SECTION 3: VEGETABLE, FLOWER AND DECORATIVE PLANTS PRODUCTION

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APPLICATION OF LANDSCAPE ARCHITECTURE IN RECULTIVATION OF OPEN PIT MINING IN BUKOVAC

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Abstract
The main purpose of elaboration of the General Design is getting an insight into the existing conditions of the unlicensed landfill, i.e., the open cut for excavation of clay within the former brick plant in Bukovats and through recultivation – adaptation of the available area to construction of a hippodrome with accompanying contents. The available documentation and the lack of results from surveys have conditioned a level of elaboration in accordance with the „Law on Planning and Constriction“ („Official Gazette of RS“ no. 47/2003). In further phases of elaboration of the design documentation, the necessary scope of research works will be conceived and done along with the creation of all the necessary conditions and obtaining of consents. Recultivation of the brick plant is basically a measure for preservation and protection of the environment as well as enhancement of the living conditions of the gravitating population of the urban media of Sremski Karlovats, Petrovaradin and Novi Sad. The anticipated construction of structures will enable opening of new jobs and a possibility of placement of organic food produced by individual farmers as are the bermet, the blackberry wine, the kugloff and other prducts of the surrounding population.
Key words: landscape architecture, recultivation, bukovac.

Introduction

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The available documentation and the lack of results from surveys have conditioned a level of elaboration in accordance with the „Law on Planning and Constriction („Official Gazette of RS“ no. 47/2003). In further phases of elaboration of the design documentation, the necessary scope of research works will be conceived and done along with the creation of all the necessary conditions and obtaining of consents. Recultivation of the brick plant is basically a measure for preservation and protection of the environment as well as enhancement of the living conditions of the gravitating population of the urban media of Sremski Karlovats, Petrovaradin and Novi Sad (Vitruvije, 1998). The anticipated construction of structures will enable opening of new jobs and a possibility of

placement of organic food produced by individual farmers as are the bermet, the blackberry wine, the kugloff and other prducts of the surrounding population.

Material and methods

Recultivation is aimed at creation of an interesting area accessible to people of all age and social groups or creation of space for special purposes (Stojcevsja at al, 2010). The preliminary solutions could be different:

- Retroffiting and return of the nationalized land to previous owners;
- Establishment of new ecologucally friendly habitations for the protection of authochtonous species;
- Spotanenous development of vegetation after closure of the open cut;
- Establishment of ecologically friendly areas for different purposes depending on potential users and their interests and hobbies if an urban environment is at stake;
- Establishment of food production plants if the area is in a protected zone.

In the case of application of landscape architecture in recultivation of degraded areas, it is necessary to analyze the main limitations and directions of the given space in accordance with the natural characteristics of the environment and the extent of physical chemical degradation of the area which is arranged (Sekularac at al, 2008). Then, the development of the existing infrastructure, the extent of isolation in respect to the environment, the closeness and the age structure as well as the hobbies of potential users are analyzed from the aspect of selection of the area purpose.Taking the old brick plant in Bukovats as an example, detailed analysis of natural conditions, urban environment, size of degraded area and needs of the city environment have been investigatied (Stoiljkovic, 2011). Due to the considerable length of the work, only description of the existing conditions and preliminary solution of the arrangement of the space is given in the results.

Results and discussion

The brick plant covers about 1.525 ha. On all sides, it is surrounded by residential structures. Existing conditions: the open cut has been used for uncontrolled disposal of communal and other waste by the population of Bukovats and Petrovaradin as well as the population of other inhabited places in the surrounding. Such uncontrolled refuse disposal has been going on for a number of years and has resulted in a considerable amount of waste on the considered location. The open cut is accessed by a road on the west side, from Bukovats direction, at a level of 90 m. The level of the open cut bottom varies from 87 to 90 m. The open cut has the form of an amphitheatre with a steep cut having a heigth of several tens of meters and an upper edge level of 102-110 m in south and east direction. On the Petrovaradin side, the edge of the excavation can be reached by Toma Maretic street. The street continues with the local road leading to the vineyards. At the entry on the left side, from the lower road from the direction of Bukovats, there is a porter's desk. On the left side, when entering the brick plant location, there are the abandoned production plants and the storehouses. The area covered with the structures and the access areas are asphalted. From the entry, in a straight direction, there is a hill which is with a height of 10 m in respect to the level of the excavation bottom. To the left from the entrance, when the part under vegetation and the structure on that side are passed, there is a smaller canal with a depth of about 1,5 m which is also overgrown with high grass and bushes. After that, there continues the open cut in the form of an amphitheatre covering

and area of about 47.65 ha. The area of about 0.825ha on the right side of the Bukovats road, from the Petrovaradin direction, also belongs to the brick plant. The general disposition of the structures is given on the site plan with presentation of the open cut and the production plants (Fig.1, Fig. 2a).

Figure 1. Geographic Position of the open cut of the brick plant in Bukovats covering an area of 50 ha

Figure 2. Prelimiary solution of disposition of the brick plant in Bukovats
2a) Existing production plants

Plant material: mainly self-seeding weed plants with individual dendrological species as are: in the production plant - *Platanus X acerifolia*, birch *Betula alba*, blue spruce *Picea pungens*, spruce *Picea alba*, arbor vitar *Thuja occidentalis*, willow *Salix alba*, cherry plum *Prunus cerasifer*, lilac *Syringa vulgaris*, cherry tree *Prunus avium*, while along the fence, a few specimens of *Juglans regia* (wallnut tree) are found. On the hill, in-between the production plant and the open cut, there are *Populus alba* (silver leaf poplars), *Salix alba* (willows), *Amorpha fructicosa* (false indigo), *Robinia pseudoacacia* (locusts), while the open cut is a non-arranged landfill with self-seeding bush species and grass.

Preliminary solution: From the analyses of the old brick plant area in Bukovats, construction of a hippodrome has been proposed by a preliminary solution (Vujkovic at al, 2003). The entire project

is divided into separate entities as given in Fig. 3. The hotel compound covers an area of 0.8 ha at the location of the former production plant. It is designed in the style of constrution and by selection of construction materials as those of the Petrovaradin fortress and the old core of Petrovaradin (stone, brick, wood, wrought-iron , and plain tiles for the roof). In the northwernmost part, in front of the main entrance into the hotel, there is a paved plateau with a diameter of 10 m from which there extend a number of paths toward the parking lot for the hotel guests. The hotel is in the form of cyrillic letter P, facing south. In the middle, there is a ground floor with carrefours of seasonal flowers and a grass area covering 0.18 ha (Fig. 3, position 1).In continuation of the ground floor, to the south, there is an open restaurant with a line of sight toward the race trackways and the lake (Fig. 3, position 4). The lake covers an area of 2400 m². It is of an irregualr shape and has a depth of 3 m. Below the lake is the underground room for accommodation of the system for water drive, physical, chemical and biological purification of the water. The circulation of water is realized with the smaller lake on the east edge of the open cut. The lakes and the waterfalls are decorated by stones of different forms and dimensions as well as water vegetation (Fig. 3, position 2 and 3). The east edge of the open cut is terraced, i.e., the terrain descends in cascades to the summer restaurant levelling level. The cascades are defined by retaining walls constructed of red brick and are adorned with corresponding plant material. The slope of the terrain is solved by footways and staircases. The cascades are used also in the creation of the river flow. Formed at the upper edge of the terrain is a smaller lake – a reservoir covering 100 m^2, with irregular shape and with a depth of 2 m. From this lake, there starts a water fall with a width of 1,5 and length of 70 m of meandering flow with cascades emptying into the large lake in front of the open restaurant at the lower plateau. At places where the cascade flow cuts the footways, small timber bridges are constructed.

The playground is situated west from the large lake, in the park spread over 3.7 ha. It covers an area of 250 m^2 and is enclosed by a timber fence. The playground constis of swings, seesaws, toboggan and climbers of different dimensions and shapes (Fig. 2b, 2e, Fig. 3, position 5). The gadgets are made of cast plastic and wood. The playground is adapted to children of different age. Within it, there is vegetation as a protection against the sun rays, while the area is covered with well maintained grass.

Figure 2b) Children's playground

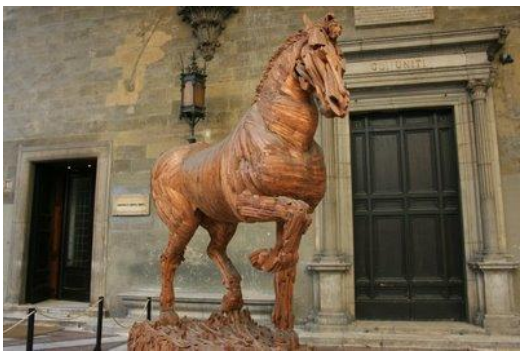

Figure 2e) Art gallery

The main entrance into the hippodrome is from the Petrovaradin direction, from the upper road. It represents a high gate of solid wood with wrought iron ornaments, door knockers and indivual safetydoor – net made of wrought iron that is kept down when the hippodrome does not work, i.e.,

when horse races are not held. Its width is 10 m, with a small pedestrian entrance on one wing of the gate, with a width of 3 m. The path with the width of the gate is bifurcated to the right up to the parking place and to the left, toward the ticket hall, the entrances into the stands and the betting house. The difference in height of the terrain is solved by stands for spectators constructed in a cascade manner under which there are business and production premises for different purposes. The line of sight of the stands is toward Frushka Gora mountain. The parking lot is further extended by an outdoor art gallery. The outdoor gallery – is the area between the main entrance on the Petrovaradin side and the small lake that falls into cascades into the lower lake, in front of the open door restaurant. This part covers an area of 0.10 ha consisting of pathways with cobbled pavement, multiannual vegetation, grassy areas and diamond shaped pavement beside the footways – the exhibiting area (Fig. 2c, 2d, Fig. 3, position 6).

Figure 2c) Children's playground

Figure 2d) Exhibition area

The race tracks are intended for galloping races without harnesses, races with jumps and harness races. The longer track is 1400 m, while the shorter one is 900 m long, which is designed according to the main parameters of length of racing tracks. The width of the tracks is 15 m. The space within the track is covered with grass. It is a gras cover made of fine grass resistant to stamping. Such area covers 9 ha. Here, there is also a system for automatic watering of the grassed area. The track itself is designed according to the standards referring to horse racing. (Fig. 3, position 8).

Underground stables and premises with equipment -These cover an area of 1000 m². There are 40 separate boxes for horses proportioned 3 x 5 serving for temporary accommodation of horses prior to the races. These premises serve for keeping equipment and machines necessary for the maintenance of the compound. Air is introduced by means of a built-in installation, while light is obtained through the glass roofs. From these premises, the horses exit, through a tunnel, onto the central part of the shorter trackway, where the horses are presented prior to the races and are warmed up. Opendoor stables and trackways for rushing out and training, horce racing club– serves for permanent accommodation of the horses. This area covers 1900 m^2. The stables are within the facilities and also have access to the fenced open area of a semicircular form. Beside the stables, theres is a smaller trackway of 300 m length that serves for training and exercising of horses. The precedure of construction 0f the trackway is the same as that for the big racing trackways (Fig. 3, position 10). Solar energy -The old brick plant in Bukovats is situated in a good location from the

Figure 3. Preliminary solution of arrangement of the brick plant in Bukovats
Legend: 1. Hotel compound; 2. Water areas – upper lake with a cascade flow; 3. Lower lake with the park area; Opendoor restaurant; 5. Children's playground; 6. Gallery; 7. Stands and business premises; 8. Racing track; 9. Production of branded food; 10. School for riding.

aspect of exposure to the Sun which is a great advantage as to utilization of the solar enegy. From that reason, active and passive solar energy has been used in the design. According to the preliminary solution, the solar collectors are placed on the roofs of the hotel compound and the business premises of the upper plateau. Passsive solar enegy has been used in the maximum orientation of the facades toward south (the longest daily insolation) with underground parts of the bussiness premises to the south and east.

Conclusions

The measures for repair of unlicensed landfills contribute to improvement of protection of the eneivonment. The anticipated purpose (compound for holding horse races, riding school and use of stable muck for production of mushrooms in the re-designed brick plant, then production of humus and biogas, construction of wine cellars) enriches the offer of branded products of Frushka Gora and

the tourist offer of Novi Sad. The energy supply of the hippodrome is done through production of biogas and solar cells as an ecologial energy for maintenance of the hippodrome and the business premises throughout the entire year. There is no danger of pollution of underground waters since there are no springs neither underground waters on the present location.

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ПРИМЕНА НА ПЕЈСАЖНА АРХИТЕКТУРА ВО РЕКУЛТИВАЦИЈА НА ОТВОРЕН КОП ВО БУКОВАЦ

Драгица Стојилковиќ, Јована Стојчевска, Милица Рајиќ, Бисерка Димишковска

Апстракт

Главна цел на изработката на Главниот проект е да се добие увид во постојните услови на нелиценцирана депонија, односно површински коп за глина во рамките на бивша циглана во Буковац и преку рекултивација – адаптација на расположивата површина, да се изгради хиподром со придружни содржини. Достапната документација и недостигот на резултати од истражувања условија ниво на изработка во согласност со Законот за планирање и градење (Службен весник на РС бр. 47/2003). Во понатамошните фази на изработка на проектната документација, ќе биде замислен и извршен неопходниот обем на истражувачки работи заедно со создавање на сите неопходни услови и добивање на дозволи. Рекултивацијата на цигланата во основа претставува мерка за сочувување и заштита на природната средина како и подобрување на условите за живеење на гравитирачкото население од урбаните средини на Сремски Карловац, Петроварадин и Нови Сад. Предвидените градби ќе овозможат отворање на нови работни места и можност за пласман на органска храна произведена од индивидуални фармери како што е бермет, вино од капини, куглоф и други производи на околното население.

Клучни зборови: пејсажна архитектура, рекултивација, буковац.

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Review Article

THE IDENTIFICATION, VALORIZATION AND PROTECTION OF HISTORICAL PARK SURFACES OF THE GREAT PARK IN SARAJEVO

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Abstract
The park heritage of Bosnia and Herzegovina is not recorded nor evaluated, and its historic gardens and parks are not categorized, and a very few of them are protected as monuments of landscape architecture or cultural monuments. The Great Park, located in one of the most frequent parts of Sarajevo, has the outstanding horticultural and historical significance. It has partially lost their functional and aesthetic value, because of the devastation during the war of the 1992- 1995, but also because of poor maintenance and unorganized planting of trees and shrubs after the war. Given the fact that the Great Park is the first public park in Sarajevo, formed in 1885, its value can also be observed from the culturally-historical aspect. It is therefore necessary to perform the evaluation of this green area, and determine the actual state of plants and architectural elements, and suggest methods of reconstruction that would restore or emphasize their functional, biological and ecological value. The choice of plant species in the reconstruction of the Great Park must fulfill all the functions that are required of this green area: decorative-aesthetic, sanitary-hygienic and culturally-educational.
Key words: Great Park Sarajevo, historical green areas, identification, valorization, protection.

Introduction

Based on its size and location, the Great Park in Sarajevo is classified as a city park, and its primary function is to bring the nature closer to the urban people and provide the peaceful place for active and passive relaxation. It is located in the Center municipality of the city, bordered by the streets Titova, Džidžikovac and Tina Ujevića.

One of the first schemes of the Great Park was made in 1885. by Hugo Krvarić, and it is believed to be the first park project in Bosnia and Herzegovina - until then, there were no public green areas, but a small private garden around each house, where trees and shrubs were planted randomly. The park was created during 1890-1895, and it has a very interesting concept, mostly informal landscape style, and several classical-style elements in the central part. The park was damaged during the World War II, and renewed in 1952, keeping its original appearance (Kulenović, 1960).

The Great Park has the area of 29,2 ha, and is divided to 22 surfaces by concrete paths (Figure 1). This green area is the valuable monument of cultural, historical and biological heritage of the city of Sarajevo, and has the following functions (Ljujić-Mijatović & Mrdović, 1998):

- Sanitary-hygienic: since it is located in a central part of the city, where there is a large traffic frequency, it has the important role in reducing air pollution by intercepting particulate matter and

absorbing gaseous pollutants, thus improving the air quality, the urban climate, and also reducing the noise levels;

- Decorative-aesthetical: the Great Park has a beautifully designed layout that is neatly combined with the architectural solution of the Austro-Hungarian period part of the city of Sarajevo. The main part of the park is formed in informal landscape style, with several classical-style elements in the central part, which gives this green area an exceptional visual effect;
- Culturally-educational: since the Great Park is the first public green area in Sarajevo, built according the plan during the Austro-Hungarian monarchy, it represents the part of cultural and historical heritage. Also, because of a large number of plant species, the surface of this park can be used as a "outdoor classroom" for education of school children and natural sciences students.

Figure 1. The copy of the cadastre plan of the Great Park Sarajevo (Institute of Planning and Development of the Sarajevo Canton)

The primary vegetation of Sarajevo was mostly destroyed or changed due to urbanization. In the past, the location of today's Great Park was covered with the forests of common oak and hornbeam (*Carpino betuli – Quercetum roboris*) on pseudogley. Those woodlands are characterized by *Quercus robur* L. and *Carpinus betulus* L., along with *Ulmus laevis* Pal., *Acer campestre* L., *Tilia platyphyllos* Scop., *Corylus avellana* L., *Euonymus europaeus* L., *Cornus mas* L., *Prunus spinosa* L. and *Cornus sanguinea* L. (Lakušić, 1988). The area where the Great Park is located has the moderate continental climate, influenced by the middle-European climate from the north and Mediterranean climate from the south, characterized by warm summers and snowy winters (Drešković, 2003). Parks can be defined as architectural objects made of organic material (Obad Šćitaroci, 1992), and they are the documents of the culture and the time that they were created in. The parks are very prone to degradation, either by the influence of nature (strong winds, snows, plant diseases) or human factors, mostly bad maintenance or bad choice of plan material.

Material and methods

The research work of this paper was conducted on the green area of the Great Park in Sarajevo, during the summer of 2011. The plants were identified using the determination key (Domac, 2002) and the available literature regarding ornamental shrubby and woody plants (Janjić, 1966, 1984, 1998; Russe & Cutler, 2004; and Šilić, 1990, 1973). The percentage of evergreen and deciduous species and cultivars was calculated, and the suggestions for introducing new plant species were given according to ecological characteristics of the Great Park location.

Results and discussion

During this research, 74 species and cultivars (44 trees and 30 shrubs) were identified. The results are presented in tables 1 and 2.

The shrubs are planted in large, irregular, mixed groups, so it was not possible to provide the exact number of plants. The analysis of dendrological composition of the Great Park in Sarajevo shows that there is a large deficiency of evergreen plant species, which gives this green area insufficient decorative effect during the late autumn and winter. Of total 44 tree species and cultivars, 40 (90,9%) are deciduous and only 4 (9,1%) evergreen, and of 30 shrub species 23 (76,6%) are deciduous and 7 (23,4%) are evergreen (Figure 2). Of total 44 tree species and cultivars, 30 (68,18%) are autochthonous, and 14 (31,82%) allochthonous, which is a very good ratio, in accordance with Obad Šćitaroci (1992) - the base of the green area is formed using autochthonous plants, that are already adapted to the ecological conditions of the given space, and the composition is later filled with the exceptionally ornamental species, that can be allochthonous, but resistant to climatic factors in the urban conditions. Of 30 shrubs, there are 14 (46,6%) autochthonous and 16 (53,4%) allochthonous species and cultivars (Figure 3). When choosing the trees for the public green areas, the most important characteristics that must be taken into consideration are the height, size and shape of the crown, shape and color of leaves, flowers and fruits. It is also important to combine trees with interesting fall colors and evergreens, so that the green area would have decorative effect in every time of the year.

Table 1. Trees in the Great Park in Sarajevo

Scientific/latin name	Type	Origin	Quantity
Acer campestre L.	deciduous	autochthonous	29
Acer heldreichii Orph. ex Boiss	deciduous	autochthonous	2
Acer obtusatum Waldst. & Kit. ex Willd	deciduous	autochthonous	1
Acer platanoides L.	deciduous	autochthonous	29
Acer platanoides 'Drummondii'	deciduous	autochthonous	4
Acer pseudoplatanus L.	deciduous	autochthonous	31
Acer tataricum L.	deciduous	autochthonous	1
Aesculus carnea Hayne	deciduous	allochthonous	1
Aesculus hippocastanum L.	deciduous	allochthonous	32
Ailamthus altissima (Mill.) Swingle	deciduous	allochthonous	10
Betula pendula Roth.	deciduous	autochthonous	3
Carpinus betulus L.	deciduous	autochthonous	5
Catalpa bignonioides Walt.	deciduous	allochthonous	1
Chamaecyparis lawsoniana (Murr.) Parl.	evergreen	allochthonous	1
Cornus mas L.	deciduous	autochthonous	1
Fagus silvatica L.	deciduous	autochthonous	4
Fraxinus angustifolia Vahl.	deciduous	autochthonous	1
Fraxinus excelsior L.	deciduous	autochthonous	24
Fraxinus ornus L.	deciduous	autochthonous	4
Fraxinus pennsylvanica Marshall	deciduous	allochthonous	1
Ginkgo biloba L.	deciduous	allochthonous	3
Gleditschia triacanthos L.	deciduous	allochthonous	6
Juglans regia L.	deciduous	autochthonous	1
Larix decidua Mill.	deciduous	autochthonous	1
Morus alba L.	deciduous	allochthonous	1
Picea abies (L.) Karsten	evergreen	autochthonous	11
Picea pungens 'Glauca'	evergreen	allochthonous	3
Pinus nigra Arnold	evergreen	autochthonous	9
Platanus × *acerifolia* (Aiton) Willd.	deciduous	allochthonous	8
Prunus avium L.	deciduous	autochthonous	11
Prunus cerasifera Ehrh.	deciduous	autochthonous	4
Prunus cerasifera 'Atropurpurea'	deciduous	autochthonous	3
Prunus padus L.	deciduous	autochthonous	4
Quercus robur L.	deciduous	autochthonous	9
Quercus rubra L.	deciduous	allochthonous	1
Robinia pseudoacacia L.	deciduous	allochthonous	16
Sophora japonica L.	deciduous	allochthonous	5
Sorbus torminalis (L.) Crantz	deciduous	autochthonous	6
Tilia cordata Mill.	deciduous	autochthonous	15
Tilia platyphyllos Scop.	deciduous	autochthonous	37
Tilia tomentosa Moench	deciduous	autochthonous	21
Ulmus glabra Huds.	deciduous	autochthonous	3
Ulmus laevis Pallas	deciduous	autochthonous	3
Ulmus minor Mill.	deciduous	autochthonous	12
Total			378

Table 2. Shrubs in the Great Park in Sarajevo

Scientific/latin name	Type	Origin
Berberis thunbergii 'Atropurpurea'	deciduous	allochthonous
Chaenomeles japonica (Thunb.) Lindl.	deciduous	allochthonous
Cornus alba 'Sibirica'	deciduous	allochthonous
Cornus sanguinea L.	deciduous	autochthonous
Corylus avellana L.	deciduous	autochthonous
Cotoneaster horizontalis Dcne.	deciduous	allochthonous
Crataegus monogyna Jacq.	deciduous	autochthonous
Euonymus europaeus L.	deciduous	autochthonous
Forsythia × *intermedia* Zab.	deciduous	allochthonous
Ilex aquifolium L.	evergreen	autochthonous
Juniperus × *media* Melle	evergreen	allochthonous
Juniperus virginiana 'Gray Owl'	evergreen	autochthonous
Ligustrum vulgare L.	deciduous	autochthonous
Lonicera nitida L.	evergreen	allochthonous
Lonicera pileata Oliver	deciduous	allochthonous
Lonicera tatarica L.	deciduous	allochthonous
Mahonia aquifolium (Pursh) Nutt.	evergreen	autochthonous
Philadelphus coronarius L.	deciduous	allochthonous
Physocarpus opulifolius (L.) Maxim.	deciduous	allochthonous
Rosa canina L.	deciduous	autochthonous
Rosa × *hybrida* Vill.	deciduous	allochthonous
Sambucus nigra L.	deciduous	autochthonous
Spiraea × *billardi* Meehan	deciduous	allochthonous
Spiraea × *vanhouttei* (Briot.) Zbl.	deciduous	allochthonous
Symphoricarpos albus (L.) Blake	deciduous	allochthonous
Syringa vulgaris L.	deciduous	autochthonous
Taxus baccata L.	evergreen	autochthonous
Thuja occidentalis L.	evergreen	allochthonous
Viburnum lantana L.	deciduous	autochthonous
Viburnum opulus L.	deciduous	autochthonous

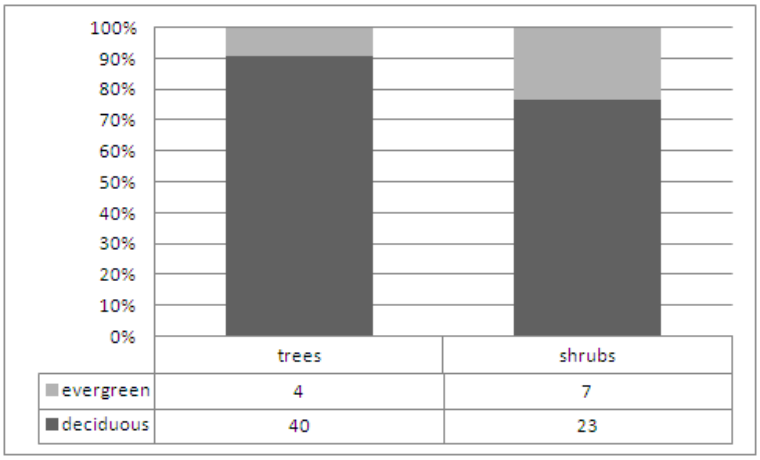

Figure 2. The total number and the ratio between deciduous and evergreen plants in the Great Park in Sarajevo

It is necessary to plant more evergreen plants, that are resistant to climatic factors in Sarajevo: *Pinus sylvestris* L., *Prunus laurocerasus* L., and to increase the number of *Picea abies* (L.) Karsten, *Pinus nigra* Arnold and *Mahonia aquifolium* (Pursh) Nutt. When choosing shrub species, it is recommended to plant more flowering shrubs, in order to improve the colour of the park during spring and summer: *Potentilla fruticosa* L., *Spiraea* × *bumalda* 'Elegans', *S. media* F. Schmidt, *S. ulmifolia* Scop., and *Hibiscus syriacus* L.

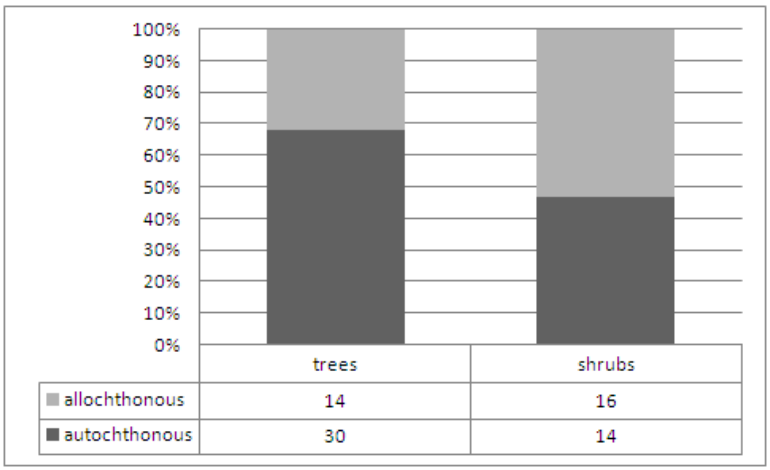

Figure 3. The total number and the ratio between autochthonous and allochthonous plants in the Great Park in Sarajevo

Although the ratio between autochthouous and allochthonous plants in the Great Park is satisfactory, it is recommended to plant more *Picea omorika* (Pančić) Purk and *Buxus sempervirens* L. – autochthonous evergreen plants that have very high ornamental properties and are highly resistant to climatic factors in Sarajevo. The choice of plant species and cultivars for should fulfill

all functions that are expected from this type of green area, and the plants should be able to endure drought and low winter temperatures.

Conclusions

After the identification and valorization of green area of the Great Park in Sarajevo, the following conclusions can be made:

- The Great Park, located in the Center municipality of the city of Sarajevo, is the first public green area in Bosnia and Herzegovina created during the rule of Austro-Hungarian monarchy, and is the valuable monument of cultural, historical and biological heritage.
- During this research, 74 species and cultivars (44 trees and 30 shrubs) were identified.
- Of total 44 tree species and cultivars, 30 (68,18%) are autochthonous, and 14 (31,82%) allochthonous.
- Of 30 shrubs, there are 14 (46,6%) autochthonous and 16 (53,4%) allochthonous species and cultivars.
- There is a large deficiency of evergreen plant species, which gives this green area insufficient decorative effect during the late autumn and winter. Of total 44 tree species and cultivars, 40 (90,9%) are deciduous and only 4 (9,1%) evergreen, and of 30 shrub species 23 (76,6%) are deciduous and 7 (23,4%) are evergreen.
- It is necessary to plant more evergreen plants, that are resistant to climatic factors in Sarajevo.
- When choosing shrub species, it is recommended to plant more flowering shrubs, in order to improve the colour of the park during spring and summer.

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ИДЕНТИФИКАЦИЈА, ВАЛОРИЗАЦИЈА И ЗАШТИТА НА ИСТОРИСКИТЕ ПАРКОВИ ПОВРШИНИ ВО ГОЛЕМИОТ ПАРК ВО САРАЕВО

Авдиќ Јасна, Сарајлиќ Нермина, Бечиќ Берина

Апстракт

Наследството на паркот во Босна и Херцеговина не е запишано или евалуирано, неговите историски градини и паркови не се категоризирани, а многу мал дел од нив се заштитени како споменици на пејзажната архитектура или како културно-историски споменици. Големиот Парк, лоциран во еден од најфрекфентните делови на Сараево, има исклучително хортикултурно и историско значење. Делумно ја има изгубено својата функционална и естетска вредност заради уништувањата во текот на војната од 1992 до 1995 година, но исто така и поради слабото одржување и неорганизираното садење на дрвја и грмушки. Со оглед на фактот дека Големиот Парк е прв јавен парк во Сараево, основан во 1885 година, неговата вредност може да се набљудува и од културно-историски аспект. Затоа е потребно да се изврши проценка на оваа зелена површина, да се утврди фактичката состојба на растенија и да се предложат методи за реконструкција со што ќе се обнови или нагласи нивната функционална, биолошка и еколошка вредност. Избор на растителни видови за реконструкција на Големиот Парк мора да ги исполни сите функции кои што треба да ги има една зелена површина: декоративни-естетски, санитарно-хигиенски и културно-образовни.

Клучни зборови: големиот парк во Сараево, историски зелени површини, идентификација, валоризација, заштита.

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Original scientific paper

DYNAMICS OF NO_3-N IN THE SOIL UNDER PEPPER AS DEPENDENT ON FERTILIZATION SYSTEMS AND MULCHING

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Abstract
In a field trial set up on the research field of Agricultural station in Sombor, the effect of different fertilization systems and mulching on yield of pepper (varieties) and mineral nitrogen (N) dynamics in soil were studied. Trial was conducted during 2010 and 2011 cropping seasons. Pepper was grown with and without plastic foil as a ground cover, and on both mulching systems it was applied 240 kg N ha^{-1} in total, through different fertilization systems. Four organic fertilizers were applied: mature cattle manure (MCM); composted pig manure (CPM); vermicompost (G) and organic fertilizer *Fertor* (F). Each organic fertilizer was applied in two different amounts which contained 120 and 240 kg N ha^{-1}. On the same plots, mineral N fertilizers were added to fulfill target value for N application (240 kg N ha^{-1}). The monitoring of NO_3-N in soil during the pepper growing season has shown that the mineralization of organic fertilizers was most intense in the first half of vegetation, while in the second, during the yield formation, concentration of mineral nitrogen in soil was significantly reduced. Concentration of mineral N in soil under plastic mulch was significantly higher compared to plots without mulch. Yield of pepper in first and second term of harvest were positively correlated with concentration of mineral N in soil.
Key words: soil, NO_3-N, fertilization systems, pepper, yield.

Introduction

Vegetable cultures produce high yields during a short vegetation period so they have greater demands for nutrients, primarily nitrogen, which is an essential factor affecting yield. In order to achieve high and stable good-quality yields in a short vegetation period of vegetable crops, not only mineral but also organic fertilizers need to be applied. Mineral fertilizers are fast-acting sources of nutrients. Organic fertilizers have a twofold effect on crops as they not only provide nutrients for the crops but they also positively affect the physical and biological properties of the soil. Organic fertilizers contain higher proportions of nutrients in an organic form, which is only after mineralization transformed into plant-available forms. It is therefore necessary to access the mineralization potential of organic matter in the fertilizer by following its nitrate dynamics so that the choice of an appropriate fertilizer and the time of its application can be coordinated with the demands of the crops (Čabilovski, 2009). Nitrate dynamics in the soil is affected by numerous factors, the most important of which are temperature and humidity. Soil humidity directly affects the mineralization process and thus the mineral nitrogen content in the soil.

Low or excessive humidity can be stressful for microorganisms in the soil and it can inhibit their growth (Stanford and Epstein, 1974; Myers *et al*., 1982; Bogdanović *et al*., 2001; Ubavić *et al*.,

2005), while alternating high and low levels of humidity increase the amount of fast-mineralizing material. Temperature directly affects the decomposition of organic matter, while the microorganisms that are involved in the process have different temperature oscillations. Vegetable production in an open field occurs in the period of constant increase of soil temperature (10-15-25-30ºC) and, as intensive vegetable production is not possible without irrigation, this means that there are favourable conditions for the mineralization of applied organic fertilizers and organic matter in the soil. The rate of organic fertilizer mineralization is determined by the type of fertilizers, the degree of decomposition of organic matter, temperature, humidity and microbiological activity (Pansu and Truries, 2003). Due to intensive mineralization, an excessive application of organic fertilizers can lead to an increased accumulation of NO_3-N in the soil, harmful accumulation in the plants and pollution of the environment. The objective of this research is to assess the effect of different systems of fertilizing pepper grown under polyethilene (PE) foil and without PE foil on NO_3-N dynamics in the soil and their effect on the yield.

Material and methods

The dynamics of NO_3-N in pepper production was observed in field experiments set up using a split plot design with and without PE foil. The experiments are two-factorial, where factor A is the fertilization systems and B is the use of PE foil as mulch (Table 1).

Table 1. Treatments of fertilization and mulching

Number of treatments	Treatments of fertilization systems
1	Control–no fertilizer
2	100% of N dose applied through NPK[1] mineral fertilizers
3	50% of N dose applied through mature catle manure (MCM) and 50% N through NPK mineral fertilizers
4	100% of N dose applied through MCM
5	50% of N dose applied through vermicompost (V) + 50% applied through NPK mineral fertilizers
6	100% of N dose applied through V
7	50% of N dose applied through composter organic fertilizer *FERTOR* (F) + 50% applied through NPK mineral fertilizers
8	100% of N dose applied through F
9	50% of N dose applied through composted pig manure (CPM) + 50% applied through NPK mineral fertilizers
10	100% of N dose applied through CMP
	Mulch treatments
1	Use of black polyethilene foil as ground cover
2	Without use of black polyethilene foil

Table 2 gives the initial results of agrochemical analyses of the soil before planting. The soil in the experiments is hydromorphic, of semigley type (meadow black soil) with the following properties:

Table 2. Agrochemical properties of soil in exspperiments before pepper planting

Year	Depth	pH		$CaCO_3$ (%)	humus (%)	total N (%)	mg $100g^{-1}$		mg NO_3-N kg^{-1}	
		H_2O	KCl				P_2O_5	K_2O	before planting	after planting
2010	0-30	7.60	7.0	4.59	3.12	0.16	21.9	22.1	36.0	27.0
	30-60	7.80	7.0	5.42	2.96	0.15	14.3	21.0	41.6	38.0
2011	0-30	8.01	6.85	3.82	2.48	0.12	17.8	21.3	46.4	30.0
	30-60	8.11	6.98	13.58	1.99	0.10	6.7	16.5	22.1	23.0

Neutral reactions, weak to medium carbonate, medium to poor in humus for vegetable production, medium supplied in total and mineral nitrogen, medium to poor in easily available phosphorus and medium supplied in easily available potassium.

- For the analysis of soil fertility standard methods were used.

-NO_3-N in the soil was measured in the 0-30 and 30-60cm layers four times during vegetation: before planting the seedlings, during intensive growth, before the first and second harvest. Analysis of mineral nitrogen in soil was done by Nmin method of Scharpft and Wehrmann (1978). The chemical composition of the applied fertilizers is given in Table 3 and Table 4.

Table 3. Chemical compozition of applied organic fertilizers at the exsperiment

Organic fertilizers	% N		% P_2O_5		% K_2O	
	2010	2011	2010	2011	2010	2011
Composted pig manure (CPM)	1.30	3.07	3.58	4.90	1.68	1.32
Mature catle manure (MCM)	1.20	2.20	1.82	3.17	0.33	0.91
Vermicompost (V)	1.50	1.38	1.75	2.15	1.83	0.96
Organic fertilizer *Fertor* (F)	4.50	4.25	2.70	2.90	2.30	2.30

On the basis of nitrogen content in the organic fertilizers, the amounts were calculated depending on the treatment applied in the pepper fertilization experiment (Table 1).

