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Effect of planting geometry and varieties on yield and economics of cotton under rainfed conditions of southern dry zone of Karnataka

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Abstract
A field investigation entitled "Standardization of agro-techniques for cotton under high density planting system for southern dry zone of Karnataka'" was conducted at Krishi Vigyan Kendra, Chamarajanagar during *kharif* season of 2016 in medium black cotton soil. The experiment was laid out in split plot design consisting of five levels of planting geometries *viz*. 45 X 10 cm, 45 X 20 cm, 60 X 10 cm, 60 X 20 cm and 90 X 60 cm as main plot treatments and three cotton genotypes *viz*., DSC-99, ARBC-64 and SURAJ in sub plot and replicated thrice. The results revealed that there is a significant difference were observed for planting geometries and varieties. The variety DSC-99 recorded significantly higher yield seed cotton yield (1383 kg/ha) followed by ARBC-64 (1383 kg/ha). DSC -99 performed better with respect to yield attributes *viz,* number of bolls (14.68/plant), boll weight (3.21g/plant) and seed cotton yield (43.53 g/plant). Among the planting geometries spacing at 45 X 10 cm recorded significantly higher Seed cotton yield (1589 kg/ha), Gross returns (Rs. 82,623/ha), Net returns (Rs. 37071/ha) and B:C ratio (1:81). However the interaction effects did not differ significantly for all the parameters studied.

Keywords: Planting geometry, genotypes, boll weight, seed cotton yield, gross returns, B:C ratio

Introduction

Cotton is an important fibre crop, which occupies a place of special significance in Indian farming and national economy. Due to the fact that cotton is the back bone of textile industry. In India cotton is cultivated in an area of 122 lakh hectare with a production of 377 lakh bales and productivity of 524 kg lint ha^{-1} (Anon.,2017) [2]. India has the largest area under cotton followed by China with 35.29% and 24% of world cotton area and production. Cotton is an important cash crop of Southern Dry zone of Karnataka, where the crop is extensively grown under rainfed condition. Rainfed cotton production has an direct impact on farmers income of the region. The productivity is quite low due to maximum area under rainfed condition and erratic distribution of rainfall. In addition poor soil fertility status, mono-cropping, occurrence of pests and diseases, imbalanced application of fertilizers, low plant population and non adaptability of improved agronomic practices also resulted in low productivity.

Hence there is need to increase the production of cotton for improving the financial status of farmers as well as national economy by increasing the area under cotton and plant population ha^{-1}. High density planting system (HDPS) is generally referred as planting at closer spacing than the recommended spacing with a sole objective of maximizing the yield per unit area and it varies from genotype to genotype. In Brazil higher productivity was achieved through development of compact genotypes suited for high density planting geometry which enables to accommodate a plant population of 1.5 to 2.5 lakh plants ha^{-1} with 8-14 bolls per plant at a single boll weight of 4.0 g, thereby achieving higher seed cotton yield (45 to 55q ha-^{1}).

The adoption of high density planting system (HDPS) along with suitable cotton genotypes is a viable approach to break the current trend of stagnating yields primarily under rainfed cotton growing areas of India. Therefore it is essential to find out suitable plant density for recently developed desi cotton genotypes to realize the maximum yield potential. Keeping these points in view the present study on growth and yield of cotton as influenced by planting geometry and genotypes under high density planting system (HDPS) was investigated.

