Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.6152

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (2):** 1122-1128 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Influence of Plant Geometry on Performance of Cotton Variety Co 14 under Winter Irrigated Condition

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Received: 6.01.2018 | Revised: 15.02.2018 | Accepted: 20.02.2018

ABSTRACT

Field experiment were conducted during winter season of 2016-17 at Tamil Nadu Agricultural University, Coimbatore to study the influence of high density planting system on cotton growth, seed cotton yield and fibre quality. Coimbatore is situated in the western zone of Tamil Nadu at 11ºN latitude and 77ºE longitude with an altitude of 42.7 m above mean sea level. The soil in the experimental site was sandy loam soil. The experiment consisted of seven spacing levels viz., 90 x 45 cm (24,691 plants ha^{-1}), 60 x 30 cm (55,555 plants ha^{-1}), 90 x 45-10 cm (42,328 plants ha^{-1}), 60 x 30-10 cm (83,333 plants ha^{-1}), 80 x 10 cm (1,25,000 plants ha^{-1}), 90 x 10 cm (1,11,111 plants ha^{-1}) and 100 x 10 cm (1,00,000 plants ha^{-1}). The cotton variety Co 14 was selected for the experiment. Observations were recorded for plant height, Leaf Area Index (LAI), Dry Matter Production (DMP), Relative Growth Rate (RGR), Crop Growth Rate (CGR), number of bolls m+^{2}, single boll weight (g), seed cotton yield (kg ha^{-1}) and quality parameters data were statistically analyzed. The results revealed that Co 14 variety with 80 x 10 cm spacing gave higher LAI (3.58), DMP (6824 kg ha^{-1}), RGR (33.2 mg g^{-1} day^{-1} between 30 to 60 DAS), CGR (9.70 g m^{-2} day^{-1} between 60 to 90 DAS), number of bolls m^{-2} (101), seed cotton yield (2734 kg ha^{-1}) and 90 x 45 cm gave higher plant height (87.43 cm), single boll weight (3.45 g) and seed cotton yield plant^{-1} (44 g plant^{-1}). The quality parameters were not differing by plant spacing levels.

Key words: *Plant spacing, Co 14 variety, Boll, Seed cotton yield, Quality parameters.*

INTRODUCTION

Cotton is an important commercial and premier natural fibre crop in India and plays a prominent role in Indian farming and industrial economy of the country. Cotton plays a pre-dominant position among all cash crops retaining its unique name of "King of Fibres" and "White Gold" because of its economical value, providing 60 to 75 per cent raw material to the textile industry [1]. At present cotton production face problems of rising input costs with static or declining returns. The cotton producers are persistently searching for ways to compensate, the increase in production cost through more production of bolls per unit area.

Cite this article: Mahil, E I.T. and Lokanadhan, S., Influence of Plant Geometry on Performance of Cotton Variety Co 14 under Winter Irrigated Condition, *Int. J. Pure App. Biosci.* **6(2):** 1122-1128 (2018). doi: http://dx.doi.org/10.18782/2320-7051.6152

The adjustment of plant density has been an important agronomic practice for enhancing yield and profitability of cotton (*Gossypium hirsutum* L.) world-wide [2]. Maximum yield can be achieved by maintaining an optimal plant population, with good crop growth and better plant morphological characteristics. Establishment of an acceptable population of cotton seedlings is paramount for high yields [3]. Plant population factor in cotton production is directly related to seed cotton yield, thus spacing plays an significant role for cotton production and productivity. The maximum yield potential of any new developed genotype in hirsutum cotton can be exploited by manipulating and suitable spacing choice. The present study was, therefore, planned and conducted to know the yield potential of the new cotton variety Co 14 released during 2016 with optimum spacing, for its suitability for western zone of Tamil Nadu.

