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Agronomic performance of common bean genotypes at Sinop, MT, Brazil

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Abstract: Brazil is the largest bean producer in the world, but the expansion of this crop is still needed. For this, it is necessary the recommendation of specific cultivars for other environments. This study aimed to evaluate breeding lines of common bean in order to recommend to the northern region of Mato Grosso state, Brazil. The experiments were conducted during 2010 and 2011 crop years and thirty two common bean genotypes were tested, including cultivars and breeding lines of the groups Carioca, Jalo, Black and Rajado, with three replications in a randomized block design. Each plot consisted of three rows of two meters in length. The evaluated variables were grain yield ($kg.ha^{-1}$), plant size, lodging and number of days to flowering. For the carioca group, BRS Requinte resulted in high yield and BRS Cometa in better characteristics related to harvest. Jalo Precoce and BRS Supremo presented the higher yield for the Jalo and Black group, respectively. In the Black group, BRS Supremo was the genotype with higher resistance to lodging.

Key words: *Phaseolus vulgaris*, Breeding programs, Grain yield

Desempenho agronômico de genótipos de feijoeiro no município de Sinop no norte do Estado de Mato Grosso

Resumo: O Brasil é o principal produtor de feijão do mundo, porém ainda há necessidade de realizar a expansão dessa leguminosa. Para isso, torna-se necessário a recomendação de cultivares específicas para outros ambientes. Dessa forma, o trabalho teve finalidade de avaliar genótipos de feijoeiro comum, visando sua recomendação para região Norte de Mato Grosso. Foram conduzidos dois experimentos, o primeiro, com semeadura em fevereiro de 2009, e o segundo, semeadura em maio de 2010. Foram testados 32 genótipos de feijoeiro comum, abrangendo linhagens e cultivares dos grupos Carioca, Jalo, Preto e Rajado, com três repetições no delineamento em blocos casualizados. As parcelas foram constituídas por três linhas de dois metros de comprimento. Avaliaram-se os caracteres produtividade de grãos em kg/ha, porte, acamamento e número de dias para o florescimento. No grupo Carioca, sobressaiu-se a cultivar BRS Requinte, quanto à produtividade, a cultivar BRS Cometa quanto às características relacionadas à colheita. No grupo Jalo, destacou-se a cultivar Jalo Precoce, pela produtividade superior às demais cultivares. No grupo Preto, destacaram–se as cultivares BRS Supremo, pela alta produtividade e pela resistência ao acamamento.

Palavras chave: *Phaseolus vulgaris*, *M*elhoramento genético, Produtividade de grãos

Introduction

The common bean (*Phaseolus vulgaris* L.) is the most cultivated species of genus *Phaseolus* (Bertoldo et al., 2010). Considering all the encompassed genera and species such as beans on FAO statistics, this involves about 107 producing countries worldwide. Considering only the genus *Phaseolus*, Brazil is the largest producer, followed by Mexico. The common bean is grown by small and large producers in several production systems, coating is of great economic and social importance. The common bean is grown by small and large farmers in diversified production systems and considered of great economic and social importance.

Depending on the cultivar and the ambient temperature, the common bean may present cycles ranging from 65 to 100 days, which makes it an appropriate culture to form highly technical irrigated farming systems and also low technology system or subsistence. Due to its evidenced nutritional and therapeutic properties, beans are highly desirable as diet components in combating hunger and malnutrition. Furthermore, there is an interesting protein complementation when bean is combined with cereals, especially rice, providing the eight essential amino acids to our organism (Borém et al., 2005).

The common bean is one of the most important constituents of the Brazilian diet, being recognized as an excellent protein source (Coimbra et al., 2008). The common bean is grown by small and large farmers in diversified production systems and considered of great economic and social importance.

The Brazilian bean production has not been enough to supply the domestic market, due to the reduced cultivated area, of about 35% in the last 17 years. Even the increase of 48% in productivity that occurred in this period, resulted in a decrease of 4% in production, therefore, not enough to meet the demand National Supply Company [CONAB], (2011). Therefore, it is extremely important to spread this culture in other Brazilian regions including the northean region of Mato Grosso, as it is a suitable region for new culture implementationand also may contribute to the increase of Brazilian production.