Material and Methods

A field experiment was conducted at Krishi Vigyan Kendra, Chamarajanagar during *kharif* season of 2016. The soil of the experimental site is medium black soil with low in organic carbon content (0.23 %), low in available nitrogen (214.6 kg/ha), medium in available phosphorous (22.3 kg/ha) and high in available potassium (293.8 kg/ha). The annual rainfall received during the cropping season was 272.0 mm. The experiment was laid out in split plot design and replicated thrice. The experiment consists of 15 treatment combinations comprising five planting geometries (P_1 :45 X10 cm, P_2: 45 X20 cm, P_3: 60 X10 cm, P_4:60 X10 cm, P_5:90 X 60cm (planting densities of 222222, 111111, 166666, 83333 and 18518 plants/ha, respectively) in main plots and three cotton genotypes (V_1:DSC-99, V_2:ARBC-64 and V_3:Suraj) as subplots. All the recommended agronomic practices and timely need based plant protection measures were were under taken to establish and healthy maintenance of crop. The yield observations such as number of bolls/plant, single boll weight (g) and seed cotton yield (kg/ha) were recorded as per the standard procedure. The data was statistically analyzed by adopting standard statistical analysis of variance by Gomez and Gomez (1984) [5].

Results and Discussion

Effect of planting geometry and cotton genotypes on yield and yield attributes

Number of bolls

The number of bolls per plant was significantly higher in DSC-99 (14.68 plant^{-1} and) and found to be on par with ARBC-64 (12.78). The lowest number of bolls per plant was observed in SURAJ (11.78).These results are in accordance with those of Hussain *et al.,* (2000) [6] who reported significant increase in number of bolls per plant using different varieties. Such increase in number of bolls per plant was direct consequence of more number of monopodial and sympodial branches per plant. Similar findings were also recorded by Iyarin (2017) [7], Veeraputhiran and Gunsekaran (2018) [12]. The wider spacing of 90 X 60 cm produced significantly higher number of bolls per plant (17.83) compared to other spacing 60 X 10 cm (11.13), 45 X 20 cm (12.50) and 45 X 10 cm (8.60) but it was on par with spacing of 60 x 20 cm (15.33). Ahmed *et al.* (2014) [1] reported that number of bolls per plant increased with increase in plant spacing.

The number of bolls/m^2 was significantly higher with closer spacing of 45 X 10 cm (189.2) compared to other spacing of 90 X 60 cm (35.7), 60 X 20 cm (122.7) and 45 X 20 cm (137.5) but it was on par with spacing of 60 x 10 cm (178.1). The increase in bolls per unit area is due to more number of plants per unit area. Similarity cotton variety DSC-99 (150.9) recorded significantly maximum number of bolls per unit area followed by ARBC-64 (130.2). The lowest number of bolls per unit area was observed in SURAJ (116.9).

Boll weight (g/boll)

Significantly higher individual boll weight was recorded in DSC-99 (3.21g), followed by ARBC-64 (2.99 g) and it was on par with SURAJ (2.84 g). The wider spacing of 90 X 60 cm (3.36 g) recorded significantly higher individual boll weight than other spacing's. Spacing at 60 x 20 cm (3.21 g) which was on par with 45 x20 cm (3.04 g). The lower boll weight was recorded at closer spacing 45 x10 cm (2.63g). Similar findings were also recorded by Shekar (2011) [11] and Munir *et al.,* (2015) [9].

Seed Cotton Yield

It was noticed that the genotype DSC-99 recorded significantly higher seed cotton yield (43.53 g/plant and 1383 kg/ha) followed by ARBC-64 with (34.36 g/plant and 1328 kg/ha). The lower seed cotton yield was observed in SURAJ (29.52 g/plant 1286 kg/ha). The probable reason of this might be due to variation in the genetic constitution of the variety which has responded better in harvesting the maximum bolls and good boll weight. These results were in conformity with the finding of Gadade *et al.* (2015) [4]. Seed cotton yield was significantly influenced by planting geometry, closer spacing of 45 X 10 cm recorded significantly higher seed cotton yield (1589 kg/ha) compared to all other spacing's and found to be on par with the spacing of 60 X 10 cm (1451 kg/ha). The results are in accordance with Chavan *et al.* (2011) [3], Karle *et al.* (2015) [8], Pradeep *et al.* (2017) [10], The higher yields in closer spacing might be due to accommodation of more number of plants per unit area even though there is a decrease in yield attributes. This decrease in yield attributes may be due to over population per unit area and more inter plant competition between the plants for light, nutrients and moisture. The interaction effect between planting geometry and genotypes with respect to yield and yield components found to be non- significant.

