



Study on effect of growth regulators on growth parameters and detopping in *Bt* cotton (*Gossypium hirsutum* L.) under rainfed condition

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ABSTRACT : A field experiment was conducted at Junagadh Agricultural University, Main Dry Farming Research Station, Targhadia (Rajkot) under fourth Saurashtra agro climatic zone of Gujarat during *kharif* 2012-2013 to 2015-2016. Nine treatment combinations were tried in randomized block design with three replications. The result revealed that growth parameters registered remarkably maximum values of root length (28.6 cm), (2.5) monopodia/plant, (13.9) sympodia/plant, (24.5) open bolls/plant at maturity and one open boll weight (5.9), of cotton were recorded under treatment of detopping at 75 DAS and spraying of Ethrel @ 50 ppm at 90 DAS (T_8) as compared to rest of treatments. Whereas, the maximum value of plant height (92.5 cm) was recorded with T_4 (Ethrel @ 50 ppm at 60 DAS).

Key words : *Bt* cotton, detopping, growth parameters, growth regulators

Cotton (*Gossypium hirsutum* L.) is an important fibre crop of global significance. Cotton is a major cash crop of our country which plays a key role in the national economy in terms of generation of direct and indirect employment in the Agricultural and Industrial sectors.

In India, cotton occupied about 122.38 lakh ha area under cultivation (2018-2019). Approximately 65 per cent of India's cotton is produced on dryland and 35 per cent on irrigated; the percentage of irrigated area is lower in the central zone (23 %) and south zone (40 %). The central zone (Maharashtra, Madhya Pradesh and Gujarat) contributes more than 68 per cent to the total production and is characterized by rampant proliferation of *Bt* cotton hybrids. Under the rainfed growing condition, rainfall ranges from >400 to <900 mm coupled with aberrant precipitation patterns over the years leading to large fluctuations in production. The cotton growers in Gujarat achieved cotton yield of 577 kg/ha during 2018-2019, which was higher than the national average of 501 kg/ha. Cotton is cultivated in 27.09 lakh ha in the state. Particularly in Saurashtra region, cotton is

cultivated in more than 15 lakh hectares. The consistent and perceptible increase in cotton production and productivity during the last 10 years is partially attributed to higher rate of adoption (more than 95 %) of *Bt* cotton in the Gujarat and Saurashtra.

The average production is very low particularly in dryland areas due to low and erratic distribution of rainfall in Saurashtra areas. Any increase or decrease in temperature may alter days required to initiate square, onset of flowering, boll opening and maturation. There is evidence that plant growth regulators could be used to partially counteract environmental stresses and improve crop productivity. Hallikeri *et al.*, (2010) reported that detopping, decrease plant height and number of sympodial branches/plant but has a non significant effect on boll weight and per cent lint. However, the increase in seed cotton yield by detopping over no detopping was reported by Shwetha *et al.*, (2009). Many attempts have been made to alter the growth habit of the crop for increase the productivity and to bring about some more amenability for cultural manipulations. Several

reports on ethylene and MH enhanced physiological reactions and a series of growth processes leading to greater main stem node and sympodial branches, squares, bolls and enhance seed cotton yield. These results are in conformity with earlier works of Nawalkar *et al.*, (2014), Kumari and George (2012). Keeping these facts in mind, the present investigation was carried out to characterize the growth and development of *Bt* cotton hybrids by detopping and use of plant growth retardants for improving cotton productivity.

MATERIALS AND METHODS

The field experiment was conducted at Junagadh Agricultural University, Main Dry Farming Research station, Targhadia, Gujarat during four consecutive *kharif* season of 2012-2013 to 2015-2016.

