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Evaluation of small size fruit peppers *Capsicum annuum* spp. microcarpum with cluster and factor analysis

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Abstract. *43 specimens of local small size fruit peppers (Capsicum annuum sub. microcarpum) were examined and characterized with reference to the indicators: shrub height, number of shrub branches, leaf length, leaf width, fruit length, fruit diameter, one pepper mass, 1000 seeds mass, number of fruit on one plant. The research was conducted in the experimental field of Institute of Plant Genetic Resources (IPGR), Sadovo, in the period of 2009 – 2011. On the base of the examined indicators, the specimens were evaluated complexly through a hierarchical cluster analysis. Genetically close specimens were grouped in 7 main clusters and presented with the help of a dendrogramm. In addition, a factor analysis was made to establish the indices with the highest influence of distribution of the specimens in the received clusters. The main 10 indicators from the research are reduced to 4 factors, which are responsible for 76.16% from the total dispersion of variables. The principal indicators that separate the examined specimens in clusters are: leaf length and width, fruit length and diameter, as well as mass of one pepper. This classification helps for a higher objectiveness of evaluation. It leads to a more complete characterization of small size fruit peppers for their more rational use in different selective programs.*

Keywords: small size fruit peppers, cluster analysis, dendrogramm, factor analysis

Introduction

Capsicum L. (pepper) is a member of the Solanaceae family and this genus has a great economic importance in food, drug, spices and industry. *Capsicum* has at least between 20 – 30 species, from which five of them have become domesticated: *Capsicum annuum*, *C. frutescens*, *C. chinense, C. pubescens* and *C. baccatum* (Eshbaugh, 1993; Lanteri, 1993; Pozzobon et al., 2005; De Teodoro-Pardo et al., 2007). Pepper has important roles in various aspects of econo-my, food and pharmaceutics. It has the highest content of vitamin C among all plants and has important medicinal properties such as prevention of heart disease, actuation of blood ambulation and antioxidant characteristics (Salehi, 2006).

A collection of 179 specimens of small size fruit peppers of *Capsicum annuum* L. is maintained in IPGR Sadovo. It consists of old varieties and populations, new selected varieties and lines – an appropriate base for plant material to be chosen. Grouping of specimens by basic morphological indicators gives opportunity for searching of donors and creating productive high-quality varieties (Krasteva, 1989).

Statistical-mathematical analyses (like a cluster and a factor analysis) have been used for a more objective evaluation of the specimens (Ivanova, 2010; Ilchovska and Ivanova**,** 2014; Milev et al., 2015). Both methods can be complementary to one another. The cluster analysis allows specimens to be grouped on the base of the examined indicators. The factor analysis helps for the decrease of the initial indicators, which have strongest impact on the distribution of the specimens into clusters.

The aim of the present research was to establish the genetic proximity of 43 specimens of small size fruit peppers and their grouping on the base of important morphological indicators through a hierarchical cluster analysis and to reduce the number of the examined indicators (with a factor analysis) with a strongest impact on the distribution of specimens in the received clusters (Gorsuch, 1983).

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Materials and methods

The study was conducted in the IPGR K. Malkov, Sadovo in the period of 2009 – 2011. The research was made with 43 specimens of small size fruit peppers preserved in the National GenBank. The collection comes from various geographic locations. The examined specimens were set on meadow-cinnamon smolnitzi (vertisol) soil type (Stanchev, 1974). The fruits of these specimens have a fish-shape form. The plants were being grown accordingly the technology for middle-early field production (Veselinov, 1984). Fruit was gathered in its botanic ripeness. Methodically, the experimental work was based completely on the indicators from the international classifier for the variety *Capsicum annuum* L. *Descriptors for Capsicum (*IPGRI, Descriptors for Capsicum - *Capsicum* spp., 1995). Data was average for the period.

The evaluation of the genetic proximity was conducted by a comparison of the following indicators: shrub height – x_1; number of shrub branches – x_2, leaf length – x_3, leaf width – x_4, fruit length - x_5, fruit diameter – x_6, one pepper mass – x_7, 1000 seeds mass – x_8, number of fruit on one plant – x_9; mass of fruit on one plant – x_{10}.

