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RESEARCH ARTICLE :

Phenology, plant height and dry matter production plant^{-1}of Bt and non-Bt cotton (*Gossypium hirsutum* L.) cultivars at different stages as influenced by different plant densities and nitrogen levels

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SUMMARY : A field experiment was conducted during 2015-16 and 2016-17 at Agricultural Research Institute, Rajendranagar,Hyderabad to assess the performance of two cotton cultivars Bt (MRC 7201 BGII) and non-Bt (WGCV-48) in response to plant densities (P_1: 18,518 plants ha^{-1}, P_2: 55,555 plants ha^{-1} and P_3:1,48,148 plants ha^{-1}) and nitrogen fertilization (120, 150 and 180 kg N ha^{-1}). The results revealed that, during 2015 and 2016, among the two cultivars (V_1: MRC 7201 BG II, V_2: WGCV-48), MRC 7201 BG II cultivar showed higher plant height, crop dry matter plant^{-1}, leaf area index,number of main stem nodes plant^{-1}, number of sympodial branches plant^{-1}over V_2: WGCV-48 cultivar in all growth stages. Among the plant densities, even though the plant density of P_1: 18,518 plants ha^{-1}showed more crop dry matter plant^{-1},number of main stem nodes plant^{-1}**,**number of sympodial branches plant^{-1} in all growth stages, but the plant density of P_2: 55,555 plants ha^{-1}significantly more kapas yield (3319, 2726 kg ha^{-1} with more number of bolls m^{-2} (131, 116). However, remaining two plant densities P_1: 18518 plants ha^{-1} and P_3:1,48,148 plants ha^{-1} were showed comparable yields. Regarding nitrogen levels (N_1: 120 kg ha^{-1}, N_2: 150 kg ha^{-1} and N_3: 180 kg ha^{-1}) did not show any significant effect on growth and yield components in any stage of crop growth.

KEY WORDS :
Bt cotton, Nitrogen, Leaf area index, Phenology, Main stem nodes, Sympodia, Seed cotton yield, Plant density

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BACKGROUND AND OBJECTIVES

Cotton (*Gossypium hirsutum* L.) is the most important commercial fibre crop of India since time immemorial. Its productivity however, has made little progress since independence.The development of cotton hybrids with a gene from the soil bacterium *Bacillus thuringiensis* (Bt) by Monsanto enabled the plant to produce toxins to defend against bollworms attack. The Bt cotton hybrids were commercialized in USA in 1996 and subsequently introduced to Central and Southern cotton zones of India in 2002 with the grant of permission for cultivation of three Bt cotton hybrids. Subsequently in 2005, six Bt cotton hybrids were approved for cultivation in North cotton zone. Recent region-specific studies in India have found that Bt hybrids improved yields by 45-87 per cent (AICCIP, 2007).

The high density planting system (HDPS) is now being conceived as an alternate production system having a potential for improving productivity and profitability, increasing efficiency, reducing input costs and minimizing risks associated with India's cotton production system. A high density planting system (HDPS) leading to more rapid canopy closure and decreased soil water evaporation, is becoming popular to address water scarcity challenges. In many countries, narrow row plantings have been adopted after showing improvement in cotton productivity (Ali *et al*., 2010). Monsanto has reported a 13-65 per cent rise in yields in Gujarat, while the yields were up 44 per cent in Maharashtra. In Andhra, the yields were up by about 48 per cent. The adoption of HDP, along with good fertilizer management and better genotypes, is a viable approach to break the current trend of stagnating yield sunder primarily rainfedhirsutum (upland) cotton growing areas. So, a proper space between plants and row spacing is a key agronomic factor to optimize the crop profit (Zaxosa *et al*., 2012).

