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NEW SOYBEAN VARIETIES VARIABILITY BY PLANTS MORPHOLOGY FROM ECOLOGICAL WHITE LUVIC SOIL CONDITIONS

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Abstract

Recent studies have shown that the analysis of morphological traits in soybeans could provide new directions in the breeding process. Having a rich genetic diversity, the plant manifest itself in close connection with the concrete conditions in the crop environment. In the present study, two early soybean varieties were compared: Cristina TD and Onix, which are recommended by their performance in farm conditions. In both varieties, some new directions have been found, these being recently improved, namely through improved morphological characters. In the comparison between the two varieties, the plants had a height of 69 cm in Cristina TD and 65 cm in Onix. In the same order the wieght of the average plant was 24 g to 27 g, with a number of about 4 branches. The number of pods on a plant was 31 (Cristina TD) to 40 (Onix), weighing 12 g and 15 g. The number of beans on an average plant was 67 to 85, weighing 6.9 g at 8.5 g, the number of grains in a pod was approximately equal to 2.13-2.15. the grain had the length in favor of the Cristina TD variety, 7.1 mm to 6.7 mm for Onix, and the grain thickness ranged between 5.3 and 5.5 mm. The mass of one thousand grains exceeded 100 g in Cristina TD (104.5 g) and was below 100 g in Onix (98.4 g). The number of grains and their weight were positively correlated with the other characters in both varieties, while the mass of one thousand grains depended more on the weight of the grains and their thickness in the Cristina TD variety. The study of the morphological characters of the two new soybeans varieties demonstrated a good adaptability in the conditions of the white luvicsoil from the south of the territory.

Key words*: branches, grains, pods, soybeans, variability.*

INTRODUCTION

Known for a very long time (Lee et al., 2011), soybean [*Glycine max* (L.) Merrill, pro syn *G. angustifolia* Miq., *G. gracilis* Skvort., *G. hispida* (Moench) Maxim] proves very favorable agronomic (Conner et al., 2004; Mureșanu et al., 1999; Mureșanu et al., 2016) and culinary qualities (Riaz, 2006; Shekhar et al., 2016; Heuzé et al., 2017; Hu et al., 2019). Thus, the plant in a relatively long period of vegetation, namely in the first three seasons, fixes atmospheric nitrogen (N_2) (common feature of all species in the family *Fabaceae*), structures and enriches the soil in nitrates (NO_3), directly assimilable and ensures proper crop rotation. Atmospheric nitrogen fixation is based on the activity of symbiotic bacteria of the *Bradyrhizobium* type, with which the conversion of N_2 into ammonia takes place, by a path of the type: a) $N_2+8H^++8e= 2NH_3+H_2$ and then in assimilable form expressed by the ammonium ion: b) $NH_3+H^+= NH_4^+$). In nodules the bacterium produces amino acids, with which protei are formed (Endres, 2001). After harvesting the plants, the nodules left in the soil decompose, and the acumulated amino acids are also converted biologically into nitrates (NO_2^-). They become available mainly for wheat plants that usually follow in crop rotation. Soybeans are rich in protein and oil which together represent 56% of the total: 36% protein and 20% oil. The differences is 30% carbohydrates, 9% water, and the remaining 5% ash (Hu et al., 2019). At the same time, soybeans contain significant amounts of phytic acid, a wide range of minerals and B vitamins (Riaz, 2006; Shekhar et al., 2016). From a genetic point of view, soy manifest a high polymorphism (Singh et al., 2006; Schmutz et al., 2020). Of these, *Glycine max* (L.) Merrit has characteristic of 2n = 2x = 40. From botanical point of view, soybeans produce 2-4 grains in the pod,rarely more, these having a globular shape, 5-11 mm in diameter, and the colors have various shades between green,

yellow, brown and black. To study the variability of morphological traits in new cultivated soybean varieties, the following were determinated: height, number of branches, plant weight, number and weight of pods, number and weight of beans, number of beans in a pod, grain size and mass of thousand grains (MTG).

