The Bioscan 11(4): 2611-2614, 2016 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

IDENTIFICATION OF SUITABLE SPACING AND GENOTYPES FOR HIGH DENSITY PLANTING SYSTEM IN COTTON

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KEYWORDS
Cotton
Total dry matter
Proline
Yield
HDPS

Received on :
12.10.2016

Accepted on :
18.12.2016

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ABSTRACT

A field experiment was conducted during *kharif,* 2015 with an objective to find out suitable spacing and genotype for cotton cultivation under rainfed conditions for high density planting system (HDPS). Three different spacings have been tested *viz*., 75 x 10, 60 x 10 and 45 x 10 cm. Nine hirsutum genotypes including one hybrid were sown in split plot design. Morpho-physiological, biochemical parameters and yield components were studied. Maximum dry matter values were recorded in WGCV-48 (130 g) at 75 x 10 cm spacing. Deltapine 9121 under wider spacing of 75 x 10 cm recorded minimum time for square formation (41.1 days), 50% flowering (66.7 days) and boll formation (92.3 days), maximum values for yield attributes such as number of bolls per plant (7.9) and single boll weight (2.9) besides proline content (742 μg g^{-1} fresh weight), LAI (5.23) and yield (23.2 g $plant^{-1}$/ 23.9 q ha^{-1}). Deltapine-9121 and WGCV-48 at 75 x 10 cm recorded superior performance.

INTRODUCTION

Cotton the most important fibre crop of India, occupies prime position in the world. In India during 2013-14 cotton covered an area of 116.4 lakh ha with productivity of 552 kg ha^{-1}. Cotton area has been steady in Telangana state where it occupied 17.13 lakh ha with a productivity of 1039 kg ha^{-1}(Season and crop report, Agriculture action plan 2015-16).

Bt hybrids have been cultivated widely. Reuse of hybrid seeds showed decrease in crop yields. To reduce the cost of procurement of hybrid seed and as an alternative to hybrid, varieties can be used. The suitability of a cultivar to rainfed situation of Telangana state has not been worked out.

The manipulation of row spacing, plant density and the spatial arrangements of cotton plants, for obtaining higher yield have been attempted previously. High density cotton planting, more popularly called Ultra Narrow Row (UNR) cotton has row spacings of 20 cm and with plant population of 2 to 2.5 lakh plants ha^{-1}. Advantages of UNR 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). Results of plant spacing and fertilizer application have also shown that it has altered theplant architecture, photosynthetic efficiency of leaves, boll size and fruit production (Bhalerao *et al.,* 2010). This practice of HDPS which demands compact types so far has not been tested for straight varieties or hybrids.The present study therefore was taken up with an objective to identify high yielding genotypes with appropriate spacing under HDPS.

MATERIALS AND METHODS

Cotton crop was sown in *kharif,* 2015 at College farm, College of Agriculture, PJTSAU, Rajendranagar, which represents Southern Telangana agro-climatic zone of the state. RDF @ 90 N, 45 P_2O_5 and 45 K_2O kg ha^{-1} was applied in the form of Urea, SSP and MOP respectively. Pre- emergence herbicide pendimethalin @ 12.5 ml l^{-1} was sprayed and hand weeding was carried out thrice to prevent growth of weeds. Monocrotophos 1.6 ml l^{-1}, Acephate 1.5 g l^{-1} and Chlorpyrifos 2.5 ml l^{-1} were sprayed to check insect pests.

Nine cotton genotypes included in the study were ADB-39, ADB-542, H-4492859, Narasimha, NDLH-1938, Anjali, Suraj, WGCV-48 and hybrid Deltapine-9121. Experiment was laid-out in a Split plot design with three replications. Spacings adapted were 75 x 10, 60 x 10 and 45 x 10 cm. Observations were recorded at three growth stages namely, square (30 DAS), flowering (60 DAS) and boll initiation stages (90 DAS).

Dry weight of stem, leaf and boll were recorded separately. The plants were initially dried in the shade and later dried in a hot air oven at 65 ^{O}C for 72 hours and then the dry weightswere recorded. The leaf area was measured by using leaf area meter (LICOR model LI-3000).From which from the leaf area, the leaf area index (LAI) was calculated as follows (Watson, 1947):

LAI = Leaf area / Land area.

