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Evaluation of Plant Density and Cotton Genotypes (Gossypium *hirsutum* L.) on Yield and Fibre Quality

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Field experiments were conducted during winter season of 2011-12 and 2012-13 at Tamil Nadu Agricultural University, Coimbatore to study the feasibility of using cotton genotypes under high density planting system and to assess its effect on seed cotton yield, oil content and fibre quality parameters. The experiments were laid out in a strip plot design, replicated thrice. The soil in the experimental site was sandy clay loam with low available nitrogen (182 kg/ha), medium available phosphorus (12.6 kg/ha) and high available potassium (340 kg/ha). The experiment consisted of seven cotton genotypes *viz*., Jai, Ranjeet, TCH 1608, SVPR 3, Anjali, Suraj and LH 900 with four spacings *viz*., 30 × 30, 45 × 30, 60 × 30 and 90 × 30 cm. Ranjeet planted at the spacing of 30 × 30 cm recorded significantly higher seed cotton yield. The percentage of oil content was significantly higher in Ranjeet genotype than other cotton genotypes. The fibre quality parameters *viz*., fibre length, fibre strength, micronaire, elongation percentage were significantly influenced by different cotton genotypes. The oil content and fibre quality was not significantly influenced by plant densities.

Key words: Plant density, Seed cotton yield, Fibre quality, Oil content

Cotton (*Gossypium hirsutum* L.) “The king of fibres” is the leading fibre crop in the world. India is the only country where all the four species of cotton are grown among the cotton growing countries of the world. Cotton is an important raw material supplying about 65% requirement of the Indian textile industry. Crop management practices to improve fibre quality while maintaining lint yield have become the focus of intense research. Several studies have reported that lint yield in upland cotton is negatively related to fibre quality (Green and Culp, 1990), that is, cotton plants need to sacrifice fibre quality to improve lint yield. Thus, accessing strategies to improve fiber quality while maintaining yield levels is crucial and this process requires better understanding of the effects of crop management practices on cotton fiber quality. Bednarz *et al.* (2006) reported lower fibre quality from increased plant density. Cotton is also a good source of edible oil. The cotton seed oil is rich in essential fatty acids such as myristic, palmitic, palmitoleic, steric, oleic and linoleic acid. The deficiency of above acids, leads to narrowing of arteries causing reduced blood supply to the heart. Cotton seed oil will play an important role in meeting the demand of edible vegetable oil in the country (Singh, 2003). Hence, an investigation was initiated to determine influence of different plant densities on the seed cotton yield, oil content and fibre quality of cotton genotypes (*Gossypium hirsutum*).

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Materials and Methods

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during the winter season of 2011 -2012 and 2012-2013. The objectives of this study were to determine the feasibility of using cotton genotypes under high density planting system for cotton production and to assess its effect on seed cotton yield, oil content and fiber quality parameters. Coimbatore is situated in the Western Zone of Tamil Nadu at 11° North latitude and 77° East longitude with an altitude of 426.7 m above mean sea level. The experiment was laid out in a strip plot design, replicated thrice. The soil of the experimental site was sandy clay loam with low available nitrogen (182 kg/ha), medium available phosphorus (12.6 kg/ha) and high available potassium (340 kg/ha). The treatments consisted of seven cotton genotypes *viz*., Jai, Ranjeet, TCH 1608, SVPR 3, Anjali, Suraj and LH 900 with four spacings *viz*., 30 **×** 30, 45 **×** 30, 60 **×** 30 and 90 **×** 30 cm (with plant densities *viz*., 111111, 74074, 55555, and 37037 plants ha^{-1}, respectively). The crop was sown and raised using the recommended package of practices as per TNAU crop production guide. Defoliant (Dropp Ultra @ 200 ml per ha) was sprayed at 80 % maturity for uniform boll bursting so that one time harvest was done. The oil content was estimated by using the Soxhlet extraction apparatus by the procedure given by Sadasivam and Manickam (1995) . Fibre quality characters were tested using High volume instrument user model: HVI Classic 900.

