Genetic Divergence of Cultivated Ecotypes of Spring Garlic within the Territory of Yugoslavia

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Abstract

The primary centre of the origin of garlic is Middle Asia (Vavilov, according to Puhalovsky and Sozinov, 1987), with the greatest number of wild and domesticated garlic ecotypes. The secondary centre of origin is the Mediterranean within the Balkan region. Garlic (*Allium sativum* L.) is a traditional vegetable variety in Yugoslavia with a large number of cultivated ecotypes. The significance of the species lies in its usage for food, as well as for the pharmaceutical and food processing industries. The aim of this study was to characterise and conserve the genetic variability of *Allium sativum* L. Twenty different ecotypes of the spring garlic were collected for this purpose. The above-mentioned ecotypes originate from different regions in Yugoslavia, although they are currently collected and being investigated in the Centre for Vegetable Crops in Smederevska Palanka. We report an analysis of the production characteristics (bulb mass, weight and number of cloves) for twenty ecotypes of spring garlic. By applying cluster analysis, a dendogram was constructed of phenotype differences between the ecotypes. The dendogram shows grouping of the ecotypes at different hierarchical levels, based upon the variation observed.

INTRODUCTION

Garlic (*Allium sativum*, L), a monocotyledonous bulbous plant, is one of the oldest cultivated vegetables with a characteristic taste and smell. The primary centre of the origin of garlic is Middle Asia (Vavilov, according to Puhalovsky and Sozinov, 1987), with the great number of wild and domesticated garlic ecotypes. The secondary centre of origin is the Mediterranean within the Balkan region. The botanical garlic (*Allium sativum*) belongs to the *Alliaceae* family with two sub-varieties, ssp. *vulgare*, which is non-flowering, and ssp. *sagitatum*, which is a flowering type. Within the climatic conditions of Yugoslavia, this variety does not produce the seed, i.e. it multiplies only vegetatively.

Garlic (*Allium sativum* L.) is a traditional vegetable variety in Yugoslavia with a large number of cultivated ecotypes. The significance of the species lies in its usage for food, as well as for pharmaceutical and food processing industries. The need for characterisation and conservation of the genetic variability of *Allium sativum* L. that represents significant genetic resources in the region of Yugoslavia, caused collecting various ecotypes of spring garlic. The above-mentioned ecotypes originate from different regions in Yugoslavia, but at the moment they are collected and being investigated in the Centre for Vegetable Crops in Smederevska Palanka.

MATERIALS AND METHODS

For this investigation, part of the collection of spring garlic was used at the Centre for Vegetable Crops in Smederevska Palanka. The sample comprised 18 ecotypes and two garlic varieties. Ecotypes originated from 14 localities, most of which belong to the Vojvodina region. The trial with the experimental material was conducted by applying the random block system in three replications at the experimental plots of the Centre for Vegetable Crops. The basic sample for the analysis consisted of 20 plants per plot. In

order to characterise the garlic ecotypes, the production characteristics were investigated: bulb mass (g), clove mass (g) and the number of cloves. For all the investigated types the mean values were estimated as well as the variability indicators of the analysed characteristics. By carrying out cluster analysis, a dendogram was constructed of phenotype differences of the analysed characteristics. The constructed dendogram shows grouping of the ecotypes at different hierarchical levels, according to the degree of similarities and differences, as far as the investigated characteristics are concerned. The computer program, which was used for constructed dendogram, is STATGRAPHICS Plus for Windows 2.1 (1996).

RESULTS

The ecotypes had an average bulb mass from 13.06 to 28.90 g. The standard deviation for this characteristic was 2.08 (Table 1), and the calculated coefficient of variation (9.98 %) was the smallest when compared to the other characteristics (Table 2).

The lowest average clove mass was recorded in ecotype E-4 (1.21 g) and the highest was found in ecotype E-3 (2.33 g). The average value of this characteristic in the analysed ecotypes was 1.79 g. The calculated coefficient of variation for this characteristic had the highest value of 25.05 %.

A garlic clove is a closed juicy leaf with the germ inside it. The cloves are formed in the leaf stalk which dries while ripening and becomes a dry covering leaf of the clove (Lazic, 1993). The clove mass of one bulb varies and it is affected by its composition and the number in the bulb (Gvozdenovic-Varga, 1997).

The ecotype with the smallest average number of cloves in a bulb was E-2 and the largest was recorded in the variety Sedef (Table 1). The mean value for this characteristic was 12.34 with high variability of 16.90 %.

