International Scholars Journals

African Journal of Virology Research ISSN 3421-7347 Vol. 9 (4), pp. 001-004, April, 2015. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Evaluation for the retention of reproductive structures by Bt and non-Bt intra *hirsutum* cotton hybrids in different sowing dates and spacings

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Accepted 09 January, 2015

The retention of the reproductive structures (bolls) was evaluated at 90,120 and 160 days of maturity in eight Bt and non-Bt hybrids from three Private R&D establishments on three dates of sowings (90,120 and 160 days of maturity) and two spacings of 67.5 x 60 cm and 100 x 30 cm. Ankur group Bt hybrids; 651, 2226 and 2534 had reproductive structures retentivity higher than their non-Bt counterpart hybrids in all the three sowings and spacings. However, RCH group Bt hybrids; 134 and 138 had lesser/comparable boll retentivity in first two observations at 90 and 120 days in the earliest and the next sowing. In the last sowing with wider inter row spacing their trend was similar to Ankur group hybrids in the first sowing. MRC 6301 also behaved like RCH group hybrids. Bt hybrids of all the three establishments had more reproductive structure retentivity than their non-Bt hybrids counterparts in early, closer inter row and wider intra row sowing except for Bt hybrid RCH134 which had the highest bearing in the late sowing with wider inter row and closer intra row spacing. Association study indicated similar trend of boll bearing in Bt and non-Bt hybrids in early sowing and this trend seems to be reverse in later sowings.

Key words: Bt hybrids, *Gossypium hirsutum* non-Bt hybrids, reproductive structure, spacings.

INTRODUCTION

Adoption of transgenic cottons has resulted in both direct benefits, such as reduced pesticide use, improved crop management effectiveness, reduced production costs, improved yields as well as indirect benefits, such as improved populations of beneficial insects and wildlife in cotton fields, reduced pesticide runoff and reduction in labour costs and time. However, gene transfer into cotton remains inefficient because of the problems inherent to the current cotton transformation systems. In addition, consumer concerns over the ecological impact of transgenic crops and the safety of transgenic products are some of the challenges facing cotton biotechnology (Sakhanokho and Chee, 2002).

In India, Bt cotton was earlier approved for use only in those states where commercial cotton hybrids are approved, and that does not included the Northern State. Yields are higher in Northern State due to irrigation and better management practices, but hybrids have not been grown on a significant amount of area. Farmers in Punjab, Haryana and Rajasthan that forms the North Cotton Zone were impressed from the performance of Bt. hybrids other regions. In 2005, the Genetic Engineering Approval Committee permitted the commercial cultivation of six Bt hybrids; RCH-134 and 137, Ankur 651 and 2534, and MRC 6301 and 6304 for North Zone States.

Zeng et al. (1999) conducted growth studies on 2 Bt transgeneic cotton (*Gossypium* varieties and 3 conven-tional varieties). In comparison with conventional mate-rials, the Bt transgenic varieties showed slower daily increase in plant height and production of leaves on the main stem. Peak squaring, blooming and boll setting dates were earlier and boll retention was higher than in conventional varieties. Jutsi et al. (1999) reported that there were significant differences between retention at different plant densities at 80, 100 and 130 days after emergence; although it was difficult to draw a general conclusion. Zhao et al. (2002) compared the biological characteristics of Bt transgenic cotton varieties with those of conventional cotton. Bt transgenic cotton has a drawback of slow emergence, but its first true leaf appears early.

It has good fruit prolificacy at stage of early growth. Boll retention is early and concentrated. The accumulation of dry matter in individual plant is lower than that of conventional cotton, but the accumulation rate is high, with a high economic coefficient. Nowadays the boll size of Bt transgenic cotton is the factor restricting cotton yield. Rational agronomic measures such as water and fertilizer control and proper density may be adopted to improve the cotton yield. Keeping in view the earlier work on the above, studies on retention of reproductive structures by Bt and non- Bt hybrids of *G. hirsutum* cotton of three private R & D establishments was undertaken in three sowing dates with different plant densities.