Table 4. Concentration of micronutrients and heavy metals in organic fertilizers

Organic fertilizers	Mn (mg kg^{-1})	Fe (mg kg^{-1})	Zn (mg kg^{-1})	Cu (mg kg^{-1})	Cd (mg kg^{-1})	Ni (mg kg^{-1})	Pb (mg kg^{-1})
Mature catle manure (MCM)	177	1087	35.8	5.54	1.56	78.86	7.12
Composted pig manure (CPM)	123	792	170.1	31.69	1.52	88.62	3.63
Vermicompost (V)	171	1054	45.2	8.9	1.59	59.34	7.78

Pepper seedlings of the Amfora variety were obtained from Grow rasad company from Irig. The pepper was planted towards the end of May in both years, with 25cm within-row and 50cm between-row distance, which gave 8 plants per m^2. The first and the second harvests were

performed during optimum technological maturity. The research results were processed by variance analysis for a two-factorial experiment.

Results and discussion

NO_3-N dynamics in the soil under pepper with and without foil, dependent on applied fertilization systems, and fertilization treatments in 2010 and 2011 is given in Figure 1 and Figure 2. In both years a higher amount of NO_3-N was detected at all sampling times, with all systems and fertilization treatments in pepper under foil than in pepper without foil.

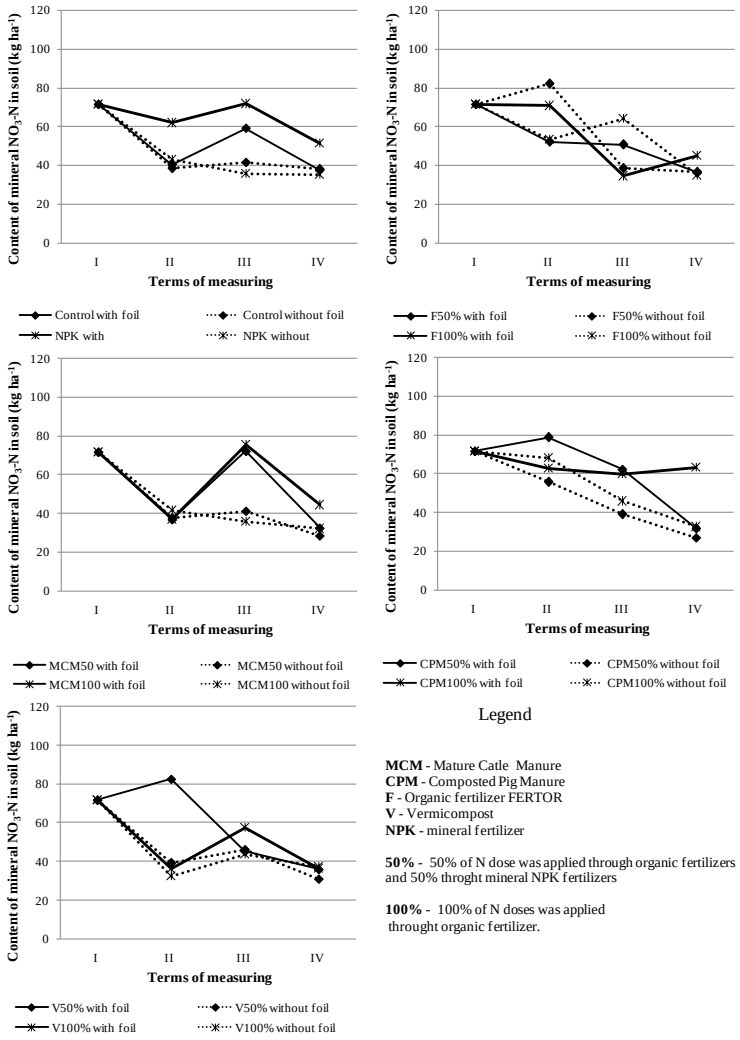

Figure 1. NO_3-N dynamics in the soil under pepper with and without foil, dependent on applied fertilization systems, and fertilization treatments in 2010

Significantly higher amounts of NO_3-N were found in the soil under foil than in the soil without foil because of better mineralization conditions. The basic prerequisite for a better mineralization of

organic fertilizers is a 2-3^{o}C higher temperature and 1.5%-2.5% higher soil humidity in the experiment under foil when compared to the experiment without foil.

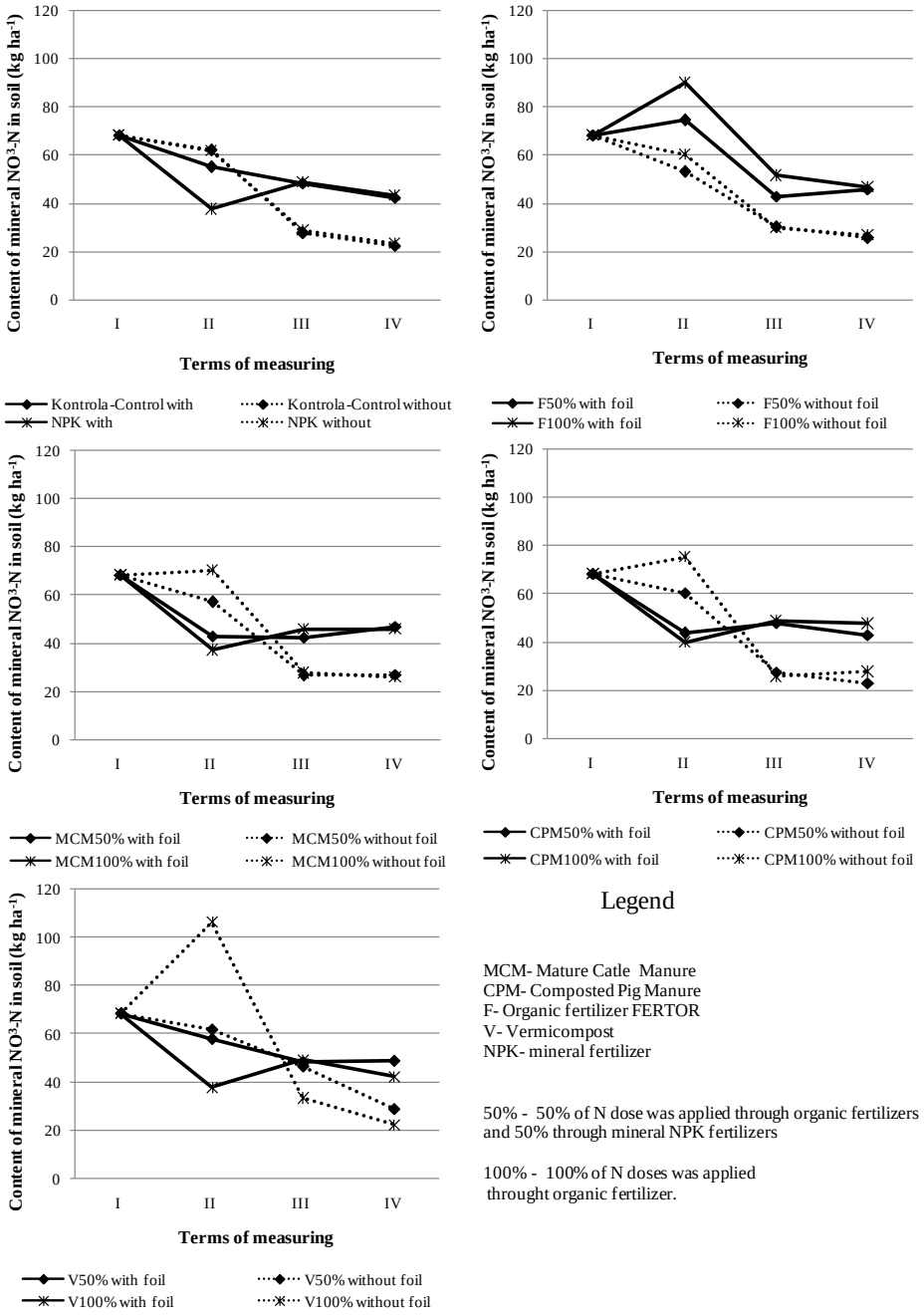

Figure 2. NO_3-N dynamics in the soil under pepper with and without foil, dependent on applied fertilization systems, and fertilization treatments in 2011

The exception is the sampling made during intensive growth in 2011, in which the sample taken from the plot with pepper without foil had a significantly higher amount of NO_3-N with all fertilization treatments.

The highest amount of NO_3-N in the soil under foil was recorded in the experiment in 2011 with 100% Fertor fertilization systems, and on the plots without foil with the application of N from vermicompost.

In the first harvest, the highest value of NO_3-N in the soil in 2010 was recorded with the treatment N from 100% MCM, and in the second harvest with the treatment N from 100% CPM under foil.

The recorded values of NO_3-N under pepper with and without foil at different sampling times indicate that organic fertilizer N mineralization was more intensive in the first period of vegetation, during intensive growth, as compared to the second period of vegetation, when lowest values were recorded at the end of the second harvest.

The recorded amounts of NO_3-N at different sampling times represent a state of equilibrium between the mineralization of applied organic fertilizers and soil organic matter on one hand, and the immobilization of mineral nitrogen by pepper crops and microorganisms on the other (Bogdanović and Čabilovski, 2007; Bogdanović and Ubavić, 2008; Čabilovski *et al*. 2010).

NO_3-N dynamics in soil under pepper in the experiments with and without foil correlates positively with obtained yields in both years. The yields in the experiments with foil were significantly higher with all fertilization systems and treatments than those produced in the experiments without foil Figure 3 and Figure 4. Higher yields in the experiments without foil are directly dependent on the amounts of NO_3-N measured in the soil, which are a result of better conditions for organic fertilizer mineralization (humidity and temperature).

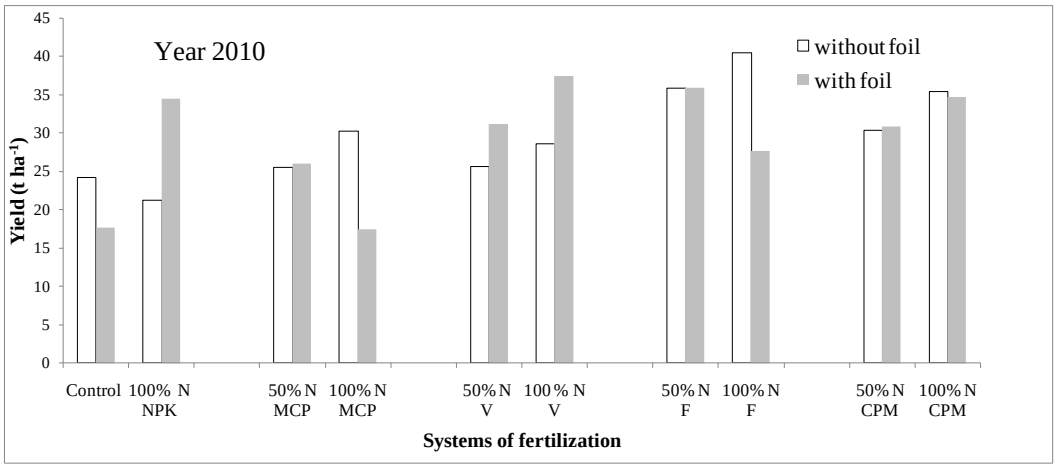

Figure 3. Pepper yield as dependent on fertilization systems and mulching in 2010

Of all the applied organic fertilizers, the highest yields with and without foil were obtained with fertor (F) treatment, followed by composted pig manure (CPM), vermicompost (V), mature cattle manure (MCM), and the lowest with mineral fertilizers (NPK) (Figure 3 and 4). The stronger effect that fertilizing with fertor had on pepper yields when compared to the other applied organic fertilizers stems from the production technology of this fertilizer and its content.

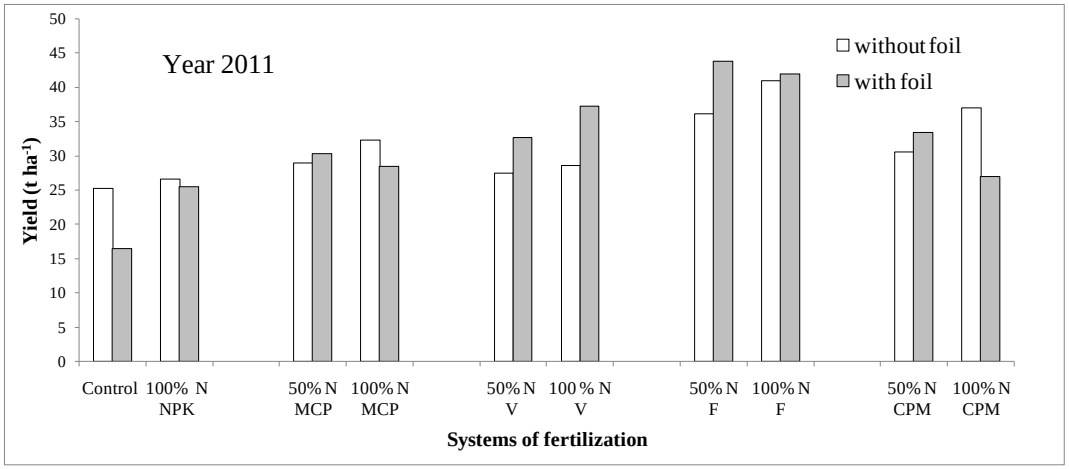

Figure 4. Pepper yield as dependent on fertilization systems and mulching in 2011

Fertor is a pelleted organic poultry manure to which other organic plant materials are added and it contains all biogenic elements. Furthermore, with CPM treatments higher yields were obtained with and without foil than with V, MCM and NPK treatments, which can be explained with significantly higher solubility and the presence of biogenic elements, primarily nitrogen from CPM, when it is compared to other fertilization systems. Research by Denić (2010) on maize and Bogdanović *et al*. (1995) on wheat shows that NO_3-N from liquid pig manure in the year of application had an effect on yield, identical to that of mineral fertilizers.

Conclusions

Based on the observed dynamics of NO_3-N in the soil under pepper with and without foil, depending on the fertilization method and its effect on yield, the following conclusions can be drawn:

- Mineralization of NO_3-N from organic fertilizers was more intensive in the first period of vegetation, during intensive growth, and considerably slower in the second period of vegetation at the times of the first and second harvest.
- The highest amount of NO_3-N was recorded in the soil under pepper with foil in 2010, at the first harvest with N from 100% MCM treatment, and at the second harvest with N from 100% CPM treatment.
- In both years higher amounts of NO_3-N were found with foil than without it, at all sampling times, with all fertilization systems and treatments.
- Pepper yields under foil with all fertilization systems and treatments are significantly higher than those without foil.
- Of all applied organic fertilizers the most favourable effect on the yield both with and without foil was achieved with fertor fertilizer with all treatments, followed by composted pig manure, vermicompost, mature cattle manure, whereas the poorest effect was obtained with a mineral fertilizer.

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ДВИЖЕЊЕ НА NO_3-N ВО ПОЧВАТА ПОД НАСАД ОД ПИПЕРКИ ВО ЗАВИСНОСТ ОД СИСТЕМОТ НА ФЕРТИРИГАЦИЈА И МУЛЧИРАЊЕ

Богдановиќ Даринка, Илин Жарко, Чабиловски Ранко

Апстракт

Во полскиот опит поставен на истражувачките полиња на земјоделска станица во Сомбор, било испитувано влијанието на различни системи за фертиригација и мулчирање врз приносот од пиперки и движењето на минералниот азот (N) во почвата. Опитот бил спроведен за време на вегетационите сезони во текот на 2010 и 2011 година. Пиперките биле одгледувани со и без примена на пластична фолија за мулчирање каде што кај двата начина било аплицирано 240 kg N ha^{-1} преку различни системи за фертиригација. Четири видови на органски ѓубрива биле аплицирани и тоа: зрело арско ѓубриво (MCM), компостирано ѓубриво од свињи (CPM), вермикомпост (G) и органско ѓубриво *Fertor* (F). Секое од огранските ѓубрива било аплицирано во две различни количини кои содржеле по 120 и 240 kg N ha^{-1}. На истите парцели биле додадени минерални азотни ѓубрива за да се достигне целната вредност за апликација на азот (240 kg N ha^{-1}). Следењето на NO_3- N во почвата за време на вегетационата сезона на пиперката покажа дека минерализацијата на органските ѓубрива била најинтензивна во првата половина од вегетацијата, додека во втората половина, за време на формирањето на плодовите, концентрацијата на минерален азот во почвата била значително намалена. Концентрацијата на минерален азот во почвата под пластичната мулч фолија била значително повисока споредено со парцелите кои не биле покриени со фолија.

Клучни зборови: почва, NO_3- N, систем за фертиригација, пиперки, принос.

UDC:634.23:635.9(497.113)
Original scientific paper

MORPHOMETRIC CHARACTERISTICS OF DECORATIVE SOUR CHERRY AND SWEET CHERRY FORMS SHAPED BY PRUNING MEASURES

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Abstract
Collection plot of sour cherry and sweet cherry cultivars at the nursery of Faculty of Agriculture in Novi Sad was established in 2009 year. The aim of the research is to shape the forms of sour cherries and sweet cherries with pruning technique, for use in horticulture and landscape architecture. The study involved one cultivar of sweet cherry and two varieties of sour cherries on two rootstocks. This paper investigated the characteristics of two decorative forms, dwarf and columnar. Natural crown form was translate with pruning measures into dwarf and columnar form as the two most attractive decorative forms. The pruning is done in the period from 2009-2012 year while, morphological measurements were performed in 2012 year. This paper presents the results of morphometric measurements of sour cherry varieties 'Erdi Botermo' and 'Maynard' and sweet cherry cultivar 'Summit' on two rootstocks, 'Oblačinska' sour cherry and magriva. The measured properties included tree height, crown diameter and height, the angle of branching, rooting and crown volume. The largest crown volume (0.8 m^3) and (0.6 m^3) was in the form of dwarf variety 'Summit' and 'Erdi Botermo' on mahaleb as a rootstock. The lowest crown volume had columnar forms of cultivar 'Summit' (0.001 m^3) and cultivar 'Maynard' (0.001 m^3) on 'Oblačinska' sour cherry as a rootstock. The intensity of rooting for all varieties on both rootstocks was satisfactory. Obtained unique dwarf and columnar forms of sour cherries and sweet cherries, combine specific genetic potential of variety, their interaction with the rootstocks and traditional horticultural skills. These forms have a double potential, decorative application and use of fruits as quality table fruits.
Key words: sour cherry, sweet cherry, decoratve forms, characterization.

Introduction

The Balkan Peninsula is one of the most valuable secondary centers of genetic diversity and gene pool sour cherries and sweet cherry (Ljubojević *et al.*, 2011; Ljubojević *et al.*, 2012; Ognjanov *et al.*, 2012). Sweet and sour cherry fruits occupy an important place in the diet, as a natural source of antioxidants, polyphenols and anthocyanins (Stoecklein, 2001a). According to research conducted by Pooler (2007), their decorative use is equally important. In private, amateur orchards and gardens, where fruit species provide fresh produce that meets family needs throughout the year, cherryes are of high value (Stoecklein, 2001b). According to Freeman (2010), sour and sweet cherries are grown in gardens together with other fruity, floral and woody species; thus, due to the limited space available, their vigor and form are important. Growing cherry fruit and ornamental species in the garden is popular because of the reduced need for protection against pests and

deseases, which is highly beneficial, as it implies that the produce is healthy and safe for human consumption. Various crown forms are most often found in sour cherries populations (Schuster, 2009). Biodiversity of natural populations, introduced cultivars and selections, is a source of genetic variability of sour and sweet cherries. In addition to the natural habitus, with a proper choice of rootstock and pruning measures, both sour and sweet cherry can be grown in dwarf, columnar and other decorative forms. According to findings Khadivi-Khub *et al.* (2011), morphological characterization is the first step in the description and classification of germplasm, as well as a good starting point for statistical analysis. As Hrotkó (2004) stated, for the intensive growing of sour and sweet cherry, dwarfing rootstocks compatible with the grafting varieties are necessary. According to research conducted by Keserović *et al*. (2011) on alkaline soils of Vojvodina province, Mahaleb is the best rootstock for the both sour and sweet cherry. Moreover, Long and Kaiser (2010) claim that Mahaleb is the most drought resistant rootstock. 'Oblačinska' sour cherry was traditionally used as a rootstock for both sour and sweet cherry and showed a high degree of adaptability to climate and edaphic conditions in Serbia (Ljubojević *et al.*, 2011). A detailed analysis of dwarfing rootstock anatomy of sour cherry and sweet cherry was reported by Zoric *et al*. (2012).

The subject of this paper is to describe the characteristics of two varieties of sour cherry and one variety of sweet cherry grafted on 'Oblačinska' sour cherry and Mahaleb rootstocks. The aim is to determine the combination of varieties and rootstocks that are most suitable for the development of dwarf or columnar form.

Material and methods

Our collection of decorative sour cherry and sweet cherry was established in the fall of 2009, in the experimental field at the plant nursery of the Department of Fruit Science, Viticulture, Horticulture and Landscape Architecture, in the temperate-continental climatic conditions and černozem soil type. As a part of this project, 1400 grafted seedlings were planted, applying 4 and 2 m spacing between adjacent rows and plants, respectively. Height reduction to 80 cm, in order to enhance uptake of seedlings, was carried out after the plants were repositioned to their permanent location. Pruning of the tree shape was performed in order to achieve dwarf and columnar forms.

This study included two varieties of sour cherry ('Maynard' and 'Erdi Botermo') and one sweet cherry variety ('Summit'). Variety 'Maynard' is characterized by its pyramidal habit, very short internodes, small leaves and small fruits. In contrast, variety 'Erdi Botermo' is characterized by long shoots, large leaves, sparse crown and bent branches. Finally, sweet cherry variety 'Summit' is of lower height, compared to the older, standard varieties of sweet cherry, such as 'Burlat'.

The quantitative characteristics measured using a micrometer of 0.01 mm precision reveal that, in the vegetation period of 2012, the diameter both above and below the graft union was 5 cm. Plant height, crown width, branch length, volume and diameter of branches were measured using tape measure of 1 mm precision. The angle of branching was measured by protractors. The evaluated characteristics were tree shape, as well as crown branching and overgrowth, and rooting intensity. In order to monitor the development of the crown size and shape, the growth of shoots was measured in 30-day interval.Statistically significant differences were analyzed by Dunckan test.

Statistically significant differences were analyzed by applying Duncan test, using STATISTICA 10 (StatSoft Inc., Tulsa, USA) software.

Results and discussion

Many research groups around the world have carried out detailed investigations of sour cherry and sweet cherry low vigor rootstocks. According to Janes and Pae (2004), as low vigor rootstocks are increasingly used, it is important to examine the interaction between the rootstocks and scions and its dependence on environmental conditions. This is of particular importance, given that these interactive mechanisms influence the formation of plant vegetative and reproductive characteristics. The importance of pruning measures as an established technique of garden design has, however, not been investigated in Serbia. Thus, in order to bridge this knowledge gap, we have monitored the development of the grafted seedlings of sour cherry and sweet cherry on rootstocks of different vigor in our collection orchards that provide environmental conditions typical of this region.

Monitoring of indicators of growth in the rootstocks 'Oblačinska' sour cherry and Mahaleb, was conducted at the beginning of the growing season, when the rootstocks started to run juices. The increase in the number of annual shoots was monitored through the observations of the development of the rootstocks. The development of graft diameter was also measured. The obtained results pertaining to dwarf varieties 'Maynard' and 'Erdi Botermo' indicate that we had achieved the appropriate value for height (92.5 cm; 90 cm) and crown diameter (57.5 cm; 57.5 cm), on 'Oblačinska' sour cherry as a rootstock. Columnar form of cultivar 'Maynard' on 'Oblačinska' sour cherry as a rootstock achieved a greater height (165 cm) and smaller crown diameter (9 cm) in relation to the columnar form on Mahaleb as the rootstock, with the height of 140 cm and the crown diameter of 27 cm. Because of the great vigor of Mahaleb rootstock, branching intensity and fouling exhibited higher values than the sour cherry rootstock.

Sweet cherry variety 'Summit' was tested on sour cherry rootstock (*Prunus cerasus* L.) and Mahaleb (*Prunus mahaleb* L.). Considering the vigor of Mahaleb rootstock, dwarf form achieved significant height (137 cm), crown diameter (110 cm) and crown volume (0.8 m^3). Ljubojević *et al.* (2011) reported similar results for Mahaleb, indicating that its use as a rootstock had a significant effect on the vigor of sweet and sour cherry varieties. Columnar form of variety 'Summit' on the rootstock Mahaleb had a high value of crown diameter (45 cm) and vigor (4), which is not a desirable trait in this form. However, better form of this variety was achieved when grafted on the sour cherry rootstock, with height of 120 cm, 10 cm crown diameter and 0.001 m^3 crown volume.

The key characteristics of the two sour cherry and one sweet cherry variety on the two rootstock types are given in Table 1 and 2.

Duncan multiple test revealed statistically significant differences within the varieties grafted on different rootstocks. Dwarf forms of varieties 'Maynard', 'Erdi Botermo' and 'Summit' on the 'Oblačinska' sour cherry showed significant differences in the crown height and diameter in relation to the same features on the Mahaleb rootstock. Considering that Mahaleb is vigorous rootstock, this result was expected and is in accordance with the previously published data. High values of crown diameter (45 cm) of columnar forms in cultivar 'Summit' on rootstock Mahaleb are not desirable and differ significantly from the diameter achieved in other columnar forms. In the dwarf form, the diameter of the graft union in rootstock Mahaleb ranged from 43.8 to 61.1 cm, while in the rootstock 'Oblačinska' sour cherry, it was only 32.6 to 40 cm. The same relation was noted for stem diameter in columnar forms, which was 49.2 to 58.1 cm, when Mahaleb was used as a rootstock. In contrast, with 'Oblačinska' sour cherry as a rootstock, it ranged from 33.1 to 46.6 cm. Thickening at the site of the graft union is the result of production of secondary wood tissue. Thus, its optimal value is approximately equal to the rootstock or scion diameter.

Table 1. Morphometric characteristics of tested varieties sour cherries and sweet cherry on two different rootstock

Rootstock	Genotype	Tree height (cm)	Diameter of the crown (cm)	Crown volume (m^3)	Diameter of 5 cm above the graft union (mm)	Diameter of graft union (mm)	Diameter of 5 cm below the graft union (mm)
		Sour cherry					
		Df/Cf*	Df/Cf	Df/Cf	Df/Cf	Df/Cf	Df/Cf
'Oblačinska' sour cherry	Mejnard	$92.5^{a}/165^{d}$	$57.5^{a}/9^{a}$	$0.01^{a}/0.001^{a}$	$28.2^{a}/24.2^{b}$	$32.6^{a}/33.1^{b}$	$25.5^{a}/30^{a}$
	Erdi Botermo	$90^{a}/-$	$57.5^{a}/-$	$0.043^{a}/-$	$18.3^{c}/-$	$33.2^{a}/-$	$16.5^{c}/-$
Mahaleb	Mejnard	$110^{b}/140^{b}$	$75^{d}/27^{b}$	$0.3^{b}/0.02^{b}$	$43.3^{b}/30.5^{a}$	$61.1^{d}/49.2^{a}$	$51.3^{b}/39.6^{b}$
	Erdi Botermo	$150^{d}/-$	$107.5^{b}/-$	$0.6^{c}/-$	$30.1^{a}/-$	$43.8^{b}/-$	$36.8^{d}/-$
		Sweet cherry					
		Df/Cf	Df/Cf	Df/Cf	Df/Cf	Df/Cf	Df/Cf
'Oblačinska' sour cherry	Summit	$90^{a}/120^{a}$	$37.5^{c}/10^{a}$	$0.03^{a}/0.001^{a}$	$29.8^{a}/29.7^{a}$	$40^{b}/46.6^{a}$	$23.9^{a}/24.4^{a}$
Mahaleb	Summit	$137^{c}/150^{c}$	$110^{b}/45^{c}$	$0.8^{d}/0.02^{b}$	$40.2^{b}/37.2^{c}$	$52.5^{c}/58.1^{c}$	$49.3^{b}/44.8^{b}$

*Df-dwarf form; Cf-columnar form

Differences in values within columns that are not followed by the same letter are statistically significant at a 0.05 significance level by ANOVA Duncan test.

Table 2. Values of qualitative traits

Rootstock	Genotype	Crown branching	Overgrowth intensity	Branching angle (°)	Rooting intensity
		Sour cherry			
		Df/Cf*	Df/Cf	Df/Cf	Df/Cf
'Oblačinska' sour cherry	Mejnard	5/4	5/4	45/45	5/5
	Erdi Botermo	4/-	4/-	50/-	4/-
Mahaleb	Mejnard	5/5	5/5	40/40	5/5
	Erdi Botermo	4/-	5/-	40/-	5/-
		Sweet cherry			
		Df/Cf	Df/Cf	Df/Cf	Df/Cf
'Oblačinska' sour cherry	Summit	3/3	3/3	35/35	4/4
Mahaleb	Summit	4/4	4/4	30/40	4/5

Based on the evaluated characteristics, the crown branching and overgrowth intensity is most pronounced on Mahaleb rootstock. Variety 'Maynard' had good rooting on both rootstocks, while the dwarf form of the variety 'Erdi Botermo' showed better rooting when Mahaleb was used as the rootstock. High values of the crown branching and overgrowth intensity, as well as rooting, were

noted for variety 'Summit' grafted on Mahaleb rootstock, which proved to be the most suitable choice in the first vegetation period, with respect to the examined parameters, such as the crown branching and overgrowth intensity, as well as rooting, for all studied varieties. 'Oblačinska' sour cherry, as low vigor rootstock, proved suitable for dwarf varieties of 'Mejnard', 'Erdi Botermo' and 'Summit' form. The results reported here indicate that, for the purposes of horticulture and landscape architecture, the dwarf tree forms should not be shaped, while seedlings grafted on rootstock Mahaleb require use of pruning measures for most optimal results.

Conclusions

Although dwarf and columnar forms in natural populations are caused by spontaneous mutation, sour and sweet cherry are rarely found in nature in this form. Therefore, it is important to examine the genetic potential of varieties grafted on dwarfing and vigorous rootstocks, in relation to the interactions with the environmental conditions. For commercial production of seedlings of dwarf and columnar form, unless the environmental conditions are optimal, it is necessary to apply extensive gardening skills.

The results of our investigations carried out in ecological conditions provided by the plant nursery in Rimski Šančevi indicate that, in the first vegetation season, 'Oblačinska' sour cherry, as low vigor rootstock, proved suitable for dwarf form of 'Maynard' and 'Erdi Botermo' varieties. In the formation of columnar forms, varieties 'Maynard' and 'Summit' grafted on the 'Oblačinska' sour cherry rootstock had desirable height and crown width values. Considering the great decorative value of these forms, their application in horticulture and landscape architecture, especially in the front gardens and terraces, is possible. In addition to decorative applications, due to the reduced need for protection against diseases and pests, fruits of sweet and sour cherry can also be used as safe and nutritious food.

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МОРФОЛОШКИ КАРАКТЕРИСТИКИ НА ФОРМИ НА ДЕКОРАТИВНА ВИШНА И ЦРЕША ОБЛИКУВАНИ СО МЕРКИ НА КРОЕЊЕ

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Апстракт

Парцелата за колекционирање на сорти на вишна и цреша во расадникот на Земјоделскиот Факултет во Нови Сад беше основана во 2009 година. Целта на истражувањето е да се обликуваат форми на вишна и цреша со техники на кроење, заради нивна употреба во хортикултурата и пејзажната архитектура. Во истражувањето се вклучени два вариетета на вишна и една сорта на слатка на две подлоги. Во овој труд се истражувани карактеристиките на две декоративни форми, џуџеста и столбеста. Природните форми на круните со мерки на кроење беа обликувани во џуџести и столбести форми, кои што се сметаат за едни од најатрактивните декоративни форми. Кроењето се вршеше во периодот од 2009 до 2012 година, додека морфолошките мерења беа извршени во 2012 година. Во трудот се презентирани резултати од морфолошките мерења кај вариететите на вишна 'Erdi Botermo' и 'Maynard' и кај сортата на цреша 'Summit', на две подлоги, 'Oblačinska' вишна и магрива. Измерените својства вклучија висина на дрвото, дијаметар и висина на круната, аголот на разгранување, волумен на коренот и круната. Најголем волумен на круната ($0.8m^3$) и ($0,6m^3$) имаа џуџестите формите на вариетот 'Summit' и 'Erdi Botermo' калемени на вишна. Најмал волумен на круната имаа столбестите формите на култиварите 'Summit' ($0.001\ m^3$) и 'Maynard' ($0.001\ m^3$) со 'Oblačinska' вишна како подлога. Интензитетот на ожилување кај сите вариетети на двете подлоги беше задоволителен. Одржувањето на уникатен облик на џуџести и столбести форми кај вишната и црешата, е комбинација од специфичниот генетски потенцијал на вариететот, неговата интеракција со подлогата и традиционалните хортикултурни вештини. Овие форми имаат двојна примена, како декоративни, а нивните плодови се користат и како трпезно овошје.

Клучни зборови: вишна, цреша, декоративни форми, карактеристики.

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KONJICA'S ONION–A NEW VARIETY FROM BOSNIA AND HERZEGOVINA

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Abstract
Onions are one of the most versatile vegetables, used year round, either fresh (green onions, mature bulbs), or processed (dehydrated, pickled, canned). Choice of cultivar and proper cultural practices are important facets in the production process. Choosing the right cultivars is one way of ensuring high yields and good quality of onions. In Bosnia and Herzegovina, production of the crop from sets predominates. The Federal Institute for Agriculture in Sarajevo has developed a new line, Konjica's onion (Konjički). This paper evaluates production characteristics (yield of bulbs, bulb weight and shape, bulb skin tightness and colour, plant height and length of growing season) and characteristics of quality (dry matter, acid content and total sugar content) of this new line of red onion, tested in Sarajevo-Butmir over three consecutive years (2009, 2010, 2011) with the Stuttgarter cultivar used as a standard. The trials were conducted in a randomised block design with five replicates. The new line is medium late (114 d) and characterised by yellow-brown flattened bulbs (bulb index of 0.68), an average bulb weight of 108.88 g, a well closed neck, very good quality of bulbs (high dry matter (15%) and sugar content (9.51%)) and mildly pungent flavour. Over three years, the variety yielded 33.15 t ha^{-1} on average, 38% more than the standard cultivar.
Key words: red onion, new line, production characteristic.

Introduction

Onions are grown for a variety of purposes, namely as fresh shoots for green 'salad' onions and as bulbs for: (i) consumption uncooked; (ii) consumption cooked; (iii) pickling; (iv) in factory-made food; (v) dehydration; (vi) seed production; and (vii) sets (Brewster, 2008). The purpose of an onion production determines the choice of variety and growing technology. Hence the goal of an onion breeding program varies (Gvozdanović-Varga *et al.*, 1996). Onions may be grown from seed, transplants or seed-grown sets (sets started from seed the previous year). Cultural system is determined by the cultivar`s biology, conditions of the environment and food preferences in the locality (Lazić *et al.*, 2000). Yields are highest where the crop is grown directly from seed and modern growing technologies are fully utilised, whereas yields are low where onions are grown from sets (Gvozdenović *et al.*, 2005). In Bosnia and Herzegovina, onion is extensively cultivated and production of the crop from sets is predominant. In this paper, the Federal Institute for Agriculture in Sarajevo introduces a new variety of red onion-Konjica's onion, specially developed for

production from onion sets to suit the environmental conditions of Bosnia and Herzegovina. The paper evaluates the variety's agronomic performances and characteristics of quality, tested in Sarajevo (Butmir) over three consecutive years with the Stuttgarter cultivar used as a standard.

Material and methods

Variety evaluation trials were conducted in Butmir (43°49′N 18°20′E) in the Sarajevo Canton of Bosna and Herzegovina in 2009, 2010 and 2011. Cultivar Stuttgarter, commonly grown and cultivated from sets in Bosnia and Herzegovina was used as the standard.

Before the trials were set up, average soil samples were taken and chemical analyses were carried out. The soil was of the brown valley type, poorly supplied with phosphorus and moderately supplied with potassium across all three years (data not shown). In accordance with soil tests and commercial recommendations, 56, 112, and 294 kg ha^{-1} of Nitrogen, Phosphorus and Potassium was applied respectively every year. The trials were conducted in a randomised block design with five replicates. Plot size was 6 square meters. March 30th 2009 and 2010 and March 16th 2011 were the sowing dates. Seeds were planted manually in triple rows spaced 30 cm apart and within-row spacing 10 cm resulting in population density of 150 plants per plot. Soil management, pest and disease control was carried out according to standard procedures. The date of technological maturity was recorded. After the onions were lifted and dried, main agronomic traits (yield of bulbs, bulb weight and shape, bulb skin tightness and colour, plant height and length of growing season) and characteristics of quality (dry matter and total sugar content) were measured. Dry matter content was determined after drying 5g of fresh matter at 104°C for two hours. Total sugar content was determined according to the Luf-Šurl method.

