Determining the Optimal Plant Spacing for Cotton Varieties to Enhance the Growth and Yield of Cotton Under HDPS in Karaikal Region.

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ABSTRACT
Cotton has now become well-known and grown all throughout the world and all the states of India. India's seed cotton production per unit area is still significantly lower than that of several other cotton-growing countries throughout the world. Two of the most prominent factors leading to the country's low cotton crop productivity are a lack of plant population and the use of low-potential cultivars. it is important to investigate new strategies for cotton production. In April 2020, a field experiment was conducted to study the effect of different plant varieties and spacing on the growth and yield of compact-type cotton. The experiment followed a split-plot design with three replications, with four levels of cotton varieties (Suraj, Supriya, CO 15 and CO 17) in the main plots and seven levels of plant spacing (60 cm x 10 cm, 60 cm x 15 cm, 80 cm x 10 cm, 80 cm x 15 cm, 100 cm x 10 cm, 100 cm x 15 cm, and 75 cm x 30 cm) in the subplots. The results revealed that cotton crop growth such as plant height, leaf area index and dry matter production, was higher in CO 17 than in other varieties. Compared to the yield and yield component variety CO 17 recorded higher seed cotton yield with more bolls per plant and highest boll weight than others.
Results revealed that the higher plant spacing of 1,66,666 plants (60 x 10 cm) observed significant maximum plant height. In contrast, the 100 x 10 cm plant spacing recorded the highest growth contributing characteristics, such as leaf area index and dry matter production. 100 x 10 cm spacing has recorded a significantly higher number of bolls per plant; the highest single boll weight and maximum seed cotton yield were recorded. Among the interaction varieties, CO 17 with a 100 x 10 cm plant spacing registered the highest leaf area index and dry matter production in growth, considering yield and yield parameters, recorded higher seed cotton yield, higher number of bolls per plant and boll weight during the cropping period.

Keywords: Cotton, high density planting system, variety, plant spacing, growth, yield

INTRODUCTION

Cotton is an important commercial fibre crop of India with a significant role in Indian agriculture and industrial development. It is known as the 'King of fibres crops' and 'White Gold' because of its high economic value. It provides employment opportunities to about 70 million people directly and it contributes nearly 70 per cent of the total raw material to the textile industry in India. India is one of the largest producer and consumer of cotton in the world around 25% and 22% share, respectively, and about 41% of the cotton cultivation area is in India. Although the productivity of cotton in India (462 kg/ha) is far behind the world average (759 kg/ha) (CCI, 2022). Cotton productivity in India is low due to many factors such as the large portion of the cotton area of the country being rainfed, terminal drought and nutrient stress in long-duration cotton cultivars, scarcity of labour and increased labour cost. Among the above constraints, scarcity of labours and labour cost are predominantly affects the cotton productivity as it needs staggered harvesting (3-5 pickings). Recent research findings suggested that the modern concept called high density planting system is the best solution for mechanical harvesting (Singh *et al*., 2016). High density planting system in cotton is also being an alternate way to enhance the productivity and profitability of cotton.

India ranks first in the world cotton production by 2021– 22, its productivity levels are very low despite the availability of Bt technology. Khan *et al*. (2019) observed that an expanding population requires global efforts to increase crop production, especially those fulfilling food and clothing needs. On the other hand, high input costs especially higher prices of Bt cotton seed (Gadade *et al*., 2015) coupled with multiple management have threatened cotton productivity. Many cotton producing countries like Brazil, China, Australia, Spain, Argentina and Greece tested, proved and adopted narrow row planting system of cotton as tool to achieve higher productivity (Rossi *et al*., 2004; Ali *et al*., 2010).

In High Density Planting System (HDPS), researchers aim to maintain 1-2 lakh cotton plants ha^{-1} of land. The intra row spacing could be as low as 30 cm instead of 90 cm to 1 meter for conventional cotton. The reshaping of crop geometry is an agronomic technique for acquiring higher yield. This alteration enables a greater number of plants per hectare with 8

- 14 bolls per plant with 4 g per boll. In cotton, the crop geometry has influence on seed cotton yield. Closer plant geometry recorded higher seed cotton yields (Paslawar *et al*., 2015; Parlawar *et al*., 2017; Madavi *et al*., 2017 and Meena *et al*., 2017. Plant competition for resources in higher population resulted in smaller cotton plant with a higher resource use efficiency (Liu *et al*., 2020) but results in poor boll load and delayed late-season leaf senescence (Luo *et al*., 2018). Increased plant density would be beneficial to cotton yield in the lower fertility field (Dong *et al*., 2010; Sankaranarayanan *et al*., 2018).