MATERIAL AND METHODS

In the breeding evaluation trial of Bt cotton hybrids under Indian Council of Agricultural (ICAR) Research programme, eight Bt hybrids from three private R & D establishments (Ankur Seeds, Monsanto [India] and Rasi Seeds Ltd), Ankur-651, RCH-134, MRC-6301, Ankur-2226, RCH-138, Ankur-2534, MRC-6304, RCH-317 and corresponding non-Bt hybrids were sown in randomized block design with three replications in the *Kharif* 2003-04 crop season on 08.05.03. The row to row and plant to plant distance was kept 67.50 x 60 cm. Six rows per entry were sown each of 6 m length.

Second and third sowings of these hybrids were done on 17.05.03 and 06.06.03 with row to row and plant to plant spacing of 100 x 30 cm in an unreplicated trial of two rows each of 6 m length. To control spotted bollworms, economic threshold based spray of quinalphos at 800 ml/l in the entries of Ankur -2226Bt, Ankur-2534 Bt, MRC-6304 non-Bt, Ankur- 2534 non-Bt and Ankur -651 non-Bt on 28.8.03 and Methomyl at 250 g/acre in the entries of MRC-6301 Bt, MRC-6304 non-Bt, Ankur-2534 non-Bt and Ankur-651 non-Bt was done on 29.09.03. .Recommended fertilizer and spray schedule for sucking pests were applied. Observations were taken at 90, 120 and 160 (maturity) days on five competitive plants of each hybrid in each replication for reproductive structures (number of bolls) per plant in replicated trial and on 15 plants in the two un replicated trials. Mean data were analyzed statistically for calculation of components of variability and rank correlations following Singh and Chaudhary (1985).

RESULTS AND DISCUSSION

In the first early plant to plant wider closer inter row sowing, Ankur hybrids 651, 2226 and 2534 retained 16.3, 19.8 and 19.1 bolls which was 24..0, 30.0 and 29.1 percent of the total bolls borne by these respective hybrids. Corresponding non-Bt hybrids had reproductive structures; 18.2, 15.2 and 16.6 which was 31.2, 28.6 and 33.6 per cent of total bolls of their respective hybrids. Observation indicated that total boll bearing in non-Bt hybrids was slightly less than corresponding Bt hybrids on 90 days after sowing, but the % bearing was higher in non-Bt hybrids. On the same date of sowing for 90 days, RCH Bt hybrids, 134 and 138 had nil or very little boll bearing though 317 had some bearing and was slightly earlier than other two hybrids of the group. Corresponding non-Bt hybrids also showed the same trend. MRC Bt and non-Bt hybrids also had lesser bearing than Ankur Bt and non- Bt hybrids, but were slightly earlier in boll bearing than RCH hybrids. MRC Bt hybrids 6301 (5.2%) and 6304 (1.1%) had less total boll bearing in comparison with their counterparts.

At 120 days of sowing of the three Ankur group Bt hybrids; 2226 (93.1%) had the highest per cent of total boll bearing. The other two hybrids also had more than 75% of total boll bearing. The trend was same for corresponding non-Bt hybrids and was more than 75%. None of the three non-Bt Ankur hybrids could exceed in boll bearing in comparison with their Bt counter part at this stage of plant growth (Zhen et al., 1999). All the three non- Bt RCH group hybrids had higher (65.3 to 77.8%) total boll retentivity and total number of boll per plant in comparison with their Bt counterpart hybrids (48.9 to 65.3%). MRC Bt hybrid 6301 had comparable boll bearing at 120 days of sowing with its counterpart, but its comparative total boll bearing was quite less (Bt, 56.2% and non-Bt, 93.0%). For another MRC hybrid total boll bearing for Bt and Non-Bt hybrid was comparable. The results are shown in Tables 1, 2 and 3.

At 160 days of sowing (crop maturity), three Bt hybrids each of Ankur and RCH and two of MRC had boll rentivity higher than their corresponding non-Bt counter parts. In the 2nd sowing (of higher plant density) with wider inter row (100 cm) and closer (30 cm) intra row spacing, at 90 days of sowing, Ankur group hybrids (both Bt and non-Bt) again showed earliness in boll bearing and retained highest reproductive structures. Boll bearing % over the total boll number was comparable between the two kinds of hybrids of this group. Like in 1st sowing, RCH and MRC group hybrids were poor in boll bearing at this stage, and
% boll bearing over the total boll number ranged from 0.0 to 8.4% in Bt and 0.2 to 19.1 in non-Bt hybrids.