Nitrogen, an integral component of many plant compounds such as amino acids, that are the building blocks of proteins, is a vital nutrient for the growth and development of cotton. As N is a mobile element, its deficiency during the early and mid-season results in the chlorosis of older leaves. Its deficiency also leads to reduced plant height, fruiting branches and increased boll shed. The yield response of Bt cotton (Pettigrew and Adamczyk, 2006) and increases in Bt protein content with N fertilization (Yang *et al*., 2005) demands adequate N fertilization. The information on comparative performance of Bt and non-Bt cottons under different nitrogen fertilization levels and plant densities in Telangana state of India is lacking. Hence, the present study was undertaken to find the response of Bt and non Bt cotton cultivars to different N fertilizer and plant densities for highest yield.

RESOURCES AND METHODS

These investigations were carried out during *Kharif* 2015-16 and 2016-17 at Agricultural Research Institute, Rajendranagar, Hyderabad situated at an altitude of 542.3 m above mean sea level at 17°19' N latitude and 78°23' E longitude. It is in the Southern Telangana agro-climatic zone of Telangana. According to Troll's climatic classification, it falls under semi-arid tropics (SAT). The experiment was laid out in Randomized Block Design (Factorial) replicated thrice with two cultivars (MRC 7201 BG II, WGCV-48) three plant densities (P_1: 18,518 plants ha^{-1} P_2: 55,555 plants ha^{-1} P_3:1,48,148 plants ha^{-1}) and three nitrogen levels (N_1: 120 kg ha^{-1}, N_2: 150 kg ha^{-1}, N_3: 180 kg ha^{-1}). The soil of the experimental site was sandy loam in texture, neutral in reaction, low in available nitrogen, phosphorus and high in available potassium. During the crop period rainfall of 375.3 mm was received in 27 rainy days in first year and 740.9 mm in 37 rainy days in second year, respectively as against the decennial average of 616.2 mm received in 37 rainy days for the corresponding period indicating 2016-17 as wet year comparatively.

Field was ploughed once with tractor drawn mould board plough followed by cultivator and later with disc harrow. The land within each plot was leveled in order to maintain uniform irrigation water application. Cotton crop was sown on July 8, 2015 and July 7, 2016 by dibbling seeds in opened holes with a hand hoe at depth of 4 to 5 cm as per the spacing in treatments *viz.*, 90 cm x 60 cm, 60 cm x 30 cm and 45 cm x 15 cm. A uniform dose of 60 kg ha^{-1} P_2O_5 as single super phosphate, potassium @ 60 kg ha^{-1} as muriate of potash was applied to all the treatments of Btcotton cultivar. Entire dose of phosphorus was applied as basal at the time of sowing.Nitrogen was applied as per the treatments (wherever it was required) in the form of urea (46 % N) in four equal splits (20, 40, 60 and 80 days after sowing). Similarly, the remaining potassium was applied along with urea in four splitsat 20, 40, 60 and 80 days after sowing (DAS), respectively. Whereas, for non Bt cotton cultivar uniform dose of 45 kg ha^{-1} P_2O_5 as single super phosphate, potassium @ 45 kg ha^{-1} as muriate of potash was applied to all the treatments. Entire dose of phosphorus was applied as basal at the time of sowing. Nitrogen was applied as per the treatments (wherever it was required) in the form of urea (46 % N) in three equal splits (30, 60 and 90 days after sowing). Similarly, the remaining potassium was applied along with urea in 3 splitsat 30, 60 and 90 days after sowing), respectively.

