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Research Article
Agronomic Performance of Upland Cotton Cultivars in Cerrado Depending on Row Spacing

[1]Jefferson Luis Anselmo, [2]Paulo Eduardo Teodoro, [3]Carlos Antonio da Silva Junir, [4]Flávia Alves da Silva, [4]Caio Cezar Guedes Corrêa and [4]Francisco Eduardo Torres

[1]Fundação de Apoio à Pesquisa Agropecuária de Chapadão do Sul, Chapadão do Sul, Mato Grosso do Sul, Brazil
[2]Federal University of Viçosa (UFV), Viçosa, Minas Gerais, Brazil
[3]State University of Mato Grosso (UNEMAT), Postal Code 78580-000, Alta Floresta, Mato Grosso, Brazil
[4]State University of Mato Grosso do Sul (UEMS), Aquidauana, Mato Grosso do Sul, Brazil

Abstract

Background and Objective: Upland cotton is one the main crops of economic importance in Brazil. In the face of such morphological traits, there is the need to search for cotton cultivars that are adapted to the smaller row spacing, as these can be grown in succession to soybean without the need to exchange of the seeder. However, few results encourage this practice by farmers. The aim of this study was to evaluate the agronomic performance of 16 upland cotton cultivars grown in two row spacing in the Brazilian Cerrado region. **Methodology:** The trial was conducted at Fundação Chapadão, in the municipality of Chapadão do Sul, State of Mato Grosso do Sul, Brazil. Experimental design was sub-divided plots with ten lines each, with four replications. The following agronomic traits were evaluated: Plant height, first reproductive branch height, number of bolls per plant, weight of bolls per plant and cotton yield in seed. **Results:** There were significant differences ($p = 0.05$) between cultivars for all evaluated traits. Except for the WB, the others traits were influenced by spacing. There was no interaction between factors for any evaluated traits. **Conclusion:** Spacing of 0.90 m provides better agronomic performance of cotton cultivars. The cultivars FM975, TMG41 and TMG81 stood out among the others for obtaining the highest cotton yield in seed, alternatives to the growing for farmers from Brazilian Cerrado region.

Key words: *Gossypium hirsutum* L., cotton yield, morphological traits, sowing configuration

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Corresponding Author: Carlos Antonio da Silva Junir, Department of Forest Engineering, State University of Mato Grosso, Postal Code 78580-000, Alta Floresta, Mato Grosso, Brazil

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Upland cotton (*Gossypium hirsutum* L. race *latifolium* Hutch.) is one the main crops of economic importance in Brazil[1]. In the country, fifth world producer of cotton in seed with 4.4 million tons in 2013/14, the production is concentrated in the Midwest region with 66% of this amount, with the State of Mato Grosso the major national producer. In the Northeast region, stands out the State of Bahia as the major producer of this crop[2].

Cotton plant exhibits high phenotypic plasticity, adapting to the most varied environments and notably, has soil and climate requirements to reach high yields and quality fiber[3,4]. The development of the cotton depends on the sowing configuration, which causes changes in the morphological and physiological traits of the plant and the crop as a whole[5,6]. It has branch dimorphism, i.e., monopodial or vegetative branch and sympodial or fruitful branch[7]. In addition, it holds flat structures, horizontal branches and leaves, impeding the use of higher population densities and closer spacing[8].

The cultivation of cotton under reduced spacing has been a common practice in Brazil. Under these conditions, the onset of the reproductive phase occurs during a period of high rainfall and low light availability. Balancing light capture at the plant canopy with crop spacing and plant populations and plant growth to avoid shading of lower leaves is a challenge[6]. Thus, there is the need to search for cotton cultivars that are adapted to the smaller row spacing, as these can be grown in succession to soybean without the need to exchange of the seeder. However, few results encourage this practice by farmers. Thus, the aim of this study was to evaluate the agronomic performance of upland cotton cultivars grown in two row spacing in the Cerrado region.

MATERIALS AND METHODS

The trial was conducted in the municipality of Chapadão do Sul, State of Mato Grosso do Sul, at the experimental area of the Fundação Chapadão (18°46'S, 52°38'W) with an average altitude of 810 m. The municipality belongs to Brazilian Cerrado region and its climate, according to the classification described by Köppen, is the type Cwa (tropical of altitude), with rainy season in the summer and drought in winter. Accumulated rainfall over the trial was 821 mm with an average temperature of 26.2°C. The soil in the area is classified as eutrophic Ultisol, whose chemical properties are described in Table 1.

