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Original Research Article

Effect of High Density Planting, Fertilizers and *in-situ* Moisture Conservation Techniques on Growth and Yield of *Hirsutum* Cotton

Shweta. S. Ganvir[1*], Mangala Ghanbahadur[2] and V. K. Khargkharate[1]

[1]Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (444104) India
[2]Late R.G Deshmukh College of Agriculture Tiwsa, Dist- Amravati (444903) India

**Corresponding author*

A B S T R A C T

The results revealed that closer plant density 1,66,666 plants ha^{-1} recorded significantly higher plant height , cotton stalk yield and biological yield, but seed cotton yield and lint yield was found to be at par with plant density 1,11,111 plants ha^{-1} which was significantly higher than plant density 55,555 plants. Similarly, plant density 1,11,111 plants ha^{-1} also significant over the plant density 55,555 plants ha^{-1} with respect to plant height and yield. It was observed that lower plant density produced more number of growth attributes. It was recorded that days to 50% flowering and ball brusting delay under wider plant density. Application of 150% recommended dose of fertilizer contributed to the substantial increment in yield by increasing growth attributes. More days to 50% flowering and boll brusting was recorded under increased level of fertilizer. As regards to *in situ* moisture conservation practices of opening of furrow 30 days for emergence enhanced the growth attributing characters and gave significantly higher yield than sowing on flat bed. It was also delay days to 50% flowering and boll brusting. Along with it, combined effect of increasing level of fertilizer and *in situ* moisture conservation technique of opening furrow 30 days after emergence was found to be significant with respect to biological yield.

Keywords

Cotton, Growth attributes, Moisture conservation, Nutrient, Plant density

Introduction

Cotton is the most important fibre crop of Indian farming community and plays an important role in agrarian and rural economy of India. It is considered as 'king of fibre' and is important cash crop of this country. There is need to increase the production of cotton for improving financial status of farmers and strengthen national economy. Increasing productivity of cotton not only by increasing the area under production but also plant population $hectare^{-1}$. Amongst the different agronomic practices variety, plant population, planting geometry and time of sowing are the important non- monitory inputs responsible for profitable cotton production. There is a positive relationship between plant population and seed cotton yield in cotton crop (Rao, 1982). As stand density increases the total communal demand for sunlight, water and nutrient uptake increases. The relative availability each of them will help shape, the individual response of plant growing in competition with each other (Dave *et al.*, 1993). Integrated plant nutrition system (IPNS) is an approach through which management of plant nutrition and soil fertility in farming system is adopted to take advantage of fertilizers towards production increase. Nutrient management

also one of the factor which influence yield. Soil and water conservation measures are basic to dry land farming.

Therefore, first attempt should be conserve rainfall. *In-situ* moisture conservation as the soil profile is reservoir for moisture storage. Sometimes at critical growth stage of crop like flowering and boll formation there may dry spell, which adversely affect the yield contributing characters and finally reduction in yield. To enhance the productivity under high density planting in rainfed conditions nutrient management and adoption of soil moisture conservation practices are very essential for adequate supply of nutrients and moisture. The *hirsutum* cotton variety AKH-081 having pecular characters of short duration, drawf, compact structure and maximum yield potential under rainfed condition. Therefore, expected to respond well to High Density Planting System (HDPS). Keeping in mind struggle between plants for getting more plant nutrients and moisture under high plant density, it will essential to find out the appropriate combination between the spacing and dose of NPK to achieve maximum yield under rainfed condition.

Materials and Methods

The field experiment was conducted during *Kharif* season of 2012 on Agronomy Farm of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The soil of the experimental site was clayey in texture, slightly alkaline having PH 8.1, EC 0.30 dSm^{-1}, organic carbon 0.61% and available N, P and K status of the soil was 208, 12.32 and 432 kg ha^{-1}, respectively. The experiment was laid out in Factorial Randomized Block Design with twelve number of treatments replicated in thrice. Treatment combination comprised of three plant spacing viz., S_1 - 60 x 10 cm (1,66,666 plants ha^{-1}), S_2 - 60 x 15 cm (1,11,111 plants ha^{-1}) and S_3 - 60 x 30 cm (55,555 plants ha^{-1}) allotted in first factor. Two levels of fertilizers i.e. F_1 - 100% recommended dose of fertilizer (50:25:25 kg N, P_2O_5 and K_2O ha^{-1}) and F_2 - 150% recommended dose of fertilizer (75:37.5:37.5 kg N, P_2O_5 and K_2O ha^{-1}) allotted in second factor. Two *in situ* moisture conservation practices of M_1 - sowing on flat bed and M_2 - opening of furrow 30 days after emergence was allotted in third factor. Sowing of the experiment was done on 2nd June by dibbling method. One plant was retained per hill. Fertilizers i.e. Nitrogen was applied through urea and diammonium phosphate, phosphorus was also applied through dimmonium phosphate and potash applied through muriate of potash as per treatment. Half dose of nitrogen, full dose of phosphorus and potassium were applied as basal dose and remaining half dose of nitrogen was top dressed at 30 days after emergence by ring method. The crop was raised as usual on flat bed and furrows were opened between the two rows with the help of hoe by tying rope to its tyne. The total rainfall recorded during June to December was 684.1 mm in 50 rainy days.

