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YIELD AND MINERAL COMPOSITION OF TWO NEW ONION VARIETIES FROM BOSNIA AND HERZEGOVINA

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Abstract

Onions are grown for a variety of purposes. The purpose of the production determines the choice of variety and growing technology. In this paper, the Federal Institute for Agriculture in Sarajevo introduces two new varieties-Konjica's and Zenica's onion. The new varieties are specially developed for production from onion sets to suit the environmental conditions of Bosnia and Herzegovina. This paper evaluates the new varieties production characteristics and their bulb mineral composition, tested in Butmir (Sarajevo municipality) over 2009 and 2010 with the Stuttgarter cultivar used as a standard. The new varieties are medium late, the plants are well developed and have erect leaves that are dark green in color and have a pronounced waxy coating. The new onion varieties significantly out-yielded the standard cultivar. Over two years, Konjica's onion yielded 30.68 t ha^{-1} on average (51% more than Stuttgarter cultivar), while Zenica's onion yielded 24.83 t ha^{-1} on average, 21% more than the standard cultivar. The mean concentrations of trace element in the bulbs of the new varieties were in the order: Zn>Fe>Mn>Cu indicating onions from Bosnia and Herzegovina as a good source of various vitamins and minerals important to maintain human health.

Keywords*:* onion varieties, yield, mineral composition

Introduction

Vegetable consumption helps meet the body's needs for minerals, vitamines, dietary fiber and in a small way, for protein. Nutritionally, vegetables are excellent sources of carotene, folate, niacin, iron, Vitamin C and calcium. These are of special importance in the prevention of some forms of cancer, heart desease, stroke and other chronic diseases.

Onions are one of the most versatile vegetables, used year round, either fresh (green onions, mature bulbs), or processed (dehydrated, pickled, canned). Like other vegetable species, onions provide vitamins and a good amount of minerals to the human body. Choice of cultivar and proper cultural practices are important facets in the production process. Choosing the right cultivar is one way of ensuring high yields and good quality of onion. The purpose of an onion determines the choice of variety and growing technology used. Hence the goals of onion breeding programs vary (GvozdanoviC-Varga *et al*., 1996)**.** Onions may be grown from seed, transplants or seed-grown sets (sets started from seeds from the previous year). Cultural system is determined by the cultivar's biology, environmental conditions and food preferences in the locality (LaziC *et al*., 2000). Yields are highest where the crop is grown directly from seed and modern growing technologies are fully utilised, whereas yields are low where onions are grown from sets (GvozdanoviC-Varga *et al*., 2005). In Bosnia and

Herzegovina, onion is extensively cultivated and production of the crop from sets is predominant. Therefore, the Federal Institute for Agriculture in Sarajevo has specifically developed two new onion varietes, Konjica's onion (Konjički) and Zenica's onion (Zenički) for production from onion sets that will suit the environmental conditions of the country.
The paper evaluates the varieties's production characteristics and their bulb mineral composition, tested in Sarajevo (Butmir) over two consecutive years with the Stuttgarter cultivar used as a standard.

