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Original Research Article

Effect of Hirsutum Cotton to High Plant Density and Fertilizer Doses on Yield and Nutrient Uptake under Rainfed Condition

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A B S T R A C T

The field experiment was conducted at Agronomy Farm Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidypeeth, Akola during *Kharif* season 2014 to evaluate the effect of plant density and fertilizer doses on seed cotton yield and nutrient uptake under rainfed condition. The experiment was laid out in split plot design consisting three levels of plant densities *viz*., S_1- 1,66,666 plants ha^{-1} (60 x 10 cm^2), S_2- 1,11,111 plants ha^{-1} (60 x 15 cm^2) and S_3- 55,555 plants ha^{-1} (60 x 30 cm^2) in main plots and three fertilizer doses *i.e*. F_1- 100% RDF (50:25:25 N:P_2O_5:K_2O kg ha^{-1}), F_2- 150% RDF (75:37.5:37.5 N:P_2O_5:K_2O kg ha^{-1}) and F_3- 200% RDF (100:50:50 N:P_2O_5:K_2O kg ha^{-1}) in sub plots. The results revealed that the plant density of 1,66,666 plants ha^{-1} produced significantly superior seed cotton yield (kg ha^{-1}) over plant density of 55,555 plants ha^{-1} (kg ha^{-1}) and it was at par with plant density of 1,11,111 plants ha^{-1}. Among the fertilizer doses application of 200% N P_2O_5:K_2O kg ha^{-1} registered higher seed cotton yield over 100% N P_2O_5:K_2O kg ha^{-1} but at par with application of 150% N P_2O_5:K_2O kg ha^{-1}. In case of nutrient uptake higher plant density of 1,66,666 plants ha^{-1} recorded the highest uptake of N (42.72 kg ha^{-1}), P_2O_5 (14.34 kg ha^{-1}) and K_2O (48.14 kg ha^{-1}) over the lower plant densities. The application of 200% RDF produced the higher uptake of N (41.41 kg ha^{-1}), P_2O_5 (15.11 kg ha^{-1}) and K_2O (48.19 kg ha^{-1}), respectively than 150% RDF and 100% RDF.

Keywords

Hirsutum cotton, Plant density, Fertilizer dose, Nutrient uptake, Seed cotton yield

Introduction

In Indian agriculture, Cotton (*Gossypium hirsutum* L.) possesses a position of major fiber and cash crop, which plays vital role to sustain national economy. It is an important cash crop of Vidarbha region mostly under rainfed situations. In Vidarbha it is grown on area of about 14.00 lakh hectares with productivity of 305 kg lint ha^{-1}, which is too low than other cotton growing states.

The manipulation of plant density and crop spacing is a time tested agronomic technique to improve yield and profitability (Venugopalan *et al.*, 2013). As plant density increases the cumulative demand for sunlight, water and nutrient uptake increases and leading to more rapid canopy closure and decreased soil water evaporation and weed competition is becoming popular to address water scarcity challenges. The plant density and spatial arrangement of cotton plants continues to be topics of cotton research world-wide and India is no exception. It is widely accepted that

increasing plant density is an option to increase yield or profits and also to improve input use efficiency. The earliness usually associated with high density planting makes this system suitable for rainfed vertisols where the cotton crop invariably experiences terminal moisture stress.

Among the various factor of cotton production the plant density and fertilizer dose plays significant role. Plant may show better growth and development and give highest yield per plant but may not give maximum yield per unite area because of inadequate plant population. Thus, for increasing economic yield, the optimum spacing is essential. Full yield potential of newly developed genotype of *hirsutum* cotton could be exploited by applying optimum dose of fertilizer along with suitable plant density. The present study was, therefore, conducted to know the maximum yield potential with optimum fertilizer dose and spacing (Bhalerao *et al.*, 2010).

Materials and Methods

An experiment was conducted at Agronomy farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* 2014. Soil of the experimental field was clayey in texture, slightly alkaline having pH 8.2, and low in available nitrogen (213 kg ha^{-1}), low in available phosphorus (15.92 kg ha^{-1}) and high in available potassium (369 kg ha^{-1}). The experiment was conducted in split plot design having nine treatment combinations with four replications. Main plots consisted of three plant densities *i.e.* S_1- 1,66,666 plants ha^{-1} (60 x 10 cm^2), S_2- 1,11,111 plants ha^{-1} (60 x 15 cm^2) and S_3- 55,555 plants ha^{-1} (60 x 30 cm^2) and sub plots consisted of three fertilizer doses *viz.*, F_1- 100% RDF (50:25:25 $N:P_2O_5:K_2O$ kg ha^{-1}), F_2- 150% RDF (75:37.5:37.5 $N:P_2O_5:K_2O$ kg ha^{-1}) and F_3- 200% RDF (100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1}). The cotton variety AKH-081 was sown on July 11, 2014. Full dose of phosphorus and potassium were applied as basal dose through Di-ammonium phosphate and muriate of potash. Nitrogen was applied through urea in two equal splits i.e. 50% at the time ofsowing and second half at 30 DAS. All other agronomic practices were followed as per recommendations.

