Evaluation of genetic parameters and morphoagronomic characterization of sunflower in brazilian savanna environments of Distrito Federal

Avaliação de parâmetros genéticos e caracterização morfopatológica do girassol em ambientes de cerrado do Distrito Federal

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Renato Fernando Amabile
Doutor em Agronomia pela UnB.
Instituição: Embrapa Cerrados.
Endereço: BR - 020, km - 18, Brasília, DF. CEP: 73.310-970.
E-mail: renato.amabile@embrapa.br

Pedro Ivo Aquino Leite Sala
Mestre em Agronomia pela UnB.
Instituição: Universidade de Brasília/Embrapa Café.
Endereço: Campus Universitário Darcy Ribeiro - ICC Centro - Faculdade de Agronomia e Medicina Veterinária, Brasília, DF. CEP: 70.910-900.
E-mail: pedroivo.sala@gmail.com

Ricardo Meneses Sayd
Doutor em Agronomia pela UnB.
Instituição: Centro Universitário Icesp.
Endereço: QS 05, Rua 300, Lote 01, Águas Claras, DF. CEP: 71.961-540.
E-mail: ricardo_sayd@hotmail.com

Felipe Augusto Alves Brige
Mestre em Agronomia pela UnB.
Instituição: Centro Universitário Icesp.
Endereço: QS 05, Rua 300, Lote 01, Águas Claras, DF. CEP: 71.961-540.
E-mail: felipebrige@gmail.com

Ana Paula Leite Montalvão
Mestre em Crop Protection pela Universität Göttingen.
Instituição: Thünen-institut for Forest Genetics.
Endereço: Sieker Landstraße 2, 22927 Großhansdorf, Alemanha.
E-mail: ana.montalvao@thuenen.de

Claudio Guilherme Portela de Carvalho
Doutor em Agronomia pela Universidade Federal de Viçosa.
Instituição: Embrapa Soja.
Endereço: Caixa Postal 231, Londrina, PR. CEP: 86001-970.
E-mail: portela.carvalho@embrapa.br

João Victor Pinheiro Melo
Graduando em Agronomia pela UnB.
Instituição: Universidade de Brasília.

Endereço: Campus Darcy Ribeiro - ICC Sul, Faculdade de Agronomia e Medicina Veterinária, Asa Norte, Brasília, DF. CEP: 70.910-900.
E-mail: joaovictormelo29@gmail.com

Marcelo Fagioli
Doutor em Agronomia pela UNESP-Jaboticabal.
Instituição: Universidade de Brasília.
Endereço: Campus Darcy Ribeiro - ICC Sul, Faculdade de Agronomia e Medicina Veterinária, Asa Norte, Brasília, DF. CEP: 70.910-900.
E-mail: mfagioli@unb.br

ABSTRACT
The purpose of this study was to assess genetic, phenotypic and environmental characteristics related to agro-morphological traits of sunflower in three rural centers of Distrito Federal. The experiments were conduced at the experimental areas of Embrapa Cerrados, Planaltina, DF, Embrapa Cerrados - Centro de Inovação e Genética Vegetal (CIGV), Riacho Fundo II, DF, and at Fazenda Água Limpa, of Universidade de Brasília. Through the obtained results, were verified significate genotypic differences of sunflower at the three rural centers of Brazilian Savanna for all traits evaluated. In addition, low coefficients of environmental variation for almost all trait, except the days of initial flowering, indicate good experimental precision and high values of heritability, genetic variation and accuracy showed favorable conditions to selecting materials for the agronomic traits evaluated.

Keywords: Agronomic traits, Genetic diversity, Brazilian Savanna, *Helianthus annuus* L.

RESUMO
O objetivo deste estudo foi avaliar características genéticas, fenotípicas e ambientais relacionadas a características agromorfológicas do girassol em três centros rurais do Distrito Federal. Os experimentos foram realizados nas áreas experimentais da Embrapa Cerrados, Planaltina, DF, Embrapa Cerrados - Centro de Inovação e Genética Vegetal (CIGV), Riacho Fundo II, DF, e na Fazenda Água Limpa, da Universidade de Brasília. Através dos resultados obtidos, foram verificadas diferenças genotípicas significativas do girassol nos três centros rurais da savana brasileira para todos os traços avaliados. Além disso, baixos coeficientes de variação ambiental para quase todas as características, exceto os dias de floração inicial, indicam boa precisão experimental e altos valores de herdabilidade, variação genética e precisão.

Palavras-chave: Tratos agronômicos, Cerrado, *Helianthus annuus* L.

