



E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(3): 377-381
Received: 12-03-2020
Accepted: 16-04-2020

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Effect of growth regulators and detopping on reproductive growth parameters of *Bt* cotton (*Gossypium hirsutum* L.) under rainfed condition

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Abstract

A Field experiment was conducted at Main Dry Farming Research Station, Junagadh Agricultural University, Targhadia (Rajkot) under North Saurashtra Agro climatic Zone of Gujarat. during kharif season of the year 2012-13 to 2015-16 with the view to study the "Effect of plant growth regulators and detopping on yield of *Bt* cotton (*Gossypium hirsutum* L.) under rainfed condition. Nine treatment combinations were tried in randomized block design with three replications. The result revealed that the significantly maximum number of flowers/plants were recorded under treatment of (T₈) (30.9) at 75 DAS, (T₈) (29.7) at 85 DAS and (T₈) (6.9) at 110 DAS, respectively i.e. Detopping at 75 DAS and spraying of Ethrel @ 50 ppm at 90 DAS. The maximum number of bolls per plant at 75 DAS was recorded (11.2) with T₃ (Detopping at 75 DAS). Whereas, maximum number of bolls per plant at 27.2 at 85 DAS and 28.3 at 110 DAS with T₈ (Detopping at 75 DAS + Ethrel @ 50 ppm at 90 DAS), respectively. The effect of growth regulators and detopping on yield, It was indicated that the maximum seed cotton yield (2859 kg ha⁻¹) was obtained in treatments of detopping at 75 DAS + spraying of ethrel @ 50 ppm at 90 DAS (T₈) and it was statistically at par with T₆ (Detop.at 60 DAS+Ethrel 50 ppm at 75 DAS). Similarly, maximum biological yield (7238 kg ha⁻¹) also recorded with T₈ and which was statistically at par with T₄ and T₅.

Keywords: Growth regulators, Detopping, Reproductive growth parameters and *Bt* cotton

Introduction

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, all the four cultivated cotton species viz., *Gossypium arboreum*, *Gossypium herbaceum*, *Gossypium hirsutum* and *Gossypium barbadense* are grown commercially. The diploid cottons (*G. arboreum* and *G. herbaceum*) are mainly cultivated in dryland tracts, though Bengal Deshi is grown under irrigated situation in the Northern states. *G. hirsutum* is known as the American cotton and most popular varieties and hybrids now under cultivation belong to this group. *G. barbadense* is popularly known as the Egyptian cotton and is grown in small area in South India.

In India, cotton occupied about 122.38 lakh ha area under cultivation (2018-19). 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 per cent) and South Zone (40 per cent). 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 2018-19, which was higher than the national average of 501 kg/ha. (CAB as on 17:04:2020). 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 per cent) 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. Induction of higher number of sympodial branches and thereby increases in number of square and bolls are essential for yield maximization of seed cotton (Shwetha *et al.* 2009) [4].

Any increase or decrease in temperature may alter days required to initiate square, onset of flowering, boll opening and maturation (Reddy *et al.*, 1999) [3]. There is evidence that plant growth regulators could be used to partially counteract environmental stresses and improve crop productivity. The manipulate the growth of cotton to get a good architecture to reduce the transpiration some extent without affecting productivity of plants. Several workers reported that the productivity of an irrigated cotton improved by manipulation of the growth of cotton by using several agro-techniques like detopping and spraying of growth regulators i.e. maleic hydrazide and ethrel have been initiated under the present experiment. Hallikeri *et al.*, (2010) [2] reported that detopping, decrease plant height and number of sympodial branches plant-1 but has a non-significant effect on boll weight and percent lint. However, the increase in seed cotton yield by detopping over no detopping was reported by Shwetha *et al.*, (2009) [4]. Therefore, the objective of this study was 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 Main Dry Farming

