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Performance of streaked bean genotypes (Phaseolus vulgaris L.) in a low-altitude "cerrado" region

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ABSTRACT
The study aimed to evaluate different genotypes of speackled beans in comparison with established cultivars through the Cultivation and Use Value Trial. The research, conducted in collaboration with with EMBRAPA – Rice and Beans, took place in an experimental area characterized by typical Dystrophic RED Oxisol soil. (EMBRAPA, 2018). The average annual precipitation is 1,370 mm, the average annual temperature is 74.3ºF and the relative humidity is between 70 and 80%. Planting was carried out in April/May 2022. The experimental design was randomized complete block, with 12 treatments, consisting of different speackled beans genotypes, each with three replications. The genotypes used were: CNFRJ 17783, BRS FS311; CNFRJ 17774, BRSMG REALCE; CNFRJ 17778; CNFRJ 18239; CNFRJ 18237; CNFRJ 18222; CNFRJ 17792; CNFRJ 18217; CNFRJ 17548; CNFRJ 17545. Experimental plots consisted of four rows, each 4 meters in lenght, with inter-row spacing of 0.45 meters. The following evaluations were performed: plant population; flowering and cycle duration; number of pods per plant; number of grains per plant; number of grains per pod; 100-grains wight; and grain yield. "The genotype CNFRJ 17783 exhibited excellent performance across all variables, particularly noteworthy for its superior grain productivity. The highest yields were observed in genotypes CNFRJ17783, CNFRJ17545, CNFRJ18239, and CNFRJ18217, indicating efficiency in crop yield. Based on these results, the genotype CNFRJ 17783 may be recommended for the Cerrado region as a new cultivar.

Keywords: Phaseolus vulgaris L., Genotype performance, Striped beans.

1 INTRODUCTION

Beans (*Phaseolus vulgaris L.*) play an important role in food security and in the economy of Brazil, being one of the main foods consumed by the population. With a high protein content and the presence of essential amino acids, beans are essential in the nutritional complementation of the diet. Its versatile adaptability and wide selection over time make it possible to grow crops in different regions, including the low-lying Cerrado (AGUIAR *et al.*, 2022)

However, the current agricultural landscape faces significant challenges, such as climate change, scarcity of natural resources, and the need for more sustainable practices. In this context, sustainable cultivation emerges as an essential approach to ensure food security and the preservation of the environment. The search for cultivation methods that increase productivity in a sustainable manner has become a priority for modern agriculture.

Considering the three harvests, it is estimated that the total area of beans will reach 3,214 thousand hectares, representing an increase of 1.1% compared to the last harvest. The national production of beans is estimated at 3,380 thousand tons, registering an increase of 0.6% compared to the last season (CONAB, 2018).

The objective of this study was to evaluate the agronomic performance and adaptive capacity of different genotypes of gusted bean cultivated during the autumn-winter period in the region of Selvíria, Mato Grosso do Sul, Brazil.

2 LITERATURE REVIEW

2.1 BEAN CULTIVATION INBRAZIL

Beans (*Phaseolus vulgaris* L.) represent an essential component in the Brazilian diet, being recognized as an excellent source of protein, in addition to containing significant amounts of good carbohydrate and iron content. Cultivated by small and large producers in various production systems and in all regions of Brazil, the common bean plays a role of great economic and social importance.

Common beans are one of the most cultivated and exported grains throughout the Brazilian territory, consequently requiring production at high levels. Brazil ranks third in the world in bean production, with a cultivated area of 2.927 million hectares and an average production of more than 1060 kg $^{ha-1}$ (CONAB, 2018).

In the 2019/2020 season, bean productivity was estimated at 3.2 million tons per harvest. The short-cycle crop offers a strong advantage, allowing adjustments in planting within a more restricted window, without the need to give up the cultivation of other grains in the same crop year. Brazil adopts three different planting seasons, which favors a constant supply of the grain throughout all years: the sowing of the first crop occurs between August and December, the second between January and April, and the third between May and June (CONAB, 2018).

2.2 CULTIVAR BRS RFRENTE

The BRS Radiant Cultivar, object of evaluation in this study, belongs to the commercial group rajado. Characterized by a determined growth habit, which means that vegetative development ends after flowering, this cultivar has an upright height and an average cycle of 80 days. Its characteristics include green pods with red streaks and beige grains with purple streaks. It stands out for having great culinary qualities, being able to meet the demands of the domestic market and supply some niches in the foreign market (EMBRAPA, 2021).