Results and Discussion

Seed cotton yield

The seed cotton yield was significantly influenced by cotton genotypes and plant spacing. Among the cotton genotypes, Ranjeet and Jai recorded significantly higher seed cotton yield of 3311 and 3115 kg ha^{-1}, respectively during 2011-12 and were on par with each other Table 1. The cotton genotype SVPR 3 recorded less yield (1510 kg ha^{-1}), which is also comparable with Suraj during 2011-12. Jagannathan and Venkitaswamy (1996) revealed that dwarf compact genotypes responded favourably to a population of 1, 11,000 plants ha^{-1} on Vertisols.

Comparing the plant spacings, the plant spacing of 30 × 30 cm recorded significantly higher seed cotton yield (3168 kg ha^{-1}) followed by 45 × 30 cm spacing. Lower seed cotton yield was observed with the plant spacing of 90 × 30 cm (1498 kg ha^{-1}) in 2011-12. Ali *et al.* (2010) revealed that significantly higher seed cotton yield was obtained with narrow spacing 15 cm followed by 30 cm than 45 cm row spacing in silt loam soil in Pakistan. Similar results were reported by Delaney *et al.* (2002); Brodrick *et al.* (2012) and Singh *et al.* (2012).

Table 1. Effect of plant densities on seed cotton yield (kg ha^{-1}) in *G.hirsutum* genotypes

Genotypes	2011-12Spacing (cm)					2012-13Spacing (cm)				
	30×30	45×30	60×30	90×30	MEAN	30×30	45×30	60×30	90×30	MEAN
Jai	4378	3304	2783	1996	3115	4003	3085	2605	1830	2881
Ranjeet	4511	3378	3072	2281	3311	4232	3095	2783	2005	3029
TCH 1608	3556	2963	2333	1644	2624	3112	2545	2141	1535	2333
SVPR 3	2178	1615	1300	948	1510	1963	1462	1181	861	1367
Anjali	2556	2133	1867	1326	1970	2376	1901	1659	1208	1786
Suraj	2478	1748	1400	1052	1669	2193	1598	1268	858	1479
LH 900	2522	1793	1650	1237	1800	2197	1678	1503	1138	1629
MEAN	3168	2419	2058	1498		2868	2195	1877	1348	
		SE.d	CD (P=0.05)				SE.d	CD (P=0.05)		
Genotypes (G)		126	275				120	262		
Spacing (S)		92	226				90	220		
G at S		185	386				171	356		
S at G		186	393				170	363		

Table 2. Effect of plant densities on oil content (%) in *G.hirsutum* genotypes

Treatments	2011-12	2012-13
Genotypes		
Jai	16.60	16.68
Ranjeet	24.70	24.50
TCH 1608	14.25	14.18
SVPR 3	12.40	12.53
Anjali	13.35	13.18
Suraj	17.13	17.20
LH 900	17.38	17.35
SEd	1.08	1.06
CD (P = 0.05)	2.35	2.31
Spacing (cm)		
30×30	16.61	16.31
45×30	16.36	16.51
60×30	16.60	16.53
90×30	16.60	16.70
SEd	0.73	0.77
CD (P = 0.05)	NS	NS
Interaction	NS	NS

The interaction was significant with cotton genotypes and different plant spacing. In the year 2011-12, plant spacing of 30 × 30 cm in Ranjeet significantly recorded higher seed cotton yield of 4511 kg ha^{-1} followed by Jai (4378 kg ha^{-1}) and both were comparable with each other. The genotype SVPR 3 at the spacing of 90 × 30 cm registered lower seed cotton yield but was comparable with Suraj and LH 900. The differences in the yield of SVPR 3, Suraj and LH 900 did not differ significantly because they did not cause significant variation with respect to all parameters i.e., growth, physiological and yield parameters. This was also observed by Bhalerao *et al.* (2008). Venugopalan *et al.* (2011) found that *Gossypium hirsutum* genotypes Anjali, PKV 081 and CCH 724 were more amenable to closer spacings i.e. higher planting densities (166000 plants ha^{-1}) on rainfed vertisols under Maharastra. Similar trend was observed during 2012-13 also.