Research station, Junagadh Agricultural University, Targhadia (Dist.: -Rajkot, Gujarat, India) during four consecutive *kharif* season of 2012-13 to 2015-16. The experiment included total 9 treatment combinations *viz.* T₁ – Control, T₂ - Detopping at 60 days after sowing (DAS), T₃ - Detopping at 75 DAS, T₄ - Foliar spray of ethrel @ 500ppm at 70 DAS, T₅ - Foliar spray of MH @ 30 ppm at 70 DAS, T₆ - Detopping at 60 DAS + foliar spray of ethrel @ 500ppm at 85 DAS, T₇ - Detopping at 60DAS + foliar spray of MH @ 30ppm at 85 DAS, T₈ - Detopping at 75 DAS + foliar spray of ethrel@500ppm at 100DAS, T₉ - Detopping at 75 DAS + foliar spray of MH@ 30ppm at 100 DAS each replicate three times in randomized block design with the plot size of (a) gross plot size: Gross: 4.2 m X 3.6 m, (b) net plot size: 3.6 m X 1.8 m. The spacing and seed rate were 90 cm X 30 cm and 1.25 kg/ha respectively. The crop was fertilized with 80-0.0-0.0 NPK kg /ha.

The observations of: 1) No of Flowers/plant (75 DAS, 85 DAS & 110 DAS), 2) No of Balls/plant (75 DAS, 85 DAS & 110 DAS), 3) No. of open bolls/plant at maturity, 4) One open boll weight(g), 5) Yield (Seed cotton, Dry stalk & Biological kg/ha) were recorded.

Results and Discussion

Table 1: Effect of plant growth regulators and detopping on number of flowers of *Bt.* cotton (*Gossypium hirsutum* L.) under rainfed condition.

Sr. No.	Treatment	2012	2013	2014	2015	Pooled	Y	Y X T
1.1	No of Flowers/plant at 75 DAS							
T ₁	Control	11.5	25.7	24.3	28.7	22.5		
T ₂	Detopping at 60DAS	14.6	33.5	25.5	29.2	25.7		
T ₃	Detopping at 75DAS	15.2	35.4	30.8	35.7	29.3		
T ₄	Ethrel-50ppm at 60DAS	14.8	30.5	30.1	38.0	28.4		
T ₅	MH-30ppm at 60DAS	18.9	29.0	29.9	32.8	27.7		
T ₆	Detop.at 60 DAS+Ethrel 50 ppm at 75 DAS	15.0	32.2	33.9	37.3	29.6		
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	16.7	27.9	26.8	30.3	25.4		
T ₈	Detop. at75 DAS+Ethrel-50ppm at 90 DAS	15.4	34.5	34.4	39.5	30.9		
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	14.0	26.9	31.6	34.2	26.7		
	S.Em. +	1.2	2.1	1.9	2.5	1.0	0.7	2.0
	C.D.at 5%	3.7	6.4	5.8	7.4	2.8	1.9	NS
	C.V. %	14.1	12.1	11.2	12.6	12.6		
1.2	No of Flowers/plant at 85 DAS							
T ₁	Control	13.9	27.8	30.3	13.9	21.5		
T ₂	Detopping at 60DAS	18.5	35.5	31.8	14.5	25.1		
T ₃	Detopping at 75DAS	21.7	38.7	37.1	18.7	29.0		
T ₄	Ethrel-50ppm at 60DAS	14.5	31.1	37.1	21.3	26.0		
T ₅	MH-30ppm at 60DAS	15.9	30.9	36.9	15.6	24.8		
T ₆	Detop. at60 DAS+Ethrel 50 ppm at 75 DAS	15.2	33.5	40.9	19.7	27.3		
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	14.7	30.0	33.1	15.8	23.4		
T ₈	Detop. at75 DAS+Ethrel-50ppm at 90 DAS	17.9	37.0	41.4	22.5	29.7		
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	14.5	28.5	38.3	17.1	24.6		
	S.Em. +	1.4	2.4	2.4	1.8	1.0	0.7	2.0
	C.D.at 5%	4.1	7.1	7.1	5.5	2.9	1.9	NS
	C.V. %	14.6	12.7	11.4	18.1	13.7		
1.3	No of Flowers/plant at 110 DAS							
T ₁	Control	0.8	2.9	7.4	7.8	4.7		
T ₂	Detopping at 60DAS	1.2	7.5	9.0	8.4	6.5		
T ₃	Detopping at 75DAS	1.6	9.8	5.5	10.2	6.8		
T ₄	Ethrel-50ppm at 60DAS	0.8	6.9	6.6	10.5	6.2		
T ₅	MH-30ppm at 60DAS	1.0	5.4	8.2	8.3	5.7		
T ₆	Detop. at60 DAS+Ethrel 50 ppm at 75 DAS	1.0	7.3	6.4	11.1	6.4		
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	0.5	4.9	8.2	9.5	5.8		
T ₈	Detop. at75 DAS+Ethrel-50ppm at 90 DAS	1.2	8.9	6.4	11.2	6.9		
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	0.9	3.7	8.8	9.0	5.6		
	S.Em. +	0.1	0.5	0.7	0.8	0.7	0.5	0.6
	C.D.at 5%	0.3	1.5	2.1	2.3	NS	1.4	1.7
	C.V. %	16.5	14.0	16.6	14.1	16.7		

