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Production Potential of *hirsutum* COTTON (AKH-081) As Affected by Plant Density and Nutrient Management under Rainfed Condition of Vidarbha Region

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ABSTRACT

A Field experiment was carried out to study the performance of American cotton (Gossypium hirsutum) variety under different plant density and nutrient management under rainfed condition of Vidarbha region for two consecutive kharif season of 2012 and 2013. The treatment combination comprised three different density viz., S_1- 1,66,666 plants ha^{-1} at spacing (60 x 10 cm^2), S_2- 1,11,111 plants ha^{-1} at spacing (60 x 15 cm^2) and S_3- 55,555 plants ha^{-1} at spacing (60 x 30 cm^2) and four nutrient management viz., F_1- 100% RDF (50:25:25 NPK Kg ha^{-1}), F_2- 150% RDF (75:37.5:37.5 NPK Kg ha^{-1}), F_3-100% RDF + Foliar spraying of 2.0% DAP at flowering (60 DAS), 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ at boll development stage (80 DAS) and F_4-150% RDF + Foliar spraying of 2.0% DAP at flowering (60 DAS), 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ at boll development stage (80 DAS) allocated to subplots in split plot design with three replication. The plant density of 1,66,666 plants ha^{-1} (S_1) on pooled analysis was recorded significantly higher plant height and seed cotton yield (2404 Kg ha^{-1}) over 55,555 plants ha^{-1} (S_3) and fallowed by the 1,11,111 plants ha^{-1} (S_2). The closer plant density of 60 x 10 cm^2 gave 4.02% and 33.97% more yield ha^{-1} over 60 x 15 cm^{2}and 60 x 30 cm^2 respectively. Whereas, increment in nutrient management 150% RDF + Foliar spraying of 2.0% DAP at flowering (60 DAS), 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ at boll development stage (80 DAS), was significantly increased in growth attributes and seed cotton yield towards 100% RDF (F_1) and 100% RDF + micronutrient (F_3) except 150% RDF (F_2).

Key words: *Hirsutum cotton, High Density Planting, Nutrient Management, Yield.*

INTRODUCTION

The manipulation of row spacing, plant density and the spatial arrangement 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^{-1} m^{2} [7]resulting in a population of 50,000 to 1,50,000 plants ha^{-1}.

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The concept of high density cotton planting, more popularly called Ultra Narrow Row (UNR) cotton was initiated by Briggs *et al.*[4]. Vigilant production and economics strategies are important for cotton growing farmers due to expanding cost of cultivation and stagnating productivity. Adoption of High density planting system (HDPS) and newly release *hirsutum* cotton varieties offer an alternate to sustainable production and decreased production cost. Cotton (*Gossypium spp.)* the king of fiber or white gold, is one of the most important commercial crop of India. It is one of the most important cash crops next to food grains that play vital role in Indian national economy [12]. In India cotton is grown over an area of 115.53 lakh hectars with production of 375.00 lakh bales with productivity of 552 kg lint ha^{-1} [1]. Cotton production in India is considered to have a wide reaching impact not only on the livelihood of farmers and economy of the country but also on international trade. Even though maximum area is under *hirsutum* cotton, but average productivity is lower than world average. Cotton productivity depends on various factors among them selection of potential genotypes along with plant densities play a vital role in increasing the productivity of cotton. The *hirsutum* cotton are known to tolerant and resistant to diseases, pests and adverse environmental condition. New *hirsutum* cotton variety AKH-081 have been released in recent times by Dr. PDKV, Akola. The maximum exploitation of these genotypes can be achieved only after determining their optimum planting densities in comparison to recommended cotton varieties. In general, it was observed that the lower plant densities produces high values of growth and yield attributes $plant^{-1}$ but yield per unit area was higher with higher plant densities[5,9,16]. However, it may happen that moderate increase in plant densities may not increase the yield but decrease due to competition between plants for nutrients, water, space and light[10]. In view of the above, present research work carried out with the objective to find out the effect of High Density Planting System (HDPS) on growth and yield of *hirsutum* cotton.Fertilizer has become necessary input to supply essential plant nutrients to get expected crop yield as soils are poor in NPK content. Three known principal elements for plant growth are nitrogen, phosphorus and potassium. Optimum fertilizer level increases the fertilizers use efficiency and correcting nutrient deficiency of plant and boost up the productivity. Essential micronutrients like Zinc and Magnesium play an important role in physiology of cotton crop being a part of enzyme system or catalyst in enzymatic reactions. They are required for plant activities such as aspiration, meristematic development, chlorophyll formation, photosynthesis, energy system, protein and oil synthesis, gossypol, tannin and phenolic compounds development. The role of micronutrients in various physiological and biochemical processes in plant is well known, which enables a rapid change in the physiology of plant within one season to achieve desirable results . Foliar application of micronutrients play an important role in changing growth and physiological characteristics of cotton.