Given the above, the aim of this study was to identify and select the most adapted genotypes and breeding lines to the region, in order to be introduced in a bean breeding program or to recommended as a cultivar to the region.

Material and methods

The experiments were conducted at the experimental station of Embrapa Agrosilvipastoril (crop year 2010) and Farenonn farm (crop year 2011), located in Sinop / MT, Brazil (11 º 51' 50 " latitude 55 º 30'14" longitude, and 378 meters of altitude). It was used genetic material from the bean germplasm bank of the Federal University of Lavras (UFLA), thirty two common bean genotypes were tested, including cultivars and breeding lines of the groups Carioca, Jalo, Black and Rajado among them some materials already recommended for cultivation and the remaining germplasm that are in breeding process.

The experiments were carried out in a randomized block design with three replications. Each plot consisted of three rows of two meters in length, with 15 seeds per meter. The evaluated variables were: grain yield in $kg.ha^{-1}$, each plot was harvested and threshing individually for further grain weighing; plant size and lodging were performed by a scale adapted by Collicchio et al. (1997). This scale ranges from 1 to 5, where: grade 1 refers to the plant type II, erect, with one stem and high insertion of the first pod; grade 2, the plant type II erect and with some branching; grade 3 to the plant type II or III, erect, with many branching and a tendency to prostrate; grade 4 to the plant type III, semi erect and moderately prostrate, and grade 5 to the plant type III, with long internodes and very prostrate. The number of days to flowering corresponded to the date when 50% of plants per plot had at least one open flower. The cultural practices were the same used to the region culture.

The variance analysis was performed considering each character, involving the two

tested environments, adopting the following statistical model: $Y_{ija} = \mu + p_i + r_j + l_a + p_i l_a + r_j (l_a) + e_{ija}$, where: Y_{ija} - observation for the treatment *i* in repetition *j* at the local *a*, μ is the overall average; p_i – treatment effect *i* (*i* = 1,2,3, ..., 32); r_j – repetition effect *j* (*j* = 1,2,3), l_a - the environment effect *a* (*a* = 1.2); $p_i l_a$ - interaction treatment *i* x environment effects *a*; $r_j (l_a)$ – repetition effect *j* within the local *a*; e_{ija} - experimental error associated with the observation Y_{ija} ($e_{ija} \cap N0, \sigma^2$). The genotypes performance in relation to the evaluated traits was compared by the multiple comparison of Scott Knott test.

Results and discussion

The summary of the analysis of variance involving different crop years is presented on Table 1. The coefficient of variation (CV) was equal to or less to 12%, differing only for yield, with 24.04%, but the values stayed within the acceptable limits proposed by Oliveira et al. (2009), in studies with bean. It was found that there were significant difference, according to F test at 5% of probability, for variables (plant size, lodging, number of days to flowering and yield) for crop years, genotypes and the interaction between genotypes x crop year. It is possible to Observe that genotypes behaved differently according to the studied crop year. These results are in accordance to Backes et al. (2005) that obtained similar results in studies evaluating the adaptability and stability of beans.

The general averages obtained for the crop years (2010 and 2011) in the analysis of variance (Table 2) show that the performance of the genotypes varied for the 2010 crop year, when the plant size achieved 2.88 of mean, increasing for 3.62 in 2011. The differences between crop years can be explained by cultivar and lines conditions during the 2011 harvest, with daily irrigation, which may have stimulated the vegetative growth. This result was the same for the variable plant lodging, where the overall average obtained for 2010 harvest was 2.40 and 3.94 for 2011, confirming that there was a positive correlation between these characters, as mentioned above.

