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САДРЖАЈ / *CONTENTS*

ПРЕГЛЕДНИ РАДОВИ

ОРИГИНАЛНИ НАУЧНИ РАДОВИ

ПРЕТХОДНА САОПШТЕЊА

СТРУЧНИ РАДОВИ

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Review paper
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Plant Genetic Resources as a part of the biodiversity

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Summary

The preservation of plant biodiversity of Bulgarian flora is the main priority in scientific activities of IPGR – Sadovo. It is a part of the National Programme on Plant Genetic resources (PGR). Plant accessions in the base collections are evaluated according to the standards of FAO and European programme for PGR. The scientific programme for conservation of germplasm under controlled conditions in the gene bank is prepared according to the FAO requirements. The national collection of PGR in Sadovo includes crops and crop wild relatives- new varieties, selection lines, old varieties, local populations, mutants and wild species. The collection is divided into 7 main groups: cereals, grain legumes, industrial crops, vegetable crops, forage crops and medical and ornamental plants. The scientific work is carried out in 6 directions: enrichment with new geneplasm; evaluation of PGR; maintenance of PGR; conservation of PGR; documentation of PGR; use of PGR.

Key words: biodiversity, PGR, germplasm, gene bank

Introduction

Conservation of plant genetic resources (RGR) is a priority worldwide. According to the Convention on Biological Diversity (CBD), the sustainable use and conservation of crop diversity is a national task, duty and responsibility of each country. In line with the Convention is the International Treaty on Plant Genetic Resources for Food and Agriculture, which entered into force in 2004. The Institute of Plant Genetic Resources, Sadovo (IPGR) entered into this contract as a coordinator for Bulgaria.

The preservation of plant biodiversity of Bulgarian flora is the main priority in the scientific activities of IPGR – Sadovo that is a part of the National programme in Plant Genetic resources (PGR) through realization of the ”Conservation, Management and Use of PGR in Bulgaria” Project. The main goal of the project is conservation of the national plant biodiversity.

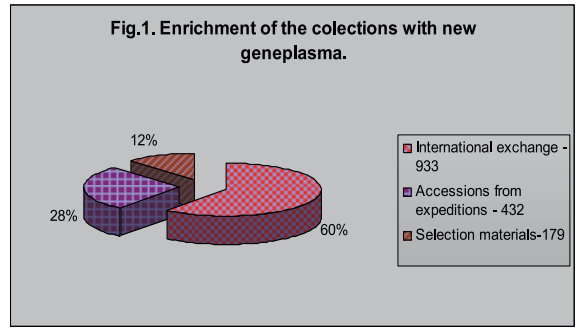
Materials and methods

The plant accessions in base collections are evaluated according to actual methods, classification and standards of FAO and the European programme for PGR. The scientific programme for conservation of germplasm under controlled conditions in the genebank is prepared according to the FAO requirements.

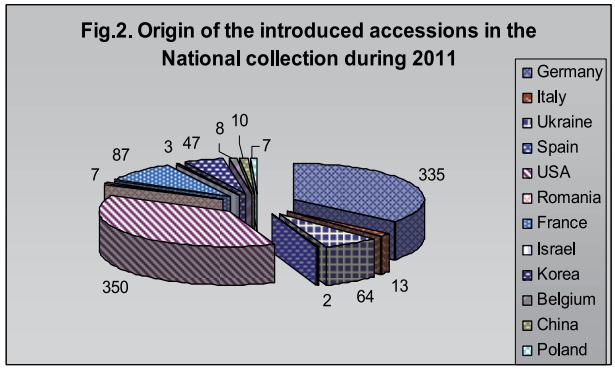
Different methods for potato vine, mint, hops and medical plants storage-sterilization of starting explants, establishment of appropriate composition of the food environment are developed and applied for prolonged storage *in vitro*. To reduce the growth rate maintained at a high level of vitality, different approaches for each type of plant and its adjacent varieties are experimented with - low positive temperatures, growth inhibitors, osmotic stress, reduction of nutritive composition of culture media and their combined impact.

Results

The national collection of PGR in Sadovo includes crops and crop wild relatives- new varieties, selection lines, old varieties, local populations, mutants and wild species. The collection is divided into 7 main groups: cereals, grain legumes, industrial crops, vegetable crops, forage crops and medical and ornamental plants. The scientific work is carried out in 6 directions: enrichment with new germplasm; evaluation of PGR; maintenance of PGR; conservation of PGR; documentation of PGR; use of PGR.



Enrichment. Each year the collections are enriched with 950 to 1544 accessions (Fig. 1.).



The biggest part of these includes the accessions either obtained through international exchange or collected during expeditions (Fig. 2.).

New accessions are registered with cat. Number and passport information.

*Evaluation***.** By using the methods and descriptors of Bioversity International and UPOV, evaluation of the accessions in

the main collections is done. During 2011, 2453 accessions were evaluated. The evaluation diagram for the *ex situ* collections is given in Figure 3.

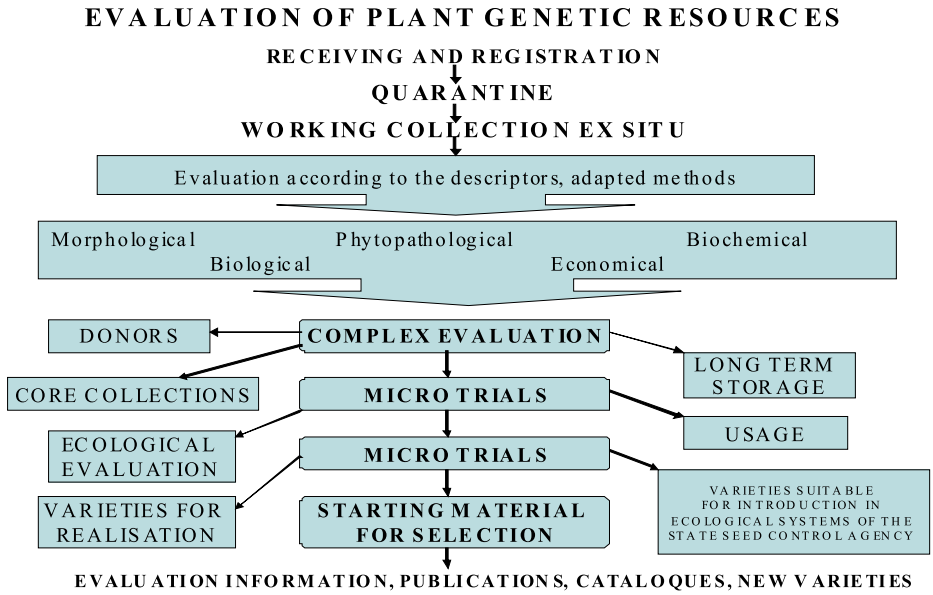


Fig. 3. Evaluation of plant genetic resources
Evaluacija biljnih genetičkih resursa

The evaluation of in situ collections is shown in Figure 4.

In Situ evaluation
Ecologogeographical data
GPS Data – altitude, slope, aspect
Flora:
Type of the plant communities – areals, description of the species, covering rate, ratio.
Use:
Now and in the past - haymaking, pasture, cultivation, watering
Ecological evaluation:
Ecological situation – rare, endangered and endemic plants
Threats – anthropological, natural
Actions – monitoring, ex situ, status determination

Fig. 4. In situ evaluation
In situ evaluacija

Maintenance of PGR. This is done by applying the most suitable methods:

Reproduction – each year about 2000 accessions are reproduced for their preservation.
Propagation – recognised grain legumes, forage and vegetable crops varieties are maintained.

In *ex situ* field collections, 983 accessions are maintained from vegetatively propagated crops - potatoes, forage grasses, sunflower, ornamental and medical species. *In situ* conservation – a database is created including the investigated areas with wild species in Strandja mountain, South Dobrudja, Black Sea (North), East and West Rhodopi mountains. *On farm* conservation – information is collected about areas where old varieties and forms are grown.

In vitro. For *in vitro* storage of vine plants, low positive temperatures (2 C^{o}) allow growth suppression over a period of 18 months, but the vitality is lowered to 72%. The differences between cultivars and rootstocks are not essential (Ruseva, 2011).

For storage of varieties of hops and mint, the use of osmotic stress is recommended (high carbohydrate content in the culture media) and reduced content of culture media. Both approaches are suitable for maintaining samples of hops and peppermint for a period of one year and the reported viability of explants after the storage period is within 61% - 73% (Rousseva, 2000, 2011).

Figure 5. shows *in vitro* storage of the vine, potatoes and hops samples in test-tube cultures whose form is preferred over other type of culture vessels in order to prevent fungal and bacterial infections.

Fig.5. *In vitro* stored samples from the vine, potatoes and mint
Uzorci vinove loze, krompira i mente koji se čuvaju in vitro

As for medical plants, the experimental work requires longer time due to the specifics of each type. The same methods are applied separately as well as combined to establish optimal conditions for each of the species studied. The results achieved so far allow maintenance in *in vitro* conditions to a maximum period of six months but the extent of survival is not very high - 30-40% (Varbanova et al., 2002).

Currently, local Bulgarian and introduced varieties of potatoes, wine and dessert wine varieties and rootstocks from the vine, hops - Bulgarian and foreign selection as well as mint varieties are stored *in vitro*. Medical plants with warranted price for their medicinal qualities, typical for the flora of Bulgaria are also stored (Table 1.).

Tab. 1. *In vitro* collections of vegetative propagated plant species
In vitro zbirke biljnih vrsta dobijenih vegetativnim razmnožavanjem

***Solanum tuberosum* L.**	**VITIS spp.**		***Mentha* spp.**	***H. lupilus* L.**	**Medical plant species**
	Bulgarian varieties	**Introduced varieties**			
Bulgarian varieties **67**	Wine **23**	Wine **22**	species **4**	Introduced varieties **17**	*L. aestivum* L.,*S. officinalis* L. *A. montana* L.,*G. glabra* L.,*L. vera* L.,*A. beladona* L.
Introduced varieties 92	Desert **31**	Desert **23**	species **13**		*S. rebaudiana* L.,*R. tinctotum C. etythraea* L.,*H. perforatum* L., *O. majorana* L., *H. officinalis* L.
Old varieties **11**	Rootstocks **4**				*N. cataria* L.,*M. offcinalis* L. *P. elongate* L.,*S. scardica* L. *R. graveolens* L.,*S. marianum* L.
Total **170**	Total **103**		Total **17**	Total **17**	Total **18**

Completion of *in vitro* assortment continues each year after conducting preliminary studies on *in vitro* culture and micropropagation and testing of the storage conditions for each plant species and variety.

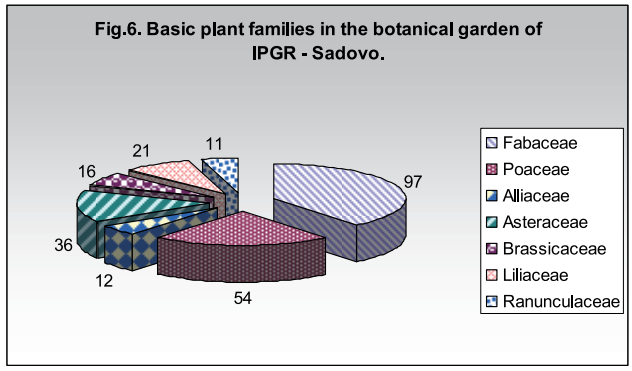
As a result of long-time research, all the methods mentioned are applied on *in vitro* storage of potato samples. The best results are achieved with the use of growth inhibitors, where 12-month storage is reached with preserved viability of explants up to 80% (Dimitrova, 2009).

Conservation of PGR. Bulgaria has a national PGR programme with gene bank whose main priorities are in line with international standards and national interests. The national genebank was developed in 1984 and undertakes a scientific programme for long-term preservation of germplasm with seeds under controlled conditions in accordance with FAO standards (1980/1995). The preservation of the diversity of cultural plant species and their relatives is carried out in 3 different

conditions: a base collection – long term preservation in air-proof packages under -18° C; a working collection – preservation of the seeds up to ten years under 6° C; an exchange collection – a non-currency exchange with partners from the national and international system is established.

The National Gene Bank supports more than 56 000 samples from 2 670 plant species. 39 340 samples are kept in the base collection. The specific activity of the laboratory to the gene bank includes the following tasks: seed control analysis and preparation of samples for preservation; monitoring of the status of the seeds; support of exchange collection and establishing of free exchange; defending of cultivar identity according to the methods of ISTA and UPOV. The national gene bank in IPGR - Sadovo is nominated by the European PGR programme as a focal point for Bulgaria, which is a significant achievement for the agricultural science. Thus, the right of other institutes in the country to join the system and participate in the electronic catalogue is protected. The database for the National Collection of PGR as part of the EURISCO - European electronic catalogue, can be found on the web site of the European Programme on Genetic Resources (http://eurisco.ecpgr.org) (Stoyanova, 2005; Koeva, 1987, Koeva et al., 1995). Information (uploaded on-line) is annually updated and there are conditions to include partners from other scientific institutes with their collections. As part of the database for Bulgarian collections of PGR (PHYTO `2002 in the ACCESS file format), Dobrudja Agricultural Institute - G. Toshevo and the Institute of Roses, Essential and Medical Cultures- Kazanlak also participate.

Documentation. By creating a European electronic catalogue, EURISCO (http://eurisco.ecpgr.org), it has become clear that we have the richest collection of plant gene pool stored in a gene bank in the Southeast Europe and the third largest collection of wheat varieties (common and hard) after those in Gatersleben - Germany and VIR - Russia. The electronic catalogue contains passport data, about 26 descriptors and includes 62 131 specimens, 57 710 of which are in the IPGR - Sadovo, 3 857 are at DAI - G. Toshevo and 564 in IREMC - Kazanlak. The total collection in the National gene bank - Sadovo, which is maintained under conditions of medium and long term controlled storage, consists of 57 684 seed samples from more than 1 400 plant species, representatives of cultural and wild flora, of local and foreign origin (Stoyanova, 2007; Krasteva, et al., 2009, Angelova, et al., 1998).



There have been 238 crop species of

Bulgarian origin registered in the gene bank: 33 cereals, 34grain legumes, 41 industrial crops, 29 vegetable crops, 43 forage crops, 19 ornamental and 39 permanent crops.

The Botanical garden is a specialised unit of the Programme of Plant Genetic Resources of IPGR – Sadovo. It was established in 2002 with its main goal being the preservation of local resources through *in vivo* and in garden conservation. Rare, endemic, and endangered plants are kept there belonging to 54 families (Fig.6). Out of their total number, 8 are Balkan endemits - *Achillea clypeolata, Allisoides bulgarica, Knautia macedonica, Chamaecitisus janke, Iris reichenbachii, Iris suaveolens, Aegilops cylindrica, Haberlea rhodopensis*, which is also rare; 5 are Bulgraian endemits - *Allium rhodopaeum, Sedum album, Vicia incisa, Aegilops neglecta , Soldanella rhodopaea*; 4 are endangered plants - *Leucoyum aestivum, Artemisia pedemontana, Anemone sylvestris, Pyracantha coccinea*; 11 are rare plants - *Meum athamanticum, Artemisia lerchiana, Artemisia pontica, Leontopodium alpinum, Leucanthemum vilgare, Andrachne telephioides , Aegilops triuncialis , Koeleria brevis, Secale cereale var. perene, Clematis alpina, Paeonia tenuifolia.* The medical plant collection that is kept in the botanical garden comprises 51 species. The specimens in the Botanical Garden are divided thematically as follows: essential –oil plants; grasses; forage crops; ornamental plants; rare and endangered plants; crop wild relatives; introduced plant species.

Demonstrative collections in the botanical garden are made of species that include crop wild relatives, old varieties and ecotypes: *Beta maritima, Trigonella coerulea, Luffa acutangula;* old pea varieties as well as introduced plant species- *Physalis peruviana, Cynara scolymus*, *Cynara cardunculus.*

Herbarium collection. Enriched with samples from expeditions, a herbarium collection was created at the IPGR - Sadovo, including rare, endangered and endemic species: *Dracunculus vulgaris* – endangered; *Artemisia chamaemelifolia*; *Centaurea parilica* – rare, Balkan endemic plant; *Ligularia sibirica* – endangered; *Anthemis sancti-johannis* – rare, Bulgarian endemic plant; *Onosma rhodopaea* – endangered, Balkan endemic plant; *Trachelium rumelianum* – rare, Balkan endemic plant; *Astragalus physocalix* – Balkan endemic plant; *Gentiana punctata* – endangered; *Lilium rhodopaeum* – rare, Balkan endemic plant; *Geum rhodopaeum* – rare, Bulgarian endemic plant; *Origanum vulgare*.

Use of PGR. Exchange collection and use of the germplasm. It comprises 2930 accessions, and 1000 of them, stored for more than 5 years, are tested for vitality. Selection of starting material – 26 new varieties were created in the IPGR for 35-year period. Educational work – rare and endemic plants, crop wild relatives, old varieties as well as introduced varieties, medical and spice plants, divided in thematical collections are maintained in connection with different educational projects.

Conclusion

Priorities for future activities within the PGR Programme in the IPGR – Sadovo:

- Close interaction with the scientific and educational centres in Bulgaria;

- Collection of the existing old varieties and populations of vegetables, grain legumes, cereals, forage, ornamental and other crops;
- Establishment of new territories and producers for *in situ* and *on farm* conservation;
- Creation of demonstrative collections and trials for educational and practical purposes (with wild species, very old varieties, plants interesting for cultivation, etc.);
- Creation of seed plots with wild forage, medical, oil and other plant species for reintroduction or improvement of areas of high natural value.
- Preparation of a plan for interaction between biodiversity, agriculture and good practices.

Modern agriculture is based on a limited range of varieties and a few species. Generations before us have used countless local forms with large genetic variation, even within one country and region. The conservation and use of old plant material provides researchers, now and in the future, with valuable germplasm resistant to biotic and abiotic factors, many of which are stored only in the gene bank of PGRI - Sadovo.

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Biljni genetički resursi kao dio biodiverziteta

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Sažetak

Očuvanje biljnog biodiverziteta bugarske flore je glavni prioritet u naučnim aktivnostima IPGR – Sadovo. On je sastavni dio Nacionalnog programa o biljnim genetičkim resursima (BGR). Prinove biljaka u baznim kolekcijama ocjenjuju se prema standardima FAO i Evropskog programa za BGR. Naučni program za čuvanje germplazme u kontrolisanim uslovima banke gena priprema se prema zahtjevima FAO. Nacionalna kolekcija BGR u Sadovu sadrži kulture i divlje srodnike biljaka – nove sorte, selekcione linije, stare sorte, lokalne populacije, mutante i divlje vrste. Kolekcija je podijeljena u 7 osnovnih grupa: žitarice, zrnate mahunarke, industrijsko bilje, povrtne kulture, krmno bilje, ljekovito i ukrasno bilje. Naučni rad je usmjeren u 6 pravaca: poboljšanje novom germplazmom; evaluacija BGR; održavanje BGR; čuvanje BGR; dokumentacija o BPGR; upotreba BGR.

Ključne riječi: biodiverzitet, BGR, germplazma, banka gena

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Pomological characterisation of pear varieties of "Lubenicarka" group

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Summary

Pomological characterisation of pears of the so-called "Lubenicarka" (watermelon pear) group has been based on three genotypes identified in numerous vegetative progeny as part of the native assortment of Bosnia and Herzegovina. "Krupna Lubenicarka" (common watermelon pear) variety was recommended for the expansion of production at the beginning of the XX century, and there were two more genotypes ("Crna Lubenicarka" (black watermelon pear) and "Bijela Lubenicarka" (white watermelon pear)) that were listed under the common name of "Lubenicarka". The research results show that "Krupna Lubenicarka" variety has vegetative progeny characterised by stable pomological features which clearly and reliably determine this variety. "Crna" and "Bijela Lubenicarka" genotypes are characterised by certain pomological distinctions that clearly make them different, but also by some similarities, whose variability raises up the question of their reliable pomological and genetic characterisation. Morphometric analyses of the fruit and leaf of "Krupna Lubenicarka" variety and "Crna" and "Bijela Lubenicarka" genotypes represent their first pomological characterisation that can be adopted as a reliable foundation for collecting, further pomological studies and genetic characterisation.

Key words: "Krupna lubenicarka", "Crna lubenicarka" and "Bijela lubenicarka"

Introduction

According to the specific fruit features, pear varieties are traditionally divided into a number of different groups: "Maslovka", "Vodenjaca" ("Jeribasma"), "Bergamotka" (Bergamot), "Karamanka", "Muskatnica", "Lubenicarka", "Mostaca", etc. (Todorović, 1899; Vitolović, 1949; Bubić, 1952). This classification of pear varieties is not up to date in terms of contemporary fruit production,

primarily because culinary use, post-harvest handling and marketing led to the introduction of completely new assortments in the production; hence most varieties that the said classifications were based on practically became extinct. However, realising the importance of biodiversity conservation and development of modern genetic methods, the old or abandoned varieties, as well as the native ones, are of more interest to geneticists and selectors, for the most part as a potential source of genes, but also because of possible patenting and protection of copyright. This renewed interest in abandoned and native varieties has opened up a number of questions, chiefly methodological ones, that need to be cleared out before general confusion arises that may bring about far-reaching adverse consequences. Namely, every genetic characterisation of such assortment, that is, assortment with no established nor identified pomological standard, including native and autochthonous genotypes that need to be preserved because of their properties or recognised as a new variety, must be done according to the following algorithm: collecting (vegetative progeny with the aim of verification of inheritable properties) → morphological – pomological characterisation (identification of specific inheritable and pomological properties central to fruit growing science and production) → genetic characterisation (molecular marking of specific genetic properties – genes), that is, the genotype standard defined and verified – varieties. In this paper, the pears of "Lubenicarka" group served as an example for discussion of the said algorithm.

"Lubenicarka" pear varieties include those that accumulate anthocyans in the flesh and seed cases in the final stages of physiological ripening so the flesh acquires red colour similar to that of watermelons. In the current literature and fruit growing practice, there is neither scientifically, nor professionally elaborated pomological characterisation, nor specific genotype standardisation of "Lubenicarka" pears based on which characterisation of their numerous vegetative progeny could be done. However, a lot of information can be found under the name "Lubenicarka" at ardent local fruit growers, especially on the Internet, that, under a unique name "Lubenicarka", refers to a number of various pear genotypes with red coloured flesh, but also, completely incorrectly, to some genotypes having bright red skin, and even to some commercial varieties.

Consulting the literature from the time when "Lubenicarka" varieties were part of the then assortment (Lolić, 1934; Lukman, 1937), it is evident that the general term "Lubenicarka" mainly refers to "Krupna Lubenicarka" variety that was widely recommended in the former Yugoslavia in the first half of the XX century. Apart from "Krupna Lubenicarka" variety, the same authors specifically mention "Lubenicarka" variety, as a variety of no particular interest to the fruit production of that period. Seventy years later, "Lubenicarka" pear varieties appeared again in the fruit growing literature, although this time, they were included into the native assortment of Serbia and Bosnia and Herzegovina (Mratinić, 2000; Beširević, 2009; Kanlić, 2010). These sources of literature provide description of "Krupna Lubenicarka" variety and "Lubenicarka" variety in terms of visual description of the fruit and some consumption properties, but without pomological description and scientific characterisation of the morphometric and organoleptic ones. Further,

Beširević (2009) only gives a short account of “Bijela” and “Crna Lubenicarka” as "sisters" of “Krupna Lubenicarka” variety. According to the literature cited, it can be concluded that, as part of old i.e. native assortment, there are numerous vegetative progeny of “Krupna Lubenicarka” variety in the field, which spread as a recommended variety, as well as vegetative progeny of a group of genotypes under the common name of “Lubenicarka”, mainly comprised of “Crna Lubenicarka” and “Bijela Lubenicarka” genotypes.

Materials and methods

Pomological characterisation of “Krupna Lubenicarka”, “Crna Lubenicarka” and “Bijela Lubenicarka” fruits was conducted from 2010–2012 on the fruits taken from the variety collection in Spionica in Srebrenik, the collection of Vahid Beširevic from Gradacac, and "*in situ*" conserved accessions in the Genetic Resources Institute, University of Banjaluka.

Anatomic–morphological features and fruit description (according to Mićić and Đurić, 2008) were completed in the Pomological Laboratory of the Horticulture Institute within the Faculty of Agriculture in Banjaluka.

The samples of 50 fruits for each variety were delivered successively to the laboratory and analysed. All fruit samples were photographically documented. 10 samples of each variety were examined in terms of vertical and horizontal cross-section as to be scanned and graphically analysed for the fruit shape parameters whereas 20 fruits were analysed in terms of fruit mass, flesh firmness and total soluble solids content in cell juice (% Brix). At the same time, morphometric analysis of 30 leaves for each was conducted by scanning the leaf blade thus measuring the leaf surface and leaf stalk length. In addition, leaf edge serration was photographically documented.

Results and discussion

The pomological analyses of pear fruit of “Lubenicarka” group collected in Bosnia and Herzegovina confirm the presence of a number of different genotypes whose properties are being transferred to vegetative progeny in a steady manner. By identifying the trees "*in situ*" and carrying out pomological analysis of their fruits as well as the fruits from two variety collections, a genotype under the name “Krupna Lubenicarka” was confirmed and at least two genotypes under the common name “Lubenicarka”, thus complying with the claims of Lolić (1934), Lukman (1937) and Beširević (2010). Besides the fruit size, these genotypes are also visually very distinct in terms of the fruit shape, main and auxiliary skin colour, length of fruit stalk and a number of other elements of pomological characterisation (Fig. 1).

The graphic analysis of the fruit confirmed differences between the common fruit shape as well as the specific content of anthocyans in the flesh during the physiological stage of fruit ripening (Fig. 2.). The most coloured flesh was found in “Krupna Lubenicarka” variety, indicating the highest content of anthocyans in the fruit flesh. A comparison of the coloured flesh in “Crna Lubenicarka” and “Bijela

Lubenicarka" genotypes showed the lowest amount of anthocyans in the flesh of "Bijela Lubenicarka" genotype. "Bijela Lubenicarka" also differs in regard with its skin colour which altogether strongly suggests the origin of its name.

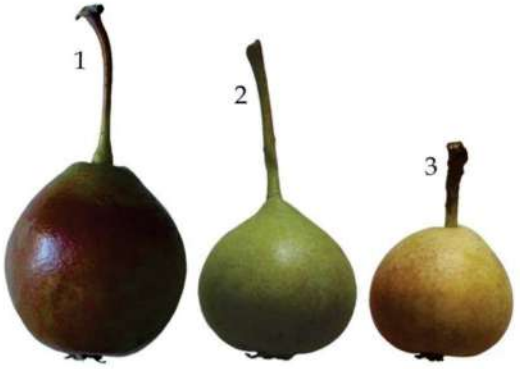


Fig.1. Appearance of pear fruits of "Lubenicarka" group which are dominant in numerous vegetative progeny throughout Bosnia and Herzegovina. "Krupna Lubenicarka" genotype (1) spread considerably at the beginning of the XX century across fruit growing regions. At the same time, at least two genotypes: "Crna Lubenicarka" (2) and "Bijela Lubenicarka" (3) spread throughout BiH under the name "Lubenicarka".

Izgled plodova krušaka iz grupe Lubeničarki koje su dominantno prisutne u brojnom vegetativnom potomstvu na prostoru Bosne i Hercegovine. Genotip Krupna lubeničarka (1) početkom XX veka značajno je proširena u voćarskim regionima. Istovremeno pod nazivom Lubeničarka na prostoru BiH raširena su i najmanje dva genotipa: Crna lubeničarka (2) i Bijela lubeničarka (3).

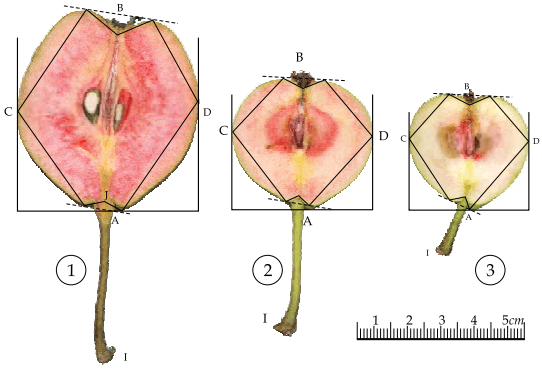


Fig. 2. The graphic analysis of the fruit shape and specific content and distribution of anthocyans in the flesh of the "Lubenicarka" genotypes studied: 1) "Krupna Lubenicarka"; 2) "Crna Lubenicarka"; and 3) "Bijela Lubenicarka".

Grafička analiza oblika ploda i karakteristična zastupljenost i distribucija antocijana u mesu ploda proučavanih genotipova lubeničarki: 1) Krupna lubeničarka; 2) Crna lubeničarka; i 3) Bijela lubeničarka.

A comparative review of morphometric and pomological parameters of the fruit concerning the three genotypes of "Lubenicarka" under study is given in Table 1.

Tab. 1. Main pomological parameters of the fruit and leaf of the "Lubenicarka" genotypes studied.
Osnovni pomološki parametri ploda i lista proučavanih genotipova lubeničarki.

Fruit and leaf properties	*"Lubenicarka" varieties – genotypes*		
	"Krupna lubenicarka"	"Crna lubenicarka"	"Bijela lubenicarka"
Fruit mass (g)	71,59 ± 2,35	53,65 ± 2,06	38,3 ± 2,14
Fruit height - AB (mm)	61,64 ±	44,28 ±	45,61 ±
Fruit diameter – CD (mm)	55,91 ±	45,03 ±	48,27 ±
Fruit stalk length – AJ (mm)	42,37 ±	44,35 ±	27,38 ±
Flesh firmness (kg/cm^2)	4,95 ±	8,33 ±	5,19 ±
Total soluble solids content (Brix %)	11,81 ± 0,36	13,47 ± 0,55	12,01 ± 0,48
Anthocyans in fruit flesh (visual)	4 - 5	2 - 3	1 – 2
Leaf edge serration	Serrate	Entire	Entire
Leaf blade surface (cm^2)	20,48 ± 0,89	39,64 ± 2,17	35,43
Leaf stalk length (cm)	3,87 ± 0,99	4,86 ±	5,05

Taking into account the data from Table 1, the observed distinctions concerning fruit size as well as some common properties are evident and clearly confirmed. A striking difference in the average fruit mass between "Crna Lubenicarka" and "Bijela Lubenicarka" was not confirmed in regards with the average fruit shape parameters which can be linked with the specific fruit mass, that is, the difference in the occurrence of stone cells. This was further confirmed through pronounced difference in flesh firmness with values being considerably higher for "Crna Lubenicarka" genotype.

Having in mind the fact that pomological description of the fruit, that is, morphometric and pomological characterisation of "Krupna Lubenicarka", "Crna Lubenicarka" and "Bijela Lubenicarka" genotypes does not exist in the existing literature, the main pomological features of these genotypes were photographically documented during this research as a basis for their determination with the aim to collect and study them in the future.

Krupna lubeničarka

Izgled lista sa detaljem ruba lista

Presek ploda - zastupljenost i raspored antocijana

Tipičan izgled ploda

Karakteristične varijacije oblika ploda

Fig. 3. "Krupna lubenicarka" variety – general appearance of the leaf and fruit
Sorta Krupna lubeničarka – opšti izged lista i ploda

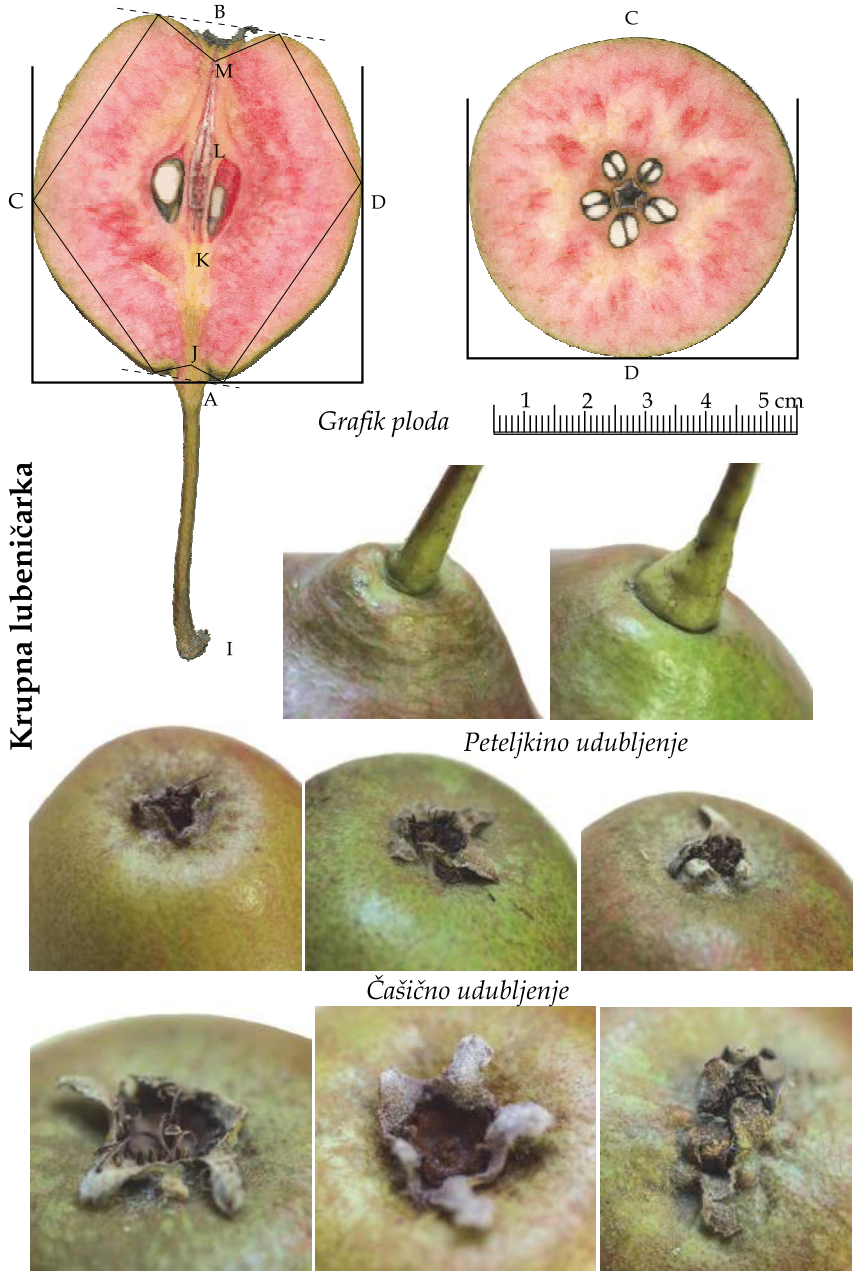
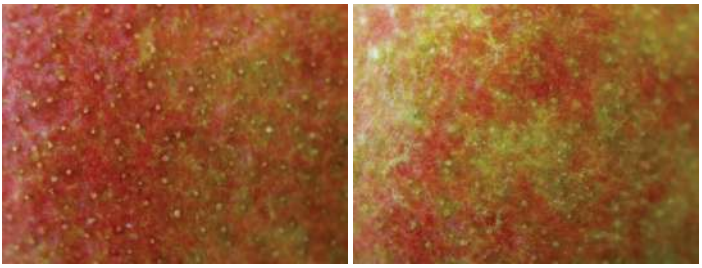
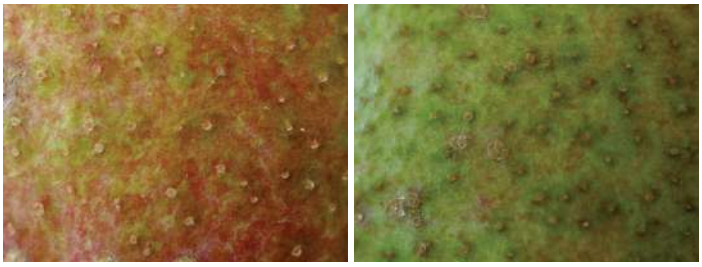


Fig. 4. "Krupna lubenicarka" variety – pomological fruit details
Sorta Krupna lubeničarka – pomološki detalji ploda

Krupna lubeničarka



Boja pokožice ploda



Izgled i zastupljenost lenticela na pokožici ploda

Izgled i zastupljenost normalnih i šturih sjemenki.

Fig. 5. "Krupna lubenicarka" variety – pomological details of the fruit skin and seeds

Sorta Krupna lubeničarka – pomološki detalji pokožice ploda i semenki

"Krupna Lubenicarka" variety has a specific fruit shape. The main colour of the fruit is dark green with brown-red and dark purple auxiliary skin colour that most often covers the whole fruit. When physiologically ripe, flesh and pergament-like chambers acquire intensive red colour that makes them very appealing. The flavour is sweet-acidic, aromatic and refreshing. Becoming completely ripe, their flesh softens, anthocyans oxidise and acquire brown colour, whereas sugar in the flesh ferments into alcohol. "Krupna Lubenicarka" variety is a distinctive variety that needs to be protected and conserved. The only lack is a relatively rapid ripening after the period of physiological fruit ripening, therefore research is to be expected aiming at making this red fleshed fruit last longer for culinary use.