In the 3rd sowing which was late and with wider inter row (100 cm) and closer (30 cm) intra row spacing; at 90 days after sowing, all the hybrids of both the classes were without any boll or with very little number of bolls. At 120 and 160 days after sowings reproductive structure retentivity was lesser than first and second sowings (Jutsi et al., 1999) except for the Bt hybrid RCH134 which had higher bearing 203.1% and 113.4% in the late sown condition (Tables 1 and 3). Mayee et al. (2004) also reported superiority in bolls/plant by Bt hybrids. Significant positive association between Bt and non-Bt hybrids in the first sowing indicated that at any of the three stages of plant growth if Bt hybrids had more number of bolls per plant then its counterpart non-Bt hybrids also had more bolls and vice versa (Table1). But this relation tends to be reverse in later sowings.

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Table 1. Boll bearing of Bt and non-Bt hybrids in three sowings at different crop growth stage.

S/N	1st sowing			2nd sowing			3rd sowing		
	90 days	**120 days**	**160 days**	**90 days**	**120 days**	**160 days**	**90 days**	**120 days**	**160 days**
1.Ankur-651	16.33 (18.22)	51.22(45.78)	68.11(58.33)	11.85(12.5)	45.00(32.67)	44.67(37.67)	1.00(3.33)	32.50(11.00)	38.50(37.33)
2.RCH-134	0.00(0.22)	25.44(32.11)	48.22(46.89)	0.00(5.33)	27.00(29.00)	32.67(43.33)	0.00(0.00)	51.67(18.00)	54.67(27.67)
3.MRC6301	3.22(10.11)	34.67(37.11)	61.67(39.890	2.27(6.50)	36.67(32.67)	33.00(42.00)	0.00(0.00)	39.33(19.33)	53.33(38.3)
4.Ankur222	19.78(15.22)	61.67(46.78)	66.22(53.22)	14.00(12.00)	29.33(32.33)	38.33(39.33)	0.33(0.00)	28.67(2.67)	45.34(24.67)
5.RCH138	0.22(0.67)	25.89(27.88)	52.89(42.67)	0.20(0.50)	31.00(29.67)	35.00(45.67)	0.00(0.00)	46.67(15.00)	49.67(37.00)
6.Ankur-253	19.11(16.56)	51.11(42.55)	65.67(49.22)	14.50(12.50)	49.00(28.33)	59.33(41.00)	0.00(0.33)	32.00(15.00)	41.33(40.33)
7.MRC-6304	0.56(5.00)	35.22(26.890	52.33(41.00)	0.30(3.50)	31.00(31.00)	34.67(47.00)	0.00(0.00)	26.00(36.67)	26.00(38.44)
8.RCH-317	4.22(11.11)	39.44(42.11)	55.00(54.11)	3.80(9.00)	32.33(35.00)	35.67(47.00)	0.00(1.33)	36.00(31.00)	52.33(53.67)
Mean	7.93(9.64)	40.58(37.65)	58.76(48.17)	16.21(15.83)	33.67(31.33)	39.17(42.88)	0.17(0.6)	36.61(18.58)	45.14(37.18)
Range	0.00to19.11 (0.22to18.22)	25.44to51.2 (27.9to45.8)	48.22to68.11 (39.9to58.3)	0.00to14.5 (0.10to12.5)	27.00to49.00 (28.33to35.00)	32.67to59.33 (37.67to47.00)	0.00to1.00 (0.00to3.33)	26.00to51.67 (2.67to36.67)	26.00to54.67 (27.67to53.67)
SD	8.85(7.03)	12.98(7.88)	7.56(6.73)	12.20(7.76)	9.00(2.24)	9.00(3.50)	0.36(1.19)	8.86(10.81)	9.67(8.71)
CD at 5%	9.00(8.02)	10.90(8.50)	8.32(7.85)	10.57(8.43)	9.08(4.80)	9.08(5.66)	1.87(3.29)	9.0099.95)	9.14(8.93)
Rank correlation of Bt with non Bt hybrids	0.90**	0.88**	0.57*	0.98**	0.12	-0.62*	-	-0.06	-0.19

In parenthesis are given values for non-Bt cotton.
*and ** indicate significant at 5% and 1%, respectively.

Table 2. Boll bearing (%) over total bolls of Bt and non-Bt hybrids in three sowings.

