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MORPHOLOGICAL CHARACTERS IN PROGRESS FOR FIELD PEAS (Pisum sativum L.)

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ABSTRACT

Since ancient times, the field pea has stood out, on the one hand, for its special nutritional value, and, on the other hand, for the favorable impact it leaves on the environment through cultivation. Currently, more and more performing varieties are obtained and with increased adaptability in different environmental conditions. Recently, the plant is also recommended for the establishment of green, protective crops, including in horticulture. It is believed that by growing peas, there is also a conservation of CO_2, as a response to the need to reduce the phenomenon of global warming. The new pea variety Avatar thus has a number of improved morphological characters, which proves that pea breeding is making visible progress. Among these new morphological characters, the height of the plant was 80 cm, with the dominant weight of 11 g. The plant had 15 nodes of which the last 6 formed pods. Pod mass was 8 g/plant and contained 22 grains/plant. Pea grains had a mass of 5 g/plant, a diameter of 7 mm, and an absolute mass (BMB) of 260 g. The correlations obtained between these characters showed generally positive trends. Considering the gain of these morphological characters in progress, it is recommended to increase the proportion of the plant in the structure of crops within the farm.

INTRODUCTION

Field pea [*Pisum sativum* L., pro syn. *P. sativum* ssp. *arvense* (L.) Asch., dun (grey, brown) pea, Kapucijner pea, Austrian winter pea] has proven particularly good agronomic and culinary qualities over time (Myers et al, 2010; Siddika et al, 2013). Etymologically, the name ((Kreplak et al, 2019) pea comes from *pisum* through the Latinization of the word *pison* from *πισον* (Greek).

In culture, the plant has a short growing season, with sowing in very early spring and harvesting towards the beginning of summer (Sturzu et al, 2005). The plant demonstrates a series of particularly valuable agricultural advantages:

a) fixes atmospheric nitrogen (N_2) (typical of the entire *Fabaceae family*),
b) structures the soil,
c) enriches the soil in directly assimilable nitrates (NO^{3-}) and
d) ensures an adequate rotation with the other cultures.

Atmospheric nitrogen fixation is based on the activity of symbiotic bacteria of the *Bradyrhizobium* type. With their help, N_2 is converted into ammonia, through the reactions: a) $N_2+8H++8e^-= 2NH_3+H_2$, obtaining the assimilable form expressed by the ammonium ion: b) $NH_3+H^+= NH^{4+}$).

In the formed nodules (currently called nodules), the bacterium produces amino acids, from which proteins are then formed. After harvesting the plants at maturity, the nodules left in the soil decompose, and the accumulated amino acids are also biologically converted into nitrates (NO^{2-}).

The nitrates thus formed become available to the wheat plants (usually peas precede wheat in the crop rotation). Peas obtained in culture are rich in fiber, protein, vitamins A, B6, C and K, along with a number of chemical elements: P, Mg, Cu, Fe, Zn and lutein. The peptide fractions in the grains have a very important role: they contribute to the elimination of free radicals (like glutathione) as well as to the inhibition/blocking of linoleic acid oxidation.

From a genetic point of view (Avci & Ceyhan, 2006), the karyotype consists of 7 chromosomes, of which 5 are acrocentric and 2 submetacentric (Ellis & Poyser, 2002). Botanically, field peas produce an average of 3-9 grains in pods. The berries have a globular shape, and the colors have quite diverse shades, but the predominant ones are green and yellow (Sturzu et al, 2016).

The absolute mass (the mass of a thousand grains - MTG) has wide values, these being between 50-450 g. The pea grains represent between 35% and 50% of the biomass of the whole plant. To study the variability of some morphological characters in the *Avatar* pea variety, the following were measured and determined: plant length, plant weight, number of nodes per stem, number and weight of pods per plant, number and weight of grains per plant, grain diameter and the mass of one thousand grains (MTG).