Material and methods

Variety evaluation trials were conducted in Butmir (43°49′N 18°20′E) in the Sarajevo Canton of Bosna and Herzegovina in 2009 and 2010. Cultivar Stuttgarter, commonly grown and cultivated from sets in Bosnia and Herzegovina was used as the standard.
Before the trials were set up, average soil samples were taken and chemical analyses were carried out. The soil was of the brown valley type, poorly supplied with phosphorus and moderately supplied with potassium across both years (Table 1.). In accordance with soil tests and commercial recommendations, 56, 112, and 294 kg ha^{-1} of Nitrogen, Phosphorus and Potassium was applied respectively every year. The trials were conducted in a randomised block design with five replicates. Plot size was 6 square meters. March 30th 2009 and 2010 were the sowing dates. Seeds were planted manually in triple rows spaced 30 cm apart and within-row spacing 10 cm resulting in population density of 150 plants per plot. Soil management, pest and disease control was carried out according to standard procedures. The date of technological maturity was recorded. After the onions were lifted and dried, production characteristics (yield and days to maturity) and their bulb mineral composition at full maturity were determined. Bulb mineral content was determinate according to EN 13805:2002, ITD and EN 15763:2009, ITD method using Induced coupled plasma with mass spectrometry (ICP-MS 7700x, Agilent Technologies, Japan) using plant material previously prepared in a microwave oven for digestion (MDS-8, Sineo, China). Plant material samples were destroyed with Nitric acid 65% Suprapur puroty, Hydrogen peroxide, 30% Suprapur purity and Hydrochloric acid 30% purity Suprapur. Detection limits were: Cr-0.99 ng kg^{-1} (ppt), Mn-0.66 ppt, Fe-9.17 ppt, Co-0.14 ppt, Cu-0.41 ppt, Zn-1.02 ppt, Mo-0.12 ppt, Pb-0.16 ppt.
Data (minimal, maximal and mean monthly temperatures and monthly precipitation sums) from the weather station at Butmir were used to obtain weather data for the growing seasons studied. Yield data were analysed for the differences between the standard (Stuttgarter) and the tested varieties (Konjički and Zenički) using analysis of variance. Mean separation was based on a LSD test. Differences were considered to be significant at P=0.05 and P=0.01.

Table 1. Soil composition in Butmir, Bosnia and Herzegovina.

Year	pH		Content (%)			Physiologically active (mg $100g^{-1}$ of soil)	
	in H_2O	in KCl	Total N	$CaCO_3$	Humus	P_2O_5	K
2009	5.89	-	0.09	-	1.80	12.50	10.90
2010	6.02	-	0.08	-	1.80	8.45	14.20

Results and discussion

Growing conditions during variety evaluation trials

Seed-grown sets make a more robust plant at emergence than seeds, have a shorter growing

season and the whole plant growth is less dependent on conditions of environment (Brewster, 2008; Đurovka, 2008). If higher temperatures prevail in germination stage, rooting may be shortened and above-ground grow hastened (Đurovka, 2008).

