J. Farm Sci., 38(2): (147-151) 2025

RESEARCH PAPER

Effect of various growth retardants and detopping techniques on *Bt* cotton (*Gossypium hirsutum* L.) for source sink manipulation

SIDDANAGOUDA R. KOLOOR[1*], U. V. MUMMIGATTI[1], S. R. KAREEKATTI[1] AND MD. AKBAR[2]

[1]Department of Crop physiology, [2]Department of Biochemistry, College of Agriculture, Dharwad University of Agricultural Sciences, Dharwad - 580 005, India

*E-mail: siddanagouda9148@gmail.com

(Received: August, 2024 ; Accepted: June, 2025)

DOI: 10.61475/JFS.2025.v38i2.11

Abstract: A field experiment to study the manipulation of source sink through growth regulators was carried out during *kharif*, 2023 at Agricultural Research Station, Dharwad Farm. The experiment was laid out in Randomized Block Design with ten treatments and three replications. The treatments include foliar spray of maleic hydrazide, cycocel, mepiquat chloride and detopping in isolation and control. The study revealed that the significant impacts of growth retardants and detopping on morphological parameters such as plant height, monopodial and sympodial branch count.The study found that significant variations in physiological parameters such as SPAD values and dry matter production. Among different treatments the application of maleic hydrazide, cycocel and mepiquat chloride as growth retardants along with detopping, resulted in increased seed cotton yield, attributed to delayed senescence of leaves, leading to an extended period of photosynthate supply to the reproductive parts.Whereas, the treatment with maleic hydrazide at 30 ppm after 80 days of sowing showed superior growth and productivity compared to other treatments. The study concluded that the application of growth retardants and detopping techniques can optimize dry matter allocation, enhance photosynthetic activity and improve crop productivity in *Bt* cotton.

Key words: Growth, Morphological, Source sink, SPAD values,Yield parameters

Introduction

Cotton (*Gossypium hirsutum* L.) is a major commercial cash and fiber crop grown in over 70 countries. It is a key raw resource for the economy regarding job creation and foreign exchange and referred as "white gold," or "king of fibers." Cotton belongs to the *Malvaceae* family and the genus *Gossypium*. Cotton is one of India's most important crop, contributing considerably to export profits and jobs. India accounts for around 25% of the world's cotton productivity. Cotton covers around 12.7 million hectares, produces 260.5 lakh bales and productivity of 439 kg ha^{-1} (USDA Foreign Agriculture Service 2024). Gujarat, Maharashtra, Andhra Pradesh and Karnataka are the top cotton-producing states. Cotton is grown on 6.95 lakh hectares in Karnataka, producing 16.38 lakh bales and yielding 414.12 kg ha^{-1}.

Plant growth regulators (PGRs) can be used to modulate plant growth and development by applying them in small amounts, allowing for precise management of crop productivity and quality. Following herbicides, insecticides and fertilizers in the agrochemical hierarchy, they are regarded as the next generation inputs. Under field conditions, plant growth regulators can raise output by 10% to 15% (Kumar *et al*., 2005). Organic molecules known as plant growth regulators either stimulate, inhibit or alter the plant's physiological and/or morphological activities. By encouraging crop earliness, enhancing square, flower and boll retention, raising nitrogen absorption and preserving a balance between vegetative and reproductive growth, they have the potential to increase yield and quality (Deol *et al.,* 2018).

Enhancing cotton productivity is largely dependent on cultural practices, such as detopping. The primary goal of detopping is to optimize plant architecture, allowing for optimal solar radiation and little mutual shadowing. This will boost picking efficiency when the crop reaches maturity. Cotton field duration can be shortened by using the detopping technique, according to research by Rathinavel (2003) and Dai *et al.* (2022) in the Journal Pre-proof 3. Detopping of plant height (75 cm) improves the number of fruiting branches, the percentage of boll on sympodial branches, boll number, boll weight and seed cotton yield (Obasi and Msaakpa, 2005). Detopping enhances seed cotton output by 15.1 to 21.1 percent, as well as the number of bolls plant^{-1} and sympodial branches plant^{-1} (Kataria and Valu, 2018).

