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Scientific Article

Agronomic potential and genetic divergence in the selection of mungbean lines in tropical floodplains

Potencial agronômico e divergência genética na seleção de linhagens de feijão-mungo em várzea tropical

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ABSTRACT - Mungbean (*Vigna radiata* L.) is a Fabaceae species cultivated in several regions in Brazil. In Tocantins state, however, the few cultivars available are not indicated for the region, making it essential to select and subsequently recommend new cultivars. This study aimed to assess the agronomic potential and genetic divergence of mungbean lines to support the development of cultivars adapted to tropical floodplain conditions in Tocantins. Two trials were conducted in a randomized block design with four replications under tropical floodplain conditions, in the municipalities of Lagoa da Confusão and Formoso do Araguaia, Tocantins, Brazil. A total of 18 mungbean lines and two cultivars were studied. Were evaluated pod weight, pod length, number of grains per pod, 100-grain weight, grain yield, and grain index. Lines BRA-O84883 and BRA-O84654-1, with grain yields of 1,415.4 and 1,408.8 kg ha^{-1}, respectively, exhibited high productivity, good results for the number of grains per pod and grain index, and were quite similar. Grain yield contributed most to genetic dissimilarity between the lines, with BRA-084638 and BRA-084794 the most divergent. To generate high genetic variability in segregating populations for future selection, it is recommended that crosses between lines BRA-084654-1 and BRA-O84883 and the cultivars BRS Esperança and BRS MG Camaleão, which combine genetic divergence and high grain yield, be part of mungbean breeding for cultivation in tropical floodplains in Tocantins, Brazil.

Keywords: *Vigna radiata*. Breeding programs. Clustering. Dissimilarity.

RESUMO - O feijão-mungo (*Vigna radiata* L..) é uma Fabaceae cultivada no Brasil em várias regiões. No Tocantins, são poucas as cultivares disponíveis e não são indicadas para Estado, sendo primordial a seleção e futura indicação de novas cultivares. Esse trabalho tem como objetivo avaliar o potencial agronômico e divergência genética de linhagens para subsidiar o desenvolvimento de cultivares adaptadas ao cultivo em condições de várzea tropical no estado do Tocantins. Foram conduzidos dois ensaios em delineamento de blocos casualizados com quatro repetições sob condições de várzea tropical, nos municípios de Lagoa da Confusão e Formoso do Araguaia, estado do Tocantins, Brasil. Foram avaliados 18 linhagens e duas cultivares de feijão-mungo. Foram avaliados: peso de vagem, comprimento de vagem, número de grãos por vagens, peso de 100 grãos, produtividade de grãos e índice de grãos. As linhagens BRA-O84883 e BRA-O84654-1, com produtividades de 1.415,4 e 1.408,8 kg ha^{-1}, respectivamente, destacaram-se em produtividade de grãos. Essas linhagens apresentaram bons resultados para os caracteres número de grão por vagem, índice de grãos e foram similares entre eles. A produtividade de grãos foi o caráter que mais contribuiu para a dissimilaridade genética entre as linhagens, sendo BRA-084638 e BRA-084794 os mais divergentes. Visando gerar alta variabilidade genética em populações segregantes para futura seleção, recomenda-se os cruzamentos entre as linhagens BRA-084654-1 e BRA-O84883 com as cultivares BRS Esperança e BRS MG Camaleão, que aliam divergência genética e alta produtividade de grãos, no melhoramento do feijão-mungo para o cultivo em várzea tropical no estado do Tocantins, Brasil.

Palavras-chave: *Vigna radiata*. Melhoramento genético. Agrupamento. Dissimilaridade.

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INTRODUCTION

Mungbean is an erect/semi-erect Fabaceae species, originating in India. It shows good development in tropical and subtropical climates, adapts well to different soil types, and is relatively drought-resistant. The species has a rapid growth cycle, which varies according to genotype and climate conditions (TANG et al., 2014).

Low mungbean yields are common in Brazil; however, in Amazonas state, mungbean grown in floodplain areas produced approximately 2,175 kg ha^{-1}, while upland cultivation reached a maximum yield of 1,140 kg ha^{-1} (VIEIRA; VIEIRA; VIEIRA, 2001). Under experimental conditions in Mato Grosso state, Alves et al. (2018) obtained yields exceeding 1,300 kg ha^{-1}.

In Tocantins, mungbean cultivation on floodplain soils is similar to that of cowpea, primarily because it allows for mechanized sowing and harvesting and has a short maturation cycle. In hot climates, mungbean harvests have been completed within about 65 days during the offseason, as seen in Tocantins (MENEZES JUNIOR; SILVA; ROCHA, 2019).

A major problem for mungbean producers in Tocantins is the limited number of available cultivars, which are not officially recommended for the state. The registered cultivars have recommendations limited to one state and other regions, underscoring the need to introduce, assess, and select lines better suited to Tocantins conditions (IBRAFE, 2023).

Genotype-environment interaction (GxE) assessment is an essential tool in plant breeding, helping identify genotypes adapted to different environments, tolerant to environmental stresses, and resistant to local pests and diseases. For mungbean, studies of agronomic performance, adaptability, and production stability have advanced knowledge and adaptation of the crop in different regions worldwide (KUMAR et al., 2020; SAMYUKTHA et al., 2020; WIN et al., 2018).

A study conducted in Ethiopia assessed six green mungbean genotypes across multiple growing seasons. It revealed a variation in grain yield between genotypes and environments, with significant genotype-environment interaction accounting for around 11.59% of the total variation (BARAKI et al., 2020). In Brazil, given the need to assess mungbean adaptation in grain-producing regions, Noleto et al. (2023) evaluated the agronomic performance, adaptability, and yield stability of mungbean genotypes in the Central-North region of Mato Grosso and found significant genotype-environment interactions for grain yield.

When recommending a genotype for a particular location or growing season, it should be previously tested for the specific conditions of that site. Recommending cultivars is the final stage in breeding programs, aimed primarily at increasing yields and requiring proper selection of superior lines (SILVA et al., 2018). As such, this study aimed to assess the agronomic potential and estimate the genetic divergence of mungbean genotypes to support the development of cultivars adapted to tropical floodplain conditions in Tocantins state, Brazil.

MATERIALS AND METHODS

Eighteen mungbean lines and two control cultivars were assessed (Table 1), all with an erect growth habit. The lines and the BRS Esperança cultivar were obtained from the Embrapa Central-North mungbean breeding program. The BRSMG Camaleão cultivar was acquired from the EPAMIG/ EMBRAPA breeding program. The seed coat color of the lines and cultivars assessed is green, except for line BRA-084689, which has a yellow seed coat.

