English Version

Genetic variability among soybean cultivars, under different edaphoclimatic conditions, in center south region of the state of Tocantins

Joênes Mucci Peluzio[1], Aurélio Vaz-de-Melo[2], Flávio Sérgio Afférri[2], Rubens Ribeiro Silva[2], Hélio Bandeira Barros[2], Ildon Rodrigues Nascimento[2], Rodrigo Ribeiro Fidelis[2]

Abstract

In order to evaluate the genetic divergence between twelve soybean cultivars, the essays were carried out at Formoso do Araguaia, TO, in the inter-cropping 2007. The soybean cultivars studied were DM Vitória, MG/BR 46 (Conquista), Suprema, BRS Pintado, DM 247, BRS MG 68, BRS MG Liderança, BRS MG Segurança, DM 339, BRS MG Garantia, A 7002 e DM 309. Genetic divergence was evaluated by multivariate procedures: generalized Mahalanobis distance, the grouping optimization method of Tocher, nearest neighbor and the technique of canonical variables. It was evaluated the following characteristics: grain production per plant, number of seeds per pod, number of pods per plant, number of days for blooming; number of days for maturation, plant height and height of first pod insertion. The methods of optimization of Tocher, nearest neighbor and graphic dispersion of the canonical variables were consistent with each other. The characteristics number of days for the maturation (39.49%), weigh of 100 seeds (26.56%) and number of days for flowering (13.59%) were the ones that more contributed to the genetic dissimilarity among the twelve cultivate tested. The presence of genetic variability allowed the identification of dissimilar cultivars and with high average for the studied characteristics. The hybrids BRSMG Garantia x DM 339 and BRSMG Garantia x MG/BR 46 (Conquista) are promising for obtaining segregating populations with superior variability.

Key-Words: Genetic diversity; Glycine max; Tocantins State

Introduction

Soybean [*Glycine max* (L.) Merril] is native to the temperate regions of China, and has wide adaptation to the subtropical and tropical climates. It is considered one of the most important legumes in function of the great economic interest coming from the contents of protein (40%) and oil (20%) of the grains and culture productivity (SEDIYAMA et al., 2009).

In the state of Tocantins, soybean is the third culture in terms of participation in the crude value of production, being cultivated in the period of inter-cropping (May-June), in conditions of irrigated lowland, under the regime of sub-irrigation (raise of the water table), mainly in Formoso do Araguaia, and in the crop period (November-December), in conditions of highlands. However, few studies aiming to quantify the phonotypical divergence between genotypes have been performed in this period.

According to Costa et al. (2004), the programs of genetic improvement of soybean are essential to attend the increasing demand for greater productivity, enabling an increase in variability and consequent enlargement of the genetic bases, besides the selection of the best genotypes of a population capable of surpass the standards of grain productivity.

The success of a breeding program relies on the existence of variability in the population. In the breeding programs, the intercross between superior and divergent cultivars have been used to form the base-populations (CEOLIN et al., 2007; CRUZ, 2007). The multiple information of each cultivar is express in measures of dissimilarity, which represent the diversity that there is in the set of cultivated accesses (CRUZ, 2007).

In the study of the genetic diversity of a population, it is used agronomic, morphologic and molecular characteristics which, by their turn, are submitted to multivariate biometric techniques, enabling to unify multiple information of a set of characters (RODRIGUES et al., 2002, CRUZ et

1 Universidade Federal do Tocantins. E-mail: joenesp@uft.edu.br. Author for correspondence.

2 Universidade Federal do Tocantins. E-mail: vazdemelo@uft.edu.br; flavio@uft.edu.br; rrs2002@uft.edu.br; barroshb@uft.edu.br; ildon@uft.edu.br; fidelisrr@uft.edu.br

al., 2004).

The present work had as objective to quantify the genetic variability of the soybean cultivars, promote the grouping of these cultivars in function of the genetic dissimilarity and score dispersion, indicate the relative contribution of the characteristics in the genetic dissimilarity and identify the promising superior hybrid combinations in the selection of progenies.

Material and methods

The experiments were installed in the Experimental Fields of the Federal University of Tocantins – UFT, located in the cities of Palmas, state of Tocantins, at 10° 10' 37" of south latitude, 48° 21' 27" of west longitude and altitude of 212 meters of the sea level, and the soil is Latossolo Vermelho-Amarelo distrófico[1], sandy texture (EMBRAPA 2006) and Gurupi – TO, at 11° 43' of south latitude, 49° 15' of west longitude and altitude of 287 meters of the sea level, in soil of the typo Latossolo Vermelho-Amarelo distrófico[1], sandy texture (EMBRAPA 2006). Seeding was performed in November 30th, 2007 in the first period in Palmas and in December 20th in the second period. In Gurupi, planting was performed in November 28th, 2007 in the first period, in December 15th, 2007 in the second period, and January 5th, 2009 in the third period.