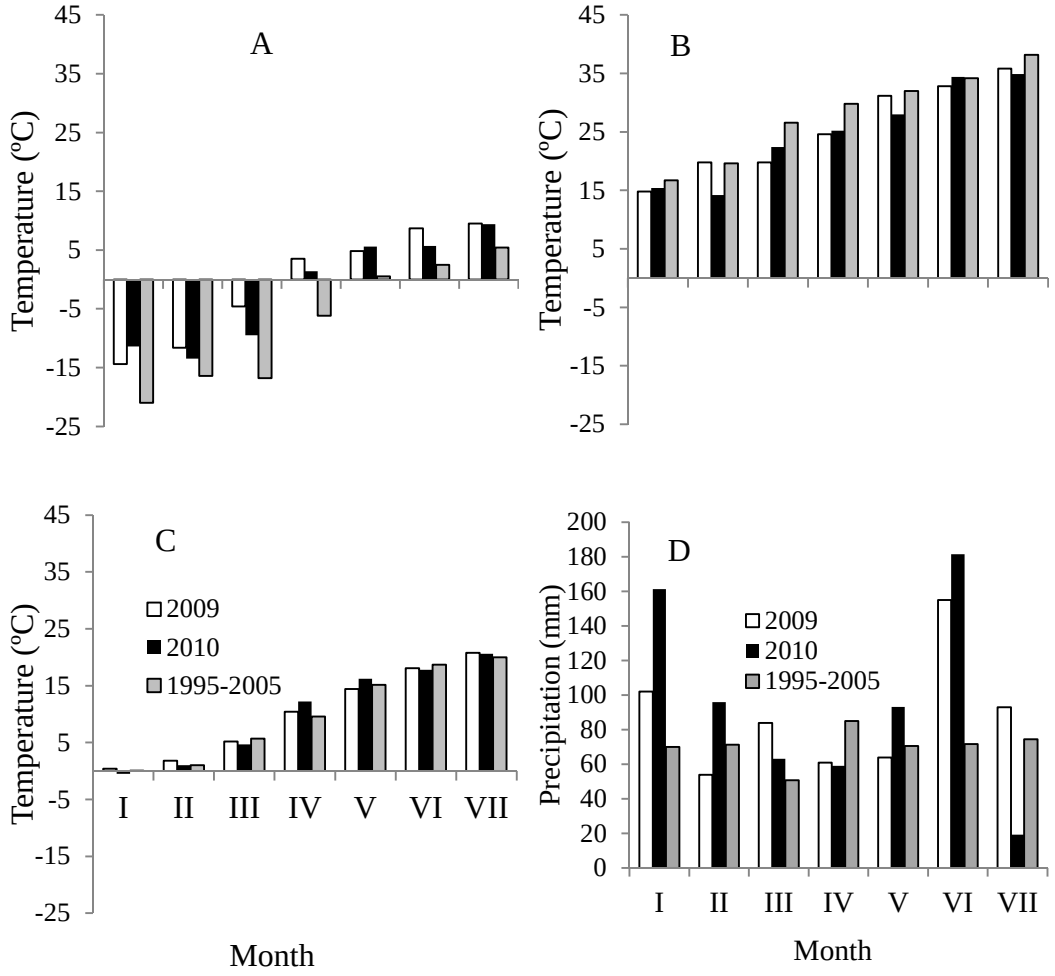

Figure 1. Weather conditions in onion growing season. Panel A, minimal monthly air temperatures. Panel B, maximal monthly air temperatures. Panel C, mean monthly air temperatures. Panel D, monthly precipitation sums.

During trial years, maximal and mean monthly air temperatures in Butmir were within the long-term average range (Figure 1B and 1C). After planting and April temperatures in 2009 and 2010 were within range of optimal 5-10 ºC and 10-15 ºC for growing stages rooting and germination, respectively. Therefore, well developed above-ground plant parts and a strong rooting system secured good bulb formation. According to Jones and Mann (1963), under conditions of extremely high temperatures, bulbs will mature early and yields may be reduced; at low temperatures, maturity is usually delayed, curing becomes difficult, and storage quality is often impaired. In 2009 and 2010 in Butmir during the stage of bulb formation (late April and early May), mean monthly air temperatures though lower than the optimal for the stage (22 ºC) (LaziC *et. al*., 2001) were higher than nine-year average so both varieties obtained good yields.

Irrigation during leaf and early bulb growth ensures that onion crop reaches a high LAI (Leaf Are Index) as quickly as possible. This will tend to promote rapid ripening and good bulb quality for storage (Brewster, 1990). In Butmir wetter-than-average conditions were observed

in January, March and June in 2009 and 2010 (Figure 1D). April in both seasons was unusually dry. Compared to the multiyear average (74.5 mm) July of 2010 was extremely dry (19.2 mm). Irrigation late in bulbing may delay maturity and reduce bulb quality by virtue of skin splitting and rotting, particularly if they follow a period in which growth has been restricted by lack of water or Nitrogen nutrition (Brewster, 1990).

Cultivars agronomic performances

The new varieties, Konjički and Zenički, are medium late (in both years technical maturity reached in 114 days), just as the standard is (data not shown). The plants are well developed and have erect leaves that are dark green in color and have a pronounced waxy coating.

Table 2. Yield of Stuttgarter, Konjički and Zenički variety in 2009 and 2010. Asterix indicates significant differences at P=0.05 and ** is significant at P=0.01 by LSD test.

Variety	Year			
	2009		2010	
	Yield (t ha^{-1})	%	Yield (t ha^{-1})	%
Stuttgarter	22.88	100	18.0	100
Konjički	37.36**	163	24.0**	134
Zenički	29.16**	127	20.5**	114
$LSD_{P= 5\ \%}$	1.16		1.57	
$LSD_{P= 1\%}$	1.70		2.29	

In both trial years, the new varieties significantly out-yielded the standard variety (Table 2). Tested varieties yielded lower in 2010 (Konjički 24.00 t ha^{-1}, Zenički 20.5 t ha^{-1} and Stuttgarter 18.0 t ha^{-1}), 13.26 t ha^{-1}, 8.66 t ha^{-1} and 4.88 t ha^{-1} less than in 2009, respectively. Over the two years, the new tested variety-Konjički obtained an average yield of 30.68 t ha^{-1}, or 51% more than standard variety- Stuttgarter (20.44 t ha^{-1}) (Table 3). The tested variety Zenički over the two years out-yielded the standard variety for 21% (Table 3).
Yield varieties in 2009 were significantly higher than in 2010 (Table 4). Temperature and rainfall conditions, in contrast to day-lengths, are never exactly alike, year after year, in the same district; consequently, onion cultivars cannot be expected to perform consistently, even though cultural practices are similar (Jones and Mann, 1963).