Table 1. Mungbean (*Vigna radiata* L.) genotypes assessed for agronomic potential and genetic divergence.

Genotype	Seed coat color	Genotype	Seed coat color
BRA-084808-1	Green	BRA-084883	Green
BRA-084638	Green	BRA-084654-2	Green
BRA-084654-1	Green	BRA-084689	Yellow
BRA-084671	Green	BRA-084930	Green
BRA-084841	Green	BRA-084981	Green
BRA-000027	Green	BRA-084999	Green
BRA-000078	Green	BRA-027570	Green
BRA-000221	Green	BG2	Green
BRA-084794	Green	BRS Esperança	Green
BRA-084808-2	Green	BRSMG Camaleão	Green

Two experiments were conducted during the 2021 agricultural year on commercial production areas under wet floodplain conditions in southwestern Tocantins, in the municipalities of Lagoa da Confusão (10° 47' 22" S, 49° 37' 50" W, altitude: 186 m, average temperature: 27.2°C, and average annual rainfall: 1882 mm) and Formoso do Araguaia (11° 47' 45" S, 49° 31' 52" W, altitude: 234 m, average temperature: 26.7°C, and average annual rainfall: 1719 mm). Both locations have a tropical summer climate (Aw), characterized by wet summers and dry winters, according to the Köppen-Geiger climate classification (1928).

Maximum and temperatures at the experimental sites ranged from 29 to 24°C and 20 to 14°C, respectively. Rainfall during the experimental period was approximately 680 mm (Figure 1).

The experiments were conducted using a randomized block design with four replications. Treatments consisted of plots containing four 5-meter rows, with the two central rows used as the study area, excluding 50 cm from each end.

Conventional soil preparation was carried out, and soil analysis is depicted in Table 2. Due to the high natural fertility of floodplain soils, local farmers use standardized fertilization with no specific soil analysis for each planting cycle. Consequently, soil analysis was not used as a reference for fertilization calculations, based instead on the soil's intrinsic fertility and traditional agricultural practices in the region. The seeds were treated with fungicides and insecticides. Plant spacing was 0.45 m between rows, and thinning was conducted ten days after emergence, leaving 16 plants per linear meter to obtain a population density of 355,550 plants per hectare. Crop management and phytosanitary practices, such as the application of fungicides, insecticides, and herbicides to control of diseases, pests, and weeds, were performed as needed. Harvesting of each plot was carried out once the plants showed signs of senescence and the pods exhibited a low moisture content (12%).

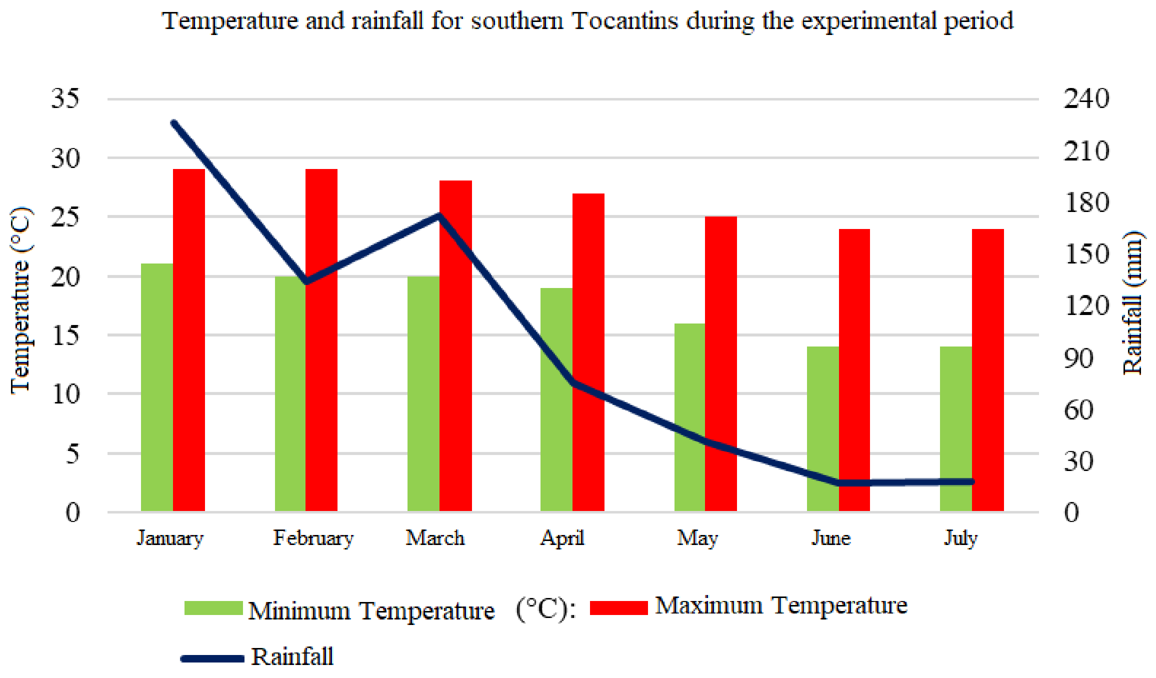

Figure 1. Temperature and rainfall for Southern Tocantins state, Brazil, during the experimental period for the assessment of agronomic potential and genetic divergence of Mungbean (*Vigna radiata* L.) genotypes.

Table 2. Soil analysis results for the area where mungbean (*Vigna radiata* L.) genotypes were cultivated to assess agronomic potential and genetic divergence.

Ca+Mg	Al	H+Al	K	T	P	MO	pH	V	Areia	Silte	Argila
----------- $cmol_c$ dm^3 ---------				--- Mg dm^3 ---		g dm^3	$CaCl_2$		------------ % -----------		
2.8	0.0	7.6	0.1	10.4	56.6	57.4	5.0	26.9	70.5	12.4	17.1

Ca=Cálcio; Mg:Magnésio; H=hidrogênio; Al=alumínio; K=potássio; T=capacidade de troca de cátions do solo; P=fósforo; pH= potencial hidrogeniônico; V=saturação de bases.

The traits assessed were pod weight (g), pod length (cm), number of grains per pod, 100-grain weight (g), yield (kg ha^{-1}), and grain index (%), all evaluated at harvest.

Individual analysis of variance was conducted, followed by a pooled analysis of the data after testing for homogeneity of variances.

The means of the traits from both locations were clustered using the Scott-Knott test ($p<0.05$). Dissimilarity measures were determined according to a multivariate analysis model with estimates of dissimilarity and a residual covariance matrix. The Tocher clustering method, proposed by Rao (1952), was applied, using Mahalanobis' generalized distance as a measure of dissimilarity. Analyses were conducted using Genes software (CRUZ, 2013).

