E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(9): 170-174
Received: 13-06-2025
Accepted: 17-07-2025

Achal R Telase
PG Scholar, Department of Agronomy, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

SU Kakade
Professor of Agronomy (CAS), Cotton Research Unit, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

OS Rakhonde
Assistant Professor, Department of Soil science, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Sujata Mundare
PG Scholar, Department of Agronomy, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Corresponding Author:
Achal R Telase
PG Scholar, Department of Agronomy, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Growth, yield and economics in high density planting system and canopy management practices in *Bt* cotton under rainfed condition

Achal R Telase, SU Kakade, OS Rakhonde and Sujata Mundare

DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i9c.3741

Abstract
The field experiment entitled "Growth, yield and economics in high density planting system and canopy management practices in Bt cotton under rainfed condition." was conducted at Cotton Research Unit Field, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the *Kharif* season 2024-2025. Three separate trials were conducted using a Randomized Block Design to set up the experiment. Eight different treatments were applied, each involving different methods of managing the plant canopy and varying levels of HDPS. Experimental results revealed that, mepiquat chloride @45ppm at square initiation and 15 days after first spray had least crop growth namely plant height (75.20 cm), number of functional leaves, leaf area and highest chlorophyll content index (37.13), total dry matter accumulation at harvest (199.17 g/plant), also it recorded significantly higher quantity of sympodial branches per plant (17.77), no of bolls per plant (27.42), seed cotton yield per plant (103.67 grams), harvest index (42.15) which ultimately led to maximum seed cotton yield of 2781 kg per hectare, over all the other canopy management practices and control. However, the mepiquat chloride @45ppm at square initiation and 15 days after first spray registered 20% yield increase over control treatment. The highest feasible gross monetary return (Rs. 203720 ha-1), net monetary return (Rs. 133474 ha-1) and B:C ratio (2.90) were recorded in mepiquat chloride @ 45 ppm at square initiation and 15 days after first spray over all the other treatments.

Keywords: *Bt* cotton, HDPS, detopping, mepiquat chloride, canopy management practices

Introduction
Cotton, which is scientifically called *Gossypium hirsutum* L., comes from the Arabic word "quotn." It belongs to the Gossypium genus, which is named after the Arabic word "goz," meaning a soft material. There are four main types of cotton grown: *Gossypium arboreum*, *Gossypium herbaceum*, *Gossypium hirsutum*, and *Gossypium barbadense*. The first two, *G. arboreum* and *G. herbaceum*, are diploid and have 26 chromosomes each. They are originally from the old world and are called Asiatic cottons because they are mostly grown in Asia. The other two, G. *hirsutum* and *G. barbadense*, are tetraploid and have 52 chromosomes each. They are called New World cottons. *G. hirsutum* is also known as American cotton or upland cotton. *G. barbadense* is called Egyptian cotton, Sea Island cotton, Peruvian cotton, Tanguish cotton, or quality cotton. India is the only country in the world that grows all four types of cotton on a large scale. Because of its economic importance to India, cotton is often called "white gold." The soft, white fibers or lint make up about 36% of raw, unprocessed cotton. These fibers are the main material used in the textile industry. The rest of the cotton is mostly seeds (about 62%) and waste (about 2%) that are removed during the ginning process. Cotton farming in India provides work for around 6 million farmers. Additionally, about 40 to 50 million people are involved in jobs related to cotton, such as trading, processing, and making clothes. Cotton makes up two-thirds of the total fiber used in India's textile industry. According to the first advance estimates for 2024-25, the cotton crop is expected to be about 299.26 lakh bales, which is less than the 325.22 lakh tonnes produced in 2023-24. Among the states, Maharashtra is the top producer with 84.80 lakh bales, followed by Gujarat (80.01 lakh bales), Telangana (48.95 lakh bales), Rajasthan (20.42 lakh bales), and Karnataka (18.56 lakh bales). As of September 27, 2024,