MATERIALS AND METHODS

The determinations were made during September in the last two years. Plants were chosen from experiments located in the specific field of research. He cultivation technology was the one recommended by the resort. At maturity, 25 plants were hervested in 4 replicates (a total of 100 plants). The cultivated varieties were *Onix* and *Cristina TD*, which has the following characteristics: they are new varieties, with improved characters, from the semi-early category (00), with determined growth and which form yellow, spherical flattened grains, with an absolute mass over 100 g. The plants harvested in the field were brought to the laboratory and dried for a few days to obtain the lowest possible humidity (equilibrium). The height and weight of the whole plant were measured, the brances formed on the stem, the number and weight of pods formed, the number, weight and thickness of the grains were counted, then the absolute mass of the grains in the form of a thousand grains. The results obtained represent the average of the two years of crop. The obtained morphological characters were analyzed by the method of histograms (frequency polygons). Both class intervals and absolute values were used in the method. The study highlighted several aspects, namely: modal values (MV), the limits od the intervals of variability of the studied characters and the specifics of each character of the varieties in the analyzed area. Simple causal links were established between the determined characters, with the help of which some trends could be observed by comparing the two varieties. The testing of the vakues was done with the theoretical values for the transgression probabilities for 0.5%, 1% and 0.1%. expressing values was used with Excel. In the statistical calculation of all the determined characters, the analysis of variance (anova test) was used, namely on the variation strings. Statistical parameters were calculated using the formulas: $\bar{a} = \Sigma x/n$, where $\bar{a}$ = average of the determinations, and x = determined values, s^2 (variance) = $1/n\text{-}1[\Sigma x^2\text{-}(\Sigma x)^2/n]$, s (standard error) = $\sqrt{S^2}$, VC% (variation coefficient) = $s/\bar{a}.100$.

RESULTS AND DISCUSSIONS

Variability of some plant characters. In general, high-growth soybean varieties are characterized by relatively low plant heights. In absolute value, the waist can reach 75-110 cm. The positioning of the stem is vertical, which is an advantage for the total mechanization of the plant. The characteristics of the two varieties covered some specific aspects. Thus, from the determinations made, the varieties showed similar plant lengths between 50 and 85 cm (Figure 1). They dominated the plants between 65 and 70 cm for the *Onix* variety (26-27%) and 75 cm for the *Cristina TD* variety (25%). Plants with small lengths (50 cm) accounted for both 2%, and the largest (80 cm) accounted for 2-3% of the total.

The total weight of the plants was between wide values, namely between 10 g and 70 g. Both varieties dominated the plants with 25 g (23% and 30%, respectively) (Figure 2). In both varieties there was a tendency to form plants with total weights around 60-70 g.

Regarding the number of branches on a plant, it was between 2 and 12. Dominated the plants with 2 branches (31%) in the *Onix* variety and those with 4 branches per stem in the *Cristina TD* variety (Figure 3). And in the case of the branches formed on a plant, there is a tendency to amplify the branching on the stem towards 10-12 pieces. Among the varieties, *Onix* branched approximately similar to *Cristina TD* (Figure 4).

Variability of soybeans pods and beans. One of the improved characters obtained was the number of pods on a plant (Figure 5). The relatively wide range determined was between both varieties between 10 and 100. The modal value was for both 40 pieces on a plant, with frequencies of 32% for *Onix* and 39% for *Cristina TD*. From the obtained data it was found that there is a tendency of the *Onix* variety to form a relatively higher number of pods than *Cristina TD*.