RESULTS AND DISCUSSION

Pooled analysis of variance for the six traits assessed in this study showed coefficients of variation ranging from 6.37 to 23.79%, indicating good experimental precision. The results demonstrated significant differences ($p<0.05$) between genotypes for all traits, indicating the presence of genetic variability in the mungbean genotypes evaluated (Table 3).

GxE was significant only for grain yield, indicating a variable productive performance of the lines due to environmental differences between the two study sites. This corroborates the results of Noleto et al. (2023) in a study on the same genotypes in Mato Grosso state.

Pod weight ranged from 1.01 to 0.74 g, forming two groups, with 13 genotypes in the first group (BRA-000078, BRSMG Camaleão, BRA-000221, BRA-084654-1, BRA-O84999, BRA-O84689, BRA-O84654-2, BRA-000027, BRA-084638, BRA-027570, BRA-084808-1, BG2, and BRA-084841) (Figure 2). These lines had a higher pod weight than the BRS Esperança cultivar, one of the controls used in this study. This information is particularly important because it demonstrates the genetic potential of these genotypes for cultivation in floodplain environments in Tocantins and highlights their value for crossbreeding aimed at generating variability for selecting higher pod weights. Genotypes with higher pod weight produce more grains per plant, resulting in increased grain yield per area. Alves et al. (2018) studied the correlation between traits and grain yield of mungbean genotypes grown in Nova Ubiratã, MT, reporting values between 0.81 and 0.49 g, highlighting the abovementioned genotypes. This suggests broader adaptation of these genotypes in terms of pod weight.

Table 3. Summary of pooled analysis of variance for six agronomic traits of 18 mungbean (*Vigna radiata* L.) lines and two cultivars assessed in two tropical floodplain areas in the cities of Formoso do Araguaia and Lagoa da Confusão, TO, Brazil, during the 2021 agricultural year.

		Mean Squares					
SV	DOF	PW	PL	NGP	100GW	YLD	GI
Block/Env	6	0.03	0.65	2.7	0.21	22917.28	23.49
Gen	19	0.05	2.46	2.23	1.27	156039.2	73.71
Env	1	0.86	1.12	56.72	21.76	15065862.46	1216.39
GxE	19	0.03	0.79	2.78	0.69	140591.72	40.27
Error	114	0.02	0.53	1.84	0.41	59024.3	17.07
Mean		0.87	9.08	10.11	6.2	1191.58	72
CV (%)		15.01	8.00	13.47	10.37	20.39	5.74

PW: weight of 5 pods (g); PL: pod length (cm); NGP: number of grains per pod; 100GW: 100-grain weight; YLD: yield (kg/ha); GI: grain index; SV: source of variation; DOF: degrees of freedom; GxE: genotype-environment interaction.

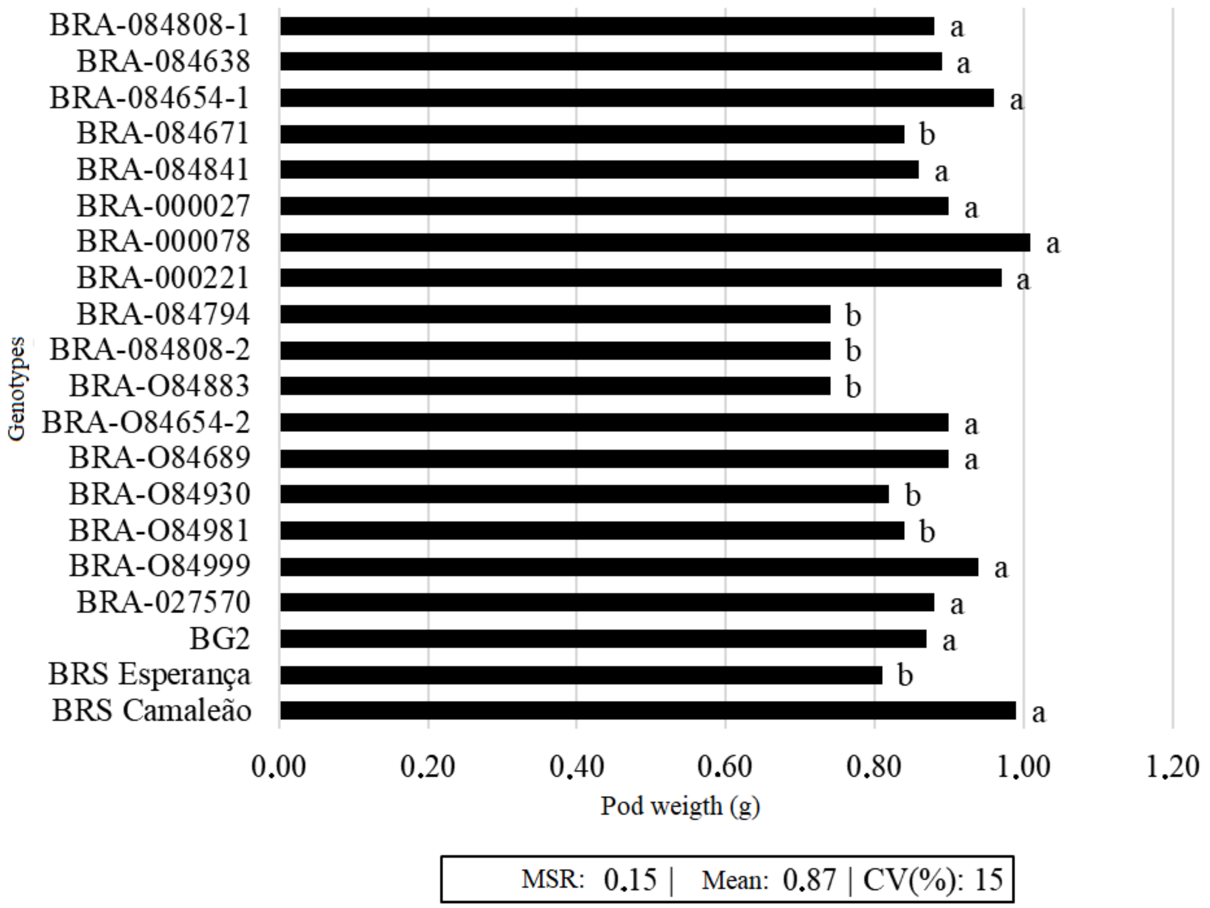

Figure 2. Pod weight (g) of 18 mungbean (*Vigna radiata* L.) lines and two cultivars assessed in two tropical floodplain areas in the cities of Formoso do Araguaia and Lagoa da Confusão, TO, Brazil, during the 2021 agricultural year.