Pre emergence herbicide pendimethalin @ 2.5 ml l^{-1} was sprayed to prevent growth of weeds. Post emergence spray of quizalofop ethyl 5% EC @ 2 ml l^{-1} and pyrithiobac sodium 10% EC @ 1 ml l^{-1}. Hand weeding was carried out once at 35 DAS.First irrigation was given immediately after sowing of the crop to ensure proper and uniform germination. Later irrigations were scheduled uniformly by adopting climatological approach *i.e.,* IW/CPE ratio of 0.80 at 5 cm depth. During crop growing season sucking pest incidence was noticed. Initially at 25 DAS spraying of monocrotophos @ 1.6 ml l^{-1} was done. During later stages, acephate @ 1.5 g l^{-1} and fipronil @ 2 ml l^{-1} were sprayed alternatively against white fly and other sucking pests complex during the crop growth period as and when required. For controlling boll worms in non Bt cultivar, monocrotophos@ 1.6 ml l^{-1} and emamectin benzoate 5 % SG @ 0.5 g l^{-1} was sprayed based on the infestation whenever required. Five plants in each net plot were selected at random and tagged for taking observations on growth parameters (phenology, plant height and dry matter production plant^{-1}) at square initiation, first flowering, first boll formation, boll development, first boll bursting and first picking stages and yield attributes and yield at each picking. Destructive sampling for dry matter production was done in gross plots by taking two plants each time from the border rows leaving the extreme row of the plot.The plants were initially dried in the shade then cut in to pieces and transferred to labeled brown paper bags and later kept in a hot air oven at 74^{0}C the weight of the oven dried plants was recorded and the mean value was recorded as the dry matter accumulation plant^{-1} of cotton.Data on different characters *viz*., growth and yield components and yield, were subjected to analysis of variance procedures as outlined for Randomized Block Design, factorial concept (Gomez and Gomez, 1984). Statistical significance was tested by F–value at 0.05 level of probability and critical difference was worked out wherever the effects were significant.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Plant height (cm) :

Data obtained on plant height during the period of study was analysed statistically and presented in Table 1. During both the years of study plant height increased as the age of crop advanced. In 2015, higher plant height was observed in MRC 7201 BGII cultivar at square initiation (26.9 cm), flower initiation (61.4 cm), boll initiation (93.6 cm), boll development (117.6 cm), boll bursting (119.2 cm), first picking (125.0 cm) and significantly superior to WGCV-48.In 2016, maximum plant height (26.2 cm, 60.8 cm, 93.9 cm, 109.6 cm, 136.7 cm, 141.4 cm) was recorded with MRC 7201 BGII cultivar at square initiation, flower initiation, boll initiation, boll development, boll bursting and first picking stages respectively and was significantly superior to WGCV-48, which recorded the lowest plant height at square initiation (23.5 cm), flower initiation (53.3 cm), boll initiation (87.4 cm), boll development (105.0 cm), boll bursting (126.5 cm), first picking (131.1 cm).The probable reason for this might be the variation in the genetic constitution of the cultivars which has responded better in plant height.These results were in closer conformity with the findings of Manjunatha *et al.* (2010) and Gangaiah *et al.* (2013). During 2015 and 2016, at square initiation, significantly higher plant height was observed in P_3: 45 cm x 15 cm (1,48,148 plants ha^{-1}) (29.6 cm, 27.8 cm) followed by P_2: 60 cm x 30 cm (55,555 plants ha^{-1}) (25.0, 24.5 cm) and P_1: 90 cm x 60 cm (18,518 plants ha^{-1}) (23.6, 22.2 cm) respectively, while P_2 (24.5 cm) was on par with P_3(22.2 cm) in 2016. The plant height was higher with P_2: 60 cm x 30 cmat flower initiation (63.5cm, 60.6 cm), boll initiation (95.4 cm, 94.7 cm), boll development (121.4 cm, 110.5 cm), and boll bursting (123.7 cm, 137.0 cm), first picking (131.7 cm, 141.2 cm) in 2015 and 2016, respectively. Morphological changes in plants are induced when plant density is increased mainly because of competition for light when soil fertility and moisture are not limited increased plant density results in mutual shading of plants which usually results in stem elongation. The taller plants at higher plant density late in the season might be due to inter plant competition for nutrients and light. Further the availability of horizontal space for individual plant at closer spacing reduced, due to which intense inter plant competition for nutrient and light suppressed node appearance and plants grew taller in respect of vertical space (Wang *et al.*, 2011). Nitrogen levels did not show any significant influence on plant height at all growth stages of cotton crop during 2015 and 2016. These results were substantiated by the findings of Aruna (2016) and Sankaranarayanan *et al.* (2011).