the area used for growing cotton in the 2024-25 season is 112.94 lakh hectares. This is lower than the 123.70 lakh hectares used in the previous season, 2023-24. Among the states, Maharashtra has the highest cotton area with 40.86 lakh hectares. Gujarat comes next with 23.66 lakh hectares, followed by Telangana at 17.70 lakh hectares, Karnataka with 6.84 lakh hectares, and Madhya Pradesh with 6.14 lakh hectares. Cotton, which is scientifically known as *Gossypium hirsutum* L., grows in a way that doesn't have a fixed end. To get better yields from *Bt* cotton in high-density planting systems under rainfed conditions, some improved farming techniques are necessary. Practices that change how the plant grows are important because they help shift the plant's focus from growing leaves and stems to developing flowers and cotton. This helps the plant use nutrients better by matching where they are needed. Creating more branches in the plant leads to more squares and bolls, which is key to getting the highest possible cotton yield. So, it's necessary to adjust how the cotton plant grows to give it a good shape. This way, the plant can get enough sunlight without the leaves blocking each other too much. To improve productivity, several agro techniques like detopping and use of growth retardants are important. Too much green growth in plants can cause serious problems in crop production, such as fruit drop, slower growth, rotting of cotton bolls, and difficulty in harvesting. Plant growth Page 1 of 2 regulators are substances that, when used in small amounts, change how plants grow, usually by slowing down some of their natural growth processes. The most commonly used growth regulator in cotton is mepiquat chloride, which works by blocking the effects of a plant hormone called gibberellic acid. Growth retardants like mepiquat chloride make the plant shorter by reducing the length between the nodes, which leads to more nodes and bolls on each plant, ultimately increasing the overall yield.

Materials and Methods

The plot experiment was conducted at the Cotton Research Unit Field, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the *Kharif* season of 2024 2025. The field had a fairly flat and even topography. The soil was medium black cotton soil, which is a type of vertisols. It had low levels of available nitrogen (214.64 kg per hectare), medium levels of available phosphorus (19.60 kg per hectare), very high levels of available potassium (310.70 kg per hectare), and was slightly alkaline in nature (pH 8.1). The electrical conductivity was 0.30 dSm^{-1}, and the organic carbon content was 4.20 grams per kilogram. The experiment was arranged in a Randomised Block Design with three replications. There were eight treatments, each involving HDPS along with different canopy management practices. The treatments included HDPS combined with various canopy management techniques. *viz.*, T_1 (Control), T_2 (Detopping (20^{th} node), T_3 (Mepiquat chloride @45ppm at square initiation), T_4 (Mepiquat chloride @45ppm at square initiation + Detopping (20^{th} node), 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 (20th node), T_7 (Mepiquat chloride @ 45ppm at square initiation and 15 days after first spray and 15 days after second spray (need based), T_8 (Mepiquat chloride @45ppm at square initiation and 15 days after first spray and 15 days after second spray (need based) + Detopping). Seeds of *Bt* cotton variety Rasi Swift RCH 971 were sown in line by dibbling method with a spacing of 90 cm x 15 cm. The recommended fertilizer dose (90:45:45 $N:P_2O_5:K_2O$ kg per hectare). To evaluate how *Bt* cotton's growth, yield, and economic performance are affected by integrated crop management techniques, observations were systematically collected at various stages of the crop's development.

Results and Discussion

Effect on Growth parameters

The data shown in Table 1 declared that effects of HDPS planting and various canopy management practices treatments on plant height, number of sympodial branches, total dry matter accumulation, chlorophyll content index, number of picked bolls per plant and seed cotton yield per plant. The outcome showed that noticeably highest plant height (97.30 cm) was registered in control (T_1). However, detopping (20^{th} node) (T_2) was found at par with control (T_1). Lowest plant height was recorded with mepiquat chloride @45ppm at square initiation and 15 days after first spray at harvest (T_5) (75.20 cm).