3 MATERIAL AND METHODS

3.1 CONDUCTING THE EXPERIMENT

Field experiment, carried out in partnership with EMBRAPA Rice and Beans, during the third harvest, in the "autumn-winter" period in 2022. The local soil is classified as a typical clayey Dystrophic Red Latosol, previously occupied by natural Cerrado vegetation.

Soil preparation consisted of plowing with a scarifying plow and a leveling harrow. After the conventional tillage of the soil, the furrows were opened and the plots were delimited by stakes. Sowing was done manually, on April 26, 2022. The experiment was arranged in a randomized block design consisting of 12 rajado bean genotypes, with 3 replications.

A total of 12 different grain genotypes were selected to compose the treatments of the experiment. Among the cultivars chosen as a control, the cultivar BRSMG Realce, widely used in the region, stands out. Grown in four rows of 4 meters in length, with row spacing of 0.45 meters. Every treatment was replicated three times. The genotypes used were: CNFRJ 17783, BRS FS311; CNFRJ 17774, BRSMG HIGHCE; CNFRJ 17778; CNFRJ 18239; CNFRJ 18237; CNFRJ 18222; CNFRJ 17792; CNFRJ 18217; CNFRJ 17548; CNFRJ 17545. The Experimental plots consisted of four rows of 4 meters in length with row spacing of 0.45 meters.

Before seed covering, pyraclostrobin, methyl thiophanate and fipronil were sprayed in the sowing furrow at doses of 5, 45 and 50 g of the active ingredient (a.i.) for each 100 liters of water + 0.3 L ha-1 of inoculant containing Rhizobium tropici + 0.1 L *ha-1* of inoculant containing *Azospirillum brasilense*.

The area was irrigated by a center pivot irrigation system. In the management of water during crop development, Kc values similar to those recommended by Doorenbos & Kassan (1979) will be used, i.e., Kc = 0.30 for the V0 – V2 phases; Kc = 0.70 from V3 – V4; Kc = 1.05 of R5 – R7; Kc = 0.75 for R8 and Kc = 0.25 for R9.

The control of weeds, pests and diseases was carried out according to the recommendation for the cultivation of "autumn-winter" beans and using products registered for the crop.

This methodological approach allowed us to evaluate the performance and adaptability of sustainable cultivation in the lowland Cerrado region, providing important results for genetic improvement and improvement of cultivation in varied agricultural systems. These specific procedures ensured a systematic and accurate approach to evaluate the performance of bean genotypes under sustainable cultivation in lowland Cerrado regions, providing reliable data for the interpretation of the results and conclusions of the research.

3.2 RATED EVALUATIONS

The evaluations carried out were:

- **Final plant population:** before harvesting, the number of plants and the extrapolated result for plants in one hectare (plants ha-1) were evaluated in two central lines, in the useful area of the plots.
- **Production components:** at the time of harvest, 6 plants were collected from the useful area of each plot, in which the total number of pods of the sample was measured and the average number of pods per plant was determined by the ratio of the total number of pods by the number of plants. The separated pods were packed in paper and taken to a furnace for renewal and circulation of forced air for approximately 72 hours, to later give segment to the subsequent analyses. Subsequently, the number of grains per plant was determined: obtained by the ratio of the total number of grains/number of plants; Average number of grains per pod: calculated by the ratio of the total number of grains/total number of pods and mass of 100 grains: obtained by random collection and weighing on a precision balance of two samples of 100 grains per plot and the result corrected for moisture content of 13% (wet basis).
- **Grain yield: the** plants were uprooted from the useful area of each plot and after being dried in full sun, they were submitted to manual tracking, weighing the grains and transforming the data into kg $^{ha-1}$ (13% wet basis).
- **Cycle:** the number of days elapsed from the emergence of common bean seedlings to harvest was counted.
- **Grain quality**: the evaluation of grains was performed using a scale ranging from 1 to 3: (1) grains with uniform color and shape and within the commercial standard; (2) grains with uneven color or shape; (3) Non-commercial grain, with uneven color and shape and out of commercial standard.

