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Response of growth and yield of Bt cotton to planting densties as influnced by growth regualtors

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Abstract

The present investigation was carried out at Department of Agronomy, Parbhani to study Response of growth and yield of Bt cotton to planting densties as influnced by growth regualtors during 2014-15 and 2015-16. The soil of the experimental plot was clayey in texture, low in available nitrogen, medium in available phosphorus and high in available potassium and slightly alkaline in reaction. The experiment was laid out in split plot design with four plant densities *i.e.* S_1-120 x 45 cm (18518 plants ha^{-1}), S_2-90 x 45 cm (24691 plants ha^{-1}), S_3-90 x 30 cm (37037 plants ha^{-1}) and S_4-90 x 15 cm (74074 plants ha^{-1}) and six growth regulator treatments G_1- CCC (60 ppm) at square formation and flowering, G_2- CCC (60 ppm) at flowering and boll formation, G_3- Mepiquat chloride (50 g ha^{-1}) at square formation and flowering, G_4- Mepiquat chloride (50 g ha^{-1}) at flowering and boll formation, G_5- Nitrobenzene (400 ppm) at square formation and flowering, G_6- Nitrobenzene (400 ppm) at flowering and boll formation. Study revealed that the plant spacing of 120 x 45 cm recorded significantly increased growth attributes *i.e.*, number of functional leaves, dry matter per plant (g), number of monopodial and number of sympodial branches per plant and yield contributing characters *i.e.* number of picked bolls per plant, boll weight (g), seed cotton yield per plant (g) over rest of the spacings. The significantly taller plants was recorded with plant spacing of 90 x 15 cm as compared to other plant spacing's. Similarly maximum seed cotton yield (kg ha^{-1}) was recorded with plant spacing of 90 x 30 cm than plant spacing's of 90 x 45 cm, 120 x 45 cm and 90 x 15 cm. The plant height was significantly lower with application of mepiquat chloride (50 g ha^{-1}) at square formation and flowering (G_3) as compared to other growth regulator treatments. Significantly higher number of sympodial branches per plant, number of picked bolls, seed cotton yield per plant (g) and boll weight were improved due to application of mepiquat chloride (50 g ha^{-1}) at square formation and flowering (G_3) as compared with other growth regulator. while significantly higher number of functional leaves per plant and dry matter accumulation per plant were recorded with application of nitrobenzene (400 ppm) at square formation and flowering (G_5).

Keywords: Plant spacing, growth regulators, yield attributes, yield Bt cotton

Introduction

Cotton (*Gossypium spp* L.) is one of the predominant fibre crops playing a pivotal role in agriculture, industrial development, employment generation and economy of India. It is also called as king of fibre due to higher economical value among all cash crops in India. Cotton is the most important cash and commercial crop contributing nearly 75 per cent of total raw material needs of textile industry in India. Textile industry is the number one export enterprise in the country earning revenue of over $ 8.5 billion. Hence, it is also called as 'White gold'. Cotton belongs to the genus Gossypium under tribe Gossypiceae of Malvaceae family. There are four species of cotton under cultivation i.e. *Gossypium herbaceum* L., *G. arboreum* L., *G. hirsutum* L., and *G. barbadense* L. India is the only country where all four cultivated species of cotton are grown. Cotton is multipurpose crop that supplies basic products like fibre, oil, oil cake, hulls and linters (Anonymous 2015-16) [1-2].