MATERIALS AND METHODS

The field experiment was conducted during *kharif* season of 2012 and 2013 on Agronomy farm of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in split plot design with three replication. The treatment combination comprised of three crop densities *viz.* The S_1- 60 x 10 cm^2 (1,66,666 plants ha^{-1}), S_2- 60 x 15 cm^2 (1,11,111 plants ha^{-1}) and S_3- 60 x 30 cm^2 (55,555 plants ha^{-1}) in the main plots and four levels of fertilizer 100% RDF (F_1) *i.e.* 50:25:25 kg $N:P_2O_5:K_2O$ ha^{-1} , 150% RDF (F_2) *i.e.* 75:37.5:37.5 kg $N:P_2O_5:K_2O$ ha^{-1}, F_3- 100% RDF + Foliar spraying of 2.0% DAP at flowering, 1.0% $MgSO_4$ and 0.5% $ZnSO_4$ at boll development stage and F_4- 150% RDF + Foliar spraying of 2.0% DAP at flowering (60 DAS), 1.0% $MgSO_4$ and 0.5% $ZnSO_4$ at boll development stage (80 DAS) were combinely allotted in subplots. The soil of the experimental field was clayey in texture, slightly alkaline having pH- 8.1, EC- 0.30 (dsm^{-1}), organic carbon 0.61% and available

NPK, Zn and Fe status of the soil was 208 kg ha^{-1}, 17.32 kg ha^{-1}, 336 kg ha^{-1}, 0.610 mg kg^{-1} and 5.57 mg kg^{-1} respectively. Sowing of experiment was done on 01.07.2012 and 12.06.2013 respectively. The representative sample was analyzed NPK by using standard procedure[6]. DTPA extractable micronutrients (Zn, Fe, Mn and Cu) were determined as per the method described by Lindsay and Norvell[8]. The total precipitation was recorded during growth period 592.8 mm and 946.4 mm, during 2012 and 2013 respectively.

RESULTS AND DISCUSSION

Effect of plant density on different parameter

Plant height was significantly influenced by various plant density throughout the crop growth period. A plant density of 1,66,666 plants ha^{-1} (60 x 10 cm^2) recorded significantly more plant height than 1,11,111 plants ha^{-1} (60 x 15 cm^2) and 55,555 plants ha^{-1} (60 x 30 cm^2) up to at harvest. Due to more number of plants per unit area resulted maximum height $plant^{-1}$ which may be due to increase competition for sunlight and carbon dioxide. Similar results were observed by Nehra *et al.*[10]. Who explained that the reduction in plant height of *hirsutum* cotton wider spacing was due to suppression of apical dominance, which resulted increased branching and vice versa to closer spacing. It was observed that any increase in the plant population per unit area the congestion in the growing crop plants increased, which induce more vertical growth and lateral spread was restricted, similar results were observed by Sisodia and Khamparia[17]. As regard to number of sympodial branches $plant^{-1}$ increase with decrease in plant densities. Plant under wider spacing of 60 x 30 cm^2 (55,555 plants ha^{-1}) produce significantly more number of sympodial branches $plant^{-1}$ than those recorded under closer spacing of 60 x 10 cm^2 (1,66,666 plants ha^{-1}) and 60 x 15 cm^2 (1,11,111 plants ha^{-1}) during both the years. Such significant increase in number of sympodial branches $plant^{-1}$ under wider row spacing was also reported by Reddy and Kumar[15]. As regard yield attributing characters like number of picked bolls $plant^{-1}$ (11.31) boll weight (2.90 g) and seed cotton weight $plant^{-1}$ (33.06) also increase with the decrease in plant densities of 55,555 plants ha^{-1}on the basis of pooled analysis. These results area in accordance with Ram and Giri[13].The higher plant density of 1,66,666 plants ha^{-1} recorded lower value of yield parameters and also observed a decreased in number bolls $plant^{-1}$ but an increase in seed cotton yield per unit area elevated population. Increase in seed cotton yield 2404 kg ha^{-1} registered under higher plant density of 1,66,666 plants ha^{-1} (60 x 10 cm^2) than lower plant density of 55,555 plants ha^{-1} (60 x 30 cm^2), but it was statistically at par with plant density of 1,11,111 plants ha^{-1} (60 x 15 cm^2) (Table 2). These results are in conformity with the findings Basavanneppa *et al*[2].