Material and methods

The present investigation was carried out to study the influence of plant growth retardants and detopping for optimization of source sink for enhancing the product of *Bt* cotton during *kharif* 2023. The experiment was layed out in RBD and the genotype used for the experiment was RCH-659. The treatments comprised of ten treatments *i.e.*$T_{1:}$ Control;T_2: Detopping;T_3: Mepiquat chloride @45ppm at square initiation; T_4: Mepiquat chloride @ 45ppm at square initiation +Detopping;T_5: Mepiquat chloride @ 45ppm at square initiation and 15 days after first spray;T_6: Mepiquat chloride @ 45ppm at square initiation and 15 days after first spray + Detopping ;T_7: Mepiquat chloride @ 45ppm at square initiation and 15 days after first spray and 15 days after second spray; T_8: Mepiquat chloride @ 45ppm at square initiation and 15 days after first spray and 15 days after second spray + Detopping; T_9: Cycocel @ 60ppm after 80 Days of sowing; T_{10}: Maleic hydrazide @ 30 ppm after 80 Days of sowing. Five plants were selected randomly from each replication and data was recorded for the characters *viz.,*plant height (cm) at harvest, monopodia

Table 1. Effect of foliar application of plant growth retardants and detopping on plantheight at different growth stages in *Bt* cotton

	Treatments	Plant height (cm)		
		90 DAS	120 DAS	At harvest
T_1	Control	71.45[a]	102.75[a]	114.07[a]
T_2	Detopping	38.59[e]	57.38[c]	56.07[d]
T_3	Mepiquat chloride @ 45 ppm at square initiation	53.49[cd]	74.65[b]	83.53[b]
T_4	Mepiquat chloride @ 45 ppm at square initiation + detopping	37.43[e]	56.35[cd]	66.40[cd]
T_5	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray	46.65[de]	65.81[bc]	80.13[bc]
T_6	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray + detopping	37.59[e]	43.37[d]	52.27[d]
T_7	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray and 15 days after second spray	45.29[de]	63.99[bc]	73.13[bc]
T_8	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray and 15 days after second spray + detopping	37.35[e]	41.90[d]	54.53[d]
T_9	Cycocel @ 60 ppm after 80 days of sowing	61.41[bc]	94.39[a]	103.87[a]
T_{10}	Maleic hydrazide @ 30 ppm after 80 days of sowing	66.58[ab]	95.61[a]	106.53[a]
	Mean	49.58	69.62	79.05
	S.E m. (±)	3.10	4.41	4.98
	C.D. at 5%	9.22	13.11	14.79

branches, sympodia branches, total dry matter, number of bolls, bolls weight per boll and seed cotton yield. The data was analyzed to find out the superior treatment with growth retardants for development of good quality cotton suitable for maximizing yield.

Results and discussion

The application of anti-gibberellin agents like, cycocel, maleic hydrazide and mepiquat chloride, reduced plant height by suppressing a transverse cell division and source sink balance. The higher plant height (cm) was observed in control followed by T_{10} (maleic hydrazide @ 30 ppm after 80 DAS) and T_9 (cycocel @ 60 ppm after 80 DAS) relative to other treatments in all growth stages. The plant height was found significantly lowest in treatment T_8 (mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray and 15 days after second spray + detopping) closely followed by T_6 (mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray + detopping) as compared to other treatments in different growth

Table 2. Effect of foliar application of plant growth retardants and detopping on SPAD values (SCMR) at different stages in *Bt* cotton