For pod length, the genotypes were divided into two groups, with the best averages observed for BRSMG Camaleão, BRA-084689, BRA-O84999, BRA-084654-1, BRA-000078, BRA-O84654-2, BG2, BRA-000221, BRS Esperança, BRA-084841, BRA-000027, and BRA-027570, ranging from 10.03 to 9.05 cm (Figure 3). Alves et al. (2018) assessed mungbean genotypes in Mato Grosso, reporting values between 9.68 and 7.47 cm for the same genotypes, with the best results obtained for BRA-084654-1, BRA-000221, BRA-O84689, BRA-O84654-2, BRS Esperança, BRA-O84999, BG2, BRSMG Camaleão, BRA-027570, BRA-000078, and BRA-084638. Keres et al. (2019) studied mungbean performance under different population arrangements in Mato Grosso, recording values of 9.4 to 9.8 cm for a planting density of 300,000 plants per hectare. According to Gonçalves and Lima (2021), pod length is of fundamental importance, since well-developed pods directly influence grain filling, mass, and growth, thereby increasing grain yield. Lines with longer pods are expected to exhibit higher grain yield.

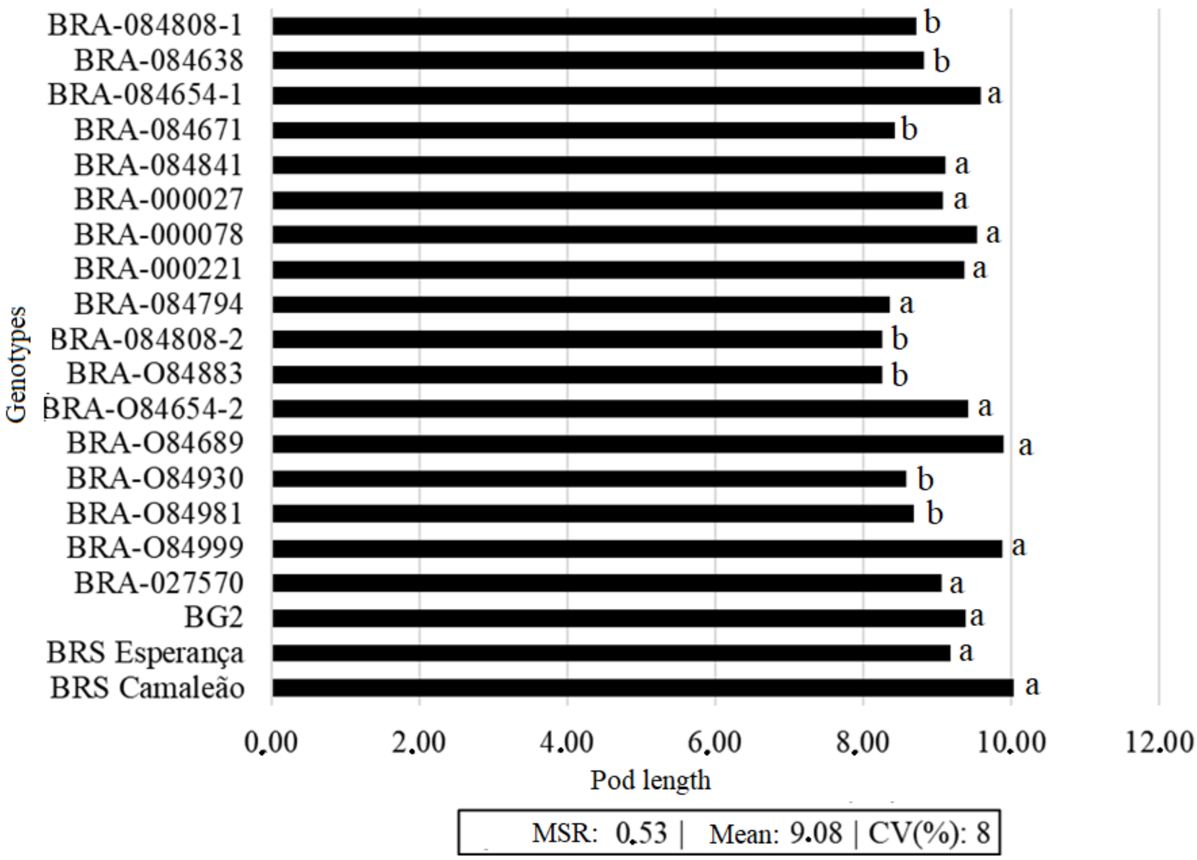

Figure 3. Pod length (cm) of 18 mungbean (*Vigna radiata* L.) lines and two cultivars assessed in two tropical floodplain areas in the cities of Formoso do Araguaia and Lagoa da Confusão, TO, Brazil, during the 2021 Agricultural Year.

With respect to the number of grains per pod (Figure 4), the genotypes were classified into two groups, with BRA-084671, BRA-O84654-2, BRA-000078, BRA-084654-1, BRS Camaleão, BRA-000221, BRA-O84689, BRA-084808-1, BRA-O84999, BRA-O84981, and BRA-084794 obtaining the highest values, ranging from 10.88 to 10.1 grains per pod. Alves et al. (2018) found values between 11.5 and 9.05 grains per pod for the same genotypes. Keres et al. (2019) reported an average of 8.8 grains per pod, and Yeasmin et al. (2016), evaluating the performance of three mungbean genotypes at different population densities, found a maximum of 11.61 grains per pod. According to Zilio et al. (2011), the number of grains per pod is a significant factor influencing the grain yield of bean cultivars.

The 100-grain weight and number of grains per pod are important traits for expressing the yield potential of a genotype. Thus, the greater the grain weight, the higher the yield of that genotype. The genotypes were clustered for this trait into two groups, with BRA-000027, BRA-084638, BRS Camaleão, BRA-O84999, BRA-000221, BRA-000078, BRA-027570, BRA-084654-1, BRS Esperança, BRA-084808-1, BRA-O84654-2, and BRA-084841 showing the best averages, ranging from 6.84 to 6.17 g (Figure 5), indicating the strong potential of these genotypes for this trait under floodplain conditions in Tocantins. In another study conducted with these same genotypes in Nova Ubiratã, MT, the 100-grain weight ranged from 6.62 to 4.16 g (ALVES et al., 2018), lower values than those obtained in the present study. Noleto et al. (2023) observed values between 6.56 and 4.63 g in a study with the same genotypes in Mato Grosso, demonstrating their stability for this trait.