MATERIAL AND METHODS

A field experiment was conducted during 2016 - 17 in winter irrigated season at Tamil Nadu Agricultural University, Coimbatore during winter irrigated season, 2016, located in the North Western Agro-climatic zone of Tamil Nadu situated at 11°N 76°57´E longitude and at an altitude of 426.7 meters above MSL to evaluate the performance spacing levels *viz.*, 90 x 45 cm (24,691 plants ha^{-1}), 60 x 30 cm (55,555 plants ha^{-1}), 90 x 45-10 cm (42,328 plants ha^{-1}), 60 x 30-10 cm (83,333 plants ha^{-1}), 80 x 10 cm (1,25,000 plants ha^{-1}), 90 x 10 cm (1,11,111 plants ha^{-1}) and 100 x 10 cm (1,00,000 plants ha^{-1}). The experiment was laid out in Randomized Block Design (RBD) with three replications. The cotton variety Co 14 was selected for the experiment, which was extra long staple cotton, having good ginning out turn. The crop was sown and raised using the recommended package of practices as per TNAU crop production guide. Observations were recorded for growth parameters like plant height, Leaf Area Index (LAI), Dry Matter Production (DMP), Relative Growth Rate (RGR), Crop Growth Rate (CGR), yield parameters like number of bolls m^{-2}, single boll weight (g), seed cotton yield (kg ha^{-1}), lint yield (kg ha^{-1}) and quality parameters. Fibre quality characters were tested using high volume instrument user model: HVI Classic 900. The experimental data on different characters of observation was statistically analyzed as described. Wherever the results were significant, critical differences was worked out at five per cent level. The treatment differences that were non significant were denoted as NS.

RESULTS AND DISCUSSION

The results obtained from the present study have been discussed in detail under following heads:

Growth parameters

Plant height

Plant height plays an important role in determining the morphological frame work related to plant type and canopy development in cotton. Spacing of 80 x 10 cm recorded higher plant height of 43.20 cm at 60 DAS, 54.77 cm at 90 DAS and 115.37 cm at harvest and was on par with spacing of 90 x 10 cm. Lower plant height was observed in the spacing of 90 x 45 cm and was on par with 60 x 30 cm and 90 x 30-10 cm spacing (Table 1). There was non significant difference observed in plant height at 30 DAS. In general, plant height increased with decrease in plant spacing which might be due to overcrowding and competition for solar radiation among the cotton plant population. Increase of plant height by decreasing row plant spacing was found by other studies [4, 5]. They observed that cotton plant at a spacing of 15 cm recorded taller plants (140.16 cm), followed by 25 cm (139.79 cm), while wider plant spacing of 35 cm displayed dwarf plants (134.41 cm).

Leaf Area Index

Leaf area is an indication of total assimilating area and increase in Leaf Area Index (LAI) favours higher photosynthetic activity of the plant [6]. Spacing of 80 x 10 cm recorded higher LAI of 0.54 at 30 DAS, 2.20 at 60 DAS, 3.58 at 90 DAS and 4.67 at harvest, on par with spacing of 90 x 10 cm. Wider spacing of 90 x 45 cm recorded lower LAI of 0.19 at 30 DAS, 0.89 at 60 DAS, 2.43 at 90 DAS and 3.15 at harvest (Table 2). The results are in conformity with the findings of [7] , who observed that plant spacing of 15 and 22.5 cm recorded higher LAI and further increase in plant spacing reduced LAI significantly in sandy loam soil.

Dry Matter Production

At earlier stages, the Dry Matter Production (DMP) was less and increased with the age of the crop. Higher DMP was observed with reduced plant spacing (Table 3). The plant spacing of 80 x 10 cm registered DMP of 1408 kg ha^{-1} at 30 DAS, 3797 kg ha^{-1} at 60 DAS, 6824 kg ha^{-1} at 90 DAS and 8066 kg ha^{-1} at harvest, followed by 90 x 10 cm spacing registered DMP of 1280 kg ha^{-1} at 30 DAS, 3464 kg ha^{-1} at 60 DAS, 6104 kg ha^{-1} at 90 DAS and 7148 kg ha^{-1} at harvest. Lower DMP was registered with 90 x 45 cm spacing at all the crop growth stages of observation. This is agreement with one report [8] , with higher plant biomass 38 cm row cotton at first squaring and mid bloom stage than 102 cm row spacing on per unit area basis.

Crop Growth Rate and Relative Growth Rate (Table 4)

Adopting plant spacing of 80 x 10 cm recorded higher CGR of 8.09 g m^{-2} day^{-1} between 30 to 60 DAS, 9.70 g m^{-2} day^{-1} between 60 to 90 DAS and 2.36 g m^{-2} day^{-1} between 90 DAS to harvest and reduced significantly with increase in plant spacing. Higher RGR of 35.10 mg g^{-1} day^{-1} between 30 to 60 DAS and 23.02 mg g^{-1} day^{-1} from 60 to 90 DAS was observed with 90 x 45 cm spacing. The lower RGR of 28.72 mg g^{-1} day^{-1} between 30 and 60 DAS at spacing of 60 x 30-10 cm and 18.08 mg g^{-1} day^{-1} between 60 and 90 DAS at spacing of 100 x 10 cm. At 80 x 10 cm spacing RGR of 3.20 mg g^{-1} day^{-1} was recorded between 90 DAS to harvest and lower value of 2.34 mg g^{-1} day^{-1} with plant spacing of 90 x 45 cm. Crop growth rate (CGR) and Relative Growth rate (RGR) are derived with biomass over time unit, hence these parameters improved with the corresponding increase in DMP with increasing levels of population[6].