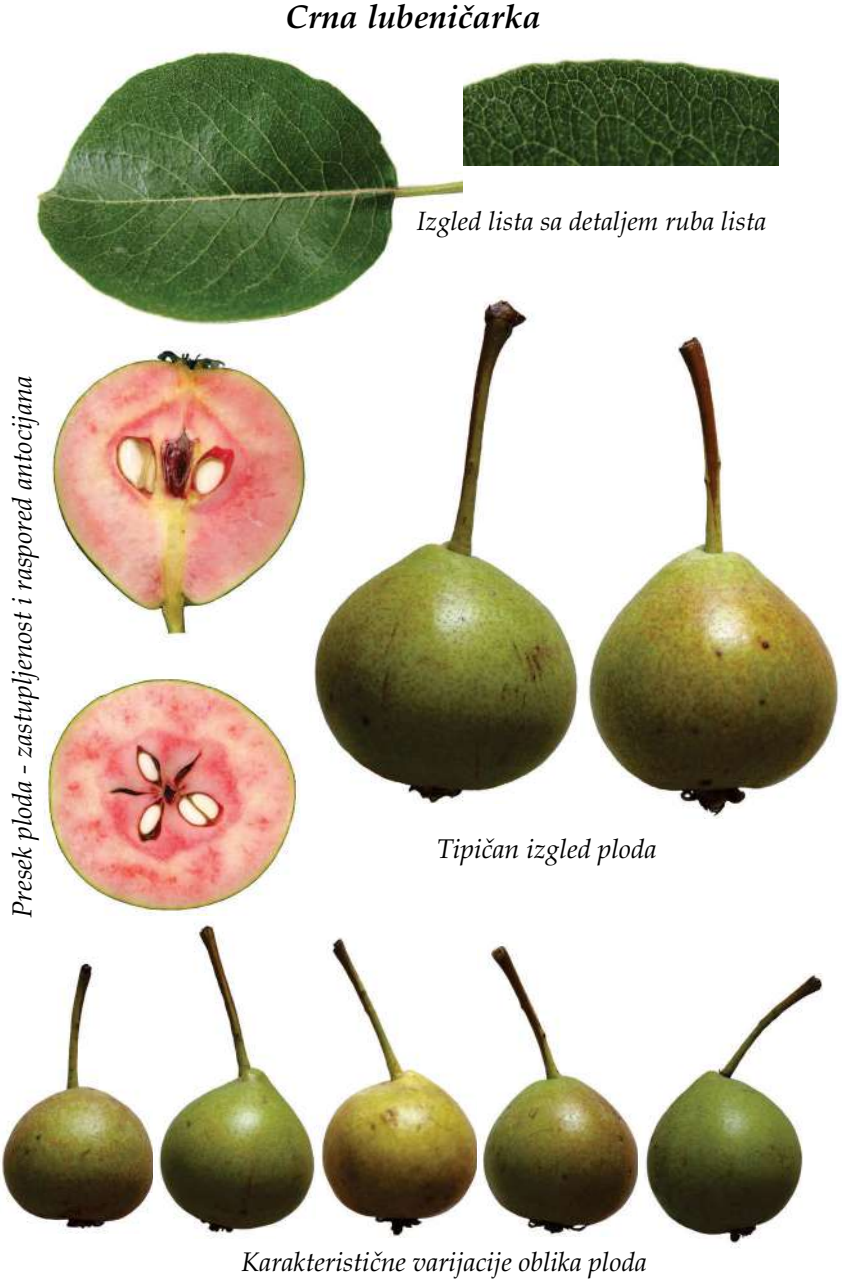


Fig. 6. "Crna lubenicarka" variety– general appearance of the leaf and fruit
Sorta Crna lubeničarka – pomološki detalji ploda

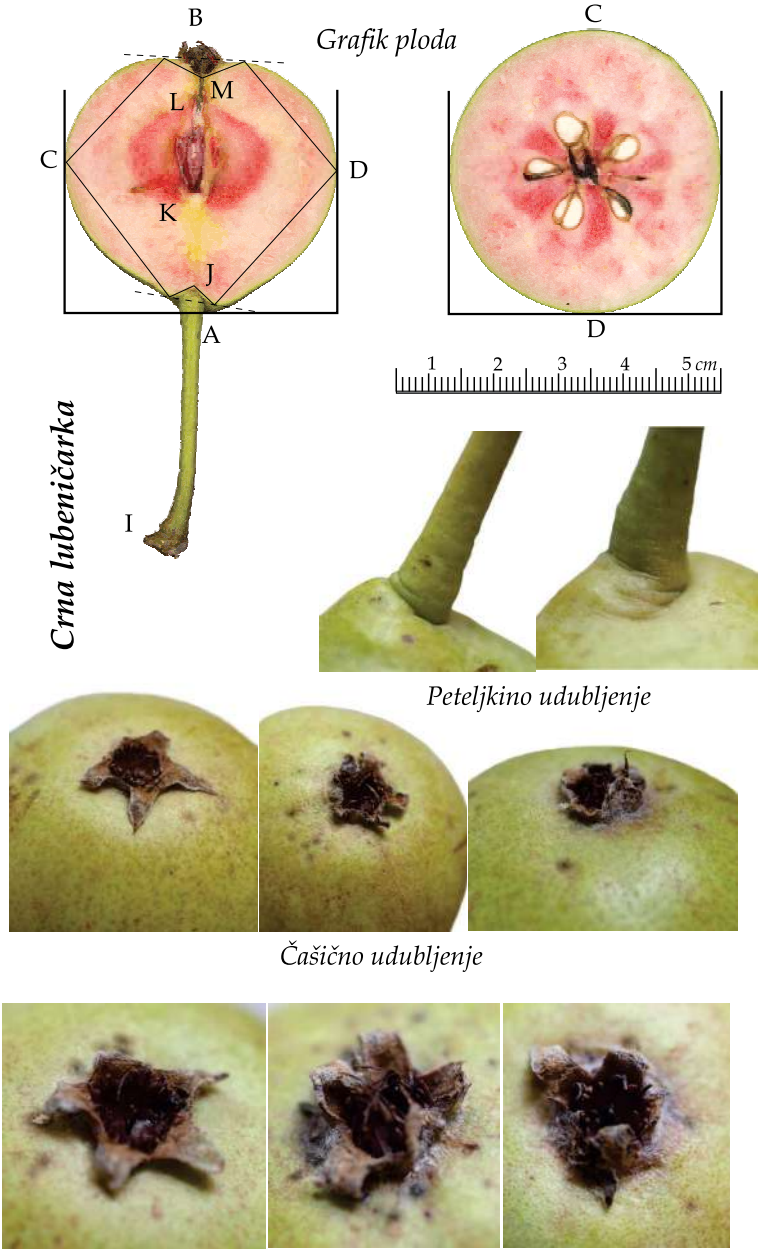


Fig. 7. "Crna lubenicarka" variety – pomological fruit details
Sorta Crna lubeničarka – pomološki detalji ploda

Crna lubeničarka

Boja pokožice ploda

Lenticele na pokožici ploda - izgled i zastupljenost

Izgled i zastupljenost normalnih i šturih sjemenki.

Fig. 8. "Crna lubenicarka" variety – pomological details of the fruit skin and seeds
Sorta Crna lubeničarka – pomološki detalji pokožice ploda i semenki

"Crna Lubenicarka" has small fruits. The main colour of the fruit is dark green with brown-reddish auxiliary skin colour that rarely appears on individual fruits. When physiologically ripe, flesh and pergament-like chambers, especially in the seed case tissue, acquire red colour that makes them very appealing. The flavour is sweet-acidic with specific aroma. Becoming completely ripe, their flesh softens, anthocyans oxidise and acquire brown colour, whereas sugar in the flesh ferments into alcohol. According to the claims of Beširević (2010), "Crna Lubenicarka" variety shows particular resistance towards pathogens and should be conserved as a potential donor of these properties.

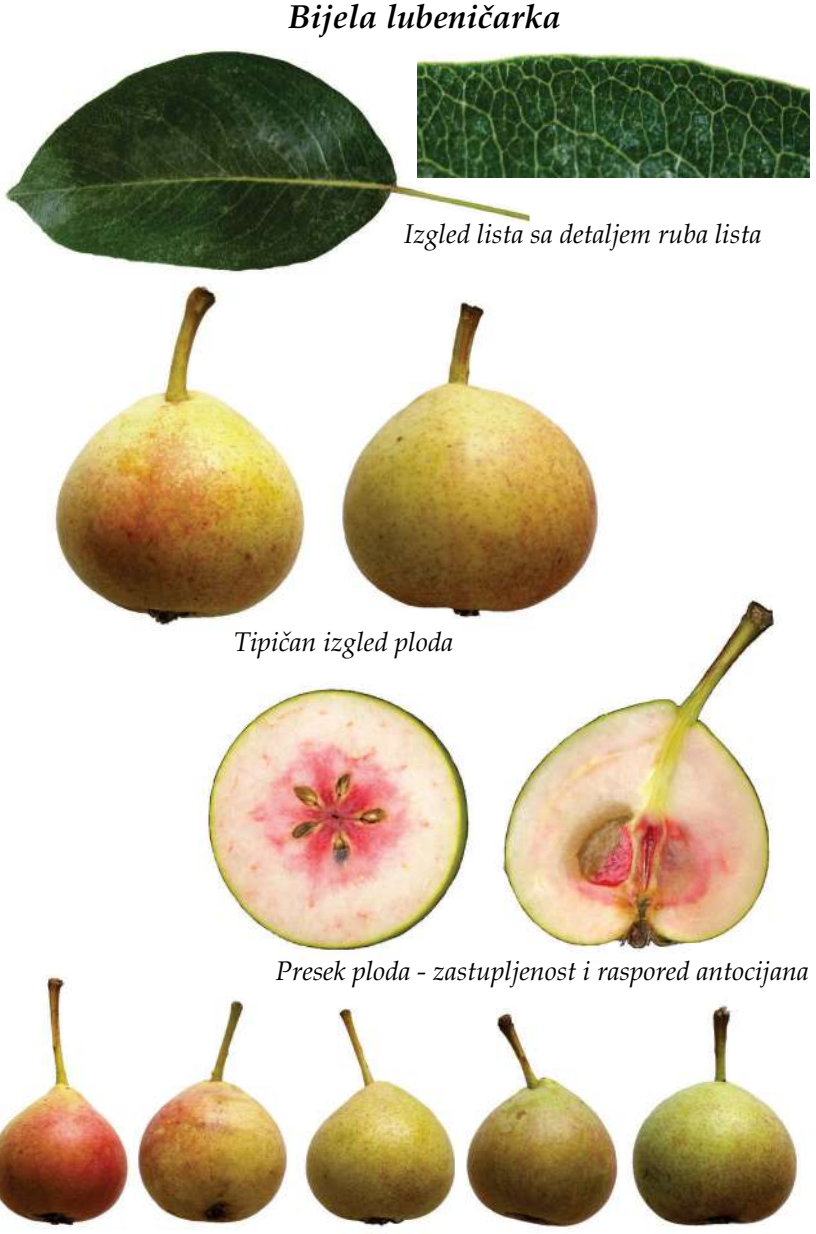


Fig. 9. "Bijela lubenicarka" variety– general appearance of the leaf and fruit
Sorta Bijela lubeničarka – opšti izgled lista i ploda

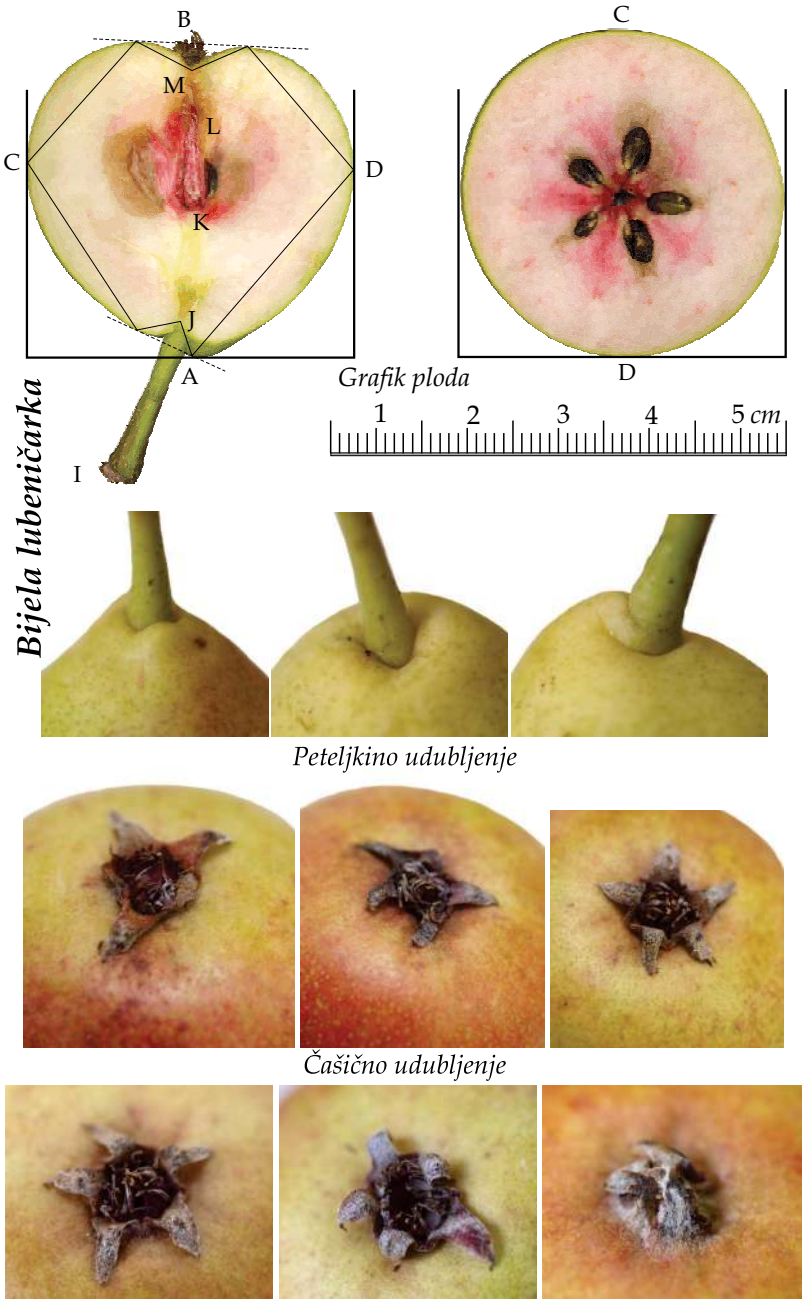
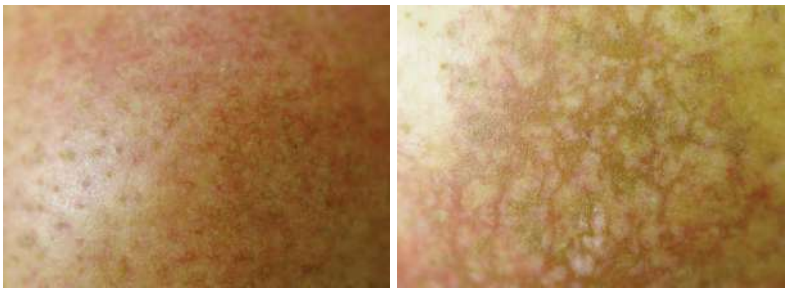
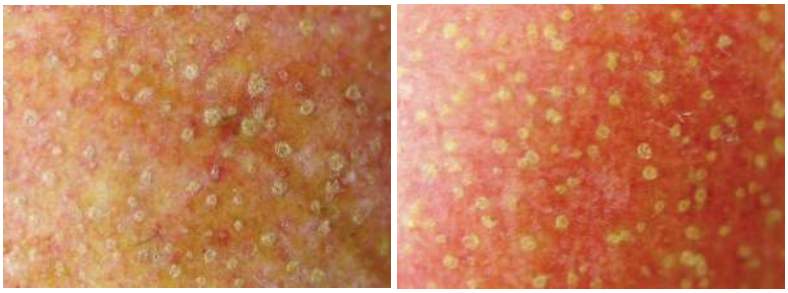


Fig. 10. "Bijela lubenicarka" variety – pomological fruit details
Sorta Bijela lubeničarka – pomološki detalji ploda

Bijela lubeničarka



Boja pokožice ploda



Lenticele na pokožici ploda - izgled i zastupljenost

Izgled i zastupljenost normalnih i šturih sjemenki.

Fig. 11. "Bijela lubenicarka" variety – pomological details of the fruit skin and seeds

Sorta Bijela lubeničarka – pomološki detalji pokožice ploda i semenki

"Bijela Lubenicarka" has small fruits. The main colour of the fruit is light green with auxiliary skin colour ranging from orange to red hues that completely cover the sunny side of the fruit. When physiologically ripe, the flesh acquires light reddish colour whereas the seed case becomes reddish and red. The fruit flavour is sweet-acidic with specific aroma. Becoming completely ripe, their flesh quickly softens, anthocyans oxidise and acquire brown colour, whereas sugar in the flesh ferments into alcohol. According to Beširević (2010), "Bijela Lubenicarka" variety

shows particular resistance towards pathogens and should be conserved as a potential donor of these properties.

Conclusion

All inventoried trees of "Krupna Lubenicarka" across the regions of Podrinje and Potkozarje have identical pomological features by which this genotype has been verified as a variety, that is, vegetative progeny of the source seedling of unknown origin.

Within the vegetative progeny of pears that have been identified in the field and that expand under the common term "Lubenicarka", two genotypes were identified in this paper – "Crna Lubenicarka" and "Bijela Lubenicarka", although the issue concerning their final status, either as two separate varieties of unknown origin or different clones in numerous vegetative progeny under the common term "Lubenicarka", still remains unresolved.

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Pomološka karakterizacija sorti krušaka iz grupe lubeničarki

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Sažetak

Pomološka karakterizacija krušaka iz grupe lubeničarki izvršena je na tri genotipa identifikovana u brojnom vegetativnom potomstvu kao deo autohtonog sortimenta Bosne i Hercegovine. Sorta Krupna lubeničarka preporučivana je za širenje u proizvodnji početkom XX veka, a pratila su je i još dva genotipa (Crna lubeničarka i Bijela lubeničarka) pod zajedničkim nazivom Lubeničarka. Rezultati istraživanja pokazuju da sorta Krupna lubeničarka ima vegetativno potomstvo stabilnih pomoloških karakteristika koje su jasna i pouzdana odrednica ove sorte. Genotipovi Crna i Bijela lubeničarka imaju određene pomološke različitosti koje ih jasno diferenciraju, ali i određene sličnosti čija varijabilnost otvara pitanje njihove pouzdane pomološke i genetičke karakterizacije. Morfometrijske analize ploda i lista sorte Krupna lubeničarka i genotipova Crna i Bijela lubeničarka predstavljaju njihovu prvu pomološku karakterizaciju koja se može usvojiti kao pouzdana osnova za njihovo kolekcionisanje, dalja pomološka proučavanja i genetičku karakterizaciju.

Ključne reči: Krupna lubeničarka, Crna lubeničarka i Bijela lubeničarka

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Estimation of red clover (*Trifolium pratense* L.) forage quality parameters depending on the cut, stage of growth and cultivar

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Summary

A field trial was conducted to determine the forage quality parameters of two red clover cultivars – Nike and K-39 and to quantify the effects of cultivar, cut and stage of growth on red clover forage quality. The experiment was conducted in a randomised block design with three replicates. The changes in chemical constituents of red clover were analysed by Weende system of analysis. The differences between forage quality of investigated red clover cultivars were significant for crude ash, crude protein, crude fibre and nitrogen free extract ($P< 0.05$). The results of this investigation indicated that the crude protein content of red clover declined with advancing maturity in the second and third cut (from 245.60 to 180.50 g kg^{-1} of DM and from 256.25 to 160.25 g kg^{-1} of DM, respectively). The achieved results show that *cv* K-39 has lower forage quality at the second cut, with lower crude protein and higher crude fibre than *cv* Nike.

Key words: red clover, forage quality, cut, stage of growth

Introduction

Animal breeding and obtaining high levels of production via healthy nurture are important for regions that deal with stockbreeding. Despite obtaining animals which are at high levels of production, there are still some problems in meeting the forage requirements of these animals. Therefore, forage crops with high production characteristics should be improved so that animals can be fed adequately and healthily during long winters.

Red clover (*Trifoium pratense* L.) is the second most important perennial forage legume, after alfalfa. It is grown on about 20 million hectares worldwide, while in Serbia it has been grown on around 120.000 ha annually in the last few years (Vasiljević et al., 2009). This forage crop is adapted to a wide range of

climatic conditions, soil types, fertility levels, use patterns and management. It is easy to establish, has high seedling vigour, is an excellent nitrogen fixer and is suitable for use in crop rotations. The yield potential of red clover is excellent and some red clover varieties can have higher fodder yields than alfalfa. Red clover is also of very good quality in the light of its nutritive value and ensiling (Taylor and Quesenberry, 1996; Hoffman and Broderick, 2001).

Forage quality is affected by many independent factors including maturity, crop species, harvest and storage, environment, soil fertility and variety. The stage of development considerably affects chemical composition and forage quality of red clover (Belonger, 2010; Marković et al., 2008; Makarenko and Pribytkov, 1989). In the early spring, young red clover plants have high proportion of leaves, high content of moisture, proteins and minerals and low content of fibres. During the growing season, under the effect of longer days and higher temperatures, the ageing plants undergo morphological changes: leaf growth becomes slower, the stem increases in length and proportion of dry matter increases. On the other hand, forage quality decreases drastically, especially digestibility and the contents of proteins and minerals. The optimum time for red clover cutting is the stage when 20-25% flowers are in bloom (Wiersma et al., 1998).

The main objectives of this study are to determine and compare forage quality of two red clover cultivars and to quantify the effects of cultivar, cut and stage of growth on red clover forage quality.

Materials and methods

The experiment was designed as three-factorial trial in a randomised block system with three replicates. Three stages of growth of red clover (*Trifolium pratense* L.) *cv* Nike and K-39 were examined in the second and third cut. Samples were hand cut with scissors at 5 cm height. The first stage was cut after 22 days of vegetation, at full boot stage, another one after 29 days of vegetation (around 40% flowering), and a third one in full flowering after 36 days of vegetation. Dry matter was determined by drying out samples at 65° C and grinding and sieving them to 1 mm particle size.

Crude ash was determined by ashing at 550° C. Crude proteins were computed indirectly from the amount of total nitrogen, measured by the Kjeldahl method modified by Bremner, multiplied by factor 6.25. Crude fibre was determined by being sequently refluxed in dilute base followed by dilute acid. Crude fat was determined by the method of Soxlet. The amount of nitrogen free extract in samples was determined as a difference between 1000 and amounts of crude ash, crude protein, crude fibre and crude fat.

The data were processed by the analysis of variance in a randomised block design. Effects were considered different based on significant ($P< 0.05$) F ratio. The significance of differences between arithmetic means was tested by LSD test.

Results and discussion

The results of analyses of variance (Table 1) revealed statistically significant effects of the cut sequence on forage quality. The cut was an important source of variability for all qualitative parameters in this trial. The analyses of

variance also revealed significant differences between stages of growth for all investigated parameters except crude fat and significant differences between investigated cultivars of red clover for all forage quality parameters.

Overall, as red clover matured, the content of crude ash decreased from the first to the third stage of growth in both investigated cuts and in both investigated cultivars. The interactions cut x stage of growth, cut x cultivar and stage of growth x cultivar were also significant ($P< 0.05$). The higher content of crude ash was found in the third cut at the first and second stage of growth. *Cv* Nike had higher content of crude ash in the second cut.

Studying the quality characteristics of dry matter at different stages of development of red clover cultivars, Vasiljević et al. (2005) found that the average ash content in the two stages was 8.9%. Dinić et al. (1990, 1994) reported the ash content of 10.3% in red clover at the stage of early bloom.

Forage quality of red clover depends primarily on the plant development, the height of cut and environmental conditions. Taylor and Quesenberry (1996) state the two most authoritative quality parameters are crude proteins and in vitro dry matter digestibility. These levels decline with age, for all perennial legumes as a result of reduction of leaf to stem proportion and the process of lignification. The decrease in digestibility after budding occurs as a result of increased lignin content and increased proportion of polysaccharide.

Growth stages and plant age are important factors affecting the chemical composition and forage quality of red clover (Ignjatovic et al. 2001, Markovic et al. 2010). In the early spring, young plants of red clover have a large proportion of leaves, high moisture content, proteins and minerals, and low content of fibres. During the period of vegetation under the influence of longer days and higher temperatures with ageing, plants undergo morphological changes: growth of leaves is slower, the stems are extended, dry matter yield increases and quality decreases dramatically, particularly digestibility, proteins and minerals.

The analyses showed significant ($P< 0.05$) cut x stage of growth, cut x cultivar, stage of growth x cultivar and cut x stage of growth x cultivar interactions for crude proteins and crude fibres. The results of the trial are presented in Table 1.

The results of this trial indicated that crude protein concentration of both red clover cultivars declined with advancing maturity. In the second cut, *cv* Nike contained more crude protein than *cv* k-39 at all sampling dates, crude protein concentration in *cv* K-39 was higher in the first development stage than in *cv* Nike (in the third cut). Along with plant growth and development, crude protein content decreased from first to third stage of growth by 22.3% in the second and by 36.6% in the third cut (*cv* Nike), and 30.7% in the second and 38.3% in the third cut (*cv* K-39).

During maturation, crude fibre concentration increased from 171.5 to 237.2 g kg^{-1} of DM in the second and from 139.6 to 197.6 g kg^{-1} of DM in the third cut (*cv* Nike), and from 195.0 to 267.0 g kg^{-1} of DM in the second and from 123.3 to 206.2 g kg^{-1} of DM in the third cut (*cv* K-39).

Tab. 1. Forage quality parameters of red clover (*Trifolium pratense* L.) *cv* Nike and K-39 (g kg^{-1} of DM)
Parametri kvaliteta crvene djeteline (*Trifolium pratense* L.) *cv* Nike i K-39 (g kg^{-1} DM)

Parameter		A_1				A_2			
		B_1	B_2	B_3	χ (AC)	B_1	B_2	B_3	χ (AC)
Crude ash	C_1	106.90^{a}	97.70^{b}	91.70^{c}	**98.77^{a}**	106.80^{a}	91.50^{b}	80.80^{c}	**93.03^{b}**
	C_2	99.20^{a}	89.90^{b}	83.70^{c}	**90.93^{b}**	106.10^{a}	97.80^{b}	79.70^{c}	**94.53^{a}**
	χ (AB)	**103.05^{a}**	**93.80^{b}**	**87.70^{c}**		**106.45^{a}**	**94.65^{b}**	**80.25^{c}**	
	χ (A)		**94.85^{a}**				**93.78^{b}**		
	χ (BC)	**106.85^{a}**	**94.60^{b}**	**86.25^{c}**		**102.65^{a}**	**93.85^{b}**	**81.70^{c}**	
	χ (B)		**104.75^{a}**		**94.22^{b}**			**83.97^{c}**	
	χ (C)		**95.90^{a}**				**92.73^{b}**		
Crude protein	C_1	246.60^{a}	211.10^{b}	191.50^{c}	**216.40^{a}**	252.90^{a}	195.10^{b}	160.40^{c}	**202.80^{b}**
	C_2	244.60^{a}	189.30^{b}	169.50^{c}	**201.13^{b}**	259.60^{a}	194.50^{b}	160.10^{c}	**204.73^{a}**
	χ (AB)	**245.60^{a}**	**200.20^{b}**	**180.50^{c}**		**256.25^{a}**	**194.80^{b}**	**160.25^{c}**	
	χ (A)		**208.76^{a}**				**203.76^{b}**		
	χ (BC)	**249.75^{a}**	**203.10^{b}**	**175.95^{c}**		**252.10^{a}**	**191.90^{b}**	**164.80^{c}**	
	χ (B)		**250.92^{a}**		**197.50^{b}**			**170.37^{c}**	
	χ (C)		**209.60^{a}**				**202.93^{b}**		
Crude fiber	C_1	171.50^{c}	190.90^{b}	237.20^{a}	**199.86^{b}**	139.60^{b}	197.60^{a}	197.60^{a}	**178.26^{a}**
	C_2	195.00^{c}	231.70^{b}	267.00^{a}	**231.23^{a}**	123.30^{c}	155.70^{b}	206.20^{a}	**161.73^{b}**
	χ (AB)	**183.25^{c}**	**211.30^{b}**	**252.10^{a}**		**131.45^{c}**	**176.65^{b}**	**201.90^{a}**	
	χ (A)		**215.55^{a}**				**170.00^{b}**		
	χ (BC)	**155.55^{c}**	**194.25^{b}**	**217.40^{a}**		**159.15^{c}**	**193.70^{b}**	**236.60^{a}**	
	χ (B)		**157.35^{c}**		**193.97^{b}**			**227.00^{a}**	
	χ (C)		**189.06^{b}**				**196.48^{a}**		
Crude fat	C_1	33.30^{c}	44.80^{a}	41.00^{b}	**39.70^{a}**	33.80^{a}	17.80^{c}	29.80^{b}	**27.13^{a}**
	C_2	26.90^{a}	25.70^{b}	17.70^{c}	**23.43^{b}**	31.60^{a}	17.80^{b}	17.50^{c}	**22.30^{b}**
	χ (AB)	**30.10^{b}**	**35.25^{a}**	**29.35^{b}**		**32.70^{a}**	**17.80^{c}**	**23.65^{b}**	
	χ (A)		**31.56^{a}**				**24.71^{b}**		
	χ (BC)	**33.55^{b}**	**31.30^{b}**	**35.40^{a}**		**29.25^{a}**	**21.75^{b}**	**17.60^{c}**	
	χ (B)		**31.40^{a}**		**26.52^{b}**			**26.50^{b}**	
	χ (C)		**33.41^{a}**				**22.86^{b}**		
Nitrogen free extract	C_1	441.70^{b}	455.50^{a}	438.60^{c}	**445.26^{b}**	466.90^{c}	498.00^{b}	531.40^{a}	**498.76^{b}**
	C_2	434.30^{c}	463.40^{a}	462.10^{b}	**453.26^{a}**	479.40^{c}	534.20^{b}	536.50^{a}	**516.70^{a}**
	χ (AB)	**438.00^{c}**	**459.45^{a}**	**450.35^{b}**		**473.15^{c}**	**516.10^{b}**	**533.95^{a}**	
	χ (A)		**449.26^{b}**				**507.73^{a}**		
	χ (BC)	**454.30^{c}**	**476.75^{b}**	**485.00^{a}**		**456.85^{c}**	**498.80^{b}**	**499.30^{a}**	
	χ (B)		**455.57^{c}**		**487.77^{b}**			**492.15^{a}**	
	χ (C)		**472.00^{b}**				**484.98^{a}**		

A_1 – second cut, A_2 – third cut; B_1 – first stage, B_2 – second stage, B_3 – third stage of growth; C_1 – *cv* Nike, C_2 – *cv* K-39; Different letters denote significantly different means ($P< 0.05$)

Red clover had more crude fibre content in the second than in the third cut. *Cv* K-39 contained 1.58 times more crude fibre content at the first stage of plant

development, 1.48 times more crude fibre at the second and 1.29 times more crude fibre at the third stage of growth in the second than in the third cut. However, *cv* Nike contained 1.23 times more crude fibre content at the first stage of plant development in the second than in the third cut, and 1.20 times more crude fibre content at the third stage of growth.

The content of crude fibre was the highest at the second cut, which was also confirmed by the results by Wiersma et al. (1998). Griffin et al. (1994) supposed that this is owing to a slower reduction of leaf to stem ratio in the summer as compared to the spring.

Forage producers have special interest in quality improvements so as to partially offset the decline in nutritive value associated with advancing maturity of the crop when harvest is delayed. Some farmers harvest second growth earlier to obtain higher protein and lower fibre concentrations during mid-summer when quality values are often the lowest of the three harvests. The protein and fibre concentrations observed for both cultivars of red clover in this early second harvest may have been excessive for normal dietary requirements in lactating dairy cattle (NRC, 2000).

An adequate fibre level is necessary in the rumen in order to promote a healthy population of cellulolytic species important to maintain normal lipid metabolism and milk fat level, and to enhance microbial protein output to the lower digestive tract (Van Soest et al., 1991). The need for early harvest in order to increase crude protein concentration may sacrifice forage yield and provide insufficient fibre concentration.

During growth and development, none of the investigated cultivars of red clover showed a consistent trend of crude fat and nitrogen free extract content. Overall, maturation and a higher concentration of crude fat in both cuts were found in *cv* Nike. Despite the crude fat, *cv* K-39 contained more nitrogen free extract than *cv* Nike at all sampling dates, except at the first stage of development in the second cut.

Conclusion

The general observation that decrease in content of crude proteins coincides with plant ageing was confirmed in this study. As plant growth advanced, there was greater accumulation of cellulose, while the content of crude proteins decreased. In the second cut, *cv* K-39 had less crude proteins than *cv* Nike, while in the third cut both cultivars were similar in terms of crude proteins content. At the same time, *cv* K-39 had higher crude fibre content than *cv* Nike. The highest content of crude fibres was recorded at the third stage of plant development (*cv* K-39) in the second cut. There were significant interactions between treatments for most forage quality parameters. Generally, *cv* Nike had better forage quality than *cv* K-39 in this period of investigation.

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Procjena parametara kvaliteta crvene djeteline (*Trifolium pratense* L.) u zavisnosti od kosidbe, stadijuma rasta i kultivara

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Apstrakt

Sproveden je poljski ogled da bi se odredili parametri kvaliteta krmnog bilja za dva kultivara crvene djeteline – Nike i K-39 i da bi se izmjerili uticaji kultivara, kosidbe i stadijuma rasta na kvalitet crvene djeteline. Eksperiment je obavljen kao nasumični blok dizajn sa tri ponavljanja**.** Ispitivane su promjene hemijskih sastojaka kod crvene djeteline korištenjem Weende sistema analize. Razlike između kvaliteta krmnog bilja kod analiziranih kultivara crvene djeteline bile su značajne na sirovi pepeo, sirove bjelančevine, sirova vlakna i BEM sadržaj ($P< 0.05$). Rezultati ovog ispitivanja ukazuju da se sadržaj sirovih bjelančevina kod crvene djeteline smanjivao sa odmaklim zrenjem u toku druge i treće kosidbe (od 245.60 do 180.50 g kg^{-1} DM i od 256.25 do 160.25 g kg^{-1} DM). Postignuti rezultati pokazuju da je *cv* K-39 imao niži kvalitet tokom druge kosidbe sa nižim sadržajem sirovih bjelančevina i višim sadržajem sirovih vlakana nego *cv* Nike.

Ključne riječi: crvena djetelina, kvalitet, kosidba, stadijum rasta

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Influence of the time of first fruit color change and the duration of fruit ripening of cherry varieties on the infestation by *R. cerasi*

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Summary

The aim of this research is to analyse the influence of the time of first fruit colour change and duration of fruit ripening of 19 cherry varieties on the infestation percentage by the European cherry fruit fly (*Rhagoletis cerasi* L.) for 2008/2009. The infestation percentage grew proportionally depending on the time of first fruit colour change from 3% for the group of varieties which started earlier with the fruit colour change to 46.2% for the group of varieties which started later with the fruit colour change for 2008, and from 0% to 65.7% for 2009, respectively. The infestation percentage grew proportionally with the duration of fruit ripening of the cherry varieties, from 10.3% for the group of varieties with a short ripening period to 55.2% for the group of varieties with a long ripening period.

Key words: European cherry fruit fly, *Rhagoletis cerasi* L., cherry varieties, cherry characteristics

Introduction

Cherry (*Prunus avium* L.) represents one of the most significant fruit tree cultures in the world and in the R. Macedonia. Cherry trees have a wide range of distribution because they are very adaptable to different ecological factors.

The European cherry fruit fly (*Rhagoletis cerasi* L.) is the most significant economic pest of cherry orchards in Europe and Turkey because of its direct damage to the fruit. The larvae of the fly develop in the cherry fruit and feed with its inside, causing serious economic damage (Ozdem & Kilincer, 2005).

The economic threshold in many European countries is 4% of infested fruits (Stamenković, Garić et al., 1993), while in Turkey there is zero tolerance for infested fruits by *R. cerasi* for cherry fruit production intended for export to foreign markets. In unprotected cherry orchards, the fly can cause 100% damage to some varieties (Stamenković, Garić et al., 1993).

