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Effect of High Density Planting System (HDPS) and Genotypes on Growth Parameters and Yield Contributing Traits in Upland Cotton

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A B S T R A C T

A field experiment was conducted during *Kharif* season of 2014-15 to evaluate the Effect of High Density Planting System (HDPS) and Genotypes on growth parameters and Yield contributing traits in upland cotton at Cotton Research Unit, Dr. P.D.K.V., Akola. The experiment was laid out in FRBD design consisting of four factors of plant densities *viz*., 45 x 10, 60 x10, 75 x 10 and 60 x 15 cm^2 in main plots and three factors of cotton varieties *i.e.,* AKH-081, NH-615 and Suraj in sub plots with replicated thrice. The taller plant height, maximum leaf area index and crop growth rate was found with higher plant densities. Whereas more leaf area and total dry matter production were increased with decreased plant densities. Similar trend was obtained with seed cotton yield (g)/plant and single boll weight. The highest seed cotton yield (2428.89 kg ha^{-1}) was recorded with high density, during both seasons.

Introduction

Cotton (*Gossypium hirsutum* L.), is one of the most ancient and important commercial crop next to food grains. Due to its importance in agriculture as well as in industrial economy, it is also known as "white gold". In India cotton is grown over an area 105 lakh hectares with production 351 lakh bales and productivity 568 kg lint ha-1 (Anonymous, 2017). In India, the seed cotton yield per unit area is still far below than many other cotton growing countries in the world. Among the various factors responsible for low yield of cotton crop in the country, low plant population and use of low potential varieties are of primary importance. Various techniques like maintaining suitable plant density, use of optimum dose of fertilizers, growth regulators etc., are being used to overcome these constraints in cotton production. The optimum level of cotton would however depend on the plant type. The present day cotton genotypes have a long duration of 180-200 days; they are late maturing, tall growing and spreading types leading to bushy appearance. They also require the wide spacing resulting in the production of netted canopy there by posing problems in taking up plant protection measures, machine picking, inefficient in trapping of solar energy, physiological efficiency and harvest index. Because of longer duration, these varieties require more number of pickings, as a result leading to manifold increase in cost of cotton cultivation especially manual picking and the margin of profit is low and fluctuating in an erratic manner. Moreover, the availability of labour for clean picking is also a serious constraint. At present, in India, entire cotton is picked manually which is labour intensive and is becoming expensive day by day. On the contrary, about 30 per cent of world cotton production in Australia, Israel and USA is machine picked.

In view of the above, present research work carried out with the objective to find out the Effect of High Density Planting System (HDPS) and Genotypes on growth parameters, Yield and Yield contributing traits in upland Cotton at Cotton Research Unit, Dr. P.D.K.V., Akola (M.S).

Materials and Methods

The experiment was conducted at experimental field of Cotton Research Unit, Dr. P.D.K.V., Akola, during 2014-15. The topography of experimental field was fairly uniform, levelled and with a good drainage. The experiment was laid out in FRBD design with four factors of plant densities i.e. 45 x 10, 60 x10, 75 x 10 and 60 x 15 cm^2 in main plots and three factors of cotton varieties *i.e.,* AKH-081, NH-615 and Suraj in sub plots. The recommended package of practices was followed during the course of the investigation. The observation on growth parameters were recorded at various crop growth stages (30, 60, 90, 120 DAS and at harvest) also yield and yield attributes were recorded. The growth parameters i.e., plant height, leaf area, leaf area index, and dry matter production $plant^{-1}$ and CGR were measured. The seed cotton yield (g)/plant from each net plot was picked and the same weighed separately at each picking. The single boll weight was also recorded. The total seed cotton yield (kg ha^{-1}) worked out by summation of a quantity of seed cotton picked in all pickings. The collected data was statistically analysed by Gomez and Gomez (1984) method.

Results and Discussion

Effect on growth parameters

Plant height is an important morphological character in cotton, which provides seat for nodes and internodes from where monopodial and sympodial branches emerge (Eaton, 1955) and it play important role in determining morphological framework relating to productivity. The plant height significantly influenced by plant geometry and genotypes throughout its growth stage (Table 1). At 60 DAS, maximum plant height (43.77 cm) was recorded at 45 x 10 cm spacing and it successively increases with increase in crop growth stage. At 90, 120 DAS and at harvest similar spacing recorded maximum plant height i.e. 61.88, 74.44 and 77.28 cm, respectively. Next to that 60 x 10 cm plant geometry recorded maximum plant height at all growth stage of plant. Among the genotypes, Suraj noted maximum plant height i.e. 44.20, 60.62, 75.31 and 76.23 cm. at 60, 90, 120 DAS and at harvest, respectively. Next to that, NH615 recorded maximum plant height at all growth stage of plant. Similar result reported by Helemani and Hellikeri (2002) and Srinivasulu *et al.,* (2006).