Yield parameters

No. of bolls m^{-2} and no. of bolls $plant^{-1}$

The spacing of 80 x 10 cm recorded 101 bolls m^{-2}, which was higher and on par with spacing of 90 x 10 cm might be due to more plant population density (Table 5). Lower number of 34 bolls was recorded with the wider spacing of 90 x 45 cm. The number of bolls $plant^{-1}$ recorded in spacing of 90 x 45 cm was 15, which was higher and on par with 90 x 45-10 cm spacing recording 14 bolls $plant^{-1}$. Significantly lower number of bolls $plant^{-1}$ (10) was observed in 80 x 10 cm spacing, which was on par with 90 x 10 cm and 100 x 10 cm spacing. This is in confirmation with the earlier findings of [9], who reported increase in number of bolls per plant with increase in plant spacing can be attributed to reduced competition within plants and more available space which would have enabled the plants to uptake more water and nutrients to produce more sympodial branches that ultimately would have resulted in more number of bolls per plant.

Single boll weight (g)

The spacing of 90 x 45 cm recorded higher value of 3.45 g single boll weight, which was on par with 60 x 30 cm and 90 x 45-10 cm spacing in the boll weight recorded. Lower value of 2.76 g single boll weight was recorded with the closer spacing of 80 x 10 cm which was on par with 90 x 10 cm and 100 x 10 cm spacing (Table 5). By increasing plant spacing there was increase in boll weight because all the natural resources *i.e*. radiation, nutrient and moisture were fully utilized by the plant. The present findings are in agreement with [10], who reported that maximum average boll weight (3.92 g) was obtained in 45 cm plant spacing against the minimum value of (3.34 g) in 30 cm plant spacing.

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

The seed cotton yield was significantly influenced by plant spacing levels (Table 5). The spacing of 80 x 10 cm recorded higher seed cotton yield of 2734 kg ha^{-1}, which was on par with spacing of 90 x 10 cm (2615 kg ha^{-1}) and 100 x 10 cm (2573 kg ha^{-1}). Lower seed cotton yield of 1068 kg ha^{-1} was observed with the plant spacing of 90 x 45 cm. 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[6]. This is in line with the findings[11], who found that significantly maximum seed cotton yield was obtained with narrow spacing 15 cm followed by 30 cm and 45 cm row spacing in silt loam soil. According to the report[12] a positive correlation of seed cotton yield with plant geometries.

Lint yield (kg ha^{-1})

The lint yield was significantly influenced by plant spacing levels (Table 5). The closer spacing of 80 x 10 cm recorded higher lint yield of 922 kg ha^{-1} which was on par with spacing of 90 x 10 cm, 100 x 10 cm and 60 x 30-10 cm. Lower lint yield of 369 kg ha^{-1}was observed with the plant spacing of 90 x 45 cm. High density planting system increase yields by raising boll numbers[13]. High plant densities reduced boll weight, but increase in boll number per unit area, therefore lint yield increased in short-season cotton[14].

Quality parameters

The quality parameters are mostly genetically controlled attributes and might not have been influenced by the plant spacing levels (Table 6).The results are agrees with an early researchers[15,16,17]. The quality parameters were not influenced by the population levels. Micronaire, fibre length, strength, and uniformity were not affected by increasing population density in silty loam soils of Stoneville[18].

Table 1: Effect of plant density on plant height (cm)

Spacing (cm)	30 DAS	60 DAS	90 DAS	At harvest
S_1- 90 x 45	20.65	34.66	44.00	87.43
S_2- 60 x 30	22.09	37.46	46.40	96.75
S_3- 90 x 45-10	21.12	35.49	44.57	90.90
S_4- 60 x 30-10	22.46	37.97	48.58	100.83
S_5- 80 x 10	24.00	43.20	54.77	115.37
S_6- 90 x 10	23.22	40.80	52.05	110.26
S_7- 100 x 10	22.77	38.60	50.81	104.76
SEd	1.19	1.82	2.30	4.85
CD (p=0.05)	**NS**	**3.76**	**4.74**	**10.01**

Table 2: Effect of plant density on Leaf Area Index (LAI)

