

## Study of the variability of the sweet peppers landrace "Gelu" (*Capsicum annuum* var. *grossum*)

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**Abstract** The study aimed to assess phenotypic variability in a local sweet pepper population, outlined over time by growers in the Gelu-Satchinez area (western Romania). Its cultivation area has been reduced, but the population remains small farmers. The biological material was purchased from seedling producers in "Gelu". The experiment was performed over three years, in an experiment based on the randomized block method, in three repetitions. The applied technology was without chemical fertilization and with irrigation only at critical moments, without ensuring the optimal level of soil moisture. Were determined the parameters of intrapopulation variability, analysis of variance, application of the t test and correlation coefficients for the connections between the studied characters. The local population "Gelu" is characterized by lower plant height, a moderate number of fruits per plant and medium-sized fruits. There is a biotype 2 that has the longest and heaviest fruits. The existence of variability is also supported by the study of correlations between characters. The characters connections do not behave the same in all biotypes. In biotype 2 it is useful for the application of selection the positive link between the length and weight of the fruit. but there are also negative correlations that must be taken into account.

### Key words

sweet pepper, landraces, variability, morphological characters

Sweet pepper is a vegetable grown and appreciated all over the world. In Romania, it is one of the main vegetables for which, sporadically, are still found landraces in culture. These will be lost by promoting a new varieties and hybrids with high production potential, but also due to the modernization of cultivation technologies. These local forms can be useful as gene sources for breeding programs, or can be grown in organic farming system, it is adapted to the local conditions and tolerant of stress factors.

Studies on the heredity to sweet peppers show that for fruit production the heredity is high (92.97%), together with a high genetic gain (50.86%). This demonstrates that the selection for this character has an effect for the processing of local populations. A high heritability, but a moderate genetic gain occurs for the average weight of the fruit, for the number of fruits per plant and the thickness of the pericarp. And for these characters, the selection is efficient in processing of variability [12].

For sweet peppers, in addition to varieties and F1 hybrids, are also cultivated many populations For sweet peppers, in addition to F<sub>1</sub> varieties and hybrids, many populations are also cultivated that have resulted from the application of random selection by growers. There is a high genetic diversity in landraces that is not studied enough, so they are grown in small areas where

they were formed. Comparative sequencing studies between inbred lines and local populations have shown that landraces are an important reserve of genes for breeding programs. They found genes that are not present in germplasm commonly used in breeding centers of the area of origin of landraces [1].

The comparison of a landrace with the established varieties, with the help of molecular markers, showed important genetic differences between them. The landrace is totally different from the varieties used as a reference, this presenting some superior characteristics: precocity in fruit ripening, higher content in vitamin C, better maintenance of vitamin C during storage or preservation by pickling, and the level of productivity is that of varieties. All this recommends the study and preservation of local populations [5].

Regarding organic pepper crops, there are fewer studies. Some studies have shown that improved varieties behave similarly in terms of productivity and precocity in the organic farming system. Cultivating local forms could lead to better profitability, especially in terms of productivity, because they are better adapted to technologies without special protection against stress factors and without a rich supply of nutrients [4].

In processing variability, it is very important to know the correlations between characters. In materials with high genetic variability, it was found that fruit production per plant is strongly correlated with the number of fruits, both being involved in the production per unit area [13].

The analysis of some crosses and of the parental forms shows the existence of some phenotypic and genotypic coefficients of variation with moderate to high values. The heredity is high for many characters, which shows that selection can be effective. Along with other correlations, the fruit production per plant is positively correlated with the number of days until the first flowering, the number of branches per plant. Thus, the study of correlations should not be limited only to the morphological characteristics of the fruit (length, diameter, thickness of the pericarp, weight of the fruit, number of fruits per plant) [2].

Numerous studies attest to the effectiveness of applying the selection in the processing of the existing variability to sweet pepper due to the high heredity and at least moderate genetic gain, for fruit production [12].

Genetic gain is also good for other traits that indirectly influence plant productivity, such as total chlorophyll in leaves [9].