Inappropriate planting density, either low or high may exhibit enormous risk for yield formation (Khan *et al*., 2020). Optimizing plant population is an inexpensive practice that can significantly increase crops production, including castor and cotton (Severino et al., 2012; Li *et al*., 2020). At present, high density planting system has been suggested as an alternative strategy instead of conventional one to increase yield and it is a time-tested agronomic technique to improve yield profitability and also to improve input use efficiency (Venugopalan *et al*., 2011; Nalayini and Manickam, 2018). Therefore, establishing an appropriate plant stand is paramount to obtain higher yields as lower plant density will be wastage of resources while, high plant density limits individual plant growth (Brodrick *et al*., 2013). Cotton is extremely sensitive to adverse environmental conditions and field management. The current day cotton varieties are of long duration, tall-growing, and with long sympodial growth. This leads to an increase in the cost of cultivation because of more manual pickings (Gunasekaran *et al*., 2020).

To improve productivity, optimize profit, and select management strategies under rising production costs, the alternative way is a high -density planting system. It is the manipulation of row spacing, plant density, and the spatial arrangement of cotton plants for obtaining higher yields. In simple terms, it is growing cotton densely than what is being practiced. This planting system produces fewer bolls than conventionally planted cotton but retains a higher percentage of total bolls in the first sympodial position and a lower percentage in the second position (Vories and Glover 2006). The High Density Planting System (HDPS) besides providing better light interception, efficient leaf area development, and early canopy closure which will shade out the weeds and reduce their competitiveness (Wright *et al*., 2011) also provides synchronized flowering, uniform boll bursting and early cut-off (Gunasekaran *et al*., 2020). Hence, HDPS is the solution to improve productivity and profitability, increase input use efficiency, and minimize the risks associated with current cotton production in India.

Differences in canopy architectural attributes among varieties impact cotton growth, lint yield and management. The response of varieties with contrasting plant architecture to planting densities has important implications to cotton crop management decisions such as seeding rates. Reductions in seeding rates are gaining traction due to high seed costs and technology fees associated with transgenic cotton varieties coupled with increased adoption of seed treatments for disease, insect, and nematode control. The consequent reduction in plant density may have implications for variety selection and crop management due to modifications in plant architectural traits. Cotton plant architecture is a hereditary character that can be modified by selection

The availability of compact genotypes, altering of crop geometry, application of growth regulators and application of fertilizers on need based will bring the high density cotton under mechanized cultivation in India. To mechanize the cotton cultivation since it is a labour intensive and to increase the profitability, compact cotton genotypes provide a great scope. Compact genotypes are ideally suited for machine pickings and high density planting because of their short stature, lesser vegetative growth, fewer and shorter fruiting branches, short inter branch and inter boll distance and synchronous maturity. Due to their earliness it can be harvested in two or three pickings (Patil *et al*., 2017).

Cotton varieties like CSH 3075, CO 15, CO 17, etc. are specifically developed for the cultivation of cotton under HDPS in India. CO 15 and CO 17 varieties are released by the Department of Cotton, Tamil Nadu Agricultural University, Coimbatore, and these varieties have shown considerable improvement in the yield over the check variety Suraj (National check entry identified for HDPS) (Kumar *et al*., 2020). Development of ideal varieties having better adaptation to high density planting with better growth characters and optimum plant population is paramount importance for this new method of HDPS. With this back ground, present investigation was carried out evaluate suitable varieties and to standardize optimum plant population requirement of cotton under HDPS.