The variable grain yield presented significant effects for crop year, with an average of 706.66 $kg.ha^{-1}$ for 2010, different from the year 2011, with 2590 $kg.ha^{-1}$, so it is possible to conclude that the year 2011 was more favorable for the expression of this character. Different response to productivity of bean genotypes according to crop year was also observed by Redden et al. (2000), Dalla Corte et al. (2002) and Londero et al. (2006).

Table 1 - Summary of analysis of variance according to plant plant size (PS), plant lodging (PL), grain yield (GY) ($kg .ha^{-1}$) and number of days to flowering (NDF) of bean genotypes. Sinop-MT, Brazil, 2011.

SV	DF	Characters			
		PS	PL	GY	NDF
Crop year (CY)	1	25.52**	114.08**	15.34**	6864.08**
Genotypes (G)	31	1.16**	1.02**	0.06**	20.82**
CY X G	31	0.53**	0.42**	0.03**	3.87**
Error	124	0.14	0.15	0.01	2.31
CV(%)		11.67	11.82	24.04	3.5

Table 2 - General averages obtained for plant size (scale 1-5) (PS), plant lodging (scale 1-5) (L), grain yield (kg.ha^{-1}) (GY) and number of days to flowering (NDF) of bean genotypes during two different crop years. Sinop, 2011.

Crop Year	Means			
	PS	PL	GY	NDF
2010	2.88	2.40	706.66	36.58
2011	3.62	3.94	2590.00	48.54

For the character number of days to flowering, the overall average considering the 2010 crop year was 36.58 days, while in 2011 it was 48.54 days. It was found that, in general, later cultivars were the most productive. The results demonstrated that, even in irrigated areas, where the fixed costs and the energy expenses are high - and therefore the period that the crop stay in the field have a great importance - the cultivars can provide a higher economic return.

On Table 3 is possible to observe the means for the variables plant size, lodging, yield and days to flowering according to the genotype. Since the interaction between genotype and crop year was significant, the results of each crop year is shown. For the plant size variable, the best performance was obtained by BRS Valente (group black) with an average of 2.00. According to Albrecht e Carvalho (2004) this cultivar has an erect plant architecture in any production system. Satisfactory results for BRS Valente for the plant size variable were also observed by Oliveira (2009).

The BRS Majestoso (carioca group) presented the average of 2.17 for plant size and according to Melo et al. (2007), cultivars from this group presented a considerable good average for plant size. In most situations, farmers seek cultivars with erect plant architecture and tolerant to lodging, which provides lower losses during mechanical harvest, better grain quality and lower incidence of diseases (Melo et al., 2007). This new demand from farmers indicates that BRS Majestoso and BRS Valente, which presented erect plant architecture and resistance to lodging, could succeed in the market, even with an average yield below some other genotypes.

For the plant lodging variable, BRS Valente followed by BRS Majestic presented the best averages, with 1.92 and 2.33, respectively. It was observed that there was a relationship between relative performance of genotypes for plant size and lodging. This fact indicates that higher the plant size, more lodging, indicating a positive correlation between these two attributes. Similar results were found by Melo et al. (2005) evaluating the interaction of environments and stability of bean genotypes. The worst performance was presented by line CVIII 39,24, with a plant size average of 3.75 and 3.92 for plant lodging.

For the variable yield, the best performance was presented by BRS Requinte with 2.350 kg.ha^{-1}. Similar results for BRS Requinte were also observed by Melo et al. (2005), evaluating adaptability of 20 bean genotypes and Portugal et al. (2009), evaluating 21 common bean genotypes with the aim of a final recommendation for the Brazilian state of Mato Grosso do Sul conditions. According to Faria et al. (2005), BRS Requinte, presented a reduction on tegument darkening during storage, factor that is a good attribute of food quality, reducing the cooking time. BRS Requinte is one of the few varieties of beans that can be stored without suffering the depreciation of its commercial value, since beans can become dark during the first five months of storage, being this genotype a good option for this crop. The P-18 171, a line from the Federal University of Lavras breeding program, resulted in an average of 2203.33 Kg.ha^{-1}, demonstrating a good potential for the region, with a following introduction of this line in a breeding program, aiming a confirmation of the characteristics and

subsequent recommendation for the Sinop-MT, Brazil region.