The manifestation of the characters is dependent on the genotype, but also on the environmental or technological conditions. The great diversity in the world and the consumer preferences for fruit size and quality show that the values for the main components of fruit production per plant fluctuate between very wide limits. They are mentioned, for the length of the fruit variations between 16.20 cm and 6.80 cm, for the number of fruits per plant between 90 and 10, for the production of fruits per plant between 7.09 kg and 0.5 kg, for the weight of a fruit between. These results highlight the possibility of exploring a very large variability in peppers [11].

## Material and Method

The aim of the study was to evaluate the phenotypic variability within a sweet pepper landrace, cultivated in western Romania. In the plain area of Banat, has emerged over time a sweet pepper landrace, recognized by growers, the population of „Gelu-Satchinez”. Its cultivation area has been greatly restricted, which is why it is appropriate to study the variability within this population. The population is maintained, but is no longer cultivated over large areas, except within households. Those who maintain it are seedling traders, who obtain seedlings from the seed produced by them. The biological material was purchased from seedling producers in Gelu, these being the most recognized in the area for the quality of the seedlings.

The experiment was performed over three years, in an experiment based on the randomized block method, in three repetitions. The establishment was

made with seedlings purchased each year from the same producers. Were used seedlings of four biotypes from four seed and seedling producers. The applied technology was an organic type, without chemical fertilization and with irrigation only in critical moments, without ensuring the optimal level of humidity in the soil.

The experimental data were processed by determining the parameters of intrapopulation variability (average, standard deviation of the average and coefficient of variability), analysis of variance, application of the t test and establishment of correlation coefficients for the connections between the studied characters. Were observed the main characters that contribute to the production of the plant, or other characters through which the biotypes can be distinguished from each to other. The comparison was made with the average experience [6].

## Results and Discussions

The study of the variability of some morphological characters highlights the fact that there is a variability through which the four biotypes are different from each to other (table 1).

The height of the plant showed low values, this being a characteristic of the "Gelu" landrace. The averages for this character were between 29.42 cm and 39.88 cm. The higher plants are present in biotype 2, and the shorter the biotype 4. In these biotypes (2 and 4) the intrapopulation variability is moderate, and in the other two biotypes it is high.

The number of fruits per plant showed low values, due to the technology applied and the high temperatures that caused the abortion of some flowers. Another reason was to consider only commercially suitable fruits, with small ones being eliminated. Biotypes 2 and 4 showed averages of over 6 marketable fruits per plant. In biotype 1, the averages were the lowest. In all biotypes, the variability of this character is very high.

The length of the fruit showed average values between 7.57 cm for biotype 1 and 9.12 cm for biotype 2. The length of the fruit is quite uniform, with a medium variability. The diameter of the fruit, taken at its base, is the most uniform character, the coefficients of variability having very low values. The averages were between 4.74 cm (biotype 1) and 5.31 cm (biotype 2).

The length of the peduncle can be used as a descriptor, which is why it has been studied. In the studied biotypes, this character had a moderate variability and presented average values between 2.55 cm and 3.35 cm.

An important feature is the average weight of the fruit. Only in biotype 4 this character has a moderate variability, in the other biotypes the variability being higher. The mean values were between 44.31 g for biotype 1 and 71.52 g for biotype 2.

According to these results, it is found that there are morphological differences between biotypes, the biotype 2 being the one with higher values of plant height, fruit size and weight. The biotype 1 is the one with the lowest average values for all characters.

Studies on the richness of local germoplasm have been performed on materials from western Romania. They highlighted the fact that there are superior landraces to the widely cultivated varieties in terms of productivity components, even in terms of fruit production per plant. Studying the correlations between the characters, a positive link was found

between the weight of the fruit per plant and the diameter and weight of the fruit, and the number of fruits per plant is closely correlated with the production of fruits per plant [8].

All studies show that qualitative or quantitative traits show large variations in the existing germplasm. Studies conducted in Asia have shown that the length and diameter of the fruit, but also the thickness of the pericarp are highly variable characters, and most forms have conical fruits and red color at maturity [3].

Table 1.

