Performance of Bt cotton and non Bt cotton hybrids against pest complex under unprotected conditions

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ABSTRACT

A field trial was conducted at Regional Agricultural Research Station, Lam, Guntur during 2002-03 to evaluate first generation Bt hybrids released in India for reaction to pest complex of cotton under unprotected conditions. The results revealed that transgenic Bt cotton does not afford any protection to sucking pests of cotton and their tolerance or resistance is mainly dependent on the morphological or genetic base. *Helicoverpa armiger*a incidence was completely absent in RCH 144 Bt as no square damage was recorded followed by lower incidence in RCH 2 Bt(3.3%) and RCH 20 Bt(5.95%). Where as non Bt versions of RCH 2(7.53%), RCH 20(11.95%) and RCH 144(9.0%) recorded higher damage and significantly differed from their respective Bt counter parts. Pink bollworm per cent green boll damage was also lowest in Bt cotton hybrids compared to their non Bt versions.

Key words : Bt cotton, sucking pests, bollworms, Cry1Ac.

INTRODUCTION

Cotton is an important commercial crop in India playing a major role in agricultural economy. Before introduction of transgenic Bt cotton, farmers of Andhra Pradesh witnessed instability in cotton production due to frequent crop failures because of outbreaks of insect pests. Among the pests problems, bollworms especially American Bollworm, *Helicoverpa armigera* and Pink bollworm *Pectinophora gossypiella* cause considerable damage to the cotton crop. *Helicoverpa* alone cause significant losses to the tune of Rs.1000 crores in the country annually warranting insecticides applications which many a times exceeds 20 sprays especially in epidemic years. The excessive and indiscriminate use of insecticides in cotton ecosystem has led to development of resistance to insecticides in *Helicoverpa* ,resurgence of minor pests and elimination of natural enemies leading to control failures with insecticides. In order to reduce dependence on chemical insecticides and resultant effect on non target organisms, tolls of biotechnology have been applied to develop cotton that can withstand certain problematic and insecticide resistant pests more efficiently. Transgenic Bt cotton is a new technology in plant protection that enables transgenic cotton plant to express a crystal (Cry) toxin called Cry1Ac,originally derived from the soil bacterium *Bacillus thuringienesis* which is a natural enemy of bollworm pest and the endotoxins produced by bacteria have proved effective against lepidopteran insects. When the target pest oviposit on the transgenic plant the larvae hatching from such eggs feed and ingest Cry protein along with plant tissue.The protein acts immediately on the inner linings of digestive system and the young larvae cease feeding and die within 2 to 3 days. As the pest is killed in its early stage, any potential damage to crop is prevented. Transgenic Bt cotton containing Cry1Ac gene which offers resistance to major bollworms was first commercially released in the world in 1996 and during 2002 in India. In the present study the first generation transgenic Bt cotton which were commercialized in India were studied for their reaction to different pests of cotton.

MATERIALS AND METHODS

Field trial was conducted during 2002-03 to evaluate three Bt hybrids along with their non Bt hybrids in comparison with standards at Regional Agricultural Research Station, Lam, Guntur under rainfed conditions. The experiment with test hybrids *viz.*, RCH 2 Bt, RCH 20 Bt, RCH 144 Bt and their non Bt hybrids along with traditional cotton savitha and first commercially released Bt hybrid MECH 162Bt was laid out with eight treatments (each hybrid as a treatment) replicated thrice in a Randomised Block Design. The plot size of each hybrid was 36.0 sq.m which were sown at a spacing of 120 cm X 60 cm and all the agronomic practices such as fertilizer application and intercultural operations were similar in all the hybrids. All the test hybrids were raised under unprotected condition except one cover spray against sucking pests with imidacloprid at 70 DAS.