Table 1: Growth features of cotton as impacted by HDPS planting and different canopy management practices

Treatments	Plant height (cm)	Number of sympodial branches per plant	Total dry matter accumulation per plant (g)	Chlorophyll content index	Number of picked bolls per plant	Seed cotton yield per plant (g)
	At harvest	At harvest	At harvest	At harvest	At harvest	At harvest
T_1: Control	97.30	16.77	149.97	29.73	18.00	55.10
T_2: Detopping (20^{th} node)	88.47	15.23	185.24	35.20	23.05	80.27
T_3: Mepiquat chloride @45ppm at square initiation	80.50	14.20	178.31	32.23	21.45	66.77
T_4: Mepiquat chloride @45ppm at square initiation + Detopping (20^{th} node)	81.60	14.40	194.85	36.47	22.18	83.60
T_5: Mepiquat chloride @45ppm at square initiation and 15 days after first spray	75.20	17.77	199.17	37.13	27.42	103.67
T_6: Mepiquat chloride @45ppm at square initiation and 15 days after first spray + Detopping (20^{th} node)	77.13	14.67	191.67	36.03	21.65	82.49
T_7: Mepiquat chloride @45ppm at square initiation and 15 days after first spray and 15 days after second spray (need based)	84.13	13.97	183.20	33.70	20.98	78.00
T_8: Mepiquat chloride @45ppm at square initiation and 15 days after first spray and 15 days after second spray (need based)+ Detopping	78.63	14.33	180.52	33.07	18.9	72.50
SE(m)±	4.05	0.57	4.47	1.23	0.95	1.15
CD at 5%	12.44	1.74	13.72	3.78	2.90	3.51
GM	82.87	15.17	182.87	34.20	21.70	77.80

Plant height decreased due to the suppression of apical dominance by detopping and the action of mepiquat chloride,

which interferes with the biosynthesis of gibberellic acid. This interference reduces gibberellin levels, thereby restricting plant growth and resulting in shorter stature. Similar results have been announced by Kaul *et. al* (2016) [14], Collins *et al*. (2017) [7], Singh *et al*. (2017) [25], Wenqing *et al*. (2019) [29], Hiyat *et.al* (2020) [10], Veeraputhiran *et al*. (2020) [27], Dharani *et.al* (2022) [8], Zohaib *et al.* (2024) [30], Alam *et al*. (2024), Iqbal *et al*. (2024) [11].

Noticeably more number of sympodial branches per plant (17.77) was seen in the treatment of canopy management where mepiquat chloride was sprayed twice @45ppm at square initiation and 15 days after first spray (T_5). However, control (16.77) (T_1) were statistically comparable with mepiquat chloride @45ppm at square initiation and 15 days after first spray (T_5). The increase in sympodial branches could be happening due to both cutting the top of the plant and applying mepiquat chloride These methods help the plant move from growing leaves and stems to making fruit. Detopping, done after the plant has finished its main growth period, probably helps existing branches grow stronger and makes more places where fruit can form. At the same time, using mepiquat chloride helps create more nodes and spaces between stems, which gives the plant more spots for new branches to grow from. This leads to more sympodia. These results are in accordance with those reported by Kataria and Valu (2018) [15], Chaudhari *et al*. (2021) [6], Sun *et al*. (2023) [26], Gohil *et al*. (2024) [9], Iqbal *et al*. (2024) [11].

Highest dry matter accumulation per plant (199.17 g) was also observed in mepiquat chloride @45ppm at square initiation and 15 days after first spray (T_5). However, T_4, T_6 were statistically comparable with T_5. Lowest dry matter accumulation per plant was recorded in control (149.97 g) (T_1). The distribution of total dry matter in various plant parts showed that at early stages, leaves contributed to more proportion of total dry matter but at later stages stem and reproductive parts contributed high. Similar results have been reported by Rajni and Deol (2015) [20] Kataria and Valu (2018) [15], Chaudhari *et al*. (2021) [6].