The chemical characteristics of the soil, sampled at the depth of 0-20 cm, in the municipality of Gurupi-TO were: 0.0 of Al^{+++} ($mmol_c\ dm^{-3}$); 2.1 of Ca^{++} ($mmol_c\ dm^{-3}$); 0.6 of Mg^{++} ($mmol_c\ dm^{-3}$); 0.0 of K^{+} ($mg\ dm^{-3}$)[1]; 3.7 of P ($mg\ dm^{-3}$) and 5.9 of pH (H_2O) and in the municipality of Palmas-TO they were: 0.0 of Al^{+++} ($mmol_c\ dm^{-3}$); 2.3 of Ca^{++} ($mmol_c\ dm^{-3}$); 1.2 of Mg^{++} ($mmol_c\ dm^{-3}$); 60.0 of K^{+} ($mg\ dm^{-3}$)[1]; 8.4 of P ($mg\ dm^{-3}$) and 6.0 of pH (H_2O).

The experiment design used was randomized blocks, with 14 treatments and three replications in five environments. The treatments constituted in the cultivars M9144RR, ENGOPA-314, P98Y51, P99R01, M8867RR, MSOY-9056, M8527RR, M8360RR, MSOY-9350, TMG108RR, MS – 8925, MS – 8849, MS – 8787 e P98R62.

The experimental plot was composed by four rows with the length of 5.0 m, spaced by 0.45 m. In the harvest, it was despised 0.50 m of the end of each center row. The useful area of the parcel was represented by the two central rows, which constitute 3.6 m^2.

It was performed the operations of ploughing, harrowing and furrowing. The fertilization performed was 400 kg ha^{-1} of fertilizer 05-25-15. It was also performed the cover fertilization with Potassium chloride 90 kg ha^{-1}. In the moment of the planting, it was performed the inoculation of the seeds with strains of *Bradyrhizobium japonicum*, aiming to obtain a good nodulation of the plant roots, guaranteeing the supply of nitrog to the culture.

When it achieved third definitive trefoil, V3 stage according to Fehr et al. (1977), it was conducted the application of herbicides: graminicide (Targa 1,2 L ha^{-1}) and broadleaf herbicide (Cobra, 400 ml ha^{-1} and Classic 40 g ha^{-1}), both referent to the soybean culture.

In the plague control, it was used the insecticide Decis in the dosage of 0.6 L ha^{-1}, and the first application was conducted 20 days after the emergence and there was biweekly applications by the beginning of the flowering.

The plants from each experimental plot were harvested one week after they presented 95% of mature pods, i.e., in the R8 stage of the scale by Fehr et at. (1971). After the harvest, the plants were trilled and the seeds weighted, after being dried (12% of humidity) and cleaned to determine grain productivity.

Based on the useful area of the parcel, it was obtained the following agronomic characteristics of the plant: plant height, height of first pod insertion, both performed in five plants per plot; number of days to flowering; number of days to maturation; number of pods per plant (in five plants per plot); number of seeds per pod (mean of seeds per pod of all the pods from five plants per plot); weight of 100 seeds; grain productivity.

It was conducted the individual analysis of variance and later the joint, since the higher mean square of the residue divided by the lower was inferior to seven, presenting thus homogeneity of variance and being possible to perform the joint analysis. The

1 Brazilian soil classification system

measures of dissimilarity were determined according to the model of multivaried analysis, which enabled the obtaining of the dissimilarity matrix, the residual covariance matrix and the average of the cultivars.

Later, it was determined the canonic variables, according to what was reported by Rao (1952). The canonic variables were used in the study of the genetic dissimilarity aiming to identify similar genotypes in tridimensional scatter plots. In this study, the first three canonic variables involved more 80% of the total genotype variation and each variable was a linear combination of the original variables. It was applied the methods of grouping by Tocher (RAO, 1952) and nearest neighbor (JOHNSON and WICHERN, 1992; CRUZ et al., 2004),, the generalized distance of Mahalanobis (D^2), as measure of dissimilarity. It was used, also, the criterion of Singh (1981) to quantify the relative contribution of these characteristics on the genetic divergence. The analyses were performed using the computer program Genes, version 2006 (CRUZ, 2007).