Phenology :

Days taken to attain each phenological phase was significantly affected by cultivars, whereas, nitrogen (N) levels and plant densities did not influence the phenology of the cotton(Table 2). Interactions were not found statistically significant at any stage of the crop growth.In 2015 and 2016, the earliest square initiation (30, 32 days), flower initiation (50, 52 days),boll initiation (57, 58 days), boll development (80, 84 days), boll bursting (102, 107 days) and days to first picking (113, 119 days) were observed with MRC 7201 BGII cultivar, which was significantly more number of days to square initiation (31, 33 days),flower initiation (56, 57 days), boll initiation (59, 64 days),boll development (83, 88 days) boll bursting (112, 116 days) first picking(129, 136 days) were taken for WGCV-48. In general, all the hybrids required lesser days to square, to flower, to boll and to mature than conventional varieties. MRC 7201 BGII cultivar was the earliest and took least number of days for all phenological events.Theseresults were in close agreement with findings of Ban *et al.* (2015).

Dry matter production (g plant^{-1}) :

Data pertaining to cultivars, plant densities and nitrogen levels on dry matter (DM) productionper plant was analysed statistically and found to vary significantly at all the growth stages during 2015 and 2016 (Table 3). Dry matter production increased steadily after square initiation until maturity with regard to cultivars and plant densities during the period of investigation.

At square initiation, there was no significant difference between different cultivars during both years while, MRC 7201 BGII cultivar was significantly superior in dry matter plant^{-1} at flower initiation (53, 45 g plant^{-1}), boll initiation (81, 67g plant^{-1}), boll development (220, 177g plant^{-1}), boll bursting (222, 242g plant^{-1}), first picking (246, 241g plant^{-1}) to WGCV-48.The per cent increase in dry matter production of MRC 7201 BGII over WGCV-48was 5, 9 % during 2015 and 2016, respectively at first picking. Higher dry matter production per plant pertaining to MRC 7201 BGII cultivar may be attributed to the improvement in the assimilation of photosynthates and their accumulation inleaves, stem and reproductive parts at various stages of crop growth.These results were in

Table 1 : Plant height (cm) of cotton cultivars at different growth stages as influenced by plant densities and nitrogen levels

Treatments	Square initiation		Flower initiation		Boll initiation		Boll development		Boll bursting		1st picking	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Factor 1 (Cultivars)												
V_1 (MRC 7201 BGII)	26.9	26.2	61.4	60.8	93.6	93.9	117.9	109.6	119.2	136.7	125.0	141.4
V_2 (WGCV-48)	25.2	23.5	58.6	53.3	89.2	87.4	114.5	105.0	113.8	126.5	120.0	131.1
S.E.±	0.5	0.4	0.9	0.7	1.3	1.1	1.1	1.2	1.9	1.8	1.7	2.0
C.D. (P=0.05)	1.5	1.1	2.5	2.0	3.6	3.3	3.3	3.5	5.3	5.3	4.8	5.7
Factor 2 (Plant densities)												
P_1 (90 cm x 60 cm)	23.6	22.2	59.2	57.3	91.6	89.8	117.0	106.9	117.5	130.0	120.3	132.8
P_2 (60 cm x 30 cm)	25.0	24.5	63.5	60.6	95.4	94.7	121.4	110.5	123.7	137.0	131.2	141.2
P_3 (45 cm x 15 cm)	29.6	27.8	57.4	53.3	87.1	87.4	110.1	104.5	108.4	127.7	116.0	134.6
S.E.±	0.6	0.5	1.1	0.8	1.5	1.4	1.4	1.5	2.3	2.2	2.0	2.4
C.D. (P=0.05)	1.8	1.3	3.1	2.4	4.4	4.0	4.0	4.3	6.5	6.4	5.9	7.0
Factor 3 (Nitrogen levels)												
N_1 (120 kg N ha^{-1})	26.7	24.9	59.3	56.6	91.9	90.5	115.0	107.5	117.0	133.1	121.3	138.8
N_2 (150 kg N ha^{-1})	25.7	25.1	60.7	57.1	90.4	91.9	116.0	107.9	114.2	128.7	121.9	132.4
N_3 (180 kg N ha^{-1})	25.8	24.6	60.1	57.4	91.8	89.5	117.5	106.4	118.2	132.9	124.4	137.4
S.E.±	0.6	0.5	1.1	0.8	1.5	1.4	1.4	1.5	2.3	2.2	2.0	2.4
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS=Non-significant

close agreement with findings of Manjunatha *et al.* (2010) and Shukla *et al*. (2013).

