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Yield Maximization of *Bt.* Cotton by Integrated Crop Management Techniques

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Abstract

A field experiment entitled, "Yield maximization of *Bt*. cotton by integrated crop management techniques" was caried out during kharif, 2023 at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra (India). The experiment was laid out in Randomized Block Design (RBD) with three replications and nine treatments.The results of present investigation revealed that, yield and yield contributing characters of *Bt*. cotton were significantly influenced by differenttreatments.Treatment T_1 i.e., wider spacing (90 cm x 90 cm) recorded significantly maximum number of picked bolls plant^{-1} (49.55) and seed cotton yield plant^{-1} (180.36 g). The highest boll weight (4.00 g), seed cotton yield (4162.18 kg ha^{-1}) and stalk yield (6201.64 kg ha^{-1}) were recorded with treatment T_9 (Cotton in closer spacing + Detopping at 100 cm height + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS).The quality parameters *viz*., ginning percentage (%), lint index (%),micronaire value (µg inch^{-1}), tensile strength (g tex^{-1}), 2.5% span length (mm) and uniformity ratio (%) were not influenced significantly due to different treatments. In economic studies, treatment T_9 (Cotton in closer spacing + Detopping at 100 cm height + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS) recorded highest cost of cultivation (Rs.1,27,328), gross monetary returns (Rs. 2,81,780), net monetary returns (Rs. 1,54,452) and B:C ratio (2.21) than rest of all treatments.

Key words : *Bt*. cotton, closer spacing,mepiquat chloride, detopping, pruning of monopodia.

Cotton is one of the predominant fiber crop and plays a pivotal role in agriculture, industrial development, employment generation and economic development of India. It is called as "King of fibers" and "White gold " due to higher economical values among all cash crops in India. Nearly one third of India's export earnings are from the textile sectors. Apart from its fiber, it contributes considerably to the non-edible oil pool of our country and likely to play pivotal role in paper, particle board and card board industries, etc. in coming decades (Elamathy *et al*., 2022).

With the better understanding of plant growth habits, new agricultural practices are developed for high productivity of the crops. Production and productivity of cotton crop increased with the introduction of genetically modified Bt. cotton in the country. For fully exploitation of the crop yield, there is a need to develop new crop management practices. Excessive vegetative growth with imbalance use of fertilizers and poor agronomic practices attribute to low productivity of cotton in India. Some situation such as high soil fertility and fertilization in irrigated area leads to more vegetative growth of the cotton crop. Growth modification practice becomes important by converting the vegetative phase of the cotton crop to the reproductive phase (Chaudhari *et al*., 2021).

Cotton is a sub-tropical plant having indeterminate growth habit. Among various agronomic practices to boost up crop productivity, plant population is one of the most important factor for efficient utilization of

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available resources. The manipulation of plant density and crop geometry is a time-tested agronomic technique for achieving higher crop yield. In wider spacing, yield reduces due to less plant per unit area and closer spacing reduces yield due to competition within the plants (Gohil *et al*., 2023).

Managing the equilibrium between vegetative and reproductive growth is an important part in cotton production. This can be achieved by detopping and pruning or removal of monopodial branches. Detopping is the removal of top terminal portion after prominent vegetative growth stage. This may encourage growth of already formed sympodia as well as formation and development of fruiting bodies. Detopping may also help to reduce sucking pests and bollworm infestation, as it avoids fresh growth emergence which is unwanted at particular stage (Kakde *et al*., 2023).

Regulation of plant growth and canopy with application of any promising growth regulator may provide an opportunity to modify the plant geometry and density per unit area which affects the economic yield of the crop (Patel *et al*., 2021).Plant growth regulators could be used to partially counteract environmental stresses and improve crop productivity by manipulation of the growth of cotton to get a good architecture to reduce the transpiration to some extent without affecting productivity of plants. Several workers reported that the productivity of unirrigated cotton improved by manipulation of the growth of cotton by using several agro-techniques like detopping and spraying of growth regulators (Vekaria *et al*., 2020).

