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Possibility of Use of Romanian Bell Pepper (*Capsicum annuum* L. var. *grossum*) Local Landraces in Breeding Process

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Abstract

For breeding new varieties, local germoplasm can constitute a gene reservoir that is still unused. The study concerned 29 local populations collected from the counties of Timis, Arad, Bihor, which were compared with 'Cristal'variety. The main morphological characters, components of production capacity, concerning variability and existing correlations, were followed. 4 populations with significantly bigger fruits than the control varieties, were observed. Compared with 'Cristal'variety, three populations have a very significantly bigger number of fruit per plant: 'Satchinez', 'Siria', 'Girisu de Cris'. The yield of fruit per plant is superior for many of the collection population: 'Satchinez' ,'Temeresti I', 'Siria', 'Girisu'de Cris', 'Fizis', 'Tomnatic' and 'Vinga'. The study indicate positive correlation between fruit weight/plant and fruit's diameter and weight. However, about 80% of the fruit diameter variability is due to the influence of other characters. The correlation between fruit diameter and fruit weight/plant is not significant. Depending of the path coefficients, it was found that the number of fruit per plant shows a very tight correlation with fruit yield, and that there are considerable indirect influence on the correlation between fruit production and fruit diameter, fruit weight respectively. The established dendrogram shows that there is an obvious diversity between the populations that were collected from the same locality. Bidimensional diagram shows that 'Temeresti I' and 'Fizis' populations have the fruits of the highest length, diameter and weight, and 'Satchinez', 'Siria', 'Girisu de Cris' populations have the highest number of fruits and the highest weight of fruit per plant.

Keywords: *Capsicum annuum* L. var. *grossum*, landraces, morphological charactrers variability, correlation

Introduction

Natural variability of pepper is very pronounced, being due to the large number of varieties, as well as a wide range of forms within each variety. In the world several hundred types of peppers are cultivated (Sanatombi and Sharma, 2008). The types are under specific categories that allows to distinguish between specific horticultural varieties. Most of peppers cultivars that are grown for commercial purposes have very different characters, but all belong to the genus *Capsicum annuum*. Exceptions are *C. chinense* and *C. frutescens* (Bosland *et al*., 1998)

By using dialele hybridization, has been found that for the fruit weight and fruit diameter the additivity is essential, and for the fruit precocity and length there are specific effects, other than additive. the data that were leading to these conclusions are shown in tab. 3-1 (Harzallah and Chalbi, 1993)

In the world several hundred types of peppers are cultivated. Their improvement in terms of productivity and quality is continuous due to the specific requirements of the industry. (Greenleaf, 1986)

Germoplasm diversification may be achieved on different ways. The breeding program of pepper, founded by Cardi in 1997, has managed to get results in three directions, among those is the use of local landraces. A selection for stability has permitted creation of valuable cultivars from local landraces (Herman, 2005).

Exotic germoplasm offers a high genetic diversity that is useful in pepper breeding and played an important role in breeding and genetics programs from New Mexico State University. Because the exotic germoplasm can be found in different climatic conditions areas, it can be used as useful genes reservoir. However, the potential of exotic germoplasm is insufficiently exploited (Bosland, 1993).

For the bell pepper, the breeding process has progressed, in culture being placed varieties and hybrids. The program of hybrids obtaining can be facilitated by using the androsterility. Concerning that on the widest scale, for obtaining commercial hybrid seed, castration and manual pollination is applied, the cultivars will still remains in culture, seed production costs being lower (Subodh and Berke, 2005).

For breeding new races, the local germoplasm may constitute a gene reservoir yet unused. The disappearance of

those from culture is inevitable concerning the conditions of an intensive agriculture. For organic farming, based on the exploitation of the natural reserves of fertility and the exclusion of chemical treatments, local landraces will be the main starting point in getting some varieties with a high degree of adaptability and reduced requirements to technological measures. Study of genetic inheritance, of treats variability, of correlations between those, it is necessary for valuing this biological material. The most valuable populations, as results from experimental evaluations, may be recommended to be cultivated in the areas of origin, areas for which those have been adapted during cultivation (Madosa *et al*., 2002; Madosa, 2003).