Data (mean monthly temperatures and monthly precipitation sums) from the weather station at Butmir were used to obtain weather data for the growing seasons studied. Yield data were analysed for the differences between the standard (Stuttgarter) and the tested variety (Konjički) using analysis of variance. Mean separation was based on a LSD test. Differences were considered to be significant at P=0.05 and P=0.01.

Results and discussion

Growing conditions during variety evaluation trials

Seed-grown sets make a more robust plant at emergence than seeds, have a shorter growing season and the whole plant growth is less dependent on conditions of environment (Brewster, 2008; Đurovka, 2008). If higher temperatures prevail in germination stage, rooting may be shortened and above-ground grow hastened (Đurovka, 2008). During trial years, mean monthly air temperatures in Butmir were within the long-term average range (Figure 1A.). After planting and April temperatures in 2009-2011 were within range of optimal 5-10 ºC and 10-15 ºC for growing stages rooting and germination, respectively. Therefore, well developed above-ground plant parts and a strong rooting system secured good bulb formation. According to Jones and Mann (1963), under conditions of extremely high temperatures, bulbs will mature early and yields may be reduced; at low temperatures, maturity is usually delayed, curing becomes difficult, and storage quality is often impaired. In 2009-2011 trials in Butmir during the stage of bulb formation (late April and early May), mean monthly air temperatures though lower than the optimal for the stage (22 ºC) (Lazić *et. al*., 2001) were higher than nine-year average so both varieties obtained good yields. Irrigation during leaf and early bulb growth ensures that onion crop reaches a high LAI (Leaf Area Index) as

quickly as possible. This will tend to promote rapid ripening and good bulb quality for storage (Brewster, 1990). In Butmir wetter-than-average conditions were observed in January, March and June in 2009 and 2010 (Figure 1B). April in all three seasons was unusually dry. Compared to the multiyear average (74.5 mm) July of 2010 was extremely dry (19.2 mm). Irrigation late in bulbing may delay maturity and reduce bulb quality by virtue of skin splitting and rotting, particularly if they follow a period in which growth has been restricted by lack of water or Nitrogen nutrition (Brewster, 1990). Although July 2011 summed 134 mm of precipitations, nearly twice than was recorded in the 1996-2005 period (74.5 mm), all rain fell late in the month when the crop had already been lifted. That was the reason why the bulb yield remained good in 2011 (Table 2.).

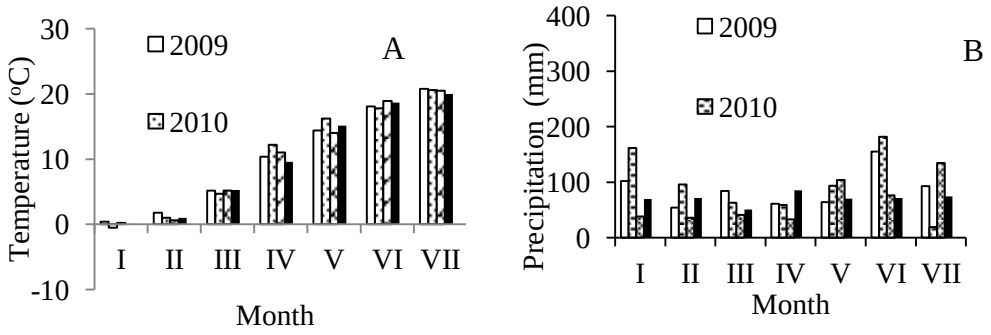

Figure 1. Weather conditions in onion growing season. Panel A, mean monthly air temperatures. Panel B, monthly precipitation sums

Agronomic and quality attributesof Konjica's onion

In onion, bulbing will not start until the temperature-day-length combination exceeds the minimum requirement. Thus from year to year a considerable spread may occur in the maturity date of a given cultivar (Jones and Mann, 1963). The new variety, Konjički, is medium late (in 2009 and 2010 technical maturity reached in 114 days, while in 2011 in 129 days), just as the standard is (data not shown). The plants are well developed and have erect leaves that are dark green in color and have a pronounced waxy coating. The height of the above ground portion of the plant is 58.96 cm, making the new line 1.8 cm taller than the standard (Table 1.). The number of hearts in the bulb is positively correlated with the number of germs (Gvozdanović-Varga *et al*., 1996) but negatively correlated with bulb shape, so flattened varieties most often have 1-2 hearts with a larger number of germs. Konjica`s onion is characterised by a flattened bulb (bulb index of 0.68) that is yellow-brown in color and has a well closed neck. Its leaves are juicy and white-yellow in color, while the bulb has 1-2 hearts. The average weight of the bulb over the three study years was 106.88 g, which is 17.25 g more than the standard. The bulb is well enveloped and there are no cracks in the bulb skin.

Table 1. Characteristics of the above-ground plant parts and the bulb

Variety	Plant height (cm)	Average bulb weight (g)	Bulb index	Bulb skin tightness (1-9)	Colour	Pungency
Konjički	58.96	106.88	0.68	8	Yellow-brown	Mildly pungent
Stuttgarter	57.15	89.63	0.68	9	Yellow-brown	Mildly pungent

The average dry matter content over the three years was 15.41%, which is typical of onion populations from former Yugoslavia grown from sets (Gvozdanović-Varga *et al.* 2005). Sugar content as a quality indicator of onion, affects bulb storage life (Fenvick and Hanley 1990). New variety had high level of total sugars (9.51%), but still lower levels than the standard (10.61%) (Table 2).

Table 2. Quality attributes of Konjički and Stuttgarter variety in 2009-2011

Variety	Konjički			Mean	Stuttgarter			Mean
Trait	2009	2010	2011		2009	2010	2011	
Dry matter (%)	14.00	18.78	13.45	15.41	13.31	15.09	13.42	13.94
Total sugars (%)	9.50	8.60	10.43	9.51	9.80	10.20	10.50	10.16

In all trial years, the new variety significantly out-yielded the standard variety (Table 3.). Tested varieties yielded the lowest in 2010 (21.00 t ha^{-1}), 12.26 t ha^{-1} and 13.72 t ha^{-1} less than in 2009 and 2011, respectively. Maximal yield varieties were obtained in 2011 (Table 4). Temperature and rainfall conditions, in contrast to day-lengths, are never exactly alike, year after year, in the same district; consequently, onion cultivars cannot be expected to perform consistently, even though cultural practices are similar (Jones and Mann, 1963). Over the three years, the new tested variety- Konjički obtained an average yield of 33.15 t ha^{-1}, or 27% more than standard variety- Stuttgarter (26.17 t ha^{-1}) (Table 5).

Table 3. Yield of Konjički and Stuttgarter variety in 2009-2011. Asterix indicates significant differences at *P*=0.05 and *P*=0.01 by LSD test

Variety	Year					
	2009		2010		2011	
	Yield (t ha^{-1})	%	Yield (t ha^{-1})	%	Yield (t ha^{-}	%
Stuttgrater	29.16	100	18.00	100	31.35	100
Konjički	37.36**	163	24.00**	133	38.10**	121
LSD $_{P=5\%}$	1.51		1.08		0.63	
LSD $_{P=1\%}$	2.17		1.57		1.058	

Onion is one of the important vegetable crops grown in Bosnia and Herzegovina. It is extensively cultivated (mainly for domestic production) by small holdings with no irrigation possibilities, thus production of the crop from sets is predominant. Culture system (production from seed-grown sets), high quality and good agronomic characteristics make the new variety, Konjica's onion (Konjički), highly suitable for production conditions in our country.

Table 4. Effect of year on onion yield

Year	Yield in t ha^{-1} (average for both varieties)	%
2009	33.26	158
2010	21.00	100
2011	34.72	165
$LSD_{P=5\%}$	17.68	
$LSD_{P=1\%}$	40.81	

Table 5. Effect of variety on average yield (2009-2011)

Variety	Average yield (t ha^{-1})	%
Stuttgrater	26.17	100
Konjički	33.15	127
$LSD_{P=5\%}$	10.21	
$LSD_{P=1\%}$	23.56	

Conclusions

In Bosnia and Herzegovina, expansion of domestic varieties, development of varietal technology and controlled onion set production should result in an increase of domestic production of the crop and reduction of its import from abroad.

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КОЊИЧКИ КРОМИД - НОВА СОРТА ОД БОСНА И ХЕРЦЕГОВИНА

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Апстракт

Кромидот е зеленчук кој наоѓа примена во текот на целата година, било да е во свежа состојба (зелен кромид, зрели луковици) или преработен (сушен, кисел, конзервиран). Изборот на сорта и соодветни земјоделски практики се значајни аспекти во процесот на производство. Изборот на правилна сорта е еден од начините со кој се обезбедува висок принос и добар квалитет на кромидот. Федеративниот институт за земјоделство во Сараево создаде нова сорта на кромид- Коњички кромид. Во овој труд се оценети производните карактеристики (принос од луковици, тежина и форма на луковиците, дебелина и боја на лушпата на луковицата, висина на растенијата и должина на вегетациониот период) и квалитативните карактеристики (сува материја, содржина на киселини и вкупна содржина на шеќери) на оваа нова сорта на црвен кромид, испитувана во Сараево-Бутмир, во текот на три последователни години (2009, 2010, 2011), при што сортата Stuttgarter се користеше како стандард. Опитите беа спроведени во рандомизиран блок систем со пет повторувања. Новата сорта е средно доцна (114 дена), карактеристична по жолто-кафените сплескани луковици (индекс 0,68), просечна маса на луковиците од 108,88 g, добро затворен врат, многу добар квалитет на луковиците (висок процент на сува материја-15% и содржина на шеќер- 9,51% и малку лут вкус). Во текот на трите години просечниот принос на сортата беше 33.15 t ha^{-1}, што е за 38% повисок од приносот на стандардните сорти.

Клучни зборови: црвен кромид, нова сорта, производни карактеристики.

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INFLUENCE OF COMPOUND MINERAL FERTILIZERS PRODUCED BY DIFFERENT TECHNOLOGIES ON YIELD AND QUALITY OF LETTUCE

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Abstract
Overabundant and unbalanced input of nutritional elements to soil has a negative effect to the yield and quality of lettuce. Accumulation of nitrates and harmful effects of the chloride ion are the reasons why there is a need to establish an optimal quantity and relation of nutrients in lettuce nourishment. In the experiment which was carried out during years 2010 and 2011 on the farm of Secondary Agricultural Boarding School in Futog, nitrate content in a fresh mass of lettuce (mgNO3 kg^{-1}) was obesrved, in dependence on applied compound fertilizers. produced by different technologies at different quantities of nitrate and potassium fertilizers. The results of the research show that in a technological ripeness, the highest average lettuce yield has been obtained in the treatment where the highest dosage of nitrate fertilizers was used in spring, in a combination with complex fertilizers in autumn. The lowest average yield has been obtained on the control plot. The highest average nitrate concentration in a fresh lettuce mass has been recorded in using technology of applying mixed fertilizers and the smallest in using a technology of complex fertilizers. At the moment of harvest, the highest nitrogen content in a dry mass of a plant has been recorded when complex fertilizers of phosphorus and potassium were used by the technology of mixed fertilizers.
Key words: soil, nutritional elements, nitrates, lettuce, yield.

Introduction

The research results made by several scientists have shown that the yield and chemical content of lettuce depend on:variety, prodouction conditions, mineral nutrition, termines of sowing and harversting (Brunsgaard *et al.*, 1994; Sady *et al*., 1995; Bronzeti, 1997).

Among all the factors that influence total yield, 30-70% belong to a correct nutrition or fertilizing (Богдановић and Убавић, 2008). The influence of fertilizes can be positive and negative (Кастори, 1995; Чувардић *et al*., 1999, 2004; Богдановић *et al*., 1999).

A positive influence of fertilizing results in fertility increasing and biological soil activity.(Богдановић *et al.*, 1997; 1998). It has also been noticed that genetic productivity potential can be fully expressed only under the condition of an optimal and balanced nutrition (Богдановић and Убавић, 2008). Fertilizes can also have negative influence on quality of vegetables and living environment. For example, overabundant and untimely usage of nitrogen can lead to enormous increasing of nitrate in lettuce leaves, as well as increasing of nitrate concentration in ground waters (Brumm and Schenk, 1993). Lettuce belongs to the group of nitrophilic plants so it is apt to harmful nitrate accumulation in leaves. High nitrate content in an organism of human being can cause

methemoglobinemia and forming of carcinogenic nitrosamines and nitrosamides (Кастори *et al*., 2005). It should not neglect lettuce sensibility to chloride ion (Cl^-).

All these facts lead to a conclusion that lettuce fertilizing needs special care in choosing a corresponding type of fertilizer and its dosage. The aim of this research was to find out and confirm the effect of compound mineral fertilizers produced by different technologies, to lettuce yield and quality.

Material and methods

In 2010 and 2011 a field experiment was set up on the farm of Agricultural Boarding School in Futog, in a split- plot design in four repetitions. The influence of compound mineral fertilizers produced by different technologies, on lettuce yield and quality, was explored by different technologies:

a) by a simple blending of particular fertilizers

b) by a chemical reaction between the components

c) by compacting (under pressure) without chemical reactions between the components

In nutrition of lettuce, different dosage of nitrogen and potassium fertilizers was applied. (Table 1.)

Table 1. Fertilizing treatment schedule in the lettuce experiment

	Fertilization	Treatments		Total of introduced nutrients		
	Autumn		Spring	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
1		Ø		/	/	/
2	400kg/ha NPK (8:16:24)	Mixed		90	64	96
		Compact	58 kg/ha N			
		Complex				
3	400kg/ha NPK (8:16:24)	Mixed		70	64	96
		Compact	38 kg/ha N			
		Complex				
4	400kg/ha NPK (8:16:24)	Mixed		90	64	120
		Compact	58 kg/ha N +			
		Complex	24 kg/ha K2O			

In the autumn, before spreading mineral fertilizers, soil samples were taken for basic chemical properties analysis. The results of soil agrochemical analysis are shown in table number 2.

Table 2. Agrochemical soil properties before an application of fertilizers

Depth	pH		$CaCO_3$	Humus	N	mg P_2O_5	mg K_2O	NO_3-N
	H_2O	Cl	(%)	(%)	(%)	$100g^{-1}$	$100g^{-1}$	kg/ha
0-30	7,74	7,04	8,4	1,38	0,09	63,87	32,8	13,18
30-60	8,07	7,17	15,96	0,84	0,05	15,45	18,16	17,05

The analyzed soil belongs to carbonated chernozem on alluvial depositions have following chemical properties:

The analyzed soil has neutral reaction, it belongs to the carbonated, weak humus soil class, and it is poor in total nitrogen. The content of easily reached phosphorus is very high in the soil layer of 0-30cm, while it is middle secured in the layer of 30-60 cm. Easily reached potassium is between optimal boundaries for vegetable production. Standard methods were used for soil fertility analysis.
The mineral nitrogen content in the field conditions was determined in samples of natural soil moisture by Scharpf and Wehrmann method (1978).
The lettuce was planted into an open field on 29th March 2011 at 30 cm space between the rows and 25 cm between the plants which supplied the group of 11 plants per m2. In the second half of April in the phase of developing of leaf rosette, nitrogen sulfate (urea) and potassium (potassium sulfate) fertilizers were spread. Lettuce harvesting was on 17th May 2011 in the phase of technological ripeness.
The following parameters were observed during the period of vegetation:

- The yield of fresh leaf mass (the plant mass in its technological ripeness).
- Nitrate concentration in a fresh leaf lettuce mass (mg NO_3 kg^{-1}) in phase of leaf rosette developing at harvesting time.
- The content of the total N, P, K (%) in the shoot when developing leaf rosette and in technological ripeness.
- Content of the total phosphorus was determined destruction of plant material with H_2O_2 and $HClO_4$.
- The content of total phosphorus in the plant material was determined from parental solution from which the phosphorus concentration was determined (JANWAY), (Арсенијевић-Максимовић and Пајевић, 2002).
- The nitrate content in lettuce after extraction by distilled water and applying of phenol disulphonic acid and ammonium hydroxide, was determined by spectrophotometry (λ, 420) (Арсенијевић-Максимовић and Пајевић, 2002).

Statistic data processing was made by method of variance analysis by the program STATISTICS 7. Statistical importance of differences was tested by LSD test.

Results and discussion

Statistically important difference between the treatments in which mineral fertilizers that have been applied and those where mineral fertilizers haven't been applied, has been established. The highest average lettuce yield (796,1 g plant^{-1} or 87,6 t ha^{-1}) was recorded at the second treatment where the higher dosage of nitrogen fertilizers was applied with the usage of complex fertilizers technology. The average yield values per fertilizers treatments, depending on applied dosage of nitrogen and potassium fertilizers, show that the highest yield was realized at the second treatment (85,0 t ha^{-1}), while the lowest yield (78,5 t ha^{-1}) was recorded at the treatment number three.
Higher dosage of nitrogen fertilizers as well as the combination of nitrogen with potassium fertilizers had a good influence on the height of lettuce yield. If we compare the average lettuce yields depending on applied technologies of compound mineral fertilizers, we find out that the highest average yield of lettuce was when fertilizing by the compact fertilizer (751,5 g plant^{-1} or 82,7 t ha^{-1}) and the lowest was when applying the complex fertilizer (716,0 g plant^{-1} or 78,8 t ha^{-1}).
Lettuce belongs to the group of nitrophilic vegetables, which means that it is apt to nitrate accumulating. According to the vegetable classification of nitrate content in a fresh leaf mass (Correand, Breimer, 1979; Terbe *et, al.*, 1986), lettuce belongs to the vegetable group with the

highest nitrate content (over 2500 mg NO3 kg⁻¹ of a fresh mass), together with red beet, celery, radish, spinach etc. Nitrate content in a fresh lettuce mass in dependence of used compound fertilizers produced by different technologies at the usage in nutrition of different quantities of nitrogen and potassium fertilizers were shown in table number 4.

Table 3. Average yield of lettuce at the end of vegetation depending on the treatment of fertilizing and of production technology of compound fertilizers

Fertilization		Yield of lettuce (g plant ⁻¹)	Average	Yield of lettuce (t ha⁻¹)	Average
Treatments					
In autumn N32P64K96	In spring - a phase of leaf rosette developins				
Ø	Control	485,1 б	485,1 б	53,4 б	53,4 б
Mixed	58 kg/ha N	758,1 a	738,3 a	83,4 a	81,3 a
	38 kg/ha N	698,9 a		76,9 a	
	58 kg/ha N + 24 kg/ha K_2O	757,8 a		83,5 a	
Compact	58 kg/ha N	765,4a	751,5 a	84,2 a	82,7 a
	38 kg/ha N	712,5 a		78,4 a	
	58 kg/ha N + 24 kg/ha K_2O	776,6 a		85,4 a	
Complex	58 kg/ha N	796,1 a	716,0 a	87,6 a	78,8 a
	38 kg/ha N	728,7 a		80,2 a	
	58 kg/ha N + 24 kg/ha K_2O	623,2 a		68,5 a	
Average		710,2 a		78,2 a	

The values signified by different bold letters within a column are statically of great difference on the level n<0,05.

Table 4. Average nitrate concentrations in fresh lettuce mass (mg NO3 kg⁻¹ of a fresh mass)

Fertilization treatments		A phase of leaf rosette developins	A phase of technological ripenes	Average in treatmetns	Average
In autumn N32P64K96	In spring	27.april	17. may		
Ø Control		1022 b	667 б	844 b	844 b
Mixed	58 kg/ha N	5676 a	2418 a	4047 a	2894 ab
	38 kg/ha N	3918 a	1412 ab	2665 ab	
	58 kg/ha N + 24 kg/ha K2O	2252 ab	1691 ab	1971 б	
Compact	58 kg/ha N	6165 a	2293 a	4229 a	2426 ab
	38 kg/ha N	2136 ab	1531 ab	1833 ab	
	58 kg/ha N + 24 kg/ha K2O	1428 ab	1007 аб	1217 b	
Complex	58 kg/ha N	3967 a	1904 ab	2935 ab	2038 ab
	38 kg/ha N	1906 ab	1472 ab	1689 ab	
	58 kg/ha N + 24 kg/ha K2O	2211 ab	772 b	1491 b	
Average		3068 A	1517 B		

The values signified by different bold letters within a column are statically of great difference on the level n<0,05.

Average nitrate content in fresh lettuce leaf content in a technological peak was reduced nearly to a half according to the measured nitrate values in phase of leaf rosette developing. The lowest nitrate concentration in fresh leaf mass was measured in control plot in both examined phases of lettuce development. In the phase of leaf rosette development, the highest nitrate concentration was in the second treatment at the usage compact fertilizers technology (6165 mg NO_3 kg^{-1} of a fresh mass) and in technological peak, also in the second treatment but at the usage of mixed fertilizers (2418 mg NO_3 kg^{-1} of fresh mass). The highest nitrate accumulation in a fresh lettuce mass was at the usage of mixed fertilizers technology (2894 mg NO_3 kg^{-1} of fresh mass), and the lowest nitrate content was recorded in lettuce plants which were fertilized by the complex fertilizers (2038 mg NO_3 kg^{-1} of a fresh mass). The results like that show that the best nitrate assimilation was at the usage of complex fertilizers. If we look at the the average nitrate content per treatments in the phase of technological ripeness, the highest nitrate quantities in a fresh lettuce mass were recorded at the second treatment (2205 mg NO_3 kg^{-1} of a fresh mass) on which the nitrogen fertilizer was used in quantities of 58 kg ha^{-1}, while the lowest average nitrate content in fresh mass of the plant recorded at the fourth treatment (1157 mg NO_3 kg^{-1} of a fresh mass). The fourth treatment was treated with nitrogen and potassium fertilizer with the quantities of 58 kg ha^{-1} K_2O). The potassium fertilizer which was used for the nutrition at the fourth treatment influenced the reduced accumulation NO_3 ion in a leaf lettuce mass in technological ripeness. It is known that potassium stimulates nitrogen metabolism and participate in protein synthesis. The role of potassium in forming of enzymes in nitrogen reduction reaction and transport systems responsible for nitrogen taking (Kastori and Petrović, 2003). From this, we can conclude that the fourth treatment fertilizing was the best for lettuce production. The content of total nitrogen (N), phosphorus (P) and potassium (K) in a dry mass of lettuce shoot in the period of intensive growing (27th April) and in the technological ripeness was shown in the table number 5.

If we look average values of the nutritive elements in a dry lettuce mass, we can conclude that the nitrogen content decreased in technological ripeness according to the recorded values of this element in the period of developing of leaf rosette. Phosphorus and potassium contents have been constantly increasing during the vegetation period. The results of a two-year research of the organic fertilizers influence on lettuce chemical compositions (Чабиловски, master's thesis, 2009) show that in the both years of research the highest nitrogen content in a dry plant substance recorded in the middle of the period of vegetation, and in opposite to nitrogen, phosphorus and potassium contents have been constantly increasing till the end of the vegetation. During the period of leaf rosette development, the highest nitrogen content (4,57%) in a dry mass of the plant was recorded on the second treatment when mixed fertilizers were used. The highest content of potassium (6,60%) in a dry lettuce mass was recorded also on the second treatment but when complex fertilizers were used, while in this phase of the lettuce development the applied fertilizers didn't influence phosphorus increase in a dry mass of the lettuce shoot. In the period of the technological ripeness, the highest nitrogen content (3,67%) in a dry lettuce mass was recorded on the second treatment when complex fertilizers technology was used. On the third treatment, when mixed fertilizers were used, the highest phosphorus content (0,52%) was recorded in a dry lettuce mass and potassium on the second treatment when mixed fertilizers were used. At the harvest time, when the complex fertilizers technology was used, the highest nitrogen content was reached (3,53%) in a dry

lettuce mass. When the mixed fertilizers technology was used, the highest phosphorus percentage (0,49%) and potassium (6,63%) was reached.

Table 5. Content of nutritive elements in a dry mass of the plant in the phase of leaf rosette and in technological ripeness

Fertilization treatments		Content of nutritive elements in a of the plant				Dry mass	
		N (%)		P (%)		K(%)	
In autumn N32P64K96	In spring	A phase of leaf rosette developing	A phase of technological ripeness	A phase of leaf rosette developing	A phase of technological ripeness	A phase of leaf rosette developing	A phase of technological ripeness
Ø	Control	3,79 б	2,95 б	0,42 a	0,47 a	5,30 б	5,84 б
Mixed	58 kg/ha N	4,57 a	3,66 a	0,40 a	0,49 a	6,19 a	6,81 a
	38 kg/ha N	4,11 аб	3,41 a	0,42 a	0,52 a	6,00 a	6,44 a
	38 kg/ha N + 24 kg/ha K_2O	4,25 a	3,43 a	0,41 a	0,47 a	6,33 a	6,64 a
Averages		4,30	3,50	0,41	0,49	6,17	6,63
Compact	58 kg/ha N	4,38 a	3,61 a	0,44 a	0,47 a	6,53 a	6,59 a
	38 kg/ha N	4,17 аб	3,23 аб	0,44 a	0,48 a	6,22 a	6,42 a
	38 kg/ha N + 24 kg/ha K_2O	3,89 б	3,29 аб	0,41 a	0,47 a	6,33 a	6,64 a
Average		4,15	3,38	0,43	0,47	6,36	6,47 a
Complex	58 kg/ha N	4,30 a	3,67 a	0,39 a	0,46 a	6,60 a	6,47 a
	38 kg/ha N	4,25 a	3,37 a	0,43 a	0,50 a	5,97 a	6,47 a
	38 kg/ha N + 24 kg/ha K_2O	4,13 аб	3,66 a	0,42 a	0,46 a	6,22 a	6,61 a
Average		4,32	3,53	0,41	0,47	6,26	6,51
Average		4,18	3,43	0,42	0,48	6,17	6,47

The values signified by different bold letters within a column are statically of great difference on the level n<0,05.

Conclusions

The highest average lettuce yield was recorded on the second treatment where the technology of complex fertilizers was used.

The average nitrate content in fresh lettuce mass in its technological ripeness decreased approximately to a half according to measured nitrate values in the phase of the leaf rosette development.

Depending of applied technology of complex fertilizers, the highest average nitrate concentration in a fresh mass was at the usage of mixed fertilizers and the lowest ath usage of complex fertilizers.

On the treatments where nitrogen and potassium fertilizers were used in nutrition, less nitrate concentration was recorded in a fresh lettuce mass. It shows the positive potassium influence to nitrate implement into nitrogen organic compounds.

The nitrogen content was reduced in the technological ripeness according to the recorded values of this element in the period of leaf rosette development. Phosphorus and potassium contents were

constantly increasing till the end of the vegetation.

At the time of harvest, when complex fertilizers technology was used the highest nitrogen content was reached in a dry lettuce mass. When mixed fertilizers technology was used, the highest phosphorus and potassium percentage in a dry mass was achieved.

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ВЛИЈАНИЕТО НА СЛОЖЕНИТЕ МИНЕРАЛНИ ЃУБРИВА ПРОИЗВЕДЕНИ ПО РАЗЛИЧНИ ТЕХНОЛОГИИ ВРЗ ПРИНОСОТ И КВАЛИТЕТОТ НА САЛАТАТА

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Апстракт

Изобилното и неизбалансираното внесување на хранливи елементи во почвата има негативен ефект на приносот и квалитетот на салатата. Акумулацијата на нитрати и штетните ефекти на хлоридни јони се причините зошто е потребно да се воспостави оптимална количина и однос на хранливите материи во исхраната на салатата. Во експериментот кој беше спроведен во текот на 2010 и 2011 година на фармата на средното земјоделско училиште во Футог, беше утврдена содржината на нитрати во свежа маса на салата (mgNO3 кг$^{-1}$), во зависност од употребата на сложени вештачки ѓубрива произведени со различни технологии во различни количини на нитрати и калиумски ѓубрива. Резултатите од истражувањето покажуваат дека во технолошка зрелост, највисок просешен принос на салата е добиен во третманот каде што беше употребена највисока доза на нитратни ѓубрива во пролет, во комбинација со сложени ѓубрива во есен. Најнизок просечен принос е добиен кај контролната парцелка. Највисока просечна концентрација на нитрати во свежа маса на салата е утврдена со користење на технологија со примена на мешани ѓубрива и најмала со користење на технологија на комплексни ѓубрива. Во моментот на берба, највисока содржина на азот во сувата маса на растенијата е забележан со примена на сложени ѓубрива на фосфор и калиум со примена на технологија на мешани ѓубрива.

Клучни зборови: почва, хранливи елементи, нитрати, салата, принос.

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DETERMINATION OF LYCOPEN CONTENT IN '*LAGUNA*' VARIETY PRODUCED IN SKOPJE REGION

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Abstract
Food products that contain antioxidants are an important part of everyday diet. As a natural antioxidant lycopene is essential in the nutrition for preservation and improvement of human health. The samples were taken from the Banjani village in Skopje region. The experiment was done in four replications and four harvests were carried out. The analyses of lycopene were performed by VARIAN CARY 50 Scan UV / Vis Spectrophotometer. Results show that the average content of lycopene in *Laguna* variety is 83,131 mg/kg, variation width is 66.5, standard deviation 17.28, coefficient of variation 20.79 and with mean error of 4.46.
Key words: lycopen, tomato, Laguna, UV/Vis.

Introduction

The presence of red color in tomatoes, pepper, watermelon, papaya and other fruits and vegetables is because of lycopene in their content (2, 3). Tomato (Lycopersicon esculentum L) is consumed worldwide (1). Tomatoes have highest lycopene content in comparison to any fruit or vegetable (4). Lycopene is a found in tomatoes (5). Tomatoes and its products are main sources from where an individual human being can introduce enough lycopene content in the body (7, 8). Bioavailability of lycopene in tomatoes depends of capability of human body to process tomatoes. Tomatoes that are thermically processed allow lycopene to be extracted from bonding cells which means easier absorption of lycopene by the human body (6). There is some evidence that first tomatoes brought in Europe were yellow by color. Red tomatoes appeared in the 19th century (9, 10).
Lycopene is the strongest antioxidant (11). The structure of lycopene is determined in 1930 by Karrer. Lycopene, $C_{40}H_{56}$, has high molecule mass 536 g/mol and intensive red color (13, 15). Open structure contains 11 double bonds and 2048 isomers theoretical possible although few of them determined in plants (14). Twenty five percent of lycopene is trans isomer so called (all-E)-Lycopene and the rest is in cis configuration.

Material and methods

Samples were taken from village Banjani, Skopska Crna Gora, Skopje. The examined variety is Laguna. Four harvests and four repetitions were made. The samples were collected during summer period. Repetitions were made from different clusters. Laguna plants are 1 -1.2 m high (12). Leaves are dark green, medium size, resistant to most diseases. Flowers are medium size with flower formula 6. The yield is oval with green colour during maturation and dark red after maturation. The

mass of the yield is 250 – 350 g. When matured the tomatoes can be stored in ambient temperature for 5 – 7 days. The yield can be consumed or processed. The tomatoes contain 5.5 % dry matter.
Sample preparation was made by the following steps: Samples were cut and homogenized. Five grams dried sample is taken as representative sample. A portion of 5 ml, 0.05 % BHT in acetone is added, 5 ml ethanol and 10 ml hexane. The sample is taken on ice bath for several minutes and then stirred for 15 minutes. A portion of 3 ml water is added and then the sample is again placed on ice bath for additional 5 minutes. After 5 minutes the sample is leaved remaining in ambient temperature for 5 minutes. The sample is dried by low temperature and then stored in polyethylene containers on temperature -200C. Analysis was performed on Varian Cary 50 Scan UV/Vis Spectrophotometer. Wavelength is adapted for the method and calibration curve is constructed before analyzing the sample.

Results and discussion

Table 1. Statistical data gained from determination of lycopene content (mg / kg) from Laguna variety

Variety		Laguna
Flowers - plants	First	74,1
	Second	77,2
	Third	71,1
	Forth	61,9
	First	94,8
	Second	86,3
	Third	88,4
	Forth	87,7
	First	78,5
	Second	81,6
	Third	111,9
	Forth	128,4
	First	64,4
	Second	66,3
	Third	79,2
	Forth	78,3
Average		83,131
Variation width (RV)		66,5
Standard deviation (σ)		17,28
Coefficient of variation (CV)		20,79
Error in average $S_{\bar{x}}$		4,46

Table 1 show that lycopene average lycopene content in Laguna is 83.131 mg/kg. This average content is satisfactory for lycopene content in tomatoes. According to amount of lycopene in tomatoes it can be concluded that tomatoes from this variety are suitable and healthy for consummation and processing as well. Variation width is 66.5. Standard deviation is 17.28. Coefficient of variation is 20.79 and error in average is 4.46.

Table 2. Individual average by flowers

Variety Laguna		mg/kg	Average
Flowers - plants	First	74,1	77,95
	First	94,8	
	First	78,5	
	First	64,4	
	Second	77,2	77,85
	Second	86,3	
	Second	81,6	
	Second	66,3	
	Third	71,1	87,65
	Third	88,4	
	Third	111,9	
	Third	79,2	
	Forth	61,9	89,075
	Forth	87,7	
	Forth	128,4	
	Forth	78,3	

Table 2 shows that average by flowers is 77.95 mg/kg in first flower, 77.85 mg/kg in second flower, 87.65 mg/kg in third flower and 89.075 in forth flower.

Conclusions

Laguna variety has in its content significant amounts of lycopene. The average of lycopene content in the variety is 83.131 mg/kg. The average is 83.131 mg/kg which is an amount that is satisfactory. According to the amount of lycopene it can be concluded that tomatoes from variety Laguna can be used for fresh consummation and processing as well. Variation width is 66.5. Standard deviation is 17.28. Coefficient of variation is 20.79 and error in average is 4.46. The average by flowers is 77.95 mg/kg in first flower, 77.85 mg/kg in second flower, 87.65 mg/kg in third flower and 89.075 in forth flower.

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ОПРЕДЕЛУВАЊЕ НА ЛИКОПЕН КАЈ СОРТАТА *ЛАГУНА* ОДГЛЕДУВАНА ВО СКОПСКО

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Апстракт
Прехрамбените продукти кои во својот состав содржат антиоксиданси се важен дел од секојдневната исхрана на човекот. Ликопенот како природен антиоксиданс претставува есенцијален додаток во исхраната со цел зачувување и подобрување на човечкото здравје. Примероците се земени од с. Бањани, скопско. Направени се четири берби и четири повторувања. Анализите на испитуваниот ликопен се вршени со VARIAN CARY 50 Scan UV/Vis Spectrophotometer. Добиените резултати покажаа дека просекот на содржината на ликопен во сортата *Лагуна* изнесува 83,131 mg/kg, вариационата ширина изнесува 66,5, стандардната девијација 17,28, коефициентот на варијација 20,79 и грешката на средната вредност 4,46.
Клучни зборови: ликопен, домат, Лагуна, UV/Vis.

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SHADING EFFECTS ON SOME GROWN PARAMETERS OF GREENHOUSE AND OPEN FIELD TOMATO

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Abstract
The photoselective netting concept was studied in a tomato 'Vedeta' cultivation in the south part of Serbia (Aleksinac) under high solar radiation (950 Wm^{-2} and PAR around 1600 μmol $m^{-2}s^{-1}$ on sunny days), using four different colored shade-nets (pearl, red, blue and black) with relative shading (40% PAR). It is either applied by itself over net-house constructions, or combined with plastic-house technologies. Exposure to full sunlight was used as a control. Significantly higher leaf area index (LAI) was observed in plastic-house tomato integrated with shade netting technologies (6.1-7.9) than in control plants (plastic house) 5.7. Similarly, obtained value for LAI in net-house (4.8-8.2) were significantly higher at comparison with control (open field) 4.6. Lower light intensity increased stem elongation, leaf blade area and leaf area index. Changing the light intensity by color shade nets affected the biosynthesis of plant pigments (chlorophylls and carotenoides) in tomatoes. Thus, significantly higher total chlorophyll content was observed in plastic-house tomato integrated with shade netting (2.32 -2.85) or net-grown tomatoes (1.76-2.47 $mg \cdot g^{-1}$ f.w.) than in control plants from plastic-house (2.08) or open field (1.44 $mg \cdot g^{-1}$ f.w.). Tomato leaves in open field (control) and under pearl net had significantly less carotenoids than leaves grown under black or blue nets. Chlorophyll a+b /carotenoids ratio increased in shade leaves at comparison with control plants (open field or plastic house). The photo-selective, light-dispersive shade nets appear as interesting tools that can be further implemented within protected cultivation practices.
Key words: tomato, shade, LAI, chlorophyll, carotenoids.