Effect of nutrient management on different parameter

Increases in every level of nutrient management increased plant height. Maximum plant height was recorded at harvest with 150% RDF *i.e.*, 75:37.5:37.5 NPK kg ha^{-1} + 2.0% DAP at flowering (60 DAS) 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ at boll formation stage (80 DAS), which was significantly superior over lower one. These finding confirm with the earlier finding of Solanke *et al*[18]. Whereas significantly highest fruiting branches were observed by application of 150% RDF + 2.0% DAP and 1.0% $MgSO_4$ + 0.5% $ZnSO_4$over rest of the nutrient management treatment. It might be due to increasing of micro nutrient content in leaves have increased the production of metabolites synthesized and thus the plant have chance to bear more fruiting branches and consequently production of sympodial branches $plant^{-1}$ by sympodia buds through involving cell division. Results were supported with the findings of Tayade *et al*[19]. The data mentioned in Table 2 reveled that the significant increase in yield contributing parameters *viz*., number of picked bolls $plant^{-1}$ (9.62), boll weight (2.76 g) and seed cotton yield (27.01 g) could be attributed to availability of more nutrient in balance quantity to crop with ultimately produced highest seed cotton yield of 2456 kg ha^{-1} at 150% RDF + 2.0% DAP and 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ over rest of the nutrient management level in pooled analysis. The beneficial effect on yield contributing component reflect on seed cotton yield ha^{-1}. This was also reported by Sisodia and Khamparia[17] and Bhalerao and Gaikwad[3] .The magnitude of increase in seed cotton yield kg ha^{-1} under nutrient management *i.e*., 150% RDF *i.e*., 75:37.5:37.5 NPK kg ha^{-1} + 2.0% DAP at flowering (60 DAS) 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ at boll formation stage (80 DAS), to the tune of 32.62% over 100% RDF *i.e*., 50:25:25 NPK kg ha^{-1}(F_1).

Table 1: Plant height (cm) and sympodial branches $plant^{-1}$ of *hirsutum* cotton as influenced by plant density and nutrient management at harvest during 2012 and 2013

Treatments	Plant height (cm)			Sympodial branches $plant^{-1}$		
I) Main plot treatments	**2012**	**2013**	**Mean**	**2012**	**2013**	**Mean**
a) Plant Density						
S_1 - 60 x 10 cm^2 (1,66,666 plants ha^{-1})	86.73	89.96	88.35	9.72	11.85	10.79
S_2 - 60 x 15 cm^2 (1,11,111 plants ha^{-1})	77.62	81.86	79.74	10.38	12.56	11.47
S_3 - 60 x 30 cm^2 (55,555 plants ha^{-1})	71.47	71.88	71.67	14.48	16.78	15.63
S. E. (m) ±	0.37	0.43	-	0.13	0.13	-
C. D. at 5%	1.16	1.35	-	0.39	0.41	-
II) Sub plot treatments						
b) Nutrient Management						
F_1 - 100% RDF (50:25:25 NPK kg ha^{-1})	76.34	80.21	78.27	10.74	13.10	11.92
F_2 - 150% RDF (75:37.5:37.5 NPK kg ha^{-1})	79.57	81.77	80.67	11.96	13.97	12.96
F_3 - 100% RDF + 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$	77.74	80.70	79.22	11.20	13.68	12.44
F_4 - 150% RDF + 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$	80.77	82.80	81.79	12.19	14.04	13.12
S. E. (m) ±	0.34	0.38	-	0.12	0.12	-
C. D. at 5%	0.97	1.09	-	0.33	0.35	-
Interaction effect						
S x F						
S. E. (m) ±	0.59	0.66	-	0.20	0.21	-
C. D. at 5%	NS	NS	-	NS	NS	-
GM	78.61	81.31	79.96	11.52	13.71	12.62