Results and Discussion

Effect of plant density

A perusal of data on (Table 1) revealed that the yield attributing character like number of harvested boll $plant^{-1}$ and seed cotton yield $plant^{-1}$ were found significantly higher with the plant density of 55,555 plants ha^{-1} (60 x 30 cm^2) over 1,11,111 plants ha^{-1} (60 x 15 cm^2) and 1,66,666 plants ha^{-1} (60 x 10 cm^2). Whereas boll weight $plant^{-1}$ found to be non significant in regards of plant density. This might be due to availability of more photosynthates to individual plant in lower plant density that led to overall improvement in growth attributes and its positive effect on number of harvested bolls $plant^{-1}$ was more to produce maximum seed cotton weight $plant^{-1}$ as compared to higher plant density.

The above results are in conformity with the findings of Ram and Giri (2006) and Chavan *et al.*, (2011).

Increase in seed cotton yield 1807 kg ha^{-1} recorded 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 at par with plant density of 1,11,111 plants ha^{-1} (60 x 15 cm^2). 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..

These results are in conformity with the findings Basavanneppa *et al.,* (2012).

Data regarding uptake of N:P_2O_5:K_2O (kg ha^{-1}) under different treatment have been presented in Table 3.

N:P_2O_5:K_2O uptake (kg ha^{-1}) was significantly influenced by different plant density. Higher plant density show significantly higher uptake of N (42.72 kg ha^{-1}), P (14.34 kg ha^{-1}), and K (48.14 kg ha^{-1}) as compared to lower plant density. Because of higher plant density might be due to higher dry matter ha^{-1} obtained from higher plant population. Similar results were reported by Bhalerao and Gaikwad (2010[a]), Dhillon *et.al.* (2006).

Effect of fertilizer dose

The data in Table 1 showed that the application of different doses of fertilizer found significant impact on number of harvested boll plant^{-1} and seed cotton yield plant^{-1} whereas boll weight found to be non significant. Application of 100:50:50 kg N:P_2O_5:K_2O ha^{-1} (*i.e.*, 200% RDF) recorded higher number of harvested boll plant^{-1} and seed cotton weight plant^{-1}, which was significantly superior over 50:25:25 kg N:P_2O_5:K_2O ha^{-1} (100% RDF) but found to be at par with 75:37.5:37.5 kg N:P_2O_5:K_2O ha^{-1} (150% RDF). Thus due to increasing level of fertilization, increased yield attributes and ultimately increased seed cotton weight per plant. Similar findings was reported by Shah *et al* (2012).

Seed cotton yield differences among the various fertilizer doses were significantly increased with increase in level of N:P_2O_5:K_2O kg ha^{-1} fertilization 100:50:50 kg N:P_2O_5:K_2O kg ha^{-1} (*i.e.*, 200% RDF) yielded maximum seed cotton yield (1764 kg ha^{-1}) which was significantly superior to 50:25:25 kg N:P_2O_5:K_2O ha^{-1} (1444 kg ha^{-1}), but found to be at par with 75:37.5:37.5 kg N:P_2O_5: K_2O ha^{-1} (1718 kg ha^{-1}). On an average application of 200 % RDF produced 22.11 and 4.17 per cent more seed cotton yield over 100 % RDF and 150% RDF respectively.

The primary nutrients (N:P_2O_5:K_2O) play an important role during vegetative as well as reproductive stage of cotton and also increased the number of sympodial branches, bolls and seed cotton weight plant^{-1} by encouraging process of photosynthesis. These results were also reported by Tomar *et al.*(2000) and Bhalerao *et al.*(2011).

The data pertaining to N, P_2O_5 and K_2O uptake as affected by different dose of fertilizer are presented in Table 4. The uptake of N, P_2O_5 and K_2O was increased significantly with the increase of fertilizer doses. The highest Nitrogen (41.41 kg ha^{-1}), Phosphorus (15.11 kg ha^{-1}) and Potassium (48.19 kg ha^{-1}) uptake were noticed with the higher dose of fertilizer 100:50:50 kg N:P_2O_5:K_2O ha^{-1} (*i.e.*, 200% RDF) which was significantly superior over lower dose of fertilizer 100% RDF (50:25:25 N:P_2O_5:K_2O kg ha^{-1}) and 150% RDF (75:37.5:37.5 N:P_2O_5:K_2O kg ha^{-1}).