The data given in Table 1 revealed that the significant results were obtained from number of flowers/plant of cotton plant at 75 DAS during the period of 2012 to 2015. The maximum number of flowers/plant at 75 DAS during period of 2012 was recorded in treatment of T₅ (18.9) which was followed by T₇ (16.7), T₈ (15.4), T₃ (15.2), T₆ (15.0), T₄ (14.8), T₂ (14.6), T₉ (14.0), and T₁ (11.5). Whereas, the minimum number of flowers/plant at 75 DAS was observed in treatment of T₁ (11.5). In case of the year of 2013, the total number of 35.4 flowers/plant at 75 DAS was observed in T₃ (35.4). It was at par with T₈ (34.5) and T₂ (33.5). During the year of 2014, the maximum number of flowers/plant at 75 DAS was recorded in T₈ (34.4) which was at par with treatment of T₆ (33.9) and T₉ (31.6). Final year of 2015, the highest flowers/plant at 75 DAS was found in T₈ (39.5) (Detop. at 75 DAS+Ethrel-50ppm at 90 DAS) and was at par with T₄ (38.0) and T₆ (37.3).

In case of growth parameter of Cotton, during period of 2012, the significantly highest number of flowers/plant of cotton plant at 85 DAS was recorded in treatment of T₃ (21.7). It was followed by the treatment of T₂ (18.5) and T₈ (17.9). Whereas, the minimum number of flowers/plant at 85 DAS was observed in treatment of T₁ (13.9). The second year (2013), the significantly highest number of flowers/plant of cotton plant at 85 DAS was observed in T₃ (38.7). It was

statistically at par with treatment of T₈ (37.0). Third year (2014), the significantly maximum number of flowers/plant of cotton plant at 85 DAS was recorded in treatment of T₈ (41.4) and this treatment was at par with T₆ (40.9). Fourth year (2015), the significantly maximum number of flowers/plant of cotton plant at 85 DAS was observed in treatment of T₈ (22.5) and was at par with treatment of T₄ (21.3)

During the period of 2012, 2013, 2014 and 2015, the significantly maximum number of flowers/plant at 110 DAS were recorded in treatment of T₈ (1.2), T₃ (9.8), T₂ (9.0), and T₈ (11.2), respectively. Whereas, the significantly minimum number of flowers/plant at 110 DAS were recorded in treatment of T₇ (0.5), T₁ (2.9), T₃ (5.5), and T₁ (7.8), respectively.