MATERIALS AND METHODS

The determinations were made at the maturity of the plants, at the beginning of July. Plants were harvested separately from an experiment located in the specific research field. Scarification work was included in the cultivation technology, with the aim of creating the best possible vegetation conditions. From this variant, 100 plants were harvested from all four repetitions (25 plants each/repetition). The cultivated variety was *Avatar*, which has the following characteristics: it is a new, *afila*- type, semi-early, high-waisted, high-yielding variety. The plant produces yellow, large, round berries with an absolute mass of more than 240 g. The harvested plants were brought to the laboratory and dried for several days to obtain relatively low moisture (equilibrium moisture). For all these plants, the height and weight of the whole plant were measured, the nodes formed on the stem, the number and weight of the pods, the number, weight and thickness of the grains, and then the absolute mass of the grains in the form of the mass of a thousand grains were counted.

The obtained morphological characters were analyzed by histograms (by frequency). Both class ranges and absolute values as such were used within the method. The conducted study highlighted several aspects including: the mode values (MV), the limits of the intervals of variability of the characters studied and the specificity of each character of the variety in the analyzed area.

The testing of the obtained values was done with the theoretical values for the transgression probabilities for 0.5%, 1% and 0.1%. the Excel program was used in data processing. In the statistical calculation of all determined characters, analysis of variance was used, namely according to the method of variation strings. Within this, the formulas were used: $\bar{a} = \Sigma x/n$, where $\bar{a}$ = the average of the determinations, and x = the determined values, S^2 (variance) $= 1/(n-1)\ [\Sigma x^2 - (\Sigma x)^2/n]$, S (standard error) $= \sqrt{(S^2)}$ and S % (variation coefficient) = $S/\bar{a}100$.

Figure 1. Avatar flowering period

Figure 2. Avatar pod formation

Figure 3. Avatar maturity period

Figure 4. Peas plants determinations

RESULTS AND DISCUSSIONS

Variability of some morphological characters of the plant. In general, classic field pea cultivars were characterized by relatively smaller plant heights. In absolute value, the waist could reach 50-60 cm. The new pea varieties, such as Avatar, have the characteristic of taller plants with a height of over 75 cm. On this support, the entire productive spectrum: the number of pods, the number of grains and their mass showed higher evolutionary values (Yucel, 2013). And in these conditions, the positioning of the stem was initially relatively vertical, while towards maturity it followed slight inclinations. In the case of the Avatar variety, being of the *afila* type, the plants are attached to each other by tendrils (modified leaves), so that their bearing remains approximately vertical in most of the vegetation.

Even when at harvest the climate is richer in precipitation, considering the weight of the pods on a plant, peas of this type lie to varying degrees on the ground. Under these conditions, mechanized harvesting takes place without registering losses. In the present case, the harvested plants had a leaning position, without touching the ground.

From the determinations made, the *Avatar* variety had plant lengths between 67 and 95 cm (figure 5). Plants between 79 and 83 cm dominated, with the modal

value at 79 cm (23%). Plants with smaller lengths (67 cm) represented 3%, and the largest (95 cm) constituted 9% of the total.

The total weight of the plants was between 7 g and 21 g. Plants dominated with 11 g (23%) (figure 6). High values were in the range of 11-15 g. The lightest plants represented 3% and the heaviest 5%. The graph also highlights the spectrum of relatively higher weights, with values between 11 and 15 g. This fact suggests that this variety, through its genetic progress, could have prospects of much higher productive capacity (Espósito et al, 2009).

