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VARIATION OF SOME NEW MORPHOLOGICAL CHARACTERS OF SOYBEAN PLANTS

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Key words*: grains, Glycine max, pods, variability*

ABSTRACT

Soybeans, a very valuable nutritious and cultivated plant, have recently received special attention for the improvement of new varieties. Their adaptability is increasing given the relatively large diversity of environmental conditions. Mainly the new varieties are distinguished both by the increased production of grains and by the contents in active principles as high as possible. At the same time, soybeans provide the current level required for the sustainable structure of crops on a farm. The Raluca TD variety, studied for its specific morphological characters, is one of the newest creations. Even in the conditions with recent dry periods, this variety has formed plants with heights of over 65 cm, with a total plant weight of 30 g. 3-4 branches have formed on a soybean stalk. Each plant formed 40-50 pods, weighing 15 g and 60 berries that weighed 7-10 g. The bean was 6.8 mm long, 5.8-6 mm thick, and the absolute weight of the berries was 120 g. Significantly positive correlations were obtained between these morphological characters in most cases. Insignificant situations were between the length of the grain with the other characters, between the thickness of the grain with the other characters - with two negative exceptions. The mass of one thousand berries was positively correlated with the weight of the berries on a plant and the size of the berries. The variability of the determined characters was reduced to the height of the plants and the size of the grains, average values were to the number, the grains from one pod and high values to the other characters, mainly due to the existence of the dry bottom. However, the Raluca TD variety, with improved morphological characteristics, proved to be a good adaptability to the zonal cultivation conditions.

INTRODUCTION

Long-known (Hymowitz & Newell 1981; Murphy 2007), soybean crop [*Glycine max* (L.) Merr., Pro syn. *G. hispida* (Moench.) Max. from subgenus *Soybean* (Moench) F.J. Herm. together with *Glycine soy* Sieb. & Zucc. like it's wild ancestor] proves very favorable agronomic and culinary qualities (Lusas & Riaz 1995; Riaz 2006; Purcell et al. 2014). Thus, the plant has a relatively long period of vegetation, located from spring to autumn, fixes atmospheric nitrogen (N_2) (a 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 (N_2 is converted to ammonia, 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 proteins are formed. After

harvesting the plants, the nodules left in the soil decompose, and the accumulated amino acids are also converted biologically into nitrates (NO_2^-). They become available for wheat plants that usually follow in crop rotation (Alves et al., 2003). Soybeans contain 36-40% protein, 13-26% fat, 13-24% non-nitrogenous extracts, 1.6-2.5% lecithin, B-complex vitamins (B_1-thiamine, B_2-riboflavin, B_6-pyridoxine) and a number of enzymes: lipoxidase, urease, lipase, amylase. Oleic, linoleic and linolenic acid represent 85%, and saturated fatty acids: palmitic and stearic acid, 15%. The difference is 30% carbohydrates, 9% water, and the remaining 5% ash. From a genetic point of view, soybeans show a high polymorphism. Of these, *Glycine max* (L.) Merrit has a characteristic of 2n = 2x = 40. From a botanical point of view, soybeans produce 2-5 grains in pods. They have a globular-elongated shape, and the colors are shades of green and yellow. The absolute mass (mass of one thousand grains - MTG) has values between 50-200 g. The biomass of the whole plant includes 35-50% grains (Mureșanu et al. 1999). To study the variability of some morphological characters (Conner et al., 2004) in the cultivated *Raluca TD* variety, the following were determined: height, plant weight, number of branches per stem, number and weight of pods on a plant, the number and weight of grains on a plant, the length and thickness of the grains and the mass of one thousand grains (MTG).

MATERIALS AND METHODS

The determinations were made during October. Plants from the experience in the specific field of research were chosen. The cultivation technology was the one recommended by the resort. At maturity, 25 plants were harvested in 4 repetitions (100 in total). The cultivated variety was *Raluca TD*, which has the following characteristics: it is a new variety, semi-early (00), with determined growth and which forms yellow, large, round grains, with an absolute mass over 120 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 branches formed on the stem, the number and weight of the pods formed, the number, weight, length and thickness of the grains, as well as the absolute mass of the grains in the form of a thousand grains were counted. The morphological characters obtained were analyzed by the method of histograms (frequency polygons). Class intervals were also used in the method and as absolute values. The study highlighted several aspects, namely: the mode values (VM), the limits of the intervals of variability of the studied characters and the specifics of each character of the variety in the analyzed area. The simple correlations were established between the analyzed characters, with the help of which it was possible to observe their tendencies within the *Raluca TD* variety, studied. The testing of the values was done with the theoretical values for the probability of transgression 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 $\bar{a}$ = the mean of the determinations and x = the values determined,

S^2 (variance) = $1/(n-1) [\Sigma x^2 - (\Sigma x)^2/n]$,

S (standard error) = $\sqrt{(S^2)}$,

S% (variation coefficient) = $S/\bar{a}.100$.