Spacing (cm)	30 DAS	60 DAS	90 DAS	At harvest
S_1- 90 x 45	0.19	0.89	2.43	3.15
S_2- 60 x 30	0.32	1.28	2.90	3.54
S_3- 90 x 45-10	0.25	1.04	2.62	3.37
S_4- 60 x 30-10	0.38	1.56	3.11	3.73
S_5- 80 x 10	0.54	2.20	3.58	4.67
S_6- 90 x 10	0.48	2.00	3.44	4.31
S_7- 100 x 10	0.42	1.77	3.22	4.05
SEd	0.02	0.11	0.14	0.24
CD (p=0.05)	**0.04**	**0.22**	**0.29**	**0.50**

Table 3: Effect of plant density on Dry Matter Production (kg ha^{-1})

Spacing (cm)	30 DAS	60 DAS	90 DAS	At harvest
S_1- 90 x 45	342	986	1962	2222
S_2- 60 x 30	703	1914	3491	4001
S_3- 90 x 45-10	569	1540	2735	3124
S_4- 60 x 30-10	1053	2501	4295	4944
S_5- 80 x 10	1408	3797	6824	8066
S_6- 90 x 10	1280	3464	6104	7148
S_7- 100 x 10	1188	3080	5305	6175
SEd	44	115	202	240
CD (p=0.05)	**90**	**237**	**418**	**594**

Table 4: Effect of plant density on Crop Growth Rate (g m^{-2} day^{-1}) and Relative Growth Rate (mg g^{-1} day^{-1})

Spacing (cm)	Crop Growth Rate			Relative Growth Rate		
	30 to 60 DAS	60 to 90 DAS	90 DAS to harvest	30 to 60 DAS	60 to 90 DAS	90 DAS to harvest
S_1- 90 x 45	2.15	3.25	0.49	35.10	23.02	2.34
S_2- 60 x 30	4.04	5.26	0.96	33.31	20.09	2.55
S_3- 90 x 45-10	3.25	3.99	0.73	33.03	19.24	2.49
S_4- 60 x 30-10	4.83	5.98	1.22	28.72	18.11	2.64
S_5- 80 x 10	8.09	9.70	2.36	33.32	18.85	3.20
S_6- 90 x 10	7.28	8.80	1.95	33.13	18.91	2.95
S_7- 100 x 10	6.30	7.42	1.62	31.76	18.08	2.82
SEd	0.26	0.31	0.07	1.58	0.97	0.13
CD (p=0.05)	**0.52**	**0.64**	**0.15**	**3.26**	**1.99**	**0.27**

Table 5: Effect of plant density on yield parameters and seed cotton yield (kg ha^{-1})

Spacing (cm)	Number of Bolls plant^{-1}	Number of Bolls m^{-2}	Single boll weight (g)	Seed cotton yield (kg ha^{-1})	Lint yield (kg ha^{-1})
S_1- 90 x 45	15	34	3.45	1068	369
S_2- 60 x 30	13	63	3.22	1936	666
S_3- 90 x 45-10	14	52	3.34	1465	556
S_4- 60 x 30-10	12	83	3.11	2389	867
S_5- 80 x 10	10	101	2.76	2734	922
S_6- 90 x 10	11	97	2.76	2615	908
S_7- 100 x 10	12	92	2.86	2573	867
SEd	0.60	3.65	0.15	105	37
CD (p=0.05)	**1.25**	**7.54**	**0.31**	**217**	**76**

Table 6: Effect of plant density on quality parameters

Spacing (cm)	Fibre length (mm)	Micronaire (10^{-6} inch^{-1})	Fibre strength (g tex^{-1})	Uniformity ratio
S_1- 90 x 45	29.3	4.0	18.3	46.5
S_2- 60 x 30	28.3	3.7	19.1	48.9
S_3- 90 x 45-10	28.7	4.0	18.6	49.0
S_4- 60 x 30-10	27.6	3.5	17.8	47.5
S_5- 80 x 10	30.3	3.6	18.1	47.2
S_6- 90 x 10	27.5	4.0	18.9	46.5
S_7- 100 x 10	28.2	4.0	18.3	46.9
SEd	1.98	0.29	1.27	3.33
CD (p=0.05)	**NS**	**NS**	**NS**	**NS**

CONCLUSION

Worldwide cotton research manipulation on plant geometry, plant population and spatial arrangement of cotton plants continues to be the major topic and India is no exception. It is widely accepted that increasing density as an option to increase yield or profits in cotton cultivation. Maximum seed cotton yield 2734 kg ha^{-1} was recorded when the spacing was 80cm × 10cm. The lowest cotton yield (1068 kg ha^{-1}) was obtained in 90cm × 45cm spacing.

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