Cluster analysis was applied for defining the similar groups. Clustering the specimens into groups was made through a hierarchical analysis and an application of the method of intergroup connection (Duran and Odelly, 1977; Ward, 1963). A hierarchical cluster analysis was made for identifying the similarity and proximity

of genotypes (Gorsuch, 1983; Kline, 1994). The Euclidean intergroup distance was used as a measure of proximity. Data was previously standardized to avoid the impact of the different dimensions. Results from the clustering were presented graphically with dendrogramms, which showed the sequence of objects joining and clusters forming. The factor analysis was conducted with the method of principal components. The number of principal components (factors) is determined by the number of own meanings of the correlation matrix, which is bigger than 1(Kaiser`s criteria). The own meanings show the relevant factor`s (component`s) contribution to the explanation of the general dispersion in the observed variables. The factor model is defined by the factor weights, which are the correlation coefficients between the relevant observed indicators and factors. Since the factors were difficult to be interpreted in the present form, we applied an additional rotation with the so called Varimax transformation to find factors more suitable for interpretation.

The statistical program SPSS was used for data processing.

Results and discussion

The morphological evaluation and the comparison of analyzed indicators` values and the standard`s values show high biological value and quality of fruit. With reference to the vegetation precipitations, the experimental year of 2009 was average, with precipitation provision of 48.2% and sum for the period April – September - 257.8 mm. The second experimental year (2010) was average moist with precipitation sum of 324.3 mm and provision of 26.8%. The third experimental year (2011) was average dry with provision of P = 66.1% and precipitation sum of 207.4 mm. It was the driest of the three experimental years.

With reference to the temperature factor, the three experimental years were favorable for pepper growing. The sum of the average twenty-four-hour air temperature for the period April – September in the first experimental year (2009) is 3501.3°C, i.e. average to average cool, with provision of 61.8%. The second experimental year (2010) was little warmer and from statistically point of view – average, with provision of 56.3%. The third experimental year (2011) was average cool with provision of 72.7%. Grouping the examined 43 specimens of local small size fruit peppers in separate clusters was shown through dendrogramms on Figures 1, 2 and 3. Seven clusters were formed in the result of the performed analysis.

The first cluster includes 9 specimens. The comparison of the Euclidean distances between them shows that practically there is no difference between 13, 18, 37 and 10; 6, 9, 21, 26 and 7. The specimens included in this cluster are close in height and brush branches; length and width of the leaf; diameter of the fruit. The second cluster combines specimens 15, 23, 8 and 25. They are similar by the indicators: leaf length, fruit diameter and mass of one plant`s fruit.

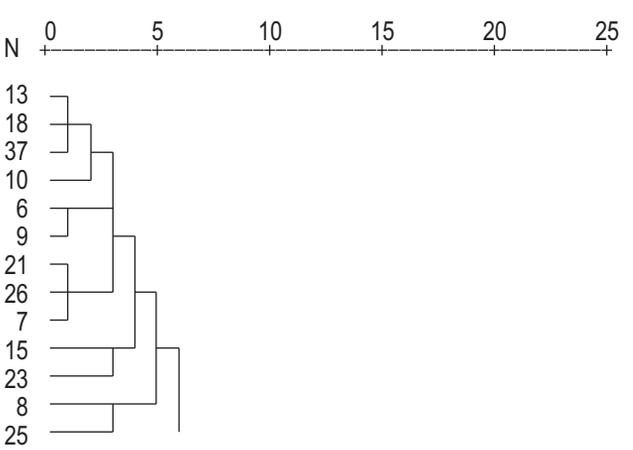

Figure 1. Dendrogramm of the I and II cluster

The third cluster includes 7 specimens – 1, 5, 27, 4, 34 and 3.

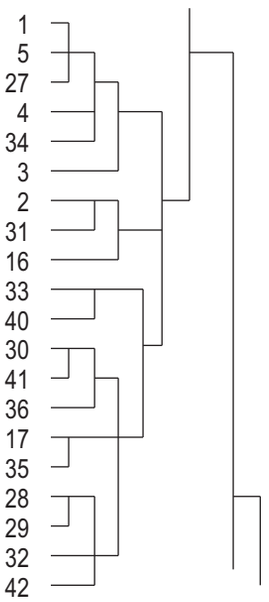

Figure 2. Dendrogramm of III, IV, V VI clusters

They are homogenous with reference to the indicators: mass of one plant`s fruit, brush branch and leaf width. The next cluster includes specimens 2, 31 and 16. They are characterized with close values of shrub height, leaf length and mass of one plant`s fruit. The fifth cluster includes 7 specimens 33, 40, 30, 41, 36, 17 and 35. All of them are similar by shrub branches, leaf length and width. Specimens 28, 29, 32 and 42 form the next sixth cluster. They have homogenous data for the following indicators: leaf length and width.