RESULTS AND DISCUSSIONS

The climate influence on soybean plants vegetation. During the vegetation period the monthly temperatures were high than normal for June-September (table 1.) Only the May month was a little beet low, but for any influence for first period of vegetation. The rainfalls (precipitation) were quite normally for May-August period (between 13,14 mm till 27 mm under normal), but enough for flowering, and seeds formation. In September was dry season influenced a good maturity of the soybean plants and seeds. The precipitations from the vegetation period, and the normal zonal values ones were at the same time not enough for real evapotranspiration of the soybean plants (ETP= 490 mm in comparison with 369 mm for normal and 281 mm for 2021 year).

Table 1.

Climatic indices evolution from soybean vegetation

Month	Temperature, tn^{0}C			Precipitations, mm			ETP** mm
	N*	2022	±	N	2022	±	
May	16,3	16,1	-0,2	81	95	14	33
Jun.	19,5	19,9	0,4	94	80	-14	74
Jul.	21,7	24,5	2,8	81	54	-27	141
Aug.	21,3	23,7	2,4	60	47	-13	176
Sep.	16,9	17,0	0,1	53	5	-48	66
±	19,14	20,24	1,1	369	281	-88	490

*N-normal values,
**ETP- evapotranspiration potential

Variability of some characteristics of the soybean plant. In general, soybean varieties are characterized by a relatively low plant height. In absolute value, the plant can reach 65-110 cm. The positioning of the stem is vertical, which is an advantage in performing mechanical work. From the determinations made, the *Raluca TD* variety had plant lengths between 50 and 78 cm (figure 1). They dominated the plants with a height of 62 cm (26%). Smaller plants (less than 50 cm) accounted for 2%, and tallest plants (78 cm) accounted for 1% of the total.
The total weight of the plants was between 20 g and 70 g. The plants dominated with 30 g (38%) (figure 2). Higher values ranged from 40 to 70 g.

Regarding the number of branches on a plant, it was between 1 and 6. The plants dominated with 3-4 branches (32-31%) (figure 3). The appearance of the plants of the *Raluca TD* variety is observed in figure 4.

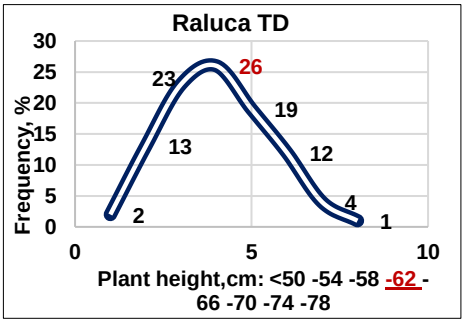

Figure 1. Frequencies of plant height

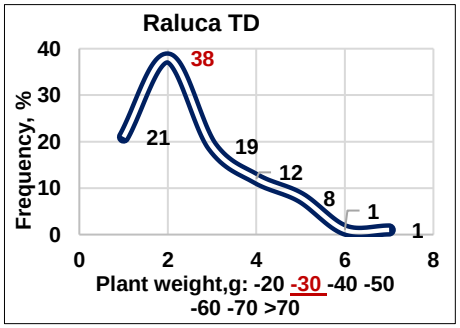

Figure 2. Frequencies of plant weight

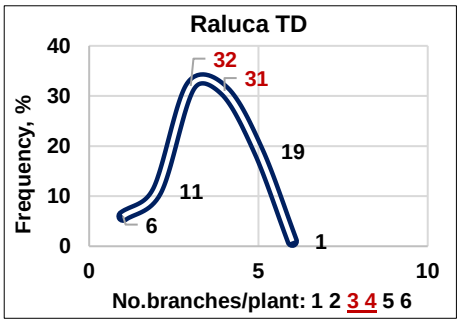

Figure 3. Frequencies of no.branches

Figure 4. Raluca TD soy new variety

Variability of soybeans pods and beans. Depending on the climatic conditions, the soybean plant produces a significant number of pods (or sheaths). In the experiment, the plants formed between 20 and over 100 pods (figure 5).