There are many publications concerning the biology of *R. cerasi* (Ozdem & Kilincer, 2005; Stamenković, Milenković et al., 1993), its control (Baric, Paukovic et al., 2007; Daniel, 2008; Katsoyannos, Papadopoulos et al., 2000), and the influence of ecological factors on this pest (Kovanci & Kovanci, 2006), but there are few publications about the influence of some characteristics of cherry varieties on the infestation caused by *R. cerasi* (Stamenković, Garić et al., 1993; Bandzo, Popovska et al., 2011).

Bandzo, Popovska et al. (2011) have established that the time of fruit ripening influences the infestation percentage by *R. cerasi*, while the fruit firmness and colour of the fruit's skin do not have any influence.

The European cherry fruit fly (*R. cerasi*) lays its eggs on the cherry fruit at the time of first fruit colour change, from green to yellowish or reddish, depending on the cherry variety (Ozdem & Kilincer, 2005). That is why the aim of this research is to establish a correlation between the time of first fruit colour change and duration of fruit ripening of the cherry varieties and infestation percentage of cherry fruits by the European cherry fruit fly.

Materials and methods

The research was conducted in 2008 and 2009 on the cherry collection field of the Agricultural Institute, near Skopje. The cherry field was not chemically treated against the fly during the analysis. The influence of the time of first fruit colour change and the duration of fruit ripening on infestation percentage by the European cherry fruit fly was tested on 19 cherry varieties. Eight of them are early–ripening (Primavera, Anone, Ranna Cherna Edra, Bigareau Burlat, Bigareau Jaboulay, Asenova rana, Junskaja ranaja, Valeska), 6 are medium–ripening (Vega, Bing, Pobeda krimskaja, Charna, Bianca di Verona, Sunburst) and 5 are late–ripening (Bigareau Napoleon, Chrzastka kozerska, Grosse Germersdorfer, Hedelfingen Reisenkirche and Star).

The time of first fruit colour change was determined by standard pomological methods by noting the date when the cherry fruit was starting to change its colour from green to yellowish or reddish. The categorisation of the varieties for this characteristic was in accordance to the eclosion time of the fly. In 2008, because the flight of the fly had two picks, the cherry varieties were divided in 3 groups:

- Varieties at the stage of first colour change before the flight of the fly;
- Varieties at the stage of first colour change during the first pick of the flight of the fly;
- Varieties at the stage of first colour change during the second pick of the flight of the fly.

In 2009, because dynamics of the flight of the Cherry fruit fly was different from the one in 2008 and the flight had only one pick, the varieties were divided into 3 following groups:

- Varieties at the stage of first colour change before the flight of the fly;
- Varieties at the stage of first colour change during the first decade of the flight of the fly;
- Varieties at the stage of first colour change during the pick of the flight of the fly.

The classification of the cherry varieties according to the duration of fruit ripening was determined according to the average values for 2008/2009 and it divided the varieties in 3 groups:

- Varieties with short ripening period (shorter than 20 days);
- Varieties with medium long ripening period (from 20 to 23 days);
- Varieties with long ripening period (longer than 24 days).

The percentage of infestation by the Cherry fruit fly was examined on 100 fully ripened fruits in three repetitions of each analysed variety. The fruits were flooded in 10% salty water and after one hour, the number of larvae that exited from the fruits was established. The statistical analysis of variation of average values on the percentage of infested fruits between different groups was performed by using LSD and t – tests with significance level of 95% and 99%.

Results and discussion

The infestation percentages of the cherry varieties according to the time of first fruit colour change in 2008 and 2009 are given in Table 1.

In 2008, six of the 19 analysed cherry varieties started with the fruit colour change before the emergence of the fly. The average infestation percentage in this group was 3%. Primavera, Anone, Ranna Cherna Edra and Bigareau Burlat varieties were not infested at all by the fly, so their infestation percentage was 0%. The most infested variety was Asenova rana with 11%. All of these are varieties with early time of fruit ripening.

In the second group were varieties which started with the first fruit colour change during the first pick of the flight of *R. cerasi*. In 2008, this group consisted of 4 varieties, two of them were early-ripening (Junskaja ranaja and Valeska) and two were medium-ripening (Vega and Bing). The average infestation percentage was 34.3% and it varied from 23% (Junskaja ranaja) and 24% (Vega) to 58% (Bing).

In 2008, there were 9 varieties in the group of cherry varieties which started to change fruit colour during the second pick of the flight of *R. cerasi*, 4 were medium-ripening (Pobeda krimskaja, Charna, Bianca di Verona and Sunburst) and 5 were late-ripening (Bigareau Napoleon, Chrzastka kozerska, Grosse Germersdorfer, Hedelfingen Reisenkirche and Star). The average infestation percentage was 46.2% and it varied from 32% (Sunburst and Bigareau Napoleon) to 67% (Grosse Germersdorfer).

The results given for 2008 showed that the infestation percentage of the cherry varieties grew proportionally from the first (3%) to the third group (46.2%). This means that the infestation percentage was rising proportionally from the varieties which started with the first fruit colour change earlier, before the emergence of the fly, to the varieties which started with the first fruit colour change later, during the pick of the flight of *R. cerasi*.

The statistical analysis of variation of average values on the percentage of infested fruits between different variety groups for 2008 was examined by the t – test. A statistically significant difference was observed among all of the tested groups, which confirmed a correlation between the infestation of cherry fruits and the time of first fruit colour change.

Tab. 1. Infestation of cherry varieties by *R. cerasi,* according to first fruit color change time

Zaraza kod sorti trešnje od R. cerasi, zavisno od vremena prve promene boje ploda

		Variety	Time of first fruit color change	Infestation % 2008
till 04.05	1	Primavera	27.04	0
	2	Anone	28.04	0
	3	Bigareau Jaboulay	01.05	7
	4	Ranna Cherna Edra	03.05	0
	5	Asenova rana	03.05	11
	6	Bigareau Burlat	04.05	0
	Average			**3,0**
05.05-10.05	7	Junskaja ranaja	06.05	23
	8	Vega	06.05	24
	9	Valeska	08.05	32
	10	Bing	10.05	58
	Average			**34,3**
17.05-23.05	11	Pobeda krimskaja	17.05	43
	12	Sunburst	17.05	32
	13	Charna	18.05	34
	14	Bianca di Verona	19.05	54
	15	Grosse Germersdorfer	20.05	67
	16	Star	20.05	62
	17	Bigareau Napoleon	22.05	32
	18	Chrzastka kozerska	22.05	57
	19	Hedelfingen Reisenkirsche	23.05	35
	Average			**46,2**

		Variety	Time of first fruit color change	Infestation % 2009
till 04.05	1	Anone	02.05	0
	2	Primavera	03.05	0
	Average			**0,0**
10.05-20.05	3	Bigareau Jaboulay	11.05	8
	4	Asenova rana	12.05	2
	5	Ranna Cherna Edra	13.05	2
	6	Bigareau Burlat	14.05	2
	7	Junskaja ranaja	16.05	4
	8	Valeska	18.05	64
	9	Vega	20.05	30
	10	Bing	20.05	45
	Average			**19,6**
22.05-30.05	11	Sunburst	22.05	72
	12	Pobeda krimskaja	23.05	55
	13	Charna	25.05	62
	14	Bianca di Verona	26.05	40
	15	Grosse Germersdorfer	26.05	36
	16	Star	26.05	80
	17	Bigareau Napoleon	26.05	94
	18	Chrzastka kozerska	26.05	52
	19	Hedelfingen Reisenkirsche	30.05	100
	Average			**65,7**

A statistically very significant difference was observed between the infestation percentages in the varieties of the first and second group with a significance level of 0.01. Moreover, a statistically very high significant difference was observed between the infestation percentages in the varieties of the first and third group with a level of significance of 0.001. Also, a statistically significant difference was observed between the infestation percentages of the varieties of the second and third group, with a significance level of 0.05.

In 2009, in the first group were only two early-ripening varieties (Primavera and Anone), which were not infested and the average infestation percentage of the group was 0%.

The second group comprised cherry varieties which started with the fruit colour change during the first decade of the flight of *R. cerasi*. Six were early-ripening and two were medium-ripening varieties. The infestation percentage in this group varied from 2% (Asenova rana, Ranna Cherna Edra, Bigareau Burlat) to 64% (Valeska) with an average infestation of 19.6%.

In the third group were cherry varieties which were at the stage of first fruit colour change during the pick of the flight of the European cherry fruit fly. There were the same nine varieties in this group that were in the third group in 2008. The average infestation percentage of this group was 65.7% and it was the highest among all of the groups. The infestation percentage varied from 36% (Grosse Germersdorfer) to total infestation of 100% (Hedelfingen Reisenkirche).

The results given for 2009 had the same pattern as the results from 2008, that is, the infestation percentage of the cherry varieties grew proportionally from the first (0%) to the third (65.7%) group. This means that the infestation percentage was rising proportionally from varieties which started with the first fruit colour change earlier, before the emergence of the fly, to varieties which started with the first fruit colour change later, during the pick of the flight of *R. cerasi*.

The statistical analysis of variation of average values on the percentage of infested fruits between different variety groups was also examined for 2009 by the t–test. A statistically significant difference was observed among all of the tested groups, as it was detected in 2008.

A statistically significant difference was observed between the infestation percentages of the varieties of the first and second group with a significance level of 0.05 whereas a statistically very high significant difference was observed between the infestation percentages of the varieties of the first and third group with a level of significance of 0.001 and a statistically very significant difference was observed between the infestation percentages of the varieties of the second and third group with a significance level of 0.01.

In Table 2, the results are given which show the infestation percentage of the cherry varieties according to duration of fruit ripening for 2008 and 2009.

Seven varieties were in the group of cherry varieties with short ripening period for the period 2008/2009. Six of them were early-ripening and one was medium-ripening. The average infestation percentage of this group was 10.3% and it varied from 0% (Primavera and Anone) to 49% (Pobeda krimskaja).

Tab. 2. Infestation of cherry varieties by *R. cerasi,* according to the duration of fruit ripening

Zaraza ploda sorti trešnje od R. cerasi, zavisno od dužine zrenja ploda

		Variety	Period of ripening			Infestation %		Average
			2008	2009	Average	2008	2009	2008/2009
Short period	1	Bigareau Jaboulay	16	15	16	7	8	7,5
	2	Bigareau Burlat	19	13	16	0	2	1,0
	3	Anone	16	18	17	0	0	0,0
	4	Primavera	17	18	18	0	0	0,0
	5	Ranna Cherna Edra	21	14	18	0	2	1,0
	6	Junskaja ranaja	21	15	18	23	4	13,5
	7	Pobeda krimskaja	19	19	19	43	55	49,0
	Average					10,4	10,1	10,3
Medium long period	8	Valeska	23	16	20	32	64	48,0
	9	Bianca di Verona	22	22	22	54	40	47,0
	10	Charna	23	21	22	34	62	48,0
	11	Asenova rana	25	19	22	11	2	6,5
	12	Bing	25	20	23	58	45	51,5
	Average					37,8	42,6	40,2
Long period	13	Bigareau Napoleon	23	24	24	32	94	63,0
	14	Chrzastka kozerska	23	24	24	57	52	54,5
	15	Hedelfingen Reisenkirsche	24	23	24	35	100	67,5
	16	Vega	29	20	25	24	30	27,0
	17	Grosse Germersdorfer	26	24	25	67	36	51,5
	18	Sunburst	25	26	26	32	72	52,0
	19	Star	28	27	28	62	80	71,0
	Average					44,1	66,3	55,2

$LSD_{0.05}$ = 22.427 $LSD_{0.01}$ = 60.961

The varieties with medium ripening period included 5 cherry varieties. Two of them were early-ripening and three medium-ripening. The average infestation percentage was 40.2%. The least infected of the varieties was Asenova rana (6.5%) and the most infected was Bing (51.5%).

The other 7 cherry varieties were in the group of varieties with long ripening period. There were all of the late varieties and two medium-ripening varieties in this group. The infestation percentage of this group varied from 27% (Vega) to 71% (Star). The average infestation percentage of this group for the two analysed years was 55.2%.

A statistically significant difference was observed between the infestation percentages of the group of varieties with short ripening period and medium ripening period and also between the groups of varieties with short and long ripening period with a significance level of 0.05.

The results given for the two analysed years showed that the infestation percentage of the cherry varieties grew proportionally from varieties with short (10.3%) to varieties with long ripening period (55.2%). A strong positive linear correlation was observed between these two characteristics. The coefficient of correlation r for 2008/2009 was r = 0.511340.

Conclusion

The time of first fruit colour change influences the infestation percentage by *R. cerasi.*

The infestation percentage grew proportionally from 3% in 2008 and 0% in 2009 for the group of varieties which started with the first fruit colour change earlier, before the emergence of the fly, to 46.2% in 2008 and 65.7% in 2009 for the group of varieties which started with the first fruit colour change later, during the pick of the flight of *R. cerasi*.

Duration of fruit ripening influences the infestation percentage by *R. cerasi.*

The average infestation percentage grew proportionally from 10.3% for the group of varieties with short ripening period to 55.2% for the group of varieties with long ripening period. A strong positive linear correlation was observed between these two characteristics.

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Uticaj vremena prve promene boje ploda i vreme trajanja zrenja kod nekih sorti trešnje na zarazu sa *R. cerasi*

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Sažetak

Cilj istraživanja je analiza uticaja vremena prve pojave promene boje ploda i vremena trajanja zrenja kod 19 sorata trešnje na procenat zaraze ploda od trešnjine muve (*Rhagoletis cerasi* L.) u toku 2008 i 2009 godine. Procenat zaraze plodova u 2008 raste proporcionalno zavisno od vremena prve promene boje ploda i to od 3% za grupu sorata sa ranijim početkom promene boje do 46.2% za grupu sorata sa kasnijim početkom promene boje plodova, da bi to za 2009 godinu iznosilo od 0% do 65.7%. Obe godine, procenat zaraze proporcionalno raste sa porastom dužine vremena zrenja ispitivanih sorti. Procenat zaraze proporcionalno raste od 10.3% za grupu sorti sa kratkim periodom zrenja do 55.2% za grupu sorti sa dugim periodom zrenja plodova.

Ključne reči: Trešnjina muva, *Rhagoletis cerasi* L., sorte trešanja, karakteristike sorata trešnje

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Yield and some morphological properties of newly introduced Italian rice varieties grown in Macedonia

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Summary

This paper presents the results of investigation of three newly introduced Italian rice varieties *Brio, Ellebi* and *Opale*, in comparison with two standards P*rima riska* and *R-76/6*. The field experiment (randomised block system) was conducted during 2010 and 2011 under the agro-ecological conditions of Kocani region. The paddy rice yield, stem height, panicle length and number of productive tillers per m^2 were analysed. In both years of investigation, the paddy rice yield of the standard variety *R-76/6* as well as the introduced *Brio*, *Ellebi* and *Opale* varieties was significantly lower compared with standard P*rima riska* variety. The stem height of the Italian rice varieties was significantly shorter in comparison with standard varieties, in both years of testing. In general, according to the results obtained in this investigation, the newly introduced varieties: *Brio*, *Ellebi* and *Opale* could be included in the rice breeding programmes, especially for breeding short stem rice varieties.

Key words: rice, varieties , paddy rice yield, stem, panicle, productive tillers

Introduction

In order to ensure higher yields and better grain quality in rice production, the use of varieties with high yielding and quality potential is an important factor, together with the technology applied. Rice production would be more successful if large assortment of rice varieties was available on the market, providing producers with the right choice regarding the productivity and quality. Lately, there has been increased interest among farmers in such varieties suited to intensive production system.

Carnahan et al. (1972) estimated 60% yield increase in USA rice production, due to introduction of new high yielding varieties. According to Russo and Callegarin (1997), the main factors limiting rice growing in Italy (low temperatures during sowing, flowering and fertilisation, diseases, weeds and red rice appearance)

might be overcome within rice breeding programmes as well as by introducing new better varieties.

The rice varieties in Macedonia are tall, with long stem, not being very suitable for intensive production systems, especially not responding to high doses of inorganic fertilisers. Medium-height rice varieties have recently contributed to higher productivity in the world rice production. This is due to a set of positive traits characterising medium-height rice genotypes, as well as increased tillering capacity, lodging resistance, positive response to nitrogen fertilisers, etc. Parallel to a breeding process, in order to enrich the assortment of rice varieties in the rice production in Macedonia, there is also need to introduce high-yielding and good quality varieties (Andov et al. 2003/2004, 2008/2009, 2010, Ilieva et al. 2005/2006). The introduced varieties require further investigations regarding their adaptability to local environmental factors (Ilieva et al. 2000, 2007, 2008). Thus, the aim of this research is to explore yield and certain morphological traits of three Italian rice varieties within the agro-ecological conditions in Kocani region (Eastern Macedonia).

Materials and methods

The research was conducted during 2010 and 2011 at the locality "Bosevica", Department for Rice in Kočani (part of the Experimental Field of the Institute of Agriculture in Skopje).

Three newly introduced Italian rice varieties (B*rio, Ellebi* and *Opale*) were investigated together with standards *prima riska* (modern Macedonian variety) and *P-76/6* (domesticated Italian variety, widely spread in production in Macedonia), in order to compare their results. Field experiments were set up upon the method of randomized block system, in three repetitions. Standard technology for rice growing was applied. The statistical analysis of the results were performed by using ANOVA and tested by LSD test.

Soil and climatic conditions

Field trials were set up on alluvium soil type, carbonate-free at the examined depths (Table 1.). The soil texture was fine sandy loam. The pH of the soil solution was acid; the content of humus was low, the content of total nitrogen was strongly correlated to the content of humus. The soil was medium supplied with easy available potassium and phosphorus.

In general, climatic conditions during both years of investigation (Table 2) provided normal development of rice plants. During the rice vegetation period (from April to October), the average monthly temperature in 2010/2011 was 19.9˚ C, average maximum temperature was 25.4˚C, while average minimum temperature was 12.8˚C. The average monthly temperature during 2010 (19.7˚C) was lower as compared with 2011 (20.1˚C).

Tab.1. Some chemical properties of the soil from the locality "Bosevica"
Neka hemijska svojstva zemljišta sa lokaliteta "Bosevica"

Depth (cm)	$CaCO_3$ (%)	Humus (%)	Total (%)	pH		Easy available (mg/100 g soil)	
				H_2O	nKCl	P_2O_5	K_2O
0-20	-	2.16	0.09	5.79	4.92	17.85	14.02
20-40	-	1.50	0.06	5.88	5.07	11.57	12.04

The sum of monthly rainfalls (average value for both years of investigation) was 277.9 mm.

Tab. 2. Average monthly temperatures and monthly sums of rainfalls during the rice vegetation period in Kočani
Prosječne mjesečne temperature i mjesečne sume padavina tokom vegetacionog perioda riže u regionu Kočani

Year	Months							Average	
	IV	V	VI	VII	VIII	IX	X	per year	per vegetation
Average monthly temperature (C°)									
2010	13.7	18.5	22.1	24.9	26.9	19.3	12.2	14.3	19.7
2011	13.1	17.2	22.1	26.2	26.3	23.1	12.6	13.9	20.1
Average	*13.4*	*17.9*	*22.1*	*25.6*	*26.6*	*21.2*	*12.4*	*14.1*	*19.9*
Average monthly maximum temperature (C°)									
2010	19.0	23.9	26.9	29.9	32.7	25.6	16.8	19.3	25.0
2011	18.4	22.2	27.5	31.9	32.2	29.7	18.6	19.2	25.8
Average	*18.7*	*23.1*	*27.2*	*30.9*	*32.5*	*27.7*	*17.7*	*19.3*	*25.4*
Average monthly minimum temperature (C°)									
2010	8.3	11.8	15.2	17.0	18.7	12.4	8.2	8.9	13.1
2011	6.7	11.2	14.4	16.9	16.8	14.8	5.8	7.3	12.4
Average	*7.5*	*11.5*	*14.8*	*17.0*	*17.8*	*13.6*	*7.0*	*8.1*	*12.8*
Monthly sum of rainfalls (mm)									
2010	63.3	20.5	86.0	19.5	6.5	33.0	119.5	623.3	348.3
2011	15.5	42.5	44.0	23.5	16.5	30.0	35.5	296.0	207.5
Average	*39.4*	*31.5*	*65.0*	*21.5*	*11.5*	*31.5*	*77.5*	*459.7*	*277.9*

Results and discussion

Paddy rice yield

The obtained results for paddy rice (rough rice) yield are presented in Table 3. The highest average yield was reached by the standard variety *Prima riska* (9465 kg ha^{-1}). In both years of investigation, the yields of this standard variety were

significantly higher (for both levels of probability) compared with other varieties (the standard *R-76/6* as well as the newly introduced *Brio, Ellebi* and *Opale*). The *Brio* variety was the best yielding among introduced varieties and slightly, but not significantly better yielding than the standard *R-78/6*. The lowest average yield (7635 kg ha-1) was found in *Ellebi.* In some former investigations (Ilieva et al. 2007), ten other introduced Italian varieties in Kocani region were examined, but none showed superiority over the standard ones regarding the yield.

Tab. 3. Paddy rice yield (kg ha^{-1})
Prinos sirovog pirinča (kg ha^{-1})

Varieties	Yield per year (kg ha^{-1})		Average yield (kg ha^{-1})	Index from	
	2010	2011		*Prima riska*	*R-76/6*
Prima riska(st.)	9960	8970	**9465.00**	0	+11,29
R-76/6 (st.)	8950	8060	**8505.00**	-10.14	0
Brio	9055	8173	**8614.00**	-8.99	+1.28
Ellebi	8070	7200	**7635.00**	-19.33	-10.23
Opale	8943	8050	**8496.50**	-10.23	-0.10
Average	**8995.60**	**8090.60**	**8543.10**	-	-
LSD 0,05	*221.50*	*363.69*			
LSD 0,01	*322.62*	*529.73*			

Tab. 4. Stem height (cm)
Visina stabla (cm)

Varieties	Year	X	S	Sx	CV (%)	min	max
Prima riska(st.)	2010	90.33	4.66	0.85	5.16	82.00	103.00
	2011	73.70	4.37	0.80	5.93	64.00	81.00
	average	**82.02**	**4.52**	**0.83**	**5.55**	**73.00**	**92.00**
R-76/6 (st.)	2010	86.20	4.21	0.77	4.89	53.00	92.00
	2011	70.30	5.06	0.92	7.20	43.00	78.00
	average	**78.25**	**4.64**	**0.85**	**6.05**	**48.00**	**85.00**
Brio	2010	61.07	3.86	0.70	6.32	53.00	70.00
	2011	50.77	3.51	0.64	6.91	43.00	60.00
	average	**55.92**	**3.69**	**0.67**	**6.62**	**48.00**	**65.00**
Ellebi	2010	62.60	3.10	0.57	4.96	57.00	69.00
	2011	53.63	2.76	0.50	5.15	47.00	59.00
	average	**58.12**	**2.93**	**0.54**	**5.06**	**52.00**	**64.00**
Opale	2010	65.67	4.05	0.74	6.16	55.00	74.00
	2011	53.33	4.94	0.90	9.26	46.00	65.00
	average	**59.50**	**4.50**	**0.82**	**7.71**	**50.50**	**69.50**
year	*2010*	*2011*					
LSD 0,05	*4.06*	*3.16*					
LSD 0,01	*5.91*	*4.60*					

Stem height

Regarding the stem height, in general, the newly introduced varieties were significantly shorter than standards in both years of investigation (Table 4.). The average stem height of *Brio* (55.92cm) had the lowest value, near the values of *Ellebi* (58.12 cm) and *Opale* (59.50 cm). The standard Prima riska variety was the tallest one (82.2 cm), but close to the other standard P-76/6 (78.25 cm).

Panicle length

The average panicle length values of the introduced *Brio* (12.75cm), *Ellebi* (16.64cm), *Opale (*13.78cm) varieties and the standard variety R-*76/6* (15.30 cm) were significantly lower compared with the panicle length of *Prima riska* (18.65cm). Among the introduced varieties, *Ellebi* was characterised by the longest panicle, significantly longer than the standard R-*76/6* (Table 5.).

Tab. 5. Panicle length (cm)
Dužina metlice (cm)

Varieties	Year	X	S	Sx	CV %	min	max
Prima riska(st.)	2010	19.23	1.99	0.36	10.37	15.00	23.00
	2011	18.07	1.39	0.25	7.68	15.00	21.00
	average	**18.65**	**1.69**	**0.31**	**9.03**	**15.00**	**22.00**
R-76/6 (st.)	2010	16.35	1.42	0.26	8.71	11.00	19.00
	2011	14.25	0.85	0.16	5.97	10.00	16.00
	average	**15.30**	**1.14**	**0.21**	**7.34**	**10.50**	**17.50**
Brio	2010	12.57	1.22	0.22	9.73	11.00	15.00
	2011	12.93	1.53	0.28	11.83	10.00	15.00
	average	**12.75**	**1.38**	**0.25**	**10.78**	**10.50**	**15.00**
Ellebi	2010	16.50	1.57	0.29	9.52	13.00	20.00
	2011	16.77	1.59	0.29	9.49	13.00	21.00
	average	**16.64**	**1.58**	**0.29**	**9.51**	**13.00**	**20.50**
Opale	2010	14.03	1.27	0.23	9.07	12.00	16.00
	2011	13.53	1.46	0.27	10.76	11.00	17.00
	average	**13.78**	**1.37**	**0.25**	**9.92**	**11.50**	**16.50**
year	*2010*	*2011*					
LSD 0,05	*0.67*	*0.73*					
LSD 0,01	*0.97*	*1.07*					

The number of productive tillers per m^2

The highest average number of productive tillers per m^2 (Table 6) was found in *Ellebi (454.34)* while the lowest was in *R-76/6* (291.83). In 2010 and 2011, the tiller number per m^2 of Ellebi was significantly higher compared with other varieties.

Tab. 6. Number of productive tillers per m^2
Broj produktivnih bokora po m^2

Varieties	Productive tillers per m^2 Year		Average productive tillers per m^2	Index from	
	2010	2011		*Prima riska*	*R-76/6*
Prima riska(st.)	371.33	330.00	**350.67**	0	+20.16
R-76/6 (st.)	306.33	277.33	**291.83**	-16.78	0
Brio	450.00	406.00	**428.00**	+22.05	+46.66
Ellebi	478.67	430.00	**454.34**	+29.56	+55.69
Opale	341.67	302.67	**322.17**	-8.13	+10.40
Average	**389.60**	**349.20**	**369.40**	-	-
LSD $_{0,05}$	*40.87*	*22.01*			
LSD $_{0,01}$	*59.53*	*32.05*			

Conclusion

The newly introduced rice varieties were, in general, lower yielding compared with standard varieties, and significantly lower than the standard *Prima riska.*

The Italian *Ellebi* variety achieved the significantly biggest number of productive tillers per m^2 in comparison with other varieties.

Since the stem of the investigated Italian varieties was shorter than the standard ones, *Brio, Ellebi and Opale* will be included in the rice breeding programme for breeding medium-tall rice varieties. Also, these new varieties are going to be tested within intensive production systems under the environmental conditions of Kocani rice growing region.

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Prinos i neka morfološka svojstva novointroduciranih italijanskih sorti pirinča u uslovima gajenja u Makedoniji

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Sažetak

U radu su prezentirani rezultati ispitivanja tri novointroducirane italijanske sorte pirinča: *Brio, Ellebi* i *Opale*, u poređenju sa dve standardne sorte P*rima riska* i *R-76/6*. Poljski eksperiment (randomizirani blok sistem) je bio sproveden tokom 2010. i 2011. u agroekološkim uslovima Kočanskog regiona. Analiziran je prinos sirovog pirinča (pirinčane arpe), zatim visina stabla, dužina metlice i broj broduktivnih bokora na m^2. U toku dve godine ispitivanja, prinos surovog pirinča kod standardne sorte *R-76/6* i kod svih intoduciranih sorti *Brio, Ellebi* i *Opale* je bio signifikantno niži od prinosa standardne sorte P*rima riska.* Visina stabla italijanskih introduciranih sorti je bila statistički značajno manja od visine standardnih sorti i to u dvegodišnjem trajanju testiranja. Generalno, u saglasnosti sa dobivenim rezultatima, novointroducirane sorte pirinča: *Brio, Ellebi* i *Opale* će biti uvedene u oplemenjivačkim programima pirinča, posebno sa ciljem dobijanja novih sorti pirinča sa kraćim stablom.

Ključne reči: pirinač, prinos sirovog pirinča, stablo, metlica, produktivni bokori

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Evaluation of the yield and the yield stability of perspective lines of barley

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Summary

The study was carried out in the Experimental field of the Department of Genetics and Plant Breeding – Agricultural University, Plovdiv during the period 2009-2011. New breeding lines were investigated using block design with 4 replications and 20 m2 plot size. The aim of the investigation was to estimate barley lines by yield, stability and some important traits, using Obzor as a standard. Applying biometrical and cluster analysis and index of yield stability, it has been established that some breeding lines: numbers 21411003, 21401409 and 21001008, respectively, had better traits in comparison with the standard cultivar "Obzor" as well as stable yields regardless of differences in the climatic conditions over the years. These lines can be certified as new cultivars according to the government's requirements for cultivar testing.

Key words: barley, cluster analysis, yield stability.

Introduction

Incessant changes in weather conditions directed selection activities towards the creation of types of barley that have good adaptive capacity and stability in the manifestation of their biological features.

Based on the surveys conducted by Allard and Bradshaw (1964), Tsenov N, T. Gubatov, V. Peeva (2006), Dimova D., M. Dimitrova, G. Rachovska (2006), Valchinkov St. (1990), the types which show good genotype productivity under various weather conditions are characterised by good adaptability as well.

The creation of types having permanent economic indicators regardless the environmental conditions is important for production.

The purpose of this survey is to evaluate the yield, yield stability and some important quantitative traits of 10 perspective lines of barley and the Obzor cultivar

in order to propose them for the State cultivar testing or include them in future breeding programmes.

Materials and methods

The investigations were conducted within the period 2009-2011 in the experimental field of the Genetics and Plant Breeding Department at the Agricultural University – Plovdiv with 10 perspective lines of barley and the standard cultivar Obzor. We used a block scheme of 4 replicates and a 20 m^2 experimental lot.

During the vegetation period, we registered the type composition and density of the weeds as well as the level of invasion for different genotypes. We took samples consisting of 40 plants per variant and analysed the following traits: height of the plant, general germination, length of the central ear, weight of the grains from the central ear, weight of the grains from the entire plant and absolute weight.

The genotypes studied have been evaluated in terms of yield and stability of its manifestation by applying the parameter of Kang (1993) – Yield stability index (Ysi).

Using the average data about the yield and traits analysed, we performed clustering of the studied variants. We used the SPSS computer programme and grouping of the variants was made by determining the Euclidean distance between two objects (Ward, 1963; Duran and Odell, 1974). The clusters were graphically illustrated by means of a dendrogram. The relative importance of the traits, when grouping genotypes into a cluster, was determined by analysing the main components, (Philippean, 1990).

Results and discussion

The yields for different variants and years were processed using a dispersion analysis. The results of the analysis, which are presented in Table 1, show that there are certain differences between the genotypes studied and between the environmental conditions over the years. The evidence proving the difference in a relation between a genotype and the environment was a reason to evaluate the variants, not only in terms of yield, but also in terms of yield stability.

In Table 2, we have shown the results from the stability analysis conducted. The lines and the standard cultivar Obzor have been presented in a descending order based on their yield. We have assessed evidence of the difference between the lines and the standard. The line 21401409 (765 kg/da) had the highest average yield for that period.

The difference between the line and the standard is statistically significant. The line 21001008 also had a yield that was higher than the standard level. The line 20411003 had an average yield of the Obzor cultivar. The other lines had low yields.

We noticed that the line 20411003, whose yield was lower than for the aforementioned lines, had the highest stability index (Ysi $=14^{+}$). This line was least influenced by climatic variations over the years of the survey.

Tab. 1. Results from the dispersion analysis (2009-2011)
Rezultati disperzione analize

Reasons for variation	Fg	SQ	S^2	$F_{exp.}$	F_{table}
General	43	68347			
Genotypes	10	13745	1374,5	$3,40^{+}$	2,35
Conditions of the environment	3	27433	9144,3	$22,65^{+}$	3,10
Interaction	30	27169	905,6	$2,24^{+}$	2,04
Heterogeneity	10	9875	987,5	$2,44^{ns}$	3,40
Errors	20	8075	403,75		

The lines 21401409 (Ysi $=13^{+}$) and 21001008 (Ysi $=10^{+}$) and the Obzor cultivar have a high level of stability (Ysi $=12^{+}$).

Tab. 2. Evaluation of the genotypes in terms of yield and stability
Evaluacija genotipova u vezi sa prinosom i stabilnošću

Variants	Average yield kg/da	Range of yield	Correc-tion of the range	Range coefficient	Variance of stability	Coefficient of stability	Stability index (Ysi)
21401409	765^{+}	10	1	11	1042,8	-1	13^{+}
21001008	723^{ns}	12	1	13	47,83	0	10^{+}
Obzor	715	17	3	20	1743,99	-8	12^{+}
20411003	686^{ns}	15	1	16	10145,36	-2	14^{+}
20801506	681^{-}	9	-3	6	2132,25	0	6^{+}
20301005	650^{-}	7	-1	6	6833,44	-4	2
20210104	644^{-}	5	-2	3	3243,58	-1	2
20510103	610^{-}	6	-2	4	1286,26	-4	0
20905108	600^{-}	5	-1	4	3416,55	-1	3
21102508	586^{-}	7	-2	5	1735,88	-6	-1
86101108	580^{-}	2	-2	0	2356,43	0	0

$LSD_{P\ 0,05} = 28,49$

In order to establish genetic closeness or remoteness of the genotypes regarding the average manifestation of the traits studied, we used a cluster analysis.

We can see from the dendrogram (Figure 1) that the variants 21041409, 21001008, Obzor and 20411003, which had the highest yields and a high stability index, were united into one cluster group. For the sake of the practical selection activities, these lines can be regarded as equal enough. The other lines are divided into two opposite cluster groups.

The analysis results concerning main components show that three of them can be used to explain 97.8% of general variation (Table 3). As regards the first component, which can explain 69.4% of general variation, yield, weight of the grains from the entire plant, weight of the grains from the central ear and absolute

weight are features that have the greatest influence on the aforementioned clustering.

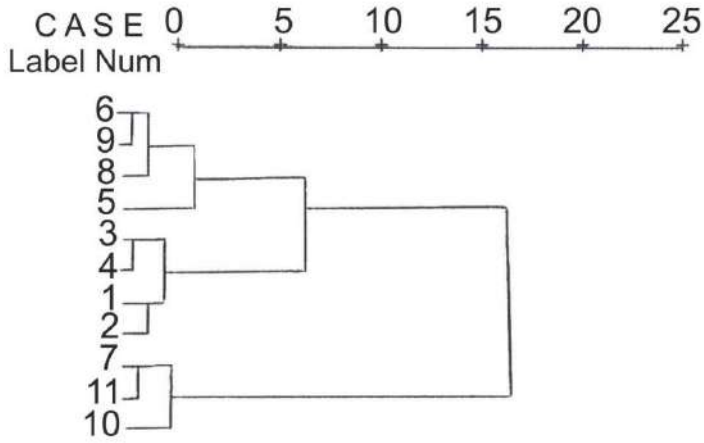

Fig. 1. Clustering of the tested genotypes
Grupisanje ispitivanih genotipova

Regarding the second main component, the highest correlation coefficients are those of the following traits: length of the central ear, weight of the grains from the entire plant, absolute weight and number of productive tillers. This component can explain 17.48% of general variation.

Tab. 3. Results from the analysis of the main components
Rezultati analize glavnih komponenti

Traits	**Main components**		
	1	**2**	**3**
Yield	0,965	0,315	0,310
Number of tillers	0,912	0,323	0,425
Weight of the grains of the central ear	0,912	0,248	0,189
Weight of the grains of the plant	0,948	0,436	0,301
Length of the central ear	0,679	0,502	0,275
Height of the plant	-0,634	0,243	0,279
Absolute weight	0,860	-0,393	0,312
Explained % of the general variation	69,4%	17,48%	10,90%

As regards the third main component, which explains 10.9% of variation, the traits related to productive germination, absolute weight, yield and length of the central ear play an important role.

Conclusion

1. Out of the 11 genotypes of barley examined, the most perspective ones in terms of yield and stability are 20411003, 21401409 and 21001008 lines. These lines can be submitted for State cultivar testing.

2. What is important for practical selection is the evaluation of genetic remoteness between the variants assessed on the grounds of their phenotype manifestation in various environments.

3. The traits that are the most important and that explain the highest percentage of general variation can be regarded as the most reliable ones in the selection process when conducting selection activities.