The incidence of sucking pests and bollworms were recorded at weekly interval from 25 randomly selected plants from each block. Sucking pests such as aphids, jassids (nymphs), thrips and whiteflies (both nymphs and adults) were recorded from three leaves, each one from top, middle and bottom canopies of the plant, while the American bollworm per cent square damage was recorded from whole plant. The incidence of pink bollworm larvae was observed through destructive sampling of 20 randomly collected green bolls from each treatment and per cent damage in green bolls were recorded. Thus, the data obtained was subjected to statistical analysis after applying suitable transformations.

RESULTS AND DISCUSSION

Transgenic Bt cotton hybrids along with their non Bt versions were evaluated against pest complex of cotton in comparison with traditional cotton Savitha and first introduced Bt cotton in India MECH 162 Bt cotton under unprotected conditions. The incidence of aphids ranged from 3.2 to 55.7 no./15leaves among different hybrids. RCH 2, RCH 20 Bt and their non Bt versions recorded lowest aphid incidence which are statistically on par and superior to rest of the hybrids. RCH144 Bt and MECH 162 Bt cotton hybrid recorded higher incidence of aphids indicating their susceptibility to aphids. The other major sucking pest infesting cotton, jassid ranged from 11.3 to 38.9 no./ 15leaves among the hybrids evaluated. RCH 144Bt and its conterpart non Bt hybrid showed resistance against jassids by recording lower population and remained statistically on par with Savitha and MECH 162 Bt hybrids. However, RCH 2, RCH 20 Bt and their non Bt cotton hybrids are highly susceptible to jassids recording higher population in the range of 28.5 to 38.9 no./15leaves. Regarding thrips RCH 2, RCH 20 Bt hybrids and their non Bt versions showed tolerance, whereas other hybrids under evaluation are susceptible. The incidence of other sucking pest whitefly which occurs in the later stages of the crop growth was very low ranging from 1.7 to 5.3 no/ 15leaves. All the hybrids exhibited almost similar reaction to whitefly and are statistically on par with each other based on population level except MECH 162 Bt hybrid which recorded slightly higher population(Table.1). In similar type of study Vennila *et al*. (2004) reported that RCH 134 Bt showed tolerance to jassids and whiteflies and RCH 138 Bt to thrips and whiteflies, while RCH 144 Bt showed susceptibility to jassids, thrips and whiteflies.

The results revealed that transgenic Bt cotton does not afford any protection to sucking pests of cotton and their relative tolerance or resistance is mainly dependent on the morphological or genetic base which is in accordance with Reed *et al*. (2000) and Bambawale *et al*. (2004) who reported that the incidence of sucking pests was more or less similar in both Bt and non Bt hybrids. However, the present results contradict with findings of Radhika *et al*., 2004; Abro *et al*., 2004; Cui and Xia, 2000 ,who reported that the incidence of sucking pests was high in Bt hybrids than their non Bt counterparts.

Among the Bt hybrids evaluated American bollworm, *Helicoverpa armiger*a incidence was completely absent in RCH 144 Bt, as no square damage was recorded followed by lower incidence in RCH 2 Bt(3.3%) and RCH 20 Bt(5.95%) with no significant difference among them. However, non Bt versions of RCH 2(7.53%), RCH

Table 1. Incidence of sucking pests (no./15 leaves) on Bt and non Bt cotton hybrids under unprotected condition

Hybirds	Aphids	Jassids	Thrips	Whitefly
RCH 2 Bt	4.0 (2.22)	30(5.71)	65.5(8.12)	2.3(1.79)
RCH 2 N Bt	3.2(2.04)	38.9(6.59)	45.35(6.74)	2.3(1.71)
RCH 20 Bt	4.36(2.30)	30.9(5.73)	71.85(8.51)	3.7(2.13)
RCH 20 N Bt	9.13(3.16)	28.5(5.02)	64.3(8.05)	1.7(1.62)
RCH 144 Bt	42.3(6.57)	15.2(4.39)	95.5(9.78)	3.3(2.03)
RCH 144 N Bt	55.7(7.47)	17.8(4.11)	148(12.20)	4.0(2.22)
Savitha	17.9(4.30)	11.3(3.48)	178.3(13.368	4.0(2.17)
MECH 162 Bt	29.4(5.50)	12.6(3.84)	149.9(12.25)	5.3(2.48)
CD	1.08	1.29	1.11	0.621
CV%	14.7	15.2	6.4	17.57