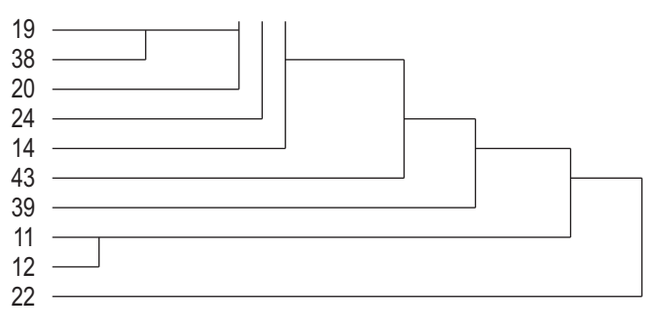

Figure 3. Dendrogramm of VII cluster

The last cluster includes specimens 19, 38 and 20. They are homogenous for the indicator – fruit diameter. Specimens 39 and 11; 11 and 22 could not be included in the formed clusters. Their genetic difference is due to the dynamic climate conditions in the country. The results from the factor analysis (with the method of principal components) are presented graphically in Figure 4.

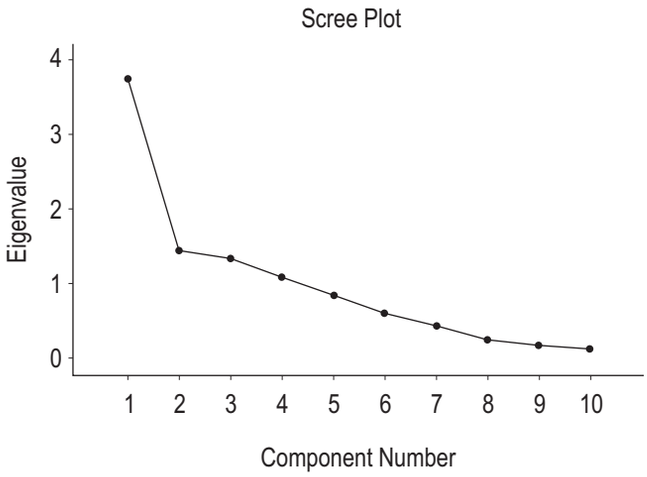

Figure 4. Values of indigenous vectors

From the factors that are joined in, only the former four are with their own meanings, bigger than 1. On the base of this result, the number of principal components is defined on 4. The factor matrix shows the percentage of general distraction, which is due to the relevant factor (Table 1).

Results show that the first factor spends 37.62% from the general distraction, the second one - 14.60%, the third one – 12.60, and the fourth one – 11.34%. In other words, the four factors are 76.16% from the general distraction. They confirm the graphic result: the former four factors are the principal components sufficient for the factor model. Table 1 shows the factor weights and the distribution of the variance between the four principal components. It is seen that the variables x_3, x_4, x_5, x_6 and x_7 have high factor weights in the first component. It means that it is basically related to the leaf length and width, fruit length and diameter, as well as the mass of one pepper. Additional rotation by Varimax method allows more precise interpretation of the factors (Table 2).

Table 1. Factor matrix obtained by the method of principal components analysis

N	Indicators	Main components			
		1	2	3	4
1.	Shrub height	0.508	0.665	0.085	0.145
2.	Number of shrub branches	0.205	-0.095	-0.240	0.688
3.	Leaf length	0.696	0.418	0.326	-0.079
4.	Leaf width	0.661	0.577	-0.054	-0.149
5.	Fruit length	0.739	-0.371	0.027	0.193
6.	Fruit diameter	0.575	-0.300	0.413	-0.299
7.	Mass of one pepper	0.865	-0.342	0.143	0.077
8.	Mass of 1000 seeds	0.425	0.140	-0.570	0.322
9.	Number of fruits of a plant	-0.842	0.370	0.250	0.168
10.	Mass of the fruits of a plant	-0.159	-0.019	0.712	0.589
Percentage of the total variation, %		37.62	14.60	12.60	11.34
Cumulative percentage of the total variation, %		37.62	52.21	64.81	76.15

Table 2. Rotated component matrix obtained by varimax transformation of the main components

N	Indicators	Main components			
		1	2	3	4
1.	Shrub height	0.016	0.832	0.178	0.059
2.	Number of shrub branches	0.110	-0.027	0.729	0.192
3.	Leaf length	0.374	0.784	-0.093	0.092
4.	Leaf width	0.184	0.835	0.056	-0.247
5.	Fruit length	0.784	0.109	0.306	0.031
6.	Fruit diameter	0.733	0.155	-0.340	0.065
7.	Mass of one pepper	0.899	0.226	0.177	0.033
8.	Mass of 1000 seeds	0.110	0.247	0.671	-0.326
9.	Number of fruits of a plant	-0.839	-0.135	-0.197	0.418
10.	Mass of the fruits of a plant	-0.021	-0.011	0.035	0.937
Percentage of the total variation, %		28.63	21.72	13.05	12.75
Cumulative percentage of the total variation, %		28.63	50.35	63.40	76.15