Overall, in pooled results (Table 1), number of flowers per plant at 75 DAS, 85 DAS and 110 DAS were significantly differed during all the years of the experimental which was due to foliar spraying of growth regulators and detopping in *Bt.* cotton. The pooled data from total four years indicated that the significantly maximum number of flowers/plant were recorded under treatment of (T₈) (30.9) at 75 DAS, (T₈) (29.7) at 85 DAS and (T₈) (6.9) at 110 DAS, respectively i.e. Detopping at 75 DAS and spraying of Ethrel @ 50 ppm at 90 DAS.

Table 2: Effect of plant growth regulators and detopping on number of bolls of *Bt.* Cotton (*Gossypium hirsutum* L.) under rainfed condition.

Sr. No.	Treatment	2012	2013	2014	2015	Pooled	Y	Y X T
2.1	No. of Bolls/plant-75 DAS							
T ₁	Control	10.1	11.9	1.5	4.5	7.0		
T ₂	Detopping at 60DAS	14.8	17.4	1.5	4.8	9.6		
T ₃	Detopping at 75DAS	17.9	20.0	1.8	5.1	11.2		
T ₄	Ethrel-50ppm at 60DAS	12.5	14.5	1.9	6.5	8.8		
T ₅	MH-30ppm at 60DAS	12.4	13.9	1.7	4.9	8.2		
T ₆	Detop. at 60 DAS+Ethrel 50 ppm at 75 DAS	13.1	15.6	2.5	5.8	9.3		
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	11.9	13.1	1.8	4.5	7.8		
T ₈	Detop. at 75 DAS+Ethrel-50ppm at 90 DAS	15.1	18.5	2.4	6.8	10.7		
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	11.1	12.4	1.8	5.3	7.6		
	S.Em. +	1.3	1.3	0.2	0.5	0.7	0.5	0.9
	C.D.at 5%	3.8	3.8	0.6	1.4	2.1	1.4	2.6
	C.V. %	16.6	14.3	19.1	15.2	18.0		
2.2	No. of Bolls/plant- 85 DAS							
T ₁	Control	10.5	17.6	19.7	24.6	18.1		
T ₂	Detopping at 60DAS	16.2	23.1	21.2	25.7	21.6		
T ₃	Detopping at 75DAS	18.0	26.0	25.8	30.8	25.2		
T ₄	Ethrel-50ppm at 60DAS	14.7	21.2	25.7	32.7	23.6		
T ₅	MH-30ppm at 60DAS	14.9	20.0	24.8	28.1	22.0		
T ₆	Detop. at 60 DAS+Ethrel 50 ppm at 75 DAS	15.4	22.9	29.5	31.3	24.8		
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	12.8	19.1	20.6	27.0	19.9		
T ₈	Detop. at 75 DAS+Ethrel-50ppm at 90 DAS	17.8	24.5	31.7	34.7	27.2		
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	11.3	18.4	21.4	29.2	20.1		
	S.Em. +	1.4	1.8	1.9	2.0	0.9	0.6	1.8
	C.D.at 5%	4.2	5.3	5.8	6.1	2.6	1.7	NS
	C.V. %	16.8	14.4	13.8	12.1	14.0		
2.3	No. of Bolls/plant-110 DAS							
T ₁	Control	12.4	23.5	19.0	25.9	20.2		
T ₂	Detopping at 60DAS	17.0	30.0	19.9	27.3	23.5		
T ₃	Detopping at 75DAS	18.7	32.2	20.1	31.8	25.7		
T ₄	Ethrel-50ppm at 60DAS	14.7	26.1	23.2	33.5	24.4		
T ₅	MH-30ppm at 60DAS	13.5	25.9	20.0	29.3	22.2		
T ₆	Detop. at 60 DAS+Ethrel 50 ppm at 75 DAS	15.7	28.1	25.5	32.6	25.5		
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	14.2	24.7	20.5	28.7	22.0		
T ₈	Detop. at 75 DAS+Ethrel-50ppm at 90 DAS	17.8	31.3	27.7	36.3	28.3		
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	13.7	24.1	20.7	30.0	22.1		
	S.Em. +	1.3	1.9	1.8	2.0	0.9	0.7	1.7
	C.D.at 5%	3.8	5.8	5.4	6.0	2.5	1.7	NS
	C.V. %	14.4	12.3	14.2	11.3	12.9		