Introduction

The use of shading nets has become very popular in Serbia due to the very high temperatures (35~40 °C) in the summer season. Netting is frequently used to protect tomato crops from excessive solar radiation, improving the thermal climate sheltering from wind and hail and exclusion of bird and insect-transmitted virus diseases. Many factors influence tomato yield (Heuvelink, 2005b), of which radiation is the most important one, as it supplies the energy for photosynthesis, the basic production process in plants. Only radiation that is intercepted by the crop can contribute to photosynthesis. Light interception shows a saturating response to LAI, with about 90% of the incident light intercepted at an LAI of 3.0 (Heuvelink, 1996a). LAI in tomato is influenced by stem density, number of leaves on a stem and individual leaf size (Heuvelink, 2005a). The LAI of vegetation depends on species composition, development stage, and seasonality. Furthermore the LAI is strongly dependent on the prevailing site conditions and the management practices.

In greenhouse tomato production, using the high wire system, plants are allowed to grow vertically up to a 3.5-4.0 m high horizontal wire. Plants produce about 3 leaves and 1 truss every week (De Koning, 1994). All side shoots are removed except for a few (e.g. one or two on each four plants) to increase stem density towards summer (Heuvelink, 2005b). Armitage, 1991 found that shaded plants grew taller than unshaded plants. El-Aidy *et al.* (1994) found that shading led to lower number of leaves and total leaf area under the Egyptian climate conditions. This result was attributed to the light intensity reduction under full shading treatment. Dry matter was decreased linearly with shade increasing (Smith *et al.*,1984). Black net greenhouse gave significantly the highest early yield, while white net greenhouse gave significantly the highest plant height, number of leaves per pepper plant, leaf area index and total yield compared to the other greenhouses (Medany *et al.*, 2009). Shading induced a LAI increase of about 40% (4.66) compared to open field (3.26), Kittas *et al.* (2009). Reducing the leaf area index (LAI) from 5.2 to 2.6, by removing old leaves, did not affect yield (Valdes *et al.*, 2010). Differences in leaf area index (LAI) between control and shaded plants increased at successive harvests. Final values were 4.70 $m^2 \cdot m^{-2}$ and 3.94 $m^2 \cdot m^{-2}$, respectively, which differed significantly (Sandri *et al.*, 2003). As the degree of shading was increased, leaves developed greater area per leaf, but less dry weight per unit area and per leaf. Chlorophyll content and photosynthetic capacity increased as the degree of shading was increased. Leaf chlorophyll content provides valuable information about the physiological status of plants (Gitelson *et al.*, 2003). In this study, less than optimum light was simulated, to observe that even with a one environment parameter, would there be a variation in the content of chlorophyll. The photoselective, light-dispersive shade nets provide a unique tool that can be further implemented within protected cultivation practices. Shading reduced the appearance of tomato cracking and eliminated sun scalds on tomato fruits and accordingly, increased the marketable tomato production by about 35% compared to non-shading conditions (Ilić *et al.*, 2012). The aim of this work was to study the effects on some grown parameters of greenhouse tomato under different shading nets (shading intensity and color) in south Serbia.

Material and methods

Tomatoes (*Solanum lycopersicon*, cv.'*Vedeta'*) were tested in greenhouse production (plastic tunnels - 2.5 m high, covered by termolux 150 μ) during 2008-2009. The experiments were performed in an experimental garden located in the village of Moravac near Aleksinac, (Longitude: 21°42' E, Latitude: 43°30' N, altitude 159 m) in the central area of south Serbia. The shade nets were applied at the start of warm weather in early June. The houses were shaded for the rest of the summer and vegetables were harvested until late August. A completely randomized block design was used, with four blocks assigned to each of four treatments (black, pearl, blue and red net) plus control. Each treatment and block consisted of four rows of 20 plants.

Plant material

The plants were grown following the technique that is usually implemented by the local producers. Seedlings were transplanted on April 30 (plant density was 2.6 plants m^{-2}) As the plants grew, all lateral shoots were manually removed except lateral branches below the first inflorescence, which serve a secondly stem plants.The shading nets were subsequently installed above the crop on June 10 (40 days after transplanting) and the measurements were carried out until September 5. All plants were irrigated using drip irrigation. The tomatoes leaf used in the study were take 90 DAT (day after transplanting) at intensive harvest period (end of July).

Net characteristics

In order to test the effect of shading nets (color and shading intensity), four different shading nets were used: the photoselective nets including 'colored-ColorNets' (red, blue and black) as well as 'neutral-ColorNets' (pearl) with shading intensity of 40% relative shading, photosynthetically active radiation (PAR) were compared to the open field microclimate and production. The color shade nets were obtained from Polysack Plastics Industries (Nir-Yitzhak, Israel) under the trade mark ChromatiNet. These nets are unique in that they both spectrally-modify, as well as scatter the transmitted light. The photoselective net products are based on the incorporation of various chromatic additives, light dispersive and reflective elements into the netting materials during manufacturing. The shading nets were mounted on a structure about 2.0 m in height over the plants (net house) or combined with plastic-house technologies.

Light interception by nets

The effect of nets on the interception of light was measured annually as a percentage of total PAR above canopy, using a Ceptometer mod. Sun Scan SS1-UM-1.05 (Delta-T Devices Ltd Cambridge, UK) with a 64 sensor photodiode linearly sorted in a 100 cm length sword. Readings are in units of PAR quantum flux (μ mol m^{-2} s^{-1}). All measurements were done on clears days at noontime. Measurements of global radiation made every second day, three times during the day.

The Solarimeter- SL 100 is an easy-to-use portable autonomous solarimeter that measures solar irrigation range from 1 W m^2 to 1300 W m^2. All spectral data were expressed as radiation intensity flux distribution in W m^{-2} nm^{-1}.

Weather measurement

Monthly meteorological data from May to September 2008. and 2009. from the meteorological stations in Aleksinac were used (Table 1).

Table 1. Temperature and solar radiation during the growing season in Aleksinac

Month	TS		TOD		TX		TM		MSR	RR		RO
	2008	2009	2008	2009	2008	2009	2008	2009		2008	2009	
May	18.4	18.7	1.8	2.1		25.	11.	11.	219.0	48.0	41.4	66.7
June	22.6	20.9	3.1	1.4		27.	15.	14.	237.2	15.8	72.4	
July	22.9	23.3	1.6	2.0		30.	15.	16.	289.0	112.	63.4	
Avgust	23.5	23.5	2.4	2.4		30.	15.	16.	276.0	55.0	23.4	
Septembe	16.6	19.0	0.6	1.8		26.	11.	12.	210.0	42.4	33.5	

TS-mean monthly air temperature (^{o}C); *TOD*-temperature deviation from 1961-1990 average (^{o}C); *TX*-mean daily temperature maximum for month (^{o}C); *TM*-mean daily temperature minimum for month (^{o}C); *MSR*, mean daily solar radiation (MJ/m^2); *RR*- precipitation amount (mm); RO-relative deviation of monthly precipitations amount from 1961-1990 average (%).

Pigments extraction from tomato leaf

Determination method of chloroplast pigments in acetone solution by Holm (1954) and Wetstein (1954). Average samples of leaves are finely cut and the analytical balance to weigh 0.5g. Measured material is placed in a mortar and pestle to homogenize with the addition of 5-10ml 100% of acetone. For better homogenization at the top adds a few tablespoons of quartz sand, and to prevent acidification of the solution adds a little $MgCO_3$. Homogenization takes about 3min. After which the content of mortar quantitatively transferred to a glass filter and the filtering is done with the help

of a vacuum pump to water spray. Mortar and pestle is rinsed several times with 2-3ml of acetone and content is quantitatively transferred to a filter, and if necessary, a filter and washed with acetone alone, until complete bleaching. The obtained filtrate was extract pigments, which are transferred from the tube measured in 25 ml of court, the court may amend acetone to the mark and well shaken. As the concentration of pigments usually large, the resulting extract is diluted, it could be done reading on the spectrophotometer. Thinning: 1ml concentrate + 9 ml of absolute acetone. The obtained extract was read on the spectrophotometer at wavelengths 644, 662, and 440 nm (absorbance) and then with reading. Chlorophyll a = 9784 · A662 - 0990 · A644, Hlorofill b = 21,426 4 · A662 – 4.650 · A662, Chlorophyll a +b = 5134 · A662 + 20. 436 · A664, Carotenoids = 4695 · A440 - 0268 (a + b) where A is the absorbance-reading spectrophotometer at the appropriate wavelength, a value of 9784, 0990; 21,426; 4650 and 0288 are the molar absorption coefficients by Holm (1954) and Wetstein (1957) in absolute acetone and the thickness of 1cm cuvette. (Holm determines absorption coefficients for chlorophyll a and b and Wetsttein for carotenoids).

When the calculated concentrations (mg/l), approaches the calculation amount of pigments in mg per g fresh or dry matter, according to the formula: $C = C1 \cdot V \cdot R / G \cdot 1000$,

C-pigments content in mg/g dry matter of fresh materije)

C1-pigment concentration was calculated according to the formula mg/l

V the original volume of extract (ml)

R-dilution (if any)

G-weighed fresh (dry) weight of plant material (g)

1000 - translation factor g mg UV / Vis spectrophotometer Agilent 8453 with the furnace length of 1 cm optical path was used to determine the content of chloroplast pigments (mg/L) on Faculty of Natural Science-Department of Chemistry, in Niš. Chlorophyll "a"/"b" and chlorophyll/carotenoid ratios were estimated.

Direct methods for leaf area determination

Method of contours on the paper. Method for the determination of the method used ordinary printer paper, regular rectangular shape. First, measure the length and width of paper and calculate the surface area (P), and then determine its mass on the analytical balance. Then remove the leaves from the plant, put it on paper and pencil outline on the edge of its contours. Contours leaf area on the paper is cut with scissors and set to its mass (G_1). Since the value of P, G and G_1 known, then one can calculate the unknown leaf area (P_1) using the formula: P/P_1 G/G_1, where $P1 = G_1 \cdot P/G$.

After the values obtained by this method started with the calculation of leaf area index. For tomato and pepper were measured three categories sheets: old, middle and upper (youngest). With plants, which were used as samples, the measured size of the three groups of leaves, then the area is multiplied by the total number of sheets in each group. For the obtained surface is taken into account and the number of stem per plant (2 stem).Total leaf surface in all three categories are added together and the value obtained is divided by the plant density. The resulting value is the leaf area index (LAI).

Statistical analysis

The data were analyzed by analysis of variance (ANOVA) followed by Tukey's HSD test, using the Statistica 6.1 software (Statsoft, Tulsa, OK, USA). All analyses were performed at a 95 % level of confidence ($p<0.05$).

Results and discussion

Leaf area index (LAI)

For tomato plastic house production in Serbia the use of containerized transplants is common. Transplants are typically 6 week old, having 3 to 5 leaf-bearing nodes an initial leaf area of 15 to 40 cm^2, and a dry weight of 0.20 to 0.30 g/plant. The LAI values at transplanting ranged from 0.002 to 0.004 (data not show). The light effect on biomass production occurs through its effects on leaf development rate, leaf expansion, stem elongation and flower and fruit development. Increase in biomass result from action related to increases in leaf area and chlorophyll content. Leaf area index - LAI is a dimensionless variable and was first defined as the maximal projected leaf area per unit ground surface area (Myneni *et al.* 1997).

It was founded here that red and pearl shade nets significantly increased the total leaf area, in comparison with LAI obtained from blue or black shade nets. Generally, tomato under plastic house integrated with color shade nets had lowest LAI in comparison with LAI obtained from screen house (only color nets). The black shade nets where LAI were lowest than other color nets.

Table. 2. Influence of different color shade nets on leaf area index (LAI) in tomato plants from plastichouse integrated with color shade nets and from sreen-house (only color shade nets)

Year (A)	Color nets (B)									
	Red		Black		Pearl		Blue		Control	
	PH+CN	CN	PH+CN	CN	PH+CN	CN	PH+CN	CN	PH	OF
2009.	8.1a	8.3a	6.5a	5.5a	7.2a	7.7a	7.2a	7.1a	6.2a	5.2a
2010.	7.9a	8.2a	6.3a	5.2a	7.1a	7.9a	6.9a	7.4a	5.9a	4.9b
2011.	7.8a	8.2a	6.3a	4.6b	6.9a	7.5a	7.1a	7.1a	5.2b	3.8b

LSD 0.05 1.268 0.983 1.117 0.665 1.094 1.046 1.242 1.167 0.393 1.217

LSD 0.01 2.103 0.188 1.853 1.102 1.815 1.735 2.059 2.290 0.651 2.017

A·B 0.963 1.029 0.988 0.947 0.922 0.988 0.863 0.908

PH+CN – Plastic house+Color Nets; CN- Color Nets

PH-Plastic House OF-Open Field

Plants grown under black color nets had similarly LAI with control plants (grown in plastic house or without nets in open field). Higher LAI values are generally indicative of excessive vegetative growth which may delay the onset of fruit production. Lower light intensity increased stem elongation, leaf blade area and leaf area index.

A shade leaves generally have a larger surface area and are thinner than sun leaves. As water is a main component in plant development, the surface area of a sun leaf is smaller to reduce water loss. As a result, less water is lost to heat and evaporation so a plant can grow. Leaf area index ranged from 3.8 - 5.2 from open field plants (control) to maximum LAI values of 8.2 - 8.3 in screen-house with red color nets (40% shade). Differences in leaf area index (LAI) between control and shaded plants increased at successive harvests.

Similarly, Smith *et al*. (1984) presented that cucumber (*Cucumis sativus* L.) grown in a greenhouse under 0.3 shade density produced less dry matter and had more biomass in leaves and stems and less in root and fruits than plants without shade. Plants acclimate to shade, in part, by increasing specific leaf area. Tomato plants grown under 0.52 shade density compared with no shade had a greater LAI, 4.7 and 3.9, and a greater specific leaf area, 320 and 230 $cm^2 \cdot g^{-1}$, respectively (Sandri *et al.*, 2003).

Previously development for drip-irrigated and subirrigated culture, reported LAI values for subirrigated field tomato and drip-irrigated greenhouse tomato were 5.5 to 6.5 and 7 to 8, respectively (Jones *et al.*, 1989; Marlowe *et al.*, 1983).

Chlorophyll content

Shades leaves harvest lower levels of light and thus contain more chlorophyll than sun leaves do. Because they're not directly exposed to sunlight, they need the extra chlorophyll to attract and absorb the sun's energy in order to produce the food needed for a plant to grow. Although sun leaves contain less chlorophyll than shade leaves do, they have a greater light saturation point and therefore can handle full exposure to the sun. Shade leaves are not predisposed to handle the extra saturation of light and can burn if exposed to the direct rays of the sun.

It could be observed that the highest average spad value was concentrated in the middle layer followed by the second highest reading within the upper layer and the lowest reading being recorded in the lower layer of the plant (data not shown). This according to Buchanan-Wollaston (1997) is a natural phenomenon in a plant's development, whereby leaf chlorophyll content is known to be lower in both the newly developed leaves and older leaves of the plant.

Table 3. Influence of different color shade nets at leaf pigments (mg/g) in tomato plants from plastic house integrated with color shade nets

	Chl a			*Chl b*			*Carotenoides*		
	2009.	2010.	2011.	2009.	2010.	2011.	2009.	2010.	2011.
Red	1.813c	1.839bc	1.252a	0.761a	0.880bc	0.425c	0.459bc	0.354d	0.329c
Black	1.799c	2.457a	1.690a	0.738a	1.069a	0.691a	0.462bc	0.527ab	0.437ab
Pearl	2.060b	1.888b	1.451a	0.852a	0.842c	0.478c	0.541ab	0.549a	0.373bc
Blue	2.228a	2.240a	1.672a	0.850a	0.938b	0.625b	0.586a	0.461bc	0.436ab
Control	1.605d	1.587c	1.338a	0.595b	0.585d	0.551d	0.435c	0.412cd	0.463a

LSD 0.05 0.152 0.277 0.920 0.124 0.087 0.087 0.087 0.087 0.087
0.01 0.252 0.460 1.527 0.209 0.145 0.145 0.145 0.145 0.145
A·B 0.214 0.096 0.067 0.297 0.133 0.094

A shade leaves generally have larger total chlorophyll (chlorophyll *a* and chlorophyll *b*) content than control leaves (from plastic house or open field). Plants from black shade nets obtained maximum leaves chlorophyll content in comparison with another color shade nets. Carotenoids content ranged from 0.416 (mg/g) from open field plants (control) to maximum carotenoids values of 0.508 (mg/g) in net-house with black nets or 0.500 (mg/g) in blue nets. A similar trend was observed in plastic house integrated with color shade nets where the lowest carotenoid content (0.426mg/g) was recorded in plastichouses (control). The highest content of carotenoids was observed in plastic house integrated with blue (494mg/g) or pearl nets (487mg/g). Similar results were found by Bergquist *et al*. (2007) who showed that the concentrations of total carotenoids and total chlorophylls in baby spinach leaves were significantly higher under the nettings, especially under the spectrum-altering and low transmittance nettings. Other authors have found an increase in chlorophyll "a" content in lemon stressed plants with high temperatures (Martin *et al.*, 1995). Thus, the shade-grown leaves had a conformation somewhat the opposite to that of leaves grown in high light intensity. Shade-grown leaves were of a softer texture and had a darker green coloration. The

increase in chlorophyll "a/b" ratio might be associated with the protection of photosynthetic system under stress conditions, due to a lesser radiation absorption at shorter wave length (Garcidueña, 1993). As the degree of shading was increased, leaves developed greater area per leaf, but less dry weight per unit area and per leaf (Woltz, 1968). Thus, with 50% shade tomato leaf area index increased with 55% in comparison with unshaded (control plants).

Table 4. Influence of different color shade nets at leaf pigments (mg/g) on tomato plants in net-house (only color shade nets)

	Chl a			Chl b			Carotenoides		
	2009	2010	2011	2009	2010	2011	2009	2010	2011
Red	1.433b	1.634ab	1.161bc	0.566b	0.884a	0.450ab	0.369b	0.441ab	0.517a
Black	1.968a	1.791a	1.469a	0.754b	0.908a	0.523a	0.535a	0.367b	0.623a
Pearl	1.412bc	1.090c	1.281ab	0.499bc	0.559c	0.447ab	0.381b	0.227c	0.544a
Blue	1.902a	1.370b	1.180b	0.771a	0.707b	0.424ab	0.510a	0.519a	0.471a
Control	1.097c	1.002c	1.041bc	0.377c	0.492c	0.325b	0.485a	0.207c	0.556a

LSD 0.05 0.3166 0.2776 0.3620 0.1242 0.124 0.2483 0.0832 0.0878 0.1242
0.01 0.2522 0.4604 0.6003 0.2059 0.2059 0.4118 0.1381 0.1456 0.2059
A·B 0.2145 0.9592 0.06782 0.2977 0.1331 0.09414

Chlorophyll content and photosynthetic capacity increased as the degree of shading was increased. Thus, with 50% shade tomato leaves increased chlorophyll level with 50% (Woltz, 1968). It should be pointed out that the shading procedure as a method of varying light intensity causes other variations, namely in the soil (temperature and moisture) and micro-climate of the plant (data not show). These variations are doubtless of considerable significance at some physiological parameters.

Table 5. Effect of different color shade nets on total chlorophyll content, carotenoid content (mg/g), chlorophyll “a/b” ratio and total chlorophyll/carotenoid ratio

	Chl a + b		Car		Chl a / b		Chl a+b /Car	
	Plastichouse + color nets	Color nets	Plastichouse + color nets	Color nets	Plastichouse + color nets	Color nets	Plastichouse + color nets	Color nets
Red	2.322	2.042	0.380	0.442	2.37	2.12	6.11	4.62
Black	2.814	2.470	0.475	0.508	2.38	2.39	5.92	4.86
Pearl	2.523	1.762	0.487	0.384	2.48	2.52	5.18	4.58
Blue	2.854	2.118	0.494	0.500	2.55	2.34	5.78	4.23
Plastic house Open field	2.087	1.444	0.426	0.416	2.61	2.63	4.90	3.47

Tomato leaves grown under black, blue or red nets had significantly more total chlorophyll content than leaves from open field (control) and under pearl net. Similarly, tomato plants grown under black, pearl and blue nets had significantly more chlorophyll level than leaves grown in a plastic house (control) and under integrated plastic house with red net. Tomato leaves in open field

(control) and under pearl net had significantly less carotenoids than leaves grown under black or blue nets. Tomato plants grown in a plastic house (control) and under integrated plastic house with red net had significantly less carotenoid level than leaves grown under black, pearl and blue net (Tab. 5). Similar results were found by Camejo and Torres (2001) who showed that the total chlorophyll content per unit leaf area remained relatively constant, although the chlorophyll a/chlorophyll b ratio declined in shade plants. Chlorophyll a+b /carotenoids ratio increased in shade leaves at comparison with control plants (open field or plastic house). The differences in total pigment content and Chl/carotenoids between sun and shade leaves, as detected also in other plants (Lichtenthaler *et al.*, 1981), are due to the high irradiance adaptation response of the photosynthetic pigment apparatus of sun leaves with a much lower quantity of light-harvesting Chl a/b proteins (LHCII) and a greater number of reaction centers on a total Chl basis as compared to shade leaves (Lichtenthaler *et al*., 1982). The lower level of LHCII proteins, with their low Chl a/b ratio of 1.1–1.3, in sun leaves results in higher values for the ratio Chl a/b of ca. 3.1–3.3 found here in ginkgo and beech sun leaves. In contrast, shade leaves possess lower Chl a/b ratios as observed here for ginkgo and beech (ca. 2.6–2.8). Photo-selective nets were designed to selectively filter different spectral bands of solar radiation, and/or transform direct light into scattered light. The spectral manipulation intends to specifically promote desired physiological responses, while the scattering improves the penetration of the spectrally modified light into the inner plant canopy. Since the nets are composed of holes, in addition to the translucent photo-selective plastic threads, shade nets actually create mixtures of natural, unmodified light, which is passing through the holes, together with the diffused, spectrally modified light, which is emitted by the photo-selective threads (Shahak *et al*., 2008).

Conclusions

Lower light intensity in shade plats increased stem elongation, leaf blade area and leaf area index. Total chlorophyll and carotenid content increased in shade leaves in comparison with leaves grown under sun. The results of the present study provide useful data for detecting differences among environment variation in leaf area index and pigment leaf content and color shade nets. However, the data are preliminary and more research is required for understanding the physiological mechanisms behind the plant responses and for testing results with other crops and other environmental conditions.

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ЕФЕКТИ ОД ЗАСЕНЧУВАЊЕ ВРЗ НЕКОИ ПАРАМЕТРИ ЗА ПОРАСТ НА ДОМАТОТ ОД ОРАНЖЕРИИ И ОД ОТВОРЕНО

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Апстракт

Концептот на фотоселективни мрежи бил изучуван во одгледувањето на 'Vedeta' домати во јужниот дел на Србија (Алексинац) под високо сончево зрачење (950 Wm-2 и PAR околу 1600 μmol $m^{-2}s^{-1}$ на сончеви денови), со помош на четири различни бои на мрежи за засенчување (бисерна, црвена, сина и црна), со релативно засенчување (40% PAR). Се применуваат над конструкции, или во комбинација со пластенички технологии. Изложеност на полна сончева светлина се користи како контрола. Значително повисоки индекс на лисна површина (LAI) е забележана кај пластениците со домати со интегрирани технологии на засенчување (6,1-7,9) отколку кај контролните растенија (пластеници) 5,7. Слично на ова, добиените вредности за LAI во пластениците од мрежа (4,8-8,2) биле значително повисоки во споредба со контролата (отворено поле) 4.6. Понискиот интензитет на светлина ги зголемува издолжувањето на стеблото, лисната површина и индексот на лисната површина. Менувањето на интензитетот на светлината со примена на обоени мрежи влијае врз биосинтезата на растителни пигменти (хлорофил и каротеноиди) во доматите. Така, значително повисока содржина на вкупен хлорофил е забележан во пластеници со домати и интегрирана мрежа за засенчување (2,32 -2,85) или нето пораст на доматите (1.76-2.47 mg•g−1 f.w.) отколку кај контролните растенија од пластеници (2,08) или отворено поле (1.44 mg•g−1 f.w). Листовите домат од отворено и под бисерна мрежа имале значително помалку каротеноиди од лисјата под црни или сини мрежи. Соодносот хлорофил а + б / каротеноиди се зголемил со засенчување во споредба со контролата (отворено поле или од пластеници). Фотоселективни, светло-дисперзивни мрежи за засенчување се интересни алатки кои можат понатаму да се спроведува при одгледување во заштитени простори.

Клучни зборови: домати, засенчување, ЛАИ, хлорофил, каротеноиди.

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EFFECT OF POSTHARVEST TREATMENTS ON MASS, β-CAROTENE AND VITAMIN C LOSSES IN CARROT ROOT DURING PROLONGED STORAGE

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Abstract
Carrots are the most popular and wide-spread of all root vegetables, and are the principal source of carotenoids in human diet. The purpose of this study was to examine differences between postharvest washed treatments (hot water, H_2O_2 and Na_2OCl) and non-washed (control) root and the effect of different storage condition S_1 (0^{o}C and 95-99% RH) or S_2 (0-2^{o}C and <90% RH) regarding the mass, β-carotene and vitamin C changes in carrots 'Maestro F_1'. Storing carrots at either 0 ^{o}C to simulate long-term storage (180 days) or 20 ^{o}C to simulate marketing practices (3 weeks) resulted in a significant reduction of micronutrient of carrot taproot. At the end of 180 days of storage the percentage mass losses ranged from 3.1 to 33.2% depending on the storage condition and disinfection treatment. Initial concentrations of β-carotene in freshly harvested carrots was 39.74 μg/g f.w. Loss of β-carotene during storage was observed higher in the S_2 (28.2- 46.9%) than in the S_1 cold storage (7.8-20.7%). Initial concentrations of vitamin C in freshly harvested carrots (5.05mg·100g^{-1}), confirming that carrots are not a rich source of this vitamin. After 180 days storage vitamin C concentration in carrots decreased depend of storage conditions. Thus, the vitamin C losses of carrot root inside the S_1 sophisticated cooling room ranged from 2.0% to 18.2%, while under simple refrigerated storage, was recorded significant higher vitamin C losses (20.7% - 52.3%).
Key words: carrot, storage condition, postharvest treatment, mass loss, β-carotene, vitamin C.

Introduction

Carrots (*Daucus carota L.)* in general are one of the best sources of β-carotene in our diet, and provide 17% of the total β-carotene intake in human nutrition (Alasalvar *et al.,* 2001). β-carotene is the principal precursor of vitamin A, which is involved in vision, cell differentiation, synthesis of glycoproteins, mucus secretion from the epithelial cells, and overall growth and development of bones. The harvested carrot root is an underground organ that has been dug out of the soil while it was in full metabolic activity. The principal factors which can be used to establish the length of postharvest life of carrots include the time of harvest of the products, stage of maturity at harvest and the handling and storage conditions (Ilić *et al.,* 2009). Carrot has good physiological storability. Provided that carrots are not infected by microbes causing storage diseases, they can be stored for 6-8 months without loss of quality under optimal storage conditions (temperature 0°C and relative

humidity 98%), Balvoll (1985). Carrot has low metabolic activity at low temperatures, as shown by the low respiration rate (Stoll and Weichmann 1987). A low storage temperature also prevents the onset of new growth. However, carrot is sensitive to wilting if not protected from water loss. In commercial refrigerated stores, storage diseases, mainly caused by pathogenic fungi, pose the greatest risk. Ethylene in the air may impair the sensory quality by inducing the synthesis of phenolic compounds, which give rise to a bitter taste (Lafuente *et al.,* 1989).

The most significant changes in postharvest quality are weight loss, bitterness, bacterial deterioration, rooting and sprouting. This can be prevented by different methods including cold storage, postharvest treatment and chemical applications. The two basic conditions, as recommended by previous researchers and confirmed by our results, are a temperature of 1^{o}C and a relative humidity of 98% (Ilić *et al.,* 2009). Typical procedure as carrot handling involves washing, tapping, chemical treatment and packaging. Disinfection is part of an overall sanitation and safety management program. The chemical fungicide iprodione is usually applied before storage to reduce the development of postharvest diseases. A technology for the precise application of steam and combined application with stabilized hydrogen peroxide (Tsunami® 100) or a yeast commercial product (Shemer™) were applied (Eshel *et al.,* 2009). Chlorination of process water is one of the primary elements of a property management postharvest sanitation program. Washing carrots with cold chlorinated water (4°C) and warm tap water (50 °C), respectively, provided good microbiological safety paired with improved sensorial properties (Klaiber *et al.,* 2005). In the last few years, carrot growers in Israel have begun to brush carrots before storage to remove the outer peel of the root (Eshel *et al.,* 2009).

Singh *et al*. (2001) mentioned vitamin C and carotenoid losses after storage, with higher losses for vitamin C. Loss of beta-carotene during carrot storage was observed higher in the cellar than in the cold storage. Mean loss of beta-carotene in dry matter for cold storage was 13.57-14.28%, compared to cellar 20-27.3% (Fikselova *et al*., 2010). Vitamin C content in different cultivars ranged from 54 mg·kg^{-1} to 132 mg·kg^{-1}. Significantly higher contents of vitamin C were also found in the late cultivars and moderately late cultivars in comparison to early ones. 30-day storage resulted in a significant reduction in vitamin C content, on average of 47%. There was also a reduction in the carotenoids content, but to a lesser extent, on average of 11% (Matejkova and Petrikova, 2010).

The aim of this study was to determine the contents of β-carotene and vitamin C in carrot and to study the effect of different postharvest treatment during 6 month storage period on the contents of these compounds.

Material and methods

Field production

Carrot (*Daucus carota L.*) cv. 'Maestro F_1' a commercial hybrid for open field during the fall, autumn and winter. Taproot of uniform size, about 150 g, were picked directly from a field in the south part of Banat (village Debeljača) at the full maturity stages. The soil condition was well drained and sandy, and drip irrigation was used. Cultural practices, such as land preparation, planting and plant protection for the crop, were as is the standard in this area. Mature carrots were harvested in the fall and went into storage immediately after harvest. Taproot without defects or diseases, at same size, shape and injury free were selected for the experiment. The carrots went into storage on November 10, 2011 and the study was terminated on April 20, 2012.

Postharvest treatment

The purpose of this study was to examine differences between postharvest washed treatments: 1) hot water washing and brushing (50 ^{o}C for 1 minut); 2) H_2O_2 (1%); 3) Na_2OCl (175 ppm) and non-washed roots (with soil) were used as a control.

Storage condition

After treatments taproot were stored for 160 d at different storage condition. The taproot were stored at 0 $\pm$ 0.5 ^{o}C, in a sophisticated requirements cooling-room (S_1) with constant relative humidity (RH 95%) in the dark or second cooling room with temperature 0-2 ^{o}C and uncontrolled conditions of relative humidity ~ 90% (S_2). For each postharvest treatment and storage regime, 25 root per replicate (4) were sampled for analysis. After 160 d storage at either temperature taproot were transferred at 20 ^{o}C to study their shelf life. Analyses were performed after 3 weeks at 20 ^{o}C (simulate marketing practices).

Samples and analysis

Ten grams of scraped carrot have been extracted with 100 ml 95% hot ethanol in 400 ml erlenmeyer flask for 30 minutes. Yellow extract has been diluted by water up to 85% and cooled down to room temperature. This solution has been transfered in separating funnel and mixed well with 50 ml of petroleum ether. After layers separations, lower one (alcoholic) has been washed with petroleum ether in portions of 2 ml, until upper layer becomes colorless, which means that all carotenes are extracted. All petroleum ether layers have been collected and washed with 85% ethanol to remove eventually present xanthophylls. Petroleum ether layer has been concentrated under the vacuum and the temperature of water bath was maintained below 40°C. Oily residue was kept in the dark at 4°C.HPLC analysis of extracts was carried out with the Agilent 1100 Series system, Waldborn, Germany (pump, detector, software). The LC column Zorbax-Eclipse XDBC18; 4.6 mm × 250 mm, 5 μm was used, with a mobile phase consisting of a mixture of acetonitrile: methanol: ethyl acetate, 6:2:2 v/v, at a flow rate of 1 cm^3/min. The injection volume was 20 μl using the detector DAD Agilent 1200 Series at 474 nm wavelength (Cvetkovic and Markovic, 2008).

Preparation of extracts for analysis

The extracts (8 cm^3) of different concentrations were evaporated to dryness with rotary vacuum evaporators at room temperature and the residues were dissolved in *n*-hexane (2 cm^3). Extracts were filtered through a 0.45 μm Millipore filter immediately before HPLC analysis.

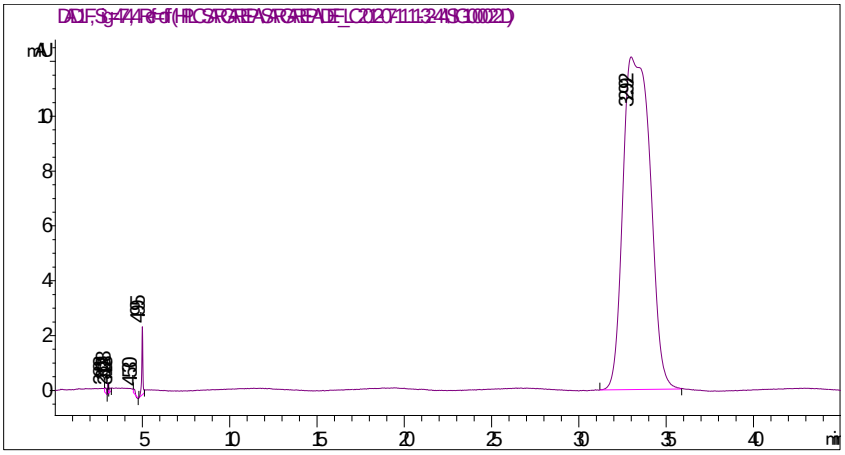

Figure 1. HPLC Chromatograms β-caroten (c = 0,00625mg/cm^3)

Calibration curve for β-carotene standard

Standard of β-carotene was dissolved in *n*-hexane just before HPLC analysis, and diluted to the appropriate concentrations (1.56-100 mg/cm^3) for calibration curve obtaining (Cvetkovic and Markovic, 2008). The external standard method was used for determination of β-carotene concentration in the extracts.

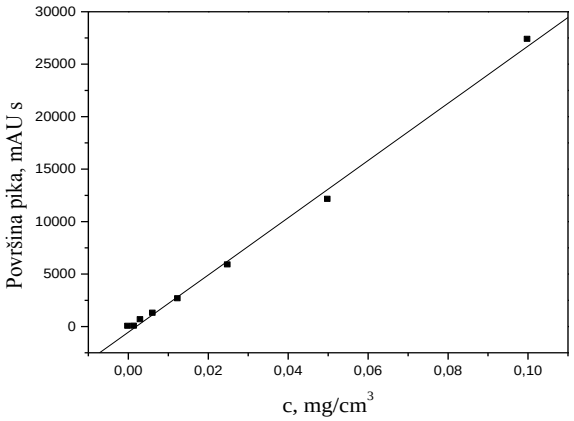

Figure 2. The calibration curve for the determination of β-carotene in carrot, based on HPLC analysis

Results and discussion

Carrot has low metabolic activity at low temperatures, as shown by the low respiration rate. A low storage temperature also prevents the onset of new growth. However, carrot is sensitive to wilting if not protected from water loss. The rate of water loss of carrot is affected by the surface area of the root, the water vapour pressure deficit and air velocity (Correa *et al.,* 2012). Water loss due to transpiration results in shriveling, loss of bright colour and increased risk of post-harvest decay. An 8% weight loss is reported to make carrots unsaleable (Robinson *et al.,* 1975).

A key goal of washing and sanitizing postharvest treatments, therefore, is removal or inactivation pathogens on fresh carrot.

Table 1. Effect of postharvest treatments and storage conditions on mass losses (%) during storage

Storage condition	S_1 - (0 ^{o}C; >95% RH)			S_2 - (0-2 ^{o}C; <90% RH)		
	days after harvest					
Treatment	60-days	120-days	180-days	60-days	120-days	180-days
Control	0.86	3.00	6.77 c	12.48	18.96	24.00 b
Hot water	3.01	4.01	4.85 b	21.80	29.76	33.24 c
H_2O_2	1.42	1.73	3.12 a	11.71	18.08	20.69 a
Na_2OCl	2.30	3.02	3.42 a	11.00	17.52	21.25 a

The moisture content of the refrigerated carrots decreased with time of storage. The relative humidity measured inside the S_1 sophisticated cooling room conditions ranged from 95% to 99%, however the relative humidity under simple refrigerated storage varied from 79% to 94%. The low

relative humidity under the refrigerated storage might have contributed to the decrease in moisture content of the carrots with time.

Mass losses (shriveling) and fungal diseases were most important cause of postharvest losses of carrot in Serbia. At the end of 180 days of storage the percentage mass losses ranged from 3.1% to 33.2% depending on the storage condition and disinfection treatment. Thus, the weight loss of carrot root inside the S_1 sophisticated cooling room conditions ranged from 3.1% with chlorinated (175ppm Na_2OCl) prestorage treatment to maximum weight loss of 6.8% in control (unwashed-control roots). A different trend was observed under simple refrigerated storage, where the lowest mass losses (20.7 %) was recorded in treatment with hydrogen-peroxide but significant the highest mass losses was observed in hot water treatment (33.2%).