Results and discussion

In the results of the analysis of variance it is verified a significant ($p \leq 0,01$) effect in all the characteristics in the interaction between cultivars and environments (seeding place and period), indicating that the effects of the cultivars and environments alone do not explain all the variations found, being performed, in this case, the decomposition (Table 1). Regarding to environments and cultivars alone it was also verified significant ($p \leq 0,01$) effect in all the characteristics, which indicated the existence of genetic variability and, consequently, the possibility of obtaining genetic gains. Thus, the analyses of genetic divergence and the data were grouped based on the interaction of cultivars with environments. Most of the coefficients of variation of the characteristics were lower than 15%, showing a good experimental accuracy in the conduction of the experiment (SCAPIN et al., 1995).

The cultivars did not differ concerning plant height and first pod insertion, independent on the planting environments (planting place and period). The plant height of the cultivars ranged from 12.7 to 15.9 cm (Table 2).

Usually, one aims to obtain cultivars with height of first pod insertion ranging from 10 to 15 cm and plant height ranging from 60 to 80 cm, since there is a tendency of higher plants (PH) and with lower height of first pod (HPI) present a lower number of pods, as it was observed by Miranda (1998). It must be emphasized, however, that the selection of high plants (> 80 cm) and with low height of first pod (< 10 cm) may cause losses in the mechanized harvest. In the present study, all cultivars presented ideal height of first pod insertion and plant height satisfactory to the mechanical harvest.

Cultivars M9144RR (46 days), MSOY-9056 (46 days), MSOY-9350 (46 days), TMG108RR (46 days), M8925RR (46 days) presented later flowering without, though, differ ($p \leq 0,05$) from the cultivars which had the flowering after 45 days. Cultivar

Table 1. Summary of the analysis of joint variance analysis, in random blocks, from characteristics evaluated in 14 commercial soybean cultivars in experiments conducted in different places and periods of seeding in the cities of Gurupi and Palmas – TO in the crop 2007/08.

F.V.	GL	Mean square							
		NDF	NDM	HPI	PH	NPP	NSP	WHS	PROD
BLOCK/AMB	10	3.2	10.7	11.9	16.5	2.55	0.006	1.15	1300632
CULTIVARS (C)	13	23**	66.7**	9.6**	109**	1045**	0.06**	11.1^{ns}	992212**
ENVIRONMENTS (E)	3	177**	388.9**	149**	2612**	2196**	1.43**	165.4**	70429703**
C x E	39	3.7**	15.9**	16.4**	119**	48**	0.08**	8.24**	919776**
RESIDUE	104	1.02	7.5	4.3	14.1	2.92	0.007	0.83	61629
Mean		44.8	116	14.3	57.9	51.3	2.09	14.1	2735
CV (%)		2.26	2.35	14.5	6.4	3.3	3.96	6.5	9.07

***, * significant by the F testa t 1 and 5%, respectively; ^{ns} – non significant by F test at 5%. NDF: number of days to flowering; NDM: Number of days to maturation; HPI: Height of first pod insertion; PH: Plant height; NPP: Number of pods per plant; NSV: Number of seeds per pod; WHS: Weight of 100 seeds; PROD: Production per plant (kg ha^{-1}).*

M8360RR (41 days) was the earliest, differing from the other cultivars.

M8360RR (110 days) presented the smallest cycle, followed by M9144RR (115 days), followed by cultivars M9144RR (115 days), M8527RR (113 days), M8849RR (115 days), MSOY-9350 (115 days) and M9144RR (110 days) which did not differ from each other (Table 2).

The highest number of pods per plant (NPP) was obtained by cultivar P99R01 (74), differing ($p \leq 0,05$) from the other cultivars. The NPP ranged from 41 to 74 (Table 2). Some authors, among them Pinchinat and Adams (1996) and Board et al., (1997), verified that the number of pods per plant is the chatacter which contributed the most the grain yield in legumes, since it presents the highest correlations with the grain production and pods with 1, 2 and 3 grains, which may influence in the size of the seeds that will be produced and, consequently, in productivity.

Cultivar M8849RR (2.2 seeds per pod) obtained the largest number of seeds per pod (NSP), which did not differ ($p \leq 0,05$) from the cultivars which obtained values above two. The NPP ranged from 2.0 to 2.2 seeds per pod (Table 2).