	Treatments	SPAD values (SCMR)	
		90 DAS	120 DAS
T_1	Control	35.07[d]	36.7[c]
T_2	Detopping	39.75[bcd]	38.6[bc]
T_3	Mepiquat chloride @ 45 ppm at square initiation	44.21[abc]	40.9[abc]
T_4	Mepiquat chloride @ 45 ppm at square initiation +detopping	46.03[ab]	38.9[bc]
T_5	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray	46.58[ab]	40.5[abc]
T_6	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray + detopping	48.49[a]	41.1[abc]
T_7	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first sprayand 15 days after second spray	49.09[a]	43.5[ab]
T_8	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray and 15 days after second spray + detopping	48.79[a]	45.0[a]
T_9	Cycocel @ 60 ppm after 80 days of sowing	34.45[d]	38.2[bc]
T_{10}	Maleic hydrazide @ 30 ppm after 80 days of sowing	36.61[cd]	37.0[c]
	Mean	42.91	40.02
	S.Em(±)	2.60	1.69
	C.D. at 5 %	7.71	5.03

Table 3. Effect of foliar application of plant growth retardants and detopping on monopodial and sympodial branches at harvest stages in *Bt* cotton

		Number of monopodial branches	Number of sympodia branches
T_1	Control	1.3[b]	22.00[ab]
T_2	Detopping	1.1[bc]	13.93[d]
T_3	Mepiquat chloride @ 45 ppm at square initiation	1.2[bc]	21.13[ab]
T_4	Mepiquat chloride @ 45 ppm at square initiation + detopping	1.0[c]	16.40[cd]
T_5	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray	1.3[b]	21.20[ab]
T_6	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray + detopping	1.3[b]	14.27[d]
T_7	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray and 15 days after second spray	1.1[bc]	19.47[bc]
T_8	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray and 15 days after second spray + detopping	1.3[b]	15.47[d]
T_9	Cycocel @ 60 ppm after 80 days of sowing	1.8[a]	22.27[ab]
T_{10}	Maleic hydrazide @ 30 ppm after 80 days of sowing	1.9[a]	23.93[a]
	Mean	1.3	19.01
	S. Em(±)	0.08	1.11
	C.D. at 5 %	0.25	3.29

Table 4. Effect of foliar application of plant growth retardants and detopping on total dry matter (TDM) at different growth stages in *Bt* cotton

Treatments		Total dry matter (TDM)(g plant^{-1})		
		90 DAS	120 DAS	At harvest
T_1	Control	25.78^{c}	77.88^{e}	132.67^{de}
T_2	Detopping	31.57^{ab}	96.62^{cd}	164.17^{b}
T_3	Mepiquat chloride @ 45 ppm at square initiation	24.17^{c}	76.63^{e}	140.33^{cde}
T_4	Mepiquat chloride @ 45 ppm at square initiation +detopping	28.17^{bc}	89.47^{d}	155.98^{bc}
T_5	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray	24.37^{c}	75.92^{e}	125.33^{e}
T_6	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray + detopping	28.05^{bc}	94.95^{cd}	150.00^{bcd}
T_7	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray and 15 days after second spray	28.35^{bc}	99.53^{c}	162.00^{bc}
T_8	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray and 15 days after second spray + detopping	26.31^{c}	77.44^{e}	130.70^{de}
T_9	Cycocel @ 60 ppm after 80 days of sowing	30.73^{ab}	109.48^{b}	186.78^{a}
T_{10}	Maleic hydrazide @ 30 ppm after 80 days of sowing	34.70^{a}	122.87^{a}	192.77^{a}
	Mean	28.22	92.08	154.07
	S.Em(±)	1.29	3.06	7.21
	C.D. at 5%	3.84	9.10	21.42

stages which presented is Table 1. Results are similar to the earlier studies (Kaur and Patil (2013), Kumar *et al*. (2005), Patil *et al*. (2005) and Mondino *et al.* (2004)).