Similar results were found by Sudimac *et al.* (2012) who showed that the percentage mass losses ranged from 15% to 35% depending on the cultivars and disinfection treatment. Commercial storage of carrots resulted mass losses of 15% fresh weight over the 3 months period (Ng *et at*., 1998).The effects of sanitation treatments were highly effective at reducing disease decay (*A. alternata*) in comparising with control (12%). In view of microbial reduction and maintenance of sensory properties, the use of cold chlorinated water proved to be effective for washing carrots (Sudimac *et al.*, 2012).

β-caroten and vitamin C levels in fresh carrot decreased during storage. Since carrots are important source of carotenoids and vitamin C in the human diet, it is appropriate to determine to what extent these compounds are lost during storage. Carrot root is associated with the presence of certain carotenoids, xanthophylls or anthocyanins. In orange carrots α-carotene account 15% to 40% of total carotenoid content while β-carotene acounts for 45% to 80% and γ-carotene for 2% to 10%. At the end of 180 days of storage the percentage of β-carotene loss resulted in a significant reduction particularly under simple refrigerated storage. Depending on the disinfection treatment loss of β-carotene was differ. Thus, loss of the β-carotene in carrot root inside the S_1 sophisticated cooling room conditions ranged from 4.1% with hot water prestorage washing treatment to maximum of 20.7 % in treatment with Na_2OCl (Tab.2).

Table 2. Effect of postharvest treatments and storage conditions on β-carotene changes (μg/g f.w)

Storage condition	S_1 - (0 °C; >95% RH)			S_2 - (0-2 °C; <90% RH)	
	β-carotene (μg/g f.w)				
Treatment	Time of harvest	180 days storage	% loss	180 days storage	% loss
Control	39.74	36.65b	7.8d	28.53a	28.2d
Hot water		38.12a	4.1c	23.02b	42.1b
H_2O_2		33.52c	15.6b	24.79b	37.6c
Na_2OCl		31.51c	20.7a	21.09c	46.9a

A similar trend was observed under simple refrigerated storage, where the lowest β-carotene loss (28.2%) was recorded in treatment with hot water treatment but significant the highest β-carotene was observed in Na_2OCl treatment (46.9%). Our findings that these compounds (β-carotene) are lost during storage depend of storage condition are in agreement with those of Fikselova *et al.* (2010) who found that, loss of β-carotene during carrot storage was observed higher in the cellar than in the cold storage. Mean loss of beta-carotene in dry matter for cold storage was 13.57-14.28%,

compared to cellar 20-27.3% (Fikselova *et al.*, 2010). In Nantes carrot, stored at 2°C and 90 percent relative humidity, alfa-carotene and beta-carotene levels increased slowly up through 100 to 125 days and then decreased (Lee, 1986). Some changes in the α and β-carotene contents of carrot could be discerned under dark and lighted cold storage (4 °C), but these changes were not found to be statistically significant (Kopas-Lane and Warthesen 1995). It was concluded that neither lighted nor dark cold storage affected the major carotenoids of carrot. Dily *et al.* (1994) showed the total carotenoid content of carrot roots stored in cold storage at 0 to 1°C for 209 days did not change. Phan *et al.*, (1973) suggested the change in total carotenoids in carrot roots is tissue specific in cold storage. They found a decrease in xylem carotenoid level and little changes in phloem carotenoid levels. Losses in total carotenoid content were reported in some vegetables, especially leaves. Both sweet pepper and parsley lost over 20 % of their total carotenoid content at cold room storage (7 °C) for 9 days (Takama and Saito 1974). Carotenoid losses amounted to 60 and 80 % at 15 °C and 17 °C, respectively. Leek lost about 53% of its total carotenoid content within 3days at both temperatures (Takama and Saito, 1974).The content of vitamin C in carrot can be influenced by various factors such as genotypic differences, preharvest climatic conditions and cultural practices, maturity and harvesting methods, and postharvest handling procedures. Temperature management after harvest is the most important factor to maintain vitamin C of vegetables; losses are accelerated at higher temperatures and with longer storage durations (Lee and Kader, 2000).

Table 3. Effect of postharvest treatments and storage conditions on vitamin C changes

Storage condition	S_1 - (0 °C; >95% RH)					S_2 - (0-2 °C; <90% RH)			
	Content of vitamin C mg·100g^{-1}								
Treatment	Time of harvest	60-days storage	% loss	180-days storage	% loss	60-days storage	% loss	180-days storage	% loss
Control	5.05	4.95 a	2.0c	3.28b	35.0c	4.27b	15.4c	2.97b	41.2b
Hot water		5.00 a	1.0c	4.07a	19.4d	4.95a	2.0d	3.52a	30.3c
H_2O_2		4.35 b	13.9b	3.08b	39.0b	3.41c	32.5a	2.56c	49.4a
Na_2OCl		4.18 b	18.2a	2.86c	43.4a	3.99b	21.0b	2.41c	52.3a

The losses of vitamin C that occur immediately after harvest. 60-day storage resulted in a significant higher reduction in vitamin C content under simple refrigerated storage (2 -32.5%) compared with loss in sophisticated cooling room (1-18.2%). Significant more vitamin C loss observed Matejkova and Petrikova (2010) after 30-day storage content, on average of 47%. At the end of 180 days of storage the percentage of vitamin C loss resulted in a significant reduction particularly under simple refrigerated storage. Depending on the disinfection treatment loss of vitamin C also was differ. Thus, the vitamin C losses of carrot root inside the S_1 sophisticated cooling room conditions ranged from 2.0% with hot water prestorage washing to maximum vitamin C losses of 18.2% in treatment with Na_2OCl. A similar trend was observed under simple refrigerated storage, where the lowest vitamin C loss (20.7 %) was recorded in treatment with hot water treatment but significant the highest vitamin C loss was observed with hydrogen-peroxide treatment (52.3%). Favell (1998) noted a 15% decrease of vitamin C in carrot after 14 days storage at 4°C. Fresh storage at ambient temperatures resulted in greater loss; for example, fresh peas stored at ambient temperatures lost

50% of their ascorbic acid in 1 week, while fresh spinach stored at ambient temperatures lost 100% of its ascorbic acid in less than 4 days (Hunter and Fletcher, 2002).

Conclusions

This work confirms the existence of important differences between storage condition and postharvest washing treatments during carrot storage regarding mass, vitamin C and β-carotene losses. Losses of mass, β-carotene and vitamin C during carrot storage were observed higher in the simple cooling room than in the sophisticated cold storage. After 180 days of storage the levels of both compounds were significantly lower. Higher losses were noted for vitamin C.

This research revealed that prestorage root washing (175ppm sodium hypochlorite) significantly reduced weight loss, while maintaining a good quality (β-carotene and vitamin C content) obtained with hot water treatment.

Acknowledgements

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ВЛИЈАНИЕ НА ПОСЛЕБЕРБЕНИТЕ ТРЕТМАНИ НА ЗАГУБИТЕ ВО МАСА, β-КАРОТИН И ВИТАМИН С КАЈ МОРКОВОТ ЗА ВРЕМЕ НА ПРОДОЛЖЕНО ЧУВАЊЕ

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Апстракт

Морковите, од сите коренови зеленчуци, се најпопуларни и широко распространети и претставуваат главен извор на каротеноиди во човечката исхрана. Целта на оваа студија беше да се испитаат разликите помеѓу послебербениот третман со миење (топла вода, H_2O_2 и Na_2OCl) и немиење (контрола) на корените и ефектот на различните услови на складирање S1 (0 ^oC и 95-99% RH) или S2 (0-2 ^oC и <90% RH) во однос на промените во масата, β-каротинот и витамин С кај сортата "Маестро F_1. Складирањето на морковите било на 0 ^oC да симулира долгорочно чување (180 дена) или на 20 ^oC да симулира услови на маркет (3 недели) што доведоа до значително намалување на хранливите материи на коренот. На крајот од складирањето (180 дена) процентот на загуби во маса се движи 3,1-33,2% во зависност од условите на чување и третманите за дезинфекција. Почетната концентрација на β-каротин во свежо набраните моркови беше 39,74 μg/g f.w. Загубите на β-каротин во текот на складирањето беше повисоко во услови на S2 (28,2-46,9%) отколку во услови на S1 ладилници (7,8-20,7%). Почетните концентрации на витамин С во свежо набраните моркови (5.05mg • 100g-1), потврдуваат дека морковот не е богат извор на овој витамин. По 180 дена складирање концентрацијата на витамин С во морковите се намалува во зависност од условите на чување. Така, загубите на витамин С во корените морков чувани во S1 софистициран систем за ладење се движеше од 2,0% до 18,2%, додека при едноставен ладилник за чување загубата на витамин С беше значајно повисока (20,7% - 52,3%).

Клучни зборови: морков, услови на складирање, послебербени третмани, загуба во маса, β-каротин, витамин С.

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BIOLOGICAL AND MORPHOLOGICAL CHARACTERISTICS OF SOME INTRODUCED HYBRIDS OF EGGPLANT (SOLANUM MELONGENA L.)

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Abstract
New, foreign varieties and hybrids of eggplant are often introduced in Republic of Macedonia, especially for greenhouse production. The selection of appropriate hybrids and varieties, according to their biological and morphological characteristics and their behavior in local production conditions, significantly affects the yield and the quality of production. The biological and morphological characteristics of four introduced hybrids of eggplant (Solanum melongena L.) were examined for the purpose of this study: Classic F_1, *Mileda* F_1, *Galine* F_1 and *Diva* F_1. The biological characteristics were studied by the occurrence and the duration of the following phenological phases: vegetation period, number of days from emergence to beginning of flowering, number of days from flowering to beginning of maturity and number of days from emergence to maturity (first harvest). In relation to the morphology, detailed analysis was performed on the fruit characteristics such as: fruit size, fruit weight with pedicle, fruit weight without pedicle, fruit shape, colour and gloss of fruit and the fruit structure. The domestic variety "*Domasen poludolg*" was taken as standard. The colected data were comparatively analyzed. The results show that the tested hybrids are characterized with good morphological and biological properties. Furthermore, this study reveals that for some of the analyzed characteristics of the hybrids *Diva F1, Classic F1 and Galine F1* even exceed the standard.
Key words: eggplant, hybrids, domestic variety, morphological and biological properties.

Introduction

For the vegetable production in our country of great importance are crops of the Solanaceae family in which are included the eggplants (Solanum melongena L). It covers an area of 62-65000 ha, which is equivalent to more than 10% of the total arable land. Lately in our country are introduced more varieties or hybrids of eggplant. The eggplant is not characterized with a wealth of nutrients and has a very low caloric and vitamin value and contains a large amount of water of about 93%. The remaining substances are nitrogen substances 1.1% no nitrogen extractive substances 3.9%, 1.2% cellulose and 0.5% ash. It also contains solanin from where the bitter taste comes. In this area this culture is an annual dikotiledon plant, while in tropical conditions it can be a perennial. The biological characteristics of vegetable varieties especially population represents internal characteristics that are acquired in the historical development under the influence of the center of origin and heritability. In our production more often a foreign varieties and hybrids of an eggplant are imported especially for greenhouse production. Selection of a suitable hybrid variety influences

on the yield and quality of the production. The main goal of the research is through morphological and biological characteristics to be provided relevant indicators provided for examined hybrids of eggplant.

Material and methods

In order to achieve the goal of the research, the two years trials were set up. Four hybrids of foreign origin and one domestic standard were grown and examined as follows: *Diva* F_1 and *Mileda* F_1 of Dutch origin and *Galine* F_1 and *Classic* F_1 of French origin. The domestic variety "Domasen poludolg" was taken as standard. The trials were in plastichouses (heated only by solar energy) with dimensions of 5 x 30 m, and area of 150 m^2 in the village Stajkovci-Skopje. Tested varieties were placed in six replications of 10 plants each, at 2.00 m^2 experiment small parcel, arranged in a random block system, with application of standard production technology and agro-technical measures. The morphological characteristics were detail studied as: characteristics of the fruit, such as the fruit size, the fruit weight with the pedicle, the fruit weight without the pedicle, the fruit shape, the colour and the gloss of the fruit and the fruit structure. The biological characteristics were studied: the occurrence and duration of the individual phenological phases such as: days from emergence to beginning of flowering, days from flowering to beginning of maturity, days from emergence to maturity (first harvest).

Results and discussion

Morphological characteristics of the fruit

Weight of the fruit is one of the parameters by which the size of the fruits is determined. It depends on the conditions and agrotehnical cultivation, location of the fruit of the plant and of other external conditions. The weight of the fruit is a varietal characteristic. The fruits of eggplant are classified as: very small (100 g); small (100 - 200 g); medium (200 - 400 g); large (400 - 800 g); very large (over 800 g). All hybrids according to the classification have large and very large fruits.

Table 1. Average weight of fruit

Hybrid	Fruit weight with pedicle (gr)	Fruit weight without pedicle (gr)
Diva F_1	600	588
Mileda F_1	500	490
Galine F_1	600	588
Classic F_1	700	685
Domasen poludolg Ø	350	338

From the table it can be concluded that all tested hybrids are larger compared with standard, which is medium (350gr) as follows: the hybrid *Classic* F_1 with weight of the fruit (700 g), *Diva* F_1 (600 g), *Galine* F_1 (600 g) and *Mileda* F_1 (500 g). It can be seen that pedicle takes a very small part of the weight of the fruit (10 - 15 g). The shape of the eggplant fruit is like berries. The fruit may be of different size, shape and colour, depending on the variety and age. The harvest of the eggplant is performed in its technological maturity when the fruit reaches a characteristic size, shape and colour appropriate for the variety. In the terms of length, the fruit can be: short (under 10 cm), medium long (10-25 cm), long (25-40 cm), very long (over 40 cm). The shape of the fruit is a varietal

characteristic which may be different such as: cylindrical, elongated, spherical, globular etc. The colour of the fruit is a varietal characteristic, but depends on the stage of maturity. The colour of fruits in technological maturity during harvest is mainly purple with the lighter or darker purple shades, but do not exclude the possibility to be green, white-green (now in the world there are varieties with white colour). Brightness of the fruits can be from very glossy to matte. In botanical maturity, the fruits are with brown or yellowish colour. Fruit structure can be hard or soft and gentle. The internal colour of the fruit is mainly white, white-greenish or greenish. The numbers of locules where the seeds are located are from 7 to 11. The seed is small, flat, and oval as kidney with light brown colour. It has a diameter of 2.5 mm, and a thickness of 2.5 mm. In a fruit there are up to 600 seeds with absolute weight 4-6g. The taste of the fruit may be sweet, faint bitter or strong bitter.

Characteristics of the fruit

Diva F_1: It is characterized by elongated-oval fruit. The length of the fruits is 30-35cm. The colour of the fruit is dark-purple, where fruits are smooth and glossy. The inner colour of the fruit is white, while the internal consistency of the fruit is soft and gentle.

Mileda F_1: The fruits are long and thinner with a length of 30cm. Unlike hybrid Diva F_1, Mileda F_1 is characterized by dark-purple colour even black. They are smooth, the whole plants are spineless and they are with good shine.

Galine F_1: The shape of the fruits is round with an obvious purple colour and expressive gloss. The length of the fruit is about 30cm. The internal consistency of the fruit is soft and gentle, with a relatively white colour with a darker shade of white around the seed.

Classic F_1: The fruit of this type of hybrid has an oval shape and dark purple colour. The length of the fetus is 35cm or more and it is very smooth and shiny. The inner colour of the fruit is white, while internal consistency is soft and gentle.

Table 2. Characteristics of fruits

Hybrid	Shape of the fruit	Length of the fruit	Colour of the fruit	Internal colour and consistency
Diva F_1	elongated-oval	30-35cm	dark-purple	White soft and gentle
Mileda F_1	long	30cm	purple black	creamy-white, soft and gentle
Galine F_1	round	30cm	purple	White, soft and gentle
Classic F_1	oval	35cm	dark-purple	White, soft and gentle

Biological characteristics

Regarding the reactions of the eggplant to external conditions it is more picky then tomatoes, but more similar with pepper. An external conditions specific for the particular region affect on ontogenetic development of plants, respectively on individual phenological phases and on the dynamics of their appearance. In this context particular phenophases of development have been noticed as: emergence, flowering, fertilization, fruitfulness and finally maturity.

Vegetation period is the period of time that plants spend all phenological phases during development from emergence to botanical maturity. On the length of the vegetation period affect environmental factors and genetic characteristics of the variety or hybrid which is different for plants, species, varieties, hybrids. According the length of vegetation period eggplants are: early, medium-early and late. During our study, the vegetation period of the tested hybrids *Diva F_1*,

Galine F_1 , and standard *Domasen poludolg* in the first year was 120 days, while the hybrids *Mileda* F_1 and *Classic F1* had 125 days vegetation period. In the second year of the study vegetation period of the tested hybrids *Diva* F_1, *Galine* F_1 and standard lasted 108 days, while the hybrids *Classic F1* and *Mileda F1* lasted 119 days.

An occurrence of the cotyledons on the soil surface is named as emergence. According to the many scientists' researches, the optimal temperature for germination and emergence is 22 - 25^{o}C although it can emergence at lower temperature from 14^{o}C where emergence is much slower. For a good germination and emergence water was added frequently, where soil moisture was 70 - 80% of SWC (soil water capacity). Because of the good conditions prevailing in the greenhouse where the seedlings were produced, plants emergenced for 13 days. Despite favourable conditions for plant emergance, also other remaining phenological phases, as blooming, require optimal amounts of water, optimum temperature, heat, light and nutrients. During this period, which many scientists consider to be a critical period in the life cycle of plants, it is essential that the preceding factors should be on optimal level. If at least one of the factors is not optimal at this phase, decreasing of flower buds occurs or the progress of this phase slows. Occurrence of the first flowers in hybrids *Diva* F_1, *Galine* F_1 and *Domasen poludolg* was after 82 days, while in hybrids *Mileda* F_1, *Classic* F_1, the time of flowering (20%) was 84 days in the first year of the examination.

In the second year of the study the number of days from emegance to the beginning of flowering (20%) was lower in all tested hybrids due to the higher temperatures that were present in this year of our study.

The number of days from emegance to the beginning of flowering (20%) in hybrids *Diva* F_1, *Galine* F_1 and in standard *Domasen poludolg* was 72 days, while the hybrids *Mileda* F_1 and *Classic* F_1 were 78 days in the second year of research.

The flower ends with the formation of the fruit which in itself carries the seeds. The fruit is formed after fertilization of the ovary, makes the fruit grow as a result of the influx of nutrients that fill the cells of the fruit (R. Grupce, 1994). In the first year of the study the period from emergence to begginig of maturing (first harvest) of tested hybrids *Diva* F_1, *Galine* F_1 and in the standard lasted 120 days, where in hybrids *Mileda* F_1 and Classic F_1 lasted 125 days. In the second year of the study, period from emergence to beginning of maturing was 108 days in hybrids *Diva* F_1, *Galine* F_1 and standard *Domasen poludolg*, while in hybrids *Mileda* F_1 and *Classic* F_1 was 119 days. This is the period of time that is required hybrids to reach harvest and is different in both studied years due to the different weather conditions. On this period from flowering to early maturing and technological maturity, beside affect of genetic traits of the examined hybrid, external factors (temperature, light, water, food, etc.) also affects. Also, in this phase, the lack of any of the above factors can lead to slower progress of this phase, and thus slower growth and development of the plants. As an example, although the eggplant belongs to the group of plants with short day with the optimal 12-14 hour lighting for normal growth and development in this phase is very important optimum lighting. In the absence of light in this phase flowers fall, and this is reflected on the yield. In this study we didn't encountered such a problem thus the plant had normal growth and development. In the first year of testing, the number of days from flowering to beginning of maturing (first harvest) in tested hybrids *Diva* F_1, *Galine* F_1 and standard *Domasen poludolg* was 38 days, while in *Mileda* F_1 and *Classic* F_1 was 41 days. The number of days from flowering to the beginning of maturing (first harvest) in the second year of the study for hybrids *Diva* F_1, *Galine* F_1 and standard Domasen poludolg was 36 days, in hybrids *Mileda* F_1 and *Classic* F_1 was 42 days.

Table 3. Observations of phenological appear in 2002

Hybrid	Date of sowing	Date of Emergence	Date of flowering (20%)	Days from emergence to start flowering (20%)	Date of maturing (first harvest)	Days from emergence to first harvest	Days of flowering (20%) to first harvest
Diva F_1	27.01.	10.02.	03.05	82	10.06.	120	38
Mileda F_1	27.01.	10.02.	05.05	84	15.06.	125	41
Galine F_1	27.01.	10.02.	03.05	82	10.06.	120	38
Classic F_1	27.01.	10.02.	05.05	84	15.06.	125	41
Domestic half long Ø	27.01	10.02	03.05	82	10.06	120	38

Table 4. Observations of phenological appear in 2003

Hybrid	Date of sowing	Date of Emergence	Date of flowering (20%)	Days from emergence to start flowering (20%)	Date of maturing (first harvest)	Days from emergence to first harvest	Days of flowering (20%) to first harvest
Diva F_1	27.01	10.02	23.04.	72	29.05.	108	36
Mileda F_1	27.01	10.02	29.04.	78	09.06.	119	42
Galine F_1	27.01	10.02	23.04.	72	29.05.	108	36
Classic F_1	27.01	10.02	29.04.	78	09.06.	119	42
Domestic half long	27.01	10.02	23.04.	72	29.05.	108	36

Conclusions

The results of two years study of morphological, biological properties of the new hybrid of eggplant, gives the following conclusions:

In terms of the weight of fruit, *with largest fruits is characterized hybrid Classic F_1*, with an average weight of 700g hybrid *Diva F_1*, then *Galine F_1* with an average weight of 600g, and finally *Mileda F_1* with an average weight of 500g. The standard *Domasen poludolg is* characterized with an average weight of 350g and is very smaller than the tested hybrids. According to the length of the vegetation period from emergence to maturity of first fruits (first harvest) in hybrids *Diva F1*, *Galine F1 and* standard Domasen poludolg this period lasted 120 days, while in hybrids *Mileda F1 and Classic F1* lasted 125 days. In the second year of the study vegetation period is shorter and in hybrids *Diva F_1, Galine F_1* and standard was 108 days, in hybrids *Mileda F_1* and *Classic F_1* was 119 days. As a result of different weather conditions there were differences in the length of the vegetation period in both years of testing hybrids and the standard. The study of the basic properties of the hybrids shows that they are characterized by good morphological and biological properties. *Diva F_1, Classic F_1, Galine F_1* for the most testing properties are on the same level with the standard, even in some cases they overcame the level of the standard *Domasen poludolg*, which give another confirmation of their successful cultivation in - plastichouses, heated only by solar energy.

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БИОЛОШКИ И МОРФОЛОШКИ КАРАКТЕРИСТИКИ НА НЕКОИ ИНТРОДУИРАНИ ХИБРИДИ ПАТЛИЏАН (SOLANUM MELONGENA L.)

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Апстракт

Странските сорти и хибриди на патлиџан се почесто се внесуваат во Република Македонија, особено за производство во заштитени простори. Изборот на соодветни хибриди и сорти, според нивните биолошки и морфолошки карактеристики и нивното однесување во локалните производни услови, значајно влијаат врз приносот и квалитетот на производството. Во ова истражување се проучени и утврдени биолошките и морфолошките својства на следните четири интродуцирани хибриди патлиџан (*Solanum melongena L.*): *Classic F_1, Mileda F_1, Galine F_1* и *Diva F_1*. Биолошките својства беа проучувани преку појавата и времетраењето на одделни фенофази како што се: вегетациски период, број на денови од никнење до почеток на цветање, број на денови од цветање до почеток на зреење и број на денови од никнење до почеток на зреење (прва берба). Од морфолошките карактеристики подетално беа анализирани својствата на плодот и тоа: големина на плод, маса на плод со дршка, маса на плод без дршка, форма на плод, боја и сјај на плод и структура на плод. Како контрола беше земена сортата „*домашен полудолг“*. Добиените податоци за својствата беа споредбено анализирани. Резултатите покажуваат дека испитуваните хибриди се одликуваат со добри морфолошки и биолошки својства. Исто така, оваа студија покажа дека некои од анализираните својства на хибридите *Diva F_1, Classic F_1* и *Galine F_1* дури и го надминуваат стандардот.

Клучни зборови: патлиџан, домашна сорта, морфолошки и биолошки карактеристики.

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PRODUCTIVE CHARACTERISTICS OF SOME INTRODUCED HYBRIDS OF EGGPLANT (SOLANUM MELONGENA L.)

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Abstract
The yield of one crop or variety is primarily genetically determined, which is characterized by the variety or hybrid, expressed through genetic. Although the yield is genetic trait, it is influenced by the complex external (production) conditions, as well as manufacturing technology. In this research some product properties of four eggplant hybrids (Solanumlo melongena L.): Classic F_1, Mileda F_1, Galine F_1 and Diva F_1 were studied and determined. The domestic variety "Domasen poludolg" was taken as standard. Some productive properties were studied, as follows: dynamic of yield achievement per harvests, total yield of fruits per hectare, index of early maturity. Total average yields of examined hybrids for two years are: *Diva F_1 104.05 t/ha, Mileda F_1 66,4 t/ha, Galine F_1 93,1 t/ha, Classic F_1 97,1 t/ha* and of standard *Domasen poludolg 70.2 t/ha*. The results show that the tested hybrids are characterized by good productive characteristic, suitable for greenhouse production, with an exception of the hybrid Classic F_1 which gave better results, with the complete removal of the foils, which means that it is a hybrid for open filed production.
Key words: eggplant, hybrids, domestic variety, productive properties.

Introduction

When we talk about plant production features we think of the productivity, which is expressed by the yield. The term productivity, more precisely general bioproductivity of plants means the sum of the circadian increase in vegetation. It actually represents the total weight of the plants with all underground and aboveground organs.

According to R. Grupce (1994) for agricultural production is especially important economic productivity, what is used in the diet and that has particular economic importance. The amount of yield of a crop or variety is primarily genetically determined capability that characterizes the variety or hybrid, expressed through genetic potential ie yield. In the literature, there are many data that show the influence of growing conditions on the yield. According Gazenbush (1958) temperature between 20-25 ° C and the length of the light day 12-14 hours are optimum conditions for growth, development and yield of peppers and eggplant.

Production technology in horticulture has a special impact on the amount of the yield, or the success of the production. The main goal of this research was to obtain relevant indicators of the examined eggplant hybrids, and to determine the productive characteristics during cultivation in greenhouse. On the basis of the results of comparative examination with the standard, the better will be recommended for production.

Material and methods

To achieve the goal of the research, trials were set up for a period of two years where four eggplant hybrids of foreign origin and a standard variety "*Domasen poludolg*" were grown and examined. The hybrids are *Diva* F_1, *Mileda* F_1 of Dutch origin, and *Galine* F_1 *and Classic* F_1 of French origin. Tested varieties were placed in six repetitions of 10 plants in repetition, with a experimental plot size of 2.00 m^2 arranged in a random block system.

For normal growth and development of the tested varieties appropriate production technology was conducted. Experiment was set up in the region of Skopje, village Stajkovci, in plastichouses with dimensions 5 x 30 meters, ie an area of 150 m^2. During the growing period were analyzed more productive properties as follows: number of fruits; percent of fertilization; dynamics of the yield per harvests; total fruit yield per unit area (ha); index of early maturity. The obtained results were statistically processed according to the method of Mudra and method of analysis of variance.

Results and discussion

Yield of market fruit

The total yield of market in eggplant is the sum of all harvests. Harvests of eggplant are successive, because of successive formation of the fruit during vegetation. The fruits are harvested in an immature state in the technological maturity. Then the fruits have typical characteristics of the variety or hybrid: shape, size, color, gloss and flavor.

The harvest in the first year of the survey began in early June (10.06), in the second year at the end of May (29.05) which is due to the higher temperatures in the second year of the examination. In these two years of research differences were identified in yield among hybrids in both studied years, and in yield among the hybrids in one studies.

Table 1. Yield in t/ha

Hybrid	Yield in t / ha		
	2002	2003	Average
Diva F_1	109.0	99.1	104.05
Mileda F_1	76.9	55.8	66.4
Galine F_1	98.4	87.8	93.1
Classic F_1	102.4	91.8	97.1
Domasen poludolg Ø	72.9	67.5	70.2

Number of fruit per plant

The arrangement of the fruit on branches in eggplant is a varietal characteristic, but depends on external conditions that are prevalent in the stages of flowering and fertilization. In unfavorable conditions, fertilization cannot be performed normally and abortion of fertilized flowers occurs. The number of fruits per branches in the tested populations is different for everyone. The number of fruits is the least in the first branch and then rises to third where the maximum number of fruits is formed. In the higher branches the number of fruits in sequence and gradually declines.

The arrangement of the fruits on branches, especially in the first three is of great importance for early maturity and affects the coefficient of early maturity.

The number of fruits per plant, among the surveyed populations in technological maturity is different. The largest variation was in hybrid *Mileda* F_1 with ten fruits, while the smallest variation was found among all remaining *hybrids Classic* F_1, *Diva F, Galine* F_1 including standard *Domasen*

*poludolg.*In our study in both tested years, the average number of fruits in examined hybrids and standard variety is presented in the Table 2.

Table 2. Number of fruits per plant

Hybrid	Number of fruits per plant		
	2002	2003	Average
Diva F_1	17	17	*17*
Mileda F_1	18	10	*14*
Galine F_1	16	16	*16*
Classic F_1	18	16	*17*
Domasen poludolg Ø	16	14	*15*

Percent of fertilization

The percent of fertilization is determined number based on recorded (emerging) flowers per plant and grown (shaped) fruits.

Table 3. Percent of fertilization

Hybrid	2002	2003	Average 2002/2003
Diva F_1	89	75	82
Mileda F_1	87	72	79.5
Galine F_1	87	73	80
Classic F_1	89	77	83
Domasen poludolg Ø	87	73	80

In the all tested hybrids, including the standard, the percent was significantly higher in the first year compared to the second year of the survey, due to the higher temperatures that prevailed in the second year, which leaded to abortion of fertilized flowers.

In the first year of the survey, the highest percent of fertilization showed hybrids *Diva F_1*, *Classic F_1* by 89%. Lower percent of fertilization was observed in hybrids *Mileda F_1*, *Galine F_1* and in standard *Domasen poludolg* whose percent of fertilization was 87%.

In the second year of the survey, the highest percent of fertilization was observed in the hybrid *Galine F_1* with 83%, and *Diva F_1* with 82%. The lowest percent of fertilization was observed in hybrid *Mileda F_1* with 79.5%. The standard *Domasen poludolg* hybrid and *Galine F_1* have a percentof fertilization of 80%.

Dynamic of yield per harvest

Hybrids Mileda F_1; Diva F_1; Galine F_1; Classic F_1, have achieved a higher yield in the first year of the examination in relation to the second year. This is due to various external conditions that prevailed in 2002/2003. Besides the external conditions that affect the dynamics of yield per harvest of tested hybrids, the yield on the dynamics affect genetic traits hybrids. The following tables indicate the yield of eggplant hybrids in t/ha per harvest in 2002 and 2003.

Table 4. Dynamic of yield per harvest t / ha in 2002

Number	Harvest	Hybrids yield in t / ha				
		Diva F_1	*Mileda F_1*	*Galine F_1*	*Classic F_1*	*Domasen*
1	10.06.2002	*10.9*	/	*6.2*	/	*4.1*
2	15.06.2002	*10.6*	*7.0*	*8.4*	*13.0*	*6.5*
3	30.06.2002	*13.4*	*12.4*	*11.2*	*17.6*	*10.9*
Total of three harvests		*34.9*	*19.4*	*25.8*	*30.6*	*21.5*
4	04.07.2002	*18.7*	*16.6*	*13.1*	*13.1*	*11.4*
5	06.07.2002	*17.1*	*12.8*	*15.5*	*14.6*	*13.5*
6	09.07.2002	*12.5*	*9.4*	*14.8*	*10.9*	*9.3*
7	12.07.2002	*9.9*	*7.8*	*10.7*	*12.0*	*5.3*
8	16.07.2002	*7.6*	*4.7*	*11.5*	*11.8*	*6.6*
9	19.07.2002	*8.3*	*6.2*	*7.0*	*9.4*	*5.3*
10	*Total*	*109.0*	*76.9*	*98.4*	*102.4*	*72.9*

Table 5. Dynamics of yield per harvest t / ha in 2003

Number	Harvest	Hybrids yield in t / ha				
		Diva F_1	*Mileda F_1*	*Galine F_1*	*Classic F_1*	*Domasen*
1	29.05.2003	*11.5*	/	*5.0*	/	*5.0*
2	09.06.2003	*15.0*	*8.5*	*8.7*	*15.3*	*7.5*
3	20.06.2003	*16.6*	*10.0*	*13.1*	*26.6*	*11.9*
Total of three harvests		*43.1*	*18.5*	*26.8*	*41.9*	*24.4*
4	28.06.2003	*15.4*	*10.6*	*14.9*	*15.4*	*9.8*
5	05.07.2003	*18.0*	*10.0*	*18.9*	*14.4*	*11.1*
6	09.07.2003	*14.4*	*9.2*	*15.6*	*9.0*	*17.2*
7	13.07.2003	*8.2*	*7.5*	*11.6*	*11.1*	*5.3*
8	*Total*	*99.1*	*55.8*	*87.8*	*91.8*	*67.5*

Hybrids *Diva F_1; Mileda F_1; Classic F_1* and standard *Domasen poludolg* in the first year of the research achieved the highest yield in 3th, 4th and 5th harvest, while hybrid *Galine F_1*, the highest yield achieved in the 4th, 5th and 6th harvest. Individually, each hybrid separately, hybrids *Diva F_1, Mileda F_1* achieved highest yield at 4th week of harvest, hybrid *Galine F_1* and standard *Domasen poludolg* highest yield achieved at 5th week of harvest, while hybrid *Classic F_1* highest yield achieved during the 3rd week of harvest.

In the second year of the examination all tested hybrids *Diva F_1, Mileda F_1, Galine F_1, Classic F_1,* as well as standard *Domasen poludolg* are characterized by a smaller number of harvests (two harvests less than the first year of the survey) or the number of harvests was seven. Hybrids *Diva F_1, Galine F_1* achieved highest yield at 5th week of harvest, hybrid *Mileda F_1* highest yield achieved at 4th week of harvest, while hybrid *Classic F_1* highest yield achieved in the 3rd week of harvest. The standard *Domasen poludolg* reached the highest yield at 6th harvest. From this it can be seen that there are not only reduces in the total yield and yield per harvest, but also reducing the yield

among the hybrids in a harvest in the second year of the examination in comparison to the first year of the examination.

Dynamic of yield per harvests is shown in the following graphs separately for tested hybrids in both years of the survey.

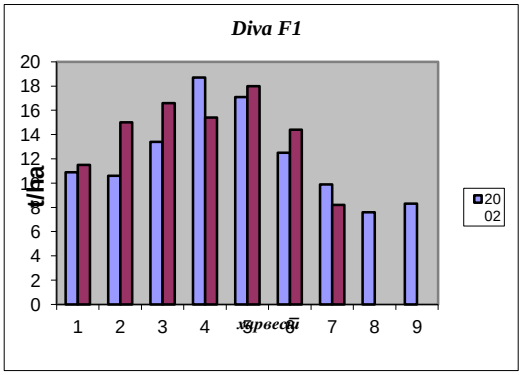

Figure 1.

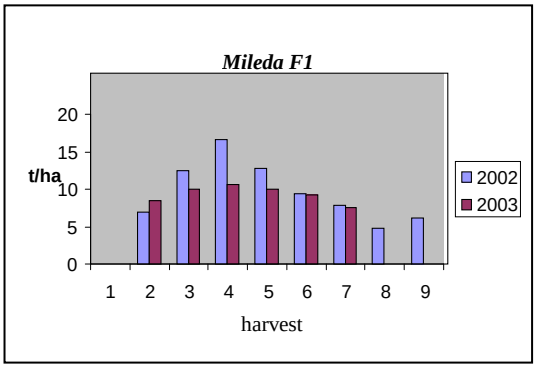

Figure 2.

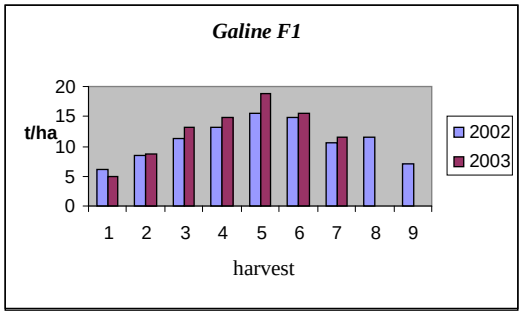

Figure 3.