By carrying out hierarchical cluster analysis, the ecotypes were classified into genetically similar and divergent groups (Figures 1, 2 & 3).

DISCUSSION

A garlic bulb consists of one or more cloves covered together (Kazakova, 1978). The largeness or the bulb mass is an important production characteristic because it affects the total yield and the market value of this vegetable. The difference in the average bulb mass was recorded (Table 1), and the lowest average bulb mass was found in the ecotype E-2 (11.6 g), whereas the highest bulb mass was recorded in the variety Sedef (28.74 g). The average mass was 21.93 g, with a smaller coefficient of variation (9.98) than for the other investigated agricultural characteristics (Table 2).

A hierarchical cluster analysis enabled classification of ecotypes into genetically similar groups (clusters) according to the average bulb mass (Fig. 1). The ecotypes are grouped into eight clusters. Within the first cluster there are the ecotypes with the average bulb mass larger than 26 g, and the mean values of the second cluster is more than 24 g. The third cluster consists of the largest average mass of over 28 g. The largest number of the ecotypes is grouped within the sixth cluster. The ecotypes with the lowest average mass are grouped in the fourth and sixth cluster.

The dendogram of phenotype distances calculated for the clove mass classified the ecotypes into seven clusters. In the last two clusters there are the ecotypes with the minimal and maximal values of this characteristic, which shows that they are phenotypically the most distant from the other groups (Fig. 2). Cluster number three comprises the largest number of ecotypes, which are very close phenotypically for this characteristic, as well as for the bulb mass characteristic.

The number of cloves in a garlic bulb depends on the intensity of its branching. Also, the number of cloves in a bulb depends on the genotype (Gvozdenovic-Varga, 1993). According to Rahim (1988), the temperature during storage and bulb forming also affected the number of cloves.

The ecotypes are grouped in seven clusters, and E-2 and E-7 that are phenotypically the most distant for this characteristic, i. e. they have the smallest and the

largest numbers of cloves in a bulb (Fig. 3). The clusters differ among themselves but within a cluster, great homogeneity could be noted for this characteristic, regardless of the geographical distance of the analysed ecotypes.

By grouping the ecotypes on the basis of all the analysed characteristics, an integrated dendogram is obtained with five clusters and four ecotypes that are phenotypically the most distant E-2, 6, 18 and E-13 (Fig. 4). The first cluster comprises the ecotypes having the high value for the average bulb mass and the number of cloves larger than 13 per bulb. The second cluster is composed of the ecotypes with the small number of cloves in a bulb, as well as the low values for the bulb mass (E-5, E-16 and E-20). The ecotypes in cluster three are characterised by average values for all the investigated characteristics, which is the reason why one could talk about the well-balanced ratio of the characteristics. The ecotypes from this cluster are present in the regions of Yugoslavia where this vegetable is mainly grown. As for the fourth cluster, it is composed of the most yielding ecotypes with the high average bulb and clove mass.

CONCLUSION

By investigating a number of production characteristics for garlic ecotypes collected from different growing localities within Yugoslavia, it can be concluded that there was a high variability expressed for these characteristics. The ecotypes showed the highest variability in mass and the number of cloves.

The dendrograms obtained confirm the significant phenotype and genetic divergence of the ecotypes. On the basis of all the investigated characteristics, five clusters have been formed.

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Tables

Table 1. Mean values of the production characteristics of garlic ecotypes.

Ecotypes	Location	Mass of bulb (g)	Mass of clove (g)	Number of clove
E-1	Pirot	26.66	1.94	13.81
E-2	Coka	11.16	1.59	7.07
E-3	Golobok	26.12	2.33	11.24
E-4	Kumanovo	17.84	1.21	14.72
E-5	Piros	15.18	1.68	9.47
E-6	Jovanovac	19.52	2.14	9.19
E-7	Kisac	19.65	1.44	13.62
E-8	Pristina	24.84	2.29	10.63
E-9	Sr. Mitrovica	26.35	1.94	13.30
E-10	Novi Sad	28.91	2.21	13.08
E-11	Temerin	25.24	1.89	13.28
E-12	Zrenjanin	28.31	1.92	14.74
E-13	Sedef	28.74	1.62	17.58
E-14	Kikinda	21.24	1.69	12.30
E-15	Pristina	21.69	1.70	12.55
E-16	Lozovik	16.07	1.76	9.13
E-17	Subotica	20.39	1.72	11.75
E-18	Loznica	13.52	1.30	10.66
E-19	B. P. Selo	19.24	1.67	11.37
E-20	Toba	17.86	1.79	10.04

Table 2. Mean values and variability indicators of the characteristics of spring garlic ecotypes.