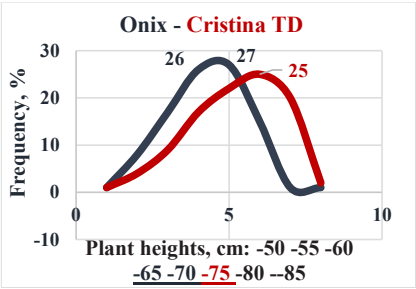

Figure 1. Frequencies of soya plants height

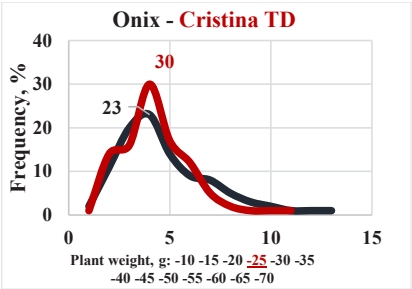

Figure 2. Frequencies of soya plants weight

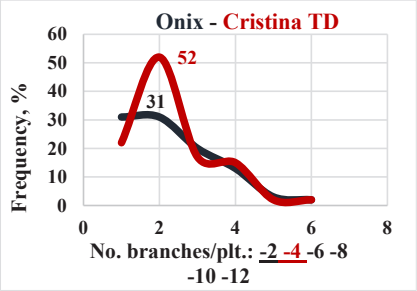

Figure 3. Frequencies of no. of branches/plant

Figure 4. *Onix* soybean variety

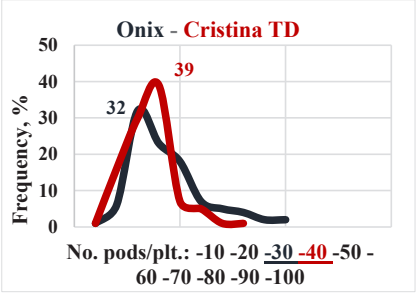

Figure 5. Frequencies of no. of pods/plant

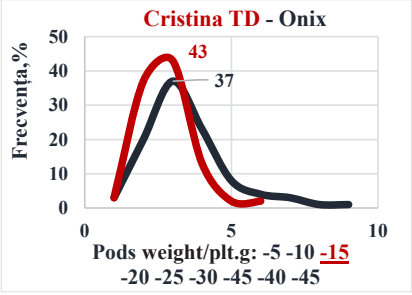

Figure 6. Frequencies of pods weight/plant

The weight of those pods on a soybean plant ranged from 5 to 45 grams. In both dominant varieties were plants that had a total pod weight of 15 g (Figure 6). At this modal value, the *Cristina TD* variety had a frequency of 43%, and the *Onix* variety at 37%. The weight of the pods on a plant shows the same tendency for the *Onix* variety to form pods with a higher total mass, i.e. around 40-45 g.

In these pods the plant forms a number of grains, depending on the genetic capacity of the variety, soil quality, climatic conditions and cultivation. In both varieties, between 30 and 250 grains of a plant were determined (Figure 7). The modal value was 70 grains similar to the two varieties, but with frequencies of 31% for *Cristina TD* and 29% for *Onix*. And in the case of the number of berries on a plant, the *Onix* variety showed a tendency to form more grains, namely over 200/plant. The density and appearance of *Cristina TD* plants are shown in Figure 8.

The weight of grains on a plant was generally between 2 g and 24 g in both varieties, however, the modal values were differentiated, namely at 6 g/plant in *Cristina TD* (31%) and at 8 g/plant in *Onix* (31%). The expression of the *Onix* variety also included plants with the total mass of the grains at slightly higher values, namely over 20 g (Figure 9).

The number of grains in a pod ranged from 1.8 to 2.8 (Figure 10). The pods dominated with

2.2 berries in both varieties, but with the modal values of 41 % in the *Cristina TD* variety and 31% in the *Onix* variety.

The size of the soybeans refer to the length and thickness/width. The data obtained showed differences between the two varieties. Thus, the grain length was generally between 4 and 8.5 mm (Figure 11). Dominant were the grains with 7 mm in the *Cristina TD* variety (27-28%) and those with 7.5 mm in the *Onix* variety (23%). Wider grain length ranges were observed in *Onix*, while the *Cristina TD* variety has slightly more grouped lengths.

The thickness of the grains was between 4 and 7 mm, with similar modal values, namely 5.5 mm: 35% for *Cristina TD* and 30% for *Onix* (Figure 12).