1 INTRODUCTION

Sunflower (*Helianthus annuus* L.) is a plant native to the Americas with great adaptability to different environments and great importance in the world economy. It is an oleaginous plant that presents important agronomic characteristics, such as greater resistance to drought, cold and heat than most species normally grown in Brazil (Leite et al., 2005). With wide adaptation to soil and climate conditions, sunflower has been studied both for its morphoagronomic characteristics and the evaluation of genetic parameters. Materials adapted to the growing conditions are indispensable

for the success of sunflower breeding programs (Lira et al., 2021). The objective of this work was to estimate genetic, phenotypic and environmental characters related to production components and agromorphological characters of sunflower in three rural nuclei of the Federal District.

2 MATERIALS AND METHODS

The trials were conducted in three rural centers in the Federal District. The first was conducted in the experimental field of Embrapa Cerrados (CPAC), Planaltina, DF, located at 15°35'30" South latitude, 47°42'30" West longitude and altitude of 1. 007 m and sown on February 23, 2016; the second was in the experimental area of Embrapa Cerrados (CIGV), Riacho Fundo II, DF, located at 15º54'53" South latitude and 48º02'14" West longitude, at an altitude of 1. 254 m, and sown on February 2, 2016; the third at the Experimental Farm and Ecological Station of the University of Brasília (UnB), Fazenda Água Limpa (FAL), DF, located at 15º56'00" South latitude, 47º55'00" West longitude and average altitude of 1100 m, sown on February 19, 2016.

The following agronomic characters were evaluated: 1. grain yield - REND (kg ha^{-1}); 2. capitulum size - TC (cm); 3. weight of a thousand achenes - PMA (g); 4. plant height - ALT (cm); 5. days of initial flowering - DFI (days). The data obtained were submitted to variance analysis and the means were grouped by the Scott-Knott test at 5% significance level. The experimental variation coefficient (CV_e), genetic variation coefficient (CV_g) and the relative correlation coefficient (CV_r) were estimated for each of the characteristics using the Genes program (Cruz, 2007).

3 RESULTS AND DISCUSSION

The estimation of genetic parameters is essential in the quantification of the magnitude of variability and the extent to which desirable traits are inherited, in order to carry out planning with a view to promoting the advancement of an efficient breeding program (Vencovsky and Barriga, 1992).

Through the relationship between genetic and phenotypic variances, it is possible to estimate the heritability and accuracy, which quantify the precision in inferences of genotypic means from phenotypic means (Resende and Duarte, 2007).

High values of heritability and coefficient of genetic variation (CV_g) are crucial for an effective inference of the genotypic value of genetic material from phenotypic evaluations (Resende, 2002). In the three environments evaluated, except for the characteristic of chapter size and height, the heritability (h^2_a) in the broad sense, for the other characters evaluated, was greater than 90%, indicating a predictive correspondence between the phenotypic value and genetic value, as stated by Falconer and Mackay (1996). Thus, it is assumed that, under Brazilian Savanna conditions, there

was efficient control of environmental variation, better expression of genetic differences and, therefore, greater heritability.

The coefficient of genetic variation (CV_g) is a parameter that allows deducing the magnitude of genetic variability present in populations and in different characters (Resende, 2002). The characteristics that have coefficients of genetic variation (CV_g) higher than the environmental (Cv_e), in general, have greater possibilities for genetic gains, and thus are more favorable for improvement. In the three environments evaluated, the characteristic of chapter size all presented CV_g greater than CV_e, therefore indicating a favorable condition for phenotypic selection for all characters.

According to Resende and Duarte (2007), the accuracy for the analyzed characters, in all environments, can be considered very high for all yield characteristics, weight of one thousand achenes, height and days to initial flowering. For capitulum size, at Fazenda Água Limpa (82.9%), it was considered high.

In general, the experiments presented adequate experimental precision. Based on the F value, the experimental precision was considered appropriate for genotypic evaluation trials, since the values obtained were higher than 2.0, as prescribed by Resende and Duarte (2007). The F values found in the trial at Embrapa Cerrados (CPAC) ranged from 5.3 to 64.6, at Embrapa Cerrados (CIGV - Fazenda Sucupira) it ranged from 8.1 to 148.6, and at Fazenda Água Limpa, it ranged from 3.2 to 73.8.

One should consider the particularities of the crop being evaluated and the character being analyzed to better understand the results of the environmental coefficients of variation (CV_e). It is a characteristic in which the environment has great influence and the values of small magnitude show adequate experimental accuracy. In the three environments evaluated, the flowering days trait was the only one to present a CV_g lower than the CV_e, therefore indicating a condition not very favorable for phenotypic selection for this trait. In the Embrapa Cerrados (CPAC) trials, the CV_e values varied from 1.49 for DFI to 4.78 for ALT. At Embrapa Cerrados (CIGV - Fazenda Sucupira) it ranged from 1.07 for DFI to 6.19 for CT. Finally, at Fazenda Água Limpa the variation was 2.85 for DFI to 5.07 for capitulum size.