It is cultivated on about 33.0 million hectare across the world. India has the distinction of having the largest area under cotton cultivation in the world ranging between 11-12 million hectare. It accounts for about 33% of the global cotton area and contributes 21% (5.86 million tonnes) of the global cotton produce, currently ranking second after China. The yield per hectare is however the lowest i.e. 481 kg ha-1 against the world average 763 kg ha-1 and major cotton producing countries viz., Brazil (1600 kg ha-1), China (1311 kg ha-1), USA (945 kg ha-1), Uzbekistan (859 kg ha-1) and Pakistan (684 kg ha-1) (Anonymous 2015-16) [1-2]. In Maharashtra cotton is cultivated over an area of 38.72 lakh hectares with production of 81 lakh bales and having productivity of 356 kg lint ha-1 (Anonymous 2015-16) [1-2]. Low productivity of cotton in Maharashtra is mainly due to growing of cotton under rainfed condition (96-97 % of area). Plant population is one of the most important factors for efficient utilization of available sources. The manipulation of plant density and crop geometry is a time tested agronomic technique for achieving high crop yield. The manipulation of row spacing, plant density and the spatial arrangements of cotton plants, for obtaining higher yield have been attempted by agronomists for several decades in many countries. In wider spacing, reduction in yield is due to less plant per unit area; where as in closer spacing reduction in yield is due to competition within the plants. Cotton (*Gossypium hirsutum* L.) is a subtropical plant with an indeterminate growth habit. Vegetative and reproductive development occurs simultaneously. While vegetative growth is necessary to support reproductive growth, excessive vegetative growth can be detrimental. Growth habits of cotton varieties are inconsistent, with many characterized by their tendency for aggressive vegetative growth. The growth habit of these varieties combined with high availability of nutrients, timely rainfall or irrigation, and delayed fruit retention can encourage excessive vegetative growth. Under excessive vegetative growth causes fruit abortion, delayed maturity, Boll rot, Shading of the lower canopy and harvest reduced. One of the important physiological disorders which reduce seed cotton yield is boll shading. To get maximum yield in cotton it is essential to retain more bolls per plant. Plant growth regulators modify plant growth and divert energy allocation within the plant. It decreases cotton vegetative growth by modifying the production of plant hormones such as gibberellins, auxins and cytokinins.

Materials and Methods

A experiment on Bt cotton was conducted during 2014-15 and 2015-16 at Agronomy Department Farm, College of Agriculture, Parbhani. The soil of the experimental plot was clayey in texture, low in available nitrogen, medium in available phosphorus and high in available potassium and slightly alkaline in reaction.

The experiment was laid out in split plot design with four plant densities that is S_1-120 x 45 cm (18518 plants ha^{-1}), S_2-90 x 45 cm (24691 plants ha^{-1}), S_3-90 x 30 cm (37037 plants ha^{-1}) and S_4-90 x 15 cm (74074 plants ha^{-1}) and six growth regulator treatments G_1- CCC (60 ppm) at square formation and flowering, G_2- CCC (60 ppm) at flowering and boll formation, G_3- Mepiquat chloride (50 g ha^{-1}) at square formation and flowering, G_4- Mepiquat chloride (50 g ha^{-1}) at flowering and boll formation, G_5- Nitrobenzene (400 ppm) at square formation and flowering, G_6- Nitrobenzene (400 ppm) at flowering and boll formation. Well decomposed FYM 5 t and recommended fertilizers dose 120:60:60 NPK kg ha^{-1} were applied.

The other usual common package of practices was carried out time to time and periodical growth observations were recorded at an interval of 30 days.

Results and Discussion

Growth parameters

Effect of plant spacing

The data in Table 1 revealed that the plant spacing of 90 x 15 cm was found to be significantly taller plants over other treatments of plant spacing's during both the years. It might be due to competitions for solar radiation in closer spacing for the photosynthesis and there by plant produced more height in search of light. Similar differences in plant height due to plant densities were reported by. The plant spacing of 120 x 45 cm was found to be significantly superior over rest of the plant spacingss by recording more monopodial branches per plant, sympodial branches, no. of leaves and total dry matter production. It was mainly due to availability of adequate amount of nutrients, moisture and light interception for optimum growth and development, leading to production of more number of sympodia, no of leaves and total dry matter production. The observations are in confirmity with Hallikeri and Halemani (2002) [3].

Effect of growth regulators

Data presented in Table 1 revealed that plant height was significantly lower with application of mepiquat chloride (50 g ha^{-1}) at square formation and flowering (G_3) as compared to other growth regulator treatments. The decrease in plant height of cotton plant sprayed with mepiqaut chloride could be due to the interference of this growth regulator in gibberellic acid biosynthetic pathway. The reduced amount of gibberellins in the plant system affects the growth and decrease plant height. The present results corroborate with the findings of It was observed (Table 1) that non significant effect by application of growth regulators on monopodial branches per plant during both the years. Significantly higher number of sympodial branches per plant was recorded by application of mepiquat chloride (50 g ha^{-1}) at square formation and flowering (G3) over rest of the treatments. Application of nitrobenzene (400 ppm) at square formation and flowering (G_5) was significantly superior in recording no of leaves per plant and dry matter accumulation over rest of the treatments except it was at par to nitrobenzene (400 ppm) at flowering and boll formation (G_6) and CCC (60 ppm) at flowering and boll formation (G_2).