Data in respect of leaf area per plant as influenced periodically by different treatments (Table 1). The leaf area expanded progressively at 90 DAS. Thereafter, there was a decline in leaf area towards harvest stage due to leaf senescence. At 90 DAS, maximum leaf area per plant (43.77 cm) was recorded at 60 x 15 cm spacing and it successively decreases with increase in crop growth stage. At 120 DAS and at harvest similar spacing recorded maximum leaf area per plant i.e. 2299.06 and 2155.055 cm, respectively. Next to that 75 x 10 cm plant geometry recorded maximum leaf area per plant at all growth stage of plant. Leaf area per plant was higher in wider spacing of 60 x 15 cm with adequate space, light, moisture and nutrient availability, solar radiation penetration and utilization of nutrients in better way to produce higher effective leaf area per plant as compared to closer spacing of 45 x 10 cm with higher plant density per unit area which produced higher degree of competition for natural resources and caused reduction in leaf area. Among the genotypes, Suraj recorded significantly maximum leaf area per plant i.e. 1608.21 cm at 60 DAS.

The leaf area index of various treatments was recorded at various growth stages. The leaf area index expanded progressively and reached to a maximum of 5.17 g/cm^2 during 90 DAS at 45 x 10 cm spacing. Thereafter, there was a decline in leaf area index towards harvest stage due to leaf senescence. At 120 DAS and at harvest similar spacing recorded significantly more leaf area index i.e. 4.87 and 4.55 g/cm^2, respectively. Differences among hirsutum genotypes in respect of leaf area index per plant were observed non significant at all stages of crop growth except at 90 and 120 DAS. At 90 DAS and at harvest similar genotype showed significantly maximum leaf area index i.e. 3.77 and 3.55 g/cm^2, respectively. Next to that, AKH081 recorded maximum leaf area index at all growth stage of plant. Leaf area index increases with increasing rate of photosynthates of different hirsutum hybrids due to varietal difference. These results were similar to earlier findings Joshi *et al.,* (2011) and Shukla *et al.,* (2013). Data in respect crop growth rate was recorded at various growth stages. Biomass formed per unit area of land is then of more practical relevance than productivity per plant. At 60-90 maximum crop growth rate was recorded in 45×10 cm i.e., 0.152. At 90-120 DAS and 120 DAS - at harvest spacing recorded significantly more crop growth rate i.e. 0.252 and -0.023 g dm^{-2} day^{-1}, respectively. Differences among hirsutum genotypes in respect of crop growth rate were observed significant at all stages of crop growth except 60-90 DAS. At 90-120 DAS maximum crop growth rate was recorded in AKH081 i.e. 0.233.and 120DAS-at harvest the genotype Suraj (-0.026) recorded significantly higher crop growth rate.

Effect on yield parameters:

Seed cotton yield $plant^{-1}$ (g)

Data regarding weight of seed cotton $plant^{-1}$ (g) as influenced by different treatments are presented in Table 2. On an average of 15.23 (g) seed cotton yield $plant^{-1}$ was collect in three picking. Treatment differences in respect of seed cotton yield $plant^{-1}$ due to different plant geometry were observed to be significant. Wider plant geometry of 60 x 15 cm i.e. 17.36 g recorded significantly higher weight of seed cotton yield $plant^{-1}$ as compared to the geometry of 45 x 10 cm (13.71 g). Under wider geometry availability of photosynthates to individual plant was more to produce maximum seed cotton yield as compared to closer plant geometry. This might be due to overall improvement in growth attributes and its positive effect on number of bolls $plant^{-1}$ under wider plant geometry. The above result is in conformity with the findings of Solanke *et al.,* (2001), Raut *et al.,* (2005), Giri *et al.,* (2008) and Reddy and Gopinath (2008). Differences in respect of seed cotton yield plant-^{1} were significant among the three hirsutum genotypes. Genotype AKH081 recorded significantly more seed cotton yield (16.52 g).