4 CONCLUSIONS

Significant differences were found for all agronomic traits evaluated among sunflower genotypes in the three rural centers of the Brazilian Savanna. Low environmental variation coefficients were observed for all characteristics, except for DFI, indicating good experimental accuracy and high values of heritability, genetic variation coefficients and accuracy showed favorable conditions for the selection of materials for the agronomic characteristics evaluated.

Table 1. F values for joint analysis of 6 sunflower genotypes in CPAC, SPM and FAL environments, DF.

	F-Values				
	REND	**TC**	**PMA**	**ALT**	**DFI**
Trat	2.316	6.061	21.306	53.292	28.241
Amb	1351.202	24.848	11.312	15.368	109.770
G x A	24.707	10.322	63.443	31.749	12.308

Table 2. Mean squares of genotypes (QMg) and error (QMe), F value and estimates of phenotypic variance at mean (σ_f^2), genotypic (σ_g^2) and environmental (σ_e^2) levels, heritability at mean (h^2_a), coefficients of experimental variation (CV_e) and genetic (CV_g), CV_r ratio and accuracy ( ) of each character evaluated $\hat{r}_{\hat{g}g}$ in sunflower genotypes. Embrapa Cerrados, Planaltina, DF.

	REND (kg ha^{-1})	**TC (cm)**	**PMA (g)**	**ALT (cm)**	**DFI (days)**
QMg	1102625.442	5.867	630.018	238.542	44.742
QMe	49035.353	0.778	9.748	0.005	0.831
F	22.486	7.543	64.631	5.341	53.870
σ_f^2	275656.360	1.467	157.505	0.006	11.185
σ_g^2	263397.522	1.272	155.068	0.005	10.978
σ_e^2	12258.838	0.194	2.437	0.001	0.208
h^2 (%)	95.553	86.742	98.453	81.275	98.144
CV_e (%)	4.279	4.789	4.201	3.709	1.499
CV_g (%)	9.918	6.125	16.755	3.863	5.450
CV_r (%)	2.318	1.279	3.988	1.042	3.636
$\hat{r}_{\hat{g}g}$	0.978	0.931	0.992	0.902	0.991
Mean	5174.458	18.417	74.321	1.802	60.792

Table 3. Mean squares of genotypes (QMg) and error (QMe), F value and estimates of phenotypic variance at mean level (σ_f^2), genotypic (σ_g^2) and environmental variance (σ_e^2), heritability at mean level (h^2_a), coefficients of experimental variation (CV_e) and genetic variation (CV_g), CV_r ratio and accuracy ( ) of each character evaluated in sunflower genotypes. Embrapa Cerrados (CIGV - Fazenda Sucupira), Riacho Fundo II, DF.

	REND (kg ha^{-1})	**TC (cm)**	**PMA (g)**	**ALT (cm)**	**DFI (days)**
QMg	427230.567	8.700	293.695	1371.667	29.267
QMe	4393.144	1.078	1.977	0.003	0.444
F	97.249	8.072	148.575	49.341	65.850
σ_f^2	106807.642	2.175	73.424	0.034	7.317
σ_g^2	105709.356	1.906	72.930	0.034	7.206
σ_e^2	1098.286	0.269	0.494	0.001	0.111
h^2 (%)	98.972	87.612	99.327	97.973	98.481
CV_e (%)	2.116	6.198	1.921	2.733	1.074
CV_g (%)	10.378	8.241	11.669	9.501	4.324
CV_r (%)	4.905	1.330	6.074	3.476	4.027
$\hat{r}_{\hat{g}g}$	0.995	0.936	0.997	0.990	0.992
Mean	3132.917	16.750	73.188	1.929	62.083

Table 4. Mean squares of genotypes (QMg) and error (QMe), F value and estimates of phenotypic variance at mlevel (σ_f^2), genotypic (σ_g^2) and environmental variance (σ_e^2), heritability at mean level (h^2_a), coefficients of experimental variation (CV_e) and genetic variation (CV_g), CV_r ratio and accuracy ( ) of each character evaluated in sunflower genotypes. Fazenda Água Limpa, UnB, DF.

	REND (kg ha^{-1})	TC (cm)	PMA (g)	ALT (cm)	DFI (days)
QMg	7441.33	9.667	71.930	2558.542	11.442
QMe	13505.033	0.867	8.431	0.004	3.575
F	15.136	11.154	8.532	73.804	3.201
σ_f^2	51104.292	2.417	17.982	0.064	2.860
σ_g^2	47728.033	2.200	15.875	0.063	0.894
σ_e^2	3376.258	0.217	2.108	0.001	1.967
h^2 (%)	93.393	91.035	88.279	98.645	68.755
CV_e (%)	2.968	5.078	4.202	3.165	2.856
CV_g (%)	5.579	8.090	5.765	13.502	2.118
CV_r (%)	1.880	1.593	1.372	4.266	0.742
$\hat{r}_{\hat{g}g}$	0.966	0.954	0.940	0.993	0.829
Mean	3915.667	18.333	69.108	1.860	66.208

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