The cultivars which obtained weight of a hundred seeds above 13.8 g were classified in the group with higher averages, which was superior ($p \leq 0,05$) to the one with lower average. The averages of WHS ranged from 12.1 to 14.9 g (Table 2). The WHS is an important characteristic in the choice of the cultivar to be planted, since the acquisition of seeds of lower weight will result in a lower cost of production per area, facing the larger number of seeds per commercialized unit and, also, in larger speed in the processes of germination and emergence.

The grain productivity (PROD) enabled the separation of the cultivars in two groups. Cultivars M9144RR (3211 kg ha^{-1}), P99R01 (3083 kg ha^{-1}), EMGOPA-314 (3057 kg ha^{-1}), M8527RR (3033 kg ha^{-1}), M8849RR (2845 kg ha^{-1}) and MSOY-9056 (2799 kg ha^{-1}) presented the highest averages of PROD, differing ($p \leq 0,05$) from the other cultivar with inferior averages. The averages of PROD ranged from 3211 to 2239 kg ha^{-1} (Table 2).

The measures of genetic dissimilarity, estimated by the distance of Mahalanobis (Table 3), presented an elevated magnitude (3.5 to 440.0), indicating the presence of wide genetic variability among cultivars. The combination between P99R01

Table 2. Overall averages of plant height (PH) and first por insertion (HPI), flowering (FLO), maturation (MAT), number of pods per plant (NPP), number of seeds per pod (NSP), weight of 100 seeds (WHS) and grain productivity (PROD) of soybean cultivars of the experiments conducted in different seeding places and periods in the cities of Gurupi and Palmas – TO in the crop 2007/08.

CULTIVARS	PH (cm)		HPI (cm)		FLO (days)		MAT (days)		NPP		NSP		WHS (g)		PROD (Kg ha^{-1})	
M9144RR	56.5	a	14.6	a	46	a	115	b	56	c	2.1	a	14.9	A	3211	a
P99R01	56.2	a	13.7	a	44	b	118	a	74	a	2.0	b	12.7	B	3083	a
ENGOPA-314	63.7	a	13.8	a	45	a	118	a	53	d	2.1	a	12.1	B	3057	a
M8527RR	52.3	a	14.4	a	43	b	113	b	49	e	2.0	b	14.8	A	3033	a
MS - 8849	55.4	a	15.5	a	45	a	115	b	41	g	2.2	a	14.9	A	2845	a
MSOY-9056	59.9	a	14.9	a	46	a	116	a	54	c	2.0	b	14.4	A	2799	a
MSOY-9350	57.7	a	13.0	a	46	a	115	b	64	b	2.0	b	14.4	a	2726	b
TMG108RR	61.0	a	15.9	a	46	a	117	a	55	c	2.1	a	14.3	a	2685	b
P98Y51	58.2	a	14.8	a	44	a	117	a	52	d	2.0	b	14.2	a	2644	b
MSoy - 8925	59.1	a	15.1	a	46	a	118	a	41	g	2.0	b	13.8	a	2625	b
M8360RR	58.1	a	14.2	a	41	c	110	b	41	g	2.2	a	15.2	a	2498	b
P98R62	53.1	a	14.3	a	45	a	118	a	50	e	2.2	a	14.8	a	2425	b
MSoy - 8787	59.6	a	12.7	a	45	a	118	a	46	f	2.1	a	14.9	a	2422	b
M8867RR	59.1	a	13.9	a	44	b	118	a	45	f	2.1	a	12.8	b	2239	b
AVERAGE	57.9		14.3		45		116		51		2.1		14.1		2735	

Group of averages followed by the same lowercase letter in the column do not differ from each other, at 5% of probability, by Scott and Knott. Palmas – TO, planting in 11/30/08; Palmas – TO, planting in 12/20/08; Gurupi – TO. Plating in 11/28/08; Gurupi – TO, planting in 12/15/08.