Table.1 Influence of plant geometry and genotypes on growth parameters of Hirsutum cotton

Treatment	Plant Height (cm)				Leaf area plant^{-1} (cm)				Leaf area index (g/cm^2)				Dry matter production plant^{-1}			
	60 DAS	90 DAS	120 DAS	At harvest	60 DAS	90 DAS	120 DAS	At harvest	60 DAS	90 DAS	120 DAS	At harvest	60 DAS	90 DAS	120 DAS	At harvest
A)Plant geometry (spacing)																
45×10 (S_1)	21.98	43.77	61.88	74.44	1506.67	2325.56	2193.06	2049.05	3.35	5.17	4.87	4.55	39.23	58.73	95.60	92.55
60×10 (S_2)	21.83	41.41	60.63	74.26	1535.94	2308.00	2175.50	2031.5	2.56	3.85	3.63	3.39	39.51	59.89	97.63	93.32
75×10 (S_3	21.45	40.83	59.67	73.31	1545.72	2427.28	2294.78	2150.78	2.06	3.24	3.06	2.87	40.11	60.67	102.21	97.04
60×15 (S_4)	21.11	40.23	57.07	72.05	1561.33	2431.56	2299.06	2155.05	1.73	2.70	2.55	2.39	41.12	61.57	102.81	97.56
SE(m)±	0.79	0.65	0.46	0.56	31.99	29.37	30.82	4.38	0.10	0.01	0.01	0.10	0.11	0.26	0.13	0.11
CD at 5%	NS	1.90	1.36	1.63	NS	86.13	90.40	12.84	0.30	0.02	0.02	0.28	0.33	0.76	0.40	0.33
B)Genotypes																
AKH081(V_1)	20.24	39.35	59.03	72.14	1511.75	2370	2237.5	2093.5	2.38	3.74	3.54	3.31	40.16	60.72	102.09	97.61
NH615 (V_2)	21.79	41.14	59.79	73.10	1492.29	2355.29	2222.79	2078.79	2.35	3.7	3.49	3.26	39.80	59.82	97.41	93.30
Suraj (V_3)	22.75	44.20	60.62	75.31	1608.21	2394	2261.5	2117.5	2.55	3.77	3.55	3.33	40.02	60.11	99.19	94.44
SE(m)±	0.69	0.56	0.40	0.48	27.71	25.43	26.69	3.79	0.09	0.01	0.01	0.08	0.10	0.22	0.12	0.10
CD at 5%	NS	1.65	1.17	1.41	81.26	NS	NS	NS	NS	0.02	0.02	NS	0.29	0.66	0.34	0.29
Interaction S×V																
S_1V_1	22.60	43.48	57.35	74.00	1623.50	2376.83	2244.33	2100.33	3.61	5.28	4.99	4.67	40.31	60.70	98.23	94.86
S_1V_2	22.60	44.56	57.51	74.03	1618.67	2332.33	2199.83	2055.83	2.70	3.89	3.67	3.43	43.00	64.79	100.97	96.54
S_1V_3	23.50	47.03	63.18	73.14	1625.50	2355.50	2223.00	2079.00	2.17	3.14	2.96	2.77	39.54	60.21	104.01	98.96
S_2V_1	22.32	41.71	61.11	73.12	1565.17	2409.33	2276.83	2132.83	1.74	2.68	2.53	2.37	37.79	57.18	105.14	100.07
S_2V_2	21.01	42.25	64.41	73.35	1444.00	2343.83	2211.33	2067.33	3.21	5.21	4.91	4.59	41.32	61.69	94.73	91.96
S_2V_3	22.03	39.51	57.33	71.26	1515.33	2275.50	2143.00	1999.00	2.53	3.79	3.57	3.33	38.21	58.58	96.74	92.13
S_3V_1	21.78	40.36	60.70	70.91	1520.33	2487.33	2354.83	2210.83	2.03	3.32	3.14	2.95	41.49	62.32	102.62	96.56
S_3V_2	22.35	42.43	60.06	73.03	1567.33	2393.33	2260.83	2116.83	1.74	2.66	2.51	2.35	39.04	57.86	102.69	97.08
S_3V_3	19.71	42.03	58.06	72.66	1452.50	2256.00	2123.50	1979.50	3.23	5.01	4.72	4.40	41.72	62.32	93.84	90.83
S_4V_1	19.98	36.63	56.36	70.90	1473.83	2316.17	2183.67	2039.67	2.46	3.86	3.64	3.40	39.12	58.65	95.18	91.28
S_4V_2	21.56	40.38	60.96	74.89	1491.33	2439.00	2306.50	2162.50	1.99	3.25	3.08	2.88	37.51	57.15	100.01	95.59
S_4V_3	19.70	38.36	60.73	73.85	1551.50	2492.00	2359.50	2215.50	1.72	2.77	2.62	2.46	40.85	61.15	100.61	95.52
SE(m)±	1.37	1.12	0.80	0.96	55.41	50.87	53.39	7.58	0.18	0.01	0.01	0.17	0.19	0.45	0.23	0.20
CD at 5%	NS	NS	2.35	NS	NS	NS	NS	22.23	NS	0.04	0.04	NS	0.57	1.31	0.69	0.58

