Progressive Research – An International Journal
Print ISSN : 0973-6417, Online ISSN : 2454-6003
Volume 11 (Special-VI) : 4242-4246 (2016)

Society for Scientific Development
in Agriculture and Technology
Meerut (U.P.) INDIA

INFLUENCE OF GENOTYPES AND PLANT DENSITY ON YIELD ATTRIBUTES AND YIELD OF COTTON

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ABSTRACT

Field experiments were conducted during *winter* irrigated season of 2013-14 and 2014-15 at South Indian Textile Mill Association Farm, (SIMA) Udumalpet with the objective to find out the influence of different genotypes and spacings (high density) on the yield attributes and yield of cotton (*Gossypium hirsutum L.*). The experiment was laid out in a split plot design replicated thrice. Three genotypes *viz,* culture SHS 102, culture SHS 374, culture SHS-2-4 and one variety Anjali were fitted in the main plot and four spacings *viz.*, 45 x 15 cm (Very high density), 45 x 20 cm, 60 x 15 cm (High density) and 60 x 20 cm (Medium high density) respectively were tried in the sub plot. The results of the experiment revealed that among the cotton genotypes, culture SHS 102 followed by culture SHS 374 recorded better yield parameters and yield. The plant spacing of 60 × 15 cm favourably increased the yield attributes and seed cotton yield of all the cotton genotypes. With regard to the treatment combinations, the culture SHS 102 and 374 registered better yield parameters and seed cotton yield at a plant spacing 60 × 15 cm and both were comparable with each other.

Key words : *Genotypes, plant density, cotton, yield attributes, yield.*

Cotton has a unique name and fame as "King of Fibres" and "White Gold" because of its high economic value among cultivable annual crops. It provides employment opportunities to about 70 million people and contributes nearly 75 per cent of total raw material to the textile industry in India. It is the backbone of the flourishing textile industry in India.

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. The most commonly tested plant densities range from 5 to 15 plants m^{-2} (Kerby *et al.,* 1990) resulting in a population of 50000 to 150000 plants ha^{-1}. The concept on high density cotton planting, more popularly called Ultra Narrow Row (UNR) cotton was initiated by Briggs *et al.* (1967). Ultra narrow row cotton has row spacings as low as 20 cm and plant population on the range of 2 to 2.5 lakh plants ha^{-1}, while conventional cotton is planted in rows of 90 to 100 cm apart and has a plant population of about 1,00,000 plants ha^{-1}. However in India, the recommended plant density for cotton seldom exceeded 55,000 plants ha^{-1}.

The advantages of high density planting system include 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). Therefore, the high density planting system (HDPS) is now being conceived as an alternate production system having a potential for improving the productivity and profitability, increasing input use efficiency, reducing input costs and minimizing the risks associated with the current cotton production system in India.

Genotype selection, a key management component in any cropping system, is even more critical in high density planting system. High yielding potential is a predominant consideration with early maturity of the crop. But, plant size and fibre properties are also important factors to be considered.

So far, limited research has been done on this aspect elsewhere. In this context, this project has been initiated with a view to evaluate the cotton genotypes with different plant densities on the yield attributes and yield of cotton.

MATERIALS AND METHODS

Field experiments were conducted at SIMA Research Farm during the year 2013-14 and 2014-15 during winter to evaluate different genotypes and plant density on the yield attributes and yield of cotton genotypes.

The experiments were laid out in split plot design replicated thrice with four cotton genotypes viz., GP 102, GP 374, culture SH-2-4 and Anjali and four spacings viz., 45×15 cm, 45× 20 cm, 60 × 15 cm and 60 × 20 cm. The soil of the experimental site was sandy clay loam in texture, belonging to *Typic Ustropept.* The nutrient status of soil at the beginning of experiment was low in available nitrogen (190 kg ha^{-1}), medium in available phosphorus (13.2 kg ha^{-1}) and medium in available potassium (346 kg ha^{-1}).

Observations on the yield attributes and seed cotton yield were recorded.

Table-1 : Effect of cotton genotypes and plant density on yield attributes of cotton.