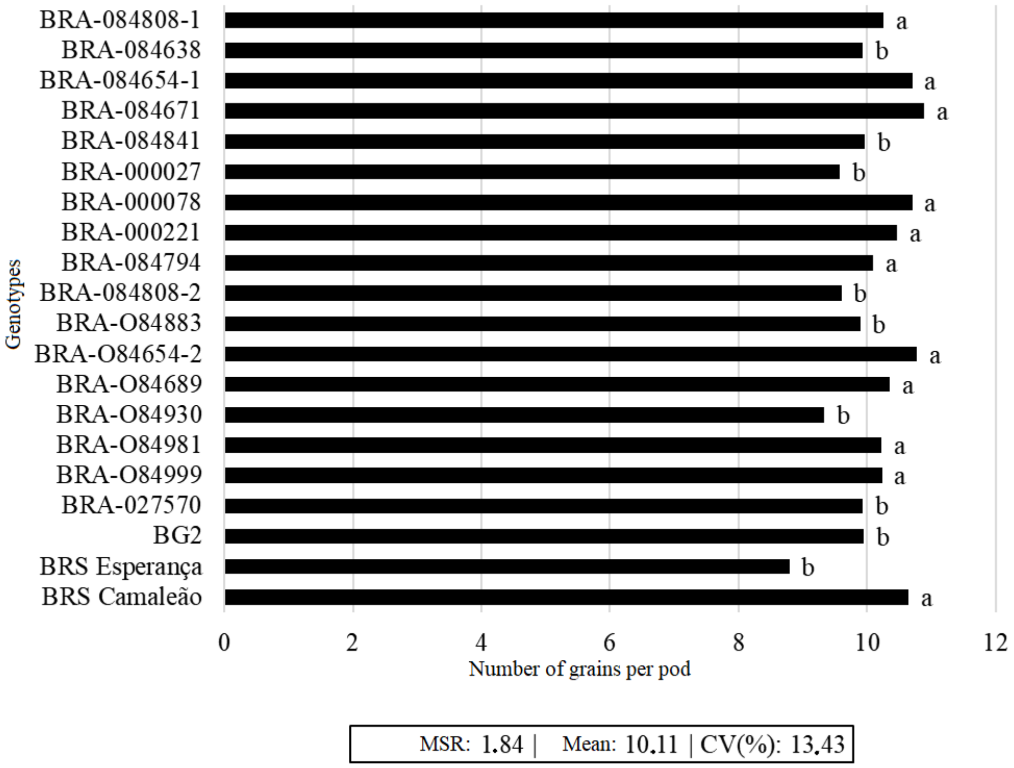

Figure 4. Number of grains per pod in 18 mungbean (*Vigna radiata* L.) lines and two cultivars assessed in two tropical floodplain areas in the cities of Formoso do Araguaia and Lagoa da Confusão, TO, Brazil, during the 2021 agricultural year.

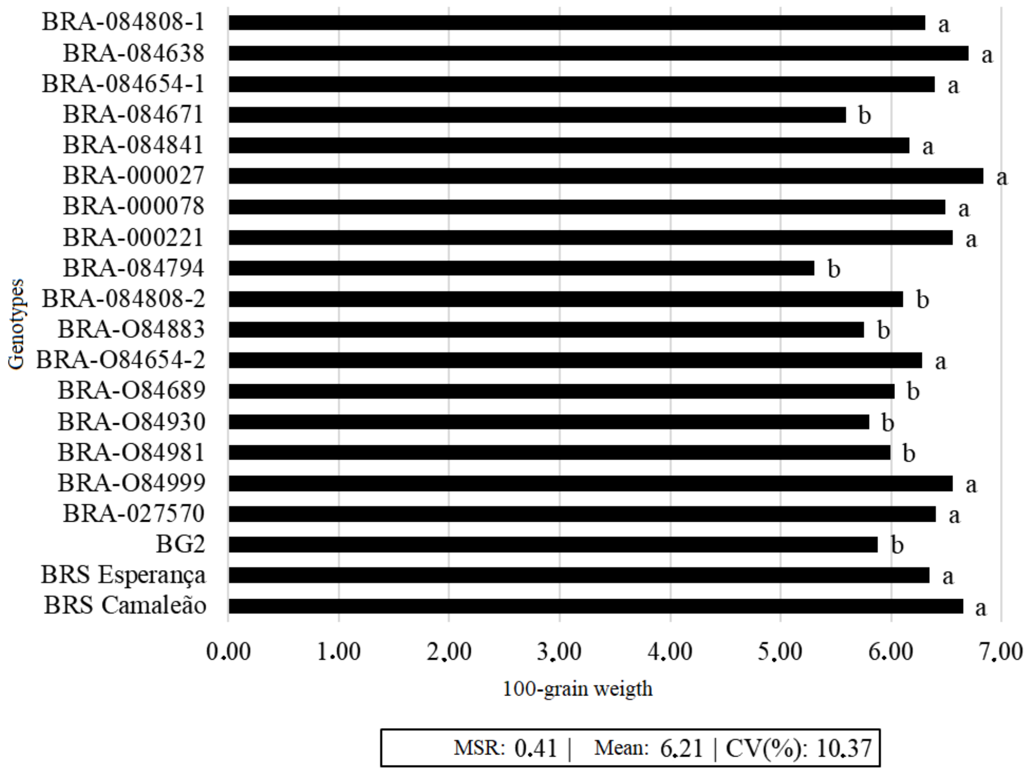

Figure 5. 100-Grain weight (g) of 18 mungbean (*Vigna radiata* L.) lines and 2 cultivars assessed in two tropical floodplain areas in the cities of Formoso do Araguaia and Lagoa da Confusão, TO, Brazil, during the 2021 agricultural year.

Three grain yield groups were formed, with genotypes BRA-O84883 and BRA-084654-1 showing the highest averages (1,415.36 and 1,408.85 kg ha⁻¹, respectively), followed by BRA-084671, BRA-084808-1, BRA-O84999, BRA-O84930, BRA-000078, BRA-O84981, BRA-000027, BG7, BRS Esperança, BG2, BRA-084841, BRA-000221, and BRA-084808-2 (Figure 6). Noleto et al. (2023) studied the adaptability and stability of mungbean genotypes in the Central-North region of Mato Grosso, observing a grain yield of 1,350 kg ha⁻¹. Lower values were reported by Keres et al. (2019), who obtained an average yield of 668 kg ha⁻¹ in Mato Grosso. In a study on early maturity and grain yield selection in mungbean accessions in the agroecological zones of southwestern Nigeria, Akinyosoye et al. (2021) observed above-average grain yield (1,472.93 kg ha⁻¹) in nine of the 20 genotypes studied.