They dominated the plants that formed 40-50 pods (23%). Near these were plants with 30 pods (15%) and those with 60 pods (14%). Soybeans with more than 80 pods accounted for only 1-2% of the total.

The pods formed on each plant weighed between 10 g and over 50 g (Figure 6). Of these, the plants dominated with 15 g, the total weight of the pods (31%). Close to these were those with 20 g (20%) and 25 g (15%). Plants with pods of 40-50 grams per plant accounted for 2-1%.

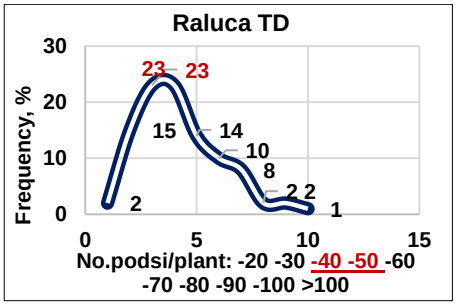

Figure 5. Frequencies of no de pods/plant

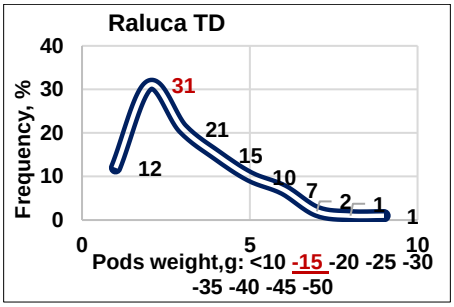

Figure 6. Frequencies of pods weight

In these pods the plant forms a number of grains, depending on the genetic capacity of the variety, climatic conditions and cultivation. In the case of the *Raluca TD* variety, between 2 and over 4 berries were determined in a pod (figure 7). The modal value was 2 grains (70%). Plants with 2 berries in one pod accounted for 22%, and those with 4 berries, 8%. The plants of the *Raluca TD* variety were distinguished by the formation of a large number of pods with many berries (figure 8).

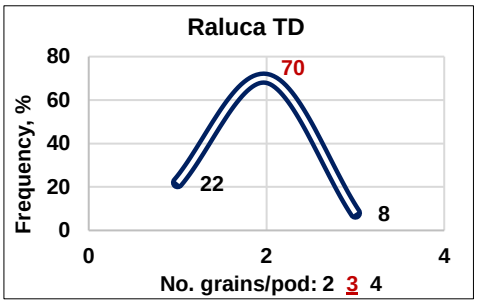

Figure 7. Frequencies of no. grains/pod

Figure 8. Pods of *Raluca TD* variety

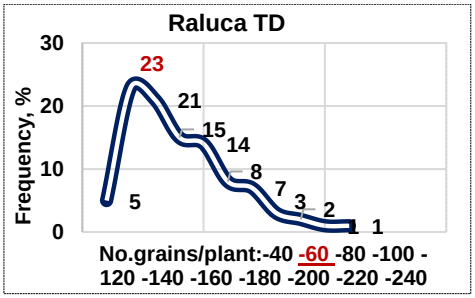

Figure 9. Frequencies of no.grains/plant

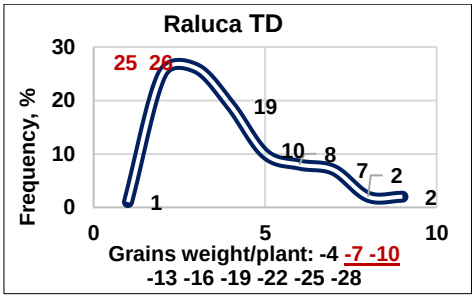

Figure 10. Frequencies of grains weight

Between 40 and 240 grains were formed on the average soybean plant (figure 9). Plants dominated with 60 berries (23%), followed by 80 berries (21%) and 100-120 berries (15-14%). Soybean plants with 220-240 grains / plant accounted for 2 and 1%, respectively. The weight of the grains formed on a soybean plant ranged from 4 to 28 g (Figure 10). Of these, plants with weights of 7-10 g (25-26%) dominated. Close to these were plants with 13 g of berries (19%). Plants weighing 25-28 g of grain per plant accounted for only 2% of the total.

