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YIELD OF DIFFERENT PUMPKIN (*Cucurbita maxima* Duch.) POPULATIONS IN AN ORGANIC PRODUCTION SYSTEM

PRINOS RAZLIČITIH POPULACIJA BUNDEVE (*Cucurbita maxima* Duch.) U ORGANSKOM SISTEMU GAJENJA

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ABSTRACT

The yield components of pumpkin seeds and fruits were examined in Stara Pazova in period 2016-2017. Different pumpkin populations were enrolled in the study, grown at following locations in Serbia: Šabac, Šumadija and Negotin.

Pumpkin originating in Šumadija was found to produce highest seed yield (0.738 t ha^{-1}) and possess greatest average seed mass per fruit (110.7 g). Highest fruit yield (95.1 t ha^{-1}) and greatest fruit mass (14.5 kg) were recorded in population from Šabac. A significant correlation ($p \leq 0.001$) was found between fruit yield and fruit mass, as well as between seed yield and seed mass per fruit. Based on two-year experiment, following conclusions can be drawn: origin of population greatly affects all components of seed and fruit yield; high yields of seeds in Northern Serbia can be produced by cultivating population from Šumadija, whereas high yields of fruits can be produced by cultivating population from Šabac.

***Key words**: pumpkin, population, seed, fruit, correlation*

REZIME

Istraživanje komponenti prinosa semena i ploda populacija bele bundeve ispitivane su tokom 2016. i 2017. godine na lokaciji severne Srbije u Staroj Pazovi. Za istraživanje korišćene su populacije bele bundeve poreklom sa tri različita lokaliteta iz Srbije: zapadna (Šabac), centralna (Šumadija) i istočna (Negotin).

Dobijeni rezultati ukazuju da poreklo populacije značajno ($p<0,01$) utiče na sve komponente prinosa bundeve. Kod populacije poreklom iz Šumadije utvrđen je najveći prinos semena (0,738 t ha^{-1}) i najveća prosečna masa semena po plodu (110,7 g), dok je najveći ukupan prinos ploda bundeve (95,1 t ha^{-1}) i najveća prosečna masa ploda (14,3 kg) konstatovana kod populacije iz Šabca. Zabeležena je visoka korelaciona zavisnost ($p\leq0,001$) između ukupnog prinosa ploda i prosečne mase ploda, kao i kod ukupnog prinosa semena i prosečne mase semena po plodu. Na osnovu rezultata dvogodišnjih istraživanja uticaja populacije i ekoloških uslova na komponente prinosa semena i ploda bundeve, možemo izvesti sledeće zaključke: - poreklo populacija bundeve značajno utiče na sve komponente prinosa za dobijanje visokih prinosa semena bundeve u uslovima severne Srbije možemo preporučiti populaciju poreklom iz Šumadije, dok za proizvodnju ploda treba gajiti populaciju bundeve iz Šabca.

***Ključne reči**: bundeva, masa ploda, seme,korelacija.*

INTRODUCTION

Pumpkins **(***Cucurbita maxima* Duch.) are cultivated throughout the world for culinary and medicinal uses. They are referred to as high-yielding vegetables, which are easy to grow and thereby cost-effective. Pumpkins have received considerable attention in recent years owing to their nutritional and health-protective values (*Caili et al., 2007; Leljak-Levanić et al., 2011, Rozylo et al., 2014*). The pumpkin is not very commonplace in Serbia, although its fruits, harvested at a physiologically mature stage, represent a rich source of valuable nutrients. White pumpkin varieties and populations with orange flesh are predominantly grown in Serbia. Pumpkin flesh is a delicious and greatly appreciated additive in a vast variety of products for children and adults. It is also a suitable and desired raw material in the production of juices, jams and marinades, as well as a colour additive for spaghetti and cakes (*Muntean et al., 2002; Danilchenko 2002*).