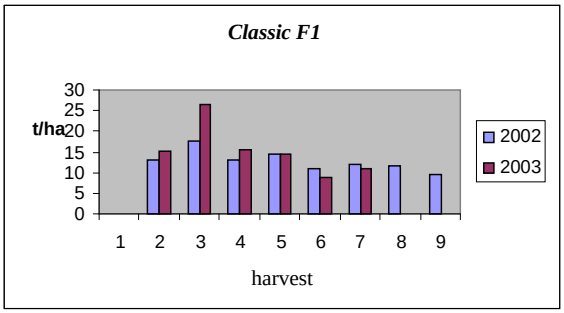

Figure 4.

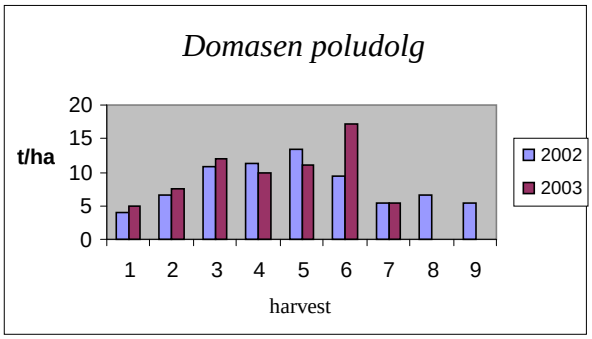

Figure 5.

Total fruit yield per hectare

Genetic properties of the hybrid, complex of external factors and production technology have a big influence in total yield or variations of total yield between individual hybrids during the survey, and

the total yield variation, during examination in a same hybrid. In addition to this, Table 6 shows the total fruit yield per hectare of tested hybrids in the both years of the survey.

Table 6. Total yield in t / ha

Hybrid	2002	2003	average	+;- од Ø in tons	percent (%)
Diva F_1	109	99.1	104.05	33.85	148.2
Mileda F_1	76.9	55.8	66.4	-3.8	94.6
Galine F_1	98.4	87.8	93.1	22.9	132.6
Classic F_1	102.4	91.8	97.1	26.9	138.3
Domasen poludolg Ø	72.9	67.5	70.2	Ø	100.0
LSD 0,05	3.07	2.56			
LSD 0,01	4.18	3.50			

From the previously stated values shown in the table can be seen that the highest yield per unit area in the first year of examination achieved hybrid *Diva* F_1 with 109,0 *t/ha*, then *Classic* F_1, *Diva* F_1 with 102,4 *t/ha*, *Galine* F_1 with 98,4 *t/ha* and *Mileda* F_1 with 76.9 *t/ha*. The standard *Domasen poludolg* in the first year of the test scored an average yield of 72.9 *t/ha* which is also the lowest yield compared to the tested hybrids. All tested hybrids, compared with the standard *Domasen poludolg* in the first year of the examination achieved significantly higher yield on the level of probability 0.05 and 0.01.

In the second year of the examination, all tested hybrids including the standard achieved lower yield compared to the first year. However, in the second year of the examination highest yield achieved the hybrid *Diva* F_1 with a yield of 99.1 *t/ha* and the lowest yield was observed in the hybrid Mileda F_1 55,8 *t/ha*. The standard *Domasen poludolg* realized yield of 67,8 *t/ha* which is subsequent to *Classic* F_1 91,8 *t/ha* and *Galine* F_1 87,8 *t/ha*, and is greater than the hybrid *Mileda* F_1.

In the second year of the examination statistically significant differences of achieved higher yield in individual hybrids on the level of probability of 0.05 and 0.01 was observed in all tested hybrids, except in *Mileda* F_1 which gave statistically significant lower yield than standard *Domasen poludolg on* probability level of 0.05 and 0.01.

Expressed as a percentage of the two years of the examination, the hybrid *Diva* F_1 had 48.2% higher yield than the standard *Domasen poludolg*. Hybrid *Mileda* F_1 had a lower yield of 5.4% from the standard, hybrid *Classic* F_1 had a higher yield of 38.3% compared with the standard, while hybrid *Galine* F_1 had 32.6% higher yield than standard.

Early maturity

Understanding and determination of the early maturity in hybrids is very important. Determining of early maturity is through two indicators:

- Coefficient of early maturity
- Index of early maturity

From the results in the Table 7 hybrid *Classic* F_1 in 2003 has the highest coefficient of early maturity 45.6 from all tested hybrids, but in average of the two tested years the highest coefficient of early maturity has hybrid *Diva* F_1 with an average 37.5.

Regarding of index of early maturity there are differences among the tested hybrids between the two years of research, as well as the differences compared with standard *Domasen poludolg*.

Table 7. Coefficient and Index of early maturity

Hybrid	Yaer	Total yield	Yield of the first three harvests	Coefficient of early maturity	Index of early maturity
Diva F_1	2002	109.0	34.9	32.0	208.8
	2003	99.1	43.1	43.5	176.6
	average	104.05	39.0	37.5	192.2
Mileda F_1	2002	76.9	19.4	25.2	90.2
	2003	55.8	18.5	33.1	75.8
	average	66.4	18.9	28.5	83.0
Galine F_1	2002	98.4	25.8	26.2	120.0
	2003	87.8	26.8	30.5	109.8
	average	93.1	26.3	28.2	114.9
Classic F_1	2002	102.4	30.6	29.9	142.3
	2003	91.8	41.9	45.6	171.7
	average	97.1	36.2	37.3	157.0
Domasen poludolg Ø	2002	72.9	21.5	29.5	100.0
	2003	67.5	24.4	36.1	100.0
	average	70.2	22.9	32.6	100.0

From the results shown in Table 7, we can see that there are differences in the index of of early maturity in tested hybrids between the two years of testing, as well as the differences compared with standard *Domasen poludolg*.

The standard *Domasen poludolg* showed the equivalent index of early maturity in two years of the examination. The standard *Domasen poludolg* during the first three harvests in the first year of the examination, achieved a yield of 21.5 *t/ha*, and in the second year 24,4 *t/ha*. In comparison to standard variety, the tested hybrids *Diva* F_1, *Galine* F_1, *Classic* F_1 have a higher index of early maturity which means that they were earlier. Hybrid *Mileda* F_1 has a lower index of early maturity compared with the standard, which means it is later hybrid.

Conclusions

From the results of two years research on the production characteristics of new eggplant hybrids in our country can be concluded:

The percent of fertilization in the tested hybrids in comparison to standard was higher in the first year then in the second year of the examination as a result of the different conditions prevailing in two years of our study.

There were no major fluctuations in terms of the number of formed fruit per plant among the tested hybrids and standard. In average of two years, least fruits formed hybrid *Mileda* F_1 - 14, while hybrids *Diva* F_1, *Classic* F_1 formed most fruits -17. *Galine* F_1 formed 16 fruits, and standard *Domasen poludolg* formed 15 fruits.

Regarding the total yield per hectare, all tested hybrids including the standard have a higher yield in the first year of the examination in relation to the second year of the examination. The highest two-year average yield is observed in hybrid *Diva* F_1 with 104,05 *t/ha*, and the lowest was observed in

the hybrid *Mileda* F_1 66,4 *t/ha*. In standard *Domasen poludolg* the average two-year yield was 70.*2 t/ha*, while in hybrid *Classic* F_1 91,1 *t/ha* and in *Galine* F_1 93,1 *t/ha*.

The highest coefficient of early maturity in 2003 had the hybrid *Classic* F_1, but in average of the two tested years the highest coefficient of early maturity had the hybrid *Diva* F_1. In average of two years examination, higher index of early maturity compared to the standard *Domasen poludolg* was observed in hybrids *Diva* F_1, *Classic* F_1, *Galine* F_1, while hybrid *Mileda* F_1 was later than the standard.

The hybrids showed excellent production properties in comparison to the standard, which give another confirmation of their successful cultivation in protectedhouses-in our case plastichouses heated only by solar energy. Hybrid *Mileda* F_1 compared to standard had relatively lower production properties, although genetically is characterized with good fertilization at relatively cold conditions. Also it should be noted that hybrid *Classic* F_1 during two years of research showed higher yield with complete removal of the foils, which means that it is a hybrid which is selected for open filed production.

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ПРОИЗВОДНИ КАРАКТЕРИСТИКИ НА НЕКОИ ИНТРОДУИРАНИ ХИБРИДИ МОДАР ПАТЛИЏАН (SOLANUM MELONGENA L.)

Стојкоска Дијана, Иљовски Игор, Ристовска Биљана, Звезда Богевска

Апстракт

Големината на приносот кај една култура или сорта пред сè е генетски определено својство што ја карактеризира сортата односно хибридот, изразено преку генетскиот потенцијал на родност односно принос. Меѓутоа, иако приносот претставува генетско својство, врз него влијае комплексот на наворешните (производните) услови, како и технологијата на производство. Во ова истражување беа проучени и утврдени одредени производни својства на четири интродуцирани хибриди патлиџан (*Solanum melongena L.*): *Classic F_1, Mileda F_1, Galine F_1* и *Diva F_1*. Како контрола беше земена сортата "*домашен полудолг"*. Од производните својства подетално беа анализирани: динамика на постигнување принос по берби, вкупен принос на плодови по единица површина (ha), индекс на раностасаност. Просекот на вкупниот принос на плодови по единица површина (хектар) остварен во двете години од истражувањето кај испитуваните хибриди е следен: *Diva F_1 104.05 t/ha, Mileda F_1 66,4 t/ha, Galine F_1 93,1 t/ha, Classic F_1 97,1 t/ha* и кај контролата *Домашен полудолг* е *70,2 t/ha*. Добиените резултатите покажуваат дека испитуваните хибриди се одликуваат со добри призводни својства, погодни за одгледување во заштитени простори, со исклучок на хибридот *Classic F_1* кој покажа подобри резултати односно повисок принос при целосно отстранување на фолиите, што значи дека тоа е хибрид што е наменет за одгледување на отворено.

Клучни зборови: патлиџан, хибрид, домашна сорта, производни својства.

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INFLUENCE OF DIFFERENT SUBSTRATES ON THE HEIGHT OF THE STALK, ROOT LENGTH, NUMBER OF LEAVES AND LEAF SURFACE ON PEPPER SEEDLINGS (CAPSICUM ANNUUM)

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Abstract
The objective of this study was to assess the growth and development of seedlings of a hybrid pepper as affected by ten growing media formulas developed from commercially available peat, inorganic media and from on-farm organic media (1st experiment: peat 100% + vermiculite 0%; peat 75% + vermiculite 25%; peat 50% + vermiculite 50%; peat 25% + vermiculite 75% and peat 25% + vermiculite 25% + organic media 50% and 2nd experiment by using perlite instead of vermiculite). The quality of seedlings is impacted by different substrates used during the seedling production. The major effect on growth parameters of pepper seedlings was obtained on substrate with on-farm organic media. This research presents data on height of stalk, height of root, leaf number per plant, leaf surface.
Key words: commercially peat, organic media, vermiculite, perlite, substrate, seedling.

Introduction

Peat, vermiculite and organic materials are the most widespread material that is used in the vegetable seedlings in greenhouse and tunnel growing in Kosovo. Vegetable production is one of the most important and at the same time the most profitable activity in crop production, (Balliu, 2004). Vegetables are grown both in the open field and in protected environments as well. In Kosovo the main vegetable crop cultivated under greenhouses are pepper, tomato, salad, onion, cucumber, etc., (Kaçiu, *et al*. 2009). From the economical point of view sweet pepper is one of the most important vegetable crops of the country. The most important limiting factor in their successful cultivation is the poor agro-technique undertaken, not adequate crop protection, and some minor factors.

Utilizing substrate on seedling growth and development is a logical alternative to the current soil-based production approach in the country. The use of different organic and inorganic substrates allows the plants the best nutrient uptake and sufficient growth and development to optimize water and oxygen holding (Verdonck et al., 1982). However, different substrates have several materials which could have direct and/or indirect effects on plant growth and development. Therefore selecting the best substrate between the various materials is imperative to plant productivity. The addition of the upper layer of coco fiber to the prelate raised the leaf water potentials (-0.74 vs. -0.84 MPa) and the rates of net assimilation (13.7 vs. 12.1 μmol CO2 m-2 s-1) and transpiration (6.01 vs. 5.19 mmol H2O m- 2 s-1) of Gerbera plants compared to the prelate alone (Paradiso and

De Pascale 2008). Fascella and Zizzo (2005) evaluated the influence of prelate and prelate mixed with coconut coir dust (coco peat) (1:1, v/v) on quantitative and qualitative parameters of cut flower (cv. Anastasia) production, they reported that the mix caused the highest amount of flowers (17.7 stems/plant) and the longest stems (65 cm). Due to diminishing supplies of peat soils for horticultural substrates, coco peat is being considered as a renewable peat substitute for use in horticulture. Tehranifar et al., 2007 reported that the vegetative growth of a number of strawberry cultivars were higher in media with peat and coco peat compared with 100% sand and prelate and in coco peat 40% + prelate 60% some cultivars produced the highest number of fruits and yield per plant. The yield in substrates with peat or coco peat was higher than in substrates with without peat or coco peat (Tehranifar et al., 2007). The selection of substratum influences not only seedlings quality, but also plant yield, the ear lines of their yielding and fruit quality (Lopez et al., 2004). Vermiculite and organic is used as the addition of other peat substratum. According to the data of Arenas and other scientists, the mixing of prelate, vermiculite, coco fibers into peat substratum influenced tomato development. Seedlings grown in peat-vermiculite and peat-prelate substratum had bigger root weight, stem diameter, leaf area (Arenas et al., 2002). The data of other scientists showed that the highest seedling quality was achieved using the mixture of substratum, peat (2/3) and enriched zeolite (1/3) (Markovic et al., 1995).The objective of this study was to evaluate the effect of different substrates on characteristics growth and seedlings development of cultivar "Bonty" of *Capsicum annuum.*

Material and methods

Bounty f1 from seminis Company

This study was carried out in the research greenhouse located at the village Godanc, municipality of Shtime in Kosovo in 2011. The plant material used in the study was F1 seeds of Capsicum annuum L., known as "Bounty F1", from "Seminis" Company. Pepper seedlings were grown in polymeric pots with prepared peat and vermiculite substratum. Sowing time – 22.04.2011. Pepper seedlings were grown in trays with different density (104,187 and 144 cell trays). The trays were disinfected with sodium hypochlorite before being filled with substrate. The seeded trays were put on 1.10 m-high tables and watered by means of micro aspersion. The duration of growing – 50 days. Seedlings were grown in different substratum. The substrates used were:

V1 – peat (potground)
V2 – peat + vermiculite (3 : 1),
V3 – peat + vermiculite (1 : 1),
V4 – peat + vermiculite (1 : 3),
V5 – peat + vermiculite +organic (1 : 1: 2).

V1 – peat (potground)
V2 – peat + perlit (3 : 1),
V3 – peat + perlit (1 : 1),
V4 – peat + perlit (1 : 3),
V5 – peat + perlit +organic (1 : 1: 2).

Each substrate was fertilized every week with NPK/MgO (18+18+18 +3) at a ratio of 100 mg·L-1. This treatment was made along with the watering during successive weeks. The samples for the characterization of the seedlings were obtained when, in most of the treatments, the transplanting size had been reached (7-8 true leaves), at 40 days. Each sample consisted on five complete plants per repetition. The fresh weights of leaves, stems and roots were determined. During the stage of seedling production, the experimental design consisted of a completely randomized arrangement, with four repetitions in a factorial combination of 5x3 factors (five substrate mixtures x three levels

of densities cell trays). The results obtained were subjected to an analysis of variance ANOVA, according to Vukadinovic (Croatia).

Results and disscusion

Pepper seedlings grown in peat substratum, enriched with 1/3 zeolite, were higher, had more leaves and dry matter (Markovic et al., 2000). The amount of zeolite also influences seedling growth and development. Stem diameter, leaf area and dry weight of seedlings increased with the increased amount of zeolite (Song et al., 2004). According to the data of Güler et al, tomato seedlings grown in peat-perlite and other substratum and grown only in peat were the same (Güler, Büyük, 2007). According to the data of Eltez and other scientists, the seedlings of aubergine and pepper grown in peat+perlit substratum didn't differ from seedlings grown in peat (Eltez et al., 1994). According to the data of Demirer and Kuzucu investigations, perlite positively influenced the growth and development of lettuce, cucumber, tomato seedlings (Demirer, Kuzucu, 2000). According to the data of our investigation, vermiculite and organic materials, mixed into peat substratum influenced biometrical parameters of seedlings. Pepper seedlings grown in peat+vermiculite and peat+vermiculite+organic materials substratum were lower and had smaller leaf area than the seedlings grown in peat. Seedlings grown in peat+vermiculite and peat+peat+vermiculite+organic materials substratum had bigger fresh weight. It is often used in order to establish as some method of growing and environmental conditions influence on characteristics of pepper seedlings. Pepper seedlings grown in peat-vermiculite and peat-vermiculite – organic materials substratum are compact, have smaller leaf area, but their above-ground and root weight is bigger than this of seedlings grown in peat. The bigger amount of vermiculite (1:1) in peat determines the fact that pepper seedlings accumulate in roots and leaves more dry matter. When the amount of vermiculite in peat is less (2:1), pepper seedlings accumulate in leaves less dry matter. The main purpose of the research work was to estimate the impact of using different types of peat mixed in the different percentage of vermiculite. By using different percentage of peat mixed we reached to get significant results in different parameters such are weight of stalks and roots, leaf area and number of leaves. Measurements which have been done and calculating them with statistical program (ANOVA) and test with LSD, it is obvious that there are significant results in different parameters, such using peat+ vermiculite (A1), with different mixtures (5) with different percentages (B1-B5) as well as using different type of trays with different holes (C1-C3). Stalk height cm: The obtained results after the data processing with ANOVA showed that there are significant statistical differences at different level with regard to substrate, mixture, modules and their interactions (Tab.1). The highest average with regard to the substrate has been recorded to A1 (11.62), whereas the lowest one with the substrate A2 (10.99) and these differences are highly significant. As for the mixture (Factor B) the highest value has been recorded with mixture B1(12.70) and the lowest one with mixture B5 (9.25). With the modules used the highest value has been recorded with module C2 (11.446), whereas the lowest one with module C3 (11.217). Statistically significant differences were recorded as well with regard to the interaction AxB, AxC, BxC and AxBxC. Root length cm: Vermikulit substrate A1 root length was B2 in module C2 with the value of 10,355 cm and smaller length has been observed to B3, module C2 worth 7,825 cm. Perlit substrate A2 length has been observed to B1, module C3 with the value of 10.60 cm, and lower length proved to mix B3, module C1 with the value of 7.49 cm (Tab.2). Leaf surface (cm^2): Vermiculite substrate A1 largest leaf surface was B1, module C1 with the value of 6.18 cm2 and less blending B3, module C3 with a value 2.63cm^2.

Perlit substrate (A2) the largest surface area was B1, module C1 with the value of 6.95 cm^2, while the lower surface is proven to mix B4, module C2 with value 1.67cm^2 (Tab.3).
Number of leaves: The majority of the leaves was found to Vermikulit substrate A1 at B1, module C1 with a value of 4.90 leaves and smaller number has been found to B4, module C1 worth of 2.25 leaves. Perlit substrate (A2) greatest number has been found to B2, module C2 with the value of 5.35 leaves, while the lowest number is verified to B3, module C1 and C3 with value 2.70 leaves (Tab.4).

Table 1. Stalk height (cm)

Substrat (A)	Mixture (B)	Modules (C)			Average (AB)	Average (A)
		C_1	C_2	C_3		
A1	B1	13.923	10.255	11.835	12.004	11.62*
	B2	10.640	10.815	15.545	12.333	
	B3	11.225	12.375	10.600	11.400	
	B4	13.033	14.275	10.945	12.751	
	B5	9.125	9.565	10.210	9.633	
	Average (AC)	11.589	11.457	11.827		
A2	B1	16.580	12.685	10.935	13.40	10.99*
	B2	9.778	14.185	11.770	11.91	
	B3	8.785	8.590	7.345	8.24	
	B4	10.550	14.005	12.970	12.50	
	B5	8.975	7.710	10.015	8.90	
	Average (AC)	10.934	11.435	10.607	Average (B)	
Dëmtuesi x Kultivari (BC)	B1	15.251	11.470	11.385	12.70**	
	B2	10.209	12.500	13.658	12.12	
	B3	10.005	10.483	8.9721	9.82	
	B4	11.791	14.140	1.958	12.63	
	B5	9.050	8.637	13.112	9.26**	
Average (C)		11.261	11.446	11.217	AxBxC	

Factors		A	B	C	AB	AC	BC	ABC
LSD	1%	0.42033	0.99837	0.63588	1.54214	0.99164	1.84900	3.58834
	5%	0.31932	0.73673	0.48308	1.09994	0.72709	1.27088	2.16361

Table 2. Root length (cm)

Substrat (A)	Mixture (B)	Modules (C)			Average (AB)	Average (A)
		C_1	C_2	C_3		
A1	B1	10.025	9.400	10.025	9.817	9.311
	B2	10.040	10.355	9.470	9.955	
	B3	10.058	7.825	9.030	8.971	
	B4	9.080	8.943	8.695	8.906	
	B5	8.330	9.165	9.220	8.905	
	Average (AC)	9.507	9.137	9.288		
A2	B1	9.880	9.875	10.600	10.118	9.020
	B2	9.192	10.000	8.250	9.148	
	B3	7.488	8.300	7.905	7.898	

	B4	9.175	9.040	9.020	9.078	
	B5	9.115	8.520	8.940	8.858	
	Average (AC)	8.970	9.147	8.943	Average (B)	
(BC)	B1	9.952	9.837	10.313	9.967	
	B2	9.613	10.177	8.860	9.551	
	B3	8.773	8.063	8.467	8.434	
	B4	9.127	8.991	8.858	8.992	
	B5	8.722	8.843	9.080	8.882	
Average (C)		9.238	9.142	9.115	AxBxC	

Factors		A	B	C	AB	AC	BC	ABC
LSD	1%	0.79754	0.71267	0.45401	1.10084	0.70801	1.32015	2.56200
	5%	0.60588	0.52591	0.34491	0.78518	0.51913	0.90728	1.54477

Table 3. Leaf surface (cm^2)

Substrat (A)	Mixture (B)	Modules (C)			Average (AB)	Average (A)
		C_1	C_2	C_3		
A1	B1	6.177	6.050	6.073	6.100	3.963
	B2	3.602	4.162	3.385	3.717	
	B3	4.438	3.810	2.673	3.640	
	B4	2.863	2.967	2.688	2.839	
	B5	3.170	4.210	3.182	3.521	
	Average (AC)	4.050	4.240	3.600		
A2	B1	6.947	3.02	5.510	5.420	3.611
	B2	5.015	2.233	5.320	4.189	
	B3	2.092	2.495	2.170	2.919	
	B4	2.282	1.670	1.775	1.909	
	B5	5.348	2.987	2.513	3.616	
	Average (AC)	4.737	2.638	3.457	Average (B)	
(BC)	B1	6.563	4.926	5.791	5.760	
	B2	4.309	3.197	4.352	3.953	
	B3	4.265	3.153	2.421	3.280	
	B4	2.572	2.319	2.231	2.374	
	B5	4.259	3.599	2.847	3.568	
Average (C)		4.394	3.439	3.529	AxBxC	

Factors		A	B	C	AB	AC	BC	ABC
LSD	1%	0.23553	0.67563	0.39693	1.04362	0.61900	1.15417	2.23990
	5%	0.17893	0.49857	0.30154	0.74437	0.45386	0.79330	1.35056

Table 4. Number of leaves

Substrat (A)	Mixture (B)	Modules (C)			Average (AB)	Average (A)
		C_1	C_2	C_3		
A1	B1	4.900	4.650	4.700	4.750	4.390
	B2	4.300	4.350	4.600	4.417	
	B3	4.000	4.200	3.900	4.033	
	B4	2.250	4.800	4.350	4.467	
	B5	4.150	4.350	4.350	4.283	
	Average (AC)	4.320	4.470	4.380		
A2	B1	4.750	4.500	4.100	4.450	3.910
	B2	3.950	5.350	4.400	4.567	
	B3	2.700	2.950	2.700	2.783	
	B4	3.550	4.650	4.150	4.117	
	B5	3.700	3.350	3.850	3.633	
	Average (AC)	4.470	4.160	3.840	Average (B)	
(BC)	B1	4.825	4.575	4.400	4.600	
Average (C)		4.025	4.315	4.110	AxBxC	

Factors		A	B	C	AB	AC	BC	ABC
LS	1%	0.52858	0.66321	0.24377	1.02444	0.38015	0.70882	1.37560
D	5%	0.40156	0.48941	0.18519	0.73069	0.27873	0.48719	0.82942

Conclusions

Pepper seedlings grown in vermiculite substratum were higher, had higher stalk, lengthen root, bigger leaf area and the biggest number of leaves than the seedlings grown in perlit.

Pepper seedlings grown in 100% peat substratum were the best mixture.

Comparing the different modules used in experiment the highest results were shown to the module type C1 (104 holes).

According to the results of this study that was conducted in order to find an alternative material to vermiculite and organic materials can be used in the production of pepper seedling together with peat.

Larger cell sizes result in larger transplants which should better withstand stresses at planting and should subsequently produce earlier peppers.

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ВЛИЈАНИЕТО НА РАЗЛИЧНИ СУПСТРАТИ ВРЗ ВИСИНАТА НА СТЕБЛОТО, ДОЛЖИНАТА НА КОРЕНОТ, БРОЈОТ НА ЛИСТОВИ И ПОВРШИНАТА НА ЛИСТОВИТЕ КАЈ РАСАД ОД ПИПЕРКА (*CAPSICUM ANNUUM)*

Скендер Рамадани, Тома Насто, Бесим Сахити, Гирнер Мурати

Апстракт
Целта на ова истражување беше да се процени влијанието на десет различни подлоги за одгледување врз растот и развојот на расадот од хибридни пиперки. Подлогите беа добиени од комерцијално достапен тресет, неоргански материи и органски материи добиени на фарма (прв експеримент: тресет 100% + вермикулит 0 %, тресет 75% + вермикулит 25%, тресет 50% + вермикулит 50%, тресет 25% + вермикулит 75% и тресет 25% + вермикулит 25% + органски материи 50%; во вториот експеримент користено е перлит наместо вермикулит). Квалитетот на расадот зависи од видот на супстратот кои се користи за негово производство. Најголем ефект врз растот на расадот од пиперки беше забележан при примената на супстрат со огранski материи. Во ова истражување се прикажани висината на стеблото, должината на коренот, бројот на листови по растение и површината на листовите.
Клучни зборови: комерцијален тресет, органски материи, вермикулит, перлит, супстрат, расад.

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Expert paper

EFFECT OF LIGHT AND ARIFICICAL LIGHTNING IN THE PRODUCTION OF SOME FLOWER SPECIES

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Abstract
Light as one of the basic production factors, that is in deficit during the winter period, can be replaced by artificial lighting. For this purpose there are various lights with different spectrum, that affects the intensity of photosynthesis (blue, orange), vegetative growth (blue) or the flowering and fruiting (red). Here are presented results from the application of artificial lighting on two flowering species Petunia Wave Purple treated with incandescent and compact fluorescent lamps. With the treatments with fluorescent lamps after 10 weeks treatment the plants were not blossomed, while with the treatment with incandescent lamps all plants blossomed for 6 to 8 weeks. The treatment with combinations of both lamps, gave rarely blossomed plants. Campanula puncata, treated with three sources of lightness (natural and two types on lamps). Visible difference in the treatments: 1 Small growth without flowers, 2 Average growth and poor flowering, 3 Full flowering. In the third treatment with high pressure sodium lamps (HPS), its full blooming plants.
Key words: Light, arificical lightning, spectrum, lamps, Pethunia, Campanula puncata.

Introduction

The production of flower crops, as well as all crops in general, is mostly organized according to the environment conditions. According to the light there is adjustment of the species, varieties and the purpose of production in general. Unsuitably representation on some of the basic factors can limit or enable the production. Providing optimal environment conditions and agro technical measures (temperature, relative humidity, fertilization etc.), often can be costly but is easily manageable. However, the factor light is difficult to manage. Deficiency is occurring mostly in winter period and depending on degree of deficit it can reduce the flowering and decrease the yield and quality of flower crops. The lack of natural light in greenhouses can be compensated with application of artificial light with use of different lights and lightning systems that have different spectrum and different influence on the growth and development of plant organs (stem, leafs, flowers).Also in the production of flower species is used appropriate spectrum.

Subject and purpose of the research

Subject of the research is assembling information for the utilization of the artificial lighting in the production of floral species in greenhouses.

The purpose is popularization of the light as factor, in particular artificial lighting in the production of floral species, so it can be used more appropriate in practice. For this there is several factors that are important such as- the influence of different lighting installations, the color spectrum, time and duration of lighting that is different for different for different species. This is especially important because of the fact that appropriate use of light affects the number of flowers and their quality that is basic for the production of flowers. But using lamps and artificial lighting means more expensive production, because of what in addition are shown some of the factors that should be considered at the time of introducing artificial lighting.

Elements of light and their influence on the crops

When all wavelengths or all colors from the spectrum are present, the light has white color. It is considered as great success in the production to get spectrum close to the sun spectrum.

Light spectrum (color and wavelength)

Purple 380 - 440 nm (nanometers), Dark blue 440-460 nm, Blue 460-510 nm, Green 510-560 nm, Yellow 560-610 nm, Orange 610-660 nm and Red 660-760 nm.

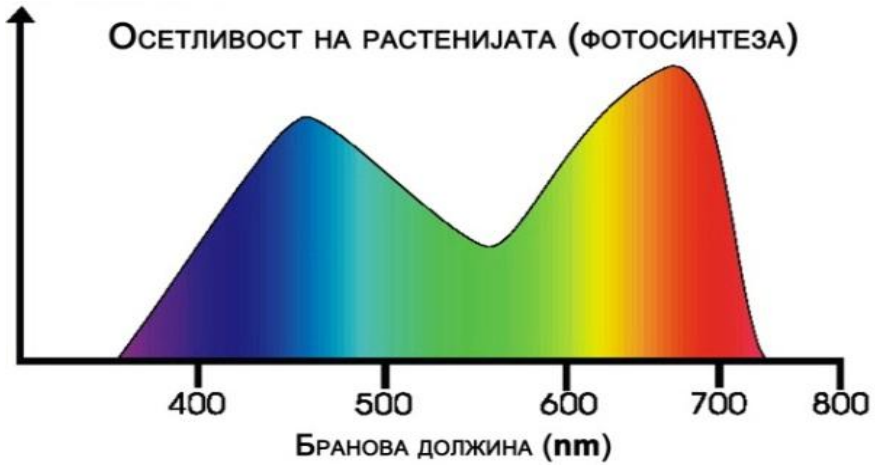

Figure 1. Photosynthetic active radiation

Different colors and wavelengths have different influence on the spectrum and intensity of photosynthesis (Picture 1). Strongest influences on the process have blue, orange and red color from the spectrum. When there is use of artificial lighting with lamps in all colors from the spectrum, it can be chosen color according to the needs of the plant, in that way blue color is used for vegetative growth and the red for flowering and fruiting.

There is a difference between the terms radiation which means general lighting and irradiation which means lighting on plant.

When artificial light from various sources is used, the light has different intensity, wavelength (color) and is present with different percentage. For artificial light sources used in greenhouse production it is very important the presence of various colors. There are several light sources that have different use and serve for different needs. The choice of lamps depends on the crop, the light installation, type and characteristics of the greenhouse, as well as other factors mutually related,

such as: level and intensity of radiation, period of irradiation (lightning on plant), photoperiod characteristics and needs, the amount of light needed for supplement or replacement of daylight and the costs for artificial light.

Basic parameters for determination of economic viability of artificial light

The decision for installation of artificial light, the growers should be making on extensive economic analysis. Additional profit with that type of installation can be achieved depending on: the quality of produced crop, the projected yield and whether there will be possibility for shortening of vegetation period and decreasing production expenses.

Detailed analysis for greenhouse production with artificial light includes: 1. Type and dimension of greenhouse, 2. Needs for artificial light of the potential crops, 3. Types of lamps and lighting bodies, 4. Light flow, 5. Period of use, 6. Intensity of daylight, 7. Height of crops to the lamps (nm), 8. Spatial index (K) and direct radiation in proportion with lighting (DR), 9. Number (n) and schedule of lamps, 10. Horizontal light uniformity (Emin/Emax), 11. Power consumption and energy costs per unit (kg, number).

Lighting on the flower species

When dealing with basic production factors, producers often are working on optimizing temperature, relative humidity, fertilization as a way to compensate the lack of light. That is feasible to certain extent, but the negative effects on yield and quality cannot be fully eliminated.

The understanding of light and its influence on the vegetative growth, flowering and fruiting is continuously growing with the development of new light technologies in plant production. The result is higher yields and regular market presence.

The achievements in genetics and plant breeding, as well as in light technology and its implementation are contributing in the extensive development of horticulture.

Whit implementation of artificial light, growers are independent from the duration of daylight in winter period. Thus, it is possible to produce transplants and cuttings for some flower crops and bushes, as well as control of vegetative period. Knowing the needs of different species, the types of lamps, type of radiation and light intensity, as well as necessary light according to the day length, in addition with the economic analysis are the foundation for successful greenhouse production.

The substitution of day light with artificial light takes place when day light is completely eliminated. In order to be economically feasible, for this technique is needed:

- production of crops that have lower needs for radiation
- crops that require higher temperature
- fast growing species
- plants with small habitus
- production of expensive crops
- plant production in greenhouses with clear time planning

From the relevant literature is known that artificial light is commonly used in the production of following species:

- tulips, narcissus, hyacinths, and other bulbs
- bushes, azaleas, chrysanthemum etc.;
- transplants for cut flowers and pot flowers (Bromelia, chrysanthemum etc.),;
- cuttings propagation of dianthus, chrysanthemum etc.;
- production of transplants for pot plants such as: begonia, chrysanthemum, bromelia;
- in vitro production.

Light treatment of flower species with different lamps

As interesting examples and results obtained during treatment with different types of lamps can be indicated the experiments in production of Petunia and Campanula punktata.

Petunia, long day plant, was treated with two types of lamps: incandescent and compact fluorescent lamps. The results show that after 10 weeks the plants did not produce flowers during the treatment with fluorescent lamps. Whereas after the treatment with incandescent lamp all plants were producing flowers in the period of 6 to 8 weeks. The combined treatment, with both types of lamps, resulted in less developed flowers.

Same flower crop was treated as a transplant, without additional light and with artificial light with HSP (High Sodium Pressure) lamps in same environment conditions. The plants treated with artificial light blossomed, and those without artificial light blossomed very poorly. Other flower crop, Campanula puncata was treated with natural light, incandescent lamps and HPS lamps. The analysis show that in natural light plants remain small and flowers are absent, the incandescent lamps gave solid results, and HPS lamps gave best results where all plants blossomed.

Conclusions

During a period when lack of light is present there are negative impacts on the flowering, yield and quality. This deficit can be substituted with artificial light in the production of many flower crops. For that purpose, different lamps with different spectrum are used, depending on the aim of production (development or stimulation of vegetative growth, flowers or fruits).

The choice of lamps depends on the crops, aim of production, type of greenhouse, the existing lack of natural light, economic parameters etc. The economic analysis for installation of artificial light in greenhouses is very important because it includes all specifics for successful implementation.

Particular problem in this area is the fact that there is not enough available information for the researches of the impact of artificial lighting in floriculture. From the minor number of popularized reports can be used the result from the treatment of Petunia and Campanula. In this research is demonstrated that various lamps have different effect on same species. In the example of petunia is demonstrated that fluorescent lamps gave no results in promotion of flowering after 10 weeks treatment, whereas the incandescent lights promoted flowering after 6-8 weeks. In other crops, such as Campanula punctata incandescent lamps gave good results, but HPS lamps gave even better results in promotion of flowering.

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ВЛИЈАНИЕ НА СВЕТЛИНАТА И ВЕШТАЧКОТО ОСВЕТЛУВАЊЕ ВО ПРОИЗВОДСТВОТО НА НЕКОИ ЦВЕТНИ ВИДОВИ

Иљовски Игор, Богевска Звезда, Давитковска Маргарита, Ристовска Биљана, Стојкоска Дијана, Илиќ Попов Станко, Ибушоска Афродита, Ибраим Јашка

Апстракт
Светлината како еден од основните фактори за производство, која во зимскиот период е во намалена, може да се надомести со вештачко осветлување. За таа цел постојат најразлични светилки со различен спектар на бои, кои влијаат на интензитетот на фотосинтезата (сина, портокалова), за вегетативниот раст (сина) или за формирање на цветот и плодот (црвена). Презентирани се резултатите од примената на вештачко осветлување на два цветни вида Petunia Wave Purple, третирано со жаречки и компакни флуросцентни светилки. При третманите со флоурецентни светилки после 10 недели растенијата не процветале, а при третманот со жаречки светилки сите растенија процветале за 6 до 8 недели. При третманот на комбинација од двете светилки, дава ретко процветани растенија.Campanula puncata, третирана со три извори на светлина - природна и два типа на светилки. Видни разлики на третманите: 1. Мал пораст без цвет, 2. Среден пораст и слабо цветање, 3. Полно цветање. Во третиот третман со натриумови светилки под видок притисок (HPS), растенијата потпоно процветале.
Клучни зборови: светлина, вештачко осветлување, спектар на бои, светилки, Pethunia, Campanula puncata.