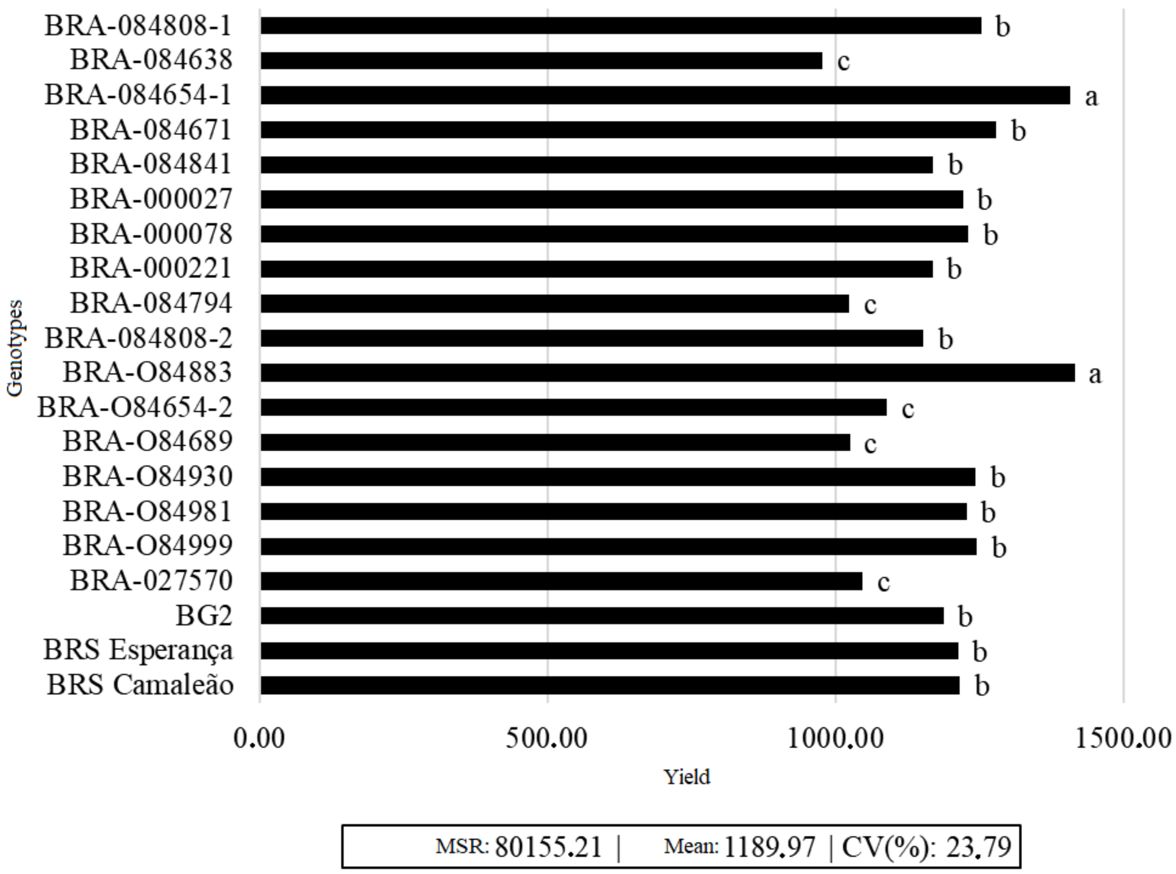

Figure 6. Grain yield (kg/ha) of 18 mungbean (*Vigna radiata* L.) lines and two cultivars assessed in two tropical floodplain areas in the cities of Formoso do Araguaia and Lagoa da Confusão, TO, Brazil, during the 2021 agricultural year.

According to Silva et al. (2018), the grain index is the ratio between the grain weight and weight of unthreshed pods, indicating each genotype's efficiency in grain production. The grain index divided the genotypes into three groups, with BRA-084808-2, BRA-084638, BRA-000027, BG2, BRA-000221, BRA-O84654-2, BRA-O84883, BRA-O84689, BRA-O84981, BRA-084654-1, and BRA-084808-1 showing the highest averages, ranging from 72.65 to 74.44%, followed by BRSMG Camaleão, BRA-027570, BRA-084671, BRA-O84999, BRA-084841, and BRA-O84930, with 70.21 to 71.51%, respectively (Figure 7). Similar results were found by Alves et al. (2018) in a study on the same genotypes in Mato Grosso, where grain indices ranged from 74.06 to 79.18%.

The genetic dissimilarity measures, estimated using Mahalanobis' distance (Table 4), for the six traits showed a range from 0.44 to 38.07, indicating the presence of genetic variability between the genotypes. The most divergent group consisted of lines BRA-084638 and BRA-084794 (D^2 = 38.07), followed by the combinations BRS Esperança and BRA-084638 (D^2 = 36.56), and BG2 and BRA-084638 (D^2 = 34.97), indicating greater genetic divergence between these pairs of lines. The smallest distance was between lines BRA-000221 and BRA-O84981 (D^2 = 0.44), followed by BRA-O84883 and BRA-084654-1 (D^2 = 0.53) and BRA-084671 and BRA-O84981 (D^2 = 1.1), showing genetic similarity between these pairs.

Although BRA-084638 appeared in 45% of all combinations with the greatest distances, it cannot be considered a suitable parent for future crossings, since it had the lowest average grain yield. Selecting parents is crucial to the success of breeding programs, given that offspring inherit their parents' traits. It is important to select genetically distinct parents with desirable traits in order to increase the genetic variability of the population.