Pumpkin flesh contains vitamin C (9-20 mg·100g^{-1}), thiamine (0.05 mg), riboflavin (0.11 mg), niacin (0.6 mg), vitamin B_6 (0.06 mg), folates (0.16-0.20 mg), vitamin E (0.06 mg), vitamin K (1.1 µg), B-carotene (2-10 mg·100g^{-1}), and nutrients such as potassium, phosphorus, magnesium, iron and selenium (USDA National Nutrient Database 2004).

Due to growing concerns about the health of humans over the last 20 years, organic production has rapidly expanded attributable to a great demand for "healthy" food. Consequently, recent comparative studies of various cultivation systems report lower levels of pesticide residues and nitrates in crops, mycotoxins in cereals, and increased concentrations of certain useful secondary metabolites in organically produced fruits and vegetables (*Lairon, 2009; Brandt et al., 2011*).

Modern agriculture in the early 21st century is characterized by numerous uncertainties regarding the prospects of its future development. Current trend analyses have rendered it possible for a number of authors to argue and predict many changes in agriculture (*Kovačević i Momirović, 2000; Kovačević i Momirović, 2003*). One of such changes is the intensive development of organic production, resulting in a growing need for seeds produced in the organic farming system. The purpose of this paper is to examine the potential for producing seeds and fruits of different white pumpkin populations grown in the organic production system, with an emphasis on the importance of preserving genetic resources for organic production.

MATERIAL AND METHOD

Productive characteristics of three pumpkin populations were studied at locations in Stara Pazova (Northern Serbia), the area of Zovice (Ltd. Jovanjica) (76 m a.s.l., chernozem) 44˚ 47 '19.6" N, 20˚ 27' 56.2" E, in the period 2016-2017. A total of three pumpkin populations were enrolled in the study, grown at the following locations in Serbia: Western (Šabac), Central (Šumadija) and Eastern (Negotin). The soil properties are shown in Table 1.

Table 1. Properties of soil in the experimental plot

Depth (cm)	Type of soil	CaCO3 %	PH		Humus %	mg/100g soil	
			H2O	nKCl		P2O5	K2O
0-30	Chernozem	6.32	-	7.70	5.86	28.09	17.71

The seed sowing in containers was performed in the first ten days of April, whereas the planting in the open field was carried out in the second ten days of May at a distance of 1 × 1.5 m, in a plot area of 6 m^2. A full factorial experiment was established in a split-plot design with four replicates. The management of pumpkin crops was conducted in keeping with commonly accepted recommendations for this species. The harvest took place in the second week of November. The following productive characteristics were analyze: total fruit yield, average fruit mass, total seed yield, average seed mass per fruit, and 1.000-seed mass. The meteorological condition data are show in Table 2.

Table 2. Meteorological conditions (air temperature and precipitation) during the pumpkin growing season (2016 and 2017) and the long-term data (2008-2016) for the area of Northern Serbia

Month	2016		2017		2008-2016	
	°C	mm	°C	mm	°C	mm
March	8.6	101.8	11.5	30.2	8.7	55.4
April	15.0	61.4	12.4	47.1	14.4	36.3
May	17.2	58.1	18.6	49.2	18.5	79.7
Jun	22.4	110.9	24.4	39.0	22.3	71.6
July	24.1	41.7	25.5	26.7	24.5	54.6
August	21.7	43.3	25.8	23.7	24.2	39.8
September	18.8	46.7	18.4	36.6	19.6	48.9
Average-sum	18.3	463.9	18.1	252.5	18.9	386.3

The experimental data obtained were processed using the statistical package STATISTICA 8.0 for Windows (Analytical software, Faculty of Agriculture, Novi Sad, Serbia). The differences between the treatments were determined by the analysis of variance (ANOVA), whereas the least significant difference test (LSD) was used for the individual comparisons. The correlations between the parameters values obtained were determined using the Pearson correlation coefficient (r).