Table 3. Dissimilarity among soybean cultivars in relation to seven characteristics, based on the generalized distance of Mahalanobis ($D^2_{ii'}$)

CULTIVARS	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	P98R62 (14)
M9144RR (1)	21.0	15.4	129.7	67.0	6.2	42.2	130.3	25.2	8.6	96.9	80.8	50.2	24.2
ENGOPA-314 (2)		12.1	171.1	32.9	12.7	39.2	101.7	56.2	16.0	64.4	63.0	35.8	28.9
P98Y51 (3)			185.5	21.0	4.7	19.1	71.8	51.1	9.2	49.3	43.3	17.0	8.4
P99R01 (4)				309.3	153.1	256.4	440.0	54.3	147.8	418.0	391.8	305.3	221.9
M8867RR (5)					41.1	32.2	40.1	129.9	45.5	16.9	20.4	9.2	21.9
MSOY-9056 (6)						33.7	106.8	31.3	3.5	69.7	65.5	29.8	14.8
M8527RR (7)							38.4	99.7	50.7	46.6	35.3	29.0	33.5
M8360RR (8)								221.3	122.0	44.4	29.6	45.3	78.4
MSOY-9350 (9)									32.3	191.9	179.3	114.3	70.3
TMG108RR (10)										78.8	70.8	35.4	13.5
MSoy – 8925 (11)											10.3	14.8	43.5
MSoy – 8849 (12)												16.1	33.4
MSoy – 8787 (13)													13.5

and M8360RR was the most divergent (D^2 = 440.0), followed by the combination P99R01 and M8925RR (D^2 = 418.0). The lower distance was obtained between cultivars M9056RR and TMG108RR (D^2 = 3.5), followed by the combination M9056RR and P98Y51 (D^2 = 4.7) and M9056RR and M9144RR (D^2 = 6.2).

The analysis of grouping by the method of Tocher separated the 14 cultivars in three groups (Table 4). Group 1 was constituted by 11 cultivars genetically similar (78.57%) of the total of the cultivars, indicating that the possible breeding of these cultivars with each others reduce the possibility of obtaining superior genotypes. Cultivar M8360RR was alone in group II and P99R01 and MSOY-9350 in group II. The formation of these groups is of major importance in the choice of the parents, since the new hybrid combinations to be established must be based in the magnitude of their dissimilarity and in the potential per se of the genitors (CRUZ et al., 2004). The cultivars in more distant groups are dissimilar, and may be considered promising in artificial breeding. However, besides dissimilarity, it is necessary that the genitors associate high average and variability in the characteristics being improved. Thus, the distance of the cultivar M8360RR, in relation to the others of the group I, mainly with P99R01, suggest that they can provide high heterotic effect after the hybridizations.

Cruz et al. (2004) suggest the non involvement of individuals of the same pattern of dissimilarity in breeding, so that there is no restriction in genetic variability and, thus, negative effects in the gains to be obtained by the selection are avoided. According

Table 4. Grouping by Tocher method, based on the generalized distance of Mahalanobis of 21 soybean cultivars, considering plant height and first pod insertion; flowering; maturation; number of pods per plant and seeds per pod; weight of a hunded seeds and grain productivity of soybean cultivars of the experiments conducted in different places and periods of seeding in the cities of Gurupi and Palmas – TO in the crop 2007/08

Group	Cultivars
I	6; 10; 3; 1; 14; 2; 13; 5; 7; 12; 11
II	4; 9
III	8

1 (M9144RR). 2 (ENGOPA-314). 3 (P98Y51). 4 (P99R01). 5 (M8867RR). 6 (MSOY-9056). 7 (M8527RR). 8 (M8360RR). 9(MSOY-9350). 10 (TMG108RR). 11 (MS – 8925). 12 (MS – 8849). 13 (MS – 8787). 14 (P98R62).

to what was reported by Carpentieri-Pípolo et al. (2000) the best hybrid combinations to be tested in breeding programs should involve both divergent parents and parents with high average performance. According to Vieira et al. (2007), the establishment of groups with genotypes with homogeneity inside and heterogeneity outside the groups is the start point of a detailed evaluation of them, aiming to perform its improvement in breeding programs.

The relative contribution of each characteristic in the genetic dissimilarity, according to the method of Singh (1981), showed that one of these characteristic contributed with 80.27% of the genetic divergence, while the others contributed with only 19.67% (Table 5). The number of pods per plant (80.27%) was the most efficient in explaining the dissimilarity between cultivars, and must be priority in the choice of progenies in breeding programs.

The number of days to flowering (FLO), even tough it presented low variability (41 to 46 cm) (Table 2), was the second in importance in the study of divergence. The grain productivity (PROD), for its turn, contributed little in the divergence, with approximately 3.74%, even presenting great variability (2239 to 3211 kg ha^{-1}) (Table 2). However, this characteristic is of main importance in breeding, since in the selection of genitors with highest averages of productivity in the breeding it provide higher probability of obtaining elite lines.