Characteristics	8 ± Sx	S	CV%
Average bulb mass	21.92 ± 0.69	2.08	9.99
Average clove mass	1.79 ± 0.14	0.44	25.05
Average number of cloves	12.34 ± 0.67	2.01	16.90

Figures

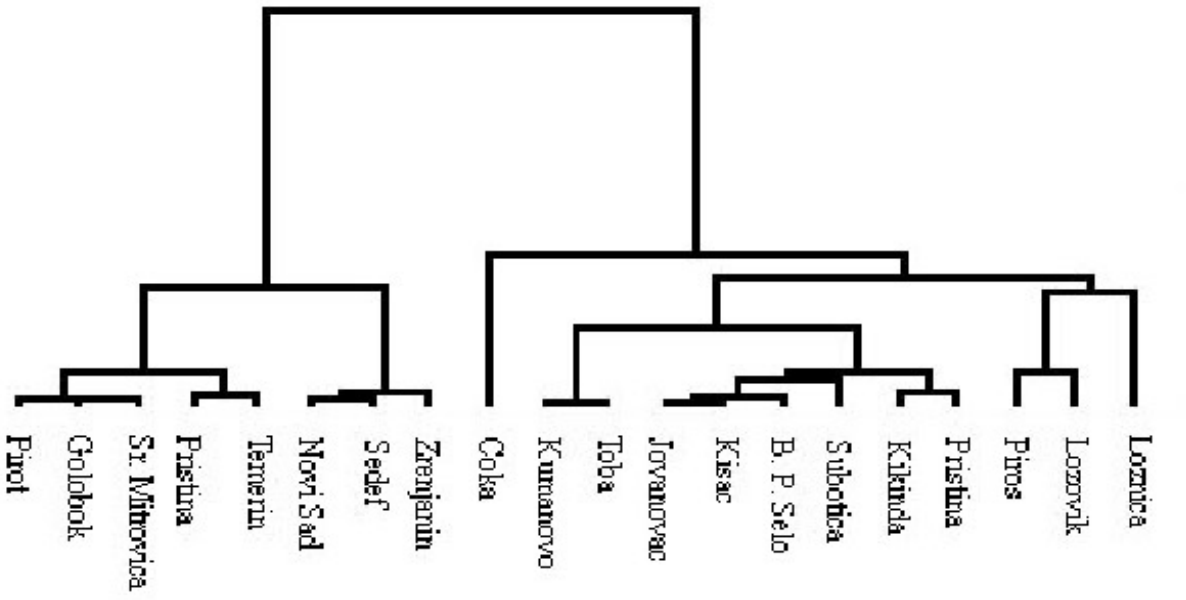

Fig. 1. Dendogram of phenotypes different for mass bulbs.

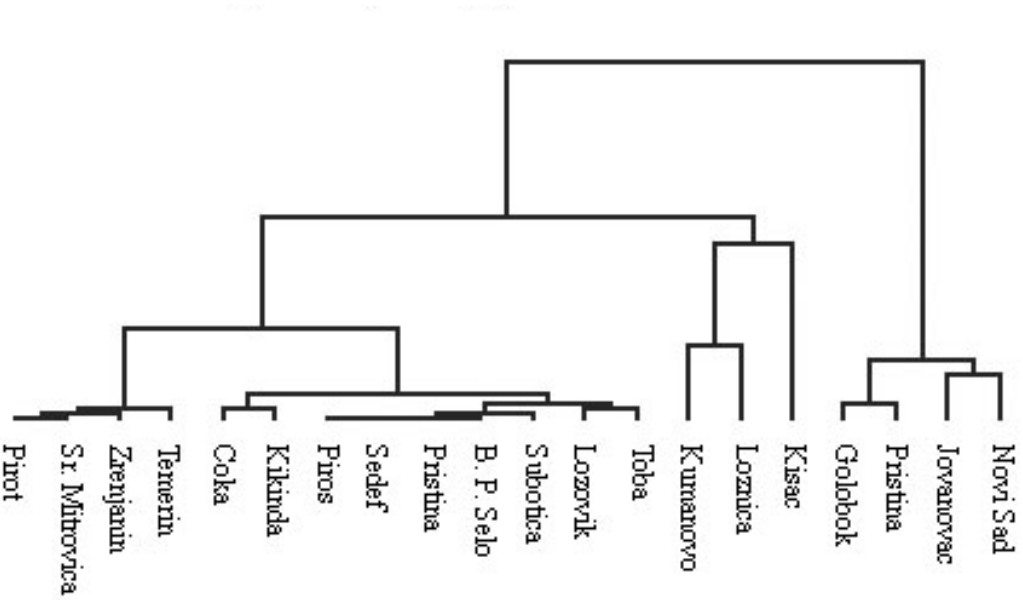

Fig. 2. Dendogram of phenotypes different for mass clove.