MATERIALS AND METHODS

The experiment on "Influence of cotton varieties and plant spacing on growth, yield and yield parameters" was conducted during April 2020 to find out the influence of different plant varieties and various plant spacing of compact type cotton on growth and yield at a farmer's field at Subrayapuram village, Thirunallar taluk, Karaikal district of Puducherry, India The experimental site is situated at 10°93'N latitude and 79°78'E longitude at an altitude of +4 m above mean sea level in the southern part of India. Karaikal region comes under the Eleventh Agro Climatic Zone of India under All India Agro Climatic Zonal Classification (PCI, 1989). It is classified as PC_2 - Coastal deltaic alluvial plain zone under All India agro ecological classification. The soil analysis resulted that the texture of the soil is clay loam with having organic carbon upto 0.46 during 2020. The initial soil analysis resulted that available nitrogen is low (208 kg ha^{-1}), available phosphorous is medium (15.8 kg ha^{-1}) and available potassium is medium (271 kg ha^{-1}) during the year 2020. Karaikal region has a tropical climate with a mean maximum and minimum temperature of 33.2 ^{o}C and 24.4 ^{o}C, respectively. The annual total rainfall is 1314.55 mm. The total annual evaporation is 1956.4 mm and the annual total bright sunshine hour is 2610.2. The mean annual morning and evening relative humidities are 87.4 and 62.2%, respectively. The statistical design adopted for the experimentation was Split Plot design, with three replications and twenty-eight treatment combinations. The main plots were four cotton varieties viz., M1: Suraj; M2 Supriya, M3: CO 15 (TCH 1705) and M4: CO 17 (TCH 1819) Each of these main plots were divided into seven sub-plots. The sub-plots consisted of seven plant spacing viz., S1: 60 cm × 10 cm; S2: 60 cm × 15 cm; S3: 80 cm × 10 cm; S4: 80 cm × 15 cm; S5: 100 cm × 10 cm; S6: 100 cm × 15 cm and S7: 75 cm × 30 cm as the experiment was laid on April 2020.

Field was ploughed once with disc plough followed by cultivator twice. Rotavator was used to break the clods and then bunds, ridges and furrows were formed. The crop was sown on April 24, 2020 by dibbling seeds at a depth of 4 to 5 cm as per spacing in treatments. Fertilizer dose of 100:50:50 kg NPK. ha^{-1} was applied. Entire dose of phosphorus, 50 per cent of N and K were applied as band placement 5 cm away and 5 cm below the seed row as basal placement. The remaining ½ N and K were top dressed at 40 – 45 DAS. Pre emergence herbicide pendimethalin @ 1.0 kg ha^{-1} was sprayed to prevent the growth of weeds. Hand weeding was carried out at 40 DAS. First irrigation was given at the time of sowing to ensure uniform germination and life irrigation was given on third day after sowing. The subsequent irrigations were scheduled at 7-10 days interval depending upon the field moisture condition. During the cropping period, sucking pest incidence was noticed. Initially imidaclorpid @ 2 ml.l^{-1} was sprayed. At later stages, Acephate @ 4 ml.l^{-1} was sprayed against white fly incidence as and when required. Harvesting of kapas was commenced on 125 DAS and pickings were taken at 2-3 days intervals. The number of bolls on labeled plants from each plot were noted at each picking and expressed per plant. Harvested bolls from each treatment was weighed and expressed in kg ha^{-1}. Data on different characters viz., growth and yield attributes were statistically analyzed as described by Gomez and Gomez (1984). Wherever the results were significant, critical differences was worked out at five per cent level.

RESULTS AND DISCUSSION

Plant Height (cm)

Plant height differs significantly among the varieties and also among the plant spacing (Table 1). Significantly higher plant height was observed in variety CO 17 (105 cm) followed by CO 15 (99.58 cm) which was on par with suraj (98.57) and recorded lower plant height of variety supriya. This is because of the compact types had a shorter stature, shorter plant height (Ahmed *et al*., 2014). Similar results were reported by Parihar *et al.* (2018)

Plant spacing showed no significant difference with plant height at 30 DAS and thereafter, the difference in plant height was observed for various spacing treatments. The highest plant height was observed with a narrow spacing of 60 x 10 cm was recorded 109.56 cm. The maximum height was because of the competition for solar radiation for the photosynthetic process. This was in confirmation with the results of Ram and Giri (2006) and Munir *et al*. (2015). In that, the availability of horizontal space for the individual cotton plant in narrow rows reduced due to which intense interplant competition for nutrient and light suppressed node appearance and plants grew taller in respect of vertical space. The data has shown evidence that there was a significant difference in plant height between the main and sub plot treatment. Among the treatment combination, CO 17 at 60 x 10 cm spacing (M_4S_1) had substantially greater plant heights of 122.6 cm. In general, the plant height increases with decrease in plant spacing dueto competition for light and variety character. Similar findings were reported by (Devi *et al*., 2012).