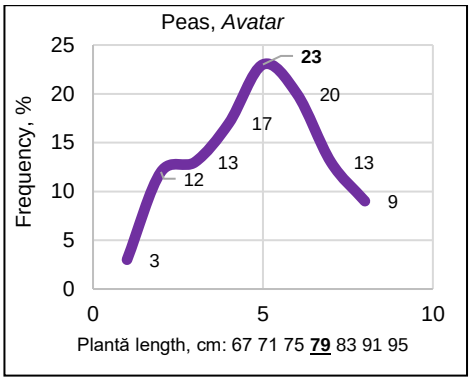

Figure 5. Frequencies of plants length

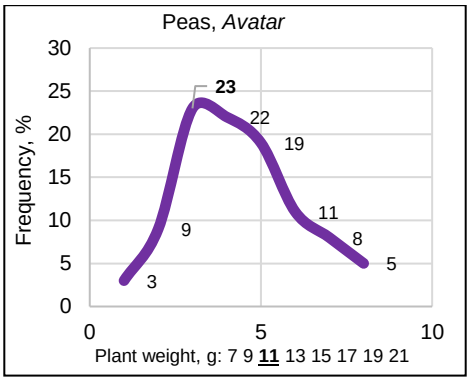

Figure 6. Frequencies of plants weight

Considering the high of plant, it was expected that the number of nodes would be a bit more numerous. From the determinations it emerged that the plants of this variety formed between 11 and 19 nodes. Those with 15-16 nodes were differentiated (figure 7). Their percentages were 21-22%, from a slightly wider range: 14-17 nodes supported by percentages between 17-18%. Pea pods were formed at the upper nodes of the plant (figure 8).

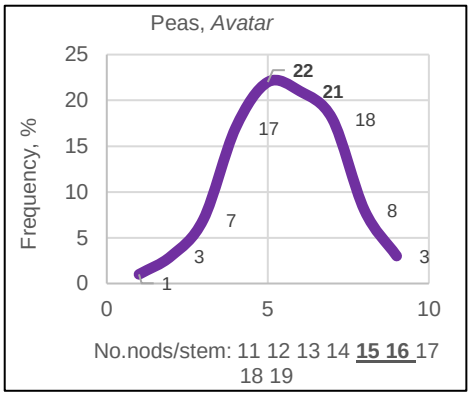

Figure 7. Frequencies of no. nods/plant

Figure 8. Pods at upper plant nods

Variability of pea pods and grains. Depending on the culture favorability: the climatic conditions and the technology used, the pea plant produced an important number of pods or pods (Togay et al, 2008; Tofiq et al, 2015). In the experiment the plants formed between 2 and 10 pods (figure 9). The plants that formed 6 pods each

(25%) dominated. Close to them were the plants with 5 pods (21%). Pea plants with 3 pods constituted only 4% of the total, and those with 10 pods, similarly, also 4%.

The total weight of the pods per plant had relatively broad limits, namely between 4 and 16 grams (figure 10). In this interval, the plants whose pods had a mass of 8 g dominated (31%). Close to them were the plants whose pods weighed 10 g (26%). Plants with a smaller pod mass (4 g) constituted 2%, and those with a pod mass of 16 g also contributed 2%.