The main goal of the study is the evaluation of local landraces, concerning some treats that are component of production capacity and the establishment of some useful indicators for breeding programs.

Material and methods

The biological material was collected in different localities of the counties of Timiş, Arad and Bihor. Areas from where the collection was performed were either areas with tradition in bell pepper cultivating, or areas with traditional agriculture where local landraces are maintained in culture. In the end 28 populations were collected, which were compared with 'Cristal'variety.

Experimental data have been processed by statistical methods: evaluation of character variability indexes, comparing those with control variety, establishing correlations between characters (correlation coefficients, partial and half partial correlation coefficients, coefficients path), and multivariate analysis of variability and phenotypic similarity between populations (coefficients of similarity, populations UPGMA by cluster average method, biplot graphic (Ciulca, 2006; Kwon and Torie 1964).

Results and discussions

This paper presents three of the main components of plant productivity: the average weight of a fruit, the number of fruits on plants and fruits production on plant. For the average weight of the fruit is found that the collected populations are close to the witness variety. Averages of two years are highlighting the 'Temeresti I' population, with an average of 91.52g average mass of fruit, exceeds the 'Cristal'witness variety with an significantly growth. In the same category of significance are also included 'Cutina', 'Fizis' and 'Becicherecu Mic' populations. Eight of the collection populations have presented fruit with significantly less weight than the mass of the control variety. This situation shows that the material collected for bell pepper has fruit close in size to those of improved races. For breeding process, these forms are useful in order to improve the average weight of the fruit (Tab. 1).

The number of fruit per plant is another element of productivity. Considering the ability of flowering, the number of fruit is very high, but not all flowers will became fruits. In addition, some of the fruits formed at the end of vegetation cannot be recovered because they remain small. The average of this character in the two experimental years was between 20.7 fruits at 'Satchinez' population and 6.24 fruits to 'Gelu' population. Very interesting is that the two populations are very different, although originate from two close localities.

Comparing to the 'Cristal'variety, three populations presents fruit number per plant significantly higher: 'Satchinez', 'Siria' and 'Girisu de Cris'. Noticeable is that the localities 'Satchinez' and 'Siria' have tradition in cultivating bell pepper, from here may result the influence of grower on the character. A longer selection can improve this character. Valuable for this character is also the population of Becicherecu (differences significant) but also populations of 'Tomnatic', 'Belint II', Ohaba Lunga and 'Pordeanu'). The number of the populations inferior to the control variety count for the number of fruits on plants is reduced. From this data it can confirmed that the local landraces have a high productivity.

The number of fruits on a plant makes the production of fruit per plant to be superior to many populations. Most valuable proved to be the population from 'Satchinez', with a total 1202g average weight of fruits per plant. It can be seen from the data recorded in each year that this character is very variable. The averages of the two years reveal distinct significant increased production per plant compared to the 'Cristal'variety, for 'Satchinez', 'Temeresti I' and 'Siria' populations and for the populations 'Girisu de Cris', 'Fizis', 'Tomnatic' and 'Vinga' yields per plant were significantly higher. Therefore, it can be found that the populations of bell pepper collected, are valuable in terms of fruits on plants production and they can be used in breeding programs both as genitors and as populations where selection can be directly applied.

Studying the productivity elements of the plant is was found that the large plant yields are obtained on the basis of the big number of fruit per plant, populations that have higher yields on the plant then the witness, presents number of fruit plant in the same category: 'Satchinez', 'Siria', 'Tomnatic', 'Vinga'. Only the yield evaluation of the 'Temeresti I' population plants is based on the size of the fruit.

The variability existing in local land races was valued by many researchers. The collection studied by us could be a starting point in breeding programs (Geleta *et al*., 2005; Sood Sonia *et al*., 2009; Sharma *et al.*, 2010).