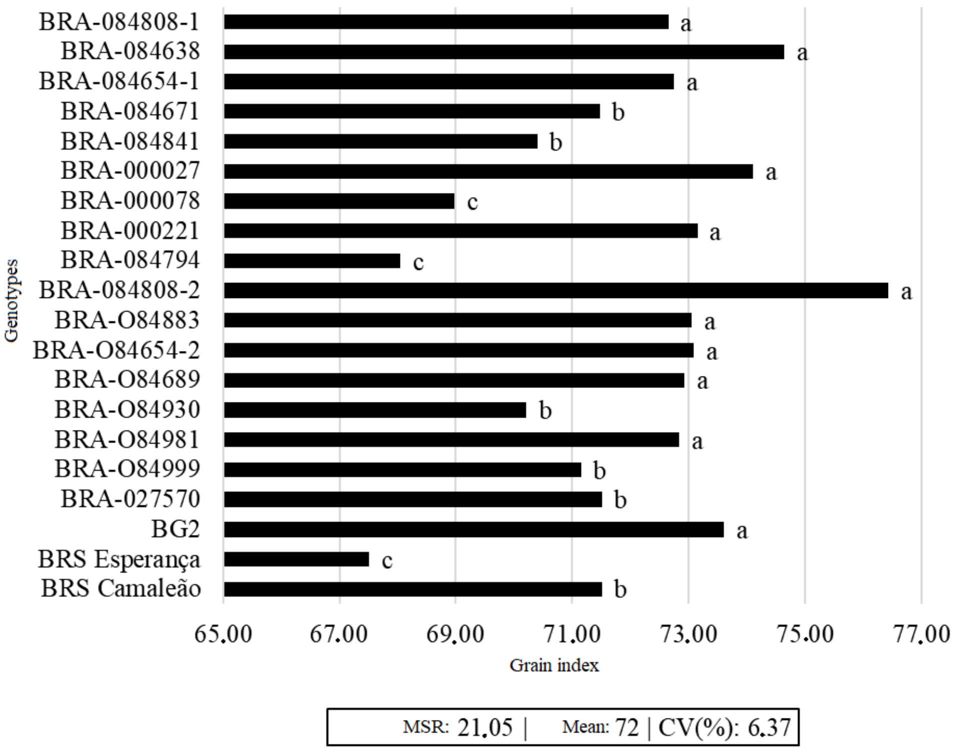

Figure 7. Grain index of 18 mungbean (*Vigna radiata* L.) lines and two cultivars assessed in two tropical floodplain areas in the cities of Formoso do Araguaia and Lagoa da Confusão, TO, Brazil, during the 2021 agricultural year.

Table 4. Genetic dissimilarity between 18 mungbean (*Vigna radiata* L.) lines and two cultivars for six traits, based on Mahalanobis` generalized distance (D²ii').

Lines	1	2	3	4	5	6	7	8	9	10
1		30.1	8.34	2.62	6	9.5	20.5	2.76	11.6	5.1
2			27.3	25.7	32.3	8.75	13.7	16.2	38.1	23
3				3.22	15.6	7.81	13.3	5.92	22	13.3
4					9.55	8.12	13.5	2.14	12.1	9.81
5						12.4	17.1	7.54	4.86	9.62
6							7.76	3.77	22.2	7.52
7								12.6	21.97	26.2
8									11.46	4.16
9										18.4

Lines	11	12	13	14	15	16	17	18	19	20
1	7.45	18.9	13.7	7.11	2.31	15.1	8.85	3.7	14.2	31
2	29.2	3.11	11	21.2	20.3	13.8	9.93	35	36.6	10.4
3	0.53	13.2	13	6.33	3.63	8.37	13.2	12.3	17.9	15.5
4	2.68	12.8	10.9	4.79	1.1	10.5	7.59	7.83	13.9	20.9
5	17.9	22	10.9	4.15	7.22	11.3	7.52	3.89	3.22	29
6	9.25	4.11	6.11	5.63	4.75	3.9	4.4	12.9	16.9	9.38
7	16.5	6.71	11.3	5.75	13	2.54	7.4	26.3	12.6	4.56
8	6.01	7.76	5.09	4.41	0.44	8.11	3.13	5.5	13.9	17.7
9	23.9	25.5	12.1	8.75	11.3	18.2	9.72	8.97	6.34	34.6
10	13.4	16.8	9.69	11.7	5	16.2	9.57	3.62	21.2	30.1
11		14.9	15.7	8.78	3.82	11.9	14.8	13.2	21.8	19.5
12			5.21	10.5	9.78	6.14	4.92	23.5	24.1	4.95
13				6.23	6.33	5.88	2.87	11	13.8	11.1
14					3.64	2.56	4.22	8.19	3.9	12.6
15						7.86	4.93	4.72	12.7	18.1
16							5.67	16.3	9.19	4.46
17								11	10.9	13.1
18									11.9	34.1
19										24.3

Genotypes: 1(BRA-084808-1); 2(BRA-084638); 3(BRA-084654-1); 4(BRA-084671); 5(BRA-084841); 6(BRA-000027); 7 (BRA-000078); 8(BRA-000221); 9(BRA-084794); 10(BRA-084808-2); 11(BRA-O84883); 12(BRA-O84654-2); 13(BRA-O84689); 14(BRA-O84930); 15(BRA-O84981); 16(BRA-O84999); 17(BRA-027570); 18(BG2); 19(BRS Esperança); 20 (BRSMG Camaleão).

Genetic divergence plays a key role in species evolution and adaptation. When genotypes exhibit differences in traits, such as variable expressivity, it is crucial to consider this diversity when selecting genotypes for hybridization. Additionally, the careful selection of genotypes is essential because those that combine high individual performance, adaptability, and stability for the traits of interest can result in offspring with greater yield potential. Thus, the strategic combination of genotypes is key to successful hybridization and the development of plants with desirable traits (AZEVEDO et al. 2014; STRECK et al. 2017).

As shown in Table 5, the relative contribution of each trait to genetic dissimilarity, according to the Singh (1981) method, revealed that grain yield was the most effective in explaining genotype dissimilarity and should be prioritized when selecting the best genotype under the evaluated conditions. According to Correa and Gonçalves (2012), analyzing the relative contribution of each trait to genetic divergence is essential because it allows for the identification of traits with the greatest impact on genotype discrimination while disregarding those with minimal contribution. This approach optimizes the use of resources such as labor, time, and costs during experiments.

Table 5. Relative contribution of six agronomic traits to the genetic dissimilarity of 18 mungbean (*Vigna radiata* L.) lines and two cultivars, using the method proposed by Singh (1981), in a floodplain area in the cities of Formoso do Araguaia and Lagoa da Confusão, TO, Brazil.

Trait	Value in %
Pod weight	0.0005
Pod length	0.0011
Number of grains per pod	0.0292
100-grain weight	0.0003
Yield	99.9326
Grain index	0.0361

Clustering analysis using the Tocher method separated the 20 genotypes into 10 genetically distinct groups (Table 6). Group I consisted of 20% of the genotypes, making it the group with the highest number of similar genotypes, followed by Group III, with three genotypes. Groups II, IV, V, VI, and VII each contained two genotypes, while the remaining groups consisted of a single genotype.

Table 6. Clustering by the Tocher method, based on Mahalanobis' generalized distance, of 18 mungbean (*Vigna radiata* L.) lines and two cultivars assessed in two floodplain locations in the cities of Formoso do Araguaia and Lagoa da Confusão, TO, Brazil.