The physical appearance of soybeans describes an approximately globular shape. In their determinations, the analysis of their length / height and thickness was used. The data showed a fairly wide range of soybean sizes. Thus, the lengths were between 6 mm and 8 mm (figure 11). The grains with a length of 6.8 mm (23%) dominated. Grains with 7 mm (18%) and 6.6 mm and 7.2 mm (13-14%) in length were close frequencies. The values were generally in line with the normal values of this crop. The grain thickness had values between 5 and 6.8 mm (figure 12) The grains with a thickness of 5.8-6 mm (27-26%) dominated. Close to these were the 6.2 mm (16%) grains.

The absolute weight of the grains (expressed in MTG values) also had a fairly wide range. Thus, it was between 90 g and 150 g (Figure 13). 120 g (35%) dominated the grains, followed by 130 g (31%) and 140 g (14%) grains. The aspect of *Raluca TD* grains is observed in figure 14.

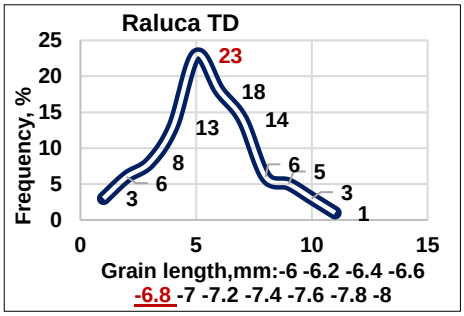

Figure 11. Frequencies of grain length

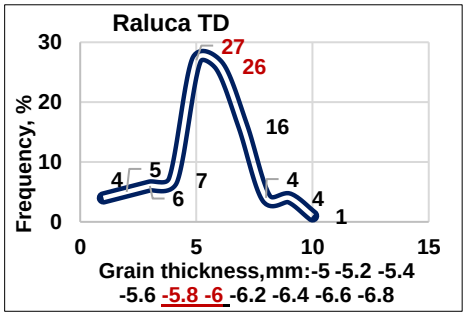

Figure 12. Frequencies of grain thickness

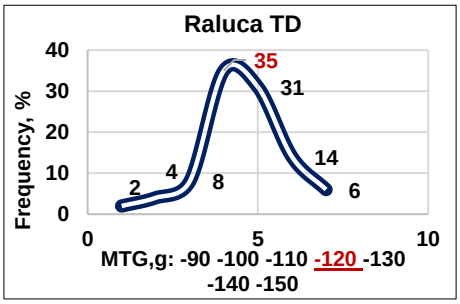

Figura 13. Frequencies of grains MTG

Figure 14. *Raluca TD* grains aspect

Correlations between morphological characters. At the level of the whole set of correlations between all the characters analyzed for this soybean variety, statistically assured correlations were obtained in most cases.

Among them were the positive correlations between height, plant weight, number of branches, number of pods and their weight on a plant, number of berries and their weight on a plant and number of berries in a pod. There were insignificant connections between the grain sizes with the other characters. The mass of one thousand grains showed oscillations except for the weight of the grains on a plant and the dimensions of the grains, with very significant positive connections (table 2).

Table 2

Correlations between the main morphological characters of *Raluca TD* soybean variety

Caractere	Plant weight, g	No. branch.	No. pods/ plant	Pods weight, g	No. grains/ plant	Grain weight, g	No grains/ pods	Grain length, mm	Grain thick mm	MTG, g
Plant height, cm	**.408**	**.367**	**.369**	**.288**	**.299**	**.252**	.163	.003	.107	-,118
Plant weight, g	1	**.577**	**.951**	**.962**	**.889**	**.882**	**.400**	.126	.131	.142
No. branches		1	**.547**	**.552**	**.546**	**.519**	**.366**	.007	-.037	.024
No. pods/plant			1	**.964**	**.877**	**.858**	**.454**	.112	.076	.096
Pods weight, g				1	**.909**	**.914**	**425**	.127	.117	.180
No. grains/plant					1	**.969**	**.435**	.067	-.009	.063
Grains weight, g						1	**.439**	.119	.063	**.284**
No. grains/ pod							1	.157	.017	.066
Grain length, mm								1	**.395**	**.235**
Grain thickness, g									1	**.307**
	DL 5 % = .190 DL 1 % = .250 DL 0.1 % = .320									

