated that Bt cotton registered significantly lower number of pink bollworm larvae (3.35larvae/30 bolls) compared to non-Bt cotton (10.03/30 bolls). In Bt cotton, about 66.60 per cent reduction in the larval population in bolls was observed over non Bt cotton hybrid. The reduction in the number of pink bollworm larvae in Bt cotton at the later stage compared to non Bt cotton may be due the presence of Bt toxin which causes the

Table 2. Population of pink bollworm larvae in Bt and non–Bt cotton hybrids

		No. PBW larvae /30 bolls	
Month	Standard Weeks	DBTHB-05 Bt	DCH-32
October	42	0.00	1.93
2007		(0.71)	(1.56)
	43	0.00	2.57
		(0.71)	(1.75)
November	44	0.00	3.84
2007		(0.71)	(2.08)
	45	0.74	4.12
		(1.20)	(2.15)
	46	0.94	4.78
		(1.28)	(2.30)
	47	1.40	4.92
		(1.38)	(2.33)
December	48	1.64	5.88
2007		(1.46)	(2.53)
	49	1.72	6.65
		(1.49)	(2.67)
	50	2.48	8.53
		(1.73)	(3.00)
	51	2.90	8.84
		(1.84)	(3.06)
	52	3.19	10.74
		(1.92)	(3.35)
January	1	4.74	12.22
2008		(2.29)	(3.57)
	2	4.96	13.94
		(2.34)	(3.80)
	3	6.12	16.84
		(2.57)	(4.16)
	4	10.87	23.43
		(3.37)	(4.89)
February	5	8.28	21.58
2008		(2.96)	(4.70)
	6	6.98	19.76
		(2.73)	(4.50)
Seasonal Mean		3.35	10.03
		(1.80)	(3.08)
't' value		3.99	
% reduction over non-Bt		66.60	

Table t value at 16 df – 2.036

Figures in parenthesis are $\sqrt{x + 0.5}$ transformed values

Table 3. Per cent green boll damage due to pink bollworm larvae in Bt and non-Bt cotton

		Per cent green boll damage	
Month	Standard weeks	DBTHB-05 Bt	DCH-32
October	42	0.00	2.88
2007		(2.81)	(9.77)
	43	0.00	5.32
		(4.51)	(13.30)
November	44	0.00	7.28
2007		(6.84)	(15.65)
	45	1.92	10.17
		(9.84)	(18.59)
	46	4.13	14.07
		(11.72)	(22.02)
	47	4.52	15.10
		(12.27)	(22.86)
December	48	6.31	19.65
2007		(14.54)	(26.27)
	49	7.71	22.58
		(16.11)	(28.36)
	50	9.8	24.52
		(18.24)	(29.67)
	51	10.11	26.61
		(18.53)	(31.04)
	52	12.35	30.85
		(20.57)	(33.73)
January	1	12.94	33.20
2008		(21.07)	(35.17)
	2	13.83	36.17
		(21.82)	(36.96)
	3	15.12	40.00
		(22.87)	(39.22)
	4	20.88	43.50
		(27.18)	(41.25)
February	5	18.42	37.08
2008		(25.41)	(37.50)
	6	16.24	32.10
		(23.76)	(34.50)
Seasonal Mean		9.08	23.59
		(15.42)	(27.99)
't' value		3.96	
% reduction over non-Bt		61.50	

Table t value at 16 df – 2.036

Figures in parenthesis with arc sine transformed values

higher mortality of the PBW neonate larvae which agrees with the findings of Henneberry *et al*. (2000).

The present findings are in agreement with Lavekar *et al*. (2004) who reported extremely low larval population of pink bollworm in Bt cotton throughout the cropping season. Similarly, Venkateshalu (2005), Nadaf and Basavangoud (2006) also opined that, lower number of pink bollworm larvae was observed in Bt cotton compared to its non-Bt counterpart.

The average mean green boll damage of 9.08 per cent was registered in Bt cotton as compared to 23.59 per cent in non-Bt cotton. Lower green boll damage of 1.7 per cent in Bt cotton compared to 10.5 per cent in non Bt cotton by pink bollworm was reported by Henneberry and Jech (2000) and Nava *et al*. (1999) which agrees with the present findings.

Table 4. Per cent locule damage due to pink bollworm larvae in Bt and non-Bt Cotton

Month	Per cent locule damage	
2008	DBTHB-05 Bt	DCH-32
January -I	7.14	17.86
	(15.49)	(24.99)
January -III	9.44	20.92
	(17.89)	(27.21)
February-I	11.38	24.44
	(19.71)	(29.62)
February-III	13.52	26.2
	(21.56)	(30.78)
March -I	8.54	18.20
	(16.67)	(25.49)
Seasonal Mean	9.94	20.18
	(18.27)	(26.63)
	't' value	6.88
	% reduction over non-Bt	50.74

Table t value – 2.30

Figures in parenthesis with arc sine transformed values

However, during peak boll development period (up to December) 12.35 and 30.85 per cent green boll damage was registered in Bt and non Bt cotton, respectively. Up to 61.50 per cent reduction in boll damage was observed in Bt cotton over non Bt cotton during the peak boll development period. Whereas, irrespective of Bt and non Bt, higher green boll damage was recorded during the month of January. Higher green boll damage was observed during the month of January may be attributed to higher larval population owing to reduction in the expression of Cry protein.

The present findings are in close agreement with the findings of Suresh (2001), who reported lower green boll damage during initial boll developmental period and later on it increased with the advancement of cropping season in non Bt cotton. Similarly, Surulivelu *et al.*, (2004) and Nadaf and Basavangoud (2006) also opined that during peak boll development period, 13.7 and 44.06 per cent green boll damage was registered in Bt and non Bt cotton, respectively.

The locule damage varied from 7.14 to 13.52 per cent in Bt cotton and 17.86 to 26.20 per cent in non-Bt cotton during the cropping period. Irrespective of Bt and non-Bt cotton hybrids significantly higher per cent of locule damage was recorded during the month of February. The mean per cent locule damage of 9.94 per cent was registered in Bt cotton compared to 20.18 per cent in non Bt cotton. The lower locule damage in Bt cotton may be due to the efficacy of Cry protien against pink bollworm. However, the per cent locule damage during the later part of the cropping season (February) was found to be quite decreased in high in both Bt as well as non-Bt cotton which could be Cry 1Ac protein expressed with the advancement of the cropping season.

These findings are in agreement with the reports of Kengegowda (2003), Udikeri *et al*. (2003) and Surulivelu *et al*. (2004) who recorded significantly less locule damage in Bt cotton hybrids over non Bt cotton hybrid.

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