The chlorophyll content index influenced well as per effect of various canopy management practices. Among different practices, mepiquat chloride @45ppm at square initiation and 15 days after first spray (T_5) (37.13) observed significantly higher chlorophyll content which was at par with T_2, T_4, T_6, T_7. While control (29.73) (T_1) gave significantly lower chlorophyll content compare to all treatment.

Similarly, canopy management practices in cotton showed better results in all the characteristics that affect yield, such as the number of picked bolls per plant, which was 27.42 grams, and seed cotton yield per plant, which was 103.67 grams, and these were found to be significantly better in mepiquat chloride @45ppm at square initiation and 15 days after first spray (T_5). This could be attributed to the spraying of mepiquat chloride, which promote the enhanced growth of existing sympodial branches. Additionally, these practices may have led to an increase in sympodial length, ultimately resulting in higher boll weight and more bolls picked per plant also led to higher seed cotton yield per plant. The lowest number of picked bolls per plant and seed cotton yield per plant was found in the control treatment (T_1). These results agree with what has been reported by Jadhav *et al*. (2015) [12], Paslawar *et al*. (2015) [18], Shekar *et al*. (2015) [22], Kaul *et. al* (2016) [14], Kataria and Valu (2018) [15], Jadhav *et al*. (2020) [13], Priyanka *et al*. (2021) [19], Murtza *et al*. (2022) [17], Ahmad *et al*. (2025) [3]

Effect on yield parameters

Table 2: Yield traits of cotton as impacted by HDPS planting and various canopy management practices

Treatments	Seed cotton yield (kg per hectare)	Harvest index (%)	Gross monetary return (Rs/ha)	Net monetary return (Rs/ha)	B:C ratio
T_1: Control	2328	38.43	171376	107298	2.67
T_2: Detopping (20th node)	2687	40.25	197373	129179	2.89
T_3: Mepiquat chloride @45ppm at square initiation	2473	39.00	181926	115331	2.73
T_4: Mepiquat chloride @45ppm at square initiation + Detopping (20th node)	2726	41.02	199965	130004	2.86
T_5: Mepiquat chloride @45ppm at square initiation and 15 days after first spray	2781	42.15	203720	133474	2.90
T_6: Mepiquat chloride @45ppm at square initiation and 15 days after first spray + Detopping (20th node)	2711	40.81	198950	127591	2.79
T_7: Mepiquat chloride @45ppm at square initiation and 15 days after first spray and 15 days after second spray (need based)	2677	40.05	196620	125601	2.77
T_8: Mepiquat chloride @45ppm at square initiation and 15 days after first spray and 15 days after second spray (need based)+ Detopping	2523	39.90	185356	113816	2.59
SE(m)±	84	-	5979	5393	_
CD at 5%	257	-	18345	16547	_
GM	2613	-	191911	122787	_

Among various treatments, remarkably highest seed cotton yield (2781 kg per hectare) was found in mepiquat chloride @45ppm at square initiation and 15 days after first spray (T_5). However, T_2, T_4, T_6, T_7 were statistically comparable with T_5 (Mepiquat chloride @45ppm at square initiation and 15 days after first spray). The lowest seed cotton yield of cotton (2328 kg per hectare) was noted in control (T_1). Similarly highest harvest index (42.15) was recorded in mepiquat chloride @45ppm at square initiation and 15 days after first spray (T_5) and lowest harvest index was recorded in control (T_1). The possible cause of the yield increase could be because of application of mepiquat chloride which can attributed to several physiological and agronomic factors that improve plants ability to focus its energy on reproductive growth rather than excessive vegetative growth. The effect of having more sympodial branches per plant, more bolls per plant, and higher average boll weight compared to other treatments led to better architectural plant which resulted more sunlight entered the canopy due to less leaf cover and plants lying down, which led to increased photosynthesis. These findings are in conformity with the results reported by Kaul *et al*.(2016) [14], Kataria and Valu (2018) [15], Veeraputhiran *et al*.(2020) [27], Jadhav *et al* (2020) [13], Vekaria *et al*.(2020) [28]

Chaudhari *et al*.(2021) [6], Priyanka *et al*.(2021) [19], Kakade *et al*.(2023) [16], Bhagat *et al*.(2023) [5], Gohil *et al*.(2024) [9], Ahmad *et al.* (2025) [3].