Interaction effects

Interaction effects between plant densities and growth regulators were found non significant.

Yield attributes and yield studies

Effect of plant densities

The data in Table 2 stated that during both the year's plant spacing of 120 x 45 cm was found to be significantly superior over other plant spacing's in recording more number of picked bolls per plant and seed cotton yield per plant except plant spacing 90 x 45 cm was found at par to it while boll weight was non significant. This might be due to the maximum interception of solar radiation, maximum utilization of available nutrient, least competition for moisture and adequate aeration resulted in synthesis of higher photosynthetes and ultimately produced higher seed cotton yield under wider plant spacing. The significant decrease in number of bolls $plant^{-1}$ with increase in plant density was also experienced by Prasad and Prasad (1993) [6].

The plant spacing 90 x 30 cm was recorded significantly more seed cotton yield (kg ha^{-1}) over other plant spacing's during 2014-15, 2015-16 and in pooled analysis but it was found at par to plant spacing 90 x 15 cm during 2014-15 and 2015-16. Though number of bolls per plant and the boll weight was higher in wider spacing's, the beneficial effect was offset due to less number of plants per unit area and higher number of plants per unit area in closer spacing. The results are in conformity with those obtained earlier by Srinivasulu *et al.* (2006) [7].

Effect of growth regulators

From the table 2 it was observed that application of mepiquat chloride (50 g ha^{-1}) at square formation and flowering (G_3) was recorded significantly higher number of picked bolls per plant and mean seed cotton yield per plant compared to other treatments except application of mepiquat chloride (50 g ha^{-1}) at flowering and boll formation (G_4) was found at par to it during both the years while boll weight was non significant. The increase in no of picked bolls per plant with mepiqaut chloride application was due to improved source sink relationship and setting percentage, increased no. of sympodials and no. of square. The results are in conformity with the results reported by More *et al.* (1993) [4].

Similarly application mepiquat chloride (50 g ha^{-1}) at square formation and flowering (G_3) produced higher seed cotton yield of 2048, 1766 and 1907 kg ha^{-1} during 2014-15, 2015-16 and pooled data respectively and was found significantly superior over other growth regulator during both the years and pooled data except application of mepiquat chloride (50 g ha^{-1}) at flowering and boll formation (G_4) and CCC (60 ppm) at square formation and flowering (G_1) were at par to it during both the years. The increased seed cotton yield kg ha^{-1} might be due to better fruiting efficiency, vegetative growth, maximum retention of squares per plant, no. of picked bolls per plant and bigger boll size which ultimately reflected in higher seed cotton yield per plant and finally seed cotton yield (kg ha^{-1}). These results are also comparable with by Nawalagathi *et al.* (2011) [5].

Interaction effects

Interaction effects between plant densities and growth regulators were found non significant.