The data given in Table 2 indicated that the significant results of number of bolls/plant at 75 DAS, 85 DAS and 110 DAS were recorded during entire period. The observations were taken from the year of 2012, the maximum number of bolls/plant at 75 DAS was recorded in treatment of T₃ (17.9). It was followed by T₈ (15.1), T₂ (14.8), T₆ (13.1), T₄ (12.5), T₅ (12.4), T₇ (11.9), T₉ (11.1), and T₁ (10.1). Data was collected from the year 2013, the maximum number of bolls/plant at 75 DAS was recorded in treatment of T₃ (20.0) which was followed by T₈ (18.5). Whereas, the lowest number of bolls/plant at 75 DAS was recorded in treatment of T₁ (11.9). During the year of 2014, the maximum number of bolls/plant at 75 DAS was recorded in treatment of T₈ (2.4) which was at par with the treatment of T₆ (2.5). The maximum number of bolls/plant at 75 DAS was recorded in treatment of T₈ (6.8) followed by T₄ (6.5). Whereas, the lowest number of bolls/plant at 75 DAS was recorded in treatment of T₁ (4.5).

The observations were recorded during period of 2012, out of nine treatments, 18.0 bolls/plant at 85 DAS was recorded significantly the best in treatment of T₃ which was at par with treatment of T₈ (17.8). Whereas, 10.5 bolls/plant at 85 DAS was recorded lowest in treatment of T₁. In the year of 2013, the significantly the maximum number of bolls/plant at 85 DAS was counted in T₃ (26.0). It was statistically at par with treatment of T₈ (24.5). Whereas, the maximum number of bolls/plant at 85 DAS was recorded during the year of 2014

was 31.7. It was found in treatment of T₈ (Detop. at 75 DAS+Ethrel-50ppm at 90 DAS) and this treatment was at par with treatment of T₄ (95.6), T₁ (93.6) and similarly more number of bolls/plant at 85 DAS was observed in T₈ (34.7) from the year of 2015.

The significantly the maximum number of bolls/plant at 110 DAS was recorded from the year of 2012 was recorded in treatment of T₃ (18.7). It was statistically at par with treatment of T₈ (17.8). The significantly results were obtained in the year of 2013, Out of nine treatments, among them, the maximum number of bolls/plant at 110 DAS was seen in T₃ (32.2) which was at par with T₈ (31.3) but the significantly minimum bolls/plant at 110 DAS was observed in treatment of T₁ (23.5). From the year of 2014, the significantly the maximum number of bolls/plant at 110 DAS was recorded in treatment of T₈ (27.7) and same treatment T₈ (36.3) was found superior during the year of 2015.

Analysed from pooled data indicated (Table-2) that the number of bolls per plant at 75, 85 and 110 DAS, the effect of foliar spraying of growth regulators and detopping were found significant during all the years. The maximum number of bolls per plant at 75 DAS was recorded (11.2) with T₃ (Detopping at 75 DAS) but It was observed maximum 27.2 at 85 DAS and 28.3 at 110 DAS with T₈ (Detopping at 75 DAS + Ethrel @ 50 ppm at 90 DAS).

Effect of growth regulators and detopping on yield

Table 3: Effect of plant growth regulators and detopping on yield of Bt cotton (*Gossypium hirsutum* L.) under rainfed condition.