Total 9 treatment combinations under experiment *viz.*,

- T₁** – Control,
- T₂** - Detopping at 60 days after sowing (DAS),
- T₃** - Detopping at 75 days after sowing (DAS),
- T₄** - Foliar spray of ethrel @ 50ppm at 60 DAS,
- T₅** - Foliar spray of MH @ 30 ppm at 60 DAS,
- T₆** - Detopping at 60 DAS + foliar spray of ethrel @ 50ppm at 75 DAS,
- T₇** - Detopping at 60DAS + foliar spray of MH @ 30ppm at 75 DAS,
- T₈** - Detopping at 75 DAS + foliar spray of ethrel @50ppm at 90 DAS,
- T₉** -Detopping at 75 DAS + foliar spray of MH@ 30ppm at 90 DAS

Each replicate three times in randomized block design (RBD) with the plot size of (a) gross plot size: Gross : 4.2 × 3.6 m, (b) net plot size: 3.6 × 1.8 m. (C) Spacing 90 × 30 cm, (D) seed rate was 1.25 kg/ha (E) with the recommended dose of fertilizer : 80-0.0-0.0 NPK kg/ha.

The observations of: root length (cm), plant height (cm), monopodia/plant sympodia/plant open bolls/plant at maturity and open boll weight were recorded.

The data given in Table 1 revealed that the non significant results of root length of cotton (cm) were recorded during the period of 2012 to 2015. The maximum root length was recorded in treatment of T₃ (24.0) during period of 2012. It was followed by T₈ (23.3), T₂ (21.9), T₆ (21.7), T₄ and T₅ (20.6), T₉ (20.3), T₁ (20.2), and T₇ (13.1). In the year of 2013, the maximum root length was observed in T₈ (37.2) followed by T₆ (35.5), T₄ (33.5), T₃ (32.8), T₉ (32.5), T₅ (30.2), T₇ (30.0), T₂ (29.2), and T₁ (29.0). During the year of 2014, the maximum root length was observed in T₈ (23.7) followed by T₆ (22.3), T₄ (21.5), T₁ and T₃ (20.4), T₉ (20.3), T₇ (19.8), T₂ (19.5), and T₅ (19.3). Last observation of the year 2015, the maximum root length was observed in T₄ (31.4) followed by T₈ (30.2), T₆ (29.3), T₃ (28.4) T₉ (28.2), T₂ (27.1), T₇ (26.8), T₅ (26.3), T₁ (24.7), and T₅ (19.3).

The significantly maximum plant height was recorded in treatment of T₄ (64.2) during the period of 2012. It was *at par* with treatment of T₅ (62.6) and T₁ (61.4). The treatment of T₁ (61.4) was *at par* with treatment of T₈ (59.8). In the year of 2013, The maximum plant height was significantly observed in T₄ (108.4). It was statistically *at par* with treatment of T₅ (107.2). During the year of 2014, the significantly higher plant height was observed in treatment of T₅ (97.3) and this treatment was *at par* with treatment of T₄ (95.6), T₁ (93.6). Similarly, the year of 2015, the significantly higher plant height (cm) was observed in treatment of T₅ (102.6) and was *at par* with treatment of T₄ (101.9).

The significantly maximum of monopodia/plant during period of 2012 was recorded in treatment of T₃ (1.4). It was statistically *at par* with treatment of T₈ (1.3). Similarly, in the year of 2013, the significantly highest monopodia/plant was found in T₃ (3.0). It was followed by T₈ (2.7). During the year of 2014, the significantly lowest monopodia/plant was observed in treatment of T₁ (1.3), Whereas, Maximum monopodia/plant was recorded in treatment of T₈ (2.5). Period of the year of 2015,

RESULTS AND DISCUSSION**Table 1.** Effect of plant growth regulators and detopping on yield attributes in *Bt. cotton (Gossypium hirsutum L.)* under rainfed condition