Treatment	2013-14			2014-15		
	Symbodial branches	Boll setting percentage (%)	Number of bolls/plant	Symbodial branches	Boll setting percentage (%)	Number of bolls/plant
Genotypes						
V_1 - Culture SHS 102	11.41	32.68	11.28	12.81	35.65	15.80
V_2 - Culture SHS 374	10.37	30.44	9.88	11.27	33.00	12.05
V_3 - Culture SHS-2-4	9.23	27.68	8.60	9.70	30.76	10.38
V_4 - Anjali	7.94	24.32	6.91	8.09	29.08	8.41
SEd	0.25	0.75	0.23	0.27	0.85	0.30
CD (P=0.05)	0.62	1.82	0.57	0.66	2.09	0.74
Plant spacing (cm)						
S_1 - 45 × 15 cm	8.63	25.32	7.74	9.00	30.13	8.99
S_2 - 45 × 20 cm	9.30	28.12	8.71	9.91	31.20	10.69
S_3 - 60 × 15 cm	10.87	31.58	10.65	11.67	34.54	14.43
S_4 - 60 × 20 cm	10.17	30.09	9.57	11.28	32.61	12.53
SEd	0.25	0.72	0.22	0.27	0.79	0.31
CD (P = 0.05)	0.51	1.49	0.48	0.56	1.63	0.64
Interaction	NS	NS	NS	NS	NS	NS

RESULTS AND DISCUSSION

Number of sympodial branches : Greater number of sympodial branches per plant is an indication of good yield. Data regarding number of sympodial branches per plant as affected by plant spacing and varieties have shown significant results.

The number of sympodial branches per plant was significantly influenced by cotton genotypes and plant spacings. The number of sympodial branches was significantly higher in culture SHS 102 (11.41 and 12.81 in 2013-14 and 2014-15, respectively) followed by culture SHS 374. Significantly lower number of sympodial branches per plant was registered with the variety Anjali.

The sympodial branches per plant were significantly higher with the culture SHS 102 and it was comparable with culture SHS 374. This might be due to the higher ability of this culture in harnessing the solar energy and converting it into biomass and subsequently into reproductive parts such as sympodia, flowers and bolls. The difference among varieties might be due to different growth habits and genetic makeup. These results are in accordance with those of Brar *et al.* (2002) who reported similar findings.

Among the plant spacings, an increase in sympodial branches was observed with increase in plant spacing. Higher number of sympodial branches was registered under 60 × 15 cm spacing (10.87 and 11.67 in 2013-14 and 2014-15, respectively) followed by 60 × 20 cm and both were comparable with each other in 2014-15.

Higher number of sympodia were recorded with 60 x 15 cm spacing and this might be due to reduced competition for resources like nutrients, light, spacing etc,. This is in confirmation with the earlier findings of Bharathi *et al.* (2012) who have reported that lower plant density increased sympodia.

Nichols *et al.* (2004) stated that plant height and number of sympodial branch, total nodes, and total bolls per plant were reduced in cotton grown in ultra-narrow row spacing. By increasing the plant spacing the number of sympodial branches per plant also increased linearly. The increase in number of sympodial branches per plant might be due to more availability of space and less competition among crop plants. These results are in line with those of Alfaqeih (2002).

Boll setting percentage : Among the cotton genotypes, culture SHS 102 recorded significantly higher boll setting percentage (32.68 and 35.65 in 2013-14 and 2014-15, respectively) followed by culture SHS 374 and it was comparable with culture SHS-2-4.

Higher number of boll production in culture SHS 102 and 374 might be attributed due to the higher boll setting percentage. The increased biomass production by culture SHS 102 and 374 resulted in better yield attributes. This in consonance with the earlier findings of Chelliah and Gopalaswamy (2000) who reported that increased boll number were higher due to better assimilation and translocation of photosynthates to the reproductive sink

Comparing the plant spacings, 60 x 15 cm spacing registered significantly higher boll setting percentage (31.58 and 34.54 in 2013-14 and 2014-15, respectively). Lower boll setting percentage was observed under 45 × 15 cm spacing and it was comparable with 45 × 20 cm in 2014-15.

The plant spacing of 60 × 15 cm had more number of fruiting points and boll setting in both the years of experiment conducted. This is in confirmation with the

Table-2 : Effect of cotton genotypes and plant density on boll weight (g) and yield of cotton (2013-14)

Treatment	Boll weight (g)					Seed cotton yield (q/ha)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
V_1	5.30	5.40	5.90	5.60	5.55	22.72	23.93	25.19	24.96	24.20
V_2	4.80	4.90	5.60	5.20	5.13	18.90	20.87	24.31	21.23	21.33
V_3	3.80	4.00	4.40	4.20	4.10	15.15	16.74	21.56	19.12	18.14
V_4	3.50	3.80	4.10	3.90	3.83	14.18	16.29	20.97	18.61	17.51
Mean	4.35	4.53	5.00	4.73		17.74	19.46	23.01	20.98	
	SEd		CD (P=0.05)			SEd		CD (P=0.05)		
V	0.12		0.30			0.58		1.43		
S	0.12		0.24			0.41		0.85		
V at S	0.24		0.49			0.92		1.90		
S at V	0.24		0.49			0.82		1.69		

V_1	:	Culture SHS 102	S_1	:	45 × 15 cm
V_2	:	Culture SHS 374	S_2	:	45 × 20 cm
V_3	:	Culture SHS-2-4	S_3	:	60 × 15 cm
V_4	:	Anjali	S_4	:	60 × 20 cm

earlier reports of Krishnaswamy and Iruthiayaraj (1983) who reported that higher number of fruiting points with plant density of 33,333 plants ha^{-1} as compared to 66,666 plants ha^{-1}.