RESULTS AND DISCUSSION

An analysis of the productivity features of pumpkin populations (Table 3) showed highly significant ($p < 0.01$) differences only relative to different populations (Factor P). The impacts of ecological conditions (Factor E) and the interactions between the experimental factors (P × E) on the traits analyzed were not determined. The obtained results, indicating the effect of population/genotype on the productivity of vegetables and field crops, are consistent with the results reported by other authors (*Poštić et al., 2012; Poštić et al., 2017; Srdić et al., 2017)*.The greatest average seed mass per fruit (110.7 g) was recorded in the pumpkin population from Šumadija, as well as the highest total seed yield (0.738 t ha^{-1}) (Table 4). The lowest total seed yield (0.628 t ha^{-1}) was recorded in the pumpkin population from Šabac, resulting from the smallest seed mass per fruit (94.1 g). The average 1.000-seed mass of the pumpkin populations analyzed ranged from 259.6 to 335.1 g.

Table 3. F-values for the factors analyzed

Factors	Average fruit mass	Total fruit yield	Total seed yield	Average seed mass per fruit	1.000 seed mass
Population (P)	**	**	**	**	**
Ecological condition (E)	ns	ns	ns	ns	ns
P × E	ns	ns	ns	ns	ns

*** - significant at 0.01; * - significant at 0.05; ns - not significant*

Table 4. Effects of population and ecological conditions on the pumpkin seed yield in the period 2016-2017

Population from Serbia		Total seed yield (t ha^{-1})			Average seed mass per fruit (g)			1.000 seed mass (g)		
Western		0.628 c			94.1 b			319.1 b		
Central		0.738 a			110.7 a			259.6 c		
Eastern		0.727 ab			109.1 a			335.1 a		
Average		0.698			104.6			304.6		
		A	B	A x B	A	B	A x B	A	B	A x B
LSD	0.05	47.28	33.43	57.90	7.09	5.02	8.69	7.00	4.95	8.57
	0.01	64.84	45.85	79.41	9.73	6.88	11.92	9.60	6.79	11.75

The greatest average fruit mass (14.3 kg) was found in the pumpkin population from Šabac, which also produced the highest total fruit yield (95.1 t ha^{-1}) (Table 5).

The average smallest fruit mass (10.7 kg) was recorded in the pumpkin population from Negotin, which also produced the lowest fruit yield (70.9 t ha^{-1}) (Table 5).

Based on the correlation analysis performed, the correlation between the total fruit yield and the average fruit mass, as well as between the total seed yield and the average seed mass per fruit proved high ($p \leq 0.001$) (Table 6).

Table 5. Effects of population and ecological conditions on the pumpkin fruit yield in the period 2016-2017

Population from Serbia		Average fruit mass (kg)			Total fruit yield (t ha^{-1})		
Western		14.3 a			95.1 a		
Central		11.8 b			78.6 b		
Eastern		10.7 bc			70.9 bc		
Average		12.3			81.5		
		A	B	A x B	A	B	A x B
LSD	0.05	1.94	1.37	2.38	12.95	9.16	15.87
	0.01	2.67	1.89	3.27	17.77	12.56	21.76

CONCLUSION

Relative to the results of a two-year experiment on the effect of population and ecological conditions on the components of

Table 6. The correlation coefficients between the traits analyzed (n=5)

Traits	Average fruit mass	Total seed yield	Average seed mass per fruit	1.000 seed mass
Total fruit yield	0.99995***	- 0.9155**	- 0.9154**	0.0058 NS
Average fruit mass	-	- 0.9150**	- 0.9149**	0.0046 NS
Total seed yield		-	0.99997***	- 0.3995 NS
Average seed mass per fruit			-	- 0.3997 NS
1.000 seed mass				-

*Pearson correlation coefficient: *** $P \leq 0.001$, ** $P \leq 0.01$, * $P \leq 0.05$, respectively*

pumpkin seed and fruit yeld, the following conclusions can be drawn:

- The origin of population greatly affects all the components of pumpkin seed and fruit yield;
- High yields of pumpkin seeds in Northern Serbia can be produced by cultivating the pumpkin population from Šumadija, whereas high yields of pumpkin fruits can be produced by cultivating the pumpkin population from Šabac

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