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Evaluacija prinosa i stabilnosti prinosa perspektivnih linija ječma

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Sažetak

Ispitivanja su sprovedena na eksperimentalnom polju Odsjeka za genetiku i oplemenjivanje bilja – Poljoprivrednog univerziteta, Plovdiv tokom 2009-2011. godine. Ispitivane su nove oplemenjivačke linije upotrebom blok dizajna za 4 replikacije na parceli od 20 m2. Cilj istraživanja bio je da se ocijene linije ječma u odnosu na prinos, stabilnost i neke važne karakteristike primjenom Obzor kao standarda. Primjenjujući biometričku i klaster analizu i indeks stabilnosti prinosa ustanovljeno je da neke oplemenjivačke linije broj 21411003, 21401409 i 21001008 imaju bolje karakteristike u odnosu na standardni kultivar „Obzor“ kao i stabilne prinose bez obzira na razlike u klimatskim uslovima tokom perioda. Ove linije mogu biti potvrđene kao novi kultivari prema državnim zahtjevima za testiranje kultivara.

Ključne riječi: ječam, klaster analiza, stabilnost prinosa.

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Changing the Albanian subsidy policy in the context of low-profit farms

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Summary

Since 2005, the Government of Albania has been providing subsidies for competitive sectors of the agriculture, mostly fruit growing. However, there is a general lack of data regarding farm revenues, profitability and competitiveness and the criteria are not very restrictive in terms of orchard size or capital. The purpose of this research was to study the competitiveness of fruit tree farms. The study was conducted from 2009 – 2011 in the Vlora region by collecting financial information from 70 fruit tree farms, distributed at different levels of altitude and slopes, both features having an impact on the choice of crops, cultural practices and market access. The average income of rural families in the Vlora region (proxy for the Reproduction Threshold) acted as a reference against which the economic viability of farming systems was evaluated. In general, despite the farm typology, location and differences in net incomes, the farms under study had low net incomes, where 95 percent were under the reproduction threshold. This was mainly due to their small farm surface and, consequently, low productivity. Therefore, there is a lack of ability to accumulate capital and intensify the production, maintaining the extensive type of fruit growing. Under these conditions, 60 percent of the farmers interviewed were involved in other secondary agricultural activities to increase their sustainability, making these farms more competitive than the specialised ones. Although the orientation of subsidises to small fruit farms will offer a better guarantee to low-income categories, it will also delay restructuring of the Albanian agriculture. It may also have a negative effect on the competitiveness of the agricultural sector, in general, because the lack of readiness to sell the land will make it difficult for other farms to grow in order to reach the reproduction threshold and to take advantage of the economics of scale. In conclusion of the above results, the Government of Albania should set some criteria for the beneficiaries of subsidies in terms of farm size and capital to be invested. This would require a set of policies to create some appealing alternatives for farmers selling the land.

Key words: subsidy, competitiveness, agricultural policy, fruit tree farms

Introduction

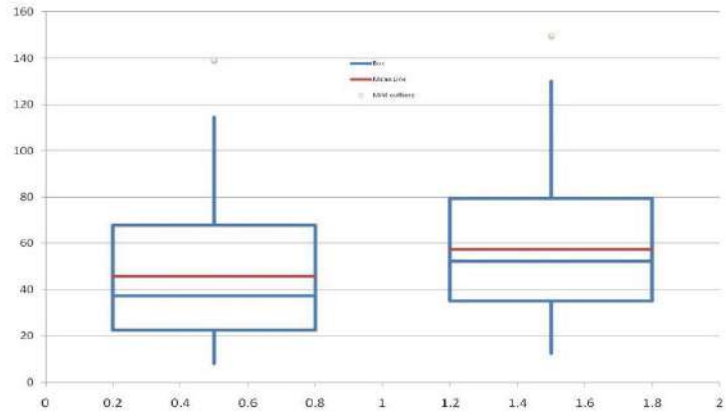
The removal of restrictions imposed by centrally planned economic policies in Albania was expected to lead to the recovery of the agricultural sector, but in the end, it was only partially successful. In implementing the transition process, in general, agricultural challenges - such as low food self-sufficiency levels, unfavourable agro-food trade balances, high employment levels in agriculture and low commercial quality of farm products - still remain. Moreover, despite the tendency for agricultural commodity prices in Albania to gradually align with those in the EU, wide differences in agricultural productivity still persist.

Since 2005, the Government of Albania has been providing subsidies for competitive agricultural sectors, mostly fruit growing. However, there is a general lack of data regarding farm revenues, profitability and competitiveness and the criteria are not very restrictive in terms of orchard size or capital.

The purpose of this research was to study the competitiveness of fruit tree farms.

Materials and methods

The study was conducted from 2009 – 2011 in the Vlora region. Farms were randomly selected by the farm database of the Agricultural Technology Transfer Centre of Vlora with a total of 700 family farms with fruit tree cultivation as their main activity.



Graph. 1. Statistical evaluation of the financial data on costs and incomes using the Box Plot analysis

Statistička procjena finsijskih podataka o troškovima i prihodima korištenjem Box Plot analize

To ensure equal representation of climatic (climate, soil), agrotechnical (opportunities for irrigation, fertilisation, mechanisation, etc.) and market (mainly distance from the main market) conditions, farms were selected at different altitudes (the ecological, agrotechnical and market influence) and slopes (agrotechnical influence). A group of 100 farms was aimed at but the data from 70 farms only were considered reliable and complete for the financial analysis.

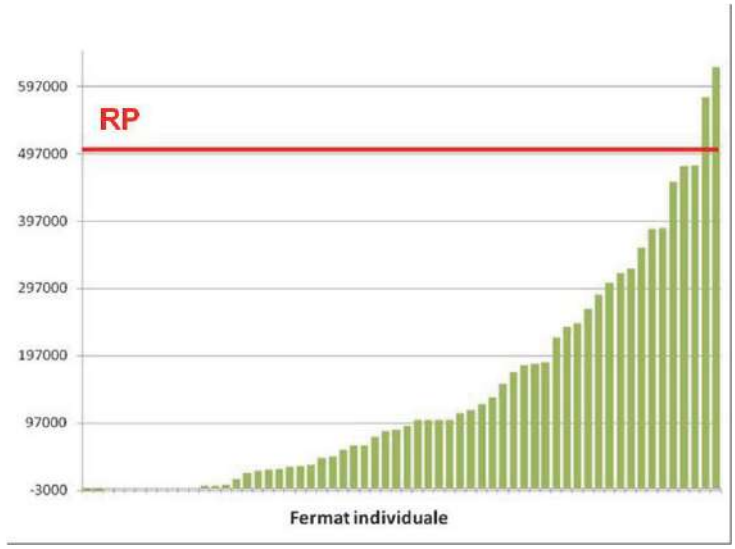
Different typologies of fruit tree farms were included: cultivation of fruits (F), olives (O), vineyards (G) and combinations like fruit + vineyards (FV), fruit + olive + vineyards (FOV) or olive + vineyards (OV)

From the methodological point of view, a major part of this study involved adaptation of the conceptual basis of Agrarian System Diagnosis (FAO, 1999).

The Reproduction Threshold (RT) was introduced as a benchmark for assessing the farms' level of incomes and therefore their profitability. For Family Farms as those in the present study, the RT is the minimum income per family below which farmers are unable to adequately pay for all inputs and to completely restore capital productivity in order to begin a new production cycle. The average income of rural families in the Vlora region (proxy for the Reproduction Threshold) acted as a reference against which the economic viability of farming systems was evaluated.

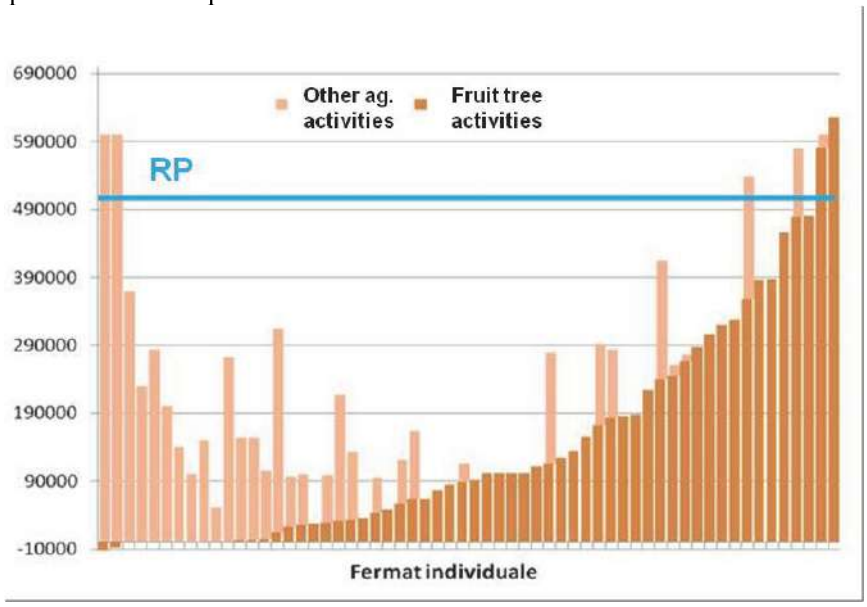
Results and discussion

In general, despite the farm typology, location and differences in net incomes, the farms under study had low net incomes, where 95 percent are under the reproduction threshold.



Graph. 2. Net income from fruit tree farming (lek)
Neto prihodi od voćarstva

This is mainly due to their small farm surface and, consequently, low productivity. Therefore, there is a lack of ability to accumulate capital and intensify the production, maintaining the extensive type of fruit growing. Under these conditions, 60 percent of the farmers interviewed are involved in other secondary agricultural activities to increase their sustainability, making these farms more competitive than the specialised ones.



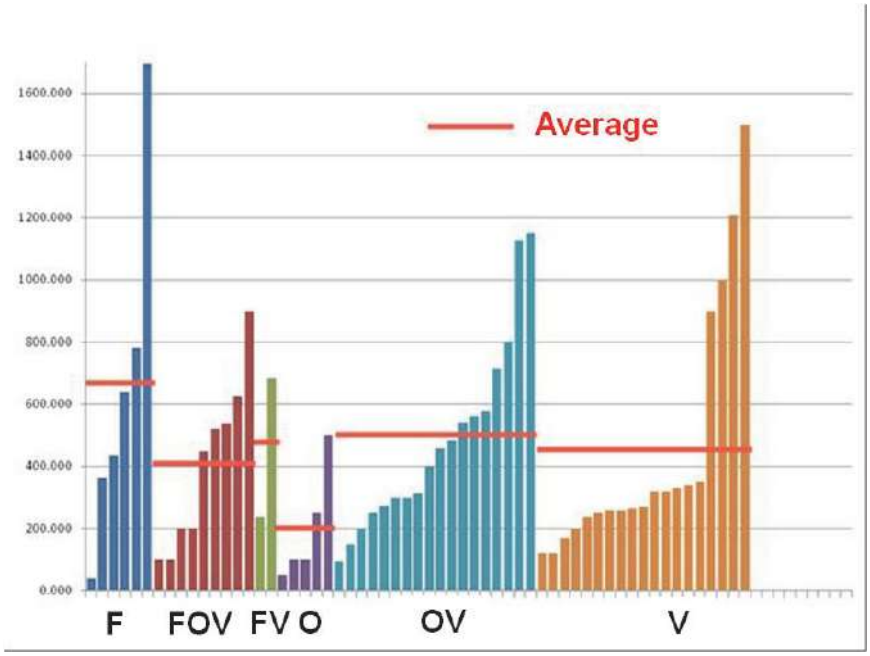
Graph. 3. Net income from fruit tree farming and other agricultural activities (lek)
Neto prihodi od voćarstva i drugih poljoprivrednih djelatnosti

Although the orientation of subsidises to small fruit farms will offer a better guarantee to low-income categories, it will also delay restructuring of the Albanian agriculture. It may also have a negative effect on the competitiveness of the agricultural sector, in general, because the lack of readiness to sell the land will make it difficult for other farms to grow in order to reach the reproduction threshold and to take advantage of the economics of scale.

Conclusion

In conclusion of the above results, the Government of Albania should set some criteria for the beneficiaries of subsidies in terms of farm size and capital to be invested. This would require a set of policies to create some appealing alternatives for farmers selling the land.

Even though 'below-RT' farmers do not contribute to the national agricultural trade to a great extent, they play a vital social role by contributing to the preservation of rural society and delivering environmental services (e.g. landscape maintenance).



Graph. 4. Gross incomes by farm typology
Bruto prihodi u skladu sa tipologijom gazdinstva

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Promjena politike subvencionisanja u Albaniji u kontekstu niskoprofitnih gazdinstava

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Apstrakt

Od 2005. godine albanska vlada daje podsticaje za konkurentne sektore u poljoprivredi, uglavnom za voćarstvo. Međutim, postoji opšti nedostatak podataka u vezi sa prihodima, profitabilnošću i konkurentnošću gazdinstava, a kriterijumi nisu restriktivni kada je u pitanju veličina voćnjaka ili kapitala. Svrha ovog istraživanje bila je da se ispita konkurentnost voćarskih gazdinstava. Istraživanje je sprovedeno od 2009. do 2011. godine u regionu Vlora prikupljanjem finansijskih podataka od 70 voćarskih farmi koje se nalaze na različitim nadmorskim visinama i nagibima zemljišta pošto obe karakteristike utiču na izbor kulture, praksu uzgoja i pristup tržištu. Prosječan prihod porodica u ruralnom regionu Vlora (predstavnik praga reproduktivnosti) poslužio je kao referenca za procjenu ekonomske održivosti poljoprivrednih sistema. Uopšteno posmatrajući, uprkos tipologiji gazdinstava, lokaciji i razlikama u neto prihodima, ispitivana gazdinstva imaju niske neto prihode i 95 odsto ih je bilo ispod praga reproduktivnosti. Razlog za ovo leži u malim gazdinstvima i samim tim niskoj produktivnosti. Stoga, ne postoji mogućnost za povećanje kapitala i jačanje proizvodnje te se dalje održava ekstenzivni tip voćarstva. U ovakvim uslovima, 60% ispitanih proizvođača bavi se sekundarnim poljoprivrednim djelatnostima kako bi povećali održivost, čineći tako svoja gazdinstva konkurentnijim u odnosu na specijalizovana. Iako će usmjeravanje podsticaja ka malim voćarskim gazdinstvima ponuditi bolju garanciju onima sa niskim prihodima, ono će odložiti restrukturiranje albanske poljoprivrede. Takođe, može imati i negativan uticaj na konkurentnost poljoprivrednog sektora uopšte zbog toga što će nedostatak spremnosti da se proda zemlja otežati drugim gazdinstvima da se povećaju kako bi dostigli prag reproduktivnosti i iskoristili ekonomiju razmjere. Kao zaključak na pomenute rezultate, albanska vlada treba da postavi određene kriterijume za korisnike podsticaja u vezi sa veličinom gazdinstva i visinom ulaganja. Za to bi bilo neophodno donošenje niza propisa kojima bi se stvorila neka primamljiva alternativna rješenja za poljoprivrednike koji prodaju zemlju.

Ključne riječi: subvencionisanje, konkurentnost, poljoprivredna politika, voćarska gazdinstva

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Agro-knowledge Journal

Economic analysis of fruit tree nurseries in Albania

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Summary

Production of healthy and certified nursery trees is one of the primary conditions for intensive and stable development of the fruit tree sector. In the last decade, fruit tree production in Albania has drastically increased with more than a thousand hectares per year. The nursery production has attempted to follow with the same pace with about 150 nurseries in the country and more than 2 million nursery trees planted and only 9 percent imported. The purpose of this research, conducted from 2008–2009, was to undertake an economic analysis of these nurseries in view of potential subsidies offered by the government. Thirty-six nurseries were interviewed having quite an intensive production of nursery trees located in the Vlora, Fier, Durrës and Tirana regions. Twenty nurseries are specialised, producing only one species of fruit trees, 8 nurseries producing two species and other 8 producing three or four species. The data showed that all the nurseries studied are profitable. On average, their net income is 20000 EUR/farm. The ratio between incomes and costs is 1:0.45. Furthermore, farms producing up to two species of nursery trees have better financial indicators than those producing 3 to 4 species. Moreover, the specialised nurseries have lower costs of more than 3 percent for all categories of nursery trees.

Key words: fruit trees, nursery, profitability, costs

Introduction

Production of healthy and certified nursery trees is one of the primary conditions for intensive and stable development of the fruit tree sector.

The binominal nurseryman– fruit grower determines successful and sustainable management of fruit orchards, olive groves, vineyards and citrus orchards.

In the last decade, fruit tree production in Albania has drastically increased with more than a thousand hectares per year. The medium and long term strategy of

the Albanian Government for development of the fruit tree sector will stimulate the nursery production even more thus avoiding uncertified propagation material.

The nursery production has attempted to follow with the same pace with about 150 nurseries in the country and more than 2 million nursery trees planted and only 9 percent imported.

The purpose of this research, conducted from 2008–2009, was to undertake an economic analysis of these nurseries in view of potential subsidies offered by the government.

Materials and methods

Thirty-six nurseries were interviewed during the period 2010–2011 having quite an intensive production of nursery trees located in four regions: Vlora, Fier, Durrës and Tirana.

Tab. 1. Nurseries studied categorised by region and level of specialisation
Ispitivani rasadnici kategorisani po regionu i nivou specijalizovanosti

Region	Nurseries	Specialised	Mixed
VLORA	16	7	9
FIER	9	6	3
DURRES	3	3	-
TIRANA	8	5	3
TOTAL	36	21	15

Out of 36 nurseries, 58.33 % are specialised in one species (12 for grapevine nursery trees, 5 for olives, 2 for fruit trees and 1 for citrus), 22.22 % in two species and 22.22 % in three and four species.

The elaboration of data through a survey form has enabled us to individualise the gross production saleable, production costs, profit, net product and the net profit of each nursery, referring to all the species presented in each of them.

In order to make the data of individual nurseries comparable, these were subsequently converted to a hectare.

The gross production saleable was determined by referring to the quantities commercialised and average sale prices declared by individual nurseries during 2010. Transport costs were not included as they are paid by buyers.

The cost elements considered for the purpose of determining the production costs include both expenses for purchasing materials and services on the market as well as for labour and costs related to production factors directly given by the nurseryman (labour, capital and land) which were monetarily incurred.

Results and discussion

The notable variability of the nursery trees per unit of surface between nurseries is related to the species and cultivars grown, typology of production, technical choices and duration of the growing cycle in the nursery.

Variability of the production costs (Figure 1) is mainly due to different densities of cultivation and the adoption of different growing systems implemented by the nurseries. In general, 42% of the costs are labour, 38% materials, 9% mechanisation and 10% water and energy.

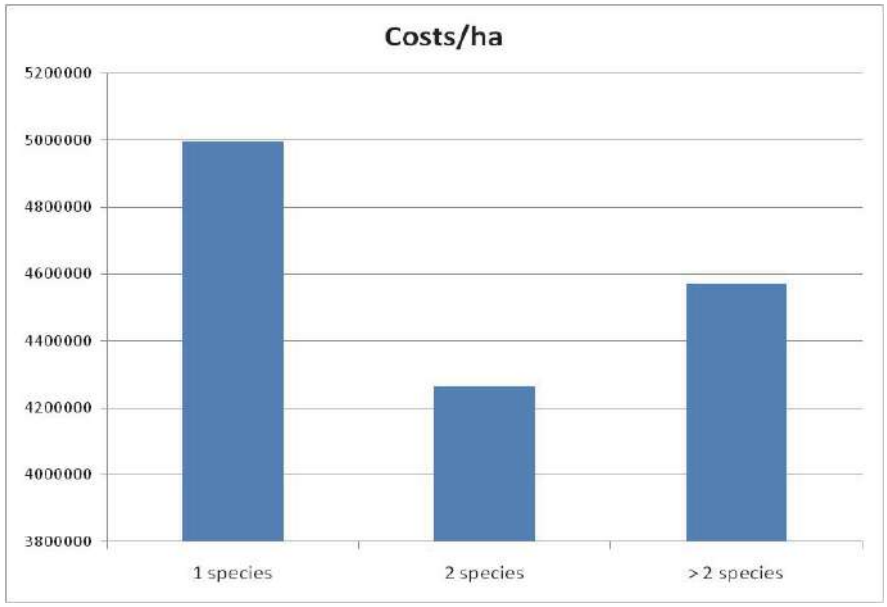

Fig. 1. Costs per hectare of nursery tree production in different groups of nurseries (lek)

Troškovi po hektaru rasadničke proizvodnje u različitim grupama rasadnika

This is mainly due to their small farm surface and, consequently, low productivity. Therefore, there is a lack of ability to accumulate capital and intensify the production, maintaining the extensive type of fruit growing. Under these conditions, 60 percent of the farmers interviewed are involved in other secondary agricultural activities to increase their sustainability, making these farms more competitive than the specialised ones.

Profits generated by the nurseries under study were in all cases positive (Figure 2), however variable. This variability is mostly based on structural and productive characteristics. The need for higher efficiency can be demonstrated by low incomes per square meter which on average amount to 988.2 lek.

The adoption of profit as an exclusive indicator of "performance" does not allow for proper assessment of profitability of the species because it refers purely to

the nursery business, whereas entrepreneurs that use different production factors also operate in this sector.

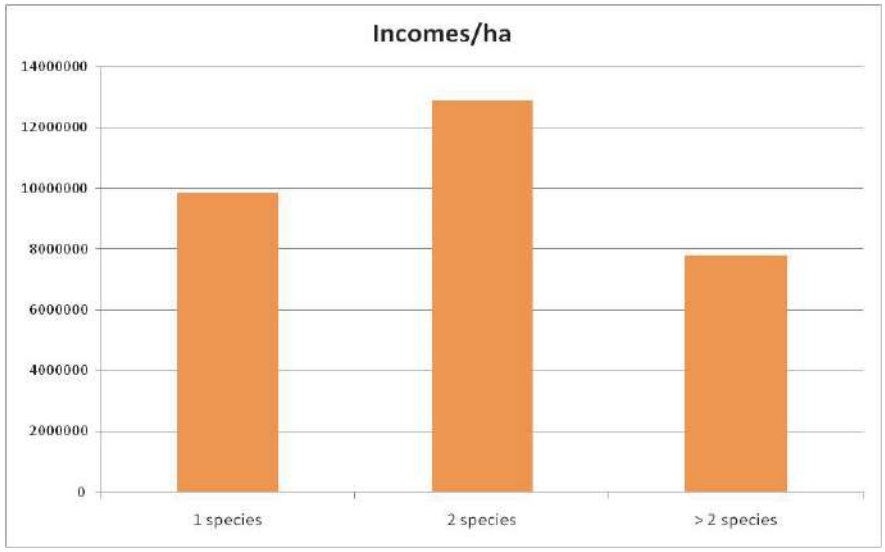

Fig. 2. Gross income per hectare from nursery tree sales (lek)
Bruto prihodi po hektaru od prodaje sadnica

The analysis has shown peculiarities of the fruit nursery sector in Albania characterised by reduced dimensions for most of the nurseries, which in many cases are refrained from the introduction of technological innovation processes, the minute supply, lack of marketing strategies and valorisation of products at private and public level.

Compared with the average of four regions, the incomes per farm for the specialised nurseries (1 species) are 19.9% lower, for the second group (2 species) 77.8% higher and for the third group (> 2 species) 28.14% lower.

In terms of incomes per ha, compared again with the average of the three groups of nurseries, respectively, it follows: 5.15% lower in the first group, 24.2% higher in the second group and 24.87% lower for the third group. The incomes of the first group compared with the third one are 26.25% and 65.3%, respectively. Moreover, the incomes per farm, compared with the average of the four regions, are 2.04 times lower for group I, 2.16 times higher for group II and 46% lower for group III. The ratio between gross income and net income is 1:0.55 with minor differences across groups.

The data related to the structure of expenditures (not shown here) demonstrate that the level of mechanisation in the nurseries is still low (9%).

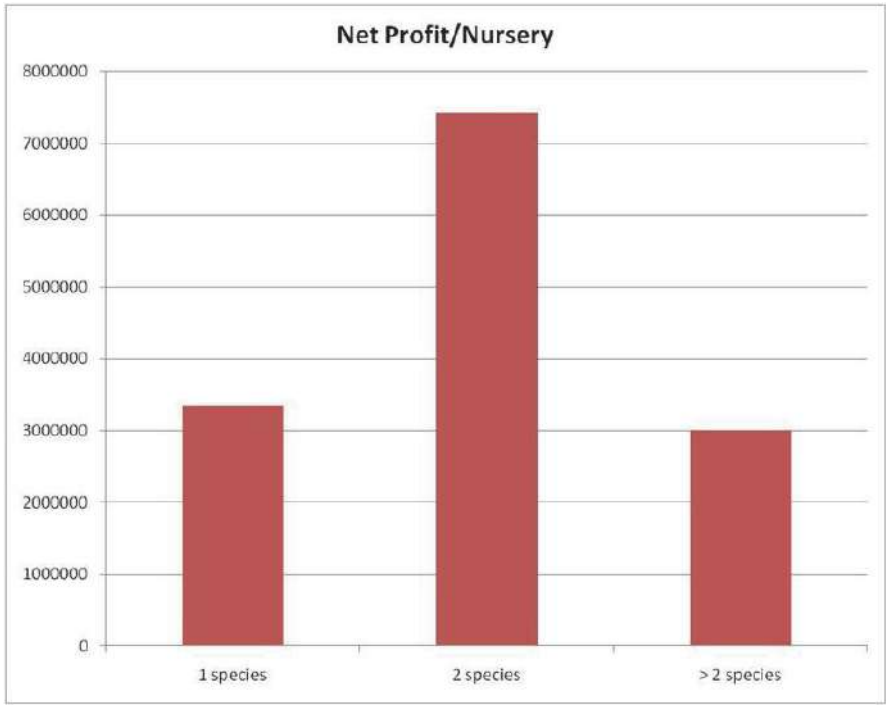

Figure 3. Net profit per nursery (lek)
Neto profit po rasadniku

Conclusion

The micro-economic analyses conducted, through the analysis of several case studies, have revealed good profitability levels (despite the variability of quantities produced and sale prices) that more than compensate high production costs.

However, judging from the net profit values and the income per square meter generated, there is still a need to increase the efficiency, especially by improving the technology.

In terms of the best model of a nursery, those producing two species of fruit trees are followed by those producing one species.

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Ekonomska analiza voćnih rasadnika u Albaniji

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Sažetak

Proizvodnja zdravih i sertifikovanih sadnica u rasadnicima je jedan od primarnih uslova za intenzivan i stabilan razvoj sektora voćarstva. U posljednjoj dekadi, voćarska proizvodnja u Albaniji je u velikom porastu sa više od hiljadu hektara godišnje. Rasadnička proizvodnja pokušava da istim koracima prati sa oko 150 rasadnika u zemlji i više od 2 miliona zasađenih sadnica iz rasadnika i samo 9 posto uvezenih. Cilj ovog istraživanja sprovedenog od 2008-2009 bio je da se izvrši ekonomska analiza ovih rasadnika u odnosu na potencijalne podsticaje koje nudi vlada. Ispitano je trideset šest rasadnika koji se bave intenzivnom proizvodnjom sadnica a koji se nalaze u regijama Vlora, Fier, Durrës i Tirane. Dvadeset rasadnika su specijalizovani i proizvode samo jednu vrstu voćnih sadnica, 8 rasadnika proizvodi dvije vrste, ostalih 8 proizvodi tri ili četiri vrste. Podaci su pokazali da su svi ispitivani rasadnici profitabilni. U prosjeku njihovi neto prihodi iznose 20000 EUR/farmi. Odnos između prihoda i troškova je 1:0.45. Pored toga, gazdinstva koja proizvode do dvije vrste sadnica u svojim rasadnicima imaju bolje finansijske pokazatelje nego ona koja proizvode 3 do 4 vrste. Nadalje, specijalizovani rasadnici imali su više od 3 posto niže troškove za sve kategorije sadnica.

Ključne riječi: voćke, rasadnik, profitabilnost, troškovi

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Influence of temperature and sowing depth on growth and development of annual flowering species

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Summary

Annuals are plants that germinate, mature, bloom, set seed and die in one growing season. They are sometimes referred to as bedding plants because they provide colour and fill in garden beds. This research was conducted in the laboratory of the Department for Plant Production at the Agricultural Faculty in Osijek. The aim of this study was to determine the effect of two different temperatures (18 and 24°C) and sowing depth (2 and 3 cm) on germination of annual flower species. For the purpose of this study, two types of annual flower seeds were used, seeds of floral species Dahlia and Zinnia. Seeds were sown in trays at two different depths (2 and 3 cm) and kept in a chamber under controlled conditions at two different temperatures (18 and 24ºC). After three weeks of controlled conditions, the stems and root of young plants were measured. Root length of both flower species was significantly influenced by sowing depth and temperature ($p = 0.01$). Dahlia stem length was affected by sowing depth and temperature ($p=0.05$) while the length of Zinnia stems was not influenced by either temperature or planting depth.

Key words: annuals, temperature, daylight, germination

Introduction

Annuals are plants that germinate, mature, bloom, set seed and die in one growing season. They are sometimes referred to as bedding plants because they provide colour and fill in garden beds. Many of these flowers are excellent choices for the garden as they can be grown during different seasons. Annual flowers differ in their tolerance to cold weather and frost, thus they are classified as hardy annuals, semi-hardy annuals and tender annuals. Zinnias are natives of the New World which were named after and in honour of Johann Zinn, a German professor of

botany and medicine, in 1763 by Linnaeus (Shepherd, 2012.). Dahlia cultivars are referred to by more than 14,000 names. This number represents an astonishing average of over 100 newly named cultivars during each of the 143 years since 1791 when dahlias were first brought into cultivation in the gardens of Spain following their arrival from Mexico (Sorensen, 1969). When considering water availability for the germination and growth of annual plants, it is also important to take into account other soil factors such as depth, parental material, and texture (Rivas-Arancibia, 2006). Temperature also interacts with light and this can modify sensitivity of seeds to light (Taylorson and Hendricks, 1972).

The aim of this study was to determine the effect of two different temperatures (18 and 24°C) and sowing depth (2 and 3 cm) on germination of annual flower species.

Materials and methods

The investigation was conducted during 2011 in the laboratory of the Department for Plant Production at the Agricultural Faculty in Osijek. The seeds of two types of annual flowers Zinnia and Dhalia were used in this study. Each flower species represented a variant of the experiment with the factors: temperature (A) and sowing depth (B). Sowing was done on 3 March in a 4L polystyrene container using substrate (Terra Brill, Gebr. Brill Substrate GmbH & Co. KG, Germany). The seeds were sown in four repetitions, 10 seeds per repetition at a depth of 2 cm and four repetitions at a depth of 3 cm for each flower type. Polystyrene containers were then placed in a chamber with controlled conditions at a temperature of 24°C and under artificial light, twenty-four hours of light ("day"). Sprouting of plants began 5-6 days after the sowing date. Measurements of root length and plant height were carried out on 17 March 2011. The same day when measurements were performed, the seeds of the same type of flower were planted again in the same arrangement and at the same depth, but placed in a chamber with controlled conditions at a temperature of 18°C and under artificial light, sixteen hours ("day") and eight hours of darkness ("night"). The measurements for this part of research were carried out on 31 March 2011.

The study was conducted as a split-plot experiment with the following factors: sowing depth (A) and temperature (B). The data obtained were statistically analysed using analysis of variance (F- test) by applying VVSTAT (Vukadinović, 1994.).

Results and discussion

The statistical analysis of data showed that the length of Dahlia roots was significantly influenced by both investigated factors. Dahlia root length was significantly higher in seedlings that were emerging at lower temperature conditions at 18°C, and sown at a depth of 3 cm ($p = 0.01$).

Maximum root length, 1.89 cm, was observed in seedlings grown at 24°C and sown at a depth of 3 cm, while the smallest root mass, 0.470 cm, was recorded

in plants grown at 24°C and sown at a depth of 2 cm, which was confirmed by the statistics showing that seedlings from A2B1 variant had significantly longer roots than in the A2B2 variant (p = 0.01). Statistical significance between A1B1 and A1B2 variant is absent (Table 1.). The seedlings sown at a depth of 3 cm had 68.12% longer roots compared with seedlings sown at a depth of 2 cm.

Tab. 1. Effect of temperature and depth of sowing on the length of root and stem of Dhalie

Uticaj temperature i dubine sadnje na dužinu korijena i stabljike dalije

Variant (A)	*Rooth lenght* (cm)			*Stem lenght* (cm)		
	Sowing depth (B1)	Sowing depth (B2)	Mean	Sowing depth (B1)	Sowing depth (B2)	Mean
Temperature (A1)	1,683	1,720	1,701	1,750	2,390	2,070
Temperature (A2)	0,470	1,898	1,184	1,467	1,783	1,625
Mean	1,076	1,809	1,4425	1,609	2,086	1,8475

Rooth lenght

LSD	Temperature (A)	Sowing depth (B)	*Interactions*
			A x B
0,01	0,3142	0,4261	0,4972
0,05	0,1712	0,2813	0,3197

Stem lenght

LSD	Temperature (A)	Sowing depth (B)	*Interactions*
			A x B
0,01	0,7644	ns	ns
0,05	0,4164	ns	ns

The interaction between the properties of temperature and sowing depth showed statistical significance (p = 0.01). According to Read (2009), containers should be placed in a warm location (not in direct sunlight) to allow seeds to germinate. Dahlias normally germinate in 5–7 days at temperatures between 21-24ºC.

In this study, Dahlia stem length was significantly influenced by temperature (p = 0.05). Maximum stem length was observed in seedlings grown at 18°C and was 2.39 cm, while the minimum stem length, 1.46 cm, was recorded in seedlings grown at 24°C. The seedlings grown at lower temperature had 27.38% greater root length compared with seedlings grown at 24°C. Although the statistical analysis of data showed that the depth of planting did not significantly affect the properties of stem length, significantly longer stems were observed in the sprouts of variant A1B1 in relation to the A1B2 variant (p = 0.05).

Table 2. Effect of temperature and depth of sowing on the length of root and stem of Zinnie

Uticaj temperature i dubine sadnje na dužinu korijena i stabljike cinije

Variant (A)	*Rooth lenght* (cm)			*Stem lenght* (cm)		
	Sowing depth (B1)	Sowing depth (B2)	Mean	Sowing depth (B1)	Sowing depth (B2)	Mean
Temperature (A1)	3,053	2,460	2,756	3,255	3,740	3,497
Temperature (A2)	5,198	4,115	4,656	3,465	3,985	3,725
Mean	4,125	3,288	3,7062	3,360	3,863	3,6112

Rooth lenght

LSD	Temperature (A)	Sowing depth (B)	*Interactions*
			A x B
0,01	ns	0,4234	ns
0,05	ns	0,2795	ns

Stem lenght

LSD	Temperature (A)	Sowing depth (B)	*Interactions*
			A x B
0,01	0,6899	0,3758	ns
0,05	0,5630	0,3716	ns

Zinnia seedling root length was significantly influenced by temperature and sowing depth (p=0.01). The seedlings grown at 24°C had 68.94% longer roots compared with seedlings grown at 18°C, while the root length of seedlings sown at 2 cm had 25.45% greater root length than the seedlings sown at a depth of 3 cm. Most plants grow best between 21-26ºC (Toogood, 1999.). Maximum root length, 5.19 cm, was observed in seedlings grown at 24°C, and sown at a depth of 2 cm, while the smallest root mass, 2.460 cm, was recorded in plants grown at 18°C and sown at a depth of 3 cm. The statistical significance of interactions between the properties of temperature and sowing depth did not appear (Table 2.).

As for the stem length of Zinnia, this property has been significantly influenced by sowing depth (p=0.01), while the property of temperature did not show any statistical difference. Maximum stem length 3.985 cm was observed in seedlings grown at 24°C, and sown at a depth of 3 cm, while the minimum stem length, 3.255 cm, was recorded in seedlings grown at 18°C, and sown at a depth of 2 cm. The seedlings grown at 24°C had 6.51% longer roots than seedlings grown at 18°C, while the root length of seedlings sown at 3 cm had 14.97% greater root length than the seedlings sown at a depth of 2 cm.

According to Parađiković (2008), 18°C temperature ensures the quality growth of *Zinnia elegans* seedlings, but slightly higher temperature can affect the root collar elongation of Zinnia seedlings.

Conclusion

The experimental results showed better development of Dahlia seedlings at the temperature of 18°C which resulted in greater length of roots and stems. Greater sowing depth ensured better development of the stem. Zinnia seedlings showed better growth at 24°C temperature and sowing depth of 3 cm which resulted in development of longer roots, while deeper sowing ensured development of longer stem.

The research indicates that the temperature and sowing depth are limited factors that should be followed by professional growers of Dahlias and Zinnia. Particularly important is the temperature during the period of germination of plants. If the temperature is higher during this period and germination is provoked by the addition of moisture, such plants will certainly be elongated from the start which in the end reflects on growth and flowering of the plant.