Statistical analyses were performed using the statistical analysis software SISVAR (FERREIRA, 2000). The results were submitted to the F test of analysis of variance to verify the significance of the differences between the treatments. After confirmation of significance, the means of the rajad bean genotypes were compared using the Scott-Knott test, adopting a significance level of 5%.

4 RESULTS AND DISCUSSION

The average treatment population was 103,549 plants $^{ha-1}$. Table 1 shows the results of days to flowering, cycle and final population. According to Dourado Neto & Fancelli (2000), bean yield is not affected if the number of plants per hectare decreases. However, Jadoski (2000) and Westermann & Crothers (1977) state that they did not observe the plant population interfering with bean yield.

In the present study, it was observed that the genotype that had the highest population was coincident with the genotype that obtained the highest productivity, but this did not occur in the following genotypes.

Most bean genotypes used by growers have an average of 90 days of cycle, from emergence to harvest. Regarding the cycle, the cultivars CNFRJ17792, CNFRJ17778, BRSFS311, CNFRJ17783, CNFRJ18239 and CNFRJ17774 had the shortest cycles, around 78 days. Short cycles offer greater flexibility in the sowing schedule, shorter period of exposure of the crop to pests and diseases in the field, in addition to being a favorable factor for the selection of bean varieties with desirable characteristics.

The behavior of the genotypes studied in the present study related to the cycle showed differences between 78 and 85 days, thus showing that it behaved within the expected, considering an average cycle of 80 days (Table 1).

Table 1 – Days to flowering, cycle and final population, obtained from the different genotypes of gusted bean. Selvíria – MS, 2022.

Genotypes	Days to bloom	Cycle (days)	Final population (HA-1 floors)
CNFRJ17792	30.0 c	78 d	85.185
CNFRJ17778	32.6 b	78 d	92.592
BRS FS311	34,0 a	78 d	93.518
CNFRJ17783	30,0 c	78 d	99.074
CNFRJ18239	33,0 b	79 d	101.851
CNFRJ18217	33,0 b	84 b	104.629
CNFRJ18222	33,0 b	84 b	104.629
CNFRJ17545	32,3 b	85 a	108.333
CNFRJ18237	33,0 b	80 c	109.259
BRSMG ENHANCEMENT	34,0 a	81 c	110.185
CNFRJ17548	32,6 b	85 a	111.111
CNFRJ17774	34,0 a	78 d	122.222
F-Test	$10,8^{*}$	$42,6^{*}$	1,05
CV (%)	2,18	0,96	16,19

Overall Average	32,63	80,6	103549

Means followed by the same letter, within each parameter studied, do not differ from each other by the Scott-Knott test at 5% probability. *, ns: significant at 5% probability and not significant by the Scott-Knott test, respectively; CV: coefficient of variation.

For the other components listed in Table 2, there were significant differences for the variables pods per plant and grains per plant, and for the variable grains per pod, the test could not identify significant differences. The results show that grain yield is related in part to the components presented in this table, which are important variables in the selection of productive genotypes.

Table 2 – Number of pods per plant, number of grains per plant and number of grains per pod, obtained from the different genotypes of common bean. Selvíria – MS, 2022.

Genotypes	Scale/plant (n°)	Grains/Plant (n°)	Grains/Pod (n°)
CNFRJ17792	14,9	55,2	3,6 a
CNFRJ17778	13,8	48,5	3,5 a
BRS FS311	18,1	56,7	3,0 b
CNFRJ17783	15,9	49,3	3,1 b
CNFRJ18239	20,3	57,8	2,8 b
CNFRJ18217	16,8	64,9	3,8 a
CNFRJ18222	17,3	54,5	3,0 b
CNFRJ17545	14,6	44,5	3,0 b
CNFRJ18237	18,4	64,4	3,5 a
BRSMG ENHANCEMENT	21,9	66,8	3,1 b
CNFRJ17548	15,8	45,3	2,8 b
CNFRJ17774	11,5	32,2	2,7 b
F-Test	1,87ns	1,59ns	2,31*
CV (%)	21,66	25,77	12,16
Overall Average	16,6	53,38	3,20

Means followed by the same letter, within each parameter studied, do not differ from each other by the Scott-Knott test at 5% probability. *, ns: significant at 5% probability and not significant by the Scott-Knott test, respectively; CV: coefficient of variation.