Table 2: Yield contributing characters and seed cotton yield (kg ha^{-1}) of *hirsutum* cotton as influenced by plant density and nutrient management during 2012 and 2013

Treatments	Number of picked bolls $plant^{-1}$			Boll weight (g)			Yield $plant^{-1}$			Seed cotton yield (kg ha^{-1})		
I) Main plot treatments	**2012**	**2013**	**Pooled**	**2012**	**2013**	**Pooled**	**2012**	**2013**	**Pooled**	**2012**	**2013**	**Pooled**
a) Plant Density												
S_1 - 60 x 10 cm^2 (1,66,666 plants ha^{-1})	6.75	6.89	6.82	2.28	2.47	2.38	15.44	16.89	16.16	2275	2533	2404
S_2 - 60 x 15 cm^2 (1,11,111 plants ha^{-1})	8.60	9.02	8.81	2.50	2.68	2.58	21.57	24.12	22.74	2174	2447	2311
S_3 - 60 x 30 cm^2 (55,555 plants ha^{-1})	11.14	11.48	11.31	2.83	2.96	2.90	33.53	34.28	33.06	1639	1810	1725
S. E. (m) ±	0.12	0.05	0.064	0.02	0.02	0.010	0.94	0.31	0.21	32.17	29.78	29.13
C. D. at 5%	0.38	0.16	0.23	0.05	0.05	0.039	2.96	0.98	0.77	101.37	93.7	93.31
II) Sub plot treatments												
b) Nutrient Management												
F_1 - 100% RDF (50:25:25 NPK kg ha^{-1})	7.78	8.24	8.01	2.38	2.54	2.46	19.37	20.96	20.17	1702	1919	1811
F_2 - 150% RDF (75:37.5:37.5 NPK kg ha^{-1})	9.42	9.66	9.54	2.62	2.79	2.70	24.98	27.34	26.16	2157	2416	2287
F_3 - 100% RDF + 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$	8.61	8.89	8.74	2.48	2.63	2.55	24.01	23.75	22.77	1920	2146	2033
F_4 - 150% RDF + 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$	9.49	9.75	9.62	2.67	2.85	2.76	25.68	28.33	27.01	2338	2573	2456
S. E. (m) ±	0.06	0.08	0.05	0.01	0.01	0.007	1.16	0.23	0.27	21.07	19.02	16.45
C. D. at 5%	0.18	0.23	0.24	0.04	0.04	0.020	3.32	0.67	0.79	58.3	52.63	48.23
Interaction effect												
S x F												
S. E. (m) ±	0.11	0.14	0.148	0.03	0.02	0.012	2.01	0.68	0.47	45.49	32.94	25.04
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	137.08	NS	NS
GM	8.83	9.13	8.98	2.54	2.70	2.62	23.51	25.09	24.01	2029	2263	2147

Interaction effect

Plant density and nutrient management interaction was found to be significant in respect of seed cotton yield kg ha $^{-1}$ during 2012.

Table 3: Seed cotton yield (kg ha $^{-1}$) as influenced by S x F interaction during 2012

S x F	At harvest (2012)			
	F_1	F_2	F_3	F_4
S_1	1944	2376	2144	2637
S_2	1855	2350	1988	2505
S_3	1308	1742	1629	1877
S. E. (m) ±	45.49			
C. D. at 5%	137.08			

The treatment combination of $S_{1[ʻ/}F_4$ (Plant density 1,66,666 plants ha^{-1} with 150% RDF i.e., 75:37.5:37.5 kg N:P_2O_5: K_2O ha^{-1} + Foliar spraying of 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$) recorded highest seed cotton yield kg ha $^{-1}$ and was significantly superior over rest of the treatment combinations and found to be at par with treatment combination S_2F_4. Due to highest plant population ha^{-1} high competition between plants for nutrient and solar radiation.

CONCLUSION

From two years data it can be concluded that the higher plant population of 1,11,111 plants ha^{-1} with higher nutrient management *i.e.*, 150% RDF i.e., 75:37.5:37.5 NPK kg ha^{-1} + 2.0% DAP at flowering (60 DAS) 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ at boll formation stage (80 DAS), improved growth, yield contributing parameters and seed cotton yield followed by 1,66,666 plants ha^{-1} with 150% RDF.

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