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SHORT COMMUNICATION

EFFECT OF SQUARE REMOVAL ON GROWTH, YIELD AND FIBRE QUALITY OF TRANSGENIC Bt COTTON HYBRIDS

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A plant type with a good morphoframe would sustain more boll load with synchronous boll development and boll burst. In Bt cotton the plant morphoframe doesn't develop fully due to retention of early formed squares. Thus an attempt was made to improve Bt plant morphoframe by removing the early formed squares. Twenty treatments, consisting of five cotton hybrids *viz.* RCH 2 Bt, JKCH 99 Bt, NCEH 2R Bt, Mallika Bt and non Bt G. Cot Hy10, two concentration of ethylene (*i.e.* 30 and 45 ppm at square initiation), one time hand removal of squares besides untreated control was tested in factorial randomised block design with three replications. The results indicated that all Bt and non Bt hybrids, following spray of 45 ppm ethylene attained significant increase in plant height, number of fruiting forms, number of sympodia, boll weight, seed cotton yield and biomass. Mechanical square removal was also found to be effective and at par with ethylene treatments for many of parameters. The fibre quality parameters, uniformity ratio and maturity coefficient reduced marginally with square removal treatments, yet it met specified norms of fibre quality. Thus, the application of 45 ppm ethylene as a square removal treatment or mechanical square removal treatment significantly improved growth and yield of Bt cotton.

***Keywords*: Cotton, ethylene, fibre quality, square removal**

Cotton is major fibre crop of global importance. It belongs to the genus *Gossypium* under tribe *Gossypiceae* of Malvaceae family. India occupies the largest area (94.06 lakh ha) with total production of 290 lakh bales. It ranks second in production of seed cotton, but the production per unit area is low as compared to other countries. Gujarat is one of the main cotton producing states in the country, ranking second in area (2.6 M ha) and first in production (110 lakh bales) and productivity (743 kg ha^{-1}) (Anonymous, 2007-08).

About 65% cotton cultivation in India is under rain fed condition. Cotton suffers from various biotic and abiotic stresses right from germination to maturity. The growth during the seedling establishment phase has a role to play in yield realisation. A good plant frame would provide sufficient space for holding and catering the needs of the reproductive parts during the later part of growth. Under Indian conditions, the initial crop growth experiences water logging followed by attack from sucking pests. Both these stresses cause considerable damage to the plant leading to stunted growth and as a consequence reduced boll load. Relatively little is known about hormonal control of cutout, but based on established effects of the hormones, it is speculated that auxin, cytokinins and gibberellins promote growth and delay cutour. Abscisic acid, promotes cutout as it inhibits growth and prolongs bud dormancy. Ethylene increases

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Table 1. Effect of square removal (mechanical and chemical) on leaf area index, plant height and total number of fruiting forms per plant in Bt and non Bt hybrids of cotton

	Leaf area index			Plant height (cm)			Total number of fruiting forms plant^{-1}		
	50 DAS	80 DAS	110 DAS	50 DAS	80 DAS	110 DAS	50 DAS	80 DAS	110 DAS
A. Variety (V)									
RCH 2 Bt	0.40	0.76	1.13	28.5	67.2	85.7	14.2	34.2	113
JKCH 99 Bt	0.40	0.76	1.21	29.4	71.8	88.6	15.1	36.2	140
NCEH 2R Bt	0.33	0.68	0.93	28.1	75.8	88.1	12.3	30.5	105
Mallika Bt	0.30	0.60	0.93	27.4	64.9	80.3	12.4	33.3	102
G.Cot Hy 10	0.35	0.70	1.08	27.3	69.5	98.5	12.6	15.3	85.3
S.E.±	0.012	0.017	0.036	0.95	1.82	2.92	0.74	1.84	4.21
C.D. at 5%	0.035	0.051	0.10	NS	5.2	8.4	2.1	5.2	12.1
B. Treatments (T)									
Control	0.33	0.66	1.03	26.6	66.1	81.8	12.3	28.2	91.9
30 ppm ethylene	0.36	0.68	1.05	27.7	71.8	89.4	14.1	31.2	116
45 ppm ethylene	0.38	0.73	1.15	29.4	69.2	92.0	14.5	33.6	120
Mechanical removal of squares	0.36	0.71	1.13	28.8	72.4	89.7	12.4	26.4	109
S.E.±	0.011	0.015	0.032	0.85	1.63	2.62	0.66	1.64	3.77
C.D. at 5%	NS	0.045	0.094	NS	4.6	7.5	NS	4.7	10.8
C. Interaction (V x T)									
S.E.±	0.024	0.035	0.073	1.9	3.64	5.85	1.49	3.70	8.43
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V.%	11.99	8.80	11.62	11.6	9.02	11.5	19.33	21.3	13.3