Statistical analysis of morphological characters in soybean plants. The results obtained in the morphological analysis of some characters in soybeans

showed specific aspects (table 3). Thus, the length (height) of the plant measured an average of 60.7 cm. This character had a low variability of 9.4%. The weight of an average plant, at maturity, was 31.15 g. The coefficient of variability was high, 42%. 3.5 branches were formed on an average soybean strain, an important element in the formation of the average grain production, and its expression was 32% variability. The average number of pods was 49, and the weight of the pods was 19 g. The average number of berries per plant was 91 and their weight was 11 g. These characters had large variability (between 47 and 49%). In an average soybean pod, an average of 2.9 grains formed had expressed 19% variability. The average soybean grain had a length of 6.84 mm and a thickness of 5.84 mm, both with low variability (6.4% in both). The mass of a thousand grains was on average 131 g, with a variability of over 38%.

Table 3

Statistical indices of morphological characters, Raluca TD variety

Indices	Talia, cm	Greut. plantă, g	No. ramificații	No. teci	Greut. teci, g	No. boabe	Greut. boabe, g	No. bob/ teacă	Lung. bob, mm	Gros. bob, mm	MMB, g
Mean	**60.71**	**31.15**	**3.49**	**48.94**	**18.821**	**91.47**	**11.064**	**2.86**	**6.84**	**5.838**	**131.0**
Variance, S^2	32.76	167.8	1.28	382.2	69.18	1817	29.23	0.283	0.195	0.141	2484
Std.dev. S	5.723	12.95	1.13	19.55	8.317	42.63	5.407	0.532	0.442	0.375	49.84
Var.Coef, %	**9.43**	**41.59**	**32.45**	**39.95**	**44.19**	**46.61**	**48.87**	**18.61**	**6.46**	**6.42**	**38.05**

CONCLUSIONS

The morphological characteristics of the soybean, the *Raluca TD* variety, had specific aspects. The choice of this variety was that it has recent genetic improvements, especially for its high productive potential.

Being a variety with determined growth, the stem had lengths of 58-62 cm. This may be a condition increasingly induced by maximizing production in a superior, intensive agricultural technics. The plants had a total dominant mass of 30 g. The stem formed 3-4 branches, very important in the additional formation of the number and weight of berries.

The number of pods formed was in the range of 40-50 per plant, and their biomass was 15 g. The number of grains in a pod was 3, and the total number of beans formed was 60 per plant, and their weight was between 7 and 10 g. The length of the grains was 6.8 mm, and the thickness of the grain 5.8-6 mm. The absolute mass of the grains was at a level of 120 g, like relatively larger grains.

Simple correlations were established between all the studied characters, with some differentiations. Positive correlations were obtained between the studied morphological characters and were statistically assured. Only the size of the grain and the mass of a thousand grains were correlated with some insignificant characters, either positive or negative.

The variability of the morphological characters studied in the *Raluca TD* soybean were generally high. The cause could be explained by the dry background in certain periods of the vegetation.

REFERENCES

Alves B.J.R., Boddey R.M., Urquiaga S. 2003. The success of BNF in soybean in Brazil. Plant and soil, 252, 1-9.

Conner T., Paschal E.H., Barbero A., Johnson E. 2004. The challenges and potential for future agronomic traits in soybean. AgBioForum, 7(1-2), 47- 50.

Hymowitz T., Newell C.A. 1981. Taxonomy of the genus Glycine, domestication and uses of soybeans. Economic Botany, 35(3), 272- 288.

Lusas E.W., Riaz M.N. 1995. Soy Protein Products: Processing and Use. Journal of Nutrition, 125(125), 573S- 580S.

Mureșanu E., Cătinaș L., Legman V., Pașca A., Trifu I. 1999. Soiuri timpurii de soia pentru Câmpia Transilvaniei. În: Contribuții ale cercetării științifice la dezvoltarea agriculturii, 6, 173- 192.

Murphy D.J. 2007. People, Plants and Genes: The Story of Crops and Humanity. New York: Oxford University Press, 122- 123.

Riaz M.N. 2006. Soy application in Food. Boca Raton, FL: CRC Press, ISBN 978-0-8493-2981-4.

Purcell l.C., Salmeron M., Ashlock L. 2014. Arkansas Soybean Production Handbook- MP 197. Little Rock, AR: University of Arkansas Cooperative Extension Service, 1- 8.