Jakulovski *et al*. (1997) showed that correlation coefficients knowledge allows simultaneous improvement of two or more characters. The correlations shown in Tab. 2 indicates positive and very significant relationship between weight of fruit/plant and diameter, weight, number of fruit lodges, as well as between the diameter and weight

of the fruit. A positive correlations between the diameter of the fruit and number of fruits/plant, the weight of the fruit and number of fruit/plant, length and weight of the fruit also exist, but they are insignificant

Knowing the path coefficients,the application of selection process can be assisted. (Mini and Vahab, 2002). As regards the path coefficients, it appears that the number of fruits per plant has a very compressed correlation to the fruit production, with a major direct contribution (P=0.654). This character presents also a considerable indirect influence on correlations between the fruit production and fruit diameter, weight of fruit, respectively (Tab. 3). The fruit weight shows an important direct contribution on the variability of weight of fruit per plant, at the same time and an indirect effect through the diameter of the fruit.

The 'Cristal'variety alongside with indigenous 'Gelu' and 'Seleus' populations shows phenotypic similarity averaging about 97% and a differentiation of approximately 7% compared to the populations of 'Aldesti', 'Temeresti II', 'Julita', 'Rieni I', 'Cenad', 'Dudestii Vechi', 'Buteni' and 'Altringen' (Fig. 1).

The second group is containing the populations 'Cutina', Simian, 'Ceica', between which a phenotypic similarity of approximately 94% is registered, on the basis of a diversity of average about 11% compared to the populations of the first group.

The third group reveals a genetic diversity of 14% compared to the first two and an medium similarity of 97% between component populations ('Belint', 'Ohaba Lunga', 'Rieni II').

Between populations: 'Siria', 'Girisu de Cris' 'Tomnatic', 'Chesint', 'Vinga', 'Tagadau', 'Pordeanu', there is a phenotypic diversity reduced to 4%, under the conditions of a average similarity of 86% compared with the group of population: 'Temeresti II', 'Fizis', 'Becicherecu Mic'. Those

Tab. 1. Values of morphological studied characters

Landrace	Weight of fruit (g)		Fruit number/plant		Weight of fruits /plant (g)	
	Average (g)	Diff. to control (g)/ Signification	Average	Diff. to control Signification	Average (g)	Diff. to control (g)/ Signification
'Cristal'(control)	66.49	0	9.51	Mt	619.25	Mt.
'Gelu'	64.24	-2.24	6.24	-3.26	391.52	-227.69
'Aldesti'	75.49	9	8.00	-1.51	603.92	-15.29
'Seleus'	56.24	-10.24^{0}	7.77	-1.74	435.51	-183.70
'Cutina'	79.02	12.53*	11.05	1.54	896.81	277.60
'Simian'	75.51	9.02	10.86	1.35	916.46	197.24
'Altringen'	68.29	1.8	9.64	0.13	648.40	29.18
'Satchinez'	54.02	12.47^{0}	20.67	11.16***	1202.12	582.91**
'Temeresti I'	91.52	25.03*	13.59	4.08	1192.80	573.58**
'Temeresti II'	64.33	-2.15	8.36	-1.15	540.13	79.08
'Julita'	61.69	-4.8	9.10	-0.41	559.66	-59.55
'Siria'	61.86	-4.63	18.62	9.11***	1176.75	557.53**
'Girisu de Cris'	59.93	-6.56	18.32	8.81***	1086.87	467.65*
'Fizis'	87.79	21.3*	11.83	2.32	1025.02	405.81*
'Tomnatic'	66.17	-0.31	15.68	6.17*	1039.56	420.35*
'Rinei I'	68.87	2.38	9.94	0.43	684.18	64.96
'Ceica'	60.47	-6.02	10.47	0.96	658.61	39.39
'Cenad'	58.80	-7.69	11.84	2.33	697.52	78.30
'Belint I'	41.16	-25.32^{0}	9.49	-0.01	403.29	-215.92
'Belint II'	55.95	-10.53	15.10	5.59*	896.43	277.21
'Tagadau'	58.77	-7.72	15.68	6.17*	884.15	264.94
'Ohaba Lunga'	38.67	27.81^{0}	14.02	4.51	550.07	-69.14
'Vinga'	66.59	0.1	16.53	7.02**	1087.92	468.70*
'Becicherecu Mic'	78.36	11.87*	12.50	2.99	978.15	358.94
'Buteni'	52.46	-14.02^{0}	12.37	2.86	624.80	5.59
'Pordeanu'	55.16	-11.32^{0}	14.92	5.41*	883.94	264.72
'Dudestii Vechi'	54.80	-11.69^{0}	12.32	2.81	714.08	94.86
'Chesinti'	62.99	-3.49	13.71	4.20	928.32	309.11
'Rieni II'	38.27	-28.22^{0}	12.20	2.69	476.15	-143.06
	DL 5%= 9.83 g DL 1%= 33.24 g DL 0.1%= 17.61 g		DL 5%= 4.87 fruits DL 1%= 6.56 fruits DL 0.1%= 8.72 fruits		DL 5%= 390.93 g DL 1%= 526.33 g DL 0.1%= 699.86 g	