Squaring, flowering and boll initiation were recorded when 50% of plants attained aparticular stage. Number of bolls per plant and boll weight was considered for yield evaluation.

Proline estimation was done by ninhydrin- based colorimetric assay (Bates et al., 1973).Principle is at acidic pH, ninhydrin can form a red product with proline and ornithine which can be used for estimation of concentration of amino acids in pure solution. Aqueous sulphosalicylic acid extracts the free proline of plant samples, also causes the precipitation of proteins. Extracted proline reacts with ninhydrin under acidic conditions (pH 1.0) to form the red colour chromophore, whose intensity can be read at 520 nm.

Data on various traits were statistically analyzed following Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

Genotypes and spacings interaction values for dry matter differed significantly (Table 1). Maximum dry matter values were recorded in WGCV-48 (130 g) which was on par with H-4492859 (128 g) at 75 x 10 cm. Dry matter of genotypes in 60 x 10 cm and 45 x 10 cm were lower than in 75 x 10 cm by18.45% and 27.56%.Shukla *et al*., (2013) also reported a

Table 1: Dry matter and leaf area index of cotton genotypes under HDPS at boll initiation stage

Dry matter (g)					Leaf area index			
Genotypes	Spacings			Mean	Spacings			
	S1 (75 x 10)	S2 (60 x 10)	S3 (45 x 10)		S1 (75 x 10)	S2 (60 x 10)	S3 (45 x 10)	Mean
WGLV-48	130	111	98.5	113.2	4.68	4.16	4.08	4.31
NDLH-1938	120	88.1	89	99	3.67	3.44	3.36	3.49
H-4492859	128	88.9	89	101.9	3.01	2.95	2.87	2.94
Suraj	90.1	77.5	62.1	76.6	2.8	2.42	1.21	2.11
ADB-39	111	87	68	88.7	2.74	2.64	2.17	2.51
Anjali	78.5	69.9	57.8	68.7	2.42	2.4	2	2.3
ADB-542	62.2	54.8	49.8	55.6	2.49	2.41	2.32	2.41
Narasimha	58.3	49.4	45.5	51.1	2.17	1.97	1.93	2.02
Deltapine-9121	90.2	81.9	70.1	80.7	5.23	4.64	4.43	4.77
Mean	96.5	78.7	69.9		3.06	3.04	2.86	
Gi-Gj	SE(G)-1.97		CD(G)-5.93		SE(G)- 0.02898		CD(G)-0.086	
Si-Sj	SE(S)-0.27		CD(S)-0.76		SE(S)- 0.03427		CD(S)-0.098	
GiSi-GiSj	SE(G x S)-0.79		CD(G x S)-2.28		SE(G x S)- 0.10281		CD(G x S)-0.29	
GiSi-GjSi	SE(G x S)-2.08		CD(G x S)-6.22		SE(G x S)- 0.08881		CD(G x S)-0.25	

Table 2: Days to square formation, days to 50% flowering and days to boll initiation in cotton genotypes under HDPS

Treatment	Days to Square formation	Days to 50% flowering	Days toboll initiation
WGLV-48	41.8	67	93.4
NDLH-1938	43	67.6	94.1
H-4492859	43.4	68.2	95.1
Suraj	43.8	69	95.8
ADB-39	44.9	69.7	97.1
Anjali	45.2	70.3	97.2
ADB-542	43.1	68.3	94.4
Narasimha	43.4	69.3	96.4
Deltapine-9121	41.1	66.7	92.3
Gi-Gj	0.21	0.31	
SE	0.63	0.92	0.29
CD(0.05)			0.89
Spacings	42.8	67.4	94.5
S1(75 x 10)			
S2(60 x 10)	43.2	68.4	95.2
S3(45 x 10)	43.9	69.5	95.6
Si-Sj	0.13	0.11	
SE	0.38	0.32	0.11
CD(0.05)			0.32
Interaction	0.39	0.34	
GiSi-GiSj	NS	NS	
SE			0.34
CD(0.05)			NS
GiSi-GjSi	0.39	0.41	
SE	NS	NS	0.4
CD(0.05)			NS