In 2015 and 2016 significantly more dry matter accumulation plant^{-1}was observed in P_1: 90 cm x 60 cm (18,518 plants ha^{-1}) at flower initiation (69, 49g plant^{-1}), boll initiation (95, 70g plant^{-1}), boll development (250, 221g plant^{-1}), boll bursting (253, 275g plant^{-1}), first picking (301, 298g plant^{-1}) and significantly superior toP_2: 60 cm x 30 cm (55,555 plants ha^{-1}) and P_3: 45 cm x 15 cm (1,48,148 plants ha^{-1}). Lowest dry matter accumulation plant^{-1} was observed in P_3: 45 cm x 15 cm at flower initiation (35, 27g plant^{-1}), boll initiation (62, 42g plant^{-1}), boll development (175, 118g plant^{-1}), boll bursting (178, 192g plant^{-1}), first picking (184, 160g plant^{-1}). The per cent increase in dry matter production forP_1 over P_2 and P_3 at first picking was 23, 21 % and 50, 59 % during 2015 and 2016, respectively. Dry matter plant^{-1} was higher with wider spacing, this might be due to more canopy development under wider spacing (Devraj *et al*., 2011). The marked improvements in growth and yield attributing character was brought due to the more availability of solar radiation and that helps to synthesis and partitioning of assimilates to individual plant under wider spacing, which ultimately translocate assimilates from source to sink that leads to significant increment in growth attributes in respect of dry matter of plant (Bhalerao *et al*., 2008 and Madhavi, 2016). Effect of different nitrogen levels on plant height, dry matter production was non-significant at all growth stages during both years of investigation. These results substantiate the findings of Aruna (2016) and Reddy and Kumar (2010). Interaction effect between cultivars and plant densities, plant densities and nitrogen levels, cultivars and nitrogen levels and cultivars, plant densities and nitrogen levels on dry matter production of cotton crop was found non- significant during both years of study.

Yield and yield attributes :

The highest number of bolls m^{-2} (132, 115) was obtained with MRC 7201 BGII cultivar and was significantly superior over WGCV-48 cultivar (89, 82) during 2015 and 2016, respectively (Fig. 1). During both the years of study significant increase in number of bolls m^{-2} was observed as the plant densities increased from 1.8 plants m^{-2} to 5.5 plants m^{-2} and then decreased as plant density increased further to 14.8 plants m^{-2}. More number of bolls m^{-2} (131, 116) was observed in P_2: 60 cm x 30 cm (55,555 plants ha^{-1}) was significantly superior to P_1: 90 cm x60 cm (18,518 plants ha^{-1}) andP_3: 45 cm x15 cm (1,48,148 plants ha^{-1})in turn P_3(78, 74) recorded significantly the lowest number of bolls m^{-2}.The above results were inconformity with results of Dong *et al.*

Table 2 : Number of days to attain different phenophases of cotton cultivars as influenced by plant densities and nitrogen levels

Treatments	Square initiation		Flower initiation		Boll initiation		Boll development		Boll bursting		1st picking	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Factor 1 (Cultivars)												
V_1 (MRC 7201 BGII)	30	32	50	52	57	58	80	84	102	107	113	119
V_2 (WGCV-48)	31	33	56	57	59	64	83	88	112	116	129	136
S.E.±	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.1
C.D. (P=0.05)	0.5	0.2	0.4	0.3	0.3	0.4	0.4	0.5	0.4	0.3	0.1	0.2
Factor 2 (Plant densities)												
P_1 (90 cm x 60 cm)	31	33	53	55	58	60	81	86	107	111	121	128
P_2 (60 cm x 30 cm)	30	33	53	55	58	61	81	86	107	111	121	128
P_3 (45 cm x 15 cm)	31	33	53	55	58	61	82	86	107	112	121	128
S.E.±	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.0	0.1
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Factor 3 (Nitrogen levels)												
N_1 (120 kg N ha^{-1})	31	33	53	55	58	61	81	86	107	111	121	128
N_2 (150 kg N ha^{-1})	31	33	53	55	58	61	81	86	107	111	121	128
N_3 (180 kg N ha^{-1})	31	33	53	55	58	61	81	86	107	112	121	128
S.E.±	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.0	0.1
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS=Non-significant