Leaf Area Index (LAI)

There existed a significant difference in leaf area index of cotton (Table 1). Among the variety, CO 17 variety recorded significantly higher LAI of 3.48 compared to other genotypes. More number of leaves produced in CO 17 variety with almost similar size of leaves with other genotypes resulted in increased LAI. Differences in leaf area index might be differences in genetic makeup viz., short stature, number of leaves per plant and shape of leaf as the broad leaf characters and okra type leaf characters agreed with the findings of Kumar *et al*., (2017)

Leaf area is the photosynthetic surface that plays an important role in production. Leaf area index increased gradually up to 90 DAS and reached a maximum of 3.59. The leaf area was higher in the narrow spacing of 100 x 10 cm was due to increased plants per unit land area. The increased LAI was due to more plants per unit area: thereby, more leaves lead to more LAI. This agreed with the findings of Udikeri and Shashidhara (2017) that the total dry matter production of cotton and supply of required photosynthates for the developing bolls largely depends on leaf area and leaf area index. The interaction effect between varieties and plant spacing followed bad significant affected the LAI. Among the treatment combination CO 17 cotton variety with a spacing of 100 x 10 spacing recorded higher LAI of 3.70 at 90 DAS and it was followed by variety CO 17 with a spacing of 60 x 15 cm. The treatment combination of Supriya with 75 x 30 cm spacing recorded least LAI of 3.30 at 90 days after sowing. This might be due to greater light interception perunit of soil area at the same LAI in narrower rows than with wider ones. The greater light interception could indicate that the leaf area was more uniformly distributed over the soil surface with narrow rows, instead of concentrated over the row centers as with wide rows. This resulted in greater cotton growth rates as measured by grams of dry matter accumulated per unit area of soil and per unit of leaf area reported by Kumar *et al*., (2019).

Drymatter production (kg ha^{-1})

Dry matter production varied significantly due to variety and due to plant spacing (Table 2). Cotton variety CO 17 produced significantly more DMP (5326 kg ha^{-1}) followed by CO 15 (5097 kg ha^{-1}) which was on par with Suraj (5040 kg ha^{-1}), however it recorded lesser DMP. Higher drymatter production by CO 17 was mainly due to higher growth parameters (plant height and leaf area index) and higher yield attributes like number of sympodiaplant^{-1}, sympodial length and number of bolls plant^{-1}. Similar results were found by Pandagale *et al*. (2007) who revealed that the drymatter produced per plant alone does not reflect on the efficiency of the genotypes, but its greater partitioning into the reproductive parts is the real index of its effectiveness.

Dry matter accumulation is the index of growth put forth by crop. Higher dry matter production was observed with the narrow spacing of 100 x 10 cm (5506 kg ha^{-1}). Increased dry matter production in narrow spacing may be due to more accumulation of dry matter in leaves, stem, and reproductive parts. Similar results were found by Kavya *et al*. (2020) that higher dry matter production of cotton at narrow spacing may be related to the better distribution of plant population in the NR (Narrow Row) system, which may be more effective to intercept the light. In dry matter production, the interventions considerably impacted the interaction between cotton varieties and plant spacing. Among, the treatment combination of CO 17 variety planted with spacing of 100 x 10 cm significantly recorded higher DMP of 5766 kg ha^{-1} at 120 DAS respectively. It was followed by CO 17 at a spacing of 60 x 15 cm. Supriya with 75 x 30 cm spacing had significantly lower DMP of 4416 kg ha^{-1} at 120 DAS. Increased DMP in the treatment combination of CO 17 variety planted with spacing of 100 x 10 cm might be due to the higher photosynthesis is achieved because of the efficient utilization of space, light and nutrients which inturn reflected in total DMP. Similar results were also obtained by Baumhardt *et al.* (2018) and Afzal *et al.* (2019).