Gi-Gj: Interaction among genotypes; Si-Sj: Interaction among spacings ; GiSi-GiSj: Interaction of one genotypes with different spacings; GiSi- GjSi: Interaction of different genotypes within one spacing

Table 3: Number of bolls per plant and boll weight of cotton genotypes under HDPS

Number of bolls plant^{-1}					Boll weight (g)			
Genotypes	Spacings			Mean	Spacings			
	S1 (75 x 10)	S2 (60 x 10)	S3 (45 x 10)		S1 (75 x 10)	S2 (60 x 10)	S3 (45 x 10)	Mean
WGLV-48	7.2	5.9	4.4	5.8	2.5	2.2	2.1	2.3
NDLH-1938	6.8	5.4	4.3	5.5	2.5	2.2	1.9	2.2
H-4492859	6.8	5.3	4.2	5.4	2.4	2.1	1.6	2
Suraj	6.4	5.7	4.1	5.4	2.4	2.2	1.9	2.1
ADB-39	6.4	4.6	3.8	4.9	2.3	2	1.5	1.9
Anjali	6.4	4.8	3.8	4.9	2.3	2.1	1.5	1.9
ADB-542	6.9	5.4	4.2	5.5	2.4	2.1	1.7	2.1
Narasimha	5.7	4.8	3.8	4.8	2.2	2	1.5	1.9
Deltapine-9121	7.9	6	4.6	6.2	2.9	2.6	2.1	2.5
Mean	6.7	5.3	4.1		2.5	2.1	1.7	
Gi-Gj	SE(G)-0.31		CD(G)-0.91		SE(G)-0.026		CD(G)-0.08	
Si-Sj	SE(S)-0.05		CD(S)-0.14		SE(S)-0.035		CD(S)-0.1	
GiSi-GiSj	SE(G x S)-0.14		CD(G x S)-0.41		SE(G x S)-0.106		CD(G x S)-0.3	
GiSi-GjSi	SE(G x S)-0.33		CD(G x S)-0.97		SE(G x S)-0.09		CD(G x S)-0.26	

Table 4: Proline content and yield of cotton genotypes under HDPS

Proline (μg g^{-1} fresh weight)					Yield (g plant^{-1})				Yield (q ha^{-1})			
Genotypes	Spacings			Mean	Spacings				Spacings			
	S1 (75 x10)	S2 (60 x 10)	S3 (45 x 10)		S1 (75 x 10)	S2 (60 x 10)	S3 (45 x 10)	Mean	S1 (75 x 10)	S2 (60 x 10)	S3 (45 x 10)	Mean
WGLV-48	408	564	825	599	18.2	13	9.1	13.4	21.7	19.2	17.6	19.5
NDLH-1938	366	508	784	553	17.1	11.9	7.9	12.3	20.2	17.4	15.2	17.6
H-4492859	341	458	780	526	16.2	11.1	6.2	11.3	19.2	16	12.7	15.9
Suraj	396	527	811	578	15.1	12.3	7.6	11.7	17.8	18	14.7	16.8
ADB-39	367	460	742	523	14.7	9.5	5.8	9.9	17.3	14.1	11.1	14.2
Anjali	333	428	725	495	14.3	9.5	5.5	9.8	16.5	13.6	10.6	13.5
ADB-542	452	382	316	383	16.6	11.4	7.1	11.7	20.6	17.22	14.38	17.4
Narasimha	430	298	272	333	12.8	9.4	5.6	9.3	16.4	14.5	11.6	14.2
Deltapine-9121	904	716	606	742	23.2	15.4	9.9	16.2	28.9	23.9	20	24.3
Mean	444	482	651		16.5	11.5	7.3		19.91	17.1	14.2	
Gi-Gj	SE(G)-9.02		CD(G)-27.05		SE(G)-0.64		CD(G)-1.93		SE(G)-0.64		CD(G)-1.93	
Si-Sj	SE(S)-10.56		CD(S)-30.28		SE(S)-0.17		CD(S)-0.49		SE(S)-0.17		CD(S)-0.49	
GiSi-GiSj	SE(G x S)-31.67		CD(G x S)-90.84		SE(G x S)-0.51		CD(G x S)-1.47		SE(G x S)-0.51		CD(G x S)-1.47	
GiSi-GjSi	SE(G x S)-27.39		CD(G x S)-78.94		SE(G x S)-0.76		CD(G x S)-2.27		SE(G x S)-0.76		CD(G x S)-2.27	

positive correlation between spacing and dry matter production per plant. 90 x 90 cm spacing as compared to 60 x 60 cm recorded higher values.