Table 3 - Averages for plant size (1-5) (PS), plant lodging (1-5) (PL), grain yield (kg.ha^{-1}) (GY) and number of days to flowering (NDF) of bean genotypes according to location. Sinop, 2011.

Treatments	PS	PL	NDF	GY
P-18.171	3.67a	4.00a	48.67a	1.10a
BRS REQUINTE	4.00a	4.17a	47.00b	1.12a
PÉROLA	4.00a	4.17a	51.33a	1.11a
TALISMÃ	3.67a	4.00a	47.67b	0.90b
BRS RADIANTE	3.00b	3.50a	44.00c	0.99b
JALO PRECOCE	2.83b	3.33a	44.00c	0.98b
RCII-10.26	4.00a	4.17a	46.67b	0.93b
CVIII-1	3.83a	3.83a	49.33a	0.93b
BRS PONTAL	3.83a	4.17a	49.33a	0.92b
CRIOULO	3.50a	4.00a	50.00a	0.91b
JURITI BRANCO	4.00a	4.17a	52.33a	0.84b
CVIII-119.4	3.67a	4.00a	49.00a	0.82c
RCII-2.2	3.50a	4.17a	47.00b	0.70c
RCII-2.21	3.50a	4.00a	47.67b	0.70c
BRS COMETA	2.67b	3.17a	50.00a	0.70c
RCII-6.14	3.33b	4.00a	48.67a	0.79c
MAIV-18.264	4.00a	4.17a	46.67b	0.79c
MAJESTOSO	4.00a	4.33a	47.33b	0.79c
BRANQUINHO	3.83a	4.00a	49.33a	0.77c
MAIII-9.91	3.83a	4.00a	50.00a	0.76c
CVIII-39.24	4.00a	4.33a	47.67b	0.74c
RP-1	3.67a	4.00a	49.33a	0.73c
SUPREMO	2.50b	2.67a	50.00a	0.73c
MAII-2	4.00a	4.00a	49.33a	0.72c
BP-31	3.17b	3.83a	47.33b	0.60d
MAIV-18.266	3.67a	4.00a	47.00b	0.66c
VALENTE	3.83a	4.17a	50.67a	0.64d
MAIII-17.179	3.33b	4.00a	48.67a	0.62d
MAII-22	3.83a	3.83a	51.00a	0.58d
MAIV-8.102	3.67a	4.17a	48.00b	0.53e
MAIV-15.203	3.67a	3.83a	50.00a	0.46e
FP-3.47	3.67a	4.00a	48.33a	0.44e

*Means followed by the same letter do not differ according to Scott Knott test (5%).

For the variable days to flowering, cultivars BRS Pontal and BRS Radiante were the earliest, with an average of 37 days to flowering.

The early characteristic is desirable for common bean, since the crop offers conditions to be grown twice a year, as it is irrigated, whose sowing starts from April to May. The latest cultivar studied was the IPR Uirapuru, with 46 days to flowering and did not promote interesting results for other studied variables. Similar results were observed for days to flowering by Afférri et al. (2003). According to literature, this cultivar has an erect plant architecture, a mean of 43 days to flowering and yield above 2000 kg.ha^{-1}. Thus, it is possible to conclude that the crop year influenced the cultivar development.

According to the discussed, it is available in breeding programs or on the marked cultivars or

lines that are phenotypically favorable to the environmental conditions of the north of Mato Grosso state, Brazil. These genotypes cited could be grown in the recommended regions or used as a genetic variability source on breeding programs.

Conclusion

It can be concluded that the cultivars showed different behaviors in different crop years. For yield, the cultivars BRS Requinte (Carioca group), Jalo Precoce (Jalo group), BRS Supremo and BRS Crioulo (Black group) and BRS Radiante (Rajado group) presented the better results, suggesting their incorporation on breeding programs that could indicate better cultivars for the north of Mato Grosso state, Brazil, as well as the recommendation for different growth regions.

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