Table.2 Influence of plant geometry and genotype on crop growth rate and yield parameters of Hirsutum Cotton

Treatment	Crop growth rate			Seed cotton yield (g)/plant	Single boll weight (g)	Seed cotton yield (kg)/ha
	90 DAS	120 DAS	At harvest			
A)Plant geometry (spacing)						
45×10 (S_1)	0.152	0.253	-0.033	13.71	2.40	2428.89
60×10 (S_2)	0.114	0.225	-0.025	14.93	2.48	2261.00
75×10 (S_3	0.091	0.188	-0.016	15.26	2.49	1818.17
60×15 (S_4)	0.106	0.219	-0.023	17.36	2.51	1901.17
SE(m)±	0.002	0.002	0.001	0.38	0.01	30.71
CD at 5%	0.004	0.006	0.002	1.13	0.02	90.06
B)Genotypes						
AKH081(V_1)	39.35	59.03	72.14	16.52	2.48	2225.00
NH615 (V_2)	41.14	59.79	73.10	14.27	2.43	1991.75
Suraj (V_3)	44.20	60.62	75.31	15.15	2.50	2090.17
SE(m)±	0.56	0.40	0.48	0.33	0.00	26.59
CD at 5%	1.65	1.17	1.41	0.98	0.01	78.00
Interaction S×V						
S_1V_1	43.48	57.35	74.00	15.01	2.40	2671.50
S_1V_2	44.56	57.51	74.03	15.96	2.48	2280.50
S_1V_3	47.03	63.18	73.14	16.27	2.50	2055.50
S_2V_1	41.71	61.11	73.12	18.85	2.53	1892.50
S_2V_2	42.25	64.41	73.35	12.39	2.35	2216.50
S_2V_3	39.51	57.33	71.26	14.08	2.46	2206.00
S_3V_1	40.36	60.70	70.91	14.09	2.46	1808.50
S_3V_2	42.43	60.06	73.03	16.53	2.46	1736.00
S_3V_3	42.03	58.06	72.66	13.73	2.45	2398.67
S_4V_1	36.63	56.36	70.90	14.75	2.49	2296.50
S_4V_2	40.38	60.96	74.89	15.43	2.52	1839.50
S_4V_3	38.36	60.73	73.85	16.70	2.55	1826.00
SE(m)±	1.12	0.80	0.96	0.67	0.01	53.19
CD at 5%	NS	2.35	NS	NS	0.03	155.99

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

The differences due to plant geometry in seed cotton yield ha^{-1} were significant. Closer plant geometry of 45 x 10 cm recorded significantly higher seed cotton yield (2428.89 kg ha^{-1}).It was observed that numbers of bolls plant^{-1} were highest under the wider geometry but the seed cotton yield was highest in closer geometry due to the higher plant population than the wider geometry. Similar results were also reported by Raut *et al.,* (2005a), Srinivasan (2006), Sisodia and Khamparia (2007), Giri *et al.,* (2008), Reddy and Gopinath (2008), Bhalerao and Gaikwad (2010) and Reddy and Kumar (2010). Pradeep Kumar *et al.,* (2017) recorded that significantly higher seed cotton yield (2063 kg/ha) was recorded at plant spacing of 45 x 15 cm^2 as compared to other spacing. Among the different hirsutum genotypes, genotype AKH081 recorded higher seed cotton yield (2225 kg ha-1).

Single boll weight (g)

The data reported in table 2 indicate that the difference due to various plant geometry in respect of boll weight was significantly influenced. A wider plant geometry of 60 x 15 cm produced more boll weight (2.51) g.The variation in boll weight in plant geometry was due to fact that the better aeration and adequate interception of light and lesser competition of nutrients at wider spacing, which resulted in synthesis of higher photosynthates and thereby helped to produce higher boll weight. Differences in respect of seed cotton yield plant-1 were significant among the three hirsutum genotypes. Genotype AKH081 (V1) recorded significantly more seed cotton yield (16.52 g). This increase in seed cotton yield might be due to more number of bolls per plant, boll weight per plant as compaired to local check (Nehra *et al.,* 2004). The boll weight is major yield components in *G. hirsutum* cotton under rainfed condition (Singh *et al.,* 1983).

In conclusion, on the basis of experimental study of cotton (*Gossipium hirsutum*) genotype AKH081 can be sown at plant spacing of 45×10cm for obtaining higher seed cotton yield respectively over the spacing.

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