The criterion of grouping adopted by the hierarchical method of the nearest neighbor establishes that firstly a group of similar cultivars is formatted, and the distance of the others is calculated in relation to the groups formed (CRUZ e REGAZZI, 2004). Trough this technique, the combination of the cultivars M9056RR and TMG108RR had the smallest difference (D^2 = 3.5), and the largest difference was attributed to the cultivars P99R01 and M8360RR (D^2 = 440.0), being this considered the measure 100% of distance to establish the dendogram. In the axe x it was represented the percentages of the distances between cultivars and in the axe y it was represented the 14 cultivars. By this method, it was possible to observe the formation of three distinct groups, which were almost identical to the groups formed by the Tocher method (Table 4), with the exception of P99R01 (4), which were with MSOY-9350 in an isolated group and in this method was grouped with the cultivars in group number I (Figure 1).

It can be verified, in Table 6, that since the two first canonical variables can explain more than 80% in the total variance contained in the set of characteristics (90.26% of the total variance accumulated), it is possible to explain satisfactorily the variability manifested among the cultivars and, this, interpret the phenomenon with considerable simplification, trough a two-dimensional graphic representation (CRUZ et al.. 2007), which can be seen in Figure 2. The graphic distortion enabled to interfere over the pattern of dissimilarity of the cultivars and separated the cultivars in six groups, partially agreeing with the results obtained by the Tocher method and the hierarchic method of the

Table 5. Contribution in % relative to plant height and first pod insertion; flowering; maturation; number of pods per plant and seeds per pod; weight of a hundred seeds and grain productivity of 21 soybean cultivars, in decreasing order of importance, in experiments conduced in different seeding places and periods in the citied of Gurupi and Palmas – TO in the crop 2007/08

Characteristics	S.J	Value in %
Plant height (cm)	112.62	1.60
Height of first pod insertion (cm)	39.19	0.56
Number of days to flowering (days)	484.84	6.91
Number of days to maturation (days)	206.14	2.94
Number of pods per plant	5652.34	80.17
Number of seeds per pod	81.67	1.16
Weight of 100 seeds (grams) Peso de 100 sementes (gramas)	203.79	2.90
Grain productivity (kg ha^{-1})	262.35	3.74

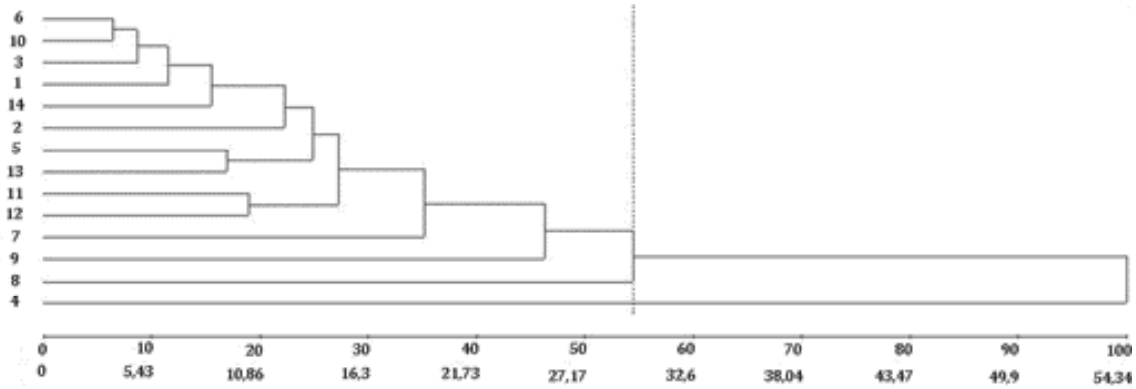

Figure 1. Representative dendrogram of the genetic dissimilarity among the 14 soybean cultivars, obtained by the technique of the nearest neighbor, using the generalized distance of Mahalanobis as a measure of dissimilarity. The experiments were conducted in different seeding places and periods in the cities of Gurupi and Palmas – TO in the crop 2007/08. Cultivars: 1 (M9144RR). 2 (ENGOPA-314). 3 (P98Y51). 4 (P99R01). 5 (M8867RR). 6 (MSOY-9056). 7 (M8527RR). 8 (M8360RR). 9(MSOY-9350). 10 (TMG108RR). 11 (MS – 8925). 12 (MS – 8849). 13 (MS – 8787). 14 (P98R62).

nearest neighbor, as it continues to maintain cultivars M8360RR and P99R01 isolated, as in the hierarchic method and the first one as in the Tocher method. However, the largest difference was in the division of the group I of the Tocher method and hierarchic of the nearest neighbor in two distinct groups.