**Results regarding the variability of characters in the biotypes of the "Gelu" sweet pepper landrace**

| Character                              | Biotype 1  |       | Biotype 2  |       | Biotype 3  |       | Biotype 4  |       |
|--|------------|-------|------------|-------|------------|-------|------------|-------|
|  | x±sx       | s%    | x±sx       | s%    | x±sx       | s%    | x±sx       | s%    |
| Plant height (cm)                      | 32.42±3.41 | 27.85 | 39.88±1.88 | 14.20 | 35.55±3.86 | 32.65 | 29.42±1.41 | 12.69 |
| Fruits number / plant                  | 4.00±0.69  | 45.64 | 6.00±0.72  | 36.32 | 5.11±0.63  | 37.17 | 6.28±0.74  | 31.43 |
| Fruit length (cm)                      | 7.57±0.47  | 16.70 | 9.12±0.57  | 18.98 | 8.61±0.38  | 13.41 | 8.52±0.41  | 12.74 |
| Diameter at the base of the fruit (cm) | 4.74±0.16  | 9.09  | 5.31±0.17  | 9.93  | 5.22±0.16  | 9.61  | 5.21±0.15  | 8.01  |
| Peduncle length (cm)                   | 2.55±0.132 | 13.33 | 3.35±0.11  | 10.33 | 3.02±0.11  | 11.31 | 2.57±0.13  | 13.78 |
| Fruit weight (g)                       | 44.31±4.72 | 28.18 | 71.52±8.55 | 35.88 | 65.59±6.31 | 28.87 | 68.55±3.75 | 14.48 |

By applying the analysis of variance, the existence is highlighted if the differences between the biotypes are statistically ensured. From the data of table 2 it is found that differences from the average of the experience appear in the case of some of the studied characters. The biotype 1 is different from the population average, with lower average values, statistically assured in the case of the characters: the number of fruits per plant, the length of the fruit and the weight of the fruit. This shows that the biotype 1 is the least productive. The biotype that stands out is the biotype 2, in which compared to the average experience, the differences are ensured statistically in the case of fruit length and fruit weight. According to this situation, it is recommended to process and promote the biotype 2, which has the highest values for the characters involved in achieving plant productivity.

The existence of different biotypes within local populations has also been found.

The value of landraces was also studied in terms of quality elements along with morphological characters. The complex characterization of the genetic and phenotypic, morphological and qualitative variability of some biotypes extracted from a landrace showed that there are differences at morphological and qualitative level. Within the population "Friariello" (cultivated in Italy) there are five distinct groups. It emphasizes that the landraces must be capitalized on in breeding programs after a very thorough study of them [10].

In the evaluation of the variability of the experimented material, in addition to these observations on the morphological characters, it is also

necessary to apply modern methods for evaluating genetic variability with the help of molecular markers.

The study of the correlation coefficients between the studied characters highlights the existence of a difference between biotypes. For none of the correlations is there a similar behavior of all biotypes (Table 3). In general, the correlation coefficients have low values. only in certain situations are correlations between some characters present in some biotypes. The highest values of the correlation coefficients (over 0.9) are present for the connection between plant height and fruit length in biotype 1, but also for the connection between fruit length, diameter and weight in biotype 2. In biotype 2, which is the most productive, this situation can be capitalized on in selection. Choosing the longest fruits will also improve the weight of the fruit.

It is very interesting that in all biotypes, the diameter of the fruit has no influence on the weight of the fruit.

Should not be omitted the significant negative correlations, in particular those present in biotype 2, namely those between the number of fruits per plant and the height of the plant or the diameter of the fruit, or those between plant height and fruit diameter.

Previous studies, performed on other materials, show that fruit production per plant is influenced by 50% of the number of fruits, following the diameter of the fruit. The diameter of the fruit has a contribution of over 70% to the weight of the fruit, less important being the length of the fruit [7].

Can be useful in the selection process may also correlations between the length of the peduncle and the weight of the fruit in biotype 1, between the

length of the peduncle and the number of fruits per plant in biotype 2, or that between the length of the fruit and the number of fruits per plant in biotype 3.