boll abscission and may restrict growth, but may not induce dormancy. Various growth regulators have been applied in cotton in order to improve boll setting, limit vegetative growth or terminate fruiting. Any attempt to improve the boll set through hormonal balance under carbohydrate limitation may be futile, as it would lead to smaller boll size and premature death of plant. Therefore, any alteration either manual or chemical must ensure a good morphoframe that would sustain more boll load with synchronous boll development and boll burst. This will help in enhanced yield and effective harvesting in one or two picking. In Bt cotton, the plant morphoframe doesn't develop fully due to early switch over to reproductive phase. Therefore the objective of the present study was to evaluate the potential ethylene to alter the morphoframe and its effect on growth and yield of cotton plant.

A field experiment was carried out at the Main Cotton Research Station, Navsari Agricultural University, Surat during the *kharif* season of year 2008-09 (date of sowing 6 July, 2008) to the study effect of square removal on cotton growth, yield and fiber quality. Twenty treatments, consisting of five hybrids of cotton (*viz.* RCH 2 Bt, JKCH 99 Bt, NCEH 2R Bt, Mallika Bt and non Bt G. Cot Hy 10) and two concentration of ethylene (*i.e.* 30 and 45 ppm at square initiation) and one time hand removal of squares besides untreated control in factorial randomised block design with three replications. The experimental soil was fertilised with 10 t FYM ha^{-1} uniformly at the time of land preparation. The chemical fertilizer was applied @ 240:00:00 kg NPK ha^{-1} in the form of urea at 25 to 30 days interval starting from 20 DAS. All the necessary plant protection measures were taken as and when required for the

Table 2. Effect of square removal (mechanical and chemical) on number of sympodia per plant, boll weight (g), yield (kg/ha) and biomass (g/ plant) in Bt and non Bt hybrids of cotton

	Number of sympodia per plant				Boll weight	Yield	Biomass
	50 DAS	80 DAS	110 DAS	Harvest	(g)	(kg/ha)	(g/ plant)
A. Variety (V)							
RCH 2 Bt	11.1	15.1	17.1	23.2	3.69	1876	309.8
JKCH 99 Bt	13.4	15.8	17.2	23.2	3.68	2156	330.4
NCEH 2R Bt	11.8	15.3	16.2	22.2	3.58	1903	331.6
Mallika Bt	11.2	13.0	15.9	20.9	3.64	1845	332.3
G. Cot Hy 10	10.4	15.3	19.0	25.2	3.05	1445	222.2
S.E±	0.68	0.67	0.72	0.74	0.08	118	12.5
C.D. at 5%	1.95	1.92	2.08	2.12	0.25	339	35.8
B. Treatments (T)							
Control	10.6	13.2	15.9	21.8	3.34	1641	272.5
30 ppm Ethylene	11.4	15.0	16.9	22.8	3.54	1750	306.7
45 ppm Ethylene	13.0	16.2	18.7	24.5	3.64	2028	327.0
Mechanical removal of squares	11.2	15.3	16.8	22.5	3.59	1959	314.8
S.E.±	0.60	0.60	0.65	0.66	0.07	106	11.2
C.D. at 5%	NS	1.72	1.87	1.90	0.22	303	32.1
C. Interaction (V x T)							
S.E.±	1.36	1.34	1.46	1.49	0.17	237	25.1
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS
C.V.%	20.37	15.61	14.78	11.22	8.58	22.2	14.2

control of insect pests. In general, the field was free from any serious pest and disease. The data on leaf area index (LAI), plant height, number of sympodia, number of fruiting forms per plant were recorded at 50, 80 and 110 DAS, whereas boll weight and biomass were recorded at harvest from randomly selected five plants in each treatment. Cotton seed yield was recorded on the basis of plot area and the whole plot pertaining to the crop was picked three times in each treatment.