Results and Discussion

Effect of plant density

The higher plant population of 1,66,666 plants ha^{-1} at spacing 60 x 10 cm recorded significantly higher plant height (96.45 cm) than plant population of 1,11,111 plants ha^{-1} at spacing 60 x 15 cm and 55,555 plants ha^{-1} at spacing 60 x 30 cm, respectively (Table 1). The results are in harmony with those reported by Jagtap and Bhale (2010).

Increase in plant height might be due to competition for solar radiation among the plants. Significantly more number of functional leaves $plant^{-1}$ (62.23), leaf area $plant^{-1}$ (48.67 dm^2) and dry matter production

plant^{-1} (50.09 g) were reported with the lower plant density 55,555 plants ha^{-1} than 1,11,111 and 1,66,666 plants ha^{-1} (Table 1). These results similar with findings of Hake (1992). With progressive increase in plant spacing from 10 to 30 cm gradual increase in dry matter plant^{-1} may be due to utilization of available nutrients, sunlight and moisture at higher level because of more available space and atmosphere area plant^{-1}. Increasing to the leaf area plant^{-1} with wider spacing was probably due to efficient utilization of solar radiation and minimum mutual shading of lower leaves.

Wider plant spacing 60 x 30 cm significantly increase in days to 50 % flowering and 50% boll brusting. These results are in conformity with the findings of Singh and Warsi (1985) and Mohapatra and Nanda (2011). The difference in yield due to different spacing was found to be significant. Significantly higher seed cotton yield (2205 kg ha^{-1}) and lint yield (814.45 kg ha^{-1}) recorded with higher plant density 1,66,666 plants ha^{-1} at spacing 60 x 10 cm than lower plant density 55,555 plants ha^{-1} at spacing 60 x 30 cm but it was statistically at par with plant density 1,11,111 plants ha^{-1} at spacing 60 x 15 cm (Table 1). Substantial increase in seed cotton yield in closer spacing was due to higher plant population per unit area which compensated the low yield per plant even though there were lesser number of bolls plant^{-1}. Similar effect of higher plant density was also reported by Tomar *et al.,* (2000). Increasing cotton stalk yield and biological yield ha^{-1} was found with higher plant density 1,66,666 plants ha^{-1} than rest of the plant densities. These results are in conformity with the findings of Chavan *et al.,* (2011).

Effect of fertilizer levels

As regards to nutrient management application of increasing level of fertilizer 75:37.5:37.5 kg N, P_2O_5 and K_2O ha^{-1} recorded significantly higher value of plant height (89.34 cm), number of functional leaves plant^{-1} (59.51), leaf area plant^{-1} (48.07 dm^2) and dry matter production plant^{-1} (46.42 g) as compared to lower level of fertilizer 50:25:25 kg N, P_2O_5 and K_2O ha^{-1} (Table 1). Similar results were reported by Ram and Giri (2006). It was also observed that days to 50% flowering and boll brusting was delayed significantly with application of 75:37.5:37.5 kg N, P_2O_5 and K_2O ha^{-1}. Maximum days were required to attain 50% flowering and 50% boll brusting with 150% recommended dose of fertilizer. Fertilizer levels also influenced the yield kg ha^{-1}.

Significantly higher seed cotton yield (2211.22 kg ha^{-1}), lint yield (822.46 kg ha^{-1}), cotton stalk yield (4344.93 kg ha^{-1}) and biological yield (64.05.85 kg ha^{-1}) were also produced by higher level of fertilizer 75:37.5:37.5 kg N, P_2O_5 and K_2O ha^{-1} (Table 1). This result similar with the findings of Modhvadia *et al*., (2011) Increasing seed cotton yield with increased level of fertilizer might be due to the macro nutrient (NPK) plays an important role during vegetative as well as reproductive stage of cotton and also increase all the yield attributes by enhancing process of photosynthesis.

Ultimate product of photosynthesis accumulated in economic plant of cotton i.e. bolls and hence increase final value of plant. Similar results were also reported by Das and Reddy (2009) showed the results that increased level of fertilizer increased cotton stalk yield and biological yield kg ha^{-1}.

Effect of in-situ moisture conservation practices

The result of present experimentation showed beneficial effect of *in situ* moisture conservation technique of opening furrow 30

days after emergence over sowing on flat bed with regards to growth attributes, days to 50% flowering and boll brusting as well as yield (Table 1).