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Original scientific paper

THE INFLUENCE OF SUBSTRATE COMPOSITION ON THE QUALITY OF ANNUAL SPECIES OF FLOWERS

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Abstract
This paper investigates the justification of the introduction of domestic raw materials for preparing substrate favourable for growing seedlings of annual flowers. The substrates prepared on the Tutin peat and perlite with zeoplant were investigated. The selected species of annual flowers Tagetes patula and Catharanthus roseus were produced in plastic containers (speedling system) and poly-propylen pots (pot system). The trial was conducted during 2009 and 2011 in the greenhouse at the Faculty of Agriculture in Belgrade. The total number of investigated substrates was 14. Research results indicate the justification of the introduction of Tutin peat (T), perlite (P) and zeoplant (Z) for preparing substrates for growing seedlings of the selected annual flowers. The results of the research show that the composition of substrates differently affects the development of investigated seedlings (plant height, above-ground mass, root mass) and accordingly their quality. The best development of plant seedlings Tagetes patula was achieved on the substrate $T_{60}+P_{20}+Z_{20}$, and of plant seedlings Catharanthus roseus on the substrate $T_{80}+P_{10}+Z_{10}$.
Key words: substrate, seedling, annual flowers, Tutin peat, perlite, zeoplant.

Introduction

In modern production of flower seedlings there are substrata of different composition. Since there is no 'ideal' substratum with respect to all grown seedlings (Samadi, 2011), special attention should be paid to the physical, chemical, and biological characteristics of a substratum during its preparation. Consequently, the selection of substrata of adequate composition plays a crucial role in the production of high quality plants (Latimer 1991; Kallo et.al., 1985; Argo, 2004). According to Landis et al. (1990), Heiskanene (1993), and Reinikainen (1993), it is desirable that the components for the preparation of substrata are easily accessible, of small specific weight, and easy for handling as well as that their use can provide the uniformity of plants. Modern substrata which are suitable for growing seedlings of flowers mostly consist of peat, sand, perlite, and vermiculite (Tinus and McDonald 1979; Landis et al., 1990). Rising peat prices worldwide call for new alternative materials which would be used for the preparation of substrata (Abad et.al., 2001; Guerin et.al., 2001; Grazia-Gomez et.al., 2002; Adalberto et al., 2006) or the application of domestic raw materials (Vujošević, 2012). Even the results of several independent authors underline the importance of finding alternative substrata for the production of flower seedlings in a glasshouse (Bayer et al., 2007; Samadi, 2011). In countries such as Serbia, apart from being ecologically viable, the use of domestic raw materials, particularly peat and mineral raw materials-zeolite, can provide an economical production of flower seedlings (Vujošević, 2012). The aim of this paper was to

investigate the justification for introducing domestic raw materials in the preparation of substrata suitable for growing seedlings of annual flowers and their effect on the quality of produced seedlings.

Material and methods

The trials on the influence substrata composition has on the quality of seedlings of annual flowers were performed from 2009 to 2011 in the greenhouse at the Faculty of Agriculture, University of Belgrade. The subject of examination were substrata of different composition, which were prepared on the basis of domestic raw materials of Tutin peat (T), perlite (P) and zeoplant (Z), and their influence on the development of seedlings of annual flowers *Tagetes patula L.* series *`Bonanza` yellow-PanAmerican seed* and *Catharanthus roseus* series *'Pacifica`-red*. The selection of species was made on the basis of the length of the seedlings vegetation. The initial seedlings were produced in plastic containers of the HP QP 144/4,5 P type according to the *speedling* system, and further growing was continued with after transplanting to plastic TEKU pots (*pot system*) of the VCC 9 cm series was done and it proceeded on substrata of different composition according to the following variants: 1. Control – imported substratum (*Floragard Medium Coarse*), 2. Control – Tutin peat 100%, 3. Tutin peat 90% with 10% of zeoplant, 4. Tutin peat 80% with 20% of zeoplant, 5. Tutin peat 70% with 30 % of zeoplant, 6. Tutin peat 90% with 10% of perlite and no zeoplant, 7. Tutin peat 80% with 10% of perlite and 10% of zeoplant, 8. Tutin peat 70% with 10% of perlite and 20% of zeoplant, 9. Tutin peat 60% with 10% of perlite and 30% of zeoplant, 10. Tutin peat 80% with 20% of perlite and no zeoplant, 11. Tutin peat 70% with 20% of perlite and 10% of zeoplant, 12. Tutin peat 60% with 20% of perlite and 20% of zeoplant, 13. Tutin peat 50% with 20% of perlite and 30% of zeoplant. Substrata were made on the basis of the volume ratio of components. For each examined substratum variant, 50 plants of the initial seedling were taken, while the selection of plants for transplanting was made randomly. At the end of the production cycle of seedlings and with a sample of 30 randomly selected plants of each substrata variant that was examined, the development of seedlings was tested using the following parameters: plant height (cm), above-ground mass (g) and root mass (g). All the data we acquired were analysed using STATISTICA 6. The results of the trial were presented through the main indicators of descriptive statistics (the range, the arithmetic mean and its standard error, the median, and the coefficient of variation). Regarding the aim of the paper, we statistically tested the claim that the average values of examined parameters of seedlings, which were obtained by applying different substrata variants, were not different from each other. Homogeneity of the treatment variances was investigated by Leven's test. Taking the results of Leven's test into consideration, the hypothesis was tested using the parameter model of the analysis of variance (ANOVA) and LSD test. By applying the I-distance (Lakić and Stevanović, 2003), the substrata were ranked in accordance with the simultaneous effect on all the investigated parameters of the development of seedlings.

Results and discussion

The results on average height, average above-ground mass and average root mass indicate that the investigated substrata were prepared using domestic raw materials, Tutin peat (T), perlite (P) and zeoplant (Z), which had a positive effect on them (Tables 1 and 2). The maximum value of height (38.3 cm) as well as the maximum average value of height of the *Tagetes patula* seedlings (26.33cm) were recorded in variant 13 ($T_{60}+P_{20}+Z_{20}$) while the minimum average height (11.367cm)

was in variant 11 ($T_{80}+P_{20}+Z_0$). The seedlings of *Catharanthus roseus* as a species with the highest vegetation of seedlings, had the maximum height value (28.1 cm) in variant 1 (commercial substratum) while they had the maximum average height value (23.95 cm) in variant 3, $T_{90}+Z_{10}$, in which, apart from peat, zeoplant accounted for 10 volume percent (Table 2). The minimum average height (8.83 cm) and the minimum singular value of height (4.9 cm) the *Catharanthus* seedlings had in variant 6, $T_{90}+P_{10}+Z_0$ (Table 2). The *Catharanthus* seedlings had the most favourable average height when grown in variants, in which, the smallest dose of zeoplant of 10 volume percent was used (3, 7, and 12). The height of the examined seedlings in all samples was homogeneous Cv ≤30% (Tables 1 and 2).

The results on the average height are in accordance with the results of Damjanović et al. (1994) who conclude that young seedlings are higher in the container production of vegetable seedlings on humus substrata with zeoplant. Marković et. al. (1994) and Pavlović (1997) had similar results by adding zeoplant in substrata for the production of tomato seedlings.

Zeoplant had an equally positive effect on the height of seedlings and the above-ground mass. Just as the above-ground mass of seedlings was dependent on the content of easily accessible nutrients, the minimum average values for the above-ground mass were recorded in the case of substrata in which zeoplant was not added (variants 2, 6, and 11). The maximum average value of the above-ground mass of the *Tagetes* seedlings (24.815 g) was recorded in variant 13, $T_{60}+P_{20}+Z_{20}$, in which the maximum average plant height was achieved (Table 1). Since the above-ground values were heterogeneous in three samples (Cv≥30%), the median was used for those samples as a more valid indicator of average (Table 1). In the case of seedlings with the longest vegetation, *Catharanthus roseus*, only in one analysed sample did the plants have heterogeneous above-ground mass (Cv≥30%), so the median was taken as a more valid indicator of average (Table 2). On the basis of average values, the above-ground mass of the *Catharanthus* seedlings ranged from 3.11 g in variant 6, $T_{90}+P_{10}+Z_0$ to 13.30 g in variant 1, the ready-made substratum. In the case of substrata based on domestic raw materials, the maximum average value of the above-ground mass was recorded in substratum 3, $T_{90}+Z_{10}$ (13.194g).

Table 1. The main indicators of descriptive statistics for the development of the *Tagetes patula Bonanza yellow* seedlings on the tested substrata

Tested characteristics	Ordinal number of the variant	Variant	Arithmetic Mean	Median	Standard deviation	Standard error	Min	Max	Coefficient of variant (%)
Height (cm)	1.	Ready-made substratum	20.163	20.000	1.972	0.360	15.900	25.800	9.780
	2.	T_{100}	12.073	12.000	1.388	0.253	9.800	15.700	11.499
	3.	$T_{90}+Z_{10}$	18.360	18.100	2.961	0.541	13.100	24.200	16.129
	4.	$T_{80}+Z_{20}$	19.667	19.550	2.563	0.468	11.800	23.900	13.033
	5.	$T_{70}+Z_{30}$	17.803	17.600	1.975	0.361	14.600	22.300	11.093
	6.	$T_{90}+P_{10}+Z_{0}$	12.210	12.100	2.567	0.469	8.100	22.100	21.027
	7.	$T_{80}+P_{10}+Z_{10}$	21.020	20.650	2.611	0.477	16.600	27.900	12.419
	8.	$T_{70}+P_{10}+Z_{20}$	22.283	23.100	3.337	0.609	11.800	27.600	14.974
	9.	$T_{60}+P_{10}+Z_{30}$	20.677	19.900	3.123	0.570	15.800	28.400	15.105
	10.	$T_{50}+P_{10}+Z_{40}$	18.307	18.000	1.629	0.297	15.800	21.100	8.901
	11.	$T_{80}+P_{20}+Z_{0}$	11.367	11.250	1.243	0.227	9.400	14.100	10.936
	12.	$T_{70}+P_{20}+Z_{10}$	21.300	21.650	3.197	0.584	15.500	28.800	15.008
	13.	$T_{60}+P_{20}+Z_{20}$	26.333	26.300	3.785	0.691	20.100	38.300	14.372
	14.	$T_{50}+P_{20}+Z_{30}$	22.737	22.950	2.484	0.454	15.900	27.600	10.925
Above-ground mass (g)	1.	Ready-made substratum	12.444	12.655	2.122	0.387	6.720	15.510	17.052
	2.	T_{100}	2.872	2.900	0.423	0.077	1.510	3.570	14.736
	3.	$T_{90}+Z_{10}$	14.083	12.800	6.456	1.179	8.590	45.800	45.847
	4.	$T_{80}+Z_{20}$	17.164	17.375	3.529	0.644	8.640	23.470	20.563
	5.	$T_{70}+Z_{30}$	18.749	18.455	2.466	0.450	14.320	25.850	13.150
	6.	$T_{90}+P_{10}+Z_{0}$	3.389	3.490	1.108	0.202	1.140	5.460	32.701
	7.	$T_{80}+P_{10}+Z_{10}$	13.200	13.480	3.134	0.572	6.740	18.050	23.741
	8.	$T_{70}+P_{10}+Z_{20}$	15.406	15.125	2.611	0.477	9.860	20.940	16.950
	9.	$T_{60}+P_{10}+Z_{30}$	15.201	15.770	2.738	0.500	7.880	20.230	18.012
	10.	$T_{50}+P_{10}+Z_{40}$	13.380	12.935	1.659	0.303	10.390	16.530	12.402
	11.	$T_{80}+P_{20}+Z_{0}$	3.486	3.515	0.763	0.139	1.150	4.470	21.894
	12.	$T_{70}+P_{20}+Z_{10}$	15.746	15.160	5.038	0.920	7.370	30.450	31.992
	13.	$T_{60}+P_{20}+Z_{20}$	24.815	23.120	6.675	1.219	13.750	41.240	26.900
	14.	$T_{50}+P_{20}+Z_{30}$	21.821	21.870	4.382	0.800	8.760	32.010	20.079
Root mass (g)	1	Ready-made substratum	5.396	5.165	1.501	0.274	2.900	8.900	27.817
	2	T_{100}	2.069	2.010	0.562	0.103	1.160	3.020	27.156
	3	$T_{90}+Z_{10}$	4.001	3.760	1.360	0.248	1.610	8.600	33.990
	4	$T_{80}+Z_{20}$	4.589	4.730	1.598	0.292	1.700	8.890	34.832
	5	$T_{70}+Z_{30}$	4.414	4.340	1.253	0.229	1.990	7.230	28.387
	6	$T_{90}+P_{10}+Z_{0}$	2.734	2.800	0.831	0.152	0.790	4.330	30.405
	7	$T_{80}+P_{10}+Z_{10}$	3.790	4.000	1.382	0.252	1.280	6.260	36.473
	8	$T_{70}+P_{10}+Z_{20}$	4.837	4.675	1.444	0.264	2.890	8.670	29.850
	9	$T_{60}+P_{10}+Z_{30}$	4.224	4.425	0.823	0.150	2.550	5.510	19.490
	10	$T_{50}+P_{10}+Z_{40}$	3.877	3.955	0.894	0.163	2.300	5.710	23.047
	11	$T_{80}+P_{20}+Z_{0}$	2.495	2.420	0.794	0.145	0.500	4.000	31.815
	12	$T_{70}+P_{20}+Z_{10}$	4.171	4.135	1.367	0.250	1.760	7.410	32.786
	13	$T_{60}+P_{20}+Z_{20}$	6.638	6.790	2.279	0.416	3.260	14.020	34.326
	14	$T_{50}+P_{20}+Z_{30}$	5.893	5.820	1.673	0.305	2.420	9.450	28.384

Table 2. The main indicators of descriptive statistics for the development of the *Catharanthus roseus Pacifica red* seedlings on the tested substrata

Tested characteristics	Ordinal number of the variant	Variants	Arithmetic mean	Median	Standard deviation	Standard error	Min	Max	Coefficient variant of (%)
Height (cm)	1.	Ready-made substratum	23.120	23.350	2.865	0.523	17.100	28.100	12.390
	2.	T_{100}	9.840	10.000	1.209	0.221	6.600	11.600	12.284
	3.	$T_{90}+Z_{10}$	23.953	24.000	2.195	0.401	19.200	27.100	9.163
	4.	$T_{80}+Z_{20}$	21.487	22.250	3.148	0.575	11.900	25.600	14.653
	5.	$T_{70}+Z_{30}$	22.356	22.650	2.138	0.390	17.600	27.100	9.563
	6.	$T_{90}+P_{10}+Z_{0}$	8.827	9.600	1.874	0.342	4.900	11.200	21.226
	7.	$T_{80}+P_{10}+Z_{10}$	23.103	23.600	2.521	0.460	15.800	27.300	10.914
	8.	$T_{70}+P_{10}+Z_{20}$	20.427	20.500	3.533	0.645	12.300	26.900	17.294
	9.	$T_{60}+P_{10}+Z_{30}$	19.113	19.250	2.300	0.420	15.400	24.200	12.036
	10.	$T_{50}+P_{10}+Z_{40}$	20.557	20.450	2.787	0.509	14.100	27,900	13.560
	11.	$T_{80}+P_{20}+Z_{0}$	11.487	11.150	1.914	0.350	7.200	15.900	16.666
	12.	$T_{70}+P_{20}+Z_{10}$	23.287	23.850	2.912	0.532	16.800	27.900	12.505
	13.	$T_{60}+P_{20}+Z_{20}$	22.740	23.150	2.605	0.476	16.400	27.400	11.455
	14.	$T_{50}+P_{20}+Z_{30}$	19.083	19.100	2.949	0.538	13.200	23.100	15.456
Above-ground mass (g)	1.	Ready-made substratum	13.302	13.185	1.634	0.298	10.110	16.630	12.283
	2.	T_{100}	3.484	3.370	0.647	0.118	2.240	5.160	18.556
	3.	$T_{90}+Z_{10}$	13.194	13.260	2.042	0.373	8.180	18.490	15.475
	4.	$T_{80}+Z_{20}$	11.695	11.585	3.826	0.699	1.980	17.900	32.718
	5.	$T_{70}+Z_{30}$	10.050	10.235	2.135	0.390	3.940	13.190	21.240
	6.	$T_{90}+P_{10}+Z_{0}$	3.106	3.105	0.870	0.159	1.080	4.640	27.995
	7.	$T_{80}+P_{10}+Z_{10}$	12.588	12.960	2.174	0.397	7.830	18.140	17.271
	8.	$T_{70}+P_{10}+Z_{20}$	9.712	9.670	2.383	0.435	4.650	14.490	24.537
	9.	$T_{60}+P_{10}+Z_{30}$	9.776	9.980	1.880	0.343	4.300	13.040	19.227
	10.	$T_{50}+P_{10}+Z_{40}$	10.766	10.555	2.668	0.487	5.370	17.280	24.782
	11.	$T_{80}+P_{20}+Z_{0}$	3.500	3.390	0.996	0.182	1.810	5.700	28.474
	12.	$T_{70}+P_{20}+Z_{10}$	11.874	11.930	2.777	0.507	0.460	16.000	23.383
	13.	$T_{60}+P_{20}+Z_{20}$	10.344	10.025	1.670	0.305	7.150	15.050	16.140
	14.	$T_{50}+P_{20}+Z_{30}$	9.202	10.190	2.560	0.467	4.720	13.210	27.824
Root mass (g)	1	Ready-made substratum	2.632	2.715	0.462	0.084	1.810	3.450	17.574
	2	T_{100}	1.962	1.875	0.458	0.084	1.050	3.070	23.342
	3	$T_{90}+Z_{10}$	1.757	1.620	0.424	0.077	1.170	2.620	24.127
	4	$T_{80}+Z_{20}$	2.030	1.995	0.580	0.106	0.880	3.300	28.574
	5	$T_{70}+Z_{30}$	1.617	1.595	0.415	0.076	0.890	2.810	25.690
	6	$T_{90}+P_{10}+Z_{0}$	2.283	2.260	0.587	0.107	0.830	3.460	25.718
	7	$T_{80}+P_{10}+Z_{10}$	2.443	2.355	0.553	0.101	1.410	3.710	22.630
	8	$T_{70}+P_{10}+Z_{20}$	2.339	2.190	0.721	0.132	1.120	4.090	30.804
	9	$T_{60}+P_{10}+Z_{30}$	2.268	2.170	0.557	0.102	0.720	3.210	24.565
	10	$T_{50}+P_{10}+Z_{40}$	2.066	1.960	0.496	0.091	1.060	3.110	24.024
	11	$T_{80}+P_{20}+Z_{0}$	1.712	1.670	0.367	0.067	1.190	2.860	21.464
	12	$T_{70}+P_{20}+Z_{10}$	2.041	1.990	0.449	0.082	1.260	3.050	22.007
	13	$T_{60}+P_{20}+Z_{20}$	1.677	1.635	0.440	0.080	0.800	2.480	26.215
	14	$T_{50}+P_{20}+Z_{30}$	2.283	2.375	0.767	0.140	0.830	3.720	33.593

The minimum and the maximum average value of the above-ground mass of the *Catharanthus* seedlings were recorded in variants in which seedlings had the minimum and the maximum average values of height (Table 2). The results of the experiment involving the root mass (Table 1) showed that the average root mass of the *Tagetes* seedlings increased when physical characteristics of tested substrata were improved when perlite was added and nutritional regime was improved when zeoplant was added. The average root mass ranged from 2.069 g in variant 2, T_{100} to 6.790 g in variant 13, $T_{60}+P_{20}+Z_{20}$. For all heterogeneous samples (Cv≥30%) the median was taken as a more valid indicator of average. In the case of seedlings with the longest vegetation, *Catharanthus roseus*, the minimum average root mass (1.617 g) was recorded in variant 5, $T_{70}+Z_{30}$, and the maximum average root mass (2.63 g) was recorded in variant 1, the ready-made commercial substratum (Table 2). The root in variant 9, $T_{60}+P_{10}+Z_{30}$ had the minimum single mass (0.72 g) while the root which was grown in variant 8, $T_{70}+P_{10}+Z_{20}$ had the maximum singular mass (4.09 g). The results of Leven's test (Table 3) showed that the variances of samples were heterogeneous for all tested characteristics of the development of seedlings. Since the tested samples were of the same height, the importance of difference in average values of examined parameters was tested using the parameter model of the analysis of variance (ANOVA). According to the results of this test (Table 3) and by using substrata variants which were tested, we got plant groups which were statistically very significantly different according to all tested parameters of the development of seedlings.

For testing the differences of average values of all examined characteristics, we used the least significant difference – LSD test (Table 4, 5, and 6). The results of these tests showed that by applying zeoplant in examined substrata, average height, average above-ground mass and average root mass of tested seedlings were statistically significantly increased when compared with average values which were recorded in the case of substrata with no zeoplant. Substrata with 20% of zeoplant (variants 8 and 13) had a statistically very significant influence on the height of the *Tagetes* seedlings compared to the ready-made commercial *Floragard medium coarse* substratum, whereas in the case of the *Catharanthus* seedlings substrata with 10% of zeoplant were statistically significant (Table 4). In substrata with the smallest dose of zeoplant (variants 3, 7, and 12), the recorded average height values of the *Catharanthus* seedlings did not differ statistically from the average height of the ready-made commercial substratum and substratum 13, $T_{60}+P_{20}+Z_{20}$ (Table 4). The test results showed that the growth of the *Catharanthus* seedlings was not only influenced by the content of zeoplant's mineral component, but also by the physical characteristics of substrata.

Table 3. The results of Leven's test on the homogeneity of variances and variance analysis for the development of seedlings

Flower species	Tested parameters	Leven's test		ANOVA	
		F	P	F	P
Tagetes patula Bonanza yellow	height	3.60	0.001**	84.4	0.001**
	above-ground mass	3.47	0.000**	266.66	0.000**
	root mass	2.88	0.000**	26.34	0.000**
Catharanthus roseus Pacifica red	height	2.50	0.003**	124.893	0.001**
	above-ground mass	3.153	0.000**	94.263	0.000**
	root mass	2.540	0.000**	10.027	0.000**

p≤ 0,05(*) the difference is significant

p≤ 0,01(*) the difference is very significant

Since the physical characteristics of substrata directly depend on the quantity of organic matter, a decrease in the organic component in substrata below 70% and an increase in the mineral one did not have a statistically favourable influence on the average height of seedlings with the longest vegetation – *Catharanthus*. The results showed that substrata in which organic matter (Tutin peat) accounted for 70-90% had the most favourable influence on the average seedling height. This can be explained by the length of the *Catharanthus* seedling vegetation, which enabled the seedlings to use easily accessible elements created by the mineralization of organic matter. This is in accordance with Stevanović and Pavlović's (1995) results, which underline the low fertilising ability of peat in the first part of vegetation due to the small mineralising ability and wider C/N ratio.

Table 4. Levels of the significance of difference in the average height of the Tagetes patula Bonanza yellow seedlings and Catharanthus roseus Pacifica red seedlings based on LSD test

Variants	1.		2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
	Average height values of Tagetes patula Bonanza yellow														
$\bar{x}$	20.163	12.073	8.360	19.667	17.803	12.210	12.210	21.020	22.283	20.667	18.307	11.367	21.300	26.333	
1.		0.566	0.007	0.459	0.000	0.000	0.202	0.002	0.444	0.006	0.000	0.091	0.000	0.000	
2.	0.000		0.000	0.000	0.000	0.838	0.000	0.000	0.000	0.000	0.292	0.000	0.000	0.000	
3.	0.209	0.000		0.052	0.407	0.000	0.000	0.000	0.001	0.937	0.000	0.000	0.000	0.000	
4.	0.014	0.000	0.000		0.006	0.000	0.044	0.000	0.132	0.043	0.000	0.015	0.000	0.000	
5.	0.249	0.000	0.016	0.189		0.000	0.000	0.000	0.000	0.453	0.000	0.000	0.000	0.000	
6.	0.000	0.127	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.209	0.000	0.000	0.000	
7.	0.980	0.000	0.200	0.015	0.260	0.000		0.060	0.609	0.000	0.000	0.676	0.000	0.011	
8.	0.000	0.000	0.000	0.110	0.004	0.000	0.000		0.017	0.000	0.000	0.143	0.000	0.499	
9.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048		0.000	0.000	0.353	0.000	0.002	
10.	0.000	0.000	0.000	0.161	0.007	0.000	0.000	0.844	0.030		0.000	0.000	0.000	0.000	
11.	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	
12.	0.801	0.000	0.314	0.007	0.161	0.000	0.782	0.000	0.000	0.000	0.000		0.000	0.033	
13.	0.566	0.000	0.068	0.059	0.563	0.000	0.583	0.001	0.000	0.001	0.000	0.409		0.000	
14.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.043	0.964	0.027	0.000	0.000	0.000		
$\bar{x}$	23.120	9.840	23.953	21.487	22.356	8.827	23.103	20.427	19.113	20.557	11.487	23.287	22.740	19.083	
	Average height values of Catharanthus roseus pacifica red														
Variants	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	

Using LSD test to compare the average values of the above-ground mass of seedlings between two groups of plants showed that in addition to an improved nutritional regime, using zeoplant made the physical characteristics of substrata result in an increase in the above-ground mass of tested seedlings of annual flowers (Table 5). In the case of seedlings with the shortest vegetation – *Tagetes*, a change of the minimum and maximum dose of zeoplant in substrata (10 and 40 volume percent) led to an increase in the above-ground mass, which became equal to the above-ground mass of the ready-made substratum and was not statistically significantly different from it (Table 5). By using zeoplant of 20 and 30 volume percent, the above-ground mass of *Tagetes* seedlings became statistically very significantly increased compared to the above-ground mass of the ready-

made substratum. The maximum average above-ground mass of the *Catharanthus* seedlings was recorded in substrata with the highest percent of organic matter (70-90%) and the lowest percent of mineral matter (variants 3, 7 and 12). The recorded values were statistically very significantly higher compared to the average values of other substrata that were tested. The above-ground mass of the *Catharanthus* seedlings of the ready-made commercial substratum was not statistically significantly different from the above-ground mass of seedlings which were grown in variants 3 and 7. Knowledge of the length of the seedlings vegetation was highly important during the preparation phase for growing suitable substrata, which was supported by our trial. As with the recorded average height, a decrease of peat in substrata for growing plants with the longest vegetation, in this case *Catharanthus*, to 70% while using the minimal dose of zeoplant (variant 12) resulted in a statistically significantly smaller above-ground mass than the average mass achieved on the ready-made commercial substratum 3, $T_{90}+Z_{10}$. In relation to the substratum with the same percentage of peat (70%) but higher percentage of zeoplant (variant 5), the above-ground mass of the *Catharanthus* seedlings was statistically significantly increased in variant 12. This underlines the importance of the percentage of organic matter in substrata for growing flower seedlings with the longest vegetation which might have a direct influence on the price of substrata. Similarly, the percentage of perlite in substrata had an influence on an increase in the above-ground mass of seedlings. It can be noted that substrata in which perlite was present with 10 volume percent were not statistically very significant to the increase of the above-ground mass of the *Tagetes* seedlings and they even led to a decrease in case the content of zeoplant was higher with regard to substrata without perlite (Table 5). The *Tagetes* seedlings had a statistically significantly greater above-ground mass on substrata with 20 volume percent of perlite and the smallest dose of zeoplant (10 volume percent) than plants on the ready-made commercial substratum (Table 5). An increase of zeoplant of 20 and 30 volume percent (variant 13 and 14) in substrata made plants obtain a greater average above-ground mass in comparison with an average mass recorded on other substrata. Even in the case of this examined indicator of the development of obtained seedlings, it turned out that the *Tagetes* plants in variant 13, $T_{60}+P_{20}+Z_{20}$, had the maximum average above-ground mass (24.815 g) which was statistically very significantly different from the average values for the above-ground mass on other substrata that were tested.

Table 5. Levels of the significance of difference in the above-ground mass of the *Tagetes patula Bonanza yellow* and *Catharanthus roseus Pacifica red* seedlings on the basis of LSD test

Variants	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13	14
	Average above-ground mass values of Tagetes patula Bonanza yellow													
$\bar{x}$	12.444	2. 872	12.800	17.164	18.749	3.490	13.200	15.406	15.201	13.380	3.486	15.160	24.815	21.821
1.			0.181	0.000	0.000	0.000	0.471	0.001	0.001	0.192	0.000	0.001	0.000	0.000
2.	0.000		0.000	0.000	0.000	0.058	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000
3.	0.843	0.000		0.000	0.000	0.000	0.536	0.034	0.064	0.972	0.000	0.047	0.000	0.000
4.	0.004	0.000	0.007		0.095	0.000	0.000	0.111	0.063	0.000	0.000	0.085	0.000	0.000
5.	0.000	0.000	0.000	0.029		0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.029
6.	0.000	0.233	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.370	0.000	0.000	0.000
7.	0.275	0.000	0.371	0.073	0.000	0.000		0.006	0.014	0.559	0.000	0.009	0.000	0.000
8.	0.000	0.000	0.000	0.006	0.555	0.000	0.000		0.790	0.031	0.000	0.897	0.000	0.000
9.	0.000	0.000	0.000	0.010	0.685	0.000	0.000	0.853		0.059	0.000	0.890	0.000	0.000
10.	0.000	0.000	0.000	0.276	0.271	0.000	0.004	0.091	0.132		0.000	0.043	0.000	0.000
11.	0.000	0.949	0.000	0.000	0.000	0.259	0.000	0.000	0.000	0.000		0.000	0.000	0.000
12.	0.013	0.000	0.022	0.691	0.010	0.000	0.162	0.002	0.003	0.138	0.000		0.000	0.000
13.	0.000	0.000	0.000	0.110	0.556	0.000	0.001	0.239	0.320	0.608	0.000	0.046		0.059
14.	0.000	0.000	0.000	0.000	0.128	0.000	0.000	0.351	0.264	0.009	0.000	0.000	0.035	
$\bar{x}$	13.301	3.484	13.194	11.695	10.050	3.106	12.588	9.712	9.776	10.766	3.500	11.874	10.344	9.202
	Average above-ground mass values of Catharanthus roseus pacifica red													
Variants	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.

Table 6. Levels of the significance of difference in the root mass of the *Tagetes patula Bonanza yellow* and *Catharanthus roseus Pacifica red* seedlings on the basis of LSD test

Variants	1.	2.	3.	4.	5.	6.	7	8.	9.	10.	11.	12.	13	14
	Average root mass values of *Tagetes patula Bonanza yellow*													
	5.396	2.069	4.001	4.589	4.414	2.734	3.790	4.837	4.224	3.877	2.495	4.171	6,638	5.893
1		0.000	0.002	0.056	0.054	0.000	0.000	0.292	0.040	0.003	0.000	0.006	0.124	0.499
2	0.000		0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.085	0.000	0.000	0.000
3	0.000	0.117		0.232	0.238	0.000	0.319	0.040	0.291	0.917	0.000	0.714	0.000	0.000
4	0.000	0.713	0.053		0.988	0.000	0.029	0.388	0.890	0.275	0.000	0.407	0.001	0.0098
5	0.000	0.007	0.248	0.002		0.000	0.030	0.379	0.901	0.282	0.000	0.416	0.001	0.009
6	0.014	0.027	0.000	0.065	0.000		0.001	0.000	0.000	0.000	0.133	0.000	0.000	0.000
7	0.190	0.001	0.000	0.003	0.000	0.249		0.002	0.041	0.272	0.000	0.173	0.000	0.000
8	0.031	0.012	0.000	0.033	0.000	0.767	0.391		0.316	0.051	0.000	0.091	0.0098	0.084
9	0.011	0.035	0.000	0.082	0.000	0.919	0.210	0.691		0.341	0.000	0.490	0.000	0.007
10	0.000	0.460	0.021	0.711	0.001	0.140	0.009	0.077	0.170		0.000	0.792	0.000	0.000
11	0.000	0.060	0.753	0.025	0.401	0.000	0.000	0.000	0.000	0.009		0.000	0.000	0.000
12	0.000	0.551	0.031	0.820	0.001	0.106	0.006	0.056	0.130	0,887	0.014		0.000	0.001
13	0.000	0.025	0.493	0.009	0.639	0.000	0.000	0.000	0.000	0.003	0.711	0.005		0.388
14	0.008	0.046	0.000	0.102	0.000	0.833	0.173	0.613	0.913	0.206	0.000	0.160	0.000	
$\bar{x}$	2.632	1.962	1.757	2.030	1.617	2.283	2.443	2.339	2.268	2.066	1.712	2.041	1.677	2.283
	Average root mass values of *Catharanthus roseus pacifica red*													
Variants	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.

The LSD test results (Table 6) indicated that growing seedlings of *Tagetes* and *Catharanthus* on substrata without zeoplant (variants 2, 6, and 11) statistically very significantly reduced the root mass of seedlings.

Improving the nutritional regime of substrata by adding zeoplant for growing *Tagetes*, from 10 to 30 volume percent (variants 3, 4, and 5) led to a statistically significant increase in the average root mass in relation to the variant with no zeoplant (2, 6, and 11). The application of zeoplant in substrata of 20 and 30 percent resulted in an increase in the average root mass but that increase was not statistically significant compared to the average root mass achieved on the ready-made commercial substratum (Table 6). The application of perlite in substrata of 10 volume percent did not statistically very significantly affect an increase in the average root mass compared to substrata without perlite (variants 3, 4, and 5). Statistically significantly greater root mass was achieved only on the observed substratum in which zeoplant accounted for 20 volume percent (variant 8) in relation to the tested substratum 3, with 10 volume percent of zeoplant. Similarly, in the case of tested substrata (variants 7 to 10) zeoplant of 20 volume percent, statistically very significantly affected an increase in the average root mass compared to substrata with 10% of zeoplant and in relation to substrata with 30% of zeoplant. This proves that the root is better elongated, and developed in substrata when less food is available, which directly affects its mass (Bloom, 2003). The results we obtained are in accordance with the results published by Pavlović (1997), who studied the root mass of tomato seedlings grown on different substrata with the addition of 20% of zeoplant. When increasing the percentage of perlite in substrata to 20 volume percent (Table 6), the application of zeoplant of 20 and 30 volume percent (variant 13 and 14) statistically very significantly increased the average root mass of *Tagetes* seedlings in relation to the lower dose of zeoplant that was administrated (variant 12). The application of zeoplant dose of 30%, variant 14, led to a decrease or increase in the average root mass compared to substrata with perlite and 20% of zeoplant (variants 8 and 13), but those changes were not statistically significant. This underlines the positive impact and justification of the application of a greater percentage of perlite in substrata when it comes to the development of the root system of the *Tagetes patula* seedlings. The average root mass of the *Tagetes* seedlings recorded on substratum 13, $T_{60}+P_{20}+Z_{20}$, was statistically very significantly greater than the average mass obtained on the other tested substrata based on domestic raw materials (Table 6). As for the other observed characteristics of the development of the *Tagetes* seedlings (seedling height and above-ground mass) substratum 13, $T_{60}+P_{20}+Z_{20}$ proved to be optimal for the observed characteristic of the root mass. In the case of seedlings with the longest vegetation, *Catharanthus roseus* as well as in the case of *Tagetes* seedlings, the application of zeoplant of 20 volume percent in the investigated substrata based on peat and zeoplant (variant 3, 4, and 5) resulted in an increase of the average root mass (Table 6). The recorded average mass, 2.03 g, was statistically very significantly higher than the average root mass (1.617 g) obtained by using higher doses of zeoplant (variant 5), whereas compared to the average root mass obtained by using a minimum dose of 10% of zeoplant, 1.75 g, it was not statistically significantly different, variant 3 (Table 6). In comparison to the other tested substrata, the average root mass of the *Catharanthus* seedlings on substratum 4 ($T_{80}+Z_{20}$) was statistically very significant and greater than the average root mass on substrata 2, T_{100}, and 13, $T_{60}+P20+Z_{20}$, but statistically significantly lower than the average mass recorded on substratum 7, $T_{80}+P_{10}+Z_{10}$. Similarly, the achieved average root mass of the *Catharanthus* seedlings on substratum 4 was even statistically significantly higher than the average root mass on substratum 11, but also statistically significantly lower compared with the root

mass recorded on substratum 8. The results we obtained only confirmed the importance of a larger percentage of an organic component (peat) in substrata for growing plant seedlings of annual flowers with the longest vegetation. The application of perlite in substrata of 10 volume percent (variants 6, 7, 8, 9, and 10) had a positive impact on the average root mass of *Catharanthus*. The LSD test results indicated that even with the same percentage of organic matter of 90% (variants 3 and 6) the average root mass in substratum 6 with added perlite, was statistically very significantly higher than in the substratum with zeoplant, variant 3 (Table 6). This can be interpreted by the improved water-air regime of substrata using perlite, which was suitable for better adoption of nutrients. Similarly, the percentage of organic matter in the substratum with 80% (variant 7, $T_{80}+P_{10}+Z_{10}$) with the use of perlite of 10% and a minimal use of zeoplant, 10%, statistically very significantly increased the average root mass compared to the average root mass recorded on the substratum with the same percentage of organic matter and a greater percentage of mineral matter (variant 4, $T_{80}+Z_{20}$). The obtained average root mass on substratum 7, 2.44 g, although smaller than the average mass, which was achieved on the ready-made commercial substratum (2.63 g), was not statistically significantly lower. A higher percentage of zeoplant in substrata in which perlite accounted for 10 volume percent (variant 6, 8 and 9) did not lead to statistically significantly higher average root mass compared to the masses that were obtained by using a minimum dose of zeoplant (variant 7) whereas when applying the highest dose (40% of zeoplant), the masses were statistically very significantly reduced (Table 6). For the purpose of ranking substrata according to the simultaneous influence on all investigated parameters of the development of seedlings, the I-distance was used (Lakić and Stevanović, 2003) (Table 7). With regard to the I-distance values, it can be concluded that the best quality plant seedlings of the group with the shortest vegetation, *Tagetes*, were obtained when plants were grown on substratum 13, $T_{60}+P_{20}+Z_{20}$. While the best quality plant seedlings with the longest vegetation *Catharanthus* are obtained when plants were grown on the ready-made commercial substratum 1, and then on substrata with the highest percentage of organic matter and the smallest percentage of zeoplant, substratum 7, $T_{80}+P_{10}+Z_{10}$ and substratum 12, $T_{70}+P_{20}+Z_{10}$.