Sr. No.	Treatment	2012	2013	2014	2015	Pooled
1.1	Root Length (cm)					
T ₁	Control	20.2	29.0	20.4	24.7	23.6
T ₂	Detopping at 60DAS	21.9	29.2	19.5	27.1	24.4
T ₃	Detopping at 75DAS	24.0	32.8	20.4	28.4	26.4
T ₄	Ethrel-50ppm at 60DAS	20.6	33.5	21.5	31.4	26.8
T ₅	MH-30ppm at 60DAS	20.6	30.2	19.3	26.3	24.1
T ₆	Detop. at 60 DAS+Ethrel 50 ppm at 75 DAS	21.7	35.5	22.3	29.3	27.2
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	19.1	30.0	19.8	26.8	23.9
T ₈	Detop. at 75 DAS+Ethrel-50ppm at 90 DAS	23.3	37.2	23.7	30.2	28.6
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	20.3	32.5	20.3	28.2	25.3
	S. Em. ±	1.6	2.9	1.5	2.0	1.0
	C.D. (p = 0.05)	NS	NS	NS	NS	2.9
	C.V. (%)	12.7	15.6	12.8	12.3	14.0
1.2	Plant height (cm)					
T ₁	Control	61.4	99.3	93.6	95.1	87.3
T ₂	Detopping at 60DAS	48.4	69.1	74.5	78.8	67.7
T ₃	Detopping at 75DAS	57.6	90.9	86.0	88.0	80.6
T ₄	Ethrel-50ppm at 60DAS	64.2	108.4	95.6	101.9	92.5
T ₅	MH-30ppm at 60DAS	62.6	107.2	97.3	102.6	92.4
T ₆	Detop. at 60 DAS+Ethrel 50 ppm at 75 DAS	52.2	88.8	73.5	79.6	73.5
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	51.7	77.3	71.2	80.9	70.3
T ₈	Detop. at 75 DAS+Ethrel-50ppm at 90 DAS	59.8	95.3	89.2	91.4	83.9
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	58.9	92.3	87.7	89.3	82.1
	S. Em. +	3.4	6.4	6.1	5.6	2.8
	C.D. (p = 0.05)	10.1	19.3	18.4	16.7	7.8
	C.V. (%)	10.2	12.1	12.5	10.8	11.8
1.3	Monopodia/plant					
T ₁	Control	0.8	1.7	1.3	2.2	1.5
T ₂	Detopping at 60DAS	1.2	2.0	1.8	2.7	2.0
T ₃	Detopping at 75DAS	1.4	3.0	2.0	2.9	2.3
T ₄	Ethrel-50ppm at 60DAS	1.0	2.3	2.0	3.1	2.1
T ₅	MH-30ppm at 60DAS	0.9	2.3	1.8	2.7	1.9
T ₆	Detop. at 60 DAS+Ethrel 50 ppm at 75 DAS	1.2	2.7	2.2	3.3	2.3
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	0.9	2.2	1.5	2.5	1.8
T ₈	Detop. at 75 DAS+Ethrel-50ppm at 90 DAS	1.3	2.7	2.5	3.5	2.5
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	0.8	2.0	1.8	2.7	1.8
	S. Em. ±	0.1	0.2	0.2	0.2	0.1
	C.D. (p = 0.05)	0.3	0.6	0.6	0.6	0.3
	C.V. (%)	16.2	15.0	19.2	12.3	15.7

the significantly highest Monopodia/plant was observed in treatment of T₈(3.5) and was *at par* with treatment of T₆ (3.3) and significantly minimum number of monopodia/plant found in treatment of T₁(2.2)

Overall, pooled results from the year of 2012 to 2015 indicated that higher values of root length (28.6 cm) of cotton were recorded under treatment of (T₈) de topping at 75 DAS and spraying of Ethrel @ 50 ppm at 90 DAS followed by

Table 2. Effect of plant growth regulators and detopping on yield attributes of *Bt* cotton (*Gossypium hirsutum* L.) under rainfed condition.