The SPAD values, serve as an indicator of leaf greenness and relative chlorophyll concentration (Kariya *et al.* 1982; Torres-netto *et al*. 2005). This parameter has a significant impact on photosynthesis rate, dry matter production as well as cotton.This study found that T_8 (mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray and 15 days after second spray + detopping) resulted in the highest chlorophyll content and lower chlorophyll content observed in control presented in Table 2 and supporting the conclusions of Heilman and Brown (1981), Reddy *et al.* (2000), Kumar *et al.* (2005) and Koler *et al.* (2008).

The number of monopodia and sympodia was affected by the application of plant growth retardants and detopping in the treatments. Mepiquat chloride, conversely, resulted in fewer monopodia than the control and thus supports the results of previous investigations (Kumar *et al.* (2001), Vistro *et al.* (2017) and Brar *et al*. (2020), Kamboj *et al*. (2023). The data on monopodia and sympodia branches was influenced significantly due to different treatments. The treatment T_{10} (maleic hydrazide @ 30 ppm after 80 DAS) followed by T_9 (cycocel @ 60 ppm after 80 DAS) proved to be significantly superior in efficacy compared to other treatments. While treatment, T_2 (detopping) recorded the lower monopodia and sympodia branches among the treatments (Table 3).

All the treatments resulted in maximum total dry matter production by harvest time. Among the growth retardants, T_{10} (maleic hydrazide @ 30 ppm applied 80 DAS) the resulted in the maximum dry matter production relative to the control. Lower TDM was recorded in T_8 (mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray and 15 days after second spray + detopping), which was lower than control which presented in Table 4. The reduction in dry matter accumulation may be due to reduced plant height and an increase in the source-sink relationship impacted by the application of various plant growth retardants and detopping. similar trends were also observed in studies on dry matter partitioning and yield by Prakash and Prasad (2000) Kataria and Khanpara (2012) and Priyank *et al.* (2021).

Table 5. Effect of foliar application of plant growth retardants and detopping on number of bolls plant^{-1}, boll weight (g boll^{-1}) and yield (kg ha^{-1}) in *Bt* cotton

	Treatments	No.of bolls plant^{-1}	Boll weight (g boll^{-1})	Yield (kg ha^{-1})
T_1	Control	10.40^{f}	5.50^{abc}	582.0^{e}
T_2	Detopping	13.87^{de}	5.10^{c}	704.00^{de}
T_3	Mepiquat chloride @ 45 ppm at square initiation	15.00^{cd}	5.90^{abc}	850.98^{cd}
T_4	Mepiquat chloride @ 45 ppm at square initiation +detopping	15.87^{bcd}	6.00^{abc}	924.46^{c}
T_5	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray	13.33^{def}	5.20^{bc}	690.77^{e}
T_6	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray + detopping	16.33^{abcd}	6.50^{a}	1159.62^{b}
T_7	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray and 15 days after second spray	17.20^{abc}	6.30^{ab}	1196.36^{ab}
T_8	Mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray and 15 days after second spray + detopping	11.47^{ef}	5.20^{bc}	676.08^{e}
T_9	Cycocel @ 60 ppm after 80 days of sowing	18.67^{ab}	6.00^{abc}	1266.91^{ab}
T_{10}	Maleic hydrazide @ 30 ppm after 80 days of sowing	18.93^{a}	6.60^{a}	1337.46^{a}
	Mean	15.11	5.83	938.87
	S.Em(±)	0.93	0.33	51.10
	C.D. at 5 %	2.77	0.99	151.80