(2012), where high plant density increased the number of bolls per unit area relative to low plant densities. No. of bolls m^{-2} was not significantly influenced by the nitrogen levels of cotton crop during both the years of the experiment. Reddy and Kumar (2010) and Bhalerao and Gaikwad (2010) also recorded non-significant influence of fertilizers on no. of bolls m^{-2}.

The response due to variation in cultivars was similar in both years of study. The highest seedcotton yield (3497 and 2866 kg ha^{-1}) was obtained with MRC 7201 BGIIcultivar and was significantly superior to WGCV-48 cultivar (2560 and 2078 kg ha^{-1}). The rate of increase in seed cotton yield with V_1 was 28 and 27 %during 2015 and 2016 over V_2, respectively (Fig. 2). Higher seed cotton yield was evidently due to cumulative effect of more number of bolls/plant and boll weight in Bthybrid than non Bt. The better performance of MRC 7201 BGII cultivar over WGCV-48 cultivar was ascribed to higher boll numbers $plant^{-1}$ and heavier boll weight and the superior performance of Bt hybrids might be also due to inbuilt resistance to boll worms by Bt gene which in turn might have caused Bt hybrids to move in to reproductive phase early by curtailing vegetative growth and helped to produce higher seed cotton yield (Aruna, 2016).

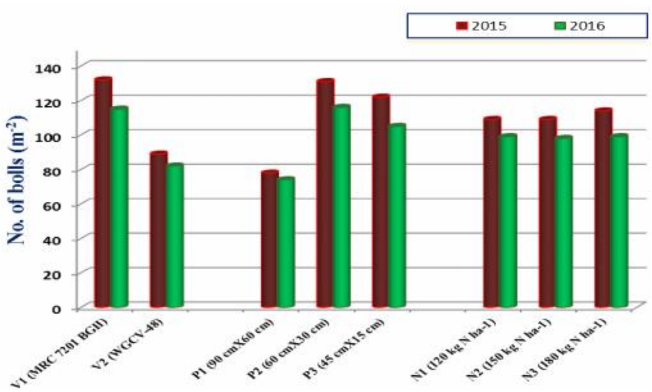

Fig. 1 : Number of bolls (m^{-2}) of Bt and non Bt cotton cultivars as influenced by cultivars, plant densities and nitrogen levels during 2015 and 2016

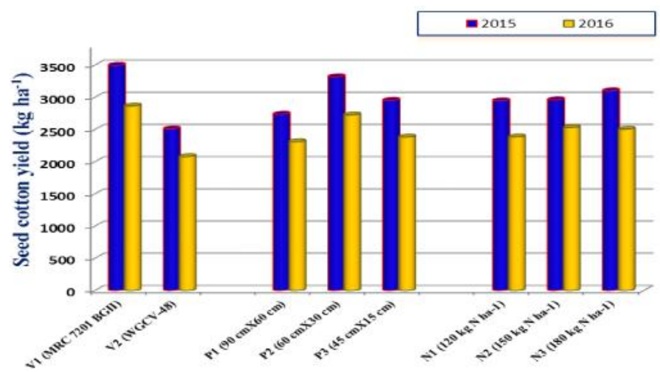

Fig. 2 : Seed cotton yield of Bt and non Bt cotton cultivars as influenced by cultivars, plant densities and nitrogen levels during 2015 and 2016