Sr. No.	Treatment	2012	2013	2014	2015	Pooled
2.1	Sympodia/plant					
T ₁	Control	7.3	9.0	11.0	13.1	10.1
T ₂	Detopping at 60DAS	9.5	11.8	12.0	13.7	11.7
T ₃	Detopping at 75DAS	12.4	13.5	12.2	16.2	13.6
T ₄	Ethrel-50ppm at 60DAS	8.1	11.7	12.5	17.0	12.3
T ₅	MH-30ppm at 60DAS	8.1	11.5	11.5	14.4	11.4
T ₆	Detop. at 60 DAS+Ethrel 50 ppm at 75 DAS	8.9	11.8	13.3	17.3	12.9
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	8.0	11.0	11.3	13.7	11.0
T ₈	Detop. at 75 DAS+Ethrel-50ppm at 90 DAS	10.7	12.0	14.7	18.3	13.9
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	7.8	9.7	11.7	15.7	11.2
	S. Em. +	0.8	0.8	0.7	1.1	0.4
	C.D.(p=0.05)	2.4	2.5	2.1	3.4	1.2
	C.V. (%)	15.3	12.6	10.0	12.8	12.7
2.2	Open bolls/plant at maturity					
T ₁	Control	11.4	22.0	17.7	17.8	17.2
T ₂	Detopping at 60DAS	15.2	28.5	16.5	18.7	19.7
T ₃	Detopping at 75DAS	16.6	31.5	18.2	22.5	22.2
T ₄	Ethrel-50ppm at 60DAS	12.8	26.8	19.2	24.1	20.7
T ₅	MH-30ppm at 60DAS	12.1	25.0	17.7	19.8	18.7
T ₆	Detop. at 60 DAS+Ethrel 50 ppm at 75 DAS	13.8	27.7	21.8	23.0	21.6
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	11.5	24.3	17.3	19.7	18.2
T ₈	Detop. at 75 DAS+Ethrel-50ppm at 90 DAS	15.6	29.8	25.7	27.1	24.5
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	11.9	23.8	18.8	21.0	18.9
	S. Em. +	1.1	1.9	1.5	1.8	0.8
	C.D.(p=0.05)	3.3	5.7	4.4	5.4	2.3
	C.V. (%)	14.3	12.4	13.2	14.5	13.8
2.3	One open boll weight (g)					
T ₁	Control	3.9	5.0	3.3	4.0	4.1
T ₂	Detopping at 60DAS	5.2	6.1	3.5	4.3	4.8
T ₃	Detopping at 75DAS	5.4	6.7	4.3	5.0	5.4
T ₄	Ethrel-50ppm at 60DAS	5.0	5.7	4.7	5.6	5.3
T ₅	MH-30ppm at 60DAS	5.1	5.6	4.0	4.5	4.8
T ₆	Detop. at 60 DAS+Ethrel 50 ppm at 75 DAS	5.1	5.9	4.6	5.2	5.2
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	4.3	5.6	3.7	4.4	4.5
T ₈	Detop. at 75 DAS+Ethrel-50ppm at 90 DAS	5.3	6.6	5.4	6.3	5.9
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	4.1	5.2	4.1	4.9	4.6
	S. Em. +	0.3	0.3	0.4	0.4	0.2
	C.D.(p=0.05)	1.0	1.0	1.2	1.2	0.5
	C.V. (%)	12.6	10.3	16.6	13.9	13.1

treatment of T₆ (Detop. at 60 DAS + Ethrel 50 ppm at 75 DAS) *i.e.* 27.2 cm, While, maximum value of plant height (92.5 cm) was observed with T₄ (Ethrel @ 50 ppm at 60 DAS). The maximum monopodia/plant (2.5), of cotton were recorded in treatment of (T₈) detopping at 75 DAS and spraying of Ethrel @ 50 ppm at 90 DAS followed by T₆ (Detop. at 60 DAS + Ethrel 50 ppm at 75 DAS). Similar results reported by Sarlach *et al.*, (2010).