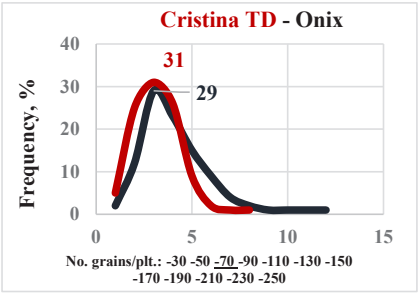

Figure 7. Frequency of no. grains/plant

Figure 8. *Cristina TD* soyabean variety

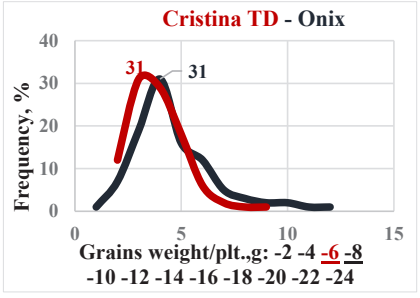

Figure 9. Frequency of grains weight/plant

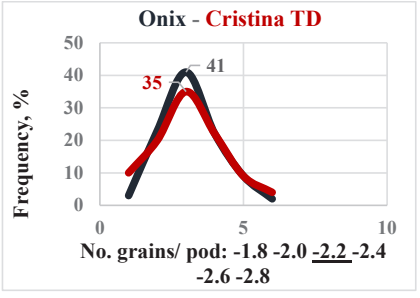

Figure 10. Frequency of no grains/pod

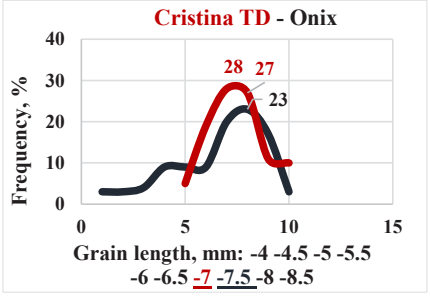

Fig. 11. Frequencies of grain length

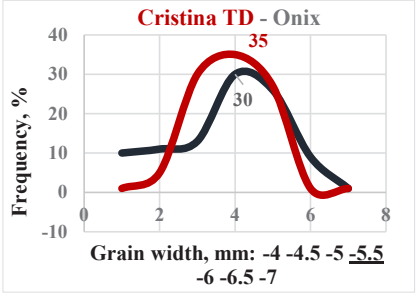

Fig. 12. Frequencies of grain width

The weight of soybeans expressed by the mass of one thousand grains was generally between 80 g and 160 g (Figure 13). In the *Cristina TD* variety the dominant weight of the grains was 100 g (32%), while in the *Onix* it was 110 g (41%). Between the two varieties, *Cristina TD* found an extension of the mass of one thousand grains to higher values, of over 140 g (Figure 14).

Correlations between the studied morphological characters. At the level of the whole set of correlations between all the characters analyzed for these soybean varieties,

statistically assured correlations were obtained in most cases. Of these, the positive correlations between the weight of the plant and the other characters related to it were noted, with correlation coefficients obtained between **.627** and **.916** for the *Cristina TD* variety and between **.657** and **.973** for the *Onix* variety.
Instead, insignificant links were obtained, either positive or negative, between the number of grains and their length with the other characters. It was generally found that the *Onix* variety had slightly more negative correlations compared to the *Cristina TD* variety. Instead, the mass character of a thousand grains correlated insignificantly, either positively or negatively with other characters in the *Cristina TD* variety, while in *Onix* this character was predominantly positive and even with statistical assurance with the other characters analyzed (Table 1).

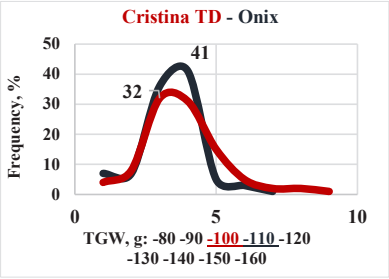

Figure 13. Frequencies of a thousand grain weight-TGW

Figure 14. Grains of Cristina TD variety

Table 1. Correlations between the main soyabean varieties characters

Indices	Plant weight	No. branch	No. pods	Pods weight, g	No. grains	No. Grains/ pod	Grains weight, g	Grain length mm	Grain width, mm	TGW g
Cristina TD variety										
Plant length, cm	**.386**	-.026	**.207**	**.272**	.181	-.140	**.221**	.007	-.066	.079
Plant weight, g	1	**.627**	**.865**	**.916**	**.880**	.089	**.875**	.001	.008	.061
No. branches		1	**.554**	**.511**	**.565**	.075	**.509**	.026	.072	.066
No. pods			1	**.912**	**.953**	-.089	**.886**	.005	-.061	-.085
Pods weight, g				1	**.946**	.155	**.974**	.022	.028	.164
No. grains/plant.					1	.193	.030	-.046	-.042	-.059
No. grains/pod						1	**.210**	-.135	.073	.065
Grains weight, g							1	-.014	.014	**.255**
Grain length, mm								1	**.336**	.092
Grain width, mm									1	**.218**
Onix variety										
Plant length, cm	**.385**	**.262**	**.324**	**.271**	**.297**	-.149	**.263**	.028	-.144	-.040
Plant weight, g	1	**.657**	**.967**	**.973**	**.962**	-.033	**.962**	.158	-.026	**.212**
No. branches		1	**.634**	**.595**	**.601**	-.117	**.581**	.052	-.137	.109
No. pods			1	**.977**	**.972**	-.123	**.962**	.101	-.066	.163
Pods weight, g				1	**.982**	.014	**.990**	.115	-.032	**.244**
No. grains/plant					1	.091	**.981**	.119	-.057	.155
No. grains/pod						1	.066	.084	.035	.042
Grains weight, g							1	.128	-.039	**.289**
Grain length, mm								1	**.646**	.130
Grain width, mm									1	.081
LSD 5 % = .190 LSD 1 % = .250 LSD 0.1% = .320										