The analysis of mean comparison, together with the groups established by the Tocher method, nearest neighbor and canonic variable, enables the identification of which are the promising breeding, as well as those that may result in restrict variability in the segregating generations, as those performed between progenies of the same group. In this sense, it can be expected as promising the following hybridizations:

Neste sentido. poderão ser esperadas como promissoras as seguintes hibridações: P99R01 x M8360RR, P99R01 x M8849RR, M9144RR x M8360RR and ENGOPA-314 x P99R01, since the cultivars were dissimilar (Figure 2) and presented high averages of productivity and acceptable characteristics related to plant height and first pod insertion (Table 2), suggesting that, when used in directed hybridizations in programs of genetic breeding, will enable to increase the number of desirable recombination, so that they can be used as source of superior genetic constructions.

Table 6. Estimative of the variances (eigenvalues), percentage accumulated variance of the canonic variables, aiming to estimate the genetic dissimilarity among 14 soybean cultivars, in experiments conducted in different places and periods of seeding in the cities of Gurupi and Palmas – TO in the crop 2007/08

Canonic Variables	Variances (eigenvalues)	Variances (Accumulated %)
1	31.54	81.8
2	3.25	90.26
3	1.44	94.00
4	1.03	96.67
5	0.66	98.38
6	0.45	99.54
7	0.12	99.86
8	0.05	100.00

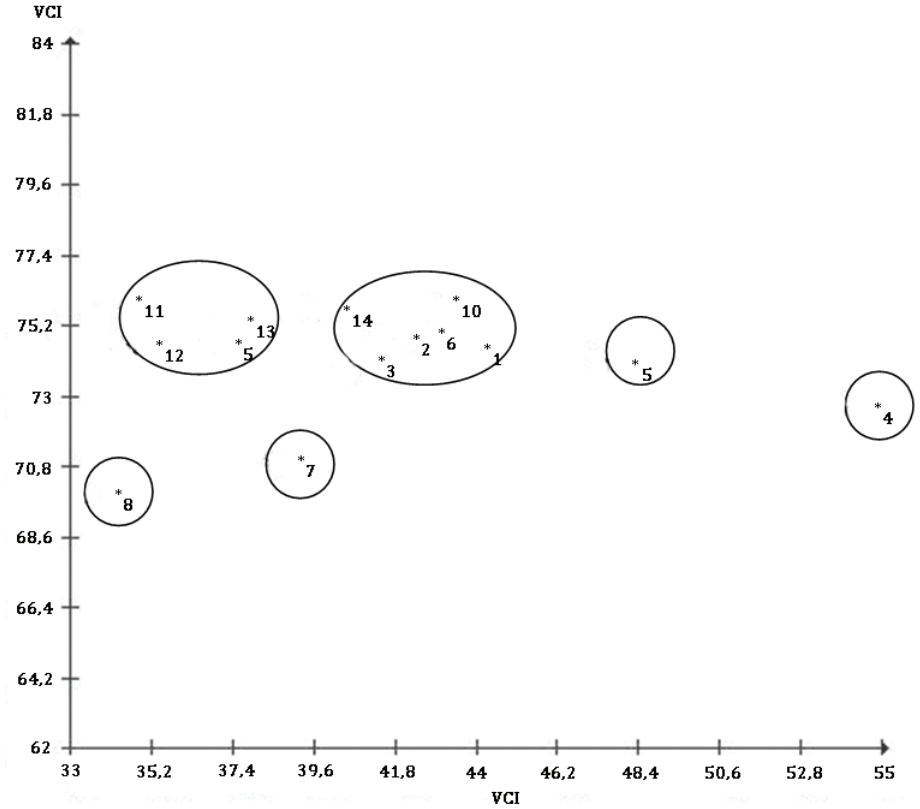

Figure 2. Graphic dispersion of the scores of 14 soybean cultivars, in relation to the two first canonic variables, established by the linear combination of eight agricultural characteristics. Cultivars: 1 (M9144RR). 2 (ENGOPA-314). 3 (P98Y51). 4 (P99R01). 5 (M8867RR). 6 (MSOY-9056). 7 (M8527RR). 8 (M8360RR). 9(MSOY-9350). 10 (TMG108RR). 11 (MS – 8925). 12 (MS – 8849). 13 (MS – 8787). 14 (P98R62).

Conclusions

The method of optimization of Tocher, nearest neighbor were more consistent in the identification of the genetic divergence among the genotypes.