Number of bolls plant^{-1}

Number of bolls per plant was significantly influenced by variety and plant spacing and also among their interactions (Table 2). The variety CO 17 produced significantly more number of bolls per plant (12.24) which was on par with CO 15 (12.03). The variety Supriya produced lower number of bolls (10.93). This difference might be due to genetic potential of the plant. Similar result was reported by Ajayakumar et al. (2017).

Comparing plant spacings, the higher number of bolls per plant of 13.18 was significantly registered with 100 x 10 cm. and this might be due to reduced competition for resources like nutrients, light, spacing etc. This is in confirmation with the earlier findings of Stephenson *et al.* (2011) and Kumar et al., (2017) they reported that higher plant density decreased the monopodia and increase sympodia and number of fruit branches. Significantly least number of bolls per plant of 11.10 was registered under the spacing of 75 x 30 cm.

Among the interaction, the treatment combinations of CO 17 cotton variety adopted with the spacing of 100 x 10 cm recorded a significantly higher number of bolls per plant of 13.86. It was followed by CO 17 with a spacing of 60 x 15 cm. Significantly lower number of bolls per plant of 12.82 was registered with the combination of Supriya raised with a spacing of 75 × 30 cm. This in consonance with the earlier findings of Udikeri and shashidhara (2017) who had reported that increased sympodia and boll number were higher due to better assimilation and translocation of photosynthates to the reproductive sink.

Boll weight (g boll^{-1})

Boll weight was significantly influenced by variety (Table 3) and the genotype CO 17 recorded significantly higher boll weight (3.67 g) which was on par with CO 15 (3.58 g). Lower boll weight (3.41 g) was recorded with supriya. The difference in genotypes in their yield potential might be depending on many physiological processes, which are controlled by both genetic makeup of the plant and the environment (Udikeri and Shashidhara, 2017).

Among the different plant spacings followed, cotton crop grown with spacing of 100 x 10cm (S_5) significantly registered higher value of 3.80 g and it was followed by 60 x 15 cm (S_2). The lower boll weight of 3.31 g was registered with 75 x 30 cm (S_7) spacing. Boll weight was significantly differed with plant spacing. This in confirmation with the report of Sadhik *et al.* (2022) that there is significant difference was observed in boll weight between different spacing treatments. The interaction effect was found to be significant. The variety CO 17 adopted with the spacing of 100 x 10 cm (M_4S_5) recorded significantly higher boll weight of 4.02 g, followed by CO 17 with 60 x 15 cm (M_4S_2) spacing. Venugopalan *et al.* (2011) and Sawan, (2016) reported that irrespective of cotton genotypes the boll number per plant decreased with closer spacing due to greater inter-plant competition. However, the increase in the number of plants per unit area at closer spacing compensated for this decline and hence the boll number m^{-2} was significantly higher at all the closer spacings compared to the recommended (75 × 30 cm) spacing.

Seed cotton yield (kg ha^{-1})

Seed cotton yield was significantly influenced due to variety and plant spacings listed in (Table 3). Among the different cotton varieties chosen, the cotton variety CO 17 (M_4) significantly registered higher the seed cotton yield of 2129 kg ha^{-1}, which was superior to the rest of the treatments. This was followed by CO 15 (M_3) with seed cotton yield of 2030 kg ha^{-1}. The lowest seed cotton yield of 1813 kg ha^{-1} was obtained from the cotton variety Supriya. The differences in seed cotton yield by the genotypes might be the yielding ability of a genotype is the reflection of its yield attributing characters like more number of matured open bolls and boll weight (Sisodia and Khamparia (2007) Tuppad (2015). Since the genotype CO 17 is resistance to bollworm attack and produced healthy matured bolls with more boll weight.