Due to improvement in total uptake in plant with increasing fertilizer dose attributed to higher production of seed cotton yield and dry matter plant^{-1} which ultimately increased total uptake of plant. Similar results were supported by Nawalakhe *et al.,* (2010), Bhalerao and Gaikwad (2010[b]) and Modhavadia *et al.,* (2012).

Table.1 Yield attributing characters and Seed cotton yield (kg ha^{-1}) of hirsutum cotton as influenced by plant density and fertilizer doses

Treatment	Number of harvested bolls $plant^{-1}$	Boll Weight (g)	Seed cotton weight per plant (g)	Seed cotton yield (kg ha^{-1})
Main plot treatment A) Plant density				
S_1- 1,66,666 plants ha^{-1} (60 x 10 cm^2)	5.61	2.15	12.14	1807
S_2- 1,11,111 plants ha^{-1} (60 x 15 cm^2)	7.02	2.42	17.00	1764
S_3- 55,555 plants ha^{-1} (60 x 30 cm^2)	9.58	2.75	26.44	1355
SE(m)±	0.11	0.02	0.48	34.37
CD at 5%	0.38	NS	1.67	118.96
Sub plot treatment B) Fertilizer dose				
F_1 –100 % RDF (50:25:25 $N:P_2O_5:K_2O$ kg ha^{-1})	7.03	2.25	16.26	1445
F_2 –150 % RDF (75:37.5:37.5 $N:P_2O_5:K_2O$ kg ha^{-1})	7.61	2.47	19.23	1718
F_3 –200 % RDF (100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1})	7.62	2.60	20.07	1764
SE(m)±	0.12	0.01	0.39	18.52
CD at 5%	0.36	NS	1.18	55.04
Interaction S x F				
SE(m)±	0.21	0.03	0.69	32.08
CD at 5%	NS	NS	NS	95.33
GM	7.42	2.44	18.52	1642.11

Table.2 Interaction between plant density and fertilizer doses on seed cotton yield kg ha^{-1}

S x F	F1	F2	F3
S1	1556	1880	1984
S2	1569	1828	1897
S3	1209	1445	1412
SE(m)±	32.08		
CD at 5%	95.33		

Table.3 Nutrient uptake of NPK (kg ha^{-1}) as influenced by plant density and fertilizer doses.

Treatment	N uptake (kg ha^{-1})	P uptake (kg ha^{-1})	K uptake (kg ha^{-1})
Main plot treatment **A) Plant spacing**			
S_1- 1,66,666 plants ha^{-1} (60 x 10 cm^2)	42.72	14.34	48.14
S_2- 1,11,111 plants ha^{-1} (60 x 15 cm^2)	39.24	13.49	45.35
S_3- 55,555 plants ha^{-1} (60 x 30 cm^2)	31.13	12.83	38.06
SE(m)±	0.98	0.09	0.63
CD at 5%	3.39	0.34	2.18
Sub plot treatment **B) Fertilizer dose**			
F_1 –100 % RDF (50:25:25 N:P_2O_5:K_2O kg ha^{-1})	32.31	11.14	37.10
F_2 –150 % RDF (75:37.5:37.5 N:P_2O_5:K_2O kg ha^{-1})	39.38	14.41	46.26
F_3 –200 % RDF (100:50:50 N:P_2O_5:K_2O kg ha^{-1})	41.41	15.11	48.19
SE(m)±	0.37	0.20	0.52
CD at 5%	1.19	0.61	1.57
Interaction			
S x F			
SE(m)±	0.65	0.35	0.91
CD at 5%	NS	NS	NS

Interaction effect (S x F)

Plant density and fertilizer dose interaction were found to be significant. The data presented in (Table 2) reported that the treatment combination of S_1F_3 *i.e.*, plant density of 1,66,666 plants ha^{-1} (60 x 10 cm^2) with fertilizer dose of 200 % RDF (100:50:50 N:P_2O_5:K_2O kg ha^{-1}) recorded highest seed cotton yield of 1984 kg ha^{-1}, but found to be at par with S_2F_3 (1897 kg ha^{-1}) *i.e.*, plant density of 1,11,111 plants ha^{-1} (60 x 15 cm^2) with fertilizer dose of 200 % RDF (100:50:50 N:P_2O_5:K_2O kg ha^{-1}).

On the basis of one year data, it can be concluded that the higher plant density of 1,11,111 plants ha^{-1} with fertilizer dose 200% RDF i.e., 100:50:50 NPK kg ha^{-1} improved yield contributing parameters and seed cotton yield followed by 1,66,666 plants ha^{-1} with 150% RDF.

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