Figures in parentheses are arc sin transformed values

Table 2. Incidence of *Helicoverpa* and pink bollworm on Bt and non Bt cotton hybrids under unprotected condition

Hybrids	Mean per cent square damage of *Helicoverpa*	Per cent green boll damage of pink bollworm at 140 DAS
RCH 2 Bt	3.30(10.23)	6.70(14.88)
RCH 2 N Bt	7.53(15.86)	18.3(25.09)
RCH 20 Bt	5.95(14.08)	6.90(15.13)
RCH 20 N Bt	11.95(20.21)	24.7(29.75)
RCH 144 Bt	0.00(0.00)	10.00(18.34)
RCH 144 N Bt	9.00(17.21)	23.30(28.83)
MECH 162 Bt	8.88(17.20)	8.50(16.18)
Savitha	13.5(21.34)	19.50(26.18)
CD	4.89	4.74
CV%	19.20	12.40

Figures in parentheses are arc sin transformed values

20(11.95%) and RCH 144(9.0%) recorded higher damage and significantly differed from their respective Bt counter parts. Highest square damage was recorded in traditional cotton savitha (13.5%) (Table.2.)The results clearly indicate that transgenic Bt cotton is highly effective against the most problematic pest in cotton which has developed many fold resistance to chemical insecticides. The present findings are in conformity with Krishna murthy and Subramanian (2004)who reported that fruiting body damage was very low in MECH 12,162 and 184 Bt hybrids over the respective non Bt counter parts and Bhatade *et al.,* (2006) findings of 89% reduction in square damage in Bt cotton over their non Bt hybrids due to *Helicoverpa*. The inbuilt resistance of transgenic Bt cotton to *Helicoverpa* was proved by many researchers by reporting very low larval population, low square and boll damage in Bt cotton hybrids than their non Bt counter parts and conventional cotton (Cui and Xia, 2000; Kranthi, 2002;Gore *et al*., 2003; Vennila *et al*., 2004).

Transgenic Bt cotton hybrids also offered protection against pink bollworm which is a late season pest in cotton. RCH 2 Bt(6.7%), RCH 20 Bt (6.9%), RCH 144 Bt (10.0%) and MECH 162 Bt(8.5%) recorded lowest percent green boll damage and statistically on par with each other and superior compared to other non Bt hybrids in the experiment in which boll damage ranged from 18.3 to 34.7%.The results are in accordance with findings of Hugar *et al*.(2006) who reported that fruiting damage to pink bollworm was 3.2% in RCH 2Bt as against 18.72% in NCH 145 non Btcotton, Pink bollworm is not visible on the plant and completes most of the life cycle in the un open boll itself and the damage in the form of stained and discoloured kapas is seen only after bursting of the boll. Since the damage is not visible before boll opening it is very difficult to time the application of insecticides for taking control measures. Transgenic Bt cotton with Cry1 Ac toxin can able to control pink bollworm, as toxins are expressed in the plant parts itself and mostly prevents insecticide application and problems of decision making for control options.The resistance of Bt hybrids against pink bollworm was proved earlier by many scientists which are in accordance with the present results (Gianessi and Carpenter (1999); Henneberry and Jech (2000)).

From the present findings it can be concluded that Bt cotton cannot control sucking pests of cotton and there is no difference in sucking pests incidence in Bt and non Bt versions of the same hybrid. The major bollworms *Helicoverpa armiger*a and *Pectinophora gossypiella* are effectively controlled in Bt cotton hybrids. Transgenic Bt cotton can play a major role in combating pest problem thereby reducing insecticide uasage on cotton ecosystem and helps to maintain eco balance by conserving natural enemies.

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