Group	Genotypes
I	BRA-000221; BRA-O84981; BRA-084671; BRA-084808-1
II	BRA-084654-1; BRA-O84883
III	BRA-000078; BRA-O84999; BRA-O84930
IV	BRA-O84689; BRA-027570
V	BRA-084638; BRA-O84654-2
VI	BRA-084841; BRS Esperança
VII	BRA-084808-2; BG2
VIII	BRA-000027
IX	BRA-084794
X	BRSMG Camaleão

The most promising crosses and those that could result in restricted variability in segregating generations can be identified based on Tocher's clustering method. In addition to showing genetic divergence, it is essential that genotypes selected for hybridization combine high yield potential. Thus, it is recommended that lines BRA-084654-1 and BRA-O84883 (the most productive genotypes) from Group II be crossed with genotypes from more divergent groups that also demonstrate grain yields at least above the overall average (1,189.97 kg ha^{-1}). Examples include line BRA-000027 (Group VIII) and cultivars BRS Esperança (Group VI) and BRSMG Camaleão (Group X) (Table 6).

CONCLUSIONS

The mungbean lines BRA-O84883 and BRA-O84654-1 exhibit high yield potential and also stand out l in terms of the number of grains per pod and grain index. The mungbean genotypes BRA-084638 and BRA-084794 are the most divergent, followed by BRS Esperança and BRA-084638, and BG2 and BRA-084638. Grain yield is the trait that most contributes to the genetic dissimilarity between the mungbean genotypes assessed, given that it showed the greatest variation in the variables studied. The mungbean lines BRA-O84883 and BRA-O84654-1 show high potential for cultivation in tropical floodplain conditions in Tocantins state, Brazil.

REFERENCES

AKINYOSOYE, S. T. et al. Selection for earliness and seed yield in Mung bean accessions using REML/BLUP. **Pesquisa Agropecuária Brasileira**, 56: e02290, 2021.

ALVES, S. M. et al. Correlação entre caracteres e produtividade de grãos de linhagens de feijão-mungo. In: ENCONTRO DE CIÊNCIA E TECNOLOGIAS AGROSSUSTENTÁVEIS, 2., 2018, Sinop. **Anais…** Sinop: Embrapa, 2018. p. 61-64.

AZEVEDO, A. M. et al. Divergência genética e importância de caracteres morfológicos em genótipos de couve. **Horticultura Brasileira**, 32: 48-54, 2014.

BARAKI, F. et al. Genotype x environment interaction and yield stability analysis of mung bean (*Vigna radiata* (L.) Wilczek) genotypes in Northern Ethiopia. **Cogent Food & Agriculture**, 6: 1729581, 2020.

CORREA, A. M.; GONÇALVES, M. C. Divergência genética em genótipos de feijão comum cultivados em Mato Grosso do Sul. **Revista Ceres**, 59: 206-212, 2012.

CRUZ, C. D. GENES: a software package for analysis in experimental statistics and quantitative genetics. Acta Scientiarum. **Agronomy**, 35: 271-276, 2013.

GONÇALVES, Z. S.; LIMA, L. K. S. Desempenho agronômico e diversidade genética de linhagens de feijão-caupi nas condições do Recôncavo da Bahia. **Journal of Biotechnology and Biodiversity**, 9: 285-294, 2021.

IBRAFE - Instituto Brasileiro do Feijão e Pulses. **Quais são os desafios na produção de feijão-mungo?** 2023. Available at: https://ibrafe.org/artigo/quais-sao-os-desafios-na-producao-de-feijao-mungo. Access on: July 18, 2024.

KERES, G. et al. Desempenho de feijoeiro mungo em densidades populacionais e espaçamento entre linhas no Mato Grosso. **Scientia Agraria Paranaensis**, 18: 251-258, 2019.

KÖPPEN, W.; GEIGER, R. **Klimate der Erde**. Gotha: Verlag Justus Perthes, 1928. 367 p.

KUMAR, S. et al. Study on genotype x environment interactions and AMMI analysis for agronomic traits in mungbean (*Vigna radiata* L. Wilczek.) under rainfed conditions. **Indian Journal of Genetics and Plant Breeding**, 80: 354-358, 2020.

MENEZES JUNIOR, J. A.; SILVA, K. J. D.; ROCHA, M. M. Feijão-mungo como perspectiva para a safrinha em Mato Grosso. In: EMBRAPA (Ed.). **Publicações Embrapa**. Brasília, DF: Embrapa, 2023. p. 1-20.

NOLETO, M. P. et al. Adaptability and stability of mungbean genotypes in the Mid-North of Mato Grosso, Brazil. **Ciência e Agrotecnologia**, 47: e012222, 2023.

RAO, R. C. **Advanced statistical methods in biometric research**. New York: John Willey and Sons, 1952. 390 p.

SAMYUKTHA, S. M. et al. Delineation of Genotype × Environment Interaction for Identification of Stable Genotypes to Grain Yield in Mungbean. **Frontiers in Agronomy**, 2: 577911, 2020.

SILVA, M. B. D. O. et al. Desempenho agronómico de genótipos de feijão-caupi. **Revista de Ciências Agrárias**, 41: 1059-1066, 2018.

SINGH, D. The relative importance of characters affecting genetic divergence. **Indian Journal of Genetics and Plant Breeding**, 41, 237-245, 1981.

STRECK, E. A. et al. Variabilidade fenotípica de genótipos de arroz irrigado via análise multivariada. **Revista Ciência Agronômica**, 48: 101-109, 2017.

TANG, D. et al. Metabolomic analysis of the polyphenols in germinating mung beans (*Vigna radiata*) seeds and sprouts. **Journal of the Science of Food and Agriculture**, 94: 1639-1647, 2014.

VIEIRA, R. F.; VIEIRA, C.; VIEIRA, R. F. **Leguminosas graníferas**. Viçosa, MG: UFV, 2001.

WIN, K. et al. Genotype by environment interaction and stability analysis of seed yield, agronomic characters in mungbean (*Vigna radiata* L. wilczek) genotypes. **International Journal of Advanced Research**, 6: 926-934, 2018.

YEASMIN, R. et al. Effect of Genotype and Density on the Productivity of Mungbean. **Bangladesh Agronomy Journal**, 19: 11-17, 2016.

ZILIO, M. et al. Contribuição dos componentes de rendimento na produtividade de genótipos crioulos de feijão (Phaseolus vulgaris L.). **Revista Ciência Agronômica**, 42: 429-438, 2011.