Not all genotypes that were good in terms of number of pods per plant, number of grains per plant and number of grains per pod were the ones that obtained the highest yields, the CNFRJ 17783 genotype showed high potential in the items found in Table 3 and was the one with the highest yield.

As well as the genotype CNFRJ 17783, but genotypes such as CNFRJ 17545, CNFRJ 18239 that had good results (Table 3) were so productive, being above the average, the control BRSMG HIGHLIGHT that had the eighth best productivity did not obtain good results in the components presented in Table 3.

In relation to the weight of 100 grains, the genotypes that showed statistical differences were CNFRJ17792, CNFRJ17778, CNFRJ17783, CNFRJ18237,

CNFRJ17548 and CNFRJ17774. Such results may be associated with a higher density of nutrients, such as proteins and starches. This can directly affect the nutritional quality of products derived from these grains.

The values of 100 grain weight, yield and grain quality are shown in Table 3. Where it can be observed that there were significant differences between the bean genotypes only for one hundred grain mass and in yield. In the case of the 100 grain mass, the preference, in the case of breeding, is for grains that weigh from 23 to 25 grams, below 23 grams there will be restrictions. This characteristic is influenced by the number of genes and environmental factors, according to RAMALHO (2004).

The genotypes studied were evaluated by weight of 100 grains, ranging from 33.5 to 44.9 grams (Table 3). Table 3 shows that the genotype CNFRJ17792 with the highest weight of 100 grains was not among those with the highest yields, the fact may be related to its number of pods per plant and its number of grains per plant being below the average. With regard to grain yield, again, there was significant variation among genotypes. BRS FS311 had the highest yield, with 2,422 kg per hectare, while CNFRJ17774 had the lowest yield, with 2,146 kg per hectare. This variation in yield can be related to a variety of factors, including genetic traits and growing conditions. The quality of the grains, represented here as a qualitative value, also showed variations among the genotypes. Some genotypes, such as BRS FS311 and CNFRJ18222, obtained a higher score, indicating a better quality of the grains, while others, such as CNFRJ17545, scored lower.

Table 3 – Weight of 100 grains, grain yield and quality of grains obtained from different common bean genotypes. Selvíria – MS, 2022.

Genotypes	Dough 100 grains (g)	Productivity (1 kg)	Quality beans (note)[1]
CNFRJ17792	44,9 a	2.150	1,3
CNFRJ17778	44,8 a	2.040	1,6
BRS FS311	37,5 b	2.422	2,0
CNFRJ17783	44,8 a	2.761	1,3
CNFRJ18239	39,4 b	2.583	1,6
CNFRJ18217	33,5 b	2.536	1,6

CNFRJ18222	37,0 b	2.281	2,0
CNFRJ17545	39,6 b	2.674	1,0
CNFRJ18237	42,3 a	2.412	2,0
BRSMG ENHANCEMENT	35,5 b	2.304	1,6
CNFRJ17548	40,6 a	2.371	1,3
CNFRJ17774	41,1 a	2.146	1,3
F-Test	$4,99^{*}$	1,42ns	0,97
CV (%)	7,23	13,43	36,97
Overall Average	40,1	2390	1,55

Means followed by the same letter, within each parameter studied, do not differ from each other by the Scott-Knott test at 5% probability. **, ns: significant at 1% probability and not significant by the Scott-Knott test, respectively; CV: coefficient of variation.

[1] Grading scale: 1 - grains with uniform color and shape and within the commercial standard; 2 - grains with ununiform color or shape; 3 - non-commercial grain, with ununiform color and shape and out of the commercial standard.

Regarding yield, there were significant differences between the genotypes studied, ranging from 2,040 to 2,761 kg ha-1, with an average of 2,390 kg ha-1. The CNFRJ 17783 strain proved to be the most productive, with a yield of 2,761, surpassing the control BRSMG DESTAQUE with 2,304 kg $^{ha-1}$.

5 CONCLUSIONS

The CNFRJ 17783 genotype showed outstanding performance in all variables evaluated, showing superior grain yield. The highest yields, ranked in descending order, were achieved by genotypes CNFRJ17783, CNFRJ17545, CNFRJ18239 and CNFRJ18217. Such results attest to the efficiency in crop yield, constituting potentially attractive values for producers. Considering these promising results, the CNFRJ 17783 genotype has the potential to be recommended in the future as a new cultivar for the cerrado region.

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