Mepiquat chloride @45ppm at square initiation and 15 days after first spray (T_5) recorded a notably higher gross monetary returns, net monetary returns and B:C ratio. Nevertheless, it was at par with treatment T_2,T_4, T_6,T_7. Lower economic values were recorded at control (T_1). Similar outcomes were recorded by Shwetha *et al*. (2009) [23], Shekar *et al*. (2010) [21], Sing *et al*. (2014) [24] and Kakade *et al*. (2023) [16].

Conclusion

Based on the current investigation, it can be said that application of Mepiquat chloride @45ppm at square initiation and 15 days after first spray showed better growth parameters, such as plant height, maximum total dry matter collected, number of sympodial branches per plant, and chlorophyll content index. It also had improved yield traits, including the number of picked bolls per plant, seed cotton yield per plant in grams, seed cotton yield per hectare in kilograms, and harvest index mepiquat chloride @45ppm at square initiation and 15 days after first spray gave highest GMR, NMR and B:C ratio.

References

1. Anonymous. Agricultural Market Intelligence Centre, PJTSAU, cotton outlook, January 2025. 2025a.
2. Anonymous. State-wise/year-wise area, production and yield in India. 2025b.
3. Ahmad I, Guanglong Z, Zhou G, Younas MU, Yan X. Melatonin and mepiquat chloride impact on cotton growth, physiological and yield at different growth stages. Ind Crops Prod. 2025;226:120702. doi:10.1016/j.indcrop.2025.120702.
4. Janangir A, Salim M, Islam N, Khairul HA, Kader MA. Detopping reduces field duration of cotton while increases the yield and quality of cotton fiber. J Agric Food Res. 2024.
5. Bhagat SP, Medhe NK, Ilhe SS, Danawale NJ, Bhute NK, Bodake PS, *et al*. Yield maximization of Bt. cotton by integrated crop management techniques. Int J Res Agron. 2023;SP-7(11):395-9.
6. Chaudhari JH, Chauhan SA, Chaudhary MM. Effect of topping and nitrogen levels on growth, yield attributes and yield of Bt cotton under drip irrigation conditions. Pharma Innov J. 2021;10(10):1898-1902.
7. Collins GD, Edmisten KL, Wells R, Whitaker JR. The effects of mepiquat chloride applied to cotton at early bloom and physiological cutout. J Cotton Sci. 2017;21(1):183-9.
8. Dharani K, Ravichandran V, Anandakumar S, Sritharan N, Sakthivel N. Impact of Growth Retardant and Defoliant on Morpho-physiological Traits and Yield Improvement in Cotton. Int J Plant Soil Sci. 2022;34(20):635-44.
9. Gohil VB, Patel DM, Chaudhary MM, Gohil NB, Patel JR. Yield maximization of Bt cotton through agro techniques. Int J Plant Soil Sci. 2024;35(23):650-7. doi:10.9734/ijpss/2023/v35i234284.
10. Hiyat S, Hussain N, Ishaq M, Rehmani A, Abbas MN, Raza S, *et al*. Effect of growth regulator and ultra-narrow row spacing on growth, yield and yield components of cotton. Pak J Agric Res. 2020;33(3):561-9.
11. Iqbal M, Iqbal S, Jahangeer A, Arshad M, Akhtar N, Hussain A, *et al*. Optimizing seed cotton yield: Exploring the synergistic effects of de-topping stage and plant spacing. Sarhad J Agric. 2024;40(4):1277-87.
12. Jadhav AS, Waskar DP, Bhosale GP. Effect of growth regulator and de-topping on productivity of cotton. J Cotton Res Dev. 2015;34(1):62-6.
13. Jadhav AS, Waskar DP, Bhosale GP. Effect of growth regulators on growth and yield of Hirsutum cotton under high density planting. J Cotton Res Dev. 2020;34(1):62-6.