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Uticaj temperature i dubine sadnje na rast i razvoj jednogodišnjih cvjetnica

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Apstrakt

Jednogodišnje biljke su one koje klijaju, sazrijevaju, cvjetaju, razvijaju sjeme i uginu u jednoj sezoni rasta. Ponekada se nazivaju i sezonskim cvjetnicama zato što popunjavaju i daju boju vrtnim lejama. Ovo istraživanje je sprovedeno u laboratoriji Odsjeka za biljnu proizvodnju Poljoprivrednog fakulteta u Osijeku. Cilj ovog istraživanja bio je da se odredi uticaj dvije različite temperature (18 i 24°C) i dubine sadnje (2 i 3 cm) na klijanje jednogodišnjih cvjetnica. U svrhu ovog istraživanje korištene su dvije vrste sjemena jednogodišnjih cvjetnica, dalija i cinija. Sjeme je sađeno u plitke kutije sa pregradicama na dvije različite dubine (2 i 3 cm) i držano u komori pod kontrolisanim uslovima na dvije različite temperature (18 i 24ºC). Nakon tri sedmice boravka u kontrolisanim uslovima, izmjereni su stabljika i korijen mladih biljaka. Na dužinu korijena obe cvjetnice znatno je uticala dubina sadnje i temperatura ($p = 0.01$). Dubina sadnje i temperatura ($p=0.05$) uticali su na dužinu stabljike kod dalije dok na dužinu stabljike cinije nisu uticale niti temperatura niti dubina sadnje.

Ključne riječi: jednogodišnje biljke, temperatura, dnevno svjetlo, klijanje

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Principal component analysis of a canning determinate tomato collection in the IPGR, Sadovo – Bulgaria

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Summary

The success of a tomato breeding programme largely depends on the study of initial material and symptoms studied as well as manifestations of dependence between them. The study was conducted during the period 2008-2011 in the IPGR, Bulgaria. The objects of the study were 37 canning tomato accessions with an oval shape of the fruit. The collection included 11 local and 26 accessions of foreign origin. Using factor analysis by applying the PCA methodology, a relationship was established between 15 morphological and biochemical parameters of the accessions studied and their effects on indicators of fruit weight and dry matter content. The investigated parameters were grouped into four general factors affecting the mass change by 73.4%. Applied to dry matter content, the same method identifies four factors with a total impact of 71.7% on this trait.

Key words: tomato collection, morphological and economical traits, evaluation, PCA

Introduction

Preservation, collection and evaluation of genetic diversity is a major factor in the successful selection of tomatoes in relation to the proper choice of initial material within potential characteristics such as productivity, disease resistance, etc., and the study of dependence among the traits [3, 8].

The national tomato collection, subject to full biosystematic, morphological and agrobiological evaluation, has been created in the Institute of Plant Genetic Resources (IPGR) through free international exchange and enhanced expeditions [6, 7].

The aim of the study was to measure the individual influence of each factor on performance change in the mass of the fruit and dry matter content in the tomato collection being evaluated through factor analysis by the method of Principal Component Analysis (PCA) [1, 2, 4].

Materials and methods

The survey was conducted during the period 2008-2011 in the experimental vegetable field of the IPGR - Sadovo.

The object of the study was a collection of 37 determinate tomato accessions with an oval - elongated fruit shape for processing, and the Bulgarian cultivar Bella as a standard. 26 introduced accessions and 11 local forms collected during expeditions in the country were studied as valuable genetic sources (Fig. 1, 2, 3).

The plants were grown based on a common technology of middle – early field production of the IPGR - Sadovo [5].

The evaluation was conducted according to the international descriptor of IPGRI (1966) for tomato [9]. The accessions were characterised by 15 morphological and biochemical indicators of economic importance to the culture.

The survey data were processed with the SPSS 13.0 statistical package [10].

Factor analysis was applied by using the PCA methodology.

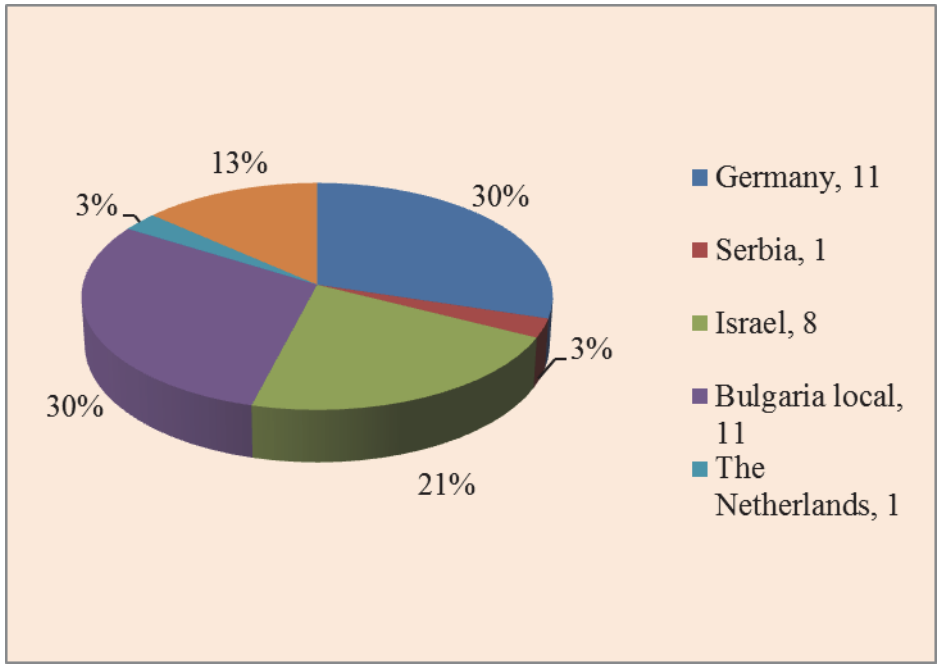

Fig. 1. The origin of the canning tomato collection
Porijeklo kolekcije paradajza za preradu

Fig. 2. Introduced tomato accession from Israel
Uvedene prinove paradajza iz Izraela

Fig. 3. Local plant genetic resources from expedition in Bulgaria
Lokalni biljni genetički resursi iz ekspedicije u Bugarskoj

Results and discussion

The results presented in Table 1 show that the models of the study regarding the influence of morphological and biochemical parameters on fruit mass and dry matter content will be based on four factors.

The data from an analysis of major components indicate that these four factors are sufficient to explain 73.4 % of the total change in the fruit mass in the collection tested (Fig. 4). The first factor explained 22.8% and included the following indicators: vitamin C, sugars, total acidity and dry matter content. The second factor - 19.7%, included those as follows: plant height, length and shape of the fruit. The third factor - 15.8%, covered the length and width of the leaves. The fourth factor - 15.1%, included the following: the number of locules in the fruit and sugar-acidity coefficient.

As regards the dry matter in the fruit, the analysis of the data summarised four factors influencing its content. The first factor explained 21.8% of total change and included plant height, length and shape of the fruit. The second factor synthesising biochemistry traits - 17.2%. The third factor - 16.6%, included width of the fruit, the number of locules and sugar-acidity coefficient. The fourth one - 16.1% referred to the dry matter change and included length and width of the leaves. The overall impact of the parameters on the dry matter content studied included in the four factors was 71.7% (Fig. 5).

During the analysis, it was found that two morphological characteristics, namely, the number and size of the flowers, according to the method used were statistically insignificant indicators regarding mass and dry matter change in the collection. The study showed that the fruit mass did not significantly affect modification of the dry matter content in the group of small-fruited tomatoes.

Tab. 1. Results from the Principal Component Analysis
Rezultati analize glavnih komponenti

Traits	Components of fruit weight				Components of dry matter content			
	F_1	F_2	F_3	F_4	F_1	F_2	F_3	F_4
Plant hight			0.779		0.765			
Leaf lenght				0.856				0.818
Leaf width				0.857				0.858
Fruit lenght			0.833		0.860			
Fruit width							0.728	
Fruit shape			0.915		0.884			
Number of locules							0.781	
Vitamin C content	0.806	0.806				0.800		
Sugar content	0.813	0.813				0.758		
Total acidity	0.733	0.733				0.732		
Sugar-acidity coefficient				-0.743			-0.708	
Dry matter content	0.930	0.930						

To build a dependence model between the mass and dry matter of received applications summarising factors in the factor analysis, a multivariate linear regression analysis was used. Multiple correlation coefficients reflecting the relationship between the morphological and biochemical parameters studied and mass and dry matter were R=0.68 for the mass and R=0.87 for the dry matter content, respectively (Table 2). The calculated multiple correlation coefficients showed significant influence of the studied parameters, as summarised by the factor analysis into four factors for dependent variables, fruit weight and dry matter content. The highest correlation coefficient (R = 0.55) was recorded between the mass and the second factor, including morphological characteristics: height of the plant, length and shape of the fruit. As for the dry matter, a single correlation was strongest with the second factor (R = 0.86), including fruit biochemistry: vitamin C, sugars and total acidity.

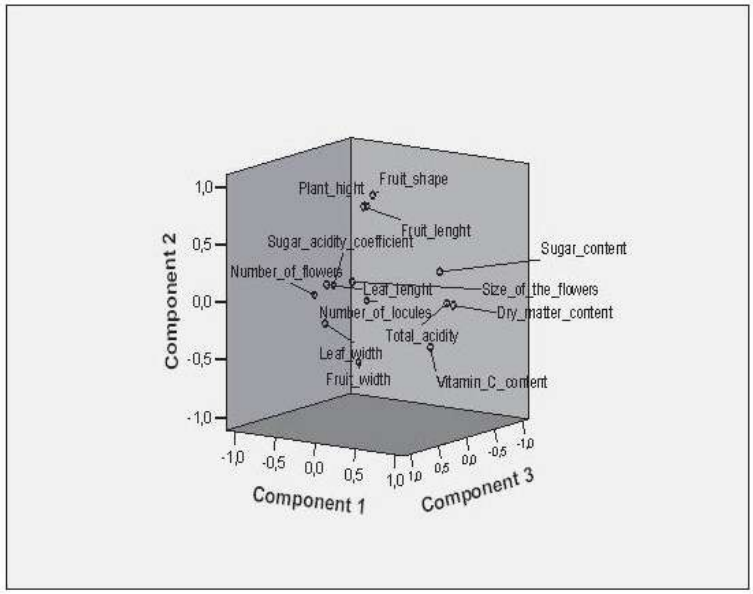

Fig. 4. Components of fruit weight
Komponente težine ploda

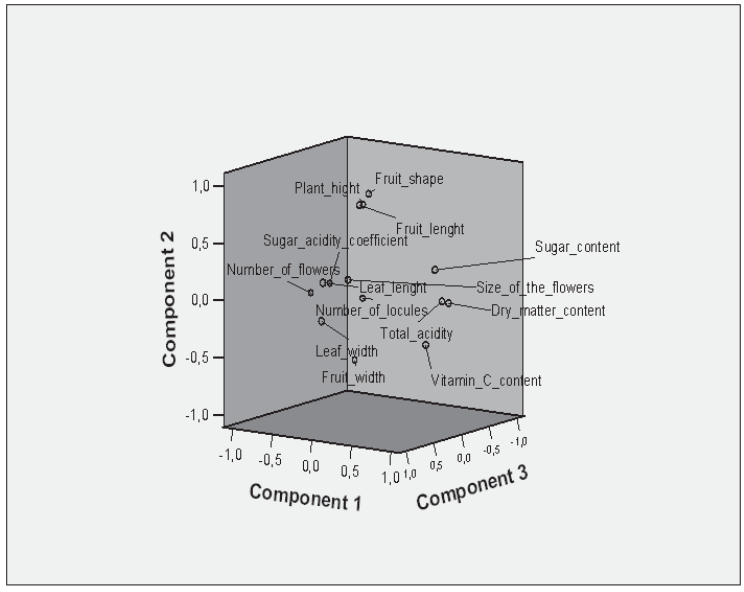

Fig. 5. Components of dry matter content
Komponente sadržaja suve materije

Table 2. Regressive model coefficients
Koeficijenti regresivnog modela

Model	Unstandardized Coefficient	Standardized Coefficient	Correlation
	B	Beta	R
Fruit weight			
Constant	92.17		
F_1	1.64	0.13	0.17
F_2	6.10	0.48	0.55
F_3	4.12	0.32	0.40
F_4	4.16	0.33	0.41
Dry matter content			
Constant	5.38		
F_1	0.02	0.04	0.04
F_2	0.54	0.86	0.86
F_3	0.08	0.13	0.13
F_4	0.001	0.001	0.001

Table 2 shows that the highest regression coefficient (B) for both characteristics tested was the second factor, respectively 6.1 and 0.48. The standardised regression coefficient (Beta) reflected a direct impact of each factor on the tested variables. The mass (0.48) was most directly influenced by the second factor, summarizing the morphological parameters as follows: plant height, length and shape of the fruit. The most direct impact (0.86) on dry matter content was obtained for this composite index factor 2. This factor combined biochemistry traits: vitamin C, sugars and total acidity content. All estimated coefficients of the models were statistically proved at significance level $\alpha = 0.05$.

The analytical representation of dependence between mass and dry matter, respectively, is defined summarising the factors:

$$\mathbf{У_{fruit\ weight} = 92.2 + 1.64}\, F_1 + \mathbf{6.09}\, F_2 + \mathbf{4.12}\, F_3 + \mathbf{4.16}\, F_4$$

$$\mathbf{У_{dry\ matter\ content} = 5.38 + 0.02}\, F_1 + \mathbf{0.54}\, F_2 + \mathbf{0.08}\, F_3 + \mathbf{0.001}\, F_4$$

Conclusion

1. The analysis led to the conclusion that the total fruit mass change of the canning tomato collection tested was most influenced by the factor F_2, including morphological characteristics as follows: height of the plant, length and shape of the

fruit. The dry matter content was most influenced by biochemical parameters such as vitamin C, sugars and total acidity, summarised in the second factor.

2. Morphological and biochemical indicators grouped into summarised factors by applying the factor analysis represent 73.4% of the total change in mass and 71.7% of dry matter content.

3. The results of the analysis could also assist breeders in successful selection of the source material for inclusion in the breeding programmes. Remarkable results could be obtained if the selection is done by considering traits explaining the highest percentage of total variability in the first and second major factor. They might be accepted provisionally as indicators of the selection of first and second level, and the others - of the third level.

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Analiza glavnih komponenti kolekcije žbunastog paradajza za preradu u IPGR, Sadovo – Bugarska

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Sažetak

Uspjeh programa za uzgoj paradajza uveliko zavisi od istraživanja početnog materijala kao i od ispitivanih simptoma i pojave njihove međuzavisnosti. Ovo istraživanje sprovedeno je tokom perioda 2008-2011. godine u IPGR, Bugarska. Predmet istraživanja bilo je 37 prinova paradajza za preradu sa ovalnim oblikom ploda. Kolekcija sadrži 11 lokalnih i 26 prinova stranog porijekla. Korištenjem faktorske analize putem metodologije PCA, otkrivena je veza između 15 ispitivanih morfoloških i biohemijskih parametara prinova i njihovih efekata na indikatore težine ploda i sadržaja suve tvari. Ispitivani parametri grupisani su u četiri opšta faktora koji su uticali na promjenu mase 73.4 %. Primjenom na sadržaj suve tvari, istim metodom su identifikovana četiri faktora sa ukupnim uticajem na ovu osobinu od 71.7%.

Ključne riječi: kolekcija paradajza, morfološke i ekonomske osobine, evaluacija, PCA

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Fish as a health food – ecotoxicological viewpoint

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Summary

Fish body metal (Cd, Pb, Zn, Cu, Al, Cr, Ni, Fe, Mn, Sr, Co) contents measurements, target organ and tissue distribution pattern analysis, bioaccumulation and biomagnification studies have been undertaken on a wide range of fish species belonging to various trophic levels within fish community from the Tikvesh reservoir in the R. Macedonia. The results of the current study indicated liver, kidney and gonads as target organs for metal accumulation and muscles as the tissue with the lowest concentrations of metal residues. Fish caught throughout 2006-2008 in the investigated area could be recommended as health food concerning metal burden as Macedonian alimentary standards for Cd and Pb in edible tissues have not been exceeded.

Key words: fish, metals, Tikvesh reservoir, R. Macedonia.

Introduction

In the past, a few accidental leaks of toxic waste into the hydro-ecosystems in the lower part of the Vardar River gave rise to discussions within the experts' community on possible threats to human health as a result of eating contaminated fish. With the help of some executive state agencies, fishing and fish trade were even prohibited on certain locations, which, ultimately as a consequence, unquestionably worsened the economic situation of the population directly involved in fishing as a source of their incomes and indirectly of the whole society as well.

This paper has not got any pretensions to give judgements on the grounds for making such a decision, nor to analyse the consequences and damages caused by these incidents. From an eco-toxicological aspect, the goal was to clarify some dilemmas on the actual exposure of people to possible metal poisoning via eating freshwater fish and to give an answer to the question whether fish really is health-safe food.

Materials and methods

The material for this research was collected in the lower part of the Vardar River in period 2006-2008. Dissection and preparation of samples were done following the standard procedure (US EPA, 1991, APHA, 1995). The concentration measurements of Cd, Pb, Cu, Zn and Al were performed on AAS, in fire, and Pb was checked on a graphite kivette. The results presented in this paper show the mean values (n+10) +-SD. Bio-accumulation was checked by linear progression of non-transformed results. Comparisons between the samples were done using independent t-test in two populations, and variance analysis using ANOVA. Statistical significance was allocated at p=0.05 or less.

Results and discussion

Fish are organisms that grow all their lives and for most of their species a linear or exponential relation between their age and weight/length can be established. The enumerated parameters were correlated with metal concentrations in the muscles and the livers of 20 barbus units *(Barbus meridionalis Risso)* 100-1720g in weight, 118-596mm in length and 0+ - 4+ years of age, taken from two locations (Demir Kapija and Gevgelija) in the lower part of the Vardar River. It is evident from Table 1 that for none of the metals analysed a significant positive correlation was established with the units' age, weight and length, in other words – these results confirm the current attitude (Spry and Wiener, 1991, Dietz *et al.,*1996, Carru *et al.,* 1996) that it does not come to progressive accumulation of Zn, Mn, Fe, Cu, Cr, Pb, Sr and Al together with ageing or growing, or that there are efficient mechanisms of detoxification or of elimination of accumulated metals in fish organisms. These results are encouraging from a health-care, but also from an ecological point of view, for they prove that commercial and bio-manipulation catch of fish for nutrition does not imply any risk increase and that it meets alimentary standards.

The analysis of accumulated metal tissue distribution is shown on the example of the gobio *(Gobio gobio Linnaeu)* from the location of Veles, the Vardar River which, based on a very high metal pollution Index (1.5), is characterised by Todorovic *et al.* (2000) as an ecosystem greatly polluted with metals.

The results (Table 2.) show that the musculature is definitively tissue with the lowest contents of accumulated heavy metals, within the limits of Macedonian alimentary norms, while the highest concentrations of metal residuum were observed in the liver and the gonads.

Tab. 1. Concentration correlation coefficients of Zn, Mn, Fe, Cu, Cr, Pb, Sr and Al in the muscles and livers vs. weight, length and age of 20 barbus units (Barbus meridionalis Risso)

Koeficijenti korelacije koncentracija Zn, Mn, Fe, Cu, Cr, Pb, Sr i Al u mišićnom tkivu i jetri nasuprot težini, dužini i starosti 20 barbus jedinica (Barbus meridionalis Risso)

	Muscles			Liver		
	Weight	Length	Age	Weigh	Length	Age
Zn	0.46	0.51	0.38	-0.54	-0.66*	0.69*
Mn	-0.87*	-0.7*	-0.42	-0.34	-0.48	-0.54
Fe	0.006	0.16	-0.4	0.36	0.52	0.51
Cu	-0.72*	-0.78*	-0.85*	-0.14	0.009	0.009
Cr	0.41	0.34	0.39			
Pb	0.05	0.16	-0.38	-0.63*	-0.64	-0.52
Sr	0.08	0.03	0.31	-0.42	-0.55	-0.6
Al	0.29	0.3	0.07	-0.33	-0.22	-0.14

Tab. 2. Distribution of accumulated metals in the tissues and the organs of gobio (Gobio gobioion Linnaeus) from the location of Veles of river Vardar

Distribucija akumuliranih metala u tkivima i organima gobio (Gobio gobioion Linnaeus) na lokaciji Veleš rijeke Vardar

	Zn	Mn	Cu	Cr	Cd	Ni	Pb	Al
Muscles	7.68 +- 2.22	1.28 +- 0.59	0.7 +- 0.19	0.52 +- 0.2	0.01	-	0.87 +- 0.1	9.15 +- 1.21
Gills	24.28 +- 3.39	4.66 +- 0.86	1.44 +- 0.25	1.53 +- 0.33	0.13 +- 0.03	0.23 +- 0.07	1.05 +- 0.5	11.34 +- 3.45
Gonads	63.26* +- 5.74	2.04 +- 1.33	2.73 +- 1.87	3.15* +- 1.08	-	-	1.88 +- 0.2	32.13* +- 13.3
Liver	21.39 +- 9.06	1.05 +- 0.46	1.32 +- 0.41	0.75 +- 0.07	0.26* +- 0.06	0.36 +- 0.2	4.02* +- 2.6	15.12 +- 6.34

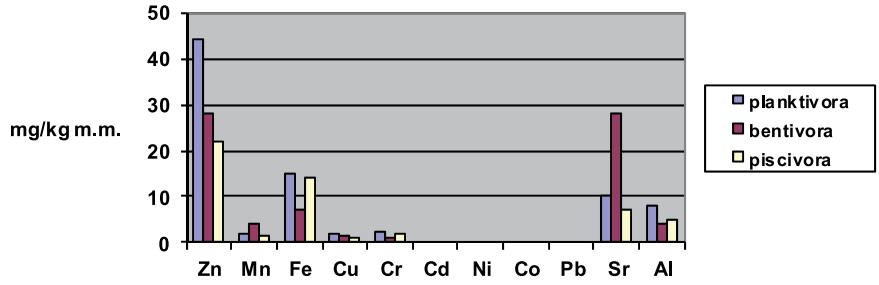
n=10; concentrations stated as mg/kg undrained (fresh) mass (i.e. weight); - below detection limit

*statistically significant the most (one-way ANOVA, p=0.05 or less)

These results are in accordance with conclusions of many authors (Salanki et al., 1982, Stripp et al., 1990, Berningen and Pannanen, 1994) that the liver and kidneys are the target organs for the accumulation of metals in fish, which is explained with efficient regulatory mechanisms: elimination via faeces (Berningen and Pannanen, 1994), high metallothionein concentrations (which efficiently bind Cd and Pb thus serving as detoxificators) in the liver and kidneys, low affinity of SH muscle fibre groups to Pb and the fact that in fish, as well as in humans, only 1-

6% Cd and up to 10% of other metals resorbed via bowel mucous reaches muscles (Ohti and Chtenior, 1991). Spry and Wiener (1991) even draw a conclusion that, unlike methyl-Hg, Pb and Cd do not accumulate in the skeletal musculature in significant concentrations, therefore contamination of fish with these metals presents no particular risk to human health.

From a health aspect, it is very important to establish whether bio-magnification of metals occurs in the alimentary chains within the hydro-ecosystem, or whether the residuum accumulates progressively from lower towards higher trophic categories.

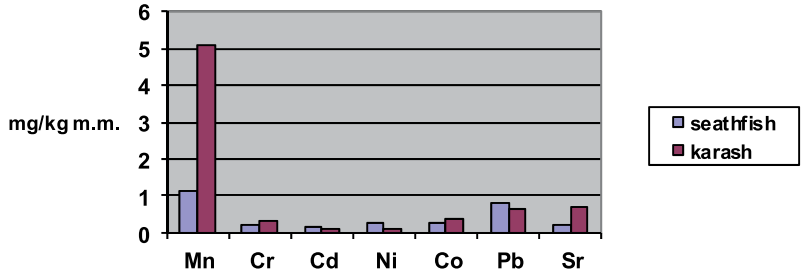


Graph. 1. Comparative review of the contents of metals in the musculature of a planctivore – plaska (Alburnus alburnus), bentivores – barbbel (Barbus barbuss Linnaeus) and black mrena (Barbus meridionalis Risso),and a piscivore – seathfish (Silurus glanis Linnaeus), from the location of Pepeliste from the river Vardar
Komparativni prikaz sadržaja metala u muskulaturi planktivora – uklija (Alburnus alburnus), bentivore – mrena (Barbus barbuss Linnaeus) i crna mrena (Barbus meridionalis Risso) i pisivore – som (Silurus glanis Linnaeus), sa lokacije Pepelište iz rijeke Vardar

N=10 (5x2); all the concentrations expressed as *mg* of metal per *kg* undrained fish mass
*statistically significant the most (one-way ANOVA, p=0.05 or less)
**the actual statistical values are: Zn: 50.5* / 37 / 26; Mn: 3 / 4.5* / 2.5; Fe: 16.5 / 9 / 25; Cu: 2.5 / 2 / 1; Cr: 3.5 / 1 / 3; Sr: 12 / 36* / 8; Al: 12* / 7 / 8

Special interest for such examinations without doubt also lies in the fact that a great number of economically and nutritionally most attractive species belong to the piscivores, which are on the top of the ichthyofauna's trophic pyramid.

Graph. 1. and Graph. 2. give a comparative review of the contents of accumulated metals in the muscles and livers of fish that belong to various trophic levels. It can be clearly seen that for none of the examined metals a statistically significant concentration increase within the alimentary chain was established, which is in accordance with numerous literature data (Pujin *et al.,* 1990, Maletin *et al.,* 1996, Dietz *et al.,* 1996, Djukic *et al.,* 1998). It is evident that the explanation lies in the biology and ecology of the species from different trophic categories. Namely, in the hydro-ecosystems where pH value ranges around 7, the most divalent cations precipitate and in that way they are temporarily immobilised in the sediment. Since pH values of water in the lower part of the Vardar River vary just within the range 7-8 (Hydrological annuals 1997, 1998, 1999), the bentivore species are exposed to heavy metals via gill filtration, exclusively the contact layer of water in which they live, but also via direct mobilisation of metals from the sediment (Davis *et al.,* 1997). Laboratory examinations (Vighi, 1981, Memmert, 1987) showed that fish resorb Pb, Cd, Ni, Zn and methyl Hg directly from water, far more than from contaminated food.



Graph. 2. Comparative review of the contents of metals in livers of seathfish (Silurus glanis Linnaeus) and karash (Carassius carassius Linnaeus) from the location Demir Kapija of river Vardar
Komparativni pregled sadržaja metala u jetri soma (Silurus glanis Linnaeus) i karaša (Carassius carassius Linnaeus) sa lokacije Demir Kapija na rijeci Vardar

n=10 (95x2); all the concentrations expressed as mg of metal per kg fresh (undrained) fish mass;
*statistically significant the most (one-way ANOVA, p=0.05 or less)
**the actual statistical values are: Mn: 1.2 / 6.7*; Cr: 2.5 / 3; Cd: 2 / 1; Ni: 3 / 1; Co: 3 / 4; Pb: 8/ 6.5; Sr: 1.5 / 7*

According to Macedonian regulations (Official Gazette of RM, 1992), metal MACs in edible parts of fish were specified, but only for As, Pb, Cd, Hg and methyl Hg. In the period 2006-2008, around 500 muscular samples of various fish

species collected on 16 locations of the Vardar River were analysed. Only 25 samples (mostly of bentivore species) exceeded MAC for Pb (l mg/kg fresh mass), while 35 of them exceeded MAC's half (0.5mg/kg fresh mass), about 10% of all the samples. However, none of muscular samples contained Cd concentrations higher than MAC (0.1mg/kg fresh mass). Moreover, in about 400 samples, Cd concentrations were below the detection limit (0.015mg/kg fresh mass). Such data are in accordance with the results of systematic monitoring of the surface waters (Hydrological annuals 1997, 1998, 1999) according to which MAC excess of Pb (0.1mg/l) and Cd (0.01mg/l) for III-IV water classes was not noticed in the examined period on any location of the Vardar River (Official Gazette of RM, 31/82, 1982).

Conclusion

Based on all the aforementioned, we can make a conclusion that freshwater fish, especially predators, are health-safe food from the aspect of heavy metal pollution providing that only muscles are to be used for human nutrition.

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Riba kao zdrava hrana – sa ekotoksikološkog stanovišta

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Sašetak

Mjerenje sadržaja metala (Cd, Pb, Zn, Cu, Al, Cr, Ni, Fe, Mn, Sr, Co) kod riba, analiza širenja u ciljanim organima i tkivima, istraživanja vezana za bioakumulaciju i biomagnifikaciju sprovedena su na velikom nizu ribljih vrsta koje pripadaju različitim trofičkim nivoima unutar ribljih zajednica iz Tikveškog akumulacionog jezera u R. Makedoniji. Rezultati ovog istraživanja ukazali su na jetru, bubrege i polne žlijezde kao ciljane organe za nakupljanje metala i mišiće kao tkivo sa najnižom koncentracijom ostataka metala. Riba ulovljena u toku 2006-2008. godine u istraživanom području mogla se preporučiti kao zdrava hrana s obzirom na sadržaj metala pošto makedonski prehrambeni standardi za Cd i Pb u jestivim tkivima nisu bili prekoračeni.

Ključne riječi: riba, metali, Tikveško akumulaciono jezero, R. Makedonija.

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Compariosn of three Chardonnay clones (*Vitis vinifera* L.), growing in Skopje'vineyard region, R.Macedonia

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Summary

Some agro-biological and technological characteristics were determined for three Chardonnay clones selections, including 95, 124 and 277, cultivated in the Skopje vineyard region, the R. Macedonia (during the period from 2006 to 2008). A certificated seedling material was introduced from France in 1999/2000, cultivated and studied at the vineyards of the Department of Viticulture and Oenology, Institute of Agriculture, Skopje. The aim of the study was to apply optimal agro-technical and ampelotechnical measures and to compare characteristics of the three Chardonnay clones (95,124,277) cultivated in the same agro-ecological conditions. Different values of the examined characteristics were observed because of the selection specification as well as the ecological conditions during the period of the study. It was found that the yield was most stable for the clone 277 with a coefficient of variable 14.4, and the biggest variation of 21.7 was noticed for the 124 clone. Considering the chemical composition, more significant variation was observed for sugar content in the grape must from the clone 277, while insignificant variations were noticed for total acids in the must of all clones studied. The content of alcohol in the wines ranged from 12.88 vol% in the clone 277 to 13.95 vol% in the clone 95 for the examined period, thus insignificant variations were found in the three clones. Wines from all three clones for the vintage 2006 had greater contents of total extract and, for the examined period, wines with most extract for the clones 95 (21,30 g/L) and 277 (21,20 g/L). The wine made from the 277 clone was with the highest wine-tasting rating of 17.97 points.

Key words: Chardonnay, clones, yield, wine, degustation rating

Introduction

In the last 10 years, the vineyards in the R. Macedonia were being rebuilt, and the assortments with certified planting material with clones of more qualitative varieties such as Chardonnay, Sauvignon White, Traminer, Merlot, Cabernet Sauvignon, Cabernet Franc and others were being improved. Studying of clones and getting a more realistic understanding of their agro-biological and technological characteristics are of great importance for the legitimacy of their breeding and further expansion. The clones of one variety differ from the population in better features of the grape and better quality of wines obtained (Michael M. Anderson et al., 2008). Thus, clones differ in some properties, such as yield, mass of the cluster, sugar content, total acids, which are mostly the result of varietal specificity and less of the impact of cultivation conditions (ENTAV-INRA, 1995). The selected clones of the Chardonnay variety, characterised by higher yield and clusters with greater mass, give lower quality of wine compared to the lower-yielding clones of Chardonnay (Simon Cowham, 1999). From a great number of Chardonnay clones, wines with distinctive fruit aroma, higher content of extract, etc. are produced in France (ENTAV-INRA, 1995), Italy (Calò, Antonio, Angelo Costacurta, 1990), Australia (Michael M. Anderson at al., 2008) and other countries.

Materials and methods

Three French clones (95, 124 and 277) were cultivated in the same agro-ecological conditions with application of regular agro-technical and ampelo-technical measures. The seedlings were raised in 2000 with certified antivirus material from France. The process of cultivation was a fruit-wall with two legged Guyot way of pruning, 2.5m planting distance between the lines and 1.3m between the grapevines in line with an optimal strain of 22 buds by grapevine. During vegetation, regular agro-technical and ampelotechnical measures were applied. 30 grapevines of each clone were included in the studies (three repetitions of 10 grapevines). The yield of grapevine per ha was determined as a representative parameter of the agro-biological and technological characteristics. The chemical composition of must (content of sugar and total acids) and the quality of the wine were studied through chemical composition and wine-tasting.

The yield of 30 grapevines by 1ha was mathematically calculated. The content of sugar in the must was determined by using Oechsle Scale and the composition of total acids was determined by titration method using solution of N/4 NaOH with factor 1.0000.

As for wine production, grapes were harvested at technological maturity from each clone separately and transported to the Institute of Agriculture, Skopje, the R. Macedonia. The must from grapes was sulphated with 80 mg/l liquid SO_2, and then selected wine yeast, *Saccharomyces cerevisiae*, was added. After turbulent fermentation, wines were collected in glass balloons wherein the alcoholic fermentation finished. The temperature during the alcoholic fermentation was 19-21 ^{0}C. The wines produced using these procedures were poured off 2 times, and during every

pouring off, a correction of SO_2 was done in order to keep it not lower than 25 mg/L free SO_2 and not higher than 80 mg/L total SO_2. The chemical analysis of the wine was done after the second pouring off and recommended methods of O.I.V (International organization of vine and wine) were used. To determine the wine specific weight, alcohol and dry extract, a pycnometer method was used. The organoleptic grade of wines was performed by application of Buxbaum method of twenty points (Standard ISO 5495, 1983).

Results and discussion

Yield is an important agro-biological characteristic that depends on agro-ecological conditions and substrate, but especially on the genetic potential of a variety. Table 1 shows the results of a quantity of handpicked grapes of the examined Chardonnay clones. Under the same conditions of cultivation, during the test period 2006/2008, the highest average yield was obtained with clones 95 (3.840 kg/vine) and 277 (3.830 kg/vine) and with the greatest stability over years, with a coefficient of variation of 14.4. In those years, the greatest variation was found in clone 124 (21.7) and it was characterised by the lowest average yield of 3.620 kg/vine.

Tab. 1. Yield of grape kg/vine
Prinos grožđa kg/čokot

Clones	2006	2007	2008	2006/2008	CV%
95	3.820	3.164	4.525	3.840	17.7
124	2.806	3.680	4.375	3.620	21.7
277	3.783	3.304	4.404	3.830	14.4

The content of sugar and total acids and their ratio are among important parameters based on which the quality of one variety or clone is assessed. The results for the sugar content and total acids in the must are presented in Table 2. Compared by years, the sugar content in the must in all clones was quite stable with the coefficient of variation from 7.0 (clone 95) to 10.2 (clone 124).

Tab. 2. Content of sugar and total acids in the must (g/L)
Sadržaj šećera i ukupnih kiselina u širi

Clones	2006		2007		2008		2006/2008		CV%	
	sugar	TA	sugar	TA	sugar	TA	sugar	TA	sugar	TA
95	223	7.9	232	6.7	202	6.8	219	7.1	7.0	7.4
124	194	7.3	235	7.1	231	6.4	220	6.9	10.2	6.8
277	202	8.1	236	7.7	236	6.7	224	7.5	8.7	9.6

Legend: T/A – total acids, CV%- variation factor

During the study period, the average sugar content ranged from 219 g/L (clone 95) to 224 g/L (clone 227), which enabled production of medium strong wines. Freshness of the wines depends on the content of total acids in the must. The average content of total acids ranged from 6.9 g/L (clone 124), 7.1 g/L (clone 95) to 7.5 g/L (clone 277). No significant changes of the content of total acids in the must of all clones were observed during the period of three years. The coefficient of variation ranged from 6.8 for the clone 124 to 9.6 for the clone 277.

The results of chemical analysis of wines made from the examined clones are presented in Table 3. There were small changes of the alcohol content in the wines produced from different clone vintages. The average content of alcohol ranged from 12.88 vol% (clone 124) to 13.66 vol% (clone 277) to 13.95 vol% (clone 95). No significant changes of the content of alcohol in the wine of all clones were observed during the period of three years. The coefficient of variation ranged from 0.70 for the clone 124 to 5.15 for the clone 277. This is due to different sugar contents in the must and completed alcoholic fermentation. In addition, the sugar-free extract (dry extract) in wine is a characteristic parameter for each variety. In the period of study, values for the dry extract ranged from 20.2 g/L in the wine made from clone 124 (2006/08) to 21.3 g/L in the wine made from clones 95 and 277 (2006/08). Wine-tasting evaluation of wine is one of the main features, and together with chemical analysis, it determines the quality of wine. Wine-tasting points of the examined wines are given in Table 3 and presented in Graph 4. Average wine-tasting grades ranged from 17.3 for the wine from clone 124 to 17.97 points for wines from clone 277. In the years of testing, wines from all Chardonnay clones were characterised by high stability assessment, i.e. the coefficient of variation ranged from 0.85 for clone 277 to 2.89 for clone 124.