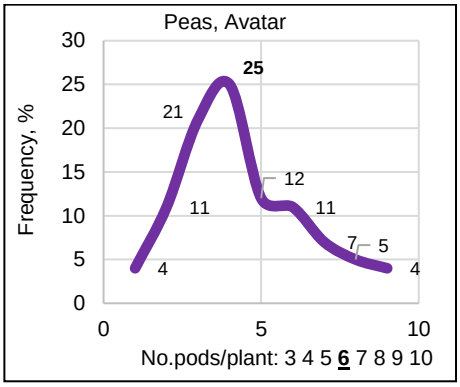

Figure 9. Frequencues of no. pods/plant

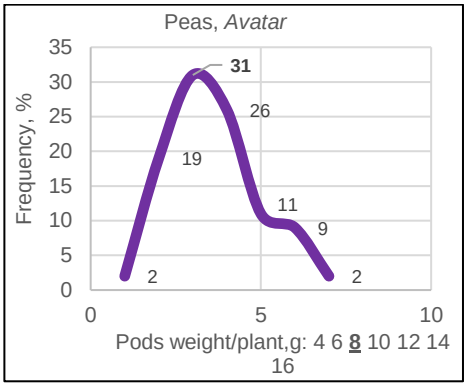

Figure 10. Pods weight/plant

The total number of grains on a pea plant had wide limits, namely between 10 and 50 (figure 11). Dominant were the plants whose grains were formed in an average number of 22 per plant (21%). Close to this number were the plants with 26 grains/plant (19%). At the extreme limits were the pea plants with 10 grains per plant (1%) and respectively 50 grains/plant (2%). The total weight of the grains on one pea plant was between 4 g and 13 g (figure 12). The plants whose berries weighed 5 g (19%) dominated, being closely followed by those with 6-7 g (17-18%) and 8 g (15%), respectively. Plants with 4 g represented 8% of the total, and those with 13 g, only 1% of the total.

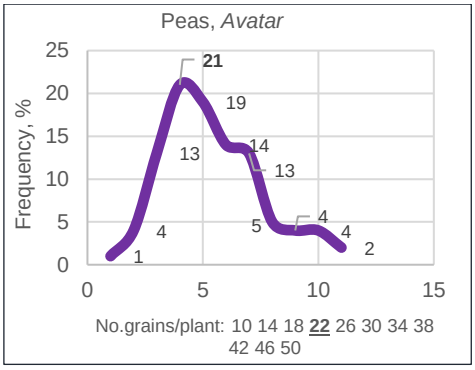

Figure 11. Frequencies of no. grains/plant

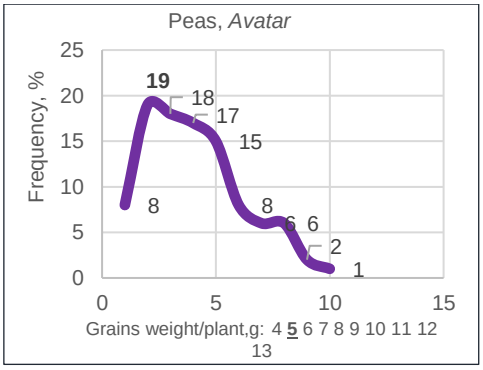

Figure 12. Frequencies of grains weight/plant

The physical appearance of peas describes a roughly globular shape with a glossy surface. The grains were measured in terms of diameter. A less wide range

of this parameter resulted from the data. Thus, the limits were between 5 mm and 8 mm (figure 13). Dominant were grains with a circumference of 7 mm (31 %). Grains with 6.5 mm (25 %) and 6 mm (23 %) in diameter had similar frequencies. The values obtained generally showed the registration between the normal values of the pea.

The absolute grain weight (expressed in MTG values) also had a fairly wide range of values. Thus, it was between 180 g and 320 g (figure 14). Grains with 260 g (26 %) dominated, being followed by those with 280 g (17 %), as well as with 240 g (15 %) and 300 g (16 %). The MTG of peas with extreme values were between 200 g (3% of the total) and 320 g (also 3%).

Correlations between determined morphological characters. At the level of the entire set of correlations obtained with all the characters analyzed in this pea variety, positive links resulted in most cases (Tofiq et al, 2015). Among these, the increasing correlations between the weight of the plant and the other characters related to it were noted (correlation coefficients obtained, r = .356 and r = .975). Instead, insignificant relationships were obtained between grain diameter and MMB with the other characters studied. Another particularly important aspect was the fact that no negative links were revealed between the main characters analyzed. The mass of 1000 grains were, however, significantly correlated with grain diameter (table 1).