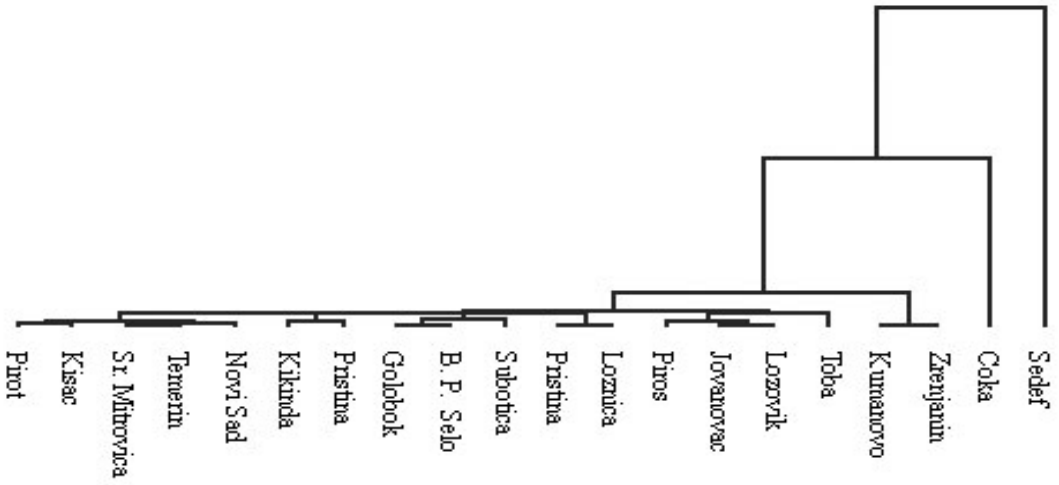

Fig. 3. Dendogram of phenotypes different for number clove.

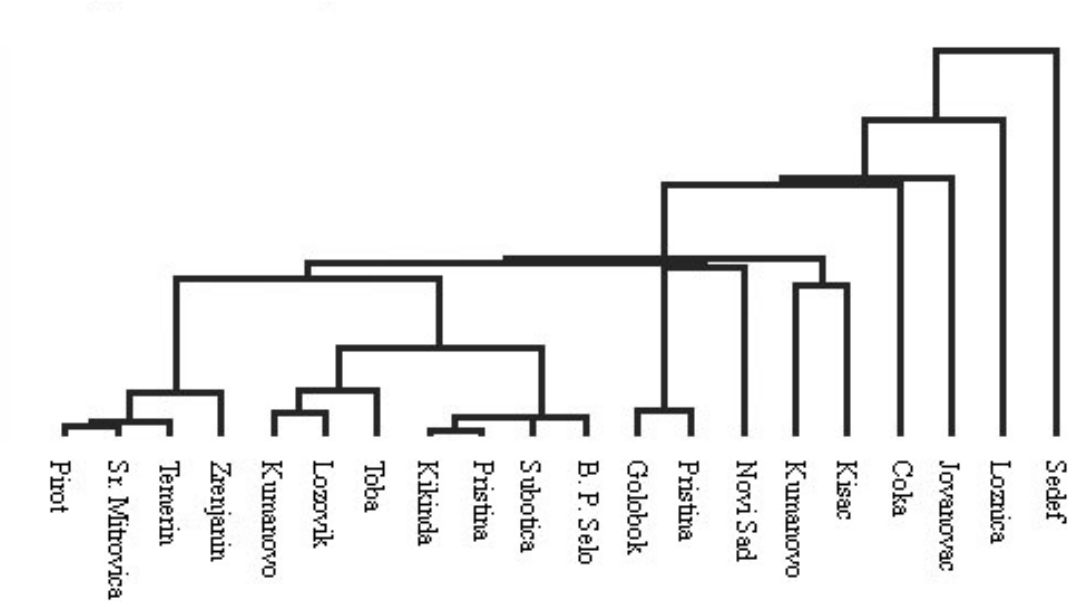

Fig. 4. Dendogram of phenotypes different between spring garlic for analyse characteristics.