S.No.	1st sowing		2nd sowing		3rd sowing	
	90 days	120days	90 days	120days	90 days	120days
1.Ankur-651	24.0(31.2)	75.2(78.5)	26.4(33.2)	89.5(86.7)	2.6.(8.9)	84.4(29.5)
2.RCH-134	0.0(0.5)	52.8(68.5)	0.0(0.2)	82.6(66.9)	0.0(0.0)	94.5(65.1)
3.MRC6301	5.2(25.3)	56.2(93.0)	7.0(15.5)	89.9(77.8)	0.7(0.0)	73.7(50.5)
4.Ankur2226	29.9(28.6)	93.1(87.9)	36.5(30.5)	76.5(82.2)	0.0(0.0)	63.2(10.8)
5.RCH138	0.5(1.7)	48.9(65.3)	0.6(1.4)	88.6(64.9)	0.0(0.8)	94.0(40.5)
6.Ankur-2534	29.1(33.6)	77.8(86.4)	24.4(8.5)	82.6(69.1)	0.0(0.0)	77.4(37.2)
7.MRC-6304	1.07(12.2)	67.3(65.6)	0.90(7.4)	89.4(65.9)	9.6(17.7)	100.0(95.4)
8.RCH-317	7.7(20.53)	71.7(77.8)	8.4(19.1)	90.6(74.5)	0.0(2.5)	68.8(57.8)
Mean	12.2(19.2)	67.9(77.9)	13.0(14.5)	86.2(79.9)	0.41(1.5)	82.0(48.3)
Range	0.0to24.0 (0.5to33.6)	48.9to93.1 (65.3to93.0)	0.0to36.5 (0.2to33.2)	76.5to90.6 (66.9to86.7)	0.0to2.6 (0.0to8.9)	63.2to94.5 (10.8to95.4)
SD	13.2(13.0)	14.8(10.7)	14.1(12.5)	5.1(9.3)	0.9(3.1)	13.3(25.5)
CD at 5%	11.0(10.9)	11.6(9.9)	11.4(9.2)	6.8(9.2)	2.9(5.3)	11.1(15.3)

In parenthesis are given values for non-Bt cotton.

Table 3. Increase (%) over first sowing for boll bearing over total bolls of Bt and non-Bt hybrids in three sowings.

S/N	2nd sowing			3rd sowing		
	90 days	120 days	160 days	90 days	120 days	160 days
1.Ankur-651	72.2(68.7)	87.8(71.4)	75.2(78.5)	6.1(31.2)	63.5(24.0)	56.5(64.0)
2.RCH-134	0.0(50.0)	106.1(90.3)	52.8(68.5)	0.0(0.5)	203.4(56.1)	113.4(59.0)
3.MRC6301	71.4(64.3)	85.6(88.0)	56.2(93.0)	5.2(25.3)	113.4(52.1)	86.5(96.0)
4.Ankur2226	70.7(78.8)	47.6(69.1)	93.1(87.9)	29.9(28.6)	46.5(5.7)	68.5(46.4.)
5.RCH138	71.1(74.6)	119.7(106.4)	48.9(65.3)	0.5(1.7)	180.3(53.8)	93.9(86.7)
6.Ankur-2534	75.8(75.3)	95.9(66.6)	77.8(86.4)	29.1(33.6)	62.6(35.2)	62.9(81.9)
7.MRC-6304	53.6(70.0)	88.0(115.3)	67.3(65.6)	1.07(12.2)	73.8(136.4)	46.7(93.8)
8.RCH-317	90.6(81.1)	82.0(83.1)	71.7(77.8)	7.7(20.53)	91.3(73.6)	95.1(99.2)
Mean	65.5(70.4)	89.1(86.3)	66.5.0(87.5)	9.7(4.0)	104.3(54.6)	78.3(78.4)
Range	0.0to91.0 (50to81.1)	47.6to119.7 (69.1to115.2)	53.5to90.3 (64.6to107.0)	0.0to71.7 (0.0to12.0)	46.5to203.1 (5.7to136.4)	49.7to113.4 (46.3to99.2)
SD	29.0(9.9)	29.9(17.7)	10.8(14.4)	25.1(7.1)	57.9(39.2)	22.2(19.5)
CD at 5%	16.3(9.5)	13.8(12.7)	10.0(11.5)	15.2(8.1)	23.0(18.9)	14.3(13.4)

In parenthesis are given values for non-Bt cotton.

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