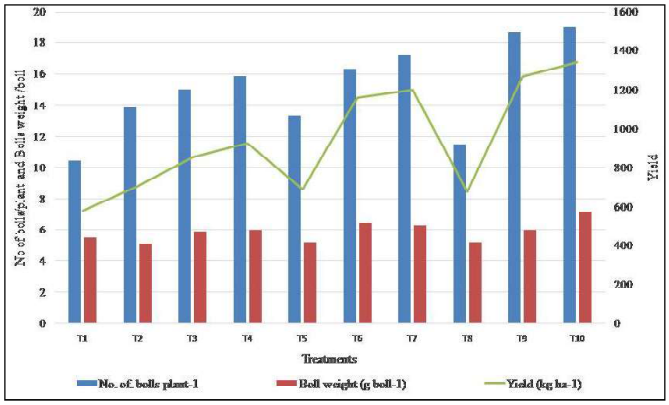

Fig 1. Effect of foliar application of plant growth retardants and detopping on number of bolls per plant, boll weight and seed cotton yield at harvest stages in *Bt* cotton

Among the treatments, T_{10} (maleic hydrazide @ 30 ppm applied 80 DAS) resulted in the maximum number of bolls plant^{-1}, boll weight (g boll^{-1}) and yield (Kg ha^{-1}) compared to control. However lower number of bolls plant^{-1}, boll weight (g boll^{-1}) and yield (Kg ha^{-1}) was recorded in control and in treatment T_8 (mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray and 15 days after second spray + detopping) (Table 5). The application of maleic hydrazide, cycocel, and mepiquat chloride as growth retardants along with detopping resulted in increased yield, which can be attributed to the delayed senescence of leaves, leading to an extended period of photosynthate supply to the reproductive sink. Moreover, mepiquat chloride was found to increase leaf thickness, subsequently enhancing photosynthesis, has also been reported in various studies by Abro *et al*. (2004), Zakir (2006) Koler (2008) and Copur *et al.* (2019).

Conclusion

The application of anti-gibberell in agents, specifically cycocel, maleic hydrazide and mepiquat chloride, resulted in reduced plant height, increased chlorophyll content, and improved yield in cotton. The treatments T_{10} (maleic hydrazide @ 30 ppm after 80 DAS) and T_9 (cycocel @ 60 ppm after 80 DAS) proved to be significantly superior in efficacy compared to other treatments, resulting in increased monopodia and sympodia branches, dry matter production and yield. The study suggests that the application of these growth retardants can be an effective in improving cotton yield and productivity.

References

Abro G H, Syed T S, Unar M A and Zhang M S, 2004, Effect of a plant growth regulator and micronutrients on insect pest infestation and yield components of cotton. *Journal of Entomology*, 1(1): 12-16.

Anon, 2024, Annual Report (2023-24), USDA Foreign Agriculture Service, p.4.www.USDA Foreign Agriculture Service.com.

Brar H S, Kumar D and Singh P, 2020, Dataset of source-sink manipulation through growth retardant for enhancing productivity and profitability of cotton in northwest, India. *Data in Brief*, 31:105914.

Copur O, Demirel T and Odabasioglu C, 2019, Effect of different gibberellic acid doses and application times on cotton (*Gossypium hirsutum* L.) in south eastern anatolia region of turkey. *Applied Ecology & Environmental Research*, 17(6):14985-14999

Dai J, Tian L, Zhang Y, Zhang D, Xu S, Cui Z, Li Z, Li W, Zhan L, Li C and Dong H, 2022, Plant topping effects on growth, yield and earliness of field-grown cotton as mediated by plant density and ecological conditions. *Field Crops Research*, 275:108337.

Deol J S, Rajni and Ramanjit K, 2018, Production potential of cotton (*Gossypium hirsutum*) as affected by plant growth regulators (PGRs). *Journal of Farm Sciences,* 34(4):386-389.

Heilman M and Brown J, 1981, Interactions of nitrogen with Pix on the growth and yield of cotton. Annual Meeting-1981, Annual meeting of beltwide cotton production research conferences, New Orleans, LA, 4-8 Jan 1981, National Cotton Council of America, Memphis, T N.

Kamboj N K and Verma G, 2023, Influence of growth retardants on productivity and profitability of *Bt* cotton in semi-arid region of north-western plain of India. *Annals of Agricultural Research*, 44(4): 468-473.