Sr. No.	Treatment	2012	2013	2014	2015	Pooled	Y	Y X T
3.1	Seed Cotton Yield (Kg/ha)							
T ₁	Control	1179	2526	1903	2418	2006		
T ₂	Detopping at 60DAS	1489	2631	2083	2481	2171		
T ₃	Detopping at 75DAS	1964	2955	2405	2975	2575		
T ₄	Ethrel-50ppm at 60DAS	1306	3254	2569	3172	2575		
T ₅	MH-30ppm at 60DAS	1312	2674	2256	2780	2255		
T ₆	Detop. at 60 DAS+Ethrel 50 ppm at 75 DAS	1404	3351	2731	3111	2649		
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	1275	2666	2155	2637	2184		
T ₈	Detop. at 75 DAS+Ethrel-50ppm at 90 DAS	1653	3591	2846	3348	2859		
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	1222	2707	2349	2772	2262		
	S.Em. +	133	221	190	190	93	62	186
	C.D.at 5%	399	663	571	569	263	176	NS
	C.V. %	16.2	13.1	13.9	11.5	13.5		
3.2	Dry Stalk Yield (Kg/ha)							
T ₁	Control	1826	5118	4295	5015	4064		
T ₂	Detopping at 60DAS	1350	4141	4527	4167	3546		
T ₃	Detopping at 75DAS	1698	4758	4321	4475	3813		
T ₄	Ethrel-50ppm at 60DAS	1903	5478	5350	5864	4649		
T ₅	MH-30ppm at 60DAS	1865	5195	5118	5658	4459		
T ₆	Detop. at 60 DAS+Ethrel 50 ppm at 75 DAS	1235	4270	5607	4835	3987		
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	1363	4141	4578	4733	3704		
T ₈	Detop. at 75 DAS+Ethrel-50ppm at 90 DAS	1595	4823	5710	5556	4421		
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	1646	4681	4733	5041	4025		
	S.Em. +	138	295	303	350	141	94	283
	C.D.at 5%	412	885	907	1049	400	267	NS
	C.V. %	14.8	10.8	10.7	12.0	12.0		
3.3	Biological Yield (Kg/ha)							
T ₁	Control	3005	7644	6184	7433	6066		
T ₂	Detopping at 60DAS	2840	6772	6649	6648	5727		
T ₃	Detopping at 75DAS	3662	7713	6659	7450	6371		
T ₄	Ethrel-50ppm at 60DAS	3209	8732	7801	9037	7195		
T ₅	MH-30ppm at 60DAS	3176	7869	7359	8439	6711		
T ₆	Detop. at 60 DAS+Ethrel 50 ppm at 75 DAS	2639	7621	8168	7946	6593		
T ₇	Detop. at 60 DAS+MH-30ppm at 75 DAS	2638	6807	6718	7370	5883		
T ₈	Detop. at 75 DAS+Ethrel-50ppm at 90 DAS	3247	8413	8386	8904	7238		
T ₉	Detop. at 75 DAS+ MH-30ppm at 90 DAS	2868	7388	7066	7813	6284		
	S.Em. +	204	399	442	460	195	130	390
	C.D.at 5%	610	1195	1327	1380	551	367	NS
	C.V. %	11.6	9.0	10.6	10.1	10.5		

The data given in Table 3 indicated that the significant results of seed cotton yield (kg ha^{-1}) were recorded from the year of 2012 to 2015. From the year 2012, the maximum seed cotton yield was obtained 1964 kg ha^{-1} in treatment of (T_3) Detopping at 75DAS which was followed by (T_8) Detopping at 75 DAS+Ethrel-50ppm at 90 DAS (1653 kg ha^{-1}). From the year 2013, the highest seed cotton yield was taken 3591 kg ha^{-1} in treatment of (T_8) Detopping at 75 DAS+Ethrel-50ppm at 90 DAS (1653 kg ha^{-1}). Whereas, the seed cotton yield was recorded 2526 kg/ha . in treatment of (T_1). During the year of 2014 and 2015, the maximum seed cotton yields were observed 2846 kg/ha . and 3348 kg ha^{-1} in treatment of (T_8) Detopping at 75 DAS+Ethrel-50ppm at 90 DAS (1653 kg ha^{-1}), respectively. The results are also confirmed with results of Blaise *et al.*, (2003) that seed cotton yield of Bt hybrids differed significantly.