Number of bolls per plant : The cotton genotypes and plant spacing significantly influenced the number of bolls per plant.

Among the cotton genotypes, culture SHS 102 recorded significantly higher number of bolls per plant (11.28 and 15.80 in 2013-14 and 2014-15, respectively) followed by culture SHS 374 in both the years of study.

The spacing of 60 × 15 cm registered significantly higher number of bolls per plant (10.65 and 14.43 in 2013-14 and 2014-15, respectively) compared to other spacings. Lower number of bolls per plant was observed under 45 x 15 cm spacing during both the years of study.

The differences among cultivars for number of bolls per plant might have been due to the difference in genetic potential of the cultivars. The significant differences among varieties for number of bolls per plant have also been reported by Copur (2006) and Ehsan *et al.* (2008). These results are in accordance with those of Hussain *et al.* (2000) who reported significant increase in number of bolls $plant^{-1}$ using different varieties. Such increase in number of bolls $plant^{-1}$ was direct consequence of more number of sympodial branches $plant^{-1}$.

Boll numbers $plant^{-1}$ were significantly higher with 60 × 15 cm due to the better assimilation of nutrients and optimum plant density without any population pressure. However the boll numbers per unit area was higher with the spacing of 60 × 15 cm due to optimum population density. The enhanced availability of nutrients to the crop at optimum density helped in improved growth and expression in terms of yield. This is in conformity with the findings of Manjunatha *et al.* (2010). The finding of Venugopalan *et al.* (2011) who reported that irrespective of cotton genotypes the boll number per plant decreased with closer spacing due to greater inter-plant competition is in support of this present findings..

Boll weight : The cotton genotypes and plant spacing significantly influenced the boll weight.

Higher boll weight was registered by the genotype 102 (5.55 and 5.60 in 2013-14 and 2014-15, respectively) followed by culture SHS 374. The least boll weight was recorded under the variety Anjali.

Boll weight is an important yield contributing parameter. Boll weight was significantly influenced by different cotton genotypes and plant spacings. Higher boll weight was recorded by the culture SHS 102 followed by culture SHS 374. This might be due to utilization of more nutrient energy in the nourishment of maximum number of bolls and boll weight. This is in consonance with the findings of Manjunatha *et al.* (2010) who reported that NCS 145-Bt recorded higher boll weight than NCS 148 - non Bt hybrid. The significant differences among the varieties for average boll weight has also been reported by Hussain *et al.* (2000) and Hofs *et al.* (2006) that coordinate with the finding in this experiment.

With regard to plant spacings, the plant spacing of 60 x 15 cm registered significantly higher boll weight (5.00 and 5.10 g in 2013-14 and 2014-15, respectively) followed by 60 x 20 cm of spacing. Lower boll weight was observed with the plant spacing of 45 x 15 cm in both the years.

With regard to plant spacings, the plant spacing of 60 x 15 cm recorded higher boll weight. Individual boll weight was higher in optimum row spacing than closer spacing. This might be due to better assimilation and translocation of photosynthates to the reproductive sink. This result is in consonance with the findings of Dong *et al.* (2012) who reported similar results. Greater average boll weight at higher plant spacing might be due to less competition and availability of resources. These results are in line with those of Hussain *et al.* (2000) and Boquet (2005) who reported that by increasing plant density average boll weight decreases.

The interaction effect of cotton genotypes and plant spacing was significant. The genotype 102 sown at the spacing of 60 x 15 cm recorded significantly higher boll weight (5.90 and 5.80 g in 2013-14 and 2014-15, respectively) followed by culture SHS 102 with the plant spacing of 60 x 20 cm and both were comparable with each other during both the years of study.

Seed cotton yield : The seed cotton yield was significantly influenced by cotton genotypes and plant spacing.

Among the cotton genotypes, culture SHS 102 recorded significantly higher seed cotton yield of 24.20 and 24.06 q ha^{-1}during 2013-14 and 2014-15, respectively. The variety Anjali recorded lower seed cotton yield (17.51 and 17.97 q ha^{-1}during 2013-14 and 2014-15, respectively). However, the yield obtained under the variety Anjali was comparable with the culture SHS-2-4 during both the years of study.