The experimental design was sub-divided plots with ten lines each, with four replications. The first factor corresponded to 16 cotton cultivars (BRS369, BRS370, BRS371, DP1228, DP555, FM944, FM951, FM966, FM975, FM982, FM993, FMT701, TMG41, TMG42, TMG81 and TMG82), while the second consisted of two row spacing (0.45 and 0.90 m).

The area was previously cultivated with soybean crop (harvest 12/13) and millet in the off-season. Sowing was done on 12/27/2013 in no-till system, with NPK fertilization of 450 kg ha^{-1} (formulate 6-24-14). Two topdressing at 200 kg ha^{-1} of urea (45% N) was done. The other cultural practices followed the recommendations preconized by EMBRAPA[9].

At harvest, we evaluated the following agronomic traits: Plant Height (PH), first Reproductive Branch Height (RBH), No. of bolls per plant (NB) and weight of bolls per plant (WB), assessed in three plants of each plot. The cotton yield in seed (YIE) was measured through the manual harvest of 4.0 m of the two central rows from each plot and the values were extrapolated for at ha^{-1}. Data were submitted to analysis of variance and means compared by the Skott-Knott test at 5% probability. Analyses were performed using the Genes software[10].

RESULTS AND DISCUSSION

Table 2 shows the summary ANOVA for all variables. There were significant differences ($p \leq 0.05$) between cultivars for all evaluated traits (Table 2). Except for the WB, the others traits were influenced by spacing. There was no interaction between factors for any evaluated traits. The coefficient of variation obtained for the variables study was similar to other studies in cotton[1,6,5,3] and shows adequate precission.

Clustring of means among spacing for the significant variables are contained in Table 3. Larger spacing (0.90 m) provided less plant height and lower first reproductive branch height, greater number of bolls per plant and greater cotton yield in seed. These results may be explained by the reduced competition between the cotton plants in the row and corroborate those obtained by Silva *et al.*[11]. The boll weight was not affected by spacing, indicating that is a trait with

Table 1: Soil chemical properties, in the layer 0-20 cm, at the experimental area of the Fundação Chapadão, Mato Grosso do Sul, Brazil

OM (g dm^{-3})	pH	P (mg dm^{-3})	K	Ca	Mg (mmolc dm^{-3})	Al	H+Al	V (%)
29.1	4.8	10.6	1.9	25	6	2.2	29	53.2

Table 2: Summary of the analysis of variance for the variables evaluated in 16 cotton cultivars grown in two row spacing in Brazilian Cerrado region

SV	GDF	PH	RBH	NB	WB	YIE
Blocks	3	133.48	108.49	5.66	1.13	636.91
Cultivars (C)	15	390.91*	240.59*	8.48*	161.02*	4,410.95*
Spacing (S)	1	400.16*	15,123.86*	773.62*	7.26^{ns}	15,044.40*
CxS	15	137.75^{ns}	74.49^{ns}	4.98	63.41^{ns}	512.78^{ns}
Erro	93	86.68^{ns}	64.90^{ns}	4.25	44.06	908.68
CV (%)	---	7.83	20.64	18.70	10.81	8.52

^{ns}and *Not significant and significant at 5% probability by the F-test, respectively, SV: Sources of variation, CV: Coefficient of variation, PH: Plant height, RBH: First reproductive branch height, NB: No. of bolls per plant, WB: Weight of bolls per plant, YIE: Cotton yield in seed

Table 3: Mean values of the traits plant height (PH), first reproductive branch height (RBH), No. of bolls per plant (NB), weight of bolls per plant (WB) and cotton yield in seed (YIE) according to row spacing, in Brazilian Cerrado region

Spacing (m)	PH (cm)	RBH (cm)	NB	WB (g)	YIE (at ha^{-1})
0.45	120.74^{a}	49.90^{a}	8.57^{b}	61.64	342.85^{b}
0.90	117.20^{b}	28.16^{b}	13.48^{a}	61.16	364.53^{a}
Mean	118.98	39.03	11.03	61.41	353.69