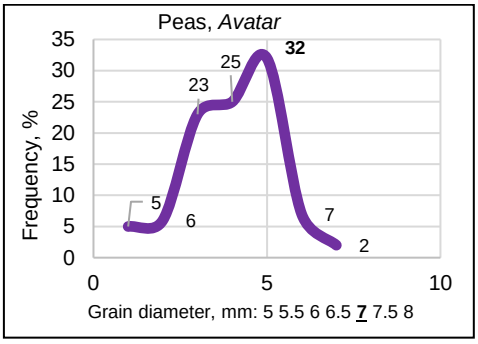

Figure 13. Frequencies of grain diameter

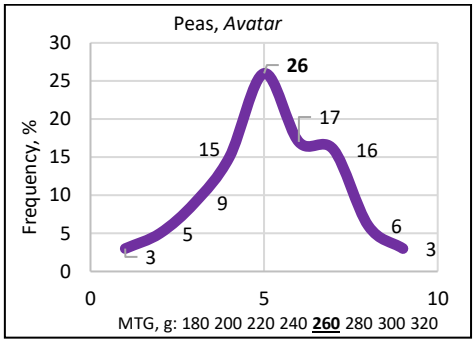

Figure 14. Frequencies of MTG

Table 1

Correlations between the main characters of peas plant, Avatar variety

Indicii	Plant weight, g	No. nods/ plant	No. pods/ plant	Pods weight/ plant, g	No. grains/ plant	Grains weight/ plant	Grain diameter, mm	MTG, g
Plant length	**.394**	**.266**	**.263**	**.405**	**.384**	**.406**	.044	.035
Plant weight	1	**.330**	**.785**	**.906**	**.869**	**.897**	.057	.040
No. nods		1	**.159**	**.232**	**.225**	**.216**	.017	.105
No. pods			1	**.826**	**.826**	**.784**	.007	.166
Pods weight,g				1	**.920**	**.989**	.101	.057
No. grains					1	**.901**	.071	.301
Grains weight,g						1	.136	.122
Grain diameter, mm							1	**.456**
LSD (5%)= .190			LSD (1%)= .250			LSD (0.1%)= .320		

Statistical analysis of morphological characters obtained in pea plants. The whole set of results obtained from the morphological analysis of pea morphological

characters showed specific aspects (table 2). Thus, the length (height) of the plant measured an average of 82 cm. This character had an average variability of 9%. The weight of an average plant at maturity was 13 g. The coefficient of variability was high, 29%. On an average pea stem, 15.5 nodes were formed, and its expression was quite low: 11% variability. The mean pod number was 6, pod weight 8 g, kernel number 26, and kernel mass 6.6 g. All these characters had high variability (between 30 and 35 %). The average pea grain was 6.36 mm in diameter, with low variability (11 %). The mass of one thousand grains was on average 256 g, with an average variability of 14.5%.

Table 2

Statistical indices of morphological characters of *Avatar* pea variety

Indices*	Plant length, cm	Plant weight, g	No. nods/ stem	No. pods/ plant	Pods weight, g	No. grains /plant	Grains weight, g	Grain diameter, mm	MTG, g
Mean	**81,65**	**12,96**	**15,51**	**6,44**	**8,22**	**26,35**	**6,61**	**6,36**	**255,8**
s^2	56.81	14.01	3.10	4.29	6.10	85.1	5,20	0,49	1371
s	7.54	3.74	1.76	2.07	2.47	9.23	2,28	0,70	37,02
VC, %	**9.2**	**28.9**	**11.4**	**32.3**	**30.0**	**35.0**	**34,5**	**11,0**	**14,5**

*S^2- variance, s- standard error, VC- variation coefficient, %

CONCLUSIONS

a) From the determinations carried out on peas, the Avatar variety, all showed morphological characters in progress. This variety has been shown to have new genetic improvements, especially for high productive potential.

b) Being a variety with a relatively large (tall) waist, the stem was 70-80 cm long. However, the plant being of the *afila* type, it resisted and remained throughout the growing season in a relatively vertical position. These characters of the plant have shown that this variety is currently very suitable for maximizing production. Improved agricultural techniques, through the scarification work, also contributed to the results obtained.