In India, cotton is grown under diverse agro-climatic conditions. With the better understanding of plant growth habits, new agricultural practices are developed for higher productivity of the crops. Production and productivity of cotton crop increased with the introduction of genetically modified Bt. cotton in the country. For fully exploitation of the crop yield, there is aneed to develop new crop management practices.

Materials and methods

The field experiment entitled, "Yield maximization of Bt. cotton by integrated crop management techniques" was conducted at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri during *kharif* season, 2023-2024.The soil of the experimental plot was clayey in texture, low in available nitrogen (161.55 kg ha^{-1}), medium in available phosphorus (24.22 kg ha^{-1}), very high in available potassium (527 kg ha^{-1}) and slightly alkaline in reaction (pH 7.7). The EC and organic carbon content was 0.38 dSm^{-1} and 0.57 % respectively.The experiment was laid out in Randomized Block Design (RBD) with three replications and nine treatments *viz*., T_1 : Farmer's practice (90 cm x 90 cm spacing), T_2: Cotton in closer spacing (90 cm x 30 cm spacing), T_3 : Cotton in closer spacing + Detopping at 100 cm height, T_4 : Cotton in closer spacing + Pruning of monopodia at 45 DAS, T_5 : Cotton in closer spacing + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS, T_6 : Cotton in closer spacing + Detopping at 100 cm height + Pruning of monopodia at 45 DAS, T_7 : Cotton in closer spacing + Detopping at 100 cm height + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS, T_8 : Cotton in closer spacing + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS, T_9 : Cotton in closer spacing + Detopping at 100 cm height + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS.Seeds of cotton variety Ajeet-155 were sown in line by dibbling method and two hand weedings were given to keep the plots weed free. The recommended fertilizer dose (125:65:65 $N:P_2O_5:K_2O$ kg

ha^{-1}) was applied through urea, SSP and MOP along with FYM.

Results and Discussion

Yield Contributing Characters Studies : The statistically analysed datarevealed that yield and yield contributing characters of Bt. cotton at harvest was significantly influenced due to various treatments. Farmer's practice (90 cm x 90 cmspacing) recorded significantly higher number of picked bolls $plant^{-1}$ at harvest, however, it was at par with treatment T_9 (Cotton in closer spacing(90 cm x 30 cm) + Detopping at 100 cm height + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS) and treatment T_6 (Cotton in closer spacing (90 cm x 30 cm)+ Detopping at 100 cm height + Pruning of monopodia at 45 DAS). Lower number of picked bolls $plant^{-1}$ was recorded at treatment T_2 i.e.,Cotton in closer spacing (90 cm x 30 cm). More number of picked bolls $plant^{-1}$ in farmer's practiceis might be due to the substantial space available for growth, more photosynthetic efficiency, frequent availability of water and nutrients, which resulted in increase in fruiting points, fruiting period, fruit retention and ultimately greater picked bolls $plant^{-1}$. Similar results were obtained by Munir *et al*. (2015) and Uma Maheswari *et al*. (2019).

Treatment T_9 (Cotton in closer spacing (90 cm x 30 cm) + Detopping at 100 cm height + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS) recorded significantly higher boll weight at harvest, however, it was at par with treatment T_6 (Cotton in closer spacing (90 cm x 30 cm) + Detopping at 100 cm height + Pruning of monopodia at 45 DAS). Lower boll weight was recorded at treatment T_2 i.e., closer spacing (90 cm x 30 cm). This might be due to improved source-sink relationship and better partitioning of photoassimilates into reproductive structures as reported by Kaul *et al*. (2016) and Uma Maheswari *et al*. (2019).