Table 1: Effect of plant densities and growth regulators on growth of Bt cotton

Treatments	Plant height (cm)		Monopodia		Sympodia		No of leaves per plant		Total dry matter (g plant^{-1})	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Plant densities (cm)										
S_1 -120 x 45 (18518 plants ha^{-1})	93.19	86.11	2.76	2.35	18.25	16.63	85.82	81.21	180.62	177.17
S_2 - 90 x 45 (24691 plants ha^{-1})	100.23	93.62	2.44	2.18	16.69	15.15	80.53	76.43	175.56	169.62
S_3 - 90 x 30 (37037 plants ha^{-1})	109.22	100.93	2.36	2.05	12.76	12.08	73.59	69.38	161.66	156.66
S_4- 90 x 15 (74074 plants ha^{-1})	121.48	115.12	2.16	1.77	10.92	9.13	69.39	64.73	145.97	143.32
S.E.(m)±	2.61	2.46	0.10	0.09	0.51	0.43	1.58	1.42	3.48	3.27
C.D. at 5%	9.01	8.50	0.33	0.31	1.78	1.48	5.45	4.91	12.05	11.33
Growth regulators										
G_1- CCC (60 ppm) at square formation and flowering	102.57	95.99	2.41	2.14	14.88	13.34	75.78	72.40	162.65	157.63
G_2- CCC (60ppm) at flowering and boll formation	106.62	100.11	2.41	2.02	13.77	12.95	78.90	73.49	166.85	163.23
G_3- Mepiquat chloride (50 g ha^{-1}) at square formation and flowering	96.17	86.53	2.64	1.97	18.80	16.71	72.15	69.22	155.31	151.62
G_4- Mepiquat chloride (50 g ha^{-1}) at flowering and boll formation	100.68	95.03	2.58	2.07	16.75	14.98	74.84	70.59	159.89	155.64
G_5- Nitrobenzene (400 ppm) at square formation and flowering	117.22	112.16	2.35	1.99	12.86	11.45	83.11	77.64	177.88	173.33
G_6- Nitrobenzene (400 ppm) at flowering and boll formation	112.93	103.84	2.21	2.33	10.87	10.03	79.20	74.27	173.13	168.70
S.E.(m)±	3.47	3.01	0.12	0.12	0.76	0.70	2.18	1.83	4.60	4.56
C.D. at 5%	9.92	8.59	NS	NS	2.17	2.00	6.22	5.22	13.15	13.02
S x G Interaction										
S.E.(m)±	6.94	6.01	0.25	0.25	1.52	1.40	4.35	3.65	9.20	9.11
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
GM	106.03	99.94	2.43	2.09	14.65	13.24	77.33	72.94	165.95	161.69

Table 2: Effect of plant densities and growth regulators on yield attributes and seed cotton yield of Bt cotton.

Treatments	No. of picked bolls		Boll weight (g)		Seed cotton yield per plant (g plant^{-1})		Seed cotton yield (kg ha^{-1})		
	2014	2015	2014	2015	2014	2015	2014	2015	Pooled
Plant densities (cm)									
S_1 -120 x 45 (18518 plants ha^{-1})	28.09	25.99	3.25	3.08	91.38	80.15	1498	1230	1364
S_2 - 90 x 45 (24691 plants ha^{-1})	26.48	24.01	3.15	3.07	83.41	73.74	1766	1517	1642
S_3 - 90 x 30 (37037 plants ha^{-1})	21.65	18.90	3.05	3.04	66.04	57.57	2055	1743	1899
S_4- 90 x 15 (74074 plants ha^{-1})	10.54	8.76	3.00	3.03	31.49	26.57	1882	1601	1742
S.E.(m)±	0.60	0.58	0.05	0.03	2.33	2.15	62.50	54.53	32.25
C.D. at 5%	2.09	2.02	NS	NS	8.05	7.43	189	158	102
Growth regulators									
G_1- CCC (60 ppm) at square formation and flowering	22.31	19.87	3.13	3.07	70.38	61.07	1851	1614	1733
G_2- CCC (60ppm) at flowering and boll formation	21.08	18.78	3.08	3.03	65.71	56.91	1760	1494	1627
G_3- Mepiquat chloride (50 g ha^{-1}) at square formation and flowering	25.17	22.96	3.14	3.10	79.77	71.62	2048	1766	1907
G_4- Mepiquat chloride (50 g ha^{-1}) at flowering and boll formation	23.48	21.38	3.11	3.06	73.92	65.58	1920	1618	1769
G_5- Nitrobenzene (400 ppm) at square formation and flowering	20.04	17.76	3.10	3.05	62.59	54.28	1696	1404	1550
G_6- Nitrobenzene (400 ppm) at flowering and boll formation	18.04	15.73	3.11	3.02	56.11	47.59	1529	1240	1385
S.E.(m)±	0.80	0.80	0.03	0.03	2.97	2.72	69	76.04	40.75
C.D. at 5%	2.28	2.27	NS	NS	8.48	7.77	197	217	120
S x G Interaction									
S.E.(m)±	1.60	1.59	0.06	0.06	5.94	5.43	137	152	97.53
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
GM	21.66	19.41	3.11	3.06	67.99	59.51	1800	1522	1661

Conclusion

From the results of present investigation it can be concluded that the plant spacing 120 x 45 cm beneficial for improving growth character and yield attributes while for higher seed cotton yield per ha plant spacing of 90 x 30 cm was found effective. In case of growth regulators application of mepiquat chloride (50 g ha^{-1}) at square formation and flowering was found effective in reducing plant height and increasing yield attributes.

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