c) The plants had a total biomass of 11 g, with growth possibilities towards 15 g. The stem formed a multitude of floral nodes, of which the stems with 15-16-17 nodes dominated.

d) The number of pods formed was in the range of 3-10 per plant, and their biomass was between 4 and 16 g. The number of grains was in the range of 10-50 per plant, and their weight was between 4 and 13 g. The diameter of the grains was between 5 and 8 mm. The absolute mass of the grains was at a maximum level of 260-320 g.

e) Between all the characters studied, simple correlations were established, very favorable for all the indices that express this improved genetic endowment. Thus, positive and statistically assured correlations were generally obtained between the studied morphological characters. Only the diameter of the grain and the mass of one thousand grains correlated insignificantly with some characters, being at the same time still positive.

f) The variability of the morphological characters studied in the Avatar pea variety were both low to medium (around 10%) and high, more than 30%. From the resulting data it was clear that this new variety of pea benefited from a real improvement progress. As a result, it is recommended for the promotion of this variety with improved characters in production farms.

REFERENCES

Avci, M.A., Ceyhan, E. (2006). Correlations and genetic analysis of pod characteristics in pea (*Pisum sativum* L.). Asian Journal of Plant Sciences, 5 (1). 1-4.

Ellis, T.H.N., Poyser, S.J. (2002). An integrated and comparative view of pea genetic and cytogenetic maps. New Phytologist. 153 (1). 17–25.

Espósito, M.A., Martin E.A., Cravero V.P., Liberatti D., López A.F.S., Cointry E.L. (2009). Relationships among agronomic traits and seed yield in pea. Journal of Basic and Applied Genetics, 20(1). 1-8. FAO. 2012. http://faostat.fao.org/site/339/default.aspx.

Kreplak, J., Madoui, M.-A., Burstin, J. (2019). A reference genome for pea provides insight into legume genome evolution. Nature Genetics. 51 (9). 1411–1422.

Myers, J.R. Baggett, J.R. Lamborn, C. (2010). Origin, History, and Genetic Improvement of the Snap Pea (*Pisum sativum* L.), In J. Janick, ed. Plant Breeding Reviews, John Wiley & Sons, Inc. 93–138.

Siddika, A., Aminul Islam, A.K.M., Golam Rasul, M., Abdul Khaleque Mian, M., Jalal Uddin A. (2013). Genetic variability in advanced generations of vegetable pea (*Pisum sativum* L.). International Journal of Plant Breeding, 7 (2). 124-128.

Sturzu, R., Nistor, T., Nistor, G., Mîrlogeanu, S. (2005). Progrese în ameliorarea mazării la S.C.D.A. Teleorman. Analele INCDA Fundulea, vol. 72. 67-75.

Sturzu, R., Ene, A.M., Melucă, C., Iordan, C. (2016). Evaluarea principalelor caracteristici morfoproductive ale genotipurilor de mazăre de câmp (*Pisum sativum* L.) din colecția de la S.C.D.A. Teleorman. Analele INCDA Fundulea, 84. 95-106.

Togay, N., Togay, Y., Yldirim, B., Dogan, Y. (2008). Relationships between yield and some yield components in Pea (*Pisum sativum* ssp. *arvense* L.) genotypes by using correlation and path analysis. African Journal of Biotechnology, 7(23). 4285-4287.

Tofiq, S.E., Abdulkhaleq, D.A., Amin, T.N.H., Azez, O.K. (2015). Correlation and path coefficient analysis in seven field pea (*Pisum sativum* L.) genotypes created by half diallel analysis in Sulaimani region for F2 generation. International Journal of Plant, Animal and Environmental Sciences, 5(4). 93-97.

Yucel, D. O. (2013). Impact of plant density on yield and yield components of pea (*Pisum sativum* ssp. *sativum* L.) cultivars. ARPN Journal of Agricultural and Biological Science, 8 (2), 169-174.