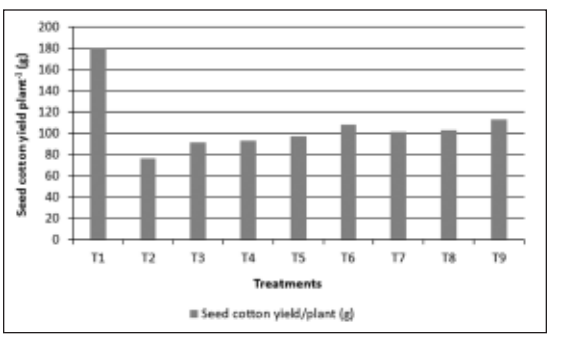
Table 1. Number of picked bolls $plant^{-1}$ and boll weight (g) as influenced by integrated crop management techniques

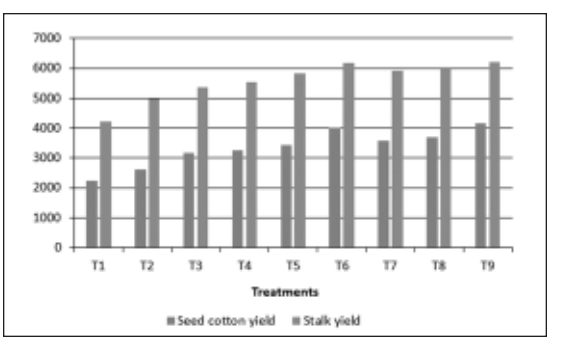
Treatment details	No. of picked bolls $plant^{-1}$	Boll weight (g)
T_1 - Farmer's practice (90 cm x 90 cm spacing)	49.55	3.64
T_2 - Cotton in closer spacing (90 cm x 30 cm spacing)	24.60	3.11
T_3 - Cotton in closer spacing + Detopping at 100 cm height	27.00	3.38
T_4 - Cotton in closer spacing + Pruning of monopodia at 45 DAS	27.15	3.43
T_5 - Cotton in closer spacing + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS	27.40	3.54
T_6 - Cotton in closer spacing + Detopping at 100 cm height + Pruning of monopodia at 45 DAS (T3 + T4)	28.00	3.86
T_7 - Cotton in closer spacing + Detopping at 100 cm height + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS (T_3 + T_5)	27.60	3.66
T_8 - Cotton in closer spacing + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS (T_4 + T_5)	27.85	3.70
T_9 - Cotton in closer spacing + Detopping at 100 cm height + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS (T_3 +T_4 + T_5)	28.20	4.00
S.Em. ±	7.21	0.08
C.D. at 5%	21.63	0.24
General mean	29.70	3.59

Farmer's practice (90 cm x 90 cm spacing) recorded significantly higher seed cotton yield plant^{-1} at harvest, however, it was at par with treatment T_9 (Cotton in closer spacing (90 cm x 30 cm) + Detopping at 100 cm height + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS) and treatment T_6 (Cotton in closer spacing (90 cm x 30 cm) + Detopping at 100 cm height + Pruning of monopodia at 45 DAS). Lower seed cotton yield plant-1 was recorded at treatment T_2 i.e.,closer spacing (90 cm x 30 cm). Under wider spacing availability of photosynthates to individual plant was more to produce maximum seed cotton yield plant-1 as compared to closer plant spacing. This might be due to overall improvement in growth attributes and its positive effect on number of bolls plant^{-1} and seed cotton weight boll^{-1} under wider plant spacing. The above results are in conformity with the findings of Khetre *et al*. (2018) and Gohil *et al*. (2023).

Treatment T_9 (Cotton in closer spacing (90 cm x 30 cm) + Detopping at 100 cm height + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS) recorded significantly higher seed cotton yield at harvest, however, it was at par with treatment T_6 (Cotton in closer spacing (90 cm x 30 cm) + Detopping at 100 cm height + Pruning of monopodia at 45 DAS). Lower seed cotton yield was recorded at farmer's practice (90 cm x 90 cm). The remarkable improvement in seed cotton yield in treatment combination of integrated crop management techniques could be due better partitioning of photo assimilates towards reproductive structures, improved source-sink relationship and better translocation of metabolites towards growing and reproductive sink due to retardation of excessive vegetative growth. The results are in conformity with those obtained earlier by Bhalerao and Gaikwad (2010), Shekar *et al*. (2015), Parihar *et al*. (2018) and Uma Maheswari *et al*. (2019).