Economics

The economics of the cotton were significantly influenced by planting geometry and genotypes. Among the cotton genotypes DSC-99 recorded significantly higher gross returns (Rs.71942 ha^{-1}), Net returns (Rs. 30,470 ha^{-1}) and B:C ratio (1.73). The spacing of 45 x 10 cm recorded significantly higher net returns (Rs. 37,071 ha^{-1}) when compared with 60 X 20 (Rs. 25,883 ha^{-1}) and 90 x 60 cm (Rs. 14,713 ha^{-1}) but it was on par with the planting geometry 60 x 10 cm (Rs. 28,269 ha^{-1}) and 45 x 20 cm (Rs. 30,403 ha^{-1}),. The higher net returns and BC ratio with closer spacing is mainly due to higher plant population and higher seed cotton yield obtained per unit area. The interaction effects did not differ significantly for all the parameters studied

Table 1: Effect of planting geometry and varieties on yield and yield attributes of cotton

Treatments	Plant Density (No./ha)	No. of bolls /plant	No. of Bolls/m^2	Boll weight (g)	Seed Cotton yield (g/plant)	Seed Cotton Yield (kg/ha)
Main Plot: Planting Geometry (P)						
P_1- 45X10	2,22,222	8.60	189.2	2.63	17.89	1589
P_2- 45X20	1,11,111	12.50	137.5	3.04	33.32	1367
P_3- 60X10	1,66,666	11.13	178.1	2.84	26.93	1451
P_4- 60X20	83,333	15.33	122.7	3.21	44.97	1255
P_5- 90X60	18,518	17.83	35.7	3.36	55.91	999
SEm±		0.67	6.0	0.10	3.75	57.92
CD at 5%		2.20	19.7	0.32	12.21	188.8
Sub Plot: Varieties (V)						

V_1-DCS-99		14.68	150.9	3.21	43.53	1383
V_2-ARBC-64		12.78	130.2	2.99	34.36	1328
V_3- SURAJ		11.78	116.9	2.84	29.52	1286
SEm±		0.58	5.4	0.07	2.92	24.19
CD at 5%		1.72	15.9	0.21	8.63	71.36
Interaction: Planting Geometry X Varieties						
SEm±		1.30	12.1	0.16	6.54	54.09
CD at 5%		NS	NS	NS	NS	NS

Table 2: Economics of cotton as influenced by genotypes and planting geometry under high density planting

Treatments	Plant Density (No./ha)	Cost of Cultivation (Rs./ha)	Gross Returns (Rs./ha)	Net Returns (Rs./ha)	B:C Ratio
Main Plot: Planting Geometry (P)					
P_1- 45X10	2,22,222	45552	82623	37071	1.81
P_2- 45X20	1,11,111	40672	71075	30403	1.75
P_3- 60X10	1,66,666	43312	75466	32154	1.74
P_4- 60X20	83,333	39362	65245	25883	1.66
P_5 90X60	18,518	37282	51995	14713	1.39
SEm±		306	3012	2755	0.06
CD at 5%		996	9822	8983	0.21
Sub Plot: Genotypes (V)					
V_1-DCS-99		41472	71942	30470	1.73
V_2-ARBC-64		41160	69048	27888	1.67
V_3- SURAJ		41076	66852	25776	1.62
SEm±		158	1258	1172	0.03
CD at 5%		NS	3711	3458	0.08
Interaction: Planting Geometry X Genotypes					
SEm±		354	2813	2621	0.06
CD at 5%		NS	NS	NS	NS

Conclusion
From the study it can be concluded that planting density and genotypes significantly influenced the yield attributes and economics of cotton. Planting geometry of 45 X 10 cm resulted in higher seed cotton yield, net returns and B:C ratio and genotype DSC-99 produced significantly better yield parameters, higher seed cotton yield and higher net returns.

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