Quality parameters

Oil content

The cotton genotypes significantly influenced oil content. The percentage of oil content was significantly higher in Ranjeet (24.7 and 24.5 % in 2011-12 and 2012-13, respectively) than other cotton genotypes followed by LH 900, Suraj and Jai and were comparable with each other. Lower oil content was recorded by SVPR 3, Anjali and TCH 1608 and they were on par with each other Table 2. The oil content in parents ranged from 17.7 (%) to 22.1 in F 1861and TCH 1644, respectively and in hybrids, it varied from 17.05 (MCU 12 x TCH 1641) to 22.9% (Surabhi x TCH 1646) (Ashokkumar and Ravikesavan, 2013). The different plant densities did not influence oil content.

Fibre quality

Lint Index, Seed Index and Ginning percentage

The quality parameters differed significantly due to genotypes. The lint index was significantly higher in Ranjeet (6.19 and 6.14 in 2011-12 and 2012-13 respectively) followed by Jai and TCH 1608 and were comparable with each other in both the years. Comparably lower lint index was registered by LH 900, Anjali and Suraj in both years of study Table 3.

The genotypes Ranjeet, TCH 1608 and Jai recorded higher seed index. Significantly lower seed index was registered by Anjali, LH 900 and Suraj and were on par among themselves in both the years of study Table 3. The genotype TCH 1705 , which is morphologically similar to the genotype TCH 1608 recorded higher lint and seed index in Coimbatore under irrigated condition (AICCIP, 2013).

No significant difference was observed with regard to different plant spacings on lint and seed index Table 3. The ginning percentage was neither significantly influenced by both cotton genotypes nor by plant densities Table 3.

2.5 % span length

Higher 2.5 % span length was recorded with Jai (30.18 and 29.58 in 2011-12 and 2012-13, respectively), which was comparable with TCH 1608,

Table 3. Effect of plant densities on ginning percentage, lint Index and seed Index in *G.hirsutum* genotypes

Treatments	2011-12			2012-13		
	Lint Index	Seed Index	Ginning percentage	Lint Index	Seed Index	Ginning percentage
Genotypes						
Jai	5.69	9.82	36.7	5.53	9.66	36.4
Ranjeet	6.19	10.30	37.5	6.14	10.21	37.5
TCH 1608	5.48	9.85	35.7	5.44	9.91	35.4
SVPR 3	4.42	7.69	36.5	3.97	7.31	35.2
Anjali	3.69	6.32	36.8	3.52	6.36	35.6
Suraj	3.74	6.72	35.8	3.60	6.50	35.7
LH 900	3.49	6.70	34.2	3.46	6.56	34.5
SEd	0.21	0.36	1.5	0.20	0.35	1.5
CD (P = 0.05)0.45	0.77	NS	0.44	0.77	NS	
Spacing (cm)						
30×30	4.64	8.23	36.0	4.50	8.09	35.6
45×30	4.68	8.14	36.5	4.50	8.06	35.7
60×30	4.65	8.23	36.0	4.55	8.06	36.0
90×30	4.70	8.20	36.3	4.53	8.07	35.8
SEd	0.12	0.21	0.9	0.12	0.20	0.9
CD (P = 0.05)	NS	NS	NS	NS	NS	NS
Interaction	NS	NS	NS	NS	NS	NS

Suraj and Ranjeet in both years Table 4. The higher fibre length was registered by cotton genotype CCH 12 and closely followed by F 2383 and F 2381 (AICCIP, 2013). Plant density did not affect fibre length. Similar results reported by Feng *et al.* (2011) is in support of the present finding.

Tenacity

The cotton genotype, Suraj recorded significantly higher values of fibre strength (20.13 and 22.05 g tex^{-1} in the year 2011 -12 and 2012-13) but was comparable with Jai in 2012-13 Table 4. The fibre strength was not significantly influenced by different plant densities.