Stable cotton varieties/hybrids with high yielding potential are of paramount importance among the large number of varieties recommended for cultivation. Among the genotypes, culture SHS 102 recorded higher seed cotton yield followed by culture SHS 374 during both the years of study. The yield reduction due to culture SHS 374 was 11.85 per cent during 2013-14 and 8.72 per cent during 2014-15 comparing the yield under culture SHS 102. The culture SHS 102 and 374 recorded comparably higher yields over the other cotton genotypes, which could be attributed due to the increased sympodial branches, fruiting points, higher boll setting and boll numbers as evidenced in the present study.

Better vegetative growth and profuse boll bearing has taken a major share in increasing the seed cotton yield of culture SHS 102 and 374 over other cotton genotypes. Ongoing growth and development events pertaining to biomass and square production, leaf area maintenance with canopy development were favourably influenced thus realizing higher productivity reflected through higher partitioning of assimilates in to the developing bolls. Further the higher seed cotton yield might be attributed due to higher retention of bolls from the first flush of flowers like Bt hybrids with no boll damage. This might have resulted due to utilization of more nutrient energy in the nourishment of maximum number of bolls that were saved from the boll damage. This is in confirmation with the earlier findings of Mayee *et al.* (2004) and Nehra *et al.* (2004) who found that Bt cotton hybrids recorded significantly higher seed yield than non-Bt hybrids.

Among the plant spacings, the plant spacing of 60 × 15 cm recorded significantly higher seed cotton yield (23.01q ha^{-1} in 2013-14 and 23.46 q ha^{-1} in 2014-15) followed by 60 × 20 cm spacing. Lower seed cotton yield was observed with the plant spacing of 45 x 15 cm (17.74 and 18.11 q ha^{-1} in 2013-14 and 2014-15, respectively).

Comparing the plant spacings, high density planting with optimum inter and intra row spacing (60 × 15 cm) recorded higher seed cotton yield compared to closer and wider row sapcing (45 x 15 and 60 x 20 cm, respectively). The yield reduction under very high density planting due to closer spacing of 45 x15 cm was 15.13 per cent in 2013-14 and 15.69 per cent in 2014-15 comparing the yield under medium high density planting of 60 x15 cm. The yield reduction under medium high density due to wider spacing (60 x 20 cm) was 8.82 per cent in 2013-14 and 10.40 per cent in 2014-15 comparing the yield under spacing of 60 x 15 cm (medium high density).

In the year 2013-14, adopting a plant spacing of 60 × 15 cm in culture SHS 102 significantly recorded higher seed cotton yield of 25.19 q ha^{-1} followed by culture SHS 102 with 60 x 20 cm of plant spacing (24.96 q ha^{-1}) and both were comparable with each other. The least seed cotton yield was recorded under the treatment combination of variety Anjali at 45 x 15 cm spacing.

During 2014-15, the treatment combination of culture SHS 102 sown at a spacing of 60 x 15 cm recorded higher seed cotton yield followed by culture SHS 374 with the plant spacing of 60 x 15 cm and culture SHS 102 at 60 x 20 cm and were comparable with each other. The least seed cotton yield was recorded under the variety Anjali at 45 x 15 cm spacing.

The interaction between cotton genotypes and plant spacing had also significant influence on seed cotton yield. This showed that optimum plant spacing varied depends on the growth habits and canopy alteration from hybrid to hybrid. This is in consonance with the findings of Bapna *et al.* (1976) who reported that optimum plant density is dependant on the inherent vegetative habit of variety and conditions of soil fertility, moisture and cultural practices.

In both the experiments conducted, culture SHS 102 and 374 had recorded significantly higher yield with a plant spacing of 60 × 15 cm. This is in conformity with the findings of Anjum *et al.* (2010) who found that maximum seed cotton yield was recorded with 75 cm row spacing followed by 60 cm row spacing, whereas minimum seed cotton yield was observed with 90 cm row spacing. From this it is clearly understood that culture SHS 102 could accommodate in optimum plant density and the competition between the plants are also found to be lesser. All the yield attributing characters were lesser with closer spacing of 45 × 15 cm thus the decrease in seed cotton yield might be due to more plant population over wider spacing in the experiment.

Another factor is that wider spacing (medium high density planting) paved a way for enhanced availability of nutrients to the crop and increased the nutrient uptake which helped in improved crop growth, which in turn was expressed in terms of yield. This is in line with the earlier findings of Bhalerao *et al.* (2008) and Saleem *et al.* (2009) who reported similar findings.

CONCLUSION

Among the cotton genotypes, culture SHS 102 followed by culture SHS 374 recorded better yield parameters and yield. The plant spacing of 45 × 15 cm favourably increased the yield attributes and seed cotton yield of all the cotton genotypes. With regard to the treatment combinations, the culture SHS 102 and SHS 374 registered better yield parameters and seed cotton yield at a plant spacing 60 × 15 cm and both were comparable with each other.

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