Among the plant spacing adopted the treatment of 100 x 10 cm (S_5) significantly registered the highest seed cotton yield of 2268 kg ha^{-1}. This was followed by 60 x 15 cm (S_2), with a seed cotton yield of 2168 kg ha^{-1}. The lowest seed cotton yield of 1714 kg ha^{-1} was recorded in the spacing of 75 x 30 cm (S_7). Single plant has greater opportunities to achieve maximum productivity when given ample space to grow, it ultimately resulted in better nourishment and higher seed cotton yield plant-1 but these higher values of yield components in wider spacing were compensated through higher plant population per unit area under closer spacings and resulted in higher yields. These results are in agreement with Singh *et al*. (2012), Nalayini and Manickam (2018)

Among the interaction between cotton varieties and plant spacing, cotton varieties CO 17 raised with a plant spacing of 100 x 10 cm (M_4S_5), registered the maximum seed cotton yield of 2456 kg ha^{-1}. This was followed by the treatment combination of cotton variety CO 17 with a spacing of 60 x 15 cm, which recorded the seed cotton yield of 2328 kg ha^{-1}. The treatment combination of variety supriya with spacing of 75 x 15 cm had registered the lowest seed cotton yield of 1624 kg ha^{-1}. From this itis clearly understood that CO 17 could withstand plant population pressure and the competition between the plants are also found to be lesser. All the yield attributing characters were lesser with closer spacing of 100 × 10 cm thus the increase inseed cotton yield might be due to more plant population over wider spacing in the experiment. Further the angle and orientation of leaves were found adjusted at higher population, thereby minimizing overlapping and mutual shading, responsible for greater leaf development at high population resulting in increased growth and yield attributes. Increase in yield in HDPS was also reported by Arunvenkatesh and Rajendran (2013); Paslawar *et al*., 2015; Pradeep Kumar *et al*., 2017; Nalayini and Manickam (2018) and chen *et al*., 2019.

Conclusions

From the results of opinion and extent of adoption of HDPS cotton, it can be concluded that, the HDPS growers in majority knew improved cultivation practices of HDPS Cotton but adopted to a moderate extent and most of the farmers opinion are, HDPS cotton cultivation was better compared to the traditional and pest attack also less. Furthermore, it was clear that as knowledge and adoption increased, there is a decrease in level of constraints faced by the HDPS Cotton producers. The present field experiment inferred that the compact cotton variety CO 17 performed differently and better to obtain higher seed cotton yield among the different varieties. Among the plant spacing, adopting 100 x 10 cm plant spacing (1,00,000 plants ha^{-1}) is found to be optimum for the high density planting system. If mechanized combine harvesting is possible with the treatment combination of CO 17 with 100 x 10 cm spacing.

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Table 1. Effect of cotton varieties and plant spacing on plant height (cm) and leaf area index

Treatment	Plant height (cm)					Treatment	Leaf area index				
	M_1	M_2	M_3	M_4	Mean		M_1	M_2	M_3	M_4	Mean
S_1	109.18	97.42	109.26	122.36	**109.56**	S_1	3.25	3.13	3.34	3.56	**3.32**
S_2	102.52	95.76	109.16	111.86	**104.83**	S_2	3.49	3.37	3.59	3.60	**3.51**
S_3	95.78	84.02	95.80	95.86	**92.87**	S_3	3.26	3.24	3.37	3.41	**3.34**
S_4	102.42	84.18	102.48	109.14	**99.56**	S_4	3.48	3.35	3.49	3.58	**3.47**
S_5	95.74	88.84	89.13	95.77	**92.88**	S_5	3.59	3.47	3.60	3.70	**3.59**
S_6	95.82	89.10	102.38	102.44	**97.44**	S_6	3.33	3.27	3.48	3.59	**3.42**
S_7	88.54	88.42	88.88	93.56	**89.85**	S_7	3.23	3.12	3.34	3.45	**3.21**
Mean	**98.57**	**89.68**	**99.58**	**105.00**		**Mean**	**3.41**	**3.30**	**3.44**	**3.48**	
	M	**S**	**MxS**	**SxM**			**M**	**S**	**MxS**	**SxM**	
SEd	1.93	2.19	4.49	4.37		**SEd**	0.03	0.03	0.05	0.05	
CD(p=0.05)	4.73	4.40	9.39	8.80		**CD(p=0.05)**	0.07	0.05	0.11	0.10	

M1: Suraj; M2 Supriya, M3: CO 15 (TCH 1705) and M4: CO 17 (TCH 1819)
S1: 60 cm × 10 cm; S2: 60 cm × 15 cm; S3: 80 cm × 10 cm; S4: 80 cm × 15 cm; S5: 100 cm × 10 cm; S6: 100 cm × 15 cm and S7: 75 cm × 30 cm