The study of these correlation coefficients does not provide data that can be generalized in the selection applied to bell peppers. These findings are useful in the selection processing of the studied biotopes. Studies on the correlations between characters can be completed by applying more complex methods of assessing the links between characters.

The correlations must be exploited effectively for establish a selection strategy. The existence of positive and significant genotypic and phenotypic correlations can improve the effectiveness of selection for productivity. Such correlations were found between plant productivity and the number of fruits per plant, fruit weight, fruit diameter, number of fruit lobes and number of primary branches. These characters are recommended to be followed in the selection for a higher productivity in sweet peppers [14].

Table 2.

**Results regarding the manifestation of morphological characters in the biotypes of the "Gelu" sweet pepper landrace**

| Character / biotype                                  | Average | Percentage relative to control | The difference compared to the control | Significance |
|--|---------|--------------------------------|--|--------------|
| <b>Plant height (cm)</b>                             |         |                                |  |              |
| biotype 1  | 32.42   | 94.49                          | -1.89                                  | -            |
| biotype 2  | 39.88   | 116.23                         | 5.75                                   | -            |
| biotype 3  | 35.55   | 103.61                         | 1.24                                   | -            |
| biotype 4  | 29.42   | 85.74                          | -4.89                                  | -            |
| average experience                                   | 34.31   | 100                            | 0                                      | mt           |
| LSD5% =7.22 cm; LSD1% = 10.94 cm; LSD 0.1% =17.58 cm |         |                                |  |              |
| <b>Fruits number / plant</b>                         |         |                                |  |              |
| biotype 1  | 4.00    | 74.90                          | -1.34                                  | 0            |
| biotype 2  | 6.00    | 112.35                         | 0.66                                   | -            |
| biotype 3  | 5.11    | 95.69                          | -0.23                                  | -            |
| biotype 4  | 6.28    | 117.60                         | 0.94                                   | -            |
| average experience                                   | 5.34    | 100                            | 0                                      | mt           |
| LSD5% =1.33; LSD1% = 2.02; LSD 0.1% =3.25            |         |                                |  |              |
| <b>Fruit length (cm)</b>                             |         |                                |  |              |
| biotype 1  | 7.57    | 89.57                          | -0.88                                  | 00           |
| biotype 2  | 9.12    | 107.92                         | 0.67                                   | *            |
| biotype 3  | 8.61    | 101.89                         | 0.16                                   | -            |
| biotype 4  | 8.52    | 100.82                         | 0.07                                   | -            |
| average experience                                   | 8.45    | 100                            | 0                                      | mt           |
| LSD5% =0.55 cm; LSD1% =0.84 cm; LSD 0.1% =1.35 cm    |         |                                |  |              |
| <b>Diameter at the base of the fruit (cm)</b>        |         |                                |  |              |
| biotype 1  | 4.74    | 92.57                          | -0.38                                  | -            |
| biotype 2  | 5.31    | 103.71                         | 0.19                                   | -            |
| biotype 3  | 5.22    | 101.95                         | 0.10                                   | -            |
| biotype 4  | 5.21    | 101.75                         | 0.09                                   | -            |
| average experience                                   | 5.12    | 100                            | 0                                      | mt           |
| LSD5% =0.90 cm; LSD1% =1.37 cm; LSD 0.1% =2.20 cm    |         |                                |  |              |
| <b>Peduncle length (cm)</b>                          |         |                                |  |              |
| biotype 1  | 2.55    | 88.85                          | -0.32                                  | -            |
| biotype 2  | 3.35    | 116.72                         | 0.48                                   | -            |
| biotype 3  | 3.02    | 105.22                         | 0.15                                   | -            |
| biotype 4  | 2.57    | 89.54                          | -0.30                                  | -            |
| average experience                                   | 2.87    | 100                            | 0                                      | mt           |
| LSD5% =0.66 cm; LSD1% =1.00 cm; LSD 0.1% =1.61 cm    |         |                                |  |              |
| <b>fruit weight (g)</b>                              |         |                                |  |              |
| biotype 1  | 44.31   | 70.90                          | -18.18                                 | 000          |
| biotype 2  | 71.52   | 114.45                         | 9.03                                   | *            |
| biotype 3  | 65.59   | 104.60                         | 3.10                                   | -            |
| biotype 4  | 68.55   | 109.69                         | 6.06                                   | -            |
| average experience                                   | 62.49   | 100                            | 0                                      | mt           |
| LSD5% =7.05 g; LSD1% =10.67 g; LSD 0.1% =17.15 g     |         |                                |  |              |

Table 3.