Statistical analysis of morphological characters in soybean plants. The results obtained in the morphological analysis of some soybean characters showed specific aspects (Table 2). Thus, the length (height) of the plant measured in comparison *Cristina TD- Onix*, 69 to 65 cm. This character demonstrated greater variability in *Onix.* The weight of an average plant, at maturity, was 24 g for the first variety and 26 g for the second variety, both with high variability. Both stems formed 4 branches each, and the number of pods was 32 to 40. The weight of these pods was 11 g to 15 g. The number of grains was 67 to 85 in favor of *Onix*, and their weight was from 7 to 8.5 g. The grains had lengths of 7.1 mm to 6.7 mm, with thickness of over 5 mm. The mass of one thousand grains was 105 g for the first variety and 98 g for the second variety.

Table 2. Statistical indices of soybean plants and grains

Indices	Height cm	Plant weight	No. branches	No. pods	Pods weight	No. grains	No. grains/ pod	Grains weight/ plt., g	Grain lengtn, mm	Grain width, mm	TGW, g
Cristina TD variety											
Mean, ā	**69.2**	**24.4**	**3.91**	**31.5**	**11.6**	**66.5**	**2.13**	**6.9**	**7.13**	**5.33**	**104.5**
Variance, s^2	59.30	56.67	5.21	123.9	7.126	650.6	0.056	7.74	0.423	0.27	231.9
Std. deviation, s	7.70	7.53	2.28	11.13	2.67	25.51	0.237	2.78	0.65	0.52	15.23
Var. coef., s%	**11.1**	**30.1**	**58.4**	**35.3**	**23.1**	**38.4**	**11.2**	**40.2**	**9.1**	**9.8**	**14.6**
Onix variety											
Mean, ā	**65.2**	**26.5**	**4.23**	**39.7**	**15.0**	**85.1**	**2.15**	**8.52**	**6.73**	**5.483**	**98.4**
Variance, s^2	1016	123.6	7.896	231.6	51.49	2520	0.520	16.94	0.781	1.106	397.34
Std. deviation, s	31.82	11.13	2.810	15.22	7.176	50.20	0.721	4.116	0.884	1.052	19.933
Var. coef., s%	**48.9**	**41.1**	**66.4**	**38.3**	**48.0**	**59.0**	**33.5**	**48.3**	**13.1**	**19.2**	**20.2**

CONCLUSIONS

The morphological characteristics of soybeans, *Cristina TD* and *Onix* varieties, had new and specific aspects. The cultivation of these varieties was due to the fact that they have recent genetic improvements, especially for the higher productive potential. Being varieties with a relatively small size, the stem had lengths of 65-70 cm. This may be an increasingly important condition for maximizing production, when superior, intensive agrotechnics can be used. The plants had a total mass of 25-27 g, and the stem formed 4 branches each.

The number of pods obtained was between 32 and 40 per plant, and their biomass was between 12 g and 15 g. The number of grains was 67-85 per plant, and their weight was between 7 g and 8.5 g. The length of the grains was between 7.1 and 6.7 mm and the absolute mass of the grains was between 100 and 105 g.

Simple correlations were established between all the studied characters, with some differentiations. In general, these correlations obtained were both positive and statistically assured. Only the diameter of the grain and the mass of a trousand grains were insignificantly correlated with some characters.

The variability of the morphological characters studied in the two soybean varieties demonstrated high variability of the characters in the *Onix* variety and relatively low in *Cristina TD*.

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