populations also revel a phenotypic diversity of approximately 18% compared to the populations of the other three clusters.

On the basis of the data presented in the dendrogram presented in Fig. 2, it can be noted that there is also an obvious diversity between collected populations, from the same locality namely: 24% between 'Temeresti' populations; 20% between 'Belint' populations and 10% between the populations of 'Rieni'.

According to the biplot graphic (Fig. 2), that explains about approximately 76% of the variability for the five studied characters, it appears that the populations of 'Temeresti I' and 'Fizis' revel the highest values of length, diameter and fruit weight . Also, the populations of 'Satchinez', 'Siria' and 'Girisu de Cris' have recorded the highest values of the number and weight of fruit per plant.

Conclusions

The collected populations have fruit,of similar average weight, close to the witness variety. The fruits are close in size to those of improved varieties. Large-fruited landraces, such as 'Satchinez', 'Siria', 'Girisu de Cris' have been noted. Yield per plant has been superior to many of the collection populations. Populations that were proved to be valuable were 'Satchinez', 'Temeresti I', 'Siria', 'Girisu de Cris', 'Fizis', 'Tomnatic' and 'Vinga'.

Tab. 2. Covariance values and correlation coefficients between quantitative characters examined in bell pepper landraces

Character	Fruit diameter (s^2=0.58)	Fruit weight (s^2=344.75)	Fruit number/ plant (s^2=14.57)	Fruit weight/plant (s^2=138567)
Fruit lengh	r = -0.029 S^2_{XY} = -0.02	r = 0.296 S^2_{XY} = 5.24	r = -0.143 S^2_{XY} = -0.52	r = 0.129 S^2_{XY} = 45.78
Fruit diameter		r = 0.841*** S^2_{XY} = 11.84	r = 0.419 S^2_{XY} = 1.21	r = 0.758*** S^2_{XY} = 213.95
Fruit weight			r = 0.316 S^2_{XY} = 22.41	r = 0.771*** S^2_{XY} = 5331.93
Fruit number/plant				r = 0.828*** S^2_{XY} = 1176.26

$r_{5\%}$ = 0.423; $r_{1\%}$ = 0.537; $r_{0,1\%}$ = 0.652

Tab. 3. Analysis of path coefficients for weight of fruit/plant from bell pepper landraces

Correlations links	Path coefficients
Fruits weight/plant - - Fruit Length	
Direct effect of fruit length	0.098
indirect effect, by fruit diameter	-0.004
by fruit weight	0.128
by fruit number/plant	-0.094
Total correlation	0.129
Fruits weight/plant - - Fruit diameter	
Direct effect of fruit diameter	0.124
indirect effect, by fruit length	-0.003
by fruit weight	0.363
by fruit number/plant	0.274
Total correlation	0.758
Fruits weight/plant - - Fruit weight	
Direct effect of fruit weight	0.432
indirect effect, by fruit length	0.029
by fruit diameter	0.103
by fruit number/plant	0.207
Total correlation	0.771
Fruits weight/plant - - Fruit number/plant	
Direct effect of fruit number/plant	0.654
indirect effect, by fruit length	-0.014
by fruit diameter	0.052
by fruit weight	0.137
Total correlation	0.828