Factor 1 has a strongest relation with the mass of one pepper, fruit length and diameter. The relation between factor 1 and number of fruit on one plant is with a negative sign. Factor 2 links with big weights the indicators: shrub height, leaf length and width. The strongest impact has the leaf width. Factor 3 includes number of shrub branches and mass of 1000 seeds. A stronger impact has the number of shrub branches.

Conclusion

In the result of the conducted factor analysis (by the method of principal components) of 43 specimens of local small size fruit peppers (*Capsicum annuum* sub. microcarpum) the main 10 indicators from the research are reduced to 4 factors, which are responsible for 76.16% from the total dispersion of variables. The principal indicators that separate the examined specimens in clusters are: leaf length and width, fruit length and diameter, as well as mass of one pepper.

References

De Teodoro-Pardo CV, García-Velázquez A and Corona-Torres, T, 2007. Chromosome Polymorphism in *Capsicum annuum* L. (Solanaceae) In Collections from Puebla, Morelos and Queretaro, Mexico. Agrociencia, 41, 873-881.

Duran B and Odelly P, 1977. Cluster analysis, Statistics, Moscow, 128 p.

Eshbaugh WH, 1993. History and exploitation of a serendipitous new crop discovery. In: Janick J. and J. E. Simon (Eds.), New crops. Wiley, New York, 132-139.

Gorsuch RL, 1983. Factor Analysis, second Edition, Lawrence Erlbaum Association, Inc., Publishers New Jersey, 291-309.

Ilchovska M and Ivanova I, 2014. Evaluation of experimental corn hybrids by using factor analysis, Proceeding of Second Scientific Conference with international participation, Yundola (Bulgaria), 370-374.

International Plant Genetic Resources Institute (IPGRI) Descriptors for *Capsicum* (*Capsicum* spp.), 1995. International Plant Genetic Resources Institute. Rome. Italy.

Ivanova I, Grozeva S and Rodeva V, 2010. Assessment of tomato mutant forms and their initial lines by cluster and factor analysis. Scientific works, Agricultural University Plovdiv, LV, 1, 353-358.

Kline P, 1994. An easy guide to factor analysis, Routledge, London.

Krasteva L, 1989. Collection and use of plant resources in vegetable crops. Problems for the conservation of plant diversity in Bulgaria, Sofia, p. 75- 90.

Lanteri, S and Pickersgill B, 1993. Chromosome structural changes in *Capsicum annuum* L. and *C. Chinens*e. Jacq. Euphytica, 67, 155-160.

Milev M, Nikolova Kr, Ivanova I and Dobreva M, 2015. Usage of K-Cluster and factor analysis for grouping and evaluation the quality of olive in accordance with physico-chemical parameters, AIP Publishing LLC. 1690, 020021-1-020021-5

Pozzobon MT, Schino-Wittmann MT and Bianchetti LDB, 2005. Chromosome numbers in wild and semidomesticated *Brazilian Capsicum* L. (Solanaceae) species: do x = 12 and x = 13 represent two evolutionary lines? Botanical Journal of the Linnean Society, 151, 259-269.

Salehi Surmaghi MH, 2006. Medicinal plants and Phytotherapy. Donyaee Taghzieh, 1, 25-29.

Stanchev L, 1974. Laboratory experiments in agricultural chemistry, 29-40.

Veselinov E, Elekov E, Karaivanov V, Popova D, Todorov J and Kumanov BI, 1984. Pepper. Zemizdat, Sofia, 142 (Bg).

Ward J, 1963. Hierarchical grouping to optimize an objective function. Journal of the American Statistical Association, 58, 236-244.

CONTENTS 1 / 2

CONTENTS 2 / 2

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Todorov N and Mitev J, 1995. Effect of level of feeding during dry period, and body condition score on reproductive performance in dairy cows,IXth International Conference on Production Diseases in Farm Animals, September 11–14, Berlin, Germany.

Thesis:

Hristova D, 2013. Investigation on genetic diversity in local sheep breeds using DNA markers. Thesis for PhD, Trakia University, Stara Zagora, Bulgaria, (Bg).

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