14. Kaul A, Deol JS, Brar AS. Response of different Bt cotton (*Gossypium hirsutum* L.) hybrids to canopy modifications practices. J Appl Nat Sci. 2016;8(3):1188-97.
15. Kataria GK, Valu MG. Effect of detopping and growth retardant on physiological parameter and yield of Bt cotton. J Cotton Res Dev. 2018;32(2):226-30.
16. Kakade SU, Deshmukh V, Gawate AN, Rakhonde OS, Potdukhe NR. Effect of fertigation levels and canopy management practices on growth, yield and economics of Bt cotton (*Gossypium hirsutum* L.). Pharma Innov J. 2023;12(6):4569-75.
17. Murtza K, Ishfaq MN, Akbar S, Hussain SA, Anjum NA, Bukhari AM, *et al*. Effect of mepiquat chloride on phenology, yield and quality of cotton as a function of application time using different sowing techniques. Agronomy. 2022;12:1200.
18. Paslawar AN, Meena AK, Deotalu AS, Bhale VM, Ingole PG, Rathod TH. Foliar application of mepiquat chloride under high density planting system on different species of cotton. In: National Symposium on Future Technologies: Indian cotton in the next decades. 2015.
19. Priyanka K, Sreerekha M, Lakshman K, Rao S. Effect of plant growth regulators on growth and yield of HDPS cotton. J Cotton Res Dev. 2021;36(1):65-70.
20. Rajni, Deol JS. Effect of plant growth regulators on dry matter accumulation, partitioning and fruit retention of Bt cotton. Indian J Ecol. 2015;42(1):270-2.
21. Shekar K, Ramana MV, Devi SS, Kumari SR. Effect of spacing and canopy management on yield, quality and economics of Bt cotton. J Cotton Res Dev. 2010;26(2):209-11.
22. Shekar K, Ramana MV, Kumari SR. Response of hybrid cotton to chloro mepiquat chloride and detopping under high density planting. J Cotton Res Dev. 2015;29(1):84-6.
23. Shwetha NS, Halepyati AS, Pujari BT. Effect of detopping, removal of monopodia and plant spacing on nutrient uptake, quality parameter and economics of Bt cotton. Karnataka J Agric Sci. 2009;22(4):892-3.
24. Singh K, Singh HP, Rathore P, Singh K, Mishra SK. Manipulation of source sink relationship through mepiquat chloride for enhancing cotton productivity and monetary returns in north western India. J Cotton Res Dev. 2014;31(1):62-8.
25. Singh K, Singh HP, Rathore P, Singh K, Mishra SK. Manipulations of source sink relationships through mepiquat chloride for enhancing cotton productivity and monetary returns in north western India. Indian J Cotton Res Dev. 2017;31(1):62-8.
26. Sun Z, Zhang CP, Zhang JL, Wu H, Liu XY, Wang ZK, *et al*. Effects of chemical detopping on cotton plant growth in Guanzhong cotton region. J Agric Sci Technol (Beijing). 2023;25(4):167-77.
27. Veeraputhiran R, Gunasekaran M. Effect of time of growth retardant application on growth of cotton plant under high density planting system. J Cotton Res Dev. 2020;34(1):67-71.
28. Vekaria GB, Patel ML, Talpada MM, Vora VD, Patel TJ,

Hirpara DS. Study on effect of growth regulators on growth parameters and detopping in Bt cotton under rainfed condition. J Cotton Res Dev. 2020;35(1):91-6.
29. Wenqing Z, Qiang Y, Hongkun Y, Xiaoni Y, Leran W, Binglin C, *et al*. Effects of mepiquat chloride on yield and main properties of cottonseed under different plant densities. J Cotton Res. 2019;2:1-10.
30. Zohaib A, Tabassum T, Akhtar N, Abbas T. Managing earliness and yield of cotton by modulating plant population, foliar boron feeding and mepiquat chloride application. N Z J Crop Hortic Sci. 2024.