Deltapine 9121 recorded maximum LAI values at wide spacing of 75 x 10 cm (5.23) followed by WGCV-48 (4.68). At square formation, flowering and boll initiation stages maximum LAI was recorded in 75 x 10 cm spacing (2.6, 4.2 and 5.23 respectively). Minimum values were recorded in Narasimha at 45 x 10 cm spacing (1.21) (Table 1) due to reduced leaf size. Similarly Ghule *et al.,* 2013, reported high leaf area per plant with wide spacing between rows of 180 x 30 cm compared to120 x 45 cm and 90 x 60 cm.Maximum leaf area recorded was because of development of tall plants that could produce more number of leaves (Pendharkar *et al.* 2010). However, high LAI under closer spacing (60 x 60 cm) than wider spacing (90x 90 cm) can be attributed to more number of plants per unit area (Shukla *et al.*, 2013).

Squares appeared in Deltapine-9121 in 41.1 days. 50 % flowering occurred early in Deltapine-9121 (66.7 days) followed by WGCV-48 (67 days). Bolls initiated in Deltapine-9121 and WGCV-48 in 92.3 and 93.4 days respectively. Bolls appeared late in Anjali (97.2 days)(Table 2). Earliness in square formation in the present study in wider row spacing (75 x 10 cm) can be attributed to maximum solar radiation interception. Earliness in cotton can be achieved by growing a short duration cultivar and by decreasing the row spacing to a certain limit (Saleem *et al*. 2009).

Maximum bolls per plant were recorded in Deltapine-9121 (7.9) at 75 x 10 cm spacing followed by WGCV-48 (7.2) and ADB-542 (6.9). 20.8% and 38.8% reduction in number of bolls per plant were recorded for 60 x10 cm and 45 x 10 cm spacings (Table 3). With narrow rows (at equal densities) plants intercepted more light and increased seasonal light interception.However, this advantage has been seldom translated into improvements in yield (Shukla *et al.*, 2013).

Maximum boll weight was recorded in Deltapine-9121 (2.5 g) followed by WGCV-48 (2.3 g) and NDLH-1938 (2.2 g) (Table 3). Such increase in boll weight has been attributed to better

retention of early formed fruiting parts in early genotypes and efficient translocation of photosynthates into the reproductive sinks (Alse and Jadhav, 2011). Lower boll weight at high plant densities in wide spacings was due to lesser availability of carbohydrates to the bolls (Rajakumar and Gurumurthy, 2008).

Proline content was significantly influenced by different HDPS and genotypes (Table 4). Maximum proline content was recorded in hybrid Deltapine 9121 in all three stages of crop growth (190 and 692 and 904 $\mu g\ g^{-1}$ fresh weight) at 75 x 10 cm spacing. Minimum values at boll development stage were recorded in genotype Narasimha (272 $\mu g\ g^{-1}$ fresh weight) under 45 x 10 cm spacing. Significant effect of nutrient concentrations on the proline content was reported by Singh *et al*. (2015). Proline has been known to impart drought tolerance.

Maximum yield per plant was recorded in Deltapine-9121 at 75 x 10 cm (23.2g $plant^{-1}$/ 24.3 q ha^{-1}) followed by WGCV-48 (18.2 g $plant^{-1}$/19.2 q ha^{-1}) and NDLH- 1938 (17.1 g $plant^{-1}$/ 20.2 q ha^{-1}). Minimum values were recorded in Anjali at narrow spacing of 45x 10 cm (5.5 g $plant^{-1}$/16.5 q ha^{-1}) (Table 4). Srinivas *et al*. (2015) and Singh *et al*. (2012),reported a positive correlation of yield per plant with plant geometry. Increase in seed cotton yield with *Bt*. hybrid to the extent of 9.50 % over non-*Bt*. hybrid was recorded by Patel *et al*. (2016).

ACKNOWLEDGEMENT

The present work was done with the financial and technical support from Central Institute for Cotton Research (CICR), ICAR, Nagpur.

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