The significant results of dry stalk yield (kg ha^{-1}) were recorded from the year of 2012 to 2015. The maximum 1903 , 5478 and 5864 kg ha^{-1} dry stalk yield (Kg/ha) were recorded in treatment of (T_4) from the year of 2012, 2013 and 2015, respectively & 5710 kg ha^{-1} in treatment of (T_8) from 2014.

The significantly maximum biological yield (3662 kg ha^{-1}) was recorded in treatment of (T_3) and it was followed by T_8 (3247 kg ha^{-1}) from the year of 2012. From the year 2013, The significantly maximum biological yield (8732 kg ha^{-1}) was observed in treatment of (T_4) and it was at par with T_8 (8413 kg ha^{-1}). It was found maximum (8386 kg ha^{-1}) in treatment of (T_8) from the year of 2014. From the year 2015, The significantly highest biological yield (9037 kg ha^{-1}) was recorded in treatment of (T_4) which was at par with T_8 (8904 kg ha^{-1}).

The data from pooled results given in Table 3 revealed that the biological yields of cotton were significantly differed during all the four years due to foliar application of growth regulators and detopping. On the bases of pooled results, maximum seed cotton yield (2859 kg ha^{-1}) was obtained due to detopping at 75 DAS + spraying of ethrel @ 50 ppm at 90 DAS (T_8) and it was statistically at par with T_6 (Detop.at 60 DAS+Ethrel 50 ppm at 75 DAS). Similarly, maximum biological yield (7238 kg ha^{-1}) was also recorded with T_8 and which was statistically at par with T_4 and T_5 . Whereas, maximum dry stalk yield (4649 kg ha^{-1}) was recorded with T_4 Ethrel-50 ppm at 60 DAS.

Conclusion

The results of the present investigation revealed that the significantly maximum number of flowers/plant were recorded under treatment of (T_8) (30.9) at 75 DAS, (T_8) (29.7) at 85 DAS and (T_8) (6.9) at 110 DAS, respectively i.e. Detopping at 75 DAS and spraying of Ethrel @ 50 ppm at 90 DAS during four the years of study. The study also suggests that foliar spraying of growth regulators and detopping in *Bt*. cotton) increased number of flowers/plant at Detopping at 75 DAS and spraying of Ethrel @ 50 ppm at 90 DAS. The maximum number of bolls per plant at 75 DAS was recorded with the treatment of detopping at 75 DAS but at 85 DAS and 110 DAS with the treatment of detopping at 75 DAS + Ethrel @ 50 ppm at 90 DAS. Seed cotton yield (2859 kg ha^{-1}) was obtained highest in treatment of detopping at 75 DAS + spraying of ethrel @ 50 ppm at 90 DAS which was statistically at par with treatment of detopping at 60 DAS+Ethrel 50 ppm at 75 DAS. Similarly, biological yield (7238 kg ha^{-1}) was also recorded with treatment of detopping at 75 DAS+Ethrel-50ppm at 90 DAS and which was statistically at par with spraying of Ethrel-50ppm at 60DAS

and MH-30ppm at 60DAS. Whereas, maximum dry stalk yield (4649 kg ha^{-1}) was recorded with spraying of Ethrel-50ppm at 60DAS. It was advised to detopping at 75 DAS + spray of Ethrel (Ethylene-39%) @ 50 ppm (1.3 ml/10 liter water) at 90 DAS for obtaining higher yield and net return. This is due to ethrel act as growth retardant & closing stomata, so that loss of transpiration, decreased number of flowers & bolls which resulted in early maturity of crop.

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