The number of pods per plant (80.17%) was the one that contributed the most in the genetic dissimilarity among the 14 cultivars;

The presence of genetic variability enabled the identification of dissimilar cultivars and with high average of the studied characteristics.

The hybridizations P99R01 x M8360RR, P99R01 x M8849RR, M9144RR x M8360RR and ENGOPA-314 x P99R01 are promising to obtain segregating populations with superior variability.

References

BOARD. J.E.; KANG. M.S.; HARVILLE. B.G. Path analysis identify indirect selection criteria for yield of late planted soybean. **Crop Science**. v. 37, n. 3, p. 879-884, 1997.

CARPENTIERI-PÍPOLO. V.; DESTRO. D.; PRETE. C.E.C.; GONZALES. M.G.N.; POPPER. I.; ZANATTA. S.; SILVA. F.A. . Seleção de genótipos parentais de acerola com base na divergência genética

multivariada. **Pesquisa Agropecuária Brasileira**. v.35, p.1613-1619, 2000.

COSTA. M. M.; MAURO. A. O. D.; UNÊDA-TREVISOLI. S. H.; ARRIEL. N. H. C.; BÁRBARO. I. M.; MUNIZ. F. R. S. Ganho genético por diferentes critérios de seleção em populações segregantes de soja. **Pesquisa Agropecuária Brasileira**. v. 39, n.11, p.1095-1102, 2004.

CRUZ. C.D. **Programa Genes*:* Aplicativo computacional em genética e estatística**. Viçosa: UFV. 2007, 648 p.

CRUZ. C.D.; REGAZZI. A.J.; CARNEIRO. P.C.S. **Modelos biométricos aplicados ao melhoramento genético**. Viçosa. MG: Imprensa Universitária. 2004. 480 p.

CEOLIN. A. C. G. *et al*. Genetic divergence of the common bean (Phaseolus vulgaris L.) group carioca using morpho-agronomic traits by multivariate analyses. **Hereditas**. v. 144, p 1-9, 2007.

EMBRAPA. Centro Nacional de Pesquisa de Solos. **Sistema brasileiro de classificação de solos.** 2.ed. Rio de Janeiro: Embrapa Solos. 2006. 306p.

FEHR. W. R.; CAVINESS. R. E.; BURMOOD. D. T.; PENNINETON. J. S. Stage of development descriptions for soybeans. *Glycine max* L. Merrill. **Crop Science.** v.11, n.6, p. 929-931, 1971.

JOHNSON. R.A.; WICHERN. D.W. **Applied multivariate statistical analysis**. 3. ed. New Jersey : Prentice-Hall. 1992. 642 p.

MIRANDA. G.V.. **Diversidade genética e desempenho de cultivares de soja como progenitores**. 1998. 117 f. Tese (Doutorado em Genética e Melhoramento de Plantas) - Universidade Federal de Viçosa. Viçosa.

PINCHINAT. A.M.; ADAMS. M.W.; Yield components in beans. as affected by intercrossing and neutron irradiation. **Turrialba**. Coronado. v.16. n.3. 247-252. 1966.

SAS INSTITUTE. **SAS user's guide:** statistics. version 6.11. ed. Cary. 956 p. (1996).

RAO. R. C. **Advanced statistical methods in biometric research**. New York: John Wiley. 1952. 390 p.

RODRIGUES. L.S.; ANTUNES. I.F.; TEIXEIRA. M.G.; SILVA. J.B.. Divergência genética entre cultivares locais e cultivares melhoradas de feijão. **Pesquisa Agropecuária Brasileira**. v. 37, n. 02, p. 1285-1294, 2002.

SCAPIM. C. A.; CARVALHO. C. G. P.; CRUZ. C. D. Uma proposta de classificação dos coeficientes de variação para a cultura do milho. **Pesquisa Agropecuária Brasileira**. v.30, p.683-686, 1995.

SEDIYAMA. T.; TEIXEIRA. R.C.; BARROS. H. B. Cultivares. In: SEDIYAMA, T. (Org.). **Tecnologias de produção e usos da soja.** 1 ed. Londrina: Mecenas. v. 1, p. 77-92, 2009

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

VIEIRA. E.A.; CARVALHO. F.I.F.; BERTAN. I. Association between genetic distances in wheat (*Triticum aestivum* L.) as estimated by AFLP and morphological markers. **Genetics and Molecular Biology**. v.30. n.2. p.392-399. 2007.