Maximum plant height (91.18 cm), number of functional leaves plant^{-1} (61.45 cm), leaf area (49.31 g) was recorded under *in situ* moisture conservation technique of opening of furrow 30 days after emergence. Result of present investigation are in conformity with the findings of Gaidhane *et al.*, (2007). It was observed that maximum days were required to attain 50% flowering (60 days) and 50% boll brusting (111.17 days) with treatment opening of furrow 30 days after emergence, it might be due to the optimum moisture in soil, which conserved the moisture that restricted dryness of plant. Significant increase in seed cotton yield (2048.50 kg ha^{-1}), lint yield (767.03 kg ha^{-1}) and cotton, stalk yield (4389 kg ha^{-1}) as well as biological yield (6569.71 kg ha^{-1}) with opening of furrow 30 days after emergence than sowing on flat bed. These results are similar with the findings of Asewar (2008) and Jadhav (2008) (Table 2).

Table.1 Growth attributes influenced by spacing, fertilizer levels and *in situ* moisture conservation techniques

Treatment	Plant height (cm)	No. of functional leaves plant^{-1}	Leaf area plant^{-1} (dm^2)	Dry matter plant^{-1} (g)	Days to 50% flowering	Days to 50% brusting
Factor-A : Spacing						
S_1- 60 x 10 cm	96.45	52.66	45.20	35.66	56.58	103.08
S_2- 60 x 15 cm	87.96	57.28	46.81	43.21	58.58	107.67
S_3- 60 x 30 cm	79.22	62.23	48.67	50.09	60.25	112.50
SE(m)±	1.84	0.46	0.42	1.60	0.38	0.53
CD at 5%	5.67	1.79	1.42	6.27	1.49	2.07
Factor-B : Fertilizer levels						
F_1- 50:25:25 kg ha^{-1}	86.41	55.27	45.72	43.26	57.28	106.11
F_2- 75:37.5:37.5 kg ha^{-1}	89.34	59.51	48.07	46.42	59.67	109.39
SE(m)±	0.56	0.30	0.28	0.72	0.48	0.23
CD at 5%	1.72	0.93	0.86	2.17	1.48	0.70
Factor-C : *In – situ* moisture conservation techniques						
M_1- Sowing on flat bed	84.57	53.33	44.50	43.37	56.94	104.33
M_2- Opening of furrow 30 DAE	91.18	61.45	49.28	46.31	60.00	111.17
SE(m)±	0.85	0.29	0.31	0.73	0.44	0.40
CD at 5%	2.58	1.02	1.05	2.17	1.53	1.39

Table.2 Yield influenced by plant spacing, fertilizer levels and *in situ* moisture conservation techniques

Treatment	Seed cotton yield (kg ha^{-1})	Lint yield (kg ha^{-1})	Cotton stalk yield (kg ha^{-1})	Biological yield (kg ha^{-1})
Factor-A : Spacing				
S_1- 60 x 10 cm	2204.75	814.45	5103.18	7307.82
S_2- 60 x 15 cm	2166.50	803.89	4455.84	6530.70
S_3- 60 x 30 cm	1574.17	588.11	3096.23	4670.39
SE(m)±	64.02	20.39	54.47	67.03
CD at 5%	212.09	80.05	213.86	263.14
Factor-B : Fertilizer levels				
F_1- 50:25:25 kg ha^{-1}	1752.39	648.51	4091.91	5933.45
F_2- 75:37.5:37.5 kg ha^{-1}	2211.22	822.46	4344.93	6405.82
SE(m)±	42.02	15.56	45.61	38.21
CD at 5%	129.50	47.10	140.54	117.75
Factor-C : In-situ Moisture conservation techniques				
M_1- Sowing on flat bed	1915.11	703.94	4047.83	5769.56
M_2- Opening of furrow 30 DAE	2048.50	767.03	4389.00	6569.71
SE(m)±	35.14	13.40	43.60	68.39
CD at 5%	121.59	46.37	150.90	236.67
Interaction S x F				
SE(m)±	72.79	26.95	78.99	66.18
CD at 5%	NS	NS	NS	NS
Interaction S x M				
SE(m)±	60.86	23.21	75.52	118.45
CD at 5%	NS	NS	NS	NS
Interaction F x M				
SE(m)±	59.43	22.00	64.50	54.04
CD at 5%	NS	NS	NS	166.52

*DAE – Days after emergence

Table.3 Combined effect of *in situ* moisture conservation and fertilizer levels on biological yield (kg ha^{-1})

	100% RDF	150% RDF
Sowing on flat bed	5440.77	6098.34
Opening of furrow 30 DAE	6426.12	6713.80
SE(m)±	54.04	
CD at 5%	166.52	

Interaction effect

The interaction effect of *in situ* moisture conservation technique and fertilizer level was significant with respect of biological yield (Table 3). Combined effect of *in situ* moisture conservation technique of opening of furrow 30 days after emergence and increasing level of fertilizer viz., 75:37.5:37.5 kg N, P_2O_5 and K_2O ha^{-1} recorded higher biological yield and was significantly superior over the rest of treatment combination.

From the results, it can be concluded that higher plant population 1,66,666 plants ha^{-1} , increased level of fertilizers @ 150 % recommended dose of fertilizer and *in – situ* moisture conservation practice of opening of furrow 30 days after emergence improved growth and seed cotton yield (kg ha^{-1}) over control. It was found to be beneficial for *hirsutum* cotton variety AKH -081 under rainfed condition to boost up the production.

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