**Results regarding the values of the correlation coefficients for the connections between the characters studied in the biotypes of the "Gelu" sweet pepper landrace**

| Biotype   | Character                              | Plant height | Fruits number / plant | Fruit length (cm) | Diameter at the base of the fruit (cm) | Peduncle length (cm) |
|-----------|--|--------------|-----------------------|-------------------|--|----------------------|
| biotype 1 | Fruits number / plant                  | 0.707**      |                       |                   |  |                      |
| biotype 2 |  | 0.002        |                       |                   |  |                      |
| biotype 3 |  | 0.296        |                       |                   |  |                      |
| biotype 4 |  | 0.658*       |                       |                   |  |                      |
| biotype 1 | Fruit length (cm)                      | 0.933        | 0.793**               |                   |  |                      |
| biotype 2 |  | -0.662*      | -0.638*               |                   |  |                      |
| biotype 3 |  | 0.170        | 0.784**               |                   |  |                      |
| biotype 4 |  | 0.094        | -0.141                |                   |  |                      |
| biotype 1 | Diameter at the base of the fruit (cm) | 0.118        | -0.273                | -0.130            |  |                      |
| biotype 2 |  | -0.158       | -0.670*               | 0.613*            |  |                      |
| biotype 3 |  | -0.141       | -0.031                | 0.134             |  |                      |
| biotype 4 |  | 0.697*       | -0.594*               | -0.197            |  |                      |
| biotype 1 | Peduncle length (cm)                   | -0.268       | -0.104                | -0.277            | -0.380                                 |                      |
| biotype 2 |  | 0.294        | -0.768**              | 0.214             | 0.384                                  |                      |
| biotype 3 |  | 0.304        | 0.137                 | -0.402            | -0.550                                 |                      |
| biotype 4 |  | 0.212        | 0.031                 | -0.368            | 0.228                                  |                      |
| biotype 1 | Fruit weight (g)                       | 0.646*       | 0.406                 | 0.684*            | 0.391                                  | 0.833***             |
| biotype 2 |  | -0.520       | -0.550                | 0.908***          | 0.714**                                | 0.126                |
| biotype 3 |  | 0.031        | 0.626*                | 0.676*            | 0.690*                                 | -0.500               |
| biotype 4 |  | -0.634*      | -0.379                | 0.378             | 0.780**                                | -0.214               |

$r_{5\%} = 0.576$  ;  $r_{1\%} = 0.708$  ;  $r_{0.1\%} = 0.823$

## Conclusions

The evaluation of the manifestation of morphological characters in the four biotypes shows that there is a significant difference between them. The "Gelu" landrace is characterized by lower plant height and plant productivity is moderate. Of the four biotypes studied, the biotype 1 is lower for the average values of the number of fruits per plant, fruit length and fruit weight, being the least productive. The biotype 2 stands out, with high values of averages for fruit length and fruit weight. It is recommended the selection processing of biotype 2, which is the most valuable in terms of plant productivity. The existence of variability is also supported by the manifestation of correlations between characters. For none of the correlations, there is no similar behavior of all genotypes. In certain situations, in some biotypes there are correlations between some characters, but it is not possible to generalize their existence to the entire landrace. The highest values of correlation coefficients are present for the relationship between plant height and fruit length in biotype 1, but also for the connection between the length and weight of the fruit in biotype 2. In biotype 2, choosing the longest fruits will also improve the weight of the fruit. The studied landrace can serve as a selection material for the improvement of production characters in order to practice an organic crop in the area of origin.

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