All Bt hybrids were superior to non Bt hybrid with respect to various growth yield and fibre quality parameters. Amongst the four Bt hybrids, JKCH 99 recorded the highest seed cotton yield because of more number of fruiting forms (*i.e.* squares, flowers and bolls), boll weight and biomass. Bt hybrid NCEH 2R Bt recorded significantly greater plant height at an early stage, while at later stage G. Cot Hy 10 attained maximum plant height than remaining hybrids. Due to limitation of sink, G. Cot Hy 10, partitioned its photosynthates to vegetative parts resulting in greater height. Hofs *et al*. (2006) and Hebbar *et al*. (2007) also reported greater plant height in non-Bt compared to Bt cotton. Sympodial branches were more in Bt hybrid JKCH 99 at early stage (*i.e.* at 50 and 80 DAS), while at later stage (at 110 DAS and at harvest) G. Cot Hy 10 recorded more branches. The greater height and node number at later stage might have contributed to more sympodia in G. Cot Hy 10. Fibres of all hybrids were long staple category (27.5-32.5 mm) with good maturity coefficient (0.81-0.90). However, uniformity ratio was excellent in JKCH 99 Bt, Mallika and G. Cot Hy 10, good in NCEH 2R Bt and average in RCH 2 Bt. In terms of fineness, RCH 2 Bt, NCEH 2R Bt and Mallika yielded fine fibre whereas it was average in JKCH 99 Bt and G. Cot Hy 10. All Bt hybrids were average in strength (21-24 g tax^{-1}) whereas non Bt G. Cot Hy 10 was good (25-28 g tax^{-1}). RCH 2 Bt and JKCH 99 Bt recorded high short fibre index as compared to others.

Table 3. Effect of square removal (mechanical and chemical) on fibre quality in Bt and non Bt hybrids of cotton

	Fibre quality parameters					
	2.5% Span length	**Uniformity ratio (%)**	**Maturity coefficient**	**Micronire (mv)**	**Fibre strength (g/tax)**	**SFI**
A. Variety (V)						
RCH 2 Bt	29.8	44.8	0.814	3.49	22.5	10.4
JKCH 99 Bt	27.8	48.7	0.839	4.48	22.0	10.2
NCEH 2R Bt	29.7	47.0	0.832	3.83	23.9	8.73
Mallika Bt	30.2	47.6	0.827	3.78	23.7	7.86
G. Cot Hy 10	29.5	48.2	0.849	4.33	25.0	8.18
S.E.±	0.33	0.44	0.003	0.09	0.34	0.42
C.D. at 5%	0.94	1.2	0.009	0.26	0.97	1.20
B. Treatments (T)						
Control	29.9	48.3	0.843	4.23	23.9	8.01
30 ppm Ethylene	29.3	46.9	0.832	3.97	23.5	9.32
45 ppm Ethylene	29.2	47.0	0.828	3.87	23.1	9.56
Mechanical removal of squares	29.2	46.9	0.827	3.87	23.2	9.38
S.E.±	0.29	0.39	0.003	0.08	0.30	0.37
C.D. at 5%	NS	1.1	0.008	0.23	NS	1.07
C. Interaction (V x T)						
S.E.±	0.65	0.87	0.006	0.18	0.67	0.84
C.D. at 5%	NS	NS	NS	NS	NS	NS
C.V.%	3.87	3.21	1.37	7.89	5.0	16.0

All square removal treatments showed increment in seed cotton yield over untreated control, which was basically because of more and bigger bolls. These, in turn, were affected by greater LAI and increase photosynthetic efficiency resulting in higher biomass as reported by Scott (1920), Abdel *et al.* (1987), Mehetre *et al.* (1993), Wankhade *et al.* (1994), Babu *et al.* (1995), Thakral *et al.* (1991), Bednarz and Roberts (2001) and Stewart *et al.* (2001). Ethylene @ 45 ppm resulted in significant increase in plant height, number of sympodia, number of fruiting forms, boll weight, yield and biomass than the remaining treatments. Square removal treatments had no significant bearing on span length as well as strength of the fibre. Interestingly, the fibres in control treatment were excellent whereas in square removal treatment they were good in uniformity ratio. This is amply indicated from maturity coefficient which declined due to square removal treatment, although all of them displayed good maturity. In contrast to uniformity ratio and maturity coefficient, the fineness of fibre improved due to square removal vis-à-vis control which was average in fineness. The short fibre index (SFI) increased due to square removal treatment which can be understood in light of the fact that the treatments had adverse effect on uniformity ratio, maturity coefficient and strength. It is probably because of more immature fibre that the micronaire was high in square removal treatment. Thakral *et al*. (1991), Pettigrew *et al*. (1992) and Tan-Qiling *et al*. (1995) have also reported similar results.

Thus, manipulation of Bt plant morphoframe through application of 45 ppm ethylene at square initiation or mechanical removal of squares significantly improved plant height, fruiting bodies, number of sympodia, boll weight, biomass and seed cotton yield. Maturity coefficient and uniformity ratio were reduced due to square removal which, in turn, improved fineness but

increased short fibre index. Despite all these differences in quality, the category of quality parameters, by and large, remained unaffected.

All Bt hybrids were superior to non Bt hybrid with respect to the number of fruiting bodies, biomass and yield. Amongst the four Bt hybrids JKCH 99 Bt was giving the highest yield duly substantiated by more number of fruiting forms.

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