Micronaire

Among the cotton genotypes, significantly finer fibres were observed with Anjali, Suraj, SVPR 3 and TCH 1608 and they were on par among themselves Table 4. LH 900 recorded significantly higher micronaire value followed by Jai. The genotype CSH 3075 registered lower micronaire value closely followed by CCH 12, RS 2718, GTHV 09, and GTHV 04 under irrigated conditions of Coimbatore (AICCIP, 2013). The plant densities did not significantly influenced the micronaire values. Clawson *et al.* (2006) reported that there is no significant difference was observed in micronaire values between plant densities of wider row spacing 38 cm and 76 cm but significant difference was observed with the 19 cm row spacing in Texas.

Uniformity (%)

No significant difference was observed with cotton genotypes and plant spacings on uniformity ratio Table 4. Jost and Cothern (2000) opined that the fibre uniformity with decrease in row spacing due to lack of photosynthate production or less available moisture.

Elongation percentage

The elongation percentage was significantly influenced by cotton genotypes Among the cotton genotypes, significantly higher elongation percentage was recorded by Anjali (7.15) but was comparable with SVPR 3, Jai and TCH 1608 in the year 2011-12 Table 4.

In 2012-13, Anjali registered significantly higher elongation percentage and was on par with SVPR 3.

Table 4. Effect of plant densities on fibre quality in *G.hirsutum* genotypes

Treatments	2011-12					2012-13				
	2.5 % Span Length (mm)	Fibre Strength (g tex^{-1})	Micronaire (10^{-6} g in^{-1})	Uniformity (%)	Elongation (%)	2.5 % Span Length (mm)	Fibre Strength (g tex^{-1})	Micronaire (10^{-6} g in^{-1})	Uniformity (%)	Elongation (%)
Genotypes										
Jai	30.18	20.13	3.63	48.35	5.90	29.58	22.05	4.13	49.55	5.53
Ranjeet	27.58	18.00	3.56	47.73	7.08	25.60	19.45	3.70	48.33	6.28
TCH 1608	29.73	18.15	3.50	48.80	6.78	28.60	21.13	3.33	46.70	5.88
SVPR 3	21.75	18.45	3.40	49.73	7.13	26.08	20.38	3.10	50.13	7.05
Anjali	23.73	20.03	3.18	50.70	7.15	23.58	19.63	2.98	50.35	7.20
Suraj	29.28	23.93	3.30	48.68	5.88	28.13	23.55	3.05	48.45	5.28
LH 900	22.60	18.58	4.63	49.75	5.93	22.38	18.53	4.58	49.70	5.75
SEd	1.42	1.08	0.17	2.43	0.33	1.38	1.09	0.19	2.46	0.30
CD (P = 0.05)	3.10	2.35	0.37	NS	0.72	3.00	2.37	0.41	NS	0.66
Spacing (cm)										
30×30	26.10	19.46	3.49	49.26	6.39	26.39	20.03	3.76	49.09	6.19
45×30	26.39	19.10	3.61	48.93	6.57	26.64	21.01	3.37	48.46	6.07
60×30	26.74	20.20	3.56	49.43	6.51	26.63	21.20	3.54	49.69	6.39
90×30	26.39	19.67	3.70	48.80	6.71	25.44	20.44	3.53	48.89	5.90
SEd	1.21	0.91	0.16	2.24	0.29	1.17	0.95	0.16	2.27	0.29
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

The elongation percentage was significantly lower with the cotton genotypes Suraj, Jai and LH 900 and were comparable among themselves during both the years of study. In the present study the increase in plant density did not influence the quality parameters. Molin and Hugie (2010) also reported that the quality parameters like Micronaire, fibre length, strength, and uniformity were not affected by increasing population density in Silty loam soils of Stoneville.

Conclusion

Among cotton genotypes, Ranjeet planted at the spacing of 30 × 30 cm recorded significantly higher yield. Irrespective of plant densities, Ranjeet recorded significantly higher oil content, lint and seed index. Finer fibre with higher elongation percentage was recorded with Anjali. The cotton genotypes, Jai and Suraj recorded significantly higher values of both fibre length and fibre strength. Ginning percentage and uniformity ratio was not significantly influenced by cotton genotypes and plant density.

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