Table 3 : Dry matter (g $plant^{-1}$) production cotton at different growth stages as influenced by cultivars, plant densities and nitrogen levels

Treatments	Square initiation		Flower initiation		Boll initiation		Boll development		Boll bursting		1st picking	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Factor 1 (Cultivars)												
V_1 (MRC 7201 BGII)	5	5	53	45	81	67	220	177	222	242	246	241
V_2 (WGCV-48)	5	4	50	33	77	50	209	163	212	227	231	219
S.E.±	0.1	0.1	1.1	1.4	1.0	2.6	1.5	4.8	1.5	2.8	4.0	7.3
C.D. (P=0.05)	NS	NS	3.1	4.0	3.0	7.4	4.4	13.7	4.4	8.2	11.6	21.1
Factor 2 (Plant densities)												
P_1 (90 cm x 60 cm)	5	4	69	49	95	70	250	221	253	275	301	298
P_2 (60 cm x 30 cm)	5	5	49	42	80	64	218	170	220	236	231	233
P_3 (45 cm x 15 cm)	5	4	35	27	62	42	175	118	178	192	184	160
S.E.±	0.1	0.1	1.3	1.7	1.3	3.2	1.9	5.8	1.9	3.5	5.0	9.0
C.D. (P=0.05)	NS	NS	3.8	4.9	3.6	9.1	5.4	16.8	5.4	10.0	14.2	25.8
Factor 3 (Nitrogen levels)												
N_1(120 kg N ha^{-1})	5	5	51	37	78	58	213	170	216	238	244	241
N_2(150 kg N ha^{-1})	5	4	50	40	78	61	213	164	215	231	237	226
N_3(180 kg N ha^{-1})	5	5	52	41	81	56	217	175	220	234	235	223
S.E.±	0.1	0.1	1.3	1.7	1.3	3.2	1.9	5.8	1.9	3.5	5.0	9.0
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS=Non-significant

Significantly higher seedcotton yield (3319 and 2726 kg ha^{-1})was obtained in P_2: 60 cm x30 cm (55,555 plants ha^{-1}) over P_3: 45 cm x15 cm (1,48,148 plants ha^{-1}) and P_1: 90 cm x60 cm (18,518 plants ha^{-1}), while P_3 (2954 and 2381 kg ha^{-1}) and P_1(2738 and 2309 kg ha^{-1}) are comparable and on par with each other. The per cent increase of seedcotton yield in $P_2$11, 13 % and 17,15 % during 2015 and 2016 over P_3 and P_1, respectively.The ultimate seed cotton yield is the manifestation of yield contributing characters. These yield attributing characters were significantly affected by different plant populations. Even though, the boll number, boll weight and seed cotton yield plant^{-1} were significantly higher with wider spacing, it could not compensate for the loss in number of plants ha^{-1} and number of bolls m^{-2}, thus recorded lower seed cotton yield ha^{-1} when compared to high density planting. Higher plant density at closer spacing recorded significantly higher seed cotton yield than lower plant density at wider spacing due to significantly more number of bolls m^{-2} and higher plant stand ha^{-1} (Manjunatha *et al.*, 2010 and Brar *et al.*, 2013). The seed cotton yield was not influenced by the nitrogen levels during both the years of study. Reddy and Kumar (2010); Bhalerao and Gaikwad (2010) and Aruna (2016) also recorded insignificant influence of fertilizers on seed cotton yield.

Conclusion :

In conclusion, during 2015 and 2016, among the two cultivars (V_1: MRC 7201 BG II, V_2: WGCV-48), MRC 7201 BG II cultivar showed higher plant height, crop dry matter plant^{-1},no of bolls m^{-2}and seed cotton yield (kg ha^{-1}) over V_2: WGCV-48 cultivar in all growth stages. Among the plant densities, even though the plant density of P_1: 18,518 plants ha^{-1} showed more plant height, crop dry matter plant^{-1}in all growth stages, but the plant density of P_2: 55,555 plants ha^{-1} significantly more seed cotton yield with more number of bolls m^{-2}.

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