Means followed by different letters in the same column differ by Skott Knott test at 5% probability

Table 4: Mean values of the traits plant height (PH), first Reproductive Branch Height (RBH), No. of bolls per plant (NB), weight of bolls per plant (WB) and cotton yield in seed (YIE) of 16 cotton cultivars in Brazilian Cerrado region

Cultivars	PH (cm)	RBH (cm)	NB	WB (g)	YIE (at ha^{-1})
BRS369	114.92^{b}	33.46^{b}	12.29^{a}	67.10^{a}	367.73^{a}
BRS370	127.71^{a}	38.25^{b}	10.08^{a}	68.48^{a}	343.66^{b}
BRS371	124.17^{a}	37.54^{b}	10.71^{a}	63.39^{a}	340.76^{b}
DP1228	127.67^{a}	50.08^{a}	9.17^{b}	58.70^{b}	350.33^{b}
DP555	121.25^{a}	41.92^{a}	11.75^{a}	57.78^{b}	370.46^{a}
FM701	118.54^{a}	44.92^{a}	9.00^{b}	58.96^{b}	358.50^{a}
FM944	116.25^{b}	32.54^{b}	11.46^{a}	57.28^{b}	338.18^{b}
FM951	121.08^{a}	41.71^{a}	11.25^{a}	67.20^{a}	325.46^{b}
FM966	105.75^{b}	35.79^{b}	10.71^{a}	68.89^{a}	354.06^{a}
FM975	122.33^{a}	45.67^{a}	11.04^{a}	60.49^{b}	391.77^{a}
FM982	128.96^{a}	43.13^{a}	10.79^{a}	59.33^{b}	335.30^{b}
FM993	121.00^{a}	43.71^{a}	10.54^{a}	61.55^{b}	304.42^{b}
TMG41	119.04^{a}	33.83^{b}	11.29^{a}	63.56^{a}	379.90^{a}
TMG42	110.96^{b}	35.25^{b}	12.38^{a}	55.80^{b}	368.15^{a}
TMG81	117.87^{a}	31.96^{b}	12.62^{a}	58.10^{b}	388.40^{a}
TMG82	106.13^{b}	34.75^{b}	11.42^{a}	55.90^{b}	342.03^{b}
Mean	11.98	39.03	11.03	61.41	353.69

Means followed by different letters in the same column differ by Skott Knott test at 5% probability

genotypic expression. Similar results were obtained by Ferrari *et al.*[8], who do not observed significant effects of row spacing about this trait.

Zanon[12] and Ferrari *et al.*[8] found no statistical difference between the studied spacing on cotton yield in seed. Brito *et al.*[13] argued that increasing the distance between plants in the same line, together with the reduction in spacing, promoted increased cotton yield in seed. Moreover, Silva *et al.*[14] found higher yields with the spacing of 0.90 m between lines, resembling the results obtained in this study.

The decrease in spacing in cotton seeding can improve light capture at the beginning of the cotton growing season but this increase may not result in increased yields because the self-shadowing can hinder the incidence of radiation on the lower leaves as closing canopy, reducing plant net photosynthesis and assimilation of production[6].

Clustring of means among cotton genotypes for all variables are contained in Table 3. The traits PH and RBH are the ones that affect the cotton harvest[15], because the harvester platform has fixed size and plant genotypes with plant height higher than 125 cm (Table 4), as BRS370 and DP1228, may come to be tumbled and kneaded by machine, reducing the quality and quantity of harvested fiber. Proper spacing is that whose plant leaves should cover entire surface between rows at the time of the maximum flowering, without intertwining it. As practical rule, based on research findings, it is suggested as ideal spacing those corresponding to 2/3 of the plant height[16]. This explains the best results obtained by row spacing of 0.90 m.

The cultivars FM975, TMG41 and TMG81 obtained the highest cotton yield in seed. It is noteworthy that the mean values obtained for cotton yield in seed are superior to those

obtained in other studies with cotton genotypes[17-20]. This, in general, demonstrates adaptability of these cultivars to Brazilian Cerrado region.

CONCLUSIONS

Spacing of 0.90 m provides better agronomic performance of cotton cultivars. The cultivars FM975, TMG41 and TMG81 stood out among the others for obtaining the highest cotton yield in seed, alternatives to the growing for farmers from the region.

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