Treatment T_9 (Cotton in closer spacing (90 cm x 30 cm) + Detopping at 100 cm height + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS) recorded significantly higher stalk yield at harvest, however, it was at par with treatment T_6 (Cotton in closer spacing (90 cm x 30 cm) + Detopping at 100 cm height + Pruning of monopodia at 45 DAS). Lower stalk yield was recorded at farmer's practice (90 cm x 90 cm). The higher cotton stalk yield under closer spacing is mainly due to higher plant population as compared to the wider spacing. These findings are in line with those supported by Bhalerao and Gaikwad (2010), Shekar *et al*. (2015) and Khetre *et al*. (2018).





Fiber Quality Studies : The statistically analysed datarevealed that the quality parameters of Bt.cotton viz.,ginning percentage (%), lint index (%),micronaire value (µg inch-1), tensile strength (g tex-1), 2.5 % span length (mm) and uniformity ratio (%) were not influenced significantly due to different treatments. Similar results were observed by

Table 2. Seed cotton yield plant^{-1} (g), seed cotton yield (kg ha-1) and stalk yield (kg ha^{-1}) as influenced by integrated crop management techniques

Treatment details	Seed cotton yield plant^{-1} (g)	Seed cotton yield (kg ha^{-1})	Stalk yield (kg ha^{-1})
T_1 - Farmer's practice (90 cm x 90 cm spacing)	180.36	2226.70	4230.73
T_2 - Cotton in closer spacing (90 cm x 30 cm spacing)	76.43	2621.31	4980.48
T_3 - Cotton in closer spacing + Detopping at 100 cm height	91.30	3157.18	5367.20
T_4 - Cotton in closer spacing + Pruning of monopodia at 45 DAS	93.13	3258.16	5538.87
T_5 - Cotton in closer spacing + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS	97.01	3432.28	5834.87
T_6 - Cotton in closer spacing + Detopping at 100 cm height + Pruning of monopodia at	108.08	4011.72	6178.04
T_7 - Cotton in closer spacing + Detopping at 100 cm height + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS (T_3 + T_5)	101.02	3588.92	5921.71
T_8 - Cotton in closer spacing + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS (T_4 + T_5)	103.05	3703.09	6036.04
T_9 - Cotton in closer spacing + Detopping at 100 cm height + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS (T_3 +T_4 + T_5)	112.80	4162.18	6201.64
S.Em.±	24.40	74.49	44.13
C.D. at 5 %	73.20	223.32	132.39
General mean	107.02	3351.28	5587.73

Table 3. Quality parameters as influenced by integrated crop management techniques

Treatment	Ginning percent (%)	Lint index (%) (µg inch^{-1})	Micronaire value	Tensile strength (g tex^{-1}) (mm)	2.5% span length (%)	Uniformity ratio
T_1 - Farmer's practice (90 cm x 90 cm spacing)	34.01	4.02	3.62	27.93	26.90	83.67
T_2 - Cotton in closer spacing (90 cm x 30 cm spacing)	34.08	4.07	3.61	28.07	26.80	85.67
T_3 - Cotton in closer spacing + Detopping at 100 cm height	34.23	4.05	3.50	27.90	27.07	84.00
T_4 - Cotton in closer spacing + Pruning of monopodia at 45 DAS	34.17	4.12	3.73	29.20	27.17	85.00
T_5 - Cotton in closer spacing + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS	33.55	4.16	3.61	28.70	27.57	84.00
T6 - Cotton in closer spacing + Detopping at 100 cm height + Pruning of monopodia at 45 DAS (T_3 + T_4)	34.57	4.26	3.63	27.40	26.00	83.00
T_7 - Cotton in closer spacing + Detopping at 100 cm height + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS (T_3 + T_5)	34.67	4.16	3.69	29.00	27.60	84.00
T_8 - Cotton in closer spacing + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS (T_4 + T_5)	34.73	4.23	3.50	27.93	27.30	85.00
T_9 - Cotton in closer spacing + Detopping at 100 cm height + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS (T_3 + T_4 + T_5)	34.80	4.39	3.70	29.60	27.20	83.00
S.Em. ±	0.26	0.11	0.11	0.47	0.32	1.67
C.D. at 5 %	NS	NS	NS	NS	NS	NS
General mean	34.31	4.16	3.62	28.41	27.07	84.15