Table 2. Effect of cotton varieties and plant spacing on Dry matter Production (kg ha^{-1}) and Number of bolls plant^{-1}

Treatment	Dry matter Production (kg ha^{-1})					Treatment	Number of bolls plant^{-1}				
	M_1	M_2	M_3	M_4	Mean		M_1	M_2	M_3	M_4	Mean
S_1	4813	4587	4877	5107	**4846**	S_1	11.26	10.22	11.58	12.18	**11.51**
S_2	5293	5067	5344	5583	**5322**	S_2	12.58	11.78	13.16	13.76	**12.82**
S_3	4877	4650	4940	5164	**4908**	S_3	11.76	10.42	11.82	11.86	**11.47**
S_4	5118	4886	5174	5400	**5144**	S_4	12.48	11.12	12.56	13.12	**12.32**
S_5	5477	5250	5531	5766	**5506**	S_5	13.18	12.45	13.22	13.86	**13.18**
S_6	5059	4827	5119	5345	**5088**	S_6	11.84	11.06	12.46	12.52	**11.97**
S_7	4643	4416	4695	4920	**4668**	S_7	10.14	9.45	10.36	11.46	**11.10**
Mean	**5040**	**4812**	**5097**	**5326**		**Mean**	**11.88**	**10.93**	**12.03**	**12.24**	
	M	**S**	**MxS**	**SxM**			**M**	**S**	**MxS**	**SxM**	
SEd	88	81	174	163		**SEd**	0.20	0.19	0.41	0.38	
CD(p=0.05)	215	163	370	327		**CD(p=0.05)**	0.48	0.39	0.86	0.77	

M1: Suraj; M2 Supriya, M3: CO 15 (TCH 1705) and M4: CO 17 (TCH 1819)
S1: 60 cm × 10 cm; S2: 60 cm × 15 cm; S3: 80 cm × 10 cm; S4: 80 cm × 15 cm; S5: 100 cm × 10 cm; S6: 100 cm × 15 cm and S7: 75 cm × 30 cm

Table 3. Effect of cotton varieties and plant spacing on Boll weight (g) and Seed cotton yield (kg ha^{-1})

Treatment	Boll weight (g)					Treatment	Seed cotton yield (kg ha^{-1})				
	M_1	M_2	M_3	M_4	Mean		M_1	M_2	M_3	M_4	Mean
S_1	3.26	3.31	3.52	3.67	**3.46**	S_1	1735	1638	1826	1915	**1779**
S_2	3.64	3.52	3.76	3.91	**3.71**	S_2	2138	1970	2236	2328	**2168**
S_3	3.49	3.39	3.56	3.57	**3.50**	S_3	1876	1712	1938	2010	**1884**
S_4	3.60	3.44	3.62	3.74	**3.60**	S_4	2063	1893	2124	2217	**2074**
S_5	3.78	3.58	3.80	4.02	**3.80**	S_5	2214	2050	2320	2486	**2268**
S_6	3.54	3.40	3.59	3.61	**3.54**	S_6	1969	1801	2032	2126	**1982**
S_7	3.37	3.14	3.44	3.68	**3.31**	S_7	1676	1624	1732	1823	**1714**
Mean	**3.54**	**3.41**	**3.58**	**3.67**		**Mean**	**1953**	**1813**	**2030**	**2129**	
	M	**S**	**MxS**	**SxM**			**M**	**S**	**MxS**	**SxM**	
SEd	0.02	0.02	0.04	0.04		**SEd**	36	35	74	70	
CD(p=0.05)	0.05	0.04	0.09	0.08		**CD(p=0.05)**	89	71	157	141	

M1: Suraj; M2 Supriya, M3: CO 15 (TCH 1705) and M4: CO 17 (TCH 1819)
S1:60 cm × 10 cm; S2: 60 cm × 15 cm; S3: 80 cm × 10 cm; S4: 80 cm × 15 cm; S5: 100 cm × 10 cm; S6: 100 cm × 15 cm and S7: 75 cm × 30 cm