Conclusions

The yield results, sugar content and total acids in the must, alcohol content, content of dry extract in wine and wine-tasting assessment, and their balance during the examination period are characteristics that distinguish the Chardonnay clones 277 and 95 from the clone 124. With these clones, we will improve the quality of white wines in the R. Macedonia along with usage of proper technology.

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Poređenje tri *Chardonnay* klona (*Vitis vinifera* L.), gajena u vinogradarskom regionu Skoplje, R. Makedonija

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Sažetak

Tokom perioda 2006-2008. godine određene su neke agrobiološke i tehnološke karakteristike tri odabrana *Chardonnay* klona, uključujući 95, 124 i 277, koji se uzgajaju u vinogradarskom regionu Skoplje, R. Makedonija. Sertifikovani sadni materijal uveden je iz Francuske 1999-2000. godine, koji je obrađivan i ispitivan u vinogradima Odsjeka za vinogradarstvo i enologiju, Poljoprivrednog instituta u Skoplju. Cilj istraživanja bio je da se primijene optimalne agrotehničke i ampelotehničke mjere i da se uporede karakteristike tri *Chardonnay* klona (95, 124 i 277) gajena u istim agroekološkim uslovima. Uočene su različite vrijednosti ispitivanih karakteristika zbog selekcione specifikacije kao i ekoloških uslova tokom perioda istraživanja. Ustanovljeno je da je prinos bio najstabilniji za klon 277 sa koeficijentom varijable 14.4, a najveća varijacija od 21.7 uočena je za klon 124. Uzimajući u obzir hemijski sastav, značajnija varijacija uočena je za sadržaj šećera u širi za klon 277, dok su neznatne varijacije uočene za ukupne kiseline u širi svih ispitivanih klonova. Sadržaj alkohola u vinima je od 12.88 vol% za klon 277 do 13.95 vol% za klon 95 za ispitivani period, a neznatne varijacije su otkrivene za sva tri klona. Vina za sva tri klona za berbu 2006. bila su sa većim sadržajem ukupnog ekstrakta, a za ispitivani period vina sa najviše ekstrakta su bila od klona 95 (21,30 g/L) i 277 (21,20 g/L). Najvišu ocjenu degustacije vina od 17,97 bodova dobilo je vino napravljeno od klona 277.

Ključne riječi: *Chardonnay*, klonovi, prinos, vino, ocjena degustacije

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Research of origin and work on clonal selection of Montenigrin grapevine varieties cv. vranac and cv. kratosija

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Summary

Viticulture production and winemaking of Montenegro are mostly based on growing of autochthonous grapevine varieties. Besides Vranac variety, Kratosija variety takes a significant place in Montenegrin autochthonous grapevine varieties. According to many literature data, Kratosija is an autochthonous grapevine variety whose origin and cultivation started earlier than with Vranac variety. Because of its heterogeneity, it is not so much represented in Montenegrin vineyards and it is mostly found in combination with Vranac variety. The research results about the origin of Vranac variety are shown in this paper. Furthermore, genetic identification which approved originality of Vranac variety is shown and it has also been approved that autochthonous variety Kratosija has the same genetic profile as cv. Zinfandel. The paper presents multi-annual results of examination of variability of their populations and work on clonal selection. Mother vines were selected and vineyards of pre-base and base category of Vranac variety potential clones were planted. The results achieved, in view of manifesting agro-biological, economic and technological characteristics, point to the need for further work on clonal selecton of these grapevine varieties.

Key words: origin, population variability, vranac, kratosija, clonal selection

Introduction

Vranac i Kratosija (Zinfandel) are the most important grapevine varieties for production of red wines in Montenegro. Vranac wine became a national brand as well as the most recognizable and the best product of the “13 jul Plantaze“ Company. A group of experts of Milan's weekly magazine “Il mondo” ranked Vranac wine among the 100 best red wines of Europe in 1991.

Kratosija is a Montenegrin autochthonous variety for production of red wines, grown for centuries in Montenegro, which falls into the category of

recommended varieties for quality wine. According to many literature data, Kratosija appeared earlier and was introduced into cultivation quite earlier than Vranac. It is known that old varieties show heterogeneity in terms of expression of their properties which leads to gradual degradation of the variety and emergence of a number of biotypes within the population with noticeable differences. In contrast to Vranac, which has stable morphological characteristics and has undergone expansion in recent years and become the main grape variety for red wines, not only in Montenegro, but also in neighbouring countries (Herzegovina, Macedonia, Dalmatia), Kratosija is a heterogeneous variety with a number of biotypes.

The research was conducted in order to gather all available literature data on the origin and growing tradition of Vranac and Kratosija in Montenegro. With exploration of the total variability of populations of these varieties and values of certain biotypes and with selection of the best vines within them (vines that stand out with high yield, grapes quality, good habit, which are visually healthy and not infected by viruses), the work on clonal selection of these varieties has started. To increase the production of grapes and improve agrobiological, economic and technological characteristics of grapevine, the methods of individualised selection and clonal selection are being applied increasingly along with hybridisation.

Materials and methods

The work on selection of Montenegrin autochthonous varieties was done in two phases. The first phase of the research was implemented until 2004 on the experimental field of the Biotechnical Institute in Podgorica. It included the study of population variability of Kratosija variety, collection of its biotypes which differ and are grown all over Montenegro under various names and synonyms (Ulicevic 1966, Pejovic 1988). All collected biotypes under original name (Kratosija Velja, Kratosija Mala, Kratosija, Kratosija Srednja, Crni Krstac, Ljutica, Vrancina, Vran, Vranac, Vrancic, Kratosija with deep notches, Velji Vranac, Srednji Vranac, Kratosija or Vran, Bikaca, Cestozglavica, Rehuljaca) were planted on the experimental field in Ljeskopolje, on the rootstock K 5BB, grown in the same shape of trunk (double horizontal cordon) and the same conditions. In continuous research throughout the period 1996-2004, out of each biotype of Kratosija, 10 vines of every biotype were studied. Vines were pruned in the shape of double horizontal cordon, with the load of 24 buds per vine and 9.6 buds per m^2 of surface, respectively. Every vine represents one repetition. Quality of grapes and wine in Kratosija biotypes (number of bunches, weight of a bunch, length and width of a bunch and a berry, content of sugar and acids in the must as well as organoleptic score of wines produced from the studied biotypes of Kratosija) were monitored. Statistical analysis was performed so as to analyse variance for two-factorial experiment. Significance of differences was determined by LSD test on the level 0.05 and 0.01. The second phase of work on clonal selection included studies in the period 2004-2011. The research was conducted at Cemovsko field, on the vineyards of the “13. jul Plantaze“ Company.

By visual observation of the variety population during the growing season, vines that stood out by their characteristics were selected. The sanitary status of the population was analysed by ELISA, PCR and indexing. Testing on viruses was conducted on 145 vines of Vranac variety and 31 vines of Kratosija variety. As regards Vranac population, 5 vines passed the complete sanitary control. Selected vines that passed sanitary control were propagated and planted in the nematode-free soil. During 2009 and 2010, all potential clones and variety population were observed and their agrobiological, economic and technological characteristics were compared. The quality of wines of potential clones was examined by applying standard methods and wine was produced in the microvinification cellar of the "13 jul Plantaze" Company.

Results and discussion

Research of Vranac and Kratosija

The old autochthonous Montenegrin grape varieties Vranac and Kratosija have been researched and described by many authors. M. Plamenac (1891) points out that Crmnica's wine is the best in Montenegro and can be compared with wines from Bordeaux. Jergovic (1892) in his publication in ‘’Montenegrin Voice’’ states that wine from Crmnica was made from Vranac and Kratosija, and it stood out by its quality. The first remarkable description of Kratosija variety was made by Petar Plamenac in the Ampelography Viale and Vermonela (1910). According to the documents of the Ministry of Internal Affairs of the Principality of Montenegro dating from 1905, description of Kratosija variety was made by M.Vujovic and P.Vojvodic. Stojanovic (1929) points out that Montenegro has vineyards. As for production of red wines in Montenegro, the author lists varieties Vranac and Kratosija. Also, he points out that the best vineyards in Montenegro are situated in Crmnica which is famous for the red wines that can reach high quality, while wines produced on Montenegrin coast are similar to wines from southern Dalmatia. Bulic (1949) gives broader ampelographic description of Kratosija (Grtosija, Grakosija and Kratkosija) from nine municipalities on Montenegrin coast, pointing out that "something" is present in Dalmatia, that is planting in Herzegovina and Montenegro and "that presumably came from these regions to Dalmatia".

Ulicevic (1959) states that characteristic variety of Crmnica viticultural area is Vranac, covering about 40% of the assortment of grape varieties. It is in proper sense a variety of Crmnica. The other variety which is almost as remarkable is Kratosija. Regarding the fact that it prevails in all vineyards older than 60-70 years, that its share is often 90% of the assortment of the grape varieties in other viticultural areas of this sub viticultural area and that it is grown in coastal and older plantations more, it may be concluded that it is the leading and probably the oldest Montenegrin variety. It is from both these varieties that the most appreciated and famous Crmnica’s red wine is made. They represent our autochthonous and original material for the production of high quality red wine since they have not been grown outside Montenegro, except perhaps, in the assortment and trial plantations. The

author claims that the oldest and most spread Californian variety Zinfandel is identical to our Kratosija. Its origin has not been determined, so it is most likely that it originates from these areas, where our emigrants could carry it. Ulicevic (1966) stated that the growing area was not wider than 30 km for Vranac and 100-150 km for Kratosija fifty-sixty years ago. Thus, Ulicevic states three types of Kratosija: Obicna Kratosija (Srednja Kratosija, Srednji Vranac, Ljutica), the type which has the greatest bearing potential and which is the most spread and of the greatest importance, Slabo Rodna Kratosija – the type you may find with the synonyms: Black Krstac, Vranj, Krstac, Vrancina which bears irregularly and the third type of Rehuljava Kratosija (Rehuljaca) - which has a morphologically regular flower but bears very loose clusters. Prof. D. Nastev (1967) states that Vranac variety (synonyms: Vranac Crnogorski, Vranac Prhljavac) is a Montenegrin variety, spread in Crmnica and on the Montenegrin coast. It was transferred to Macedonia and planted in 1950 in the trial field (Butel) first for the research under their conditions and, later, it expanded. Cetkovic (1975) states that Vranac and Kratosija are grown in the basin of Lake Skadar where very good quality wines are made. Zirojevic (1979) states that Vranac is an autochthonous variety that probably appeared by natural crossing from seeds. It is mostly represented in the basin of Lake Skadar, but lately, it has spread to Macedonia. According to Pejovic (1988), Kratosija in Crmnica, depending on the properties, is known as: Velja (big), Srednja (middle) and Mala (small), while in other viticultural areas of Montenegro, it is known as: Crna Vinogradarska, (Beri & Doljani), Crna Gorska, Srednji Vranac, Vrancina (Ljesanska & Rijecka ahija), Krstac, Vranja, Krstan, Ljutica (in Zagarac), etc. Based on the Project results in the period 1985/89/90, the author classified Kratosija into four basic variants, as follows: Velja Kratosija, which depending on the area from which it originates, has the synonym, namely, the assimilated title: Velji Vranac, Vran Krstan, Crni Krstac, Vrancina and Bikaca; - Srednja Kratosija, which has the title Middle Vranac, Vrancic, Ljutica, Obicna Kratošija, Cestzglavica; Mala Kratosija which has petty clusters and more balanced grape ripening; Rehuljaca, represented to a lesser degree and may be found as single grapevines within other variants and it has loose clusters. Avramov (1988) states that Vranac and Kratosija are autochthonous grapevine varieties of Montenegro. According to this author, Kratosija can be found under different names – synonyms such as: Gratosija, Grakosija, Kratkosija, Kratkosica and similar. A lot of clones were noticed within the variety. As for Kratosija, Cindric (1994, 2000) states that Vranac and Kratosija are autochthonous Montenegrin varieties and Kratosija is susceptible to grey rot and gathers less sugar and more acids in the grapes compared with Vranac variety. As for Buric (1995), Kratosija is an autochthonous grapevine variety of Montenegro, grown in Montenegro. Blended with Vranac, it is used for production of quality wines. These varieties complement each other perfectly- Kratosija always has more total acids in the grapes (sometimes sugar, as well) and Vranac has more colloidal substances. Bozinovik (1996, 1998) points out that Kratosija gives grapes for production of quality red wines. He recommends blending it with Vranac in the amount of 5%. He also states the existence of three variants of Kratosija: Kratosija Standard, Kratosija Rehuljava and Kratosija Neoplodjena. Vesna Maras (2000) has

classified 17 studied synonyms of the Kratosija variety into three variants-biotypes of Kratosija: Velja Kratosija, Srednja Kratosija and Rehuljaca. Milosavljevic (2008) states that Vranac is an auchthonous Montenegrin variety grown for centuries in Montenegro, adding it is likely that the crossing occurred spontaneously or as a result of spontaneous mutation. Except in Montenegro, it is grown in Herzegovina, Dalmatia, Macedonia and Metohia.

Genetic identification of varieties

As a result of cooperation between the "13. jul Plantaze" Company and Italian partners (Instituto sperimentale per la viticulture Susegana-Conrgliano TV), genetic identification of autochthonous Montenegrin vine varieties has been done. Originality has been confirmed for Vranac, Krstac and Zizak. Analyses have showed that Montenegrin autochthonous variety Kratosija has an identical genetic profile as Zinfandel from California, Primitivo from Italy and Crljenak Kastelanski from Croatia (Callo *et al.* 2008). In the same study, a DNA analysis showed a close relationship between Vranac and Kratosija and that there is the first level of relation (the closest relation).

Bearing in mind the importance of autochthonous varieties and exciting of germplasm for vine-growing and wine-producing sector of Montenegro, international projects are also implemented with the aim of identification of autochthonous varieties and other domesticated grapevine varieties, testing the variability of their population along with preservation and protection our genetic resources. All these activities are implemented through the following projects: SEEDNET project (2009-2010): “Identification, characterisation and conservation of old and autochthonous vine varieties in Eastern European countries”; SEERA NET 91/01 Project: “Preservation and establishment of true-to-type and virus free material of endangered grapevine cultivars in Croatia and Montenegro” and COST action: “East-West Collaboration for Grapevine Diversity Exploration and Mobilization of Adaptive Traits for Breeding”.

Work on clonal selection of varieties

I phase - In order to investigate variability of Kratosija variety population and values of certain biotypes in the period of 1996/1998, 17 varieties-biotypes of Kratosija were collected on the experimental field of the Biotechnical Faculty (Maras 2000, 2004).Within these biotypes, the best vines (based on the number of bunches, weight of a bunch, yield of grapes, vine productivity and quality of grapes) were selected. They served as the endpoint mother plantation for further propagation and studies (Tab. 2). The selected vines were propagated and planted on the Experimental field of Biotechnical Institute in 2000-2004. In that period, classified vines were tested on viruses and showed high level of infection so they did not pass ELISA and PCR tests (18 vines including the selected vine from the population: 8 vines (44.44%) were infected with LR1+LR3; 6 vines (33.33%) with GVA+LR3; 2 vines (11.11%) with FL+GVA+LR3 and 2 vines (11.11%) with LR1.

In the period of 2004-2011, along with genetic identification, we started the second phase of the selection of our autochthtonous grape varieties.

By visual observation during the year, vines with emphasised yield, quality and good vegetative potential were selected from the population and subjected to sanitary control ELISA, PCR and indexing. Testing on viruses was conducted on 145 vines of Vranac variety and 13 vines of Kratosija variety. Most samples of Vranac variety were infected - 55 vines (37.93%) by LR3 and 45 vines (31.03%) with GVA+LR3. The vines were not infected with AR. The presence of virus with ELISA test was not identified in 17 vines (11.72%). The vines which passed sanitary control by ELISA test were tested with PCR. Out of 17 tested vines, 5 vines (29.41%) were infected with RSP and the same percentage (29.41%) with RSP+NN. Out of the total number of tested samples (17), 4 samples (23, 53%) passed PCR and indexing and virus was not identified. They represent very useful material which entered the process of individual clonal selection. Out of 13 tested vines of Kratosija variety, none passed sanitary control.

Tab.1. Quality of grape and wine of kratosija biotypes (average for 1996-1998)
Kvalitet grozdja i vina biotipova kratosije (prosjek za 1996-1998)

Biotip (A)	Broj grozdova	Masa grozda (g)	Dužina grozda (cm)	Širina grozda (cm)	Dužina bobice (mm)	Širina bobice (mm)	Prinos po čokotu (kg)	Udio šećera (%)	Udio kiselina (g/l	Organoleptička ocjena vina
velja kratošija	16.30	332.23	18.66	11.72	14.54	15.05	5.44	21.67	7.37	17.50
velji vranac	34.77	188.00	18.21	11.40	14.52	14.86	6.48	22.13	6.83	17.36
crni krstač	16.90	290.30	18.14	11.65	14.68	14.58	4.84	22.03	6.77	17.39
vrančina	14.33	290.94	19.16	12.53	15.82	16.10	4.17	21.00	6.83	17.06
bikača	17.93	262.45	16.03	9.76	15.48	15.56	4.62	22.83	7.07	17.48
vran	12.90	302.53	18.39	11.65	15.36	15.16	3.85	23.47	7.03	17.70
srednja kratošija	19.07	274.08	17.51	11.72	15.39	14.96	5.30	21.87	6.93	17.13
kratošija ili vran	18.43	292.66	18.03	11.14	14.58	14.68	5.36	21.93	7.53	17.33
srednji vranac	26.67	229.09	18.29	11.60	13.84	13.73	5.97	20.40	7.30	17.27
vranac	12.47	418.73	18.88	12.54	14.72	14.55	4.61	21.33	7.20	17.29
vrančić	17.77	304.93	19.79	13.89	11.97	11.93	5.47	20.23	7.67	17.07
ljutica	17.00	260.73	19.02	12.55	12.60	12.54	4.27	20.03	7.80	16.93
kratošija	16.37	284.58	18.33	11.59	14.29	14.22	4.58	21.77	6.53	17.70
čestozglavica	20.83	297.72	18.89	11.97	14.02	14.05	5.37	21.63	6.63	17.26
kratošija mala	17.83	317.55	17.18	12.08	13.11	12.94	5.63	21.43	6.97	17.19
krat.sa dub. urez.	14.83	277.39	18.38	11.58	13.65	13.65	4.15	21.77	7.40	16.87
rehuljača	26.10	118.48	18.11	8.72	11.98	12.12	2.92	17.10	7.80	16.62
X	19.03	278.96	18.29	11.65	14.15	14.16	4.89	21.33	7.16	17.24
Godina I (B)	12.17	292.22	18.30	11.71	14.73	14.71	3.21	22.26	6.84	
Godina II (B)	18.49	272.96	18.35	11.74	14.06	14.13	4.69	21.66	7.05	
Godina III (B)	25.90	271.71	18.23	11.51	13.66	13.64	6.75	20.08	7.59	
(A) LSD 0.05 0.01	3.20 4.20	33.25 43.69	1.36 1.80	1.13 1.49	0.84 1.11	0.85 1.13	0.91 1.20	0.93 1.26	0.58 0.78	
(B) LSD 0.05 0.01	1.34 1.75	13.97 18.35	0.57 0.76	0.48 0.62	1.34 1.75	13.97 18.35	0.38 0.51	0.39 053	0.24 0.33	
(AxB) LSD 05 0.01	5.54 7.28	57.58 75.67	2.36 3.12	1.96 2.58	5.54 7.28	57.58 75.67	1.58 2.08			

The separated vines of Vranac population that passed sanitary control (ELISA, PCR, indexing) were propagated and planted in 2008 and 2009 at the locality ''Nikolj Crkva'' (the soil passed control on the presence of nematodes). Propagated mother vines were planted and plantation of pre-base category which would serve for the studies of potential clones and their recognition of clones was formed. After the first crop during 2009 and 2010, all potential clones and the

variety population were observed and their agrobiological, economic and technological characteristics were compared. Processing of grape and wine making using potential clones were done in a microvinification cellar of the "13 jul Plantaze" Company. Produced wines were analysed and their sensory assessment was done. They surpassed the population of the variety by the quality of wine. In table 3, two-year results of grapes and wine quality for clones candidates are compared with the variety population.

Tab.2. Selected vines within studied biotypes (average for 1996-1998)
Odabrani cokoti unutar ispitivanih biotipova (prosjek za 1996-1998)

Biotype	Selected vine num.	Number of bunch	Weight of bunch (g)	Yield of grape (kg)	Weight of pruned vine (kg)	Productivity of vine (kg)
velja kratošija	10	21.00	456	9.60	1.13	10.73
velji vranac	6	38.33	238	8.94	1.96	10.90
crni krstač	9	22.00	313	6.74	0.88	7.62
vrančina	5	18.67	290	5.60	1.44	7.04
bikača	8	21.33	364	7.60	1.26	8.86
vran	8	18.33	299	5.65	1.40	7.05
srednja kratošija	8	25.00	310	7.74	0.98	8.72
kratošija ili vran	10	24.33	260	6.52	0.69	7.21
srednji vranac	3	34.33	220	7.53	1.25	8.78
vranac	9	16.33	408	6.09	1.20	7.29
vrančić	2	25.00	324	8.20	0.93	9.13
ljutica	7	20.33	266	5.14	0.48	5.62
kratošija	8	17.00	362	6.33	1.33	7.66
čestozglavica	1	32.33	259	7.62	1.18	8.80
kratošija mala	4	25.00	299	7.55	1.09	8.64
kratošija sa dub.urezima	3	21.00	263	5.99	1.40	7.39
rehuljača	4	32.67	115	3.67	1.33	5.00

Tab.3. Yield and quality of grape and wine of potential clones of vranac variety (2009-2010)
Prinos i kvalitet grozdja i vina potencijalnih klonova sorte vranac (2009-2010)

Parametri / Potencijalni klonovi	Broj grozdova po čokotu	Masa grozda (g)	Dužina grozda (cm)	Širina grozda (cm)	Dužina bobice (mm)	Širina bobice (mm)	ŠIRA			VINO				
							Šećer (%)	pH	Ukupne kiseline (g/l)	Alkohol (vol%)	Ukupni ekstrakt (g/l)	Ukupne kiseline (g/l)	Antocijani (mg/l)	Ukupni polifenoli (g/l)
	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NC V 1	17.7	232.3	12.0	8.1	16.3	14.5	23.25	3.76	5.00	13.64	27.25	5.20	675	3.24
NC V 2	17.3	306.7	17.0	9.3	15.3	14.3	21.35	3.75	4.52	13.10	26.35	4.90	605	2.58
NC V 3	17.2	238.5	15.2	7.9	14.4	13.3	22.05	3.79	5.08	13.63	28.50	5.11	681	2.60
NC V 4	21.3	299.2	17.8	9.7	15.0	13.7	22.80	3.77	4.37	13.61	27.10	4.91	598	3.23
NC V 5	19.1	304.6	16.2	9.1	15.4	14.2	22.70	3.72	4.83	13.47	28.15	5.12	719	3.03
VRANAC POPULACIJA	21.7	229.5	16.9	9.4	16.5	15.2	21.65	3.55	4.99	13.60	28.55	6.33	591	2.92

The NCV 4 candidate had the highest number of bunches per vine and the NCV 2 candidate had the highest weight. The highest content of sugar was measured in a potential clone NCV 1. Two potential clones, namely NCV 1 and NCV 4, stood out in terms of the wine quality.

Conclusion

The testing results of 17 biotypes of Kratosija population showed variability in the variety as well as in its certain biotypes. Within the certain biotypes of vines, the best ones were separated to be used as a mother plantation for further propagation and studies according to the target selection.

Genetic identification has confirmed the authenticity of Montenegrin varieties Vranac, Krstac, Zizak, and it was confirmed for Kratosija to have an identical DNA profile as Zinfadel. Out of the selected and tested vines of Vranac population, only 5 vines have passed sanitary control and started the process of clonal selection. Two clone candidates, NCV 1 and NCV 4, surpassed the population of the variety in terms of the quality of grapes, must and wine.

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Istraživanje porijekla i rad na klonskoj selekciji crnogorskih sorti cv. vranac i cv. kratosija

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Sažetak

Vinogradarsko vinarska proizvodnja Crne Gore uglavnom se zasniva na gajenju autohtonih sorti vinove loze. Pored vranca, značajno mjesto u crnogorskom autohtonom sortimentu ima i sorta kratošija. Kratošija je autohtona crnogorska sorta nastala ranije i, prema mnogim literaturnim podacima, uvedena u kulturu gajenja znatno prije vranca. Danas je u vinogradima Crne Gore malo zastupljena zbog heterogenosti populacije, pa se uglavnom nalazi u kombinaciji sa sortom Vranac. U radu su prikazani rezultati istraživanja porijekla vranca i kratošije. Prikazana je genetička identifikacija koja je potvrdila autohtonost vranca dok je utvrđeno da autohtona sorta kratošija ima isti genetski profil kao cv. Zinfandel. U radu su prikazani višegodišnji rezultati rada na ispitivanju varijabilnosti njihovih populacija i rada na klonskoj selekciji. Izdvojeni su matični čokoti i podignuti predbazni i bazni zasad potencijalnih klonova sorte Vranac. Ostvareni rezultati u pogledu ispoljavanja agrobioloških i privredno tehnoloških pokazatelja ukazuju na potrebu daljeg rada na selekciji ovih sorti.

Ključne riječi: porijeklo, varijabilnost populacije, vranac, kratošija, klonska selekcija

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Essential (Cu and Zn) and trace (Pb and Cd) heavy metal loads in onion and potato

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Summary

Heavy metals are one of many pollutants that can be found on the surface and in tissue of fresh vegetables. Therefore, the aim of this paper was to assess and analyse concentrations of essential (Cu and Zn) and trace (Pb and Cd) heavy metals in onion (*Allium cepa* L.) and potato (*Solanum tuberosum* L.) produced in Vojvodina. The concentration of Cu, Zn, Pb and Cd was determined in edible plant parts, onion bulbs and potato tubers by atomic absorption spectrophotometry. In only two samples of onion and four samples of potato, the concentration of Cd was above the limit set by regulations of the Republic of Serbia.

Key words: onion, potato, copper, zinc, lead, cadmium

Introduction

As a source of vitamins, minerals, proteins and carbohydrates, vegetables play an important role in human nutrition. Therefore, high quality of vegetables is very important for human health. Diversity and quantities of chemicals that are added to agricultural soils have substantially increased with development of industrial technology, augmenting the risk of contamination of crops and vegetables (Nicholson et al., 2003). Heavy metals are one of many pollutants that can be found on the surface and in tissue of fresh vegetables. Vegetables mainly take up metals from soil solution and sometimes through the above-ground parts (Khairiah et al., 2004; Chojnacka et al., 2005). Sometimes, vegetable species may accumulate significant amounts of heavy metals, decreasing the quality and biological value of products without visible symptoms of their damage.

High concentrations of Pb and Cd in the diet are associated with development of many diseases, particularly cardiovascular, kidney, nerve and bone tissue (WHO, 1992, Steenland and Boffetta, 2000; Jarup, 2003). It has been proved that these heavy metals are carcinogenic, mutagenic and teratogenic (Radwan and Salama, 2006).

Given the importance that the concentrations of Cu, Zn, Pb and Cd have for the quality of vegetables and their health safety, we found it important to determine their concentrations in conventionally produced onion and potato, which are very common in our region. Onion bulbs and potato tubers develop in the soil, and therefore, the aim of this work was also to compare concentrations of Cu, Zn, Pb and Cd in those two vegetable species.

According to the regulations of the Republic of Serbia ("Official Gazette", no. 5/92, 11/92 - amended and 32/2002 and "Official Gazette RS", no. 25/2010 - another regulation and 28/2011 - another regulation), the maximum permitted concentration of Pb is 1 mg kg^{-1} and of Cd is 0.05 mg kg^{-1} in fresh vegetables, whereas according to international regulations (CODEX STAN 193-195) the maximum permitted Pb concentration is 0.1 mg kg^{-1} Pb, 0.1 mg kg^{-1} Cd for potato and 0.05 mg kg^{-1} for bulb vegetables.

Materials and methods

Plant material

Thirty two onion (*Allium cepa* L) samples, belonging to 15 different cultivars (Angela, Bonus, Burgos, Croquete, Daytona, Densitor, Holandski žuti, Kalcedon, Lazar, Manas, Redwing, Sedona, Stanfield, Talon and Vitez) were collected from 12 different sites, directly from farmers. Twenty nine potato (*Solanum tuberosum* L) samples, belonging to 10 different cultivars (Aladin, Bella Rosa, Desiree, Cleopatra, Kondor, Kuroda, Laura, Madeleine, Manitou and Trezor) were collected from 11 sites. Onion and potato samples were collected from: Bački Petrovac, Begeč, Čurug, Deronje, Despotovo, Erdevik, Gložan, Gospođinci, Iđoš, Kikinda, Kruščić, Lalić, Rusko Selo, Sakule and Zrenjanin.

Chemical analyses

Onion bulbs and potato tubers were oven dried at 60 °C to constant mass and weighed to determine the dry weight biomass production. Concentrations of Cu, Zn, Pb and Cd were determined in edible plant parts, onion bulbs and potato tubers. Common household practice was applied before the samples were prepared for the analysis of elemental composition. Onion bulbs were peeled and potato tubers were peeled and washed with running tap water. Excess water was absorbed with filter paper. The total concentration of Cu, Zn, Cd and Pb was determined by atomic absorption spectrophotometry (AAS SHIMADZU AA-6300) using flame technique (for Cu and Zn) and graphite furnace (for Pb and Cd) after ashing the plant material at t = 500° C and dissolving it in deionised hot water in the presence of 0.25 M HCl. The analyses were done in two consecutive years, in three replications. According to the regulations ("Official Gazette", no. 5/92, 11/92 - amended and 32/2002 and "Official Gazette RS", no. 25/2010 - another regulation and 28/2011 - another regulation), limiting concentration of trace elements in

vegetables, concentrations of Cu, Zn, Pb and Cd are expressed in mg g^{-1} fresh weight, and the same was done in this paper.

Statistics

The data were statistically processed by Statistica for Windows, version 10.0 (Statosft Inc., Tulsa, OK, USA). The comparison of genotypes was done using Duncan's test, at $\alpha < 0.05$.

The heavy metal pollution index (HPI) was calculated with the aim to compare total heavy metal load in onion and potato, as described by Usero et al. (1997):

HPI = $(Cf_1 \times Cf_2 \times Cf_3 \times \cdots \times Cf_n)^{1/n}$, where Cf is the concentration of *n* heavy metals in vegetable samples.

Results and discussion

The mean concentrations of heavy metals in onion (Tab. 1) and potato (Tab. 3) were in the following decreasing order: Zn, Cu, Pb, Cd, which is in accordance with results of Sharma et al. (2008). When onion and potato are compared, the latter contained 18% more Zn, 70% more Cu, 25% more Pb and 37% more Cd. For all four elements, the average concentration in potato was 37.5% higher than in onion. However, as the dry matter percentage of potato was in average 34.67% higher than that of onion, potato dry matter contained about half of Zn compared to onion, about double amount of Cu, about 10% less Pb and nearly equal concentration of Cd. The ratio of Zn/Cd concentration, however, was 26% higher in onion than in potato.

Since Cu and Zn in vegetables have only food and feed but not public health significance, there are no limits set for those elements. Average Zn concentration in onion bulbs is between 30 and 100 mg kg^{-1} dry weight (Bauer, 1971) and in potato tubers between 20 and 40 mg kg^{-1} (Geraldson et al., 1973). When concentrations analysed in this paper are expressed per dry weight, they are 12.67 mg kg^{-1} for onion and 10.1 mg kg^{-1} for potato. This means that both onion and potato in average have about a half of the average minimum concentration of Zn. It should be noted that the percentage of dry matter differed significantly between both onion (one had very high and one very low % of DM) and potato (one had much lower % of DW) cultivars (Tab. 1 and Tab. 3, respectively).

The average Cu concentration in onion bulbs is 7.1 mg kg^{-1} dry weight (Babilla-Ohlbaum et al., 2001) and if the concentration that was measured in this paper was expressed on the basis of dry weight, it would be much lower (average is 4.55 mg kg^{-1}). There were significant differences between onion cultivars with respect to Cu concentration in fresh weight. However, it should be noted that percentage of dry matter significantly differed between onion cultivars – one had much higher and another one much lower % of DW than the other cultivars (Tab. 1). Onion belongs to a group of vegetables that have high response to Cu whereas potato is classified as having a low response to it (Swiader and Ware, 2002).

Although potato is low copper-containing food, it is consumed frequently enough to be considered a substantial dietary source of copper (Lurie et al., 1989). Therefore, Cu concentration in potato may deserve more attention.

Tab. 1. Average concentrations of Cu, Zn, Pb and Cd, dry weight, Zn/Cd ratio and HPI in onion bulbs (n.d., not detected)
Prosječne koncentracije Cu, Zn, Pb i Cd, težine u suvom stanju, omjera Zn/Cd i HPI u lukovicama crnog luka (n.d, not detected)

ONION	Cultivar	Concentration (mg kg^{-1})				% dry weight	Zn/Cd	HPI CuZnPbCd
		Cu	Zn	Pb	Cd			
1.	Angela	0.712	1.458	0.182	n.d.	10.760	-	-
2.	Bonus	0.204	0.570	0.164	0.042	8.080	13.538	0.174
3.	Burgos	0.371	1.249	0.046	0.022	9.120	55.777	0.021
4.	Croquete	0.803	1.385	0.136	0.019	10.440	72.073	0.214
5.	Daytona	0.237	0.910	0.129	0.028	7.580	32.946	0.171
6.	Densitor	0.171	0.501	0.133	0.026	6.645	19.159	0.231
7.	Holandski žuti	0.592	1.820	0.211	0.016	15.940	138.396	0.125
8.	Kalcedon	0.558	1.253	0.156	n.d.	9.200	-	-
9.	Lazar	0.350	0.986	0.140	0.019	7.507	51.801	0.249
10.	Manas	0.081	0.452	0.058	0.008	3.130	59.204	0.166
11.	Redwing	0.818	2.025	0.135	0.013	10.760	159.720	0.232
12.	Sedona	0.472	1.142	0.166	0.024	9.545	48.424	0.148
13.	Stanfield	0.185	1.634	0.129	0.034	8.950	47.975	0.191
14.	Talon	0.308	1.120	0.135	0.018	8.323	61.325	0.131
15.	Vitez	0.778	1.568	0.144	0.022	12.625	71.756	0.168

None of the onion samples had Pb concentration above the limit set by regulations of the Republic of Serbia, but according to international standards, in 25 samples, it was above the limit. In one onion cultivar, Pb concentration was significantly higher, and in another one, it was significantly lower than in the others (Tab. 1). The concentration of Pb in potato was within the limits set by Serbian regulations but above it in 22 samples according to international regulations (Tab. 3). There were significant differences between potato cultivars with respect to Pb concentration.

Out of 32 samples of onion (belonging to 15 cultivars), the concentration of Cd was above the limit set both by regulations of the Republic of Serbia and international regulations in only two of them (Tab. 1). In 28 potato samples (belonging to 10 cultivars), concentration of Cd was above the limits in 4 as set by Serbian regulations and it was above the limit in only one of these according to international regulations (Tab. 3). The concentration of Cd was significantly higher in one potato cultivar than in the other nine, whereas in onion, differences between

cultivars, with respect to Cd concentration, were smaller. The coefficient of variation was the highest with respect to Cd in both onion (Tab. 2) and potato (Tab. 4), in comparison with the other elements being analysed.

Tab. 2. Descriptive statistics of concentrations of Cu, Zn, Pb and Cd, Zn/Cd ratio and dry weight of onion bulbs
Deskriptivna statistika koncentracija Cu, Zn, Pb i Cd, omjera Zn/Cd i težine lukovica crnog luka u suvom stanju

ONION	Concentration (mg kg^{-1})				Zn/Cd	% dry weight
	Cu	Zn	Pb	Cd		
Mean	0.437	1.229	0.147	0.020	93.166	9.689
Range	0.033-0.898	0.297-3.121	0.033-0.383	0-0.119	0-1594.4	2.921-28.550
Std.Dev.	0.279	0.587	0.066	0.021	226.032	4.536
Coef.Var.	63.741	47.78	44.765	109.275	242.611	46.811

There is a correlation between Zn supply and the uptake of Cd by plants. Low plant available Zn in soil promotes Cd uptake. It was found that in laboratory animals marginal deficiency of Zn may enhance Cd absorption as much as ten-fold from food containing low Cd concentrations (Reeves and Chaney, 2008). This indicates that the food that is nutritionally marginal with respect to Zn has much higher risk of containing more Cd, which is highly undesirable. Therefore, we compared Zn/Cd ratio in onion and potato samples. Overall, Zn/Cd ratio was higher in onion (93.16) than in potato (68.29) but ranges in both vegetables were very similar (Tab. 2 and Tab. 4, respectively). There were no significant differences between onion and potato cultivars with respect to Zn/Cd concentration.