Table 3. Effect of variety on average yield (2009-2010). Asterix indicates significant differences at P=0.05 and ** is significant at P=0.01 by LSD test.

Variety	Average yield (t ha^{-1})	%
Stuttgrater	20.44	100
Konjički	30.68**	151
Zenički	24.83**	121
$LSD_{P=5\%}$	0.80	
$LSD_{P=1\%}$	1.08	

Table 4. Effect of year on onion yield. Asterix indicates significant differences at *P*=0.05 and ** is significant at *P*=0.01 by LSD test.

Year	Yield in t ha^{-1} (average for all three varieties)	%
2009	29.8**	143
2010	20.83	100
LSD $_{P=5\%}$	0.65	
LSD $_{P=1\%}$	0.88	

Bulb trace element composition

The mean concentrations of trace element in the bulbs of the new varieties were in the order: Zn (1.313 mg kg^{-1})>Fe (0.72 mg kg^{-1})>Mn (0.324 mg kg^{-1})>Cu (0.221 mg kg^{-1})> Cd (0.015 mg kg^{-1}) > Pb (0.003 mg kg^{-1}) > Cr (0.003 mg kg^{-1}) (data not shown). Highest Mn (0.436 mg kg^{-1}) and Cd (0.03 mg kg^{-1}) content was determined in bulbs of Stuttgrater variety, Fe (1.145 mg kg^{-1}) and Cu (0.244 mg kg^{-1}) in bulbs of Konjički and Zn (1.715 mg kg^{-1}) in bulbs of Zenički variety (Table 5). The average Cu, Zn, Pb and Cd content was similar of 15 onion populations from Vojvodina Province (0.204-0.818 mg Cu kg^{-1}; 0.452-2.025 mg Zn kg^{-1}) (Maksimovic *et al*. 2012).

According U. S. Department of Agriculture (2003) intake of 100g of onions provides 0.04 mg of Cu, 0.19 mg of Fe, 0.16mg Zn and 0.13mg of. Results indicate onions from Bosnia and Herzegovina as a good source of various vitamins and minerals important to maintain human health. Intake of 100 g of tested varieties provides 55% of necessary daily amount of Cu, 126% of Fe, 82% of Zn and 83% of Mn recommended by the U. S. Departmant of Agriculture (2003).

Table 5. Trace element composition of the onion bulbs (mg kg^{-1}). Trace element content presented as nd is not detected.

Trace element	Variety		
	Konjički	Zenički	Stuttgrater
As	0.0004	0.0004	0.001
Cr	0.005	0.004	0.001
Cd	0.007	0.007	0.03
Mn	0.194	0.344	0.436
Fe	1.145	1.071	0.943
Co	0.0002	nd	0.001
Cu	0.244	0.186	0.233
Zn	1.158	1.175	1.065
Mo	nd	nd	nd
Pb	0.003	0.002	0.006

Conclusions

Two new varieties Konjica's onion (Konjički) and Zenica's onion (Zenički) suit the environmental conditions of Bosnia and Herzegovina. They are medium late, the plants are well developed and have erect leaves that are dark green in color and have a pronounced waxy coating and significantly out-yielded the standard cultivar. The mean concentrations of trace element in the bulbs of the new varieties were in the order: Zn>Fe>Mn>Cu indicating onions from Bosnia and Herzegovina as a good source of various vitamins and minerals

important to maintain human health. Expansion of domestic varieties of high yield and good quality such as Konjički and Zenički, development of varietal technology and controlled onion set production should result in an increase of domestic production of the crop and reduction of imports from abroad.

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