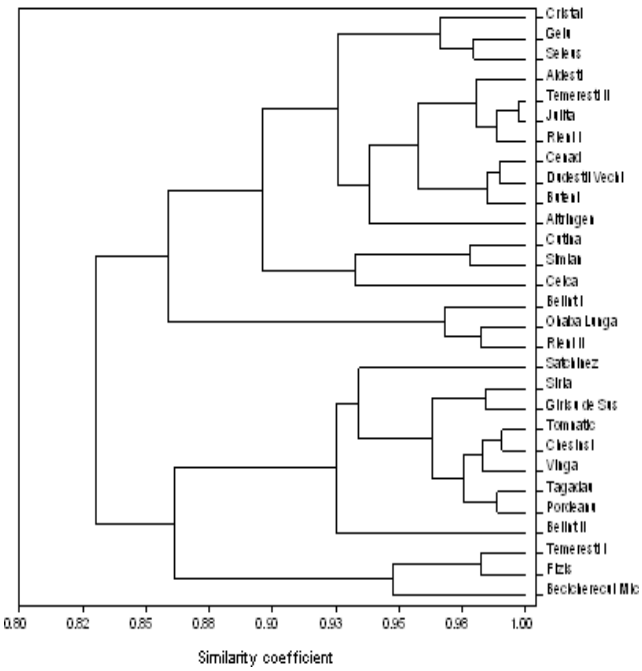

Fig. 1. UPGMA clustering of bell pepper landraces according with the quantitative yield traits

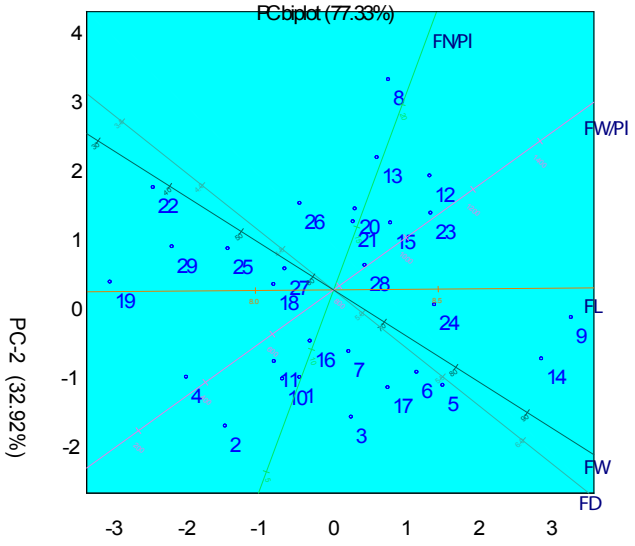

Fig. 2. Biplot graphic of first two principal components for the studied bell pepper landraces and traits

1-'Cristal'; 2-'Gelu'; 3-'Aldesti'; 4-'Seleus'; 5-'Cutina'; 6-'Simian'; 7-'Altringen'; 8-'Satchinez'; 9-'Temeresti I'; 10-'Temeresti I'I; 11-'Julita'; 12-'Siria'; 13-'Girisu de Cris'; 14-'Fizis'; 15-'Tomnatic', 16-Rieni I; 17-'Ceica'; 18-'Cenad'; 19- 'Belint I'; 20-'Belint II'; 21- 'Tagadau'; 22-'Ohaba Lunga'; 23-'Vinga'; 24-Becicherecul Mic; 25-'Buteni'; 26-'Pordeanu'; 27-'Dudestii Vechi'; 28-'Chesint'; 29-'Rieni II'.

There were found positive correlation between weight of fruits/plant and fruit diameter and weight. About 80% of the variability of the fruit diameter is due to the influence of the other characters, and the correlation between the fruit diameter and fruit weight/plant is not real but only apparent. The number of fruit/plant has a higher stability, being influenced just 19% compared the other traits and manifesting a real correlation to the production of fruit/plant.

The number of fruits on plant has a very significant correlation with the yield of fruit, a considerable indirect influence exists to correlations between the production of fruit and fruit diameter, and weight of fruit, respectively.

The cluster analysis shows that there is an obvious diversity also between the populations collected from the same locality. The populations of 'Temeresti I' and 'Fizis' revealed the highest values of length, diameter and weight of the fruit, and populations of 'Satchinez', 'Siria' and 'Girisu de Cris' have recorded the highest values of the number and weight of fruit per plant.

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