The average heavy metal pollution index (HPI) was higher in potato (0.269) (Tab. 3) than in onion (0.166) (Tab. 1) which means that there is species specificity with respect to accumulation of heavy metals in plant parts developing in the soil (bulbs and tubers).

Conclusion

In general, it can be concluded that concentrations of Zn, Cu, Pb and Cd in conventionally produced onion and potato were below the limits set by Serbian regulation, with the exception of 2 (out of 32) onion and 4 (out of 28) potato samples in regards with Cd.

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Tab. 3. Average concentrations of Cu, Zn, Pb and Cd, dry weight, Zn/Cd ratio and HPI in potato tubers
Prosječne koncentracije Cu, Zn, Pb i Cd, težine u suvom stanju, omjera Zn/Cd i HPI u krtolama krompira

POTATO	Cultivar	Concentration (mg kg^{-1})				% dry weight	Zn/Cd	HPI CuZnPbCd
		Cu	Zn	Pb	Cd			
1.	Aladin	0.108	0.435	0.093	0.012	4.611	35.858	0.566
2.	Bella Rosa	0.870	2.090	0.266	0.049	16.498	42.860	0.392
3.	Desiree	0.820	1.703	0.149	0.022	18.273	76.193	0.270
4.	Cleopatra	0.317	0.398	0.246	0.043	11.910	9.330	0.279
5.	Kondor	0.634	1.212	0.129	0.027	13.160	44.669	0.233
6.	Kuroda	0.837	1.388	0.260	0.018	16.660	78.386	0.261
7.	Laura	0.952	2.083	0.479	0.108	17.730	19.288	0.228
8.	Madeleine	1.211	2.196	0.197	0.006	18.665	393.120	0.182
9.	Manitou	0.981	1.655	0.207	0.018	15.405	91.267	0.191
10.	Trezor	0.480	1.075	0.114	0.018	11.917	58.430	0.085

Tab. 4. Descriptive statistics of concentrations of Cu, Zn, Pb and Cd. Zn/Cd ratio and dry weight of potato tubers
Deskriptivna statistika koncentracija Cu, Zn, Pb i Cd, omjera Zn/Cd i težine krtole krompira u suvom stanju

POTATO	Concentration (mg kg^{-1})				Zn/Cd	% dry weight
	Cu	Zn	Pb	Cd		
Mean	0.744	1.495	0.197	0.318	68.29	14.831
Range	0.052-1.833	0.267-3.730	0.074-0.647	0-0.184	0-1251.6	4.600-22.800
Std.Dev.	0.515	0.849	0.126	0.036	159.901	5.856
Coef.Var.	69.184	56.793	64.003	113.496	234.151	39.484

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Koncentracija neophodnih (Cu i Zn) i štetnih (Pb i Cd) teških metala u crnom luku i krompiru

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Sažetak

Teški metali mogu da se jave kao zagađujuće materije na površini i unutar tkiva povrtarskih kultura. Zato je cilj ovog rada bio da se utvrde koncentracije neophodnih (Cu i Zn) i štetnih (Pb and Cd) teških metala u crnom luku (*Allium cepa* L.) i krompiru (*Solanum tuberosum* L.) proizvedenom u Vojvodini. Koncentracije Cu, Zn, Pb i Cd su određene u jestivim biljnim delovima. lukovicama crnog luka i krtolama krompira. atomskom apsorpcionom spektrofotometrijom. U samo dva uzorka crnog luka i četiri uzorka krompira koncentracija Cd je bila iznad maksimalno dozvoljene u Republici Srbiji.

Ključne reči: luk, krompir, bakar, cink, olovo, kadmijum

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Contents of nickel, zinc, copper and lead in agricultural soils of the plains in the northwestern part of the Republic of Srpska

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Summary

This paper presents the results and methodology of investigation conducted on agricultural soils of the plains in the northwest Republic of Srpska, aiming to determine the extent of heavy metals contamination: nickel (Ni), zinc (Zn), copper (Cu) and lead (Pb). The investigation included 140 soil samples from 14 sites, where the soil samples were taken on 5 locations, from two layers (depths): arable (0-25 cm) and sub-arable (25-50 cm). The total contents of metals were determined by a method of atomic spectrophotometry after acid digestion (HNO_3+H_2O_2). Organic matter content, CEC and pH were determined by standard agrochemical methods. The total contents of nickel in 78.5% of investigated soil samples were higher than the maximum allowed in the unpolluted soils (50 mg/kg). In 22.86% of the analysed samples, the content of zinc was higher than the maximum allowed in the unpolluted soils (100 mg/kg), while the content of copper and lead in the small number of samples was higher than the allowed maximum. Acidic soil reaction (pH<5.5) that increased bioavailability of metals was found in 38.6% of the samples investigated. A high degree of correlation was determined between the total content of certain metals (Cu and Ni, Cu and Zn). This suggests their common origin in the investigated area. The average contents of investigated metals in different layers (depths) were slightly different, having determined higher concentrations of Ni and Cu in the sub-arable layer that indicated the dominance of natural, geochemical sources of these metals in the soils. Territorial distribution of samples with high content of Ni and Zn corresponds to geological substrates which include minerals- natural carriers of Ni and Zn. This also indicates probable geochemical origin of these elements in the investigated soils. High contents of metals and acid soil reaction

indicate that it is necessary to continue research in order to determine the risk of increased transfer of heavy metals from soil to the crops grown.

Key words: heavy metals, soil, total content of metals

Introduction

Intensive technological development, industrialisation and urbanisation which are some of the main characteristics of the 20th century, were followed by the emission of large quantities of various hazardous and toxic substances into the environment. Among these substances, heavy metals (trace elements) have special impact on the environment. Those elements are involved in natural biological and geochemical processes and cannot be degraded or destroyed. Because of this, they pose one of the most important ecological risks. Some of these are essential elements, important for normal biological functioning of plants, animals and humans (e.g. Cu, Ni, Zn, Mn) while the others are not so essential or they are even considered toxic (e.g. Pb, Hg, As and Cd). Their presence in the soil in concentrations higher than maximum allowed for agricultural lands can cause various adverse effects (e.g. reduction or absence of the crops' yield, bioaccumulation in the food chain, movement through the environment etc.). Because of their potential risk on human health, U.S. Environmental Protection Agency (U.S. EPA) declared Pb, Cr, Ni, Zn, As, Cd, Cu, Hg, Sb, Be, Se, Ag, and Tl as ones of the most dangerous toxic substances (NCR, 2003).

The plains in the north-west part of the Republic of Srpska represent an important agricultural region of our country. In this area, the largest urban and industrial centres are located as well. In the valleys of the Una, Sana, Vrbas, Sava, Bosna, and Ukrina rivers, fertile alluvial soils, mainly used as agricultural land, developed on the bedrock formed in quaternary period.

These soils are formed by deposition of sediments that are brought with the river flow, creating soil layers with different chemical and physical characteristics. The origin of these sediments in the investigated plains is related to special rocks as well as to dolomite, limestone, flysh, peridotite and serpentinite *(Đerković et al., 1975, Mojičević et al.,1976, Laušević et al., 1982, Šparica et al., 1983, Sofilj et al., 1984, Šparica et al., 1986, Jovanović and Magaš, 1986).*

Numerous studies worldwide indicate that heavy metals contamination is highly pronounced in the soils near rivers which are often exposed to different anthropogenic influences that in addition with natural factors (alluvial and deluvial processes) determine the overall contents of metals *(Overesch et al., 2007, Ibragimow et al., 2010, Martin, 2000, Qishalaqi and Moore, 2007)*.

Considering all the mentioned facts, the main objective of the paper was to determine the extent of contamination in the soils of the plains in the north-west part of the Republic of Srpska with specific heavy metals, i.e. nickel, zinc, copper and lead.

Material and methods

This research was carried out on agricultural soils of the plains in the north-west part of the Republic of Srpska and included 140 soil samples from 14 sites (Table 1.). The soil samples were taken at 5 locations, from two layers (depths): arable (0-25 cm) and sub-arable (25-50 cm). Sampling was carried out with the agrochemical probe forming the average sample for each depth (layer). During the process of sampling, the information relevant to description of micro locations (use of agricultural land, cultivated crops, and distance from the water stream, major roads and industrial facilities, GPS coordinates) were recorded.

The average soil samples were air dried, crushed and sieved to a particle size < 2mm. Main chemical properties of the soils were determined in these samples according to standard agrochemical methods: 1. Acidity (pH) measured in deionised water and 1M KCl, 2. Content of carbonates ($CaCO_3$) with Scheibler calcium-meter, 3. Organic matter content applying the method by Tjurin, 4. Cations exchange capacity with 1M NaAc (pH=7).

Total contents of metals were determined by the atomic spectrophotometry method after acid digestion with concentrated HNO_3 in addition of 33% solution of H_2O_2 *(Krishnamurty et.al., 1976)*. This is one of the basic methods for determination of the total metal content in soils according to which the maximum allowed concentrations of heavy metals in agricultural soils are given in the legislation of numerous countries as well as in the scientific literature *(Kabata-Pendias and Pendias, 1992)*.

Nitric acid neither causes degradation in the crystal lattice of the silicate minerals nor releases metals built in the crystal structure. The content of metals obtained after digestion with nitric acid is actually a pseudo-total content, and will be considered further as the total content.

Assessment of the degree of soil contamination with heavy metals (Pb, Ni, Zn and Cu) has been done by: 1. Comparison of their total contents in the investigated soils with the maximum allowed content for unpolluted soils, 2. Determination of the correlation degree between the contents of the same chemical elements at different depths, 3. Determination of the correlation degree between the contents of different chemical elements at the same depths 4. Estimation of the expected mobility and availability of metals based on main soil properties that were influenced by the available content of heavy metals in these. Statistical analysis was calculated using the Microsoft software package (Excel).

Tab. 1. The review of the sampling places

Pregled mjesta gdje su uzimani uzorci

Mark	Location	The sampling area
NT1	the Vrbas river valley	the field of Lijevče, route Aleksandrovac-Dubrave
NT 2	the Sana river valley 1	the field of Prijedor, route Omarska-Trnopolje
NT 3	the field of Cerovljani	the plateau of Cerovljani
NT 4	the Una river valley 1	route Dubica-Draksenić-Jasenovac
NT 5	the Una river valley 2	route Novi Grad-Kostajnica
NT 6	the Sana river valley 2	the field of Prijedor, route Prijedor-Sanski Most
NT 7	the Ukrina river valley 1	route Prnjavor-Derventa
NT 8	the Ukrina river valley 2	route Derventa-Brod
NT 9	the Bosna river valley 1	route Doboj-Podnovlje
NT 10	the Bosna river valley 2	route Modriča-Podnovlje
NT 11	the Bosna river valley 3	route Modriča-Miloševac- Crkvina
NT 12	the Sava river valley 1	the nearby of the Šamac
NT 13	the Sava river valley 2	the nearby of the Brod
NT 14	the Sava river valley 3	route Gradiška-Srbac

Results and discussion

Main chemical properties of the investigated soils

Investigated soils show great heterogeneity regarding the main chemical properties (Table 2.), which is mainly a consequence of specific features of their pedogenesis. Considering the individual samples, it is noticeable that they belong to different acidity range, from strongly acidic to alkaline soils *(Džamić et al.).* However, there is obvious dominance of the acidic and moderately acidic soils (63.6% among the tested soil samples with pH<6.5), compared with soils with neutral (30.7%) and alkaline soil reaction (5.7%).

Tab. 2. Main chemical properties of the investigated soils (mean, standard deviation and range)

Glavne hemijske karakteristike ispitivanih zemljišta (srednja, standardno odstupanje i raspon)

Soil layer (the depth)	pH 1M KCl (t=25^{0}C)	pH H_2O (t=25^{0}C)	$CaCO_3$ (%)	Organic matter (%)	CEC (meq/100g)
Arable layer (0-25 cm)	5,95±1,02 (3,95-7,37)	7,06±0,92 (5,13-8,24)	2,76±6,43 (0,0-33,10)	1,66±0,51 (0,70-3,40)	20,46±8,70 (9,75-49,75)
Sub-arable layer (25-50cm)	5,98±1,06 (3,96-7,44)	7,16±0,90 (5,10-8,30)	2,86±6,65 (0,0-34,60)	1,49±0,46 (0,60-2,60)	19,91±7,90 (8,00-44,50)

Strong acidic soil reaction (pH<5.5), which increases the bioavailability of metals, was measured in 38.6% of investigated samples. Strong alkaline reaction and high content of carbonates were determined in the soil samples from the Sana River valley. Those characteristics are due to the river flow through rocks of the dolomite and lime stones. There is evidently a huge percentage of non-carbonate soils (more than 70%) among other analysed soil samples.

According to the determined content of organic matter (humus), the investigated soils belong to the group of moderately humus soils *(Jakovljević et al., 1995).* Opposite the soil pH-reaction and content of carbonates, the content of organic matter has decreased with the soil depth due to the presence of root mass and crop residues in the topsoil.

Homogenous content of organic matter in the investigated soils can be explained by the fact that the sampling was carried out on arable land covered by the same dominant crops (e.g. corn, wheat, clover) which involved similar agricultural practices.

The variation range of the determined cations exchange capacity (CEC) in the investigated soils is wide, probably caused by differences in their mechanical structure. In 70% of the investigated soil samples, CEC was moderate (12-25 meq/100g), while in 20% of the investigated samples was high (>25 meq/100g). The results indicate high capacity and affinity of the soil for metal ions adsorption *(Hazelton and Murphy, 2007)*. The higher values of CEC are found mainly in the samples with high content of organic matter.

Total contents of nickel, zinc, copper, and lead

In 78.57% of the investigated soil samples, the determined contents of nickel (Ni) were higher than the maximum allowed for unpolluted soils (50 mg/kg), whereas in 40% of these samples the content of Ni was 2-4 times higher than the maximum allowed (Figure 1.).

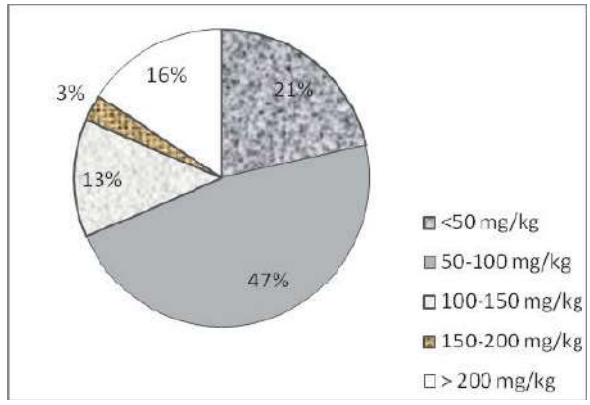


Fig. 1. The total contents of Ni (mg/kg) in the investigated soil samples
Ukupni sadržaj Ni (mg/kg) u ispitivanim uzorcima zemljišta

The highest content of Ni was found in the soils beside the Bosna and Ukrina Rivers, probably caused by the presence of peridotite and serpentinite rocks, which are natural carriers of Ni. Decomposition of primary minerals has led to Ni leaching from those rocks to the soils in the lower part of the river valley. In the previous research, it was concluded that higher contents of Ni in the soils from the lower part of the Vrbas River valley were due to a long term process of leaching this metal from the deposits of peridotite and serpentinite. This metal was leached mainly by Vrbas River tributaries *(Novković et al., 2008)*. The average total contents of Ni in the investigated soils from different depths show homogenous vertical distribution of this element (Table 3.). This is a confirmation of the assumption that the origin of Ni is determined by geochemical (natural) sources rather than by anthropogenic sources *(Soon and Abboud, 1990, Antić-Mladenović, 2004)*.

Tab. 3. Total contents of nickel, zinc, copper and lead in the investigated soil samples (mean, standard deviation and range)
Ukupni sadržaj nikla, cinka, bakra i olova u ispitivanim uzorcima zemljišta (srednja, standardno odstupanje i raspon)

	Ni (mg/kg)	**Zn (mg/kg)**	**Cu (mg/kg)**	**Pb (mg/kg)**
Arable layer (0-25 cm)	96,15±67,35 (25,00-291,20)	81,32±24,42 (49,30-170,30)	22,03±8,09 (8,90-42,90)	31,20±12,21 (13,60-100,80)
Sub-arable layer (25-50cm)	97,58±69,40 (25,30-294,70)	79,24±21,91 (46,70-135,40)	22,50±9,55 (9,70-64,80)	31,20±12,21 (10,20-52,20)
Maximum allowed contents*	50	100	60	100

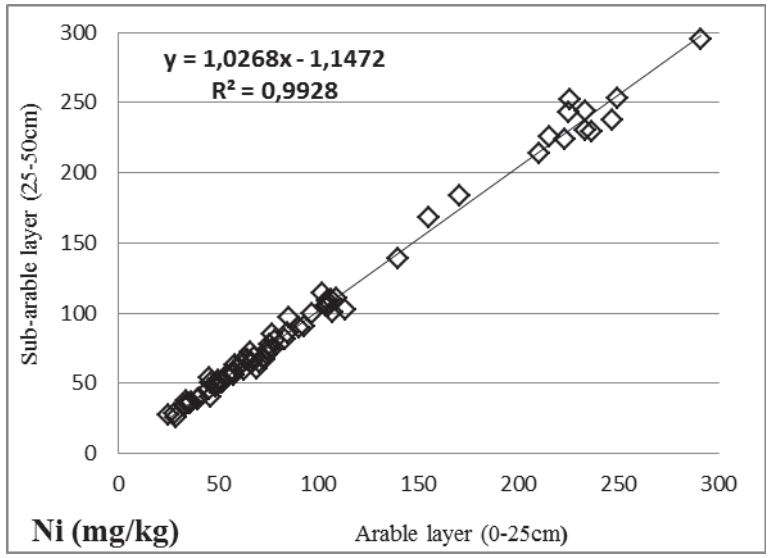
**Kabata-Pendias and Pendias (1992): Critical concentration of total metal content in the soil which could have toxic impact on plants*

This theory is confirmed by the linear regression equation between the contents of Ni in arable and sub-arable layer of the soil profile (Figure 2, a). Statistically high significant correlation has been determined between the total content of Ni in the layer 0-25 cm and 25-50 cm (r =0.99**). According to *Zhang et al. (2002),* this indicates that Ni in the soils of the plains in the north-west part of the Republic of Srpska dominantly originates from geochemical sources.

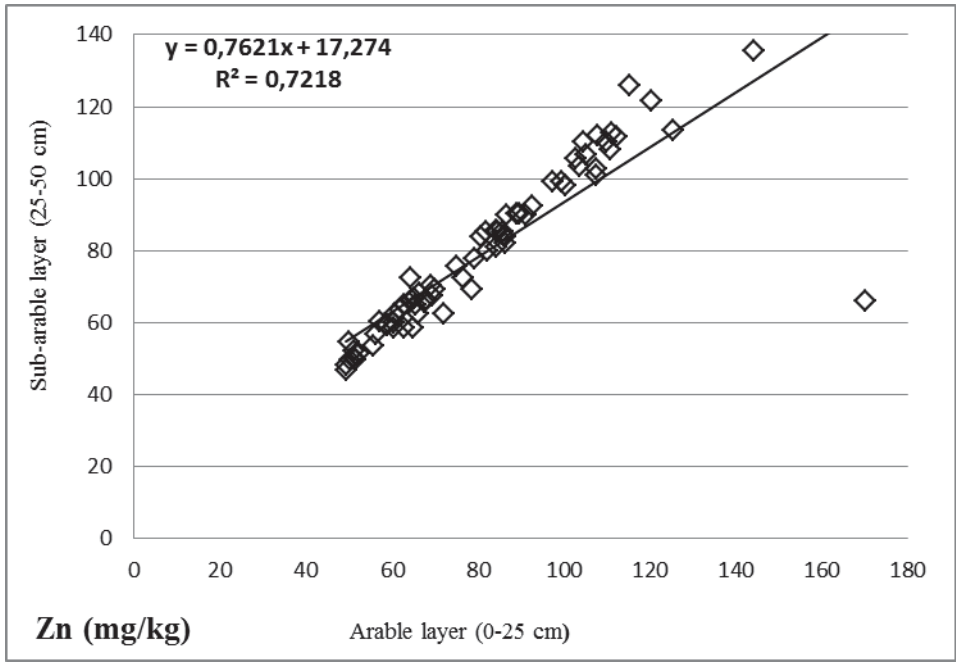
Tab. 4. Correlation coefficients between the contents of the Ni, Zn, Cu and Pb in investigated soils
Koeficijenti korelacije između sadržaja Ni, Zn, Cu i Pb u ispitivanim zemljištima

	Arable layer (0-25 cm)			**Sub-arable layer (25-50cm)**		
Metal	**Ni**	**Zn**	**Cu**	**Ni**	**Zn**	**Cu**
Zn	0,35**	1,00		0,48**	1,00	
Cu	0,75**	0,63**	1,00	0,69**	0,72**	1,00
Pb	NS	0,31**	0,25*	0,43**	0,77**	0,60**

**statistically significant on the level of 0,01
* statistically significant on the level of 0,05



(a)



(b)

Fig. 2. XY-diagram showing the relation between total content of Ni (a) and Zn (b) in the layer 0-25 cm and 25-50 cm

XY dijagram koji pokazuje odnos između ukupnog sadržaja Ni (a) i Zn (b) u sloju 0-25 cm i 25-50 cm

The Zn content was higher than the maximum allowed (100 mg/kg) in 22.86% of the analysed soil samples, while the contents of Cu and Pb were higher in a small number of soil samples than the allowed values for these elements (Table 3.).

Territorial distribution of the samples with increased contents of Ni and Zn was similar, directly indicating the same or similar origin of those metals. Regarding the Zn content, it is evident that its vertical distribution is homogenous (Table 3). Together with the linear regression equation between the total content of Zn in different soil layers (Figure 2, b), this fact indicates the dominance of natural geochemical sources of this element in the area under examination.

NS statistically not significant

Mutual correlation coefficients between the total content of the heavy metals analysed in the investigated soils (Table 4.) indicate a strong linear relationship among the content of Ni and Cu, Cu and Zn in both soil layers analysed ($r \approx 0.7$). According to the research done by Reimann et al. (2001), statistically significant correlation coefficients among the content of the same elements between different soil layers refer to their common origin from geochemical sources.

Conclusion

The results of the investigation carried out on the soils in the north-west part of the Republic of Srpska showed the following: 1. In 78.7% and 22.86% of the analysed soil samples, the total contents of Ni and Zn were determined to be higher than the maximum allowed for unpolluted soils. 2. The total contents of Cu and Pb were within the allowed range, with the exception of few individual samples, 3. Vertical distribution of Ni, Cu and Zn in the soils from the examined area was homogenous, 4. The correlation between the content of Ni and Cu, Cu and Zn, Ni and Zn in different soil depths (0-25 and 25-50 cm) was statistically significant. Together with the previous conclusion, this indicates predominant origin of these metals from natural geochemical sources but does not exclude influence of anthropogenic sources. 5. The higher content of Ni and Zn, as well as high acidity and moderate adsorption capability of the soil suggest that it is necessary to provide additional investigation in order to determine the part of the total content of Ni and Zn which is bioavailable. In regards with these results, it is possible to get useful information about the impact of Ni and Zn on the environment, and to estimate their influence in the examined area.

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Садржаји никла, цинка, бакра и олова у пољопривредним земљиштима равничарског дијела сјеверозапада Републике Српске

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Резиме

У овом раду су представљени резултати и методологија истраживања проведеног на пољопривредним земљиштима равничарског дијела сјеверозападне Републике Српске, чији је циљ био утврђивање степена загађености земљишта тешким металима: никлом (Ni), цинком (Zn), бакром (Cu) и оловом (Pb). Истраживањем је обухваћено 140 узорака са 14 локација, на којима је земљиште узорковано на пет микролокација из два слоја (дубине): ораничног (0-25 cm) и подораничног (25-50 cm). Укупни садржаји метала одређени су методом атомске апсорпционе спектрофотометрије, након киселинске дигестије (HNO_3+H_2O_2). Стандарним агрохемијским методама одређени су pH, садржај органске материје и капацитет за адсорпцију катјона у земљишту. Утврђени укупни садржаји никла су у 78,57% испитаних узорака виши од максимално дозвољеног садржаја за незагађена земљишта (50 mg/kg). У 22,86% анализираних узорака утврђен је садржај цинка виши од максимално дозвољеног (100 mg/kg), док је садржај бакра и олова у малом броју узорака виши од максимално дозвољеног. Кисела реакција земљишта (pH<5,5), која може да утиче на повећану биоприступачност метала, измјерена је у 38,6% узорака. Утврђен је висок степен корелације између укупних садржаја појединих метала (Cu и Ni, Cu и Zn), што упућује на њихово заједничко поријекло на испитиваном подручју. Установљене су приближно исте просјечне концентрације метала у оба испитивана слоја земљиша, што указује на доминантан природни, геохемијски извор тих метала на испитиваном терену. Територијални размјештај узорака са повишеним садржајима Ni и Zn одговара геолошким подлогама у чијем се минералном саставу јављају минерали – природни носиоци Ni и Zn, што такође упућује на вјероватно геохемијско поријекло поменутих елемената у земљишту. Високи садржаји неких метала и кисела реакција земљишта упућују на неопходност додатних испитивања, да би се утврдио степен ризика од њиховог могућег повишеног трансфера из земљишта у гајене културе.

Кључне ријечи: тешки метали, земљиште, укупни садржај метала

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Agronomic characteristics of winter oil rape hybrids depending of nitrogen top dressing

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Summary

Oilseed rape is one of the most important sources of vegetable oil in the world. The nutrient demand of oilseed rape is considerably higher than that of cereals. Compared to cereals, winter oilseed rape requires more available nitrogen and this element is an important component with a strong effect on seed yield and quality, but it also affects the reduction of oil content. Winter oliseed rape hybrids with high yield potential might have high nitrogen requirements. On the other hand, the vigor of those plants might also be expressed as improved nitrogen uptake by a vigorous rooting system. In many cases, N fertilisation requirement does not take into account varietal types for *Brassica napus* L. Furthermore, it is based on fertiliser norm, with corrections according to environmental conditions. The objective of this study was to evaluate preliminary results of the influence of nitrogen top dressing on the yield and yield components of 8 winter oil rape hybrids and 2 winter oil rape cultivars. A field trial was carried out in village Gluvo (near Skopje) in 2010/2011. The experimental design was a split-plot with 3 replications and 3 nitrogen regimes as main factors. Fertiliser treatments were: N, N+120 kg N/ha, N + 120 + 70 kg N/ha. N treatment as a base fertiliser corresponded to 70 kg of N/ha. Two ammonium nitrate dressings were broadcast, first on 25 February and then on 15 March. It can be concluded from the results we obtained that twice applied top dressing had statistically significant differences (P = 0.05) on the yield of the hybrids/varieties, number of seed/pods and length of a pod (compared to one application and without top dressing), but did not significantly influence the height of a plant and number of primary branches/plant. On a hybrid/variety level, Hybrirock (KWS), Rohan (NPZ-Lembke) and Albatros (Limagrin) may be considered as the most promising for the Skopje region.

Key words: winter oilseed rape, nitrogen, top dressing, yield, yield components

Introduction

The use of oilseed rape is wide-ranging in human and animal nutrition as well as for technical purposes and in the chemical industry. For the last few decades, the acreage of winter oilseed rape has increased considerably in the world (*Sieling & Kage,* 2010). Given this development, the question arises whether such an increase might be enhanced by integrated N-management strategies (*Rathke et al.,* 2005). Mineral N-fertilisation is a crucial factor in oilseed rape production (*Dreccer et al.,* 2000), and together with sulphur is among the most important elements in canola production (*Mirzashahi et al.,* 2010). Compared with cereals, canola nitrogen requirements are higher and it is considered as a high nitrogen demanding crop (*Hocking et al.,* 1997; *Rathke et al.,* 2005), especially when it is grown in irrigated fields (*Ahmadi & Javidfar,* 1998 quotes from *Mirzashahi et al.,* 2010). For the production of 0.1 t of seeds, the whole crop accumulates approximately 6 kg of N. Therefore, the use of N source in a proper way is required so as to optimise the economic seed yield (*Mason & Brennan,* 1998), and also to minimise the potential risk of environmental pollution (*Aufhammer et al.,* 1994, quotes by *Karaaslan,* 2008). The nitrogen supply of oilseed rape depends on the type of subspecies and yield. Fertiliser N rate between 200 – 300 kg/ha is the best to obtain the highest seed and oil yield in winter canola production (*Smith et al.,* 1988; *Jackson,* 2000), although there are examples when application of smaller quantities of N, 135 and 150 kg/ha, increased canola yield significantly (*Porter,* 1993; *Seyyed et al.,* 2011). Choosing the correct rate and timing of nitrogen fertiliser application is one of the most important aspects of successful oilseed rape production. According to *Bilsborrow et al.* (1993), *Sieling et al.* (1998), *Sieling et al.* (1999) (quotes from *Narits,* 2010), optimal spring top-nitrogen rate ranged from 120 to 240 kg/ha. *Michael et al.* (1979) found that seed and oil yield in oilseed rape increased by applying top-dressing, with mean N-requirements of about 230 kg/ha for satisfactory crops. The plots with no response to N or no response beyond 90 kg/ha of N were mostly low yielding. Timing of N-application within the period of mid-February to late March had little influence on seed yield but applying all or half the N in April tended to give lower yield. *Vujakovic et al.* (2010), using three nitrogen doses as a top-dressing (N 50 kg/ha, N 100 kg/ha and N 150 kg/ha), report that the seed yield and germination of oilseed rape varieties depend on the year of examination and oil and protein contents depend on the year, genotypes as well as the amount of N/ha applied. Oilseed rape hybrids with high yield potential might have high nitrogen requirements in comparison with coventional varieties (*Didier,* 2002).

Bearing in mind the importance of N in affecting quantity and quality parameters of canola, the aim of the present study was to analyse the effects of nitrogen top-dressing on the yield and yield components of winter oilrape hybrids and cultivars.

Materials and methods

The study was conducted in the Gluvo district (a village near Skopje), in 2010/2011 growing season. Eight canola hybrids: Hybrirock, Triangle, Petrol, Speed, Artoga, Albatros, Rohan and Abakus and two canola varieties Banačanka

and Majdan were tested. Experimental design was a split-plot with 3 replications and 3 nitrogen regimes as main factors. Fertiliser treatments were: N (N_0), N+120 kg N/ha (N_{0+1}), N+120+70 kg N/ha (N_{0+1+2}). N treatment as a base fertiliser corresponded to 70 kg of N/ha. Each sub plot consisted of 5 rows, 20 cm apart and 3 m long. The experiment was planted on 15 September. Sowing was done by hand. The previous crop was winter wheat. Other recommended cultural practices were applied during the period of the experiment. Ammonium nitrate (nitrogen content 34.4%) was used as top-fertiliser in two different application times: A) at the beginning of spring vegetation (oilseed rape growing code 30) and B) in phonological phases "green bud" (code 59). Timing of nitrogen application was based on the growth stages described by *Weber & Bleiholder* (1990) and *Lancashire et al.,* (1991).

Depending on the period of pods maturation of hybrids and varieties examined, the trial was harvested between 1–10 July. During the harvest, ten random guarded plants were chosen from each sub/sub plot and the data of plant height (cm), number of main branches/plant, pod length (cm) and number of seed/pod were recorded. Seed yield/ha (kg) was calculated from the yield of the inner 3 rows and then converted into kg seed/ha.

The Least Significant Difference (LSD) procedure was used when F-test was significant (P>0.05). The SPSS 6.1 programme was used to process the test results.

Results and discussion

Yield components

The effects of nitrogen rates on plant height are presented in Table 1. Means of the plant height under the nitrogen top-dressing rates showed an increase in plant height as nitrogen fertiliser rate increased, but no significant differences were detected. Plant height means ranged from 81.5 to 90.5 cm with N_0 and N_{0+1} treatment and 94.9 cm with N_{0+1+2} treatment, respectively. According to *Mobasser et al.,* (2008), nitrogen application had significant effect on plant height. *Yousaf and Ahmad* (2002) obtained almost similar results. The results obtained in our trial might be due to the positive effect of increased nitrogen and environment on the growth and development of the stem which was reflected in taller plants, but the differences were not statistically improved.

Comparing the hybrids/varieties, plant height (Table 2) revealed that hybrid Hybrirock was the tallest with mean value of 100.5 cm, with average plant height of 104.0 cm using two nitrogen applications and 103.9 cm with one nitrogen top-dressing, followed by Rohan whose mean value was 96.7 cm and 101.5 and 99.3 cm applying two or one nitrogen fertiliser. The Petrol and Abakus hybrids with average mean height of 83.4 and 86.5 cm as well as varieties Banačanka and Majdan with 82.4 and 76.1 cm formed the shortest plants. No statistical differences were calculated which means that certain cultivars may be sensitive to environmental factors while others may be tolerant. As *Sana et al.* (2003) report,

variation in plant height of different oilseed rape hybrids and varieties may be attributed to their genetic potential.

For the number of branches/plant, the mean values in Table 1 revealed that the number of branches increased following the increase in N fertiliser application rate and the maximum number of 4.8 branches was observed with N_{0+1+2} treatment and minimum of 3.7 branches with N_0 treatment. Statistical differences at 0.05 levels were not significant. These results comply with those documented by *Öztürk* (2010), who stated that number of branches per plant increased with N doses but without statistical improvement. On a hybrid/variety level (Table 2), the highest branch number per plant was obtained on Rohan hybrid - 6.48 branches, followed by hybrids Albatros with 5.24, Artoga with 5.18, Speed with 4.93 and Petrol with 4.84. On each of them, the highest branch number was obtained with N_{0+1+2} application showing statistical differences.

Several other studies have also reported positive effect of the rate of N-fertilisation on the number of branches in canola, which is not far from expectations as N fertilisers stimulate better plant growth and development (*Kazemeini et al.* 2010 and authors in the paper). According to *Sana et al.* (2003), the number of branches per plant is the result of a combined effect of genetic make up of the crop and environmental conditions, which play a remarkable role in the final seed yield of the crop.

The interaction between the nitrogen rates, nitrogen split application and canola cultivars had significant effect on pod length (Table 1). Mean values for this characteristic showed that the N_{0+1+2} treatment resulted in higher pod length of 7.3 cm. This result is opposite to those of Faramarzi et al. (2009) who obtained higher pod length by applying low nitrogen rate. Some of the hybrids examined such as Petrol, Artoga, as well as Banačanka and Majdan varieties with 7.5 cm, 6.9 cm, 7.7 cm and 7.0 cm resulted in higher pod length after applying N fertiliser two times (Table 2). *Chay and Thurling* (1989 a, b) and *Leon and Becker* (1995) conclude that the length of the pod, besides the effect of environment and fertiliser application, largely depends on the genetic constitution of the canola cultivars being examined.

By increasing the N fertiliser application rate, a number of seeds per pod increased significantly between the treatments with N_{0+1} and N_{0+1+2} compared with N_0 with mean values of 25.6, 23.8 and 19.0, respectively, although the increase was not statistically significant. Similar results were obtained for each of the hybrids and varieties examined (Table 2). Mean comparison for this trait showed that Majdan and Banačanka varieties had the lowest seed number per pod – 16.7 and 18.2 using N_0 treatment, while Speed and Albatros hybrids with 27.7 and 27.0, respectively, where the N_{0+1+2} treatment was applied, had the highest number of seeds per pod. A positive correlation between the number of seeds per pod and the application rates of N-fertilisers has also been reported in results of *Allen and Morgan* (1972), *Chauhan et al.* (1995) and *Faramarzi et al.* (2009). Other studies: *Vullioud* (1974) and *Cheema et al.* (2001) suggested a negative correlation between the N application rate and number of seeds per pod.