Kariya K, Matsuzaki A and Machida H, 1982, Distribution of chlorophyll content in leaf blade of rice plant. *Japanese Journal of Crop Sci*ences, 51(1): 134-135.

Kataria G K and Khanpara M D, 2012, Effect of cycocel and mepiquat chloride on physiology, growth and yield of irrigated *Bt* cotton (*Gossypium hirsutum* L.). *International Journal of Scientific Research*. 1(1): 90-91.

Kataria G K and Valu M G, 2018, Effect of detopping and growth retardants on physiological parameters and yield of *Bt* cotton (*Gossypium hirsutum* L.). *Journal of Cotton Research and Development*. 32 (2): 226-230

Kaur P and Patil B C, 2013, Plant growth regulator and its influence on yield, morphological and biochemical parameter in hybrid cotton. *Journal of Cotton Research and Development,* 27(1):50-55.

Koler P, 2008, Effct of plant growth regulators on morpho-physiological, biophysical and anatomical characters in cotton. *Ph.D. Thesis,* University of Agricultural Sciences, Dharwad, Karnataka, India.

Kumar K A, 2001, Effect of plant growth regulators on morphophysiological traits and yield attributes in hybrid cotton (*Gossypium hirsutum* L.). *M. Sc. (Agri.) Thesis,* University of Agricultural Sciences, Dharwad, Karnataka, India.

Kumar K A, Patil B C and Chetti M B, 2005, Effect of plant growth regulator on physiological components of yield in hybrid cotton. *Indian Journal of Plant Physiology*, 10(2): 187-190.

Mondino M H, Peterlin O A and Garay F, 2004, Response of late planted cotton to the application of a growth regulator (*Chlorocholine chloride*, Cycocel 75). *Experimental Agriculture*, 40: 381-87.

Obasi M O and Msaakpa T S, 2005, Influence of topping, side branch pruning and hill spacing on growth and development of cotton (*Gossypium barbadense* L.) in the Southern Guinea Savanna location of Nigeria. *Journal of Agriculture and Rural Development in the Tropics and Subtropics,* 106(2): 155-65.

Patil B C, Kumar K A and M B Chetti, (2005), Effect of plant growth regulators on physiological components of yield in hybrid cotton. *Indian Journal of Plant Physiology,* 10(2): 187-190.

Prakash R and Prasad M, 2000, Effect of nitrogen, chlormequat chloride and farmyard manure applied to cotton (*Gossypium hirsutum*) and their residual effect on succeeding wheat (*Triticum aestivum*) crop. *Indian Journal of Agronomy*, 45(2): 263-286.

Priyanka K, Rekha M S, Lakshman K and Rao C S, 2021, Influence of plant growth regulators in cotton under HDPS. *The Pharma Innovation Journal*, 10(7): 329-331.

Rathinavel K N G, 2003, Detopping with defoliation treatment maximizes seed yield in cotton, *Online Journal.*

Reddy A S and Rao T A, 2000, Effect of insecticides and plant hormones on growth and yield of cotton. *Pest,* 15: 27-28.

Torres-netto A, Campostrini E, Oliveira J G and Smith R E B, 2005, Photosynthetic pigments, nitrogen, chlorophyll a fluorescence and SPAD-502 readings in coffee leaves. *Horticultural Science,* 104(2): 199-209.

Vistro R, Chachar Q I, Chachar S D, Chachar N A, Laghari A, Vistro S and Kumbhar I, 2017, Impact of plant growth regulators on the growth and yield of Cotton. *International Journal of Agricultural Technology*, 13(3): 353-362.

Zakir M, Mohmoud S and Amal H E, 2006, Response of yield, yield component and fibre properties of Egyptian cotton (*Gossypium barbadense* L.) to nitrogen fertilization and foliar applied potassium and mepiquat chloride. *The Journal of Cotton Science,* 10: 224-234