Table 4. Economic studies of *Bt.* cotton as influenced by integrated crop management techniques

Treatment	Cost of cultivation (Rs. ha^{-1})	Gross monetary returns (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	B:C ratio
T_1 - Farmer's practice (90 cm x 90 cm spacing)	90567	150748	60181	1.66
T_2 - Cotton in closer spacing (90 cm x 30 cm spacing)	100143	177463	77319	1.77
T_3 - Cotton in closer spacing + Detopping at 100 cm height	109060	213741	104681	1.96
T_4 - Cotton in closer spacing + Pruning of monopodia at 45 DAS	111699	220577	108878	1.97
T_5 - Cotton in closer spacing + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS	111837	232365	120528	2.07
T_6 - Cotton in closer spacing + Detopping at 100 cm height + Pruning of monopodia at 45 DAS (T_3 + T_4)	122993	271593	148601	2.20
T_7 - Cotton in closer spacing + Detopping at 100 cm height + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS (T_3 + T_5)	116895	242970	126074	2.08
T_8 - Cotton in closer spacing + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS (T_4 + T_5)	119535	250699	131164	2.10
T_9 - Cotton in closer spacing + Detopping at 100 cm height + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS (T_3 + T_4 + T_5)	127328	281780	154452	2.21
S.Em. ±	-	3800	4841	0.03
C.D. at 5 %	-	11394	14514	0.09
General mean	112228	226881	114653	2.00

Dhillon *et al*. (2006), Pendharkar *et al*. (2010), Dadgale *et al*. (2012), Kaul *et al*. (2016) and Chetana *et al*. (2023).

Economic Studies : In economic studies, treatment T_9 (Cotton in closer spacing (90 cm x 30 cm) + Detopping at 100 cm height + Pruning of monopodia at 45 DAS + Two sprays of Mepiquat chloride @ 25 g a.i. at 45 and 60 DAS) recorded significantly higher cost of cultivation, gross monetary returns, net monetary returns and B:C ratio.However, it was at par with treatment T_6 (Cotton in closer spacing (90 cm x 30 cm) + Detopping at 100 cm height + Pruning of monopodia at 45 DAS) in case of GMR, NMR and B:C ratio.Lower economic valueswere recorded at farmer's practice(90 cm x 90 cm). This was mainly due to yield obtained in closer spacing was higher than that of wider spacing. Similar results were observed by Shwetha *et al*. (2009), Bhalerao and Gaikwad (2010), Dadgale *et al*. (2012), Singh *et al*. (2017), Khetre *et al*. (2018) and Chetana *et al*. (2023).

Conclusions

On the basis of present investigation, it can be concluded that the *Kharif* season Bt. Cotton shall be sown at 90 cm x 30 cm spacing along with complete package of integrated crop management techniques including detopping at 100 cm height, pruning of monopodia at 45 DAS and application of mepiquat chloride @ 25 g a.i. at 45 and 60 DAS for getting maximum yields, gross monetary returns, net monetary returns and benefit cost ratio in medium black soil of Maharashtra.

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Conflict of Interest : The authors declare there are no conflict of interest relevant to this article.

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