The seed yield of canola is a function of population density, number of pods per plant, number of seeds per pod and seed weight. However, yield structure

is very plastic and adjustable across a wide range of populations. Means of seed yield showed that N fertiliser had a significant effect on this characteristic. By increasing N rate from 70 (N_0) to 260 (N_{0+1+2}) kg/ha, the seed yield increased at 0.05 level. No significant increase in the seed yield was observed when the rate was increased from 190 (N_{0+1}) to 260 kg/ha. The maximum seed yield (2568 kg/ha) was obtained by plots that received N 260 kg/ha split in two top-dressings while the minimum seed yield (1535 kg/ha) was obtained by plot treated with N_0 as base fertiliser (Table 1). Analysing hybrids and varieties separately, positive yield response to higher N rates was observed only in Albatros, Rohan and Abakus hybrids where the highest seed yield from 3209 kg/ha, 3191 kg/ha and 2523 kg/ha, respectively, was obtained using two treatments of N. Other hybrids and varieties did not react significantly when nitrogen rate was increased. In the case of Hybrirock and Triangle hybrids, the increase in the amount of N (treatment N_{0+1+2}) led to a decrease in the seed yield compared with N_{0+1} treatment. Obviously, different genotypes, depending on certain environmental conditions, react positively or negatively to the increase in N-rates applied as top-dressing. Moreover, a lot of studies illustrate the positive effect of N on the seed yield of winter oilseed rape, some authors noting stagnation or reduction in seed yield at high rates of N-fertiliser (*Rathke et al.* 2006 and authors' quotes in the paper).

Tab. 1. The mean values of canola yield and yield characteristics depends of N top dressing
Srednje vrednosti prinosa repice i karakteristike prinosa u zavisnosti N-prihrane

Treatment Tretmani	Plant height Visina biljke (cm)	Number of branches/plant Broj grana/ biljka	Pod length Dužina mahuna (cm)	Number of seed/pod Broj semenki/ mahuna	Seed yield Prinos semena kg/ha
N_0	81.5	3.7	6.8	19.0	1534.7
N_{0+1}	90.5	4.4	7.1	23.8	1918.3
N_{0+1+2}	94.9	4.8	7.3*	25.6*	2568.2*
LSD (%5)	25.6	1.2	0.4	2.2	901.2

(N_0 = 70 kg/ha; N_{0+1} = 70+120 kg/ha; N_{0+1+2} = 70 + 120 + 70 kg/ha)

Conclusion

The study showed preliminary results of the effect of nitrogen top-dressing on the yield and part of the yield components of canola cultivars. According to the data which we obtained, the increased N fertiliser does not have any significant effect on the plant height and number of branches per plant. On an average level, increasing N fertiliser from 70 (N_0) to 260 kg/ha (N_{0+1+2}) length of the pod, number of seeds per pod and seed yield increased. However, no significant increase in the mentioned characteristics was observed when the rate was increased from 120 ($_{N0+1}$) to 260 kg/ha.

The results showed that some hybrids examined such as Albatros and Rohan had the significantly highest seed yield when nitrogen was applied two times. Together with Hybrirock hybrid, they are the most promising canola cultivars to be grown in the Skopje region.

Tab. 2. The mean values of yield and yield characteristics depends of N top-dressing on a hybrids/varieties level

Srednje vrednosti prinosa i karakteristike prinosa u zavisnosti N-prihrane hibrida/ sorte

Type Hibrid/ sorta		N-rates N-režim	Plant height Visina biljke (cm)	Number of branches/plant Broj grana/ biljka	Pod length Dužina mahune (cm)	Number of seed/pod Broj semenki/ mahuna	Seed yield Prinos semena kg/ha
Hibrirock	**H**	N_0	93.5	3.9	6.4	18.9	2184.2
		N_{0+1}	103.9	4.6	6.8	23.6*	2730.2
		N_{0+1+2}	104.0	4.4	6.8	24.6	2679.3
Triangle	**H**	N_0	78.5	3.3	6.8	17.7	1318.6
		N_{0+1}	87.2	3.8	7.2	22.1*	1648.3
		N_{0+1+2}	91.2	3.8	7.1	22.5	1393.6
Petrol	**H**	N_0	73.0	3.4	6.8	19.0	1435.8
		N_{0+1}	81.1	4.0	7.0	23.7*	1794.8
		N_{0+1+2}	96.2	4.8*	7.5*	26.4*	2315.0
Speed	**H**	N_0	83.5	3.2	7.0	20.4	1905.6
		N_{0+1}	92.8	3.8	7.4	25.5*	2382.1
		N_{0+1+2}	99.4	4.9*	7.4	27.7	2823.1
Artoga	**H**	N_0	84.2	4.0	6.4	20.1	1336.9
		N_{0+1}	93.5	4.7	6.8	25.1*	1671.1
		N_{0+1+2}	99.0	5.2	6.9*	26.5	2195.3
Albatros	**H**	N_0	86.7	3.8	6.8	20.8	1375.8
		N_{0+1}	96.3	4.5	7.1	26.0*	1719.6
		N_{0+1+2}	99.3	5.2*	7.2	27.0	3209.2*
Rohan	**H**	N_0	89.4	5.0	6.8	18.8	1863.6
		N_{0+1}	99.3	5.9	7.2	23.4*	2329.3
		N_{0+1+2}	101.5	6.5*	7.3	23.8	3191.1*
Abakus	**H**	N_0	78.7	4.0	7.3	19.7	1526.0
		N_{0+1}	87.4	4.7	7.7	24.6*	1908.7
		N_{0+1+2}	93.4	4.8	7.7	25.3	2522.7*
Banacanka	**V**	N_0	75.9	3.6	7.0	18.2	1494.1
		N_{0+1}	84.3	4.2	7.4	22.8*	1867.6
		N_{0+1+2}	87.1	4.4	7.7*	26.2*	2067.0
Majdan	**V**	N_0	71.3	3.0	6.3	16.7	905.2
		N_{0+1}	79.2	3.5	6.6	20.9*	1131.4
		N_{0+1+2}	77.9	3.4	7.0*	25.0*	1285.0
LSD (%5)			27.0	1.3	0.4	2.3	949.2

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Агрономске карактеристике хибрида озиме уљане репице од зависности азотне прихране

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Сажетак

Уљана репица је једна од значајних извора биљних уља у Свету. Потребе прихране код уљане репице су знатно веће од потребе прихране житарица. Упоређено са житарицама, зимска уљана репица захтева више расположљивог азота, који је важна компонента са јаким утицајем на принос и квалитет са једне стране, а са друге стране утиче на смањење садржаја уља. Хибриди зимских уљаних репица са високим потенцијалом родности, имају високе захтеве за азотом. Вигор биљака преко азотне прихране побољшава развој снажног кореновог система. У многим случајевима потреба азотне прихране не узима у обзир врсту *Brassica napus* L. већ се темељи на нормама ђубрења у складу са ванјским условима. Циљ ове студије је да процени резултате утицаја азотне прихране према приносу и компоненте приноса код 8 зимских хибрида и 2 зимске сорте уљане репице. Истраживање је спроведено у селу Глуво (код Скопља), у периоду од две године (2010/2011). Статистичка обрада је направљена према сплит-плот експерименталном дизајну, где се као главни фактор узимају 3 понављања и 3 азотна режима. Постављени третмани азотног режима су: N, N+120 кг N/ха, N+120+70 кг N /ха. Прихрана азотом, као основним ђубривом кореспондира са 70кг N/ха. Аплициране су две амонијум нитрат прихране у два наврата, 25-ог фебруара и 15-ог марта. Од добијених резултата може се закључити да код двојне прихране постоје статистички значајне разлике (P = 0.05) на принос хибрида односно сорти, број семена / љушпи и дужине махуна, у поређењу са једном прихраном и без прихране, али нема никакве сигнификантне разлике код висине биљке и броја примарних грана по биљци. На нивоу хибрида/сорте, за скопски регион, сматра се да највише обећавају или су најперспективније Hybrirock (KWS), Rohan (NPZ-Lembke) и Albatros (Limagrin).

Кључне речи: озиме уљане репице, азот, прихрана, принос, компоненте приноса

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Influence of trellis system on productive and technological characteristics of variety Victoria in Strumica vine growing district

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Summary

The data on productive and technological characteristics of Victoria variety grown on two trellis systems, pergola and espalier are shown in this paper. Mechanical composition of a bunch and a berry as well as chemical composition of the must were analysed. The results of investigation show that this variety has good results on either of the trellis systems, pergola and espalier in the Strumica vine growing district, the Republic of Macedonia. The Victoria's bunches from pergola are heavier and longer whereas the bunch and berries are wider, with uniform characteristics of berries and skin colour in comparison with bunches from espalier trellis system.

Key words: table grape variety, Victoria, pergola, spalier, yield, quality of grapes.

Introduction

The Victoria variety was created in Romania by crossing Cardinal and Afus Ali varieties by the picker Victoria Lepadatu. The grapes are big, cylinder-conical in shape, winged with average mass of 600-800 grams. The grains are very big, oval-oblong and white or green-yellowish, with amber bronze. They have dense and fleshy pulp with sweet pleasant taste. They contain 2-3 seeds. Yield is around 30-40 tons per hectare making it a very perspective variety. This variety has high transportability and a very appealing look. Taking into account that it is a new variety, recently created, it has, however, become quite popular in the countries of the Southern Europe, being considered as one of the basic early ripening white

varieties which contain seeds. It is mostly cultivated in the north of Greece, near the capital Thessaloniki and Kavala. (*Dragoljub M.Zunic 2010*).

It was introduced in all significant vineyards for production of table grapes – Gevgelija, Valandovo, Tikvesh, Strumica, Veles, and Radovish vineyards in the Republic of Macedonia in 1988. It ripens in I epoch, or in Tikves vineyards in the first and second decade of August, 10-14 days after Cardinal cultivar. Harvesting takes 30 days. Pruning is mixed with arches of 8 buds with intensive use of agro-technical and ampelo-technological measures. Its further expansion is recommended in Macedonian vineyards. (*Zvonimir Bozinovic, 2011*).

In the Republic of Macedonia, table grapes are grown on both pergola and espalier. The aim of our study was to examine the differences in production and technological characteristics of the Victoria grape variety grown on pergolas and espaliers.

Materials and methods

The research was carried out in the Strumicko- Radovishki vineyard, on the field of Agrolozar, Strumica. Productivity, yield, texture of grapes and berries, and chemical composition of the must of Victoria variety grown on two supporting constructions, pergola tendone and espalier, were examined. Each variant was analysed in four varieties or repetitions. Young plants were newly introduced from Italy. The rootstock is Paulsen 1103.

The plantation was 7 years old. It was raised in 2003. The vines are spaced at 2.5 x 2.4 m with 1667 vines per hectare on pergolas and 2.5 x 1.2 m with 3333 vines per hectare on espalier trellis systems. The yield of grapes was obtained by harvesting and weighing of all the clusters on a vine. Average cluster weight was obtained by measuring the weight of each cluster on a vine. Clusters were grouped according to the weight of 0.2 kg, 0.2 to 0.4 kg, 0.4 to 0.7 kg, 0.7 to 1 kg and the last group of over 1 kg. The yield and the percentage share of the total yield were calculated for each group. Grape harvest of both treated and untreated vines was conducted at the same date, according to full grape maturity reached by any of the treatments.

Measurement of grape yield per vine, mechanical analysis of both clusters and berries, and analysis of the chemical composition of the grape must were done in terms of sugar and acid content. Methods of the OIV – International Organisation of Vine and Wine – were employed. Statistical analysis was based on a completely randomised design at the significance level of 0.05 and 0.01.

Results and discussion

Pergolas in comparison to espaliers have an equal distance between rows (2.5 m) and twice the distance between vines in a row 2.5 m and 1.2 m. The number of lines was half the size of pergola, i.e. 1667 compared with 3333 vine / ha on espalier.

The yield of grapes per vine was 24.2 kg in pergolas compared with 12.0 kg on espalier. Despite these differences, the yield of grapes per unit area was equal in both versions and amounted to 40.3 t/ha on a pergola compared with 40.0 t/ha on espalier.

As for pergolas, there were 53 clusters, only 12.2 less clusters compared with 40.7 clusters on espalier. Although the number of clusters on pergola was not significantly greater, the weight of the grape on pergola with 466.0 g was heavier by 171.2 g than that on espalier, 294.9 g.

Tab. 1. Yield of Victoria variety on pergola tendona and shpalier trellis system
Prinos sorte Viktorija na pergola i špalir sistemu

Date of harvest 30 Avgust 2011			
Parameter	Pergola	Shpalier	Perg.–Shpa.
Distance between rows – m	2,5	2,5	0,0
Distance between vines in row – m	2,4	1,2	1,2
Number of vine per hectare	1667	3333	-1666,7
Number of cluster per vine	53	40,7	12,3
Yield - kg/vine	24,2	12,0	12,2
Yield - t/ha	40,3	40,0	0,3
Weight of cluster – gramme	466,0	294,9	171,2

Grapes grown on espaliers ripen faster compared to those on pergolas. Sugar content in pergolas is 148 g/dm3, 40 grams less than 188 g/dm3 on espaliers. The content of the total acids is 4 g/dm3 on pergolas and 3.0 g/dm3 on espaliers.

Tab. 2. Chemical content of must
Hemijski sastav šire

	Pergola	Shpalier	Perg.–Shpa.
Sugar g/dm3	148	188	-40
Total acids g/dm3	4,1	3,0	1,1
pH	3,51	3,82	-0,31
Index of sweetness	37	63	-26,1

This proportion of sugar and acid content is reflected in the perception of taste. Index sweetness of 37 points is ideal for pergolas unlike the sweetness index of 63 in espalier. Grapes harvested from a pergola are light green in colour, with a slight yellow hue and evenly coloured. The taste is pleasant, harmonious and refreshing. Grapes harvested from espalier are yellow, evenly coloured with brown shades on the sunny side. The taste is pleasant but with pronounced sweetness.

Victoria variety on both espaliers and pergolas had equal grape yields with weight from 0.4 to 0.7 kg. On pergolas, the yield was 43.7%, and 40.0% on espalier, with a difference of only 3%. Major differences occurred in the yield of grapes weighing above 0.7 kg.

The yield of grapes weighing from 0.7 to 1 kg on pergolas was 9.1 t/ha and 6.3 t/ha of clusters weighed over 1 kg, with a total yield of 15.4 t/ha of clusters weighing over 0.7 kg. The yield of clusters weighed from 0.7 to 1 kg on espaliers was 2.7 t/ha and 1.1 t/ha of clusters weighing over 1 kg for a total yield of 3.8 t/ha of clusters weighing above 0.7 kg. The yield of clusters weighing over 0.7 kg was by 11.6 t/ha higher on pergolas in comparison to espaliers.

The yield of clusters weighing between 0.2 and 0.4 kg was for 9.2 t/ha higher on espaliers in comparison to pergolas. Likewise, the yield of clusters weighing under 0.2 kg was for 3.5 t/ha higher on pergolas in comparison to espaliers. All groups of grapes from pergolas are useful for packaging.

Tab. 3. Yield of cluster with different mass in t/ha and %
Prinos grozdova različite mase u t/ha i %

	Pergola		Shpalier		Perg.–Shpa.	
Mass of cluster	t/ha	**%**	t/ha	%	t/ha	%
Up of 1 kg	6,3	**16,2**	1,1	3,1	5,2	13,1
Between 0,7-1 kg	9,1	**22,6**	2,7	6,8	6,4	15,7
Between 0,4-0,7 kg	17,7	**43,7**	16,4	40	1,3	3,7
Between 0,2-0,4 kg	4,5	**11,1**	13,7	34,5	-9,2	-23,4
Under 0.2 kg	2,6	**3,9**	6,2	4,7	-3,5	-0,8
Above 0,7 kg	15,4	**38,8**	3,8	9,9	11,6	28,8
Between 0,4-0,7 kg	17,7	**43,7**	16,4	40	1,3	3,7
Under 0.4 kg	7,1	**15**	19,9	39,2	-12,7	-24,2

The pergola cluster weight was 850.0 g, 90 grams higher compared to 760.0 g on espalier. The number of berries of normal size was almost equal in both pergolas (103.0) and espaliers (100.0). However, the number of atypical, very small berries was 41 in clusters of espalier compared to 9 in the clusters of pergola.

Tab. 4. Technological properties of clusters under 400 g
Tehnološke karakteristike grozdova ispod 400 g

Indicators – average	Pergola	Shpalier	Perg.–Shpa.
Cluster weight g	850,0	760,0	90,0
Weight of normal berries in cluster g	818,9	725,0	93,9
Weight of very small berries in cluster g	16,0	25,0	-9,0
Number of normal berries in cluster g	103,0	100,0	3,0
Number of very small berries in cluster g	9,0	41,0	-32,0
Weight of one normal berry g	8,0	7,3	0,7
Weight of one very small berry g	1,8	0,6	1,2

Normal berries weighed 8.0 grams on pergolas compared to 7 g of berries from espalier clusters. The espalier clusters of normally developed berries weighed less in comparison with espalier clusters. Many poorly developed unfertilised berries could be noticed on the espalier clusters, atypical for the variety, thus reducing the quality class and posed a problem for arranging during packing process.

On the other hand, big berries are present on pergola clusters, weighing 17.1 g and being 3.8 cm long and 2.8 cm wide compared with the largest clusters of espalier berries weighing approximately 13.2 g and being 3.1 cm long and 2.7 cm wide.

Tab. 5. Technological properties of berries
Tehnološke karakteristike bobica

Indicators	Pergola	Shpalier	Perg.–Shpa.
Weight of the largest berry g	17,1	13,2	3,9
Length of the largest berry cm	3,8	3,1	0,8
Width of the largest berry cm	2,8	2,7	0,1
Weight of 100 average berries	103,3	86,0	17,3
Skin %	6,0	4,1	1,9
Seeds %	1,2	1,6	-0,4
Flesh %	92,8	94,3	-1,6

The increase in the length of berries influences the weight gain, which seems very attractive. In clusters of pergola berries, the skin participates with 6% which is more compared to 4.1% on espaliers.

Conclusion

1. Victoria variety grown on both pergola (tendona) and espalier systems gives very fine grape quality in the conditions of Strumica vineyards, the Republic of Macedonia. The quality of grapes on the pergola is significantly better than the espalier in regards with all characteristics.

2. Growing vines on the pergola trellis system, with 1667 vines/ ha, three canes or 26.5 buds/ vine, we get 53 clusters/ vine with average mass of 466 g. The yield is 24.2 kg/ vine or 40.3 t/ ha, out of which the yield of clusters weighing over 0.7 kg is 15.4 t/ ha, the yield of clusters weighing from 0.4 to 0.7 kg is 17.7 t/ ha, and the yield of clusters weighing below 0.4 kg is 7.1 t/ ha.

3. Growing vines on the espalier trellis system, with 3333 vines/ ha and two canes or 15.75 buds/ vine, we get 40.7 clusters/ vine with average mass of 294.9 g. The yield is 12.0 kg/ vine or 40.0 t/ ha, out of which the yield of clusters weighing over 0.7 kg is 3.8 t/ ha, the yield of clusters weighing from 0.4 to 0.7 kg is 16.4 t/ ha, and the yield of clusters weighing below 0.4 kg is 19.9 t/ ha.

4. The Victoria variety grown on both cultivation systems gives a similar yield of 40 t/ ha, though the grape from pergolas has a greater mass of grapes, larger berries and greater number of large berries. It can be used for decoration more easily due to the small number of atypical berries. Further, it has a greenish skin colour and very pleasant refreshing flavour. Grapes grown on espaliers have a strikingly large number of atypical berries, yellow skin colour with shades of brown on the sunny side, weakly developed rachises and overly sweet flavour due to the inharmoniously high sugar content and very low content of total acids.

5. All groups of grapes on pergolas are useful for packing.

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Uticaj potporne konstrukcije na proizvodno tehnološkim karakteristikama sorte Viktorija u uslovima Strumičkog vinogorja

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Sažetak

U radu se prikazuju podaci o proizvodno tehnološkim karakteristikama sorte Viktorija gajene na dva tipa potpornih konstrukcija, pergola i špalir. Ispitivani su prinos, mehanički sastav grozda i bobice i hemijski sastav šire. Rezultati istraživanja su pokazali da se ova sorta može sa uspjehom gajiti na oba sistema, pergola tendone i špalir u uslovima strumičkog vinogorja, Republika Makedonija. Sorta Viktorija gajena na pergoli daje grozd sa većom težinom, dužinom i širinom grozda i bobica, gde bobice imaju ujednačenu veličinu i boju u odnosu na grožđe dobijeno na špalir.

Ključne reči: stone sorte, Viktoria, pergola, špalir, prinos, kvalitet grožđa.

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Risky periods of pesticide (insecticide and fungicide) pollution of vegetables grown in greenhouses

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Summary

Owing to the need of the population to consume vegetables in winter and spring (December-May), the production of vegetables grown in greenhouses is increasing, covering larger and larger areas. In order to protect vegetables from economically important pests, we often use a wide range of pesticides which are dangerous for the health of consumers. In connection with this, the observations in greenhouses with tomatoes and cucumbers were provided in three regions of the country, namely the following towns: Rakovski, Plovdiv and Perustitsa. During the whole vegetation period, phytosanitary status in the greenhouses was checked every week by reviewing individual plants. By growing-up tomatoes in glass greenhouses during the period from January to July, the following diseases were reported as predominant: Botrytis cinerea pers. and Alternaria porri f.sp.splani E et M., and pollution of the production was caused by fungicides. During the harvest, significant problems were caused by the pests: Myzodes persicae Sulz, Macrosiphum euphorbiae Thom., Liriomyza bryoniae Kalt. and the pollution was mainly by insecticides. As regards the cucumbers, grown in steel-glass greenhouses during the period from January to July, the problems of phytopathological character predominated: Fusarium, Erysiphe cichoracearum De Candolle, Pseudoperonospora cubensis Rostovzew. This imposed treatments more often and the pollution during that period was caused mainly by fungicides. The results obtained can be used for various technological solutions for the purpose of reducing the risk posed by the residual quantities of pesticides in the vegetables grown.

Key words: vegetables, pests, diseases, pesticides

Introduction

Growing vegetable crops (tomatoes, cucumbers) in cultivation premises is one of the most intensive sectors of agriculture. The complex consisting of diseases

and pests which deteriorate the quality of the obtained production necessitates the use of a variety of chemical devices.

In order to achieve the goal desired and to avoid the risks of using pesticides, they have to be applied within certain limits, at the exact time and under certain conditions (Sweet et al, 1990)

We know that the incorrect application of pesticides is dangerous for people's health and causes contamination of the environment (Hayes and Laws l991).

According to Clark et al. (1997), pesticides are mostly used before and during gathering of the crops.

In relation to this, the purpose of this study was to determine the risky periods of contamination of the vegetable crops grown in greenhouses as a result of applying the established plant-protection practice.

Materials and methods

The research was conducted during the period 2006-2009 in greenhouses planted with tomatoes and cucumbers in the regions of the following towns: Rakovski (180 decares), Plovdiv (60 decares) and Perushtitsa (60 decares). The observations were made once a week from January till July. We identified and registered plant-protection problems, decisions to solve them and phonological development of the cultivated plants.

Results and discussion

The conducted surveys show that the first several sprayings of tomatoes start within the period February-March (Figure 1). As a result of significant air humidity and inappropriately maintained heat and air regimen, there were favourable conditions for development of grey mould *Botrytis cinerea* Pers and brown leaf spots – *Alternaria porri f.sp.solani* E et.M. In order to prevent the diseases from spreading, 2-3 treatments were applied within 8-10 days using systemic fungicides (thiophanate methyl, benomil, symoxanil+mancozeb).

During the same period of time, we observed an increase in the number of greenhouse whiteflies - *Trialeurodes vaporariorum* Westw. and twospotted spider mites (*Tetranychus urticae* L., *Tetranychus atlanticus* \turkestani\ Mc Gregor, *Tetranychus cinnabarinus* Boisd.). In order to fight them, we conducted a number of treatments using nicotine insecticides (tiametoxam, imidacloprid+deltamethrin), synthetic pyretroids (alpha-cypermethrin, deltamethrin, lambda cyxalothrin) and acaricides (abamectin, bifenthrin, hexythiazox).

The observations show that the preparations used for fighting diseases and pests are within the established levels of biological efficacy regulated on the grounds of the approved doses. This leads to contamination of the environment where tomatoes are grown and people work, due to the fact that the attention has been focused on the efficiency of the pesticides.

Under the established growing scheme, the gathering of tomatoes started at the end of March and the beginning of April. During that period, the main problems

were entomological due to the dynamic nature of their development. Along with pests during the pre-harvest season, alphides also appeared (Peach alphides – *Myzodes persicae* Sulz., Potato alphides – *Macrosiphum euphorbiae* Thom.), tomato leafminer flies – *Liriomyza bryoniae* Kalt.). To fight these pests, we sprayed plants with preparations based on deltamethrin, alpha-cypermethrin, tau-fluvalinate, cypermethrin and abamectin.

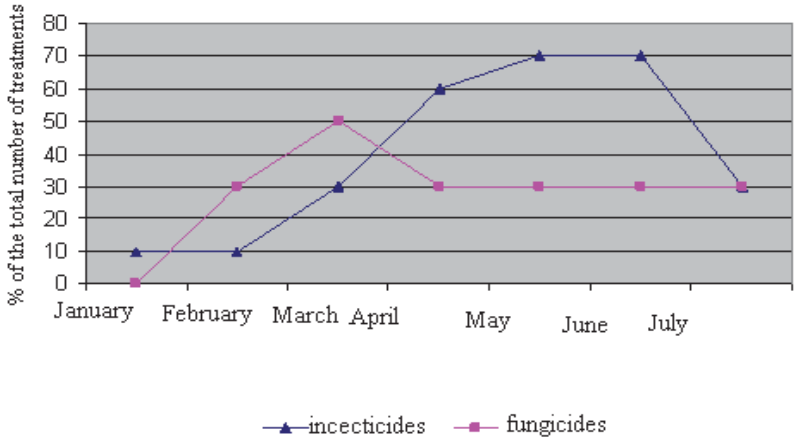

Fig. 1. Conducted treatments with insecticides and fungicides on tomatoes grown in greenhouses during the period from January to July
Sprovedena tretiranja insekticidima i fungicidima na paradajzu koji se uzgaja u staklenicima u periodu od januara do jula

In May, June and July, we continued to fight alphides, greenhouse whiteflies, leafminer flies and spider mites. We treated plants with synthetic pyretroids (alpha-cypermethrin, deltamethrin, lambda cyxalothrin) and acaricides (abamectin, bifenthrin, hexythiazox).

The conducted surveys show that the predominant diseases during the harvest period (January-mid-March) among the tomato plants grown in greenhouses were the following: alternaria and grey mould, whereas the contamination was mainly caused by fungicides. During the harvest period (March-July), the number of pests increased (greenhouse whiteflies, leafminer flies, spider mites), which required a number of treatments with insecticides and the production was mainly contaminated by them.

As a result of a three-year study, the first damages on cucumbers caused by thrips (Tobacco thrips – *Thrips tabaci* Lind., western flower thrips – *Frankliniella occidentalis* Pergande) and twospotted spider mites (*Tetranychus urticae* L., *Tetranychus atlanticus \turkestani* Uvarov rt Nikoloski, *Tetranychus cinnabarinus* Boisd.) were detected in February. In order to protect the plants against them, we used neonicotinoid insecticides (thiamethoxam, imidacloprid+deltamethrin),

synthetic pyretroids (deltamethrin, alpha-cypermethrin, cypermethrin) and acaricides (abamectin, bifenthrin, hexythiazox).

The harvest period of cucumbers grown in steel-and-glass greenhouses started in the second half of March (Figure 2). During that period, we detected damages caused by fusarium - *Fusarium* and powdery mildew – *Erysiphe cichoracearum* De Candolle. In order to restrict the spread of these diseases, we sprayed plants with preparations based on tiophanate - methyl, triadimenol, myclobutanil).

The pests that were active during that period were thrips, spider mites as well as greenhouse whiteflies *Trialeurodes vaporariorum* Westw. To fight these pests, we used neonicotinoid insecticides (thiamethoxam, imidacloprid+deltamethrin), synthetic pyretroids (deltamethrin, alpha-cypermethrin, cypermethrin) and acaricides (abamectin, bifenthrin, hexythiazox).

As a result of the emergence of alphides that have wings (Peach alphides – *Myzodes persicae* Sulz, Cotton alphides – *Aphis gossypii* Glov.), we established the development of the cucumber mosaic virus CMV – *Cucumber mosaic virus* in May. This required spraying with synthetic pyretroids and aphicides.

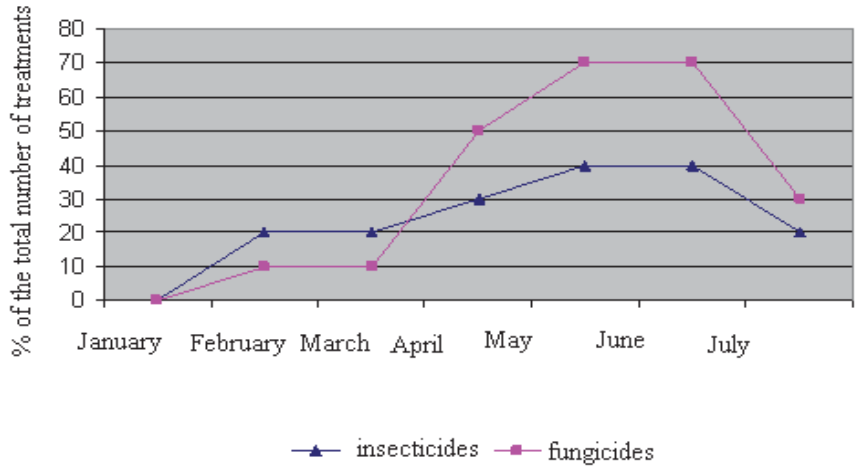

Fig. 2. Conducted treatments with insecticides and fungicides on cucumbers grown in greenhouses during the period from January to July
Sprovedena tretiranja insekticidima i fungicidima na krastavcu koji se uzgaja u staklenicima u periodu od januara do jula

In May, June and July, the main problems related to plant protection were phytopathological. Our priority was the fight against Cuban mildew – *Pseudoperanospora cubensis* Rostovzew and powdery mildew – *Erysiphe cichoracearum* De Candolle. This necessitated a larger number of treatments with short intervals of time between them (5-6 days) and we used systemic fungicides (aluminum fosethyl, dimethomorph, azoxystrobin). One of the main reasons for the

development of these pathogens was low temperature during the night, which caused formation of dew, and inadequately maintained air regimen.

At the same time, there was an increase in the number of greenhouse whiteflies and leafminer flies (*Liriomyza bryoniae* Kalt.) and we conducted a number of sprayings using preparations based on alpha-cymermethrin, cyromazine and deltamethrin.

The increase in the number of pests during that period was lower as a result of cultivation practices applied on cucumber plants – removing the upper leaves which cast a shadow on the plants located along the sprouts and also the lowest leaves of the central stem.

Based on our observations, we concluded that during the pre-harvest period, the density of pests was higher and the fight was mainly against them and the contamination was caused by insecticides. During the harvest period of cucumbers, phythopathogenic problems were more significant and the production was primarily contaminated with fungicides.

Conclusion

As a result of the conducted observations, we can draw the following conclusions:

- When growing tomatoes in glass-covered greenhouses, during the period from January till July, the main contamination of production and environment during plant-protection activities was caused by fungicides.
- During the harvest period of tomatoes, the contamination was mainly caused by insecticides.
- When growing cucumbers in steel-and-glass greenhouses during the period from January till July, the production obtained from the central stem was mainly contaminated with insecticides whereas the one obtained from the sprouts was contaminated with fungicides.

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Rizični periodi za zagađenje povrća pesticidima (insekticidi i fungicidi) uzgajanog u staklenicima

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Sažetak

Zbog potrebe stanovništva da konzumira povrće zimi i na proljeće (od decembra do maja), raste proizvodnja povrća uzgajanog u plastenicima i staklenicima pokrivajući sve veće površine. Da bi se povrće zaštitilo od ekonomski važnih štetočina, često koristimo različite pesticide koji su opasni po zdravlje potrošača. U vezi sa tim, sprovedena su ispitivanja u staklenicima u kojima se uzgajaju paradajz i krastavac u tri regiona koji uključuju gradove: Rakovski, Plovdiv i Perustitsa. Tokom cijelog perioda vegetacije, praćen je fitosanitarni status u staklenicima na osnovu pregleda pojedinih biljaka. Uzgoj paradajza u staklenicima u periodu od januara do jula prati pojava sljedećih dominantnih bolesti: Botrytis cinerea pers. i Alternaria porri f.sp.splani E et.M., a za kontaminaciju proizvodnje odgovorni su fungicidi. Štetočine koje su predstavljale najznačajniji problem tokom berbe su: Myzodes persicae Sulz, Macrosiphum euphorbiae Thom., Liriomyza bryoniae Kalt, a zagađenje je bilo uzrokovano uglavnom insekticidima. Uzgoj krastavaca u staklenicima (staklo i čelik) tokom perioda od januara do jula ometali su problemi fitopatološkog karaktera: Fusarium, Erysiphe cichoracearum De Candolle, Pseudoperonospora cubensis Rostovzew. Njihova pojava zahtijevala je još češća tretiranja, a zagađenje u ovom periodu uzrokovano je uglavnom fungicidima. Dobijeni rezultati mogu da se primijene u različitim tehnološkim rješenjima u cilju smanjenja rizika do kojih dolazi usljed ostataka pesticida u gajenom povrću.

Ključne riječi: povrće, štetočine, bolesti, pesticidi

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Упутство ауторима

Часопис "Агрознање научно - стручни часопис" објављује научне и стручне радове, који нису штампани у другим часописима. Изводи, сажеци, синопсиси, магистарски и докторски радови се не сматрају објављеним радовима, у смислу могућности штампања у "Агрознању".

Категоризација радова

"Агрознање" објављује рецензиране радове сврстане у сљедеће категорије: прегледни рад, оригинални научни рад, претходно саопштење, излагање на научном или стручном скупу и стручни рад.

Прегледни рад је највиша категорија научног рада. Пишу их аутори који имају најмање десет публикованих научних радова са рецензијом у међународним или националним часописима из домена научног питања које обрађује прегледни рад, што истовремено подразумијева да су ови радови цитирани (аутоцитати) у самом раду.

Оригинални нучни рад садржи необјављене научне резултате изворних научних истраживања.

Претходно саопштење садржи нове научне резултате које треба претходно објавити.

Излагање на научном и стручном скупу је изворни научни и стручни прилог необјављен у зборницима.

Стручни рад је прилог значајан за струку о теми коју аутор није досад објавио.

Сви радови подлијежу рецензији, а обављају је два рецензента из одговарајућег подручја.

Аутор предлаже категорију рада, али редакција часописа на приједлог рецензента коначно је одређује.

Припрема часописа за штампу

Прилог може бити припремљен и објављен на српском језику ћирилицом или латиницом и енглеском језику.

Обим радова треба бити ограничен на 12 за прегледни рад, а 8 страница за научни рад, А4 формата укључујући табеле, графиконе, слике и друге прилоге уз основни фонт 12 и 1,5 проред, те све маргине најмање 2.5 cm.

Радови се подносе редакционом одбору у два примјерка и на дискети, препорука је користити фонт Time New Roman CE.

Табеле, графикони и слике морају бити прегледни, обиљежени арапским бројевима, а у тексту обиљежено мјесто гдје их треба одштампати. Наслове табела и заглавље написати на српском и енглеском језику.

Текст прегледног рада треба да садржи поглавња: Сажетак, Увод, Преглед литературе, Дискусију или Анализу рада, Закључак, Литературу, Резиме (на једном од свјетских језика).

Текст оригиналног научног рада треба да садржи сљедећа поглавња: Сажетак, Увод, Материјал и метод рада, Резултати и дискусија, Закључак, Литература, Резиме на неком од свјетских језика.

Наслов рада треба бити што краћи, информативан, писан малим словима величине 14 п. Испод наслова рада писати пуно име и презиме аутора без титуле. Испод имена аутора писати назив и сједиште установе-организације у којој је аутор запослен.

Сажетак је сажет приказ рада који износи сврху рада и важније елементе из закључка. Сажетак треба да је кратак, до 150 ријечи, писан на језику рада.

Кључне ријечи пажљиво одабрати јер оне сагледавају усмјереност рада.

Увод излаже идеју и циљ објављених истраживања, а може да садржи кратак осврт на литературу ако не постоји посебно поглавље *Преглед литературе.*

Литература се пише азбучним односно абецедним редом са редним бројем испред аутора с пуним подацима (аутори, година, назив референце, издавач, мјесто издања, странице).

Summary писати енглеским или неким другим свјетским језиком ако је рад на српском или српским ако је рад писан неким од страних језика. То је превод сажетка са почетка рада. Обавезно навести преведен наслов рада са именима и презименима аутора и називом и сједиштем институције у којој раде.

Сви радови добијају УДК класификациони број.

Сви радови подлијежу језичној лектури и техничкој коректури, те праву техничког уредника на евентуалне мање корекције у договору са аутором.

Рукописи радова и дискете се не враћају.