The data given in Table 2 revealed that the significant results of number of sympodia/plant of cotton were recorded during the period of 2012 to 2015. The maximum sympodia/plant was recorded in treatment of T₃ (12.4) during period of 2012. It was followed by T₈ (10.7), T₂ (9.5), T₆ (8.9), T₄ and T₅ (8.1), T₇ (8.0), T₉ (7.8), and T₁ (7.3). second year of 2013, the maximum sympodia/plant was also observed in T₃ (13.5)

followed by T_8 (12.0), T_6 (11.8) and T_5 (11.5). During the year of 2014, the maximum sympodia/plant was counted in T_8 (14.7) followed by T_6 (13.3) and T_4 (12.5). Final year of observation recorded in the year of 2015, Higher number of sympodia/plant found in T_8 (18.3) followed by T_3 (16.2) and T_4 (15.7).

In case of growth parameter of cotton, The significantly maximum number of open bolls/plant at maturity was recorded in treatment of T_3 (16.6) during the period of 2012. It was *at par* with treatment of T_8 (15.6). The treatment of T_2 (15.2) was *at par* with treatment of T_8 (15.6). In the year of 2013, the significantly maximum open bolls/plant at maturity was observed in T_3 (31.5). It was statistically *at par* with treatment of T_8 (29.8). The observation was taken from the year of 2014, the significantly higher open bolls/plant at maturity was counted in treatment of T_8 (25.7) and significantly lowest open bolls/plant at maturity was recorded from treatment T_2 (16.5) Similarly, the year of 2015, the significantly higher number of open bolls/plant at maturity was observed in treatment of T_8 (27.1) and while significantly of open bolls/plant at maturity was recorded from treatment T_1 (17.8)

The significantly maximum weight (g) of one open boll was recorded in treatment of T_3 (5.4) during period of 2012. It was statistically *at par* with treatment of T_8 (5.3), T_2 (5.2), and T_5 & T_6 (5.1). Similarly, in the year of 2013, the significantly more weight (g) from one open boll was found in T_3 (6.7) which was statistically *at par* with treatment of T_8 (6.6). During the year of 2014, the significantly minimum weight (g) of one open boll was observed in treatment of T_1 (3.3), Whereas, maximum weight (g) of one open boll was recorded in treatment of T_8 (5.4). It was followed by T_4 (4.7) and T_6 (4.6). From the year of 2015, the significantly highest weight (g) of one open boll was recorded in treatment of T_8 (6.3) significantly minimum weight (g) of one open boll found in treatment of T_1 (4.0)

The observations from data of pooled results indicated that the significant difference was found after application of foliar spraying of growth regulators in number of sympodiya/plant, number of open bolls/plant at maturity as well as one weight of open boll and same significant difference was also observed by detopping (Table 2). The significantly maximum sympodia/plant (13.9) and open bolls/plant at maturity (24.5) were found superior in T_8 (Detopping at 75 DAS and spraying of Ethrel @ 50 ppm at 90 DAS) followed by detopping at 75 DAS (T_3). Treatment of T_8 (Detopping at 75 DAS and spraying of Ethrel @ 50 ppm at 90 DAS) was also found superior of weight (g) of one open boll. Increase in number of sympodial branches and its length, these results are conformity with findings of Kataria *et al.*, (2017).

CONCLUSION

The results of the present investigation revealed that the significantly highest number of root length (cm) and monopodia/plant, sympodia/plant, open bolls/plant at maturity of *Bt* cotton were recorded in treatment of detopping at 75 DAS and spraying of Ethrel @ 50 ppm at 90 DAS and also treatment of detopping at 75 DAS and spraying of Ethrel @ 50 ppm at 90 DAS was also found superior of weight (g) of One Open Boll. While, maximum value of plant height (cm) was observed treatment of (Ethrel @ 50 ppm at 60 DAS) during four the years of study. The farmers of north Saurashtra agro-climatic zone growing *Bt* cotton in *kharif* season are advised to de topping at 75 DAS + spray of Ethrel (Ethylene-39 %) @ 50 ppm (1.3 ml/10 l of water) at 90 DAS for obtaining higher yield and net return. This is only due to spraying of ethrel which was act as growth retardant and closing stomata, was helps in loss of transpiration, decreased plant height, increased root length, plant spread, number of monopodia and sympodia which resulted in early maturity of crop.

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