Table 7. The I-distance values for the parameters of the development of seedlings of annual flowers

Ordinal number of the variant	Investigated substrata	*Tagetes patula*		*Catharanthus roseus*	
		I- distance	rank	I- distance	rank
1.	Ready-madesubstrata	1.656	X	*5.277*	I
2.	Peat 100%	0.040	XIV	0.821	XIII
3.	$T_{90}+Z_{10}$	1.637	XI	3.943	V
4.	$T_{80}+Z_{20}$	2.391	IV	4.010	IV
5.	$T_{70}+Z_{30}$	2.687	III	2.797	XI
6.	$T_{90}+P_{10}+Z_{0}$	0.127	XII	1.156	XII
7.	$T_{80}+P_{10}+Z_{10}$	1.796	IX	4.489	II
8.	$T_{70}+P_{10}+Z_{20}$	2.209	VI	3.495	IX
9.	$T_{60}+P_{10}+Z_{30}$	2.134	VII	3.716	VII
10.	$T_{50}+P_{10}+Z_{40}$	1.817	VIII	3.632	VIII
11.	$T_{80}+P_{20}+Z_{0}$	0.115	XIII	0.341	XIV
12.	$T_{70}+P_{20}+Z_{10}$	2.250	V	4.054	III
13.	$T_{60}+P_{20}+Z_{20}$	3.993	I	2.873	X
14.	$T_{50}+P_{20}+Z_{30}$	3.427	II	3.728	VI

Conclusions

This paper investigates the justification of introducing domestic raw materials in the preparation of substrata suitable for growing the seedlings of annual flowers. The tested substrata were favourable for growing the seedlings of annual flowers of *Tagetes patula 'Bonanza' -yellow* and *Catharanthus roseus 'Pacifica' -red* and had different effects on their development. The highest average height of seedlings with the shortest vegetation, *Tagetes patula 'Bonanza'-yellow* (26.33 cm), the highest average above-ground mass (24.815 g) and the highest average root mass (6.79 g) were recorded on substratum 13, $T_{60}+P_{20}+Z_{20}$. In the case of seedlings with the longest vegetation, *Catharanthus roseus 'Pacifica' red*, the maximum average height of seedlings (23.95 cm) was recorded on substratum 3, $T_{90}+Z_{10}$. The maximum average above-ground masses (13.3 g and 13.19 g) were recorded in the case of the ready-made commercial substratum and substratum 3, $T_{90}+Z_{10}$, whereas the highest average root masses (2.63 g and 2.44 g) were achieved on the ready-made commercial substratum and substratum 7, $T_{80}+P_{10}+Z_{10}$.

Taking into account all tested parameters of the development of seedlings, the calculated values of the I-distance suggested that the best development of seedlings of annual flowers, *Tagetes patula 'Bonanza' -yellow* was recorded on substratum 13, $T_{60}+P_{20}+Z_{20}$ and *Catharanthus roseus 'Pacifica' -red* on substratum 7, $T_{80}+P_{10}+Z_{10}$.

These variants of substrata: $T_{60}+P_{20}+Z_{20}$, and $T_{80}+Z_{10}+Z_{10}$, were made of domestic components, and their ratio was exactly balanced according to the requirements of the seedlings of annual flowers. When producing substrata of such a composition, the substitution of the imported substratum is guaranteed. Domestic raw materials and other domestic resources are used, so it would be normal that their price as well as the price of the final product is lower.

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ВЛИЈАНИЕ НА СОСТАВОТ НА СУПСТРАТОТ ВРЗ КВАЛИТЕТОТ НА ЕДНОГОДИШНИТЕ ЦВЕТНИ ВИДОВИ

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Апстракт

Во овој труд се истражува оправданоста од примената на домашни сурови материи за подготовка на супстрати погодни за одгледување на расад од едногодишни цветни видови. Истражувани се супстрати подготвени од Тутин тресет и перлит со зеоплант.

Испитуваните едногодишни цветни видови, Tagetes patula и Catharanthus roseus беа произведувани во пластични контејнери (speedling систем) и во поли-пропиленски саксии (pot систем). Опитот беше спроведен во текот на 2009 и 2011 година во стакленик на Земјоделскиот Факултет во Белград. Вкупниот број на испитувани супстрати беше 14. Резултатите од изтражувањето ја потврдија оправданоста на воведувањето на Тутин тресетот (Т), перлитот (Р) и зеоплантот (Z) за подготовка на супстрати за одгледување на расад од испитуваните едногодишни цветни видови. Резултатите од истражувањето покажаа дека составот на супстратот различно влијае врз развојот на испитуваните видови (висина на растенијата, маса на надземниот дел, маса на коренот), а согласно со тоа и на нивниот квалитет. Најдобар развој на расадот од Tagetes patula беше постигнат при примената на супстрат од $T_{60}+P_{20}+Z_{20,}$ додека кај Catharanthus roseus најдобри резултати беа постигнати со користење на супстрат $T_{80}+P_{10}+Z_{10.}$

Клучни зборови: супстрат, расад, едногодишни цветни видови, Тутин тресет, перлит, зеоплант.

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YIELD AND YIELD COMPONENTS OF NEWLY TOMATO HYBRIDS IN REPUBLIC OF MACEDONIA

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Abstract
Tomato (*Lycopersicum esculentum*) is one of the major vegetables in Republic of Macedonia. Our National Variety List has a significant number of registered domestic varieties and introduced hybrids.Before their introduction into commercial production, all introduced hybrids and newly varieties are examined in order to determinate the yield and yield components. In this paper, we treated a total of 54 varieties / hybrids of tomato examined in the period from 2005 to 2010, of which 26 of them are grown in the open field, and 28 in the greenhouses with prescribed standard technology. Tested varieties and hybrids were compared with the standard according to the prescribed rules and procedures set by the National Variety Commission. In examined period the hybrids of tomatoes grown on open field were compared with the standard varieties: Arleta F_1, San Pier, Magnus F_1, Erato F_1 and Optima F_1, while hybrids grown in the greenhouses were compared with the following standards: Amati F_1, Monika F_1 and Balca F_1. All varieties and hybrids that have shown better results than the standards in terms of estimated parameters are recommended for introduction into commercial production.
Key words: tomato, hybrid, yield.

Introduction

Tomato is one (*Lycopersicon esculentum mill*) of the widest spread vegetable crops. It is one of the most popular and widely grown vegetable crops, ranking second in importance to potato in many countries (Hartmann et al. 1981). Tomato is nutritional crop and important source of vitamin A and C and minerals which are important ingredients for human consumption (Sekhar *et al*. 2010). Since the early 20th century, the worldwide production of tomato is growing, and per area takes the tenth place of food production. Today, it is grown in most countries around the world except in colder regions (Hannan et al.2007). It is cultivated in all parts of Macedonia due to its adaptability to a range of soil and climate. The best growing areas of tomato are southeast region in Macedonia, Ovče Pole and Povardarie with total production of 120000 - 140000 tons. Tomato (*Lycopersicon esculentum*) is the most cultivated herbaceous plant in the Republic of Macedonia leading with 66% of vegetables production (Jankulovski *et.al*). Tomato yield is a complex trait that is included in almost every selection program includes several components, the quantitative nature. According to Zdravkovic et al., (2010) studies made in relation to the inheritance of yield and yielding components in the cultivation of this crop. According to Marisici et al., (2011) the yield and fruit quality depends on the cultivar and the climate in which it is grown. In 2010, in the Republic of Macedonia tomato is represented the area of 5665 ha, and production of 168,010 t Jankulovski D. et

al., (2002). The cultivation of (*Lycopersicon esculentum mill)* is carried out on the open field and greenhouses. The objective of this study was determining the yield and yield components in tomato hybrids grown on open field and greenhouses.

Material and methods

A total of 54 tomato varieties were included in this study, out of which 26 are grown in the open field and 28 in the greenhouses. All survey was made in a period of 2005-2010. The experiments in the open field were done in Skopje, in a randomised complete block design. The unit plot size was 7.0 m², while transplantation was in rows at a distance of 70x40 cm. In 2005 there were analyzed six varieties/hybrids of tomato that carry the following names: Tamaris F1, Nemo Neta F1, Galina, V71, Agora and Valina.They were compared with two standard varieties: Arleta F1 and San Pier F1. During the 2006 there were examine a total of eight varieties/hybrids: Queen F1, Bonito, Lorena F1, T8948 F1, Charisma F1, Torpeder F1, Bobcat F1 and SLX 3749 F1.The hybrids Bobcat F1 and SLX 3749 F1 were compared with standard variety Erato F1.The other six tomato hybrids were compared with the standard named as: Magnus F1. The unit plot size of this experiment was 10.0 m², and a distance of rows was 100x15 cm. As plant material for 2007 there were used two tomato hybrids: Nemo Neta F1 which were compared with Optima F1 and Queen F1 compared with Magnus F1. Hybrids: Astraion F1, CLX 37286 F1, CLX 37147 F1, CLX 37305 F1 were analyzed during the vegetation in 2008. In these trials the standard Magnus F1, was used as a comparative variety for hybrid CLX 37147 F1, and with the standard Optima F1 were compared all the other hybrids. In 2009, five tomato varieties were analyzed as follows Staccato F1, Tourist F1, Logistica F1, Pink Paradise F1, CLX 37304 F1 which were compared with standard Optima F1. During the vegetation in 2010 hybrid assigned as Abelus F1 was compared with control variant Optima F1. Greenhouse experiments were conducted during 2005-2008, at four different locations. In 2005 the experimental fields were set up in St.Nikole with total of seven tomato hybrids: Buran F1, Newton F1, Ombelline F1, PX 01021547 F1, PS 150825 F1, Iker F1 and Merkurio F1 which were compared with two standard varieties: Amati and Monika F1. The size of the experimental plot was 4.8 $m.^2$ Tested varieties marked as: Rosaliya F1, PS6262 F1, Bonarda F1, BS 015 037 003 F1, Ballet F1 and Siluet F1, were set up on the experimental fields in Gradsko, in 2006 according to the prescribed methodology for growing tomatoes in a protected space. For comparison were used two standard varieties: Amati F1 and Balca F1. Varieties: Rosaliya F1, PS6262 F1, Bonarda F1, BS015037003 F1 are indeterminate types,which were compared with the standard variety Amaty F1. Balca F1 was ised as standard variety for comparison with the semideterminant varieties Ballet and Siluet.A group of six varieties of tomato hybrids: Teory F1, Sprinter F1, Menhir F1, Tundra F1, Mondial F1 and Trogir F1 were examinate in 2007 set up in Kumanovo. As standard variety was used Monika F1. Hybrids: Lady Rosa F1, Fantom F1, Roxana F1, Thalassa F1, Trofeo F1, Alfred F1, Mathias F1, Profilo F1, and Bonito N F1, who were compared with Monika were set up on the experimental fields in Valandovo, Anska reka. Analyzes were done during the 2008, on the experimental plot of 8m². During the production of all varieties grown in open field and protected houses data of the stages of growth, average yields and characteristics of the fruits were registerd. The yields were statistically obtained and verified with LSD test.

Results and discussion

Experiment for the study of yield and yield components have been conducted in five years. This paper reviews the five-year average values of the yield components. In tab.1 there are given stages of growth for tomato hybrids cultivated on open field. Vegetation researches made in 2005 ranged from (96days) in control variant to 104 days of examined hybrids. The greater difference compared to the control variant showed hybrids: Tamaris F1, V71, and Agora. The longest vegetation in 2006 showed the variety Bobcat F1 (108 days). In 2007 the length of the vegetation in all analyzed hybrids ranged from (88days) showen by standard Magnus F1 and (83 days) in the standard Optima F1. Tomato hybrids Nemo, Neta F1 and Queen F1 compared with the control varieties showed a longer vegetation period. In the table 1 can be noticed that the variety CLX 37147 F1 has the highest length of vegetation (100 days). Variety Astraion F1 and CLX 37286 F1 showed a longer vegetation than the standard hybrid Magnus F1. Only the hybrid CLX 37305 have showen shorter vegetation for a day. The results obtained in 2009 showed that the analyzed varieties have the same vegetation period with the standard Optima F1, except hybrid Staccato F1 in which is noticed two days longer vegetation period. Analyzed hybrid Abelus F1 in 2010 showed seven days longer vegetation period (102 days) compared with control Optima F1. In the table 2 are given the productive traits of the investigated varieties in the open filed from 2005 to 2010 expressed in average yields. From all investigated hybrids in open filed in 2005, the highest yield showed the hybrid V71 with (120.2t/ha). In 2006 all tested varieties have significant differences compared to average yield. The lower yield had given just the hybrids Queen F1 (68.3 t/ha) and Bonito (84.4t/ha). Compared to the control variant: Erato F1ø, varieties Bobcat F1 and SLX 3749 F1 also had a higher yield than the standard. The higher significant diferences in yield also gave the variety Nemo Neta F1 (71.6t/ha) in 2007, Astraion F1 (73,7t/ha) in 2008, Tourist F1 (63.6t/ha) in 2009, while in 2010 with higher yield was Abelus F1 (44.6t/ha). In Tab.3 there are given the characteristics of the fruit for tested hybrids in the period of 2005-2010.From the examined tomato hybrids in 2005, compared to standard varieties the highest average weight showed the variety V71 weight (180g). In 2006 the weight of the fruit in the tested varieties varied from 125g in control variant Magnus F1 to 189 g in the control variant Erato F1. In 2007 the highest weight of the fruit showed the standard variety Optima F1 (177.5g).

In 2008 the analyzed hybrids were compared with two standards, where the significant difference for this trait has shown the variety CLX 37147 F1 (198.7g). The hybrid CLX 37304 F1 showed the highest values for fruit weight 232,2 g and hybrid Staccato F1 had the lowest values of all other hybrids by weight of fruit (87, 2g) which were analyzed in 2009. The hybrid Abelus F1, had lower values for all tested properties Compared with the standard variant. The period of 2005-2008 analyzes were done with the tomato hybrids in greenhouses (Table 4). Length of the vegetation in 2005 ranged from 122 days (MonikaF1ø) and 124 days Amati F1ø. Longer vegetation in relation to the standards shown hybrids PX010215F1 PS150825 F1 (128 days). In 2006 the highest vegetation showed the standard variety (131 days). The others values were as follows: Tundra F1 138 days in 2007, Roxana F1, Trofeo F1 and Bonito n F1 138days in 2008. According to the results given in tab.5 and 6 best parameters for the analyzed traits showed hybrid Bonarda F1: with highest yield (171,98 t / ha) and weight of fruit (380g) analyzed in 2006.

Table 1. Stages of growth in open field production

Variety	Date of sowing	Date of suporting 50%	Date of transplanting	Date of flowering 20%	Date of first harvest	Vegetation from sprouting to first harvest
2005						
Arleta F1ø	09.04.05	17.04.05	18.05.05	5.06.05	22.07.05	96
Tamaris F1	-//-	-//-	-//-	2.06.05	22.07.05	103
NemoNetaF1	-//-	-//-	-//-	1.06.05	19.07.05	96
V 71	-//-	-//-	-//-	8.06.05	29.07.05	103
Agora	-//-	-//-	-//-	8.06.05	19.07.05	104
San Pier ø	-//-	-//-	-//-	8.06.05	22.07.05	103
Galina	-//-	-//-	-//	28.05.05	16.07.05	96
Valina	-//-	-//-	-//-	5.06.05	19.07.05	96
2006						
Magnus F1ø	12.04.06	22.04.06	25.05.06	01.06.06	24.07.06	91
Queen F1	-//-	22.04.06	-//-	02.06.06	-//-	91
Bonito	-//-	24.04.06	-//-	29.05.06	-//-	93
Lorena F1	-//-	23.04.06	-//-	03.06.06	-//-	94
T 8948 F1	-//-	22.04.06	-//-	05.06.06	-//-	91
Charisma F1	-//-	20.04.06	-//-	10.06.06	-//-	90
Torpeder F1	-//-	22.04.06	-//-	04.06.06	-//-	91
Erato F1ø	-//-	23.04.06	/	12.06.06	05.08.06	105
Bobcat F1	-//-	18.04.06	/	08.06.06	04.08.06	108
SLX3749 F1	-//-	24.04.06	/	07.06.06	28.07.06	96
2007						
Magnus F1ø	13.04.07	28.04.07	24.05.07	11.06.07	25.07.07	88
Queen F1	-//-	-//-	-//-	09.06.07	30.07.07	93
Optima F1ø	-//-	-//-	-//-	08.06.07	20.07.07	83
NemoNetaF1	-//-	-//-	-//-	09.06.07	02.08.07	96
2008						
Optima F1ø	05.04.08	13.04.08	14.05.08	30.05.08	12.07.08	92
CLX37147F1	-/-	-//-	-//-	28.05.08	20.07.08	100
Magnus F1ø	-/-	-//-	-//-	25.05.08	11.07.08	91
Astraion F1	-/-	-//-	-//-	28.05.08	12.07.08	92
CLX37286F1	-/-	-//-	-//-	25.05.08	13.07.08	93
CLX 3730	-/-	-//-	-//-	28.05.08	10.07.08	90
2009						
Optima F1ø	08.04.09	12.04.09	15.05.09	28.05.09	12.07.09	92
Staccato F1	22.04.09	01.05.09	28.05.09	10.06.09	27.07.09	94
Tourist F1	08.04.09	12.04.09	15.05.09	24.05.09	10.07.09	92
Logistica F1	-//-	12.04.09	-//-	21.05.09	13.07.09	92
PinkParadiseF1	-//-	-//-	-//-	22.05.09	02.07.09	92
CLX37304F1	-//-	-//-	-//-	22.05.09	02.07.09	92
2010						
Optima F1ø	26.04.10	10.05.10	11.06.10	21.06.10	15.08.10	93
Abelus F1	10.04.10	16.05.10	-//-	27.06.10	13.08.10	102

Table 2. Average yield t/ha in open field production

Variety	Average yield	+ – from ø*	CV%	LSD	
				0.05	0.01
2005					
Arleta F1ø	97.0	Ø	5.46	9.40	12.80
Tamaris F1	99.5	2.5	10.23		
NemoNetaF1	75.9	21.1	5.22		
V 71	120.2	23.2	4.50		
Agora	108.0	11.0	3.31		
San Pier ø	63.8	Ø	1.43		
Galina	74.7	10.9	0.94		
Valina	73.5	9.7	19.02		
2006					
Magnus F1ø	86.9	Ø	5.93	6.99	9.70
Queen F1	68.3	18.6	7.25		
Bonito	84.4	2.5	1.08		
Lorena F1	115.2	28.3	1.74		
T 8948 F1	109.2	22.3	6.63		
Charisma F1	100.4	13.5	3.99		
Torpeder F1	90.3	3.4	4.40		
Erato F1ø	45.9	Ø	1.96	4.66	7.73
Bobcat F1	57.2	11.3	5.52		
SLX 3749 F1	61.5	15.6	1.47		
2007					
Magnus F1ø	50.0	Ø	13.8	7.5	11.3
Queen F1	49.9	0.1	3.2		
Optima F1ø	66.3	Ø	6.3		
Nemo Neta F1	71.6	5.3	2.3		
2008					
Optima F1ø	65.5	Ø	4.45	5.00	7.11
CLX 37147 F1	46.6	18.9	10.76		
Magnus F1ø	54.8	Ø	3.40		
Astraion F1	73.7	18.9	4.03		
CLX 37286 F1	66.5	11.7	3.25		
CLX 37305 F1	73.4	18.8	1.32		
2009					
Optima F1ø	55.4	Ø	2.53	10,15	14.43
Staccato F1	56.4	1.0	0.94		
Tourist F1	63.6	8.2	9.31		
Logistica F1	57.9	2.5	3.82		
Pink ParadiseF1	56.3	0.9	8.01		
CLX 37304 F1	57.4	2.0	17.21		
2010					
Optima F1ø	42.5	Ø	7.1	3.52	8,11
Abelus F1	44.6	2.1	5.2		

Table 3. Characteristics of the fruit in open field production

Variety	Mass in (g)	Index of fruit	Thickness of pericarp(mm)	Number of loculess	Content of dry matters%	Green zone 0-no 1-yes	Taste	Juicy (1-3)
	2005							
Arleta F1ø	198	0.7	6.8	5.3	3.7	1	acidic	1
Tamaris F1	144	0.8	8.8	3.1	3.5	0	sweet	-//-
NemoNetaF1	106	0.8	7.9	2.8	3.7	0	sweet	-//-
V 71	180	0.7	8.2	4.0	3.4	0	sweet	-//-
Agora	167	0.8	6.8	4.1	3.3	0	acidic	-//-
San Pier ø	132	0.8	6.0	4.3	3.0	1	sweet	-//-
Galina	144	0.8	6.8	5.0	3.2	0	acidic	-//-
Valina	165	0.8	7.9	4.5	3.6	0	acidic	-//-
	2006							
Magnus F1ø	125	1.01	6.7	3.6	3.6	0	Sweet	1
Queen F1	114	0.89	6.3	4.2	3.7	0	-//-	-//-
Bonito	100	0.86	6.6	3.0	4.0	0	-//-	-//-
Lorena F1	102	0.84	6.7	2.8	4.0	1	-//-	-//-
T 8948 F1	101	0.93	6.8	3.2	3.9	0	-//-	-//-
Charisma F1	115	0.86	6.5	4.2	6.3	0	-//-	-//-
Torpeder F1	85	0.90	6.9	2.2	4.5	0	acidic	-//-
Erato F1ø	189	0.87	6.2	4.5	4.3	0	sweet	-//-
Bobcat F1	188	0.86	6.3	4.1	3.2	0	-//-	-//-
SLX3749 F1	170	0.89	6.2	4.3	4.2	0	-//-	-//-
	2007							
Magnus F1ø	99,7	0.88	3.91	3.9	3.6	0	sweet	1
Queen F1	144,2	0.82	5.70	5.5	4.1	1	sweet	-//-
Optima F1ø	177,5	0.79	5.92	5.9	4.0	1	very	-//-
NemoNetaF1	134,2	0.83	6.45	3.2	3.9	0	sweet	-//-
	2008							
Optima F1ø	196.0	0.78	6.7	5.0	3.8	1	sweet	1
CLX37147F1	198.7	0.79	6.9	5.3	3.5	0	-//-	2
Magnus F1ø	146.5	0.83	7.4	3.6	4.6	1	-//-	2
Astraion F1	148.0	0.78	7.5	4.4	4.4	1	-//-	1
CLX37286F1	148.5	0.79	8.5	4.2	3.8	0	-//-	2
CLX37305F1	126.7	0.78	6.8	4.4	4.1	0	acidic	2
	2009							
Optima F1ø	124.3	1.18	5.2	5.5	3.7	0	sweet	/
Staccato F1	87.2	0.80	4.4	3.4	3.7	0	sweet	/
Tourist F1	84.8	0.86	5.5	3.9	3.4	0	acidic	/
Logistica F1	118.0	1.39	7.0	5.0	4.0	0	acidic	/
PinkParadiseF1	144.8	1.31	5.3	7.0	4.0	0	sweet	/
CLX37304F1	232.2	1.31	7.3	6.2	3.3	0	sweet	/
	2010							
Optima F1ø	207	0.98	5.2	4.5	4.28	0	Sweet	2
Abelus F1	121	0.17	5.1	3.6	4.18	0	sweet	2

Table 4. Stages of growth in protected houses

Variety	Date of sowing	Date of sprouting 50%	Date of transplanting	Date of flowering 20%	Date of first harvest	Vegetation from sprouting to first harvest
2005 Sveti Nikole						
Amati ø	04.12.04	12.12.04	24.01.05	18.02.	15.04.05	124
MonikaF1ø	-//-	14.12.04	-//-	15.02	15.04.05	122
Buran F1	-//-	12.12.04	-//-	18.02	15.04.05	124
Newton F1	-//-	12.12.04	-//-	20.02	18.04.05	127
Ombelline	-//-	12.12.04	-//-	17.02	15.04.05	124
PX010215F1	-//-	11.12.04	-//-	20.02	15.02.05	125
PS150825 F1	-//-	11.12.04	-//-	20.02	18.04.05	128
Iker F1	-//-	11.12.04	-//-	20.02	18.04.05	128
Merkurio F1	-//-	10.12.04	-//-	20.02	15.04.05	126
2006 Gradsko						
Amati F1 ø	21.12.05	29.12.05	05.02.06	18.02.	08.05.06	131
Rosaliya F1	-//-	29.12.05	-//-	18.02.	07.05.06	130
PS6262F1	-//-	30.12.05	-//-	20.02.	08.05.06	130
Bonarda F1	-//-	31.12.05	-//-	20.02.	09.05.06	130
BS015037003F1	-//-	30.12.05	-//-	18.02.	04.05.06	125
Ballet F1	-//-	30.12.05	-//-	15.02.	04.05.06	125
SiluetF1	-//-	30.12.05	-//-	16.02.	04.05.06.	125
Balca F1ø	-//-	29.12.05	-//-	15.02.	04.05.06	126
2007 Kumanovo						
Monika F1 ø	23.12.06	28.12.06	15.02.07	05.03	10.05.07	134
Teory F1	-//-	-//-	-//-	08.03	10.06.07	131
Sprinter F1	-//-	-//-	-//-	06.03	07.05.07	134
Menhir F1	-//-	-//-	-//-	06.03	10.05.07	134
Tundra F1	-//-	-//-	-//-	08.03	10.05.07	138
Mondial F1	-//-	30.12.06	-//-	07.03	10.05.07	134
Trogir F1	-//-	-//-	-//-	07.03	11.05.07	135
2008 Valandovo- oranzerii Anska Reka						
Моника ø	03.12.07	08.12.07	25.01.08	23.02.	21.04.08	135
Lady Rosa F1	-//-	-//-	25.01.08	23.02.	18.04.08	132
Fantom F1	-//-	-//-	25.01.08	23.02.	15.04.08	129
Roxana F1	-//-	-//-	25.01.08	23.02.	21.04.08	135
Thalassa F1	-//-	-//-	25.01.08	23.02.	18.04.08	132
Trofeo F1	-//-	-//-	25.01.08	23.02.	21.04.08	135
Alfred F1	-//-	-//-	25.01.08	23.02.	15.04.08	129
Profilo F1	-//-	-//-	26.01.08	27.02.	18.04.08	132
Bonito N F1	-//-	-//-	25.01.08	23.02.	16.04.08	131
					21.04.08	135

Table 5.Average yield t/ha in protected houses

Variety	Average yield	+ and – from ø*		CV%	LSD	
					0.05	0.01
2005 Sveti Nikole						
Amati ø	92,9	Ø		2,12	4,10	5,52
MonikaF1ø	83,1	-	Ø	1,87		
Buran F1	136,2	43,3	53,1	1,76		
Newton F1	140,3	47,4	57,2	2,22		
Ombelline	110,2	17,3	27,1	3,07		
PX010215F1	110,0	17,1	26,9	1,83		
PS150825 F1	118,3	25,4	35,2	3,21		
Iker F1	150,7	57,8	67,6	3,83		
Merkurio F1	127,9	35,0	44,8	2,99		
2006 Gradsko						
Amati F1 ø	93,06	Ø		1,83	2,78	3,83
Rosaliya F1	149,3	56,24		0,92		
PS6262F1	131,64	38,58		2,14		
Bonarda F1	171,98	78,92		0,90		
BS015037003F1	143,08	50,02		2,20		
Ballet F1	109,04	6,14		0,59	5,34	7,77
SiluetF1	159,12	56,22		3,20		
Balca F1ø	102,9	Ø		2,76		
2007 Kumanovo						
Monika F1 ø	93.0	Ø		7.22	14.14	19.37
Teory F1	105.0	12.0		6.07		
Sprinter F1	104.9	11.9		7.74		
Menhir F1	106.4	13.6		14.53		
Tundra F1	119.1	26.1		9.95		
Mondial F1	120.4	27.4		4.14		
Trogir F1	120.3	27.3		6.88		
2008 Valandovo- greenhouses Anska Reka						
Моника ø	131.9	Ø		1.84	5.64	7.62
Lady Rosa F1	126.5	-5.4		3.54		
Fantom F1	146.8	14.9		3.41		
Roxana F1	146.2	14.3		3.10		
Thalassa F1	135.9	4.0		2.57		
Trofeo F1	143.7	11.8		2.50		
Alfred F1	141.8	9.9		2.26		
Profilo F1	149.7	17.8		3.73		
Bonito N F1	145.3	13.4		3.45		
	128.4	-3.6		2.89		

Table 6. Characteristics of the fruit in protected houses

Variety	Mass in (g)	Index of fruit	Thickness of pericarp (mm)	Number ofloculess	Content of drymatters %	Green zone 0-no 1-yes	Taste	Juicy of fruit (1-3)
2005 Sveti Nikole								
Amati ø	150	0,8	8	5	4,58	0	sweet	1
MonikaF1ø	120	0,8	8	5	4,46	-//-	acidic	-//-
Buran F1	200	0,7	7	5	4,82	-//-	sweet	-//-
Newton F1	180	0,6	9	5	4,09	-//-	-//-	-//-
Ombelline	150	0,7	8	5	5,35	-//-	-//-	-//-
PX010215F1	180	0,7	8	5	4,45	-//-	-//-	-//-
PS150825 F1	170	0,6	7	5	4,88	-//-	-//-	3
Iker F1	180	0,6	7	5	4,24	-//-	-//-	1
Merkurio F1	150	0,7	7	5	4,00	-//-	-//-	3
2006 Gradsko								
Amati F1 ø	200	-	0,8	2/3	-	0	sweet	1
Rosaliya F1	270	-	0,6	3/4	-	-//-	-//-	-//-
PS6262F1	300	-	0,7	3/4	-	-//-	-//-	-//-
Bonarda F1	380	-	0,8	4/5	-	-//-	-//-	-//-
BS015037003F1	280	-	0,8	4/5	-	-//-	-//-	-//-
Ballet F1	200	-	0,7	3/5	-	-//-	-//-	-//-
Silue tF1	300	-	0,7	4/5	-	-//-	-//-	-//-
Balca F1ø	180	-	0,6	4/5	-	-//-	-//-	-//-
2007 Kumanovo								
Monika F1 ø	160	0,8	5	-	-	0	Sweet	1
Teory F1	130	0,8	5	-	-	-//-	-//-	-//-
Sprinter F1	260	0,7	6	-	-	-//-	-//-	-//-
Menhir F1	170	0,8	6	-	-	-//-	-//-	-//-
Tundra F1	180	0,7	6	-	-	-//-	-//-	-//-
Mondial F1	160	1,00	7	-	-	-//-	-//-	-//-
Trogir F1	180	1,06	7	-	-	-//-	-//-	-//-
2008 Valandovo- green houses Anska Reka								
Моника ø	120	0,72	4	4	-	0	sweet	1
Lady Rosa F1	110	0,75	5	3	-	0	-//-	-//-
Fantom F1	270	0,67	4	7	-	1	-//-	-//-
Roxana F1	130	0,75	4	7	-	0	-//-	-//-
Thalassa F1	120	0,70	3	5	-	-//-	-//-	-//-
Trofeo F1	130	0,75	4	3	-	-//-	-//-	-//-
Alfred F1	165	0,80	5	5	-	-//-	-//-	-//-
Profilo F1	170	0,75	6	4	-	-//-	-//-	-//-
Bonito N F1	150	0,60	5	5	-	-//-	-//-	-//-
	90	0,70	5	6	-	-//-	-//-	-//-

"-"data not registered

Conclusions

It can be concluded that the newly tomato hybrids showed stable agronomic traits and good average yields and were introduced into commercial production. All of the investigated varieties showed the better results than standard varieties with who were comparised. Best values in relation to the examined properties in hybrids grown in the open field showed hybrid V71, while from the hybrids grown in the greenhouses will single out the hybrid Bonarda F1.

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ПРИНОС И КОМПОНЕНТИ НА ПРИНОС КАЈ ПОНОВИ ХИБРИДИ ОД ДОМАТ ВО РЕПУБЛИКА МАКЕДОНИЈА

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Апстракт

Доматот (*Lycopersicum esculentum mill)* е една од најважните зеленчукови култури во Република Македонија. Нашата Национална сортна листа изобилува со голем број на регистрирани домашни сорти и интродуирани хибриди.Пред да се воведат во комерцијалното производство, сите интродуирани хибриди и новосоздадени сорти се испитуваат со цел да се утврди приносот и компонентите на принос. Во овој труд се обработени вкупно 54 сорти/хибриди на домат испитувани во периодот од 2005 до 2010 година, од кои 26 од нив се одгледувани на отворено, а 28 во заштитен простор со пропишана стандардна технологија. Испитуваните сорти и хибриди се споредувани со стандард според пропишани правила и постапки, одредени од Националната сортна комисија. Во испитуваниот период сортите /хибридите домат одгледувани на отворено, се споредувани со стандардите: Arleta F_1, San Pier, Magnus F_1, Erato F_1, и Optima F_1, додека хибридите одгледувани во заштитен простор се споредени со следниве стандарди: Amati F_1, Monika F_1 и Balca F_1. Сите сорти и хибриди кои покажаа подобри резултати од стандардите во однос на испитуваните параметри се препорачаа за воведување во комерцијално производство.

Клучни зборови: домат, хибриди, принос.

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Original scientific paper

YIELD POTENTIAL OF SOME INTORDUCED CABBAGE HYBRIDS FOR SPRING PRODUCTION

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Abstract
The main objective of this research is description of the production capacities and adaptive values of some introduced cabbage hybrids: Parel, Kevin, Mirror, Nozomi, Pandion and Jetma RZ. To obtain this objective the biological, morphological and market characteristics of these cabbage hybrids have been evaluated trough comparative trials. The obtained results will be used as solid basis for their further implementation in the production schemes and more stable production in the region of Strumica. According to the two-year results and the statistical analyses it can be concluded that the hybrids Nozomi and Pandion mature the earliest 65 days, i.e. 9 days before the standard hybrid. From the two-years results it can be concluded that Nozomi hybrid had the highest yield, close to 70 t/ha as opposed to Jetma RZ which had the lowest yield.
Key words: cabbage, hybrids, vegetables, morphological traits, yield.

Introduction

Cabbage is an important vegetable which is vastly produced during the whole year in the Republic of Macedonia. According to data from the State Statistical Office (2012) cabbage is grown on 4630 ha with total production of 142670 t and average yield of 30 t/ha. The significance of this crop comes from the fact that in our country there are 72 recognized species, out of which 52 are foreign, 20 local (Bogevska Z et al., 2010). Keeping in mind the daily use of cabbage in nutrition and its high nutritional value, there is a need for permanent study of cabbage varieties. These studies will determine the assortments which will give the best results of production in certain conditions in order to get economically feasible cultivation. So the main objective of this research was to describe the production capacities and adaptive values of some introduced cabbage hybrids.

Material and methods

In order to achieve the goal of this research, during the two years (2009 and 2010), the following six hybrids of spring cabbage were examined: *parel*, *kevin*, *mirror*, *nozomi*, *pandion* and *jetma rz*. *parel* F_1 is the most abundant in the production, and therefore in this study it is used as a control variant. The hybrids were examined in the region of Strumica where there are favorable conditions for their cultivation. The experiment was set by a method of randomized blocks in six replications. The experimental plot was 125 m^2, by using standard technology. During the research stages of growth, the mass of the head and the total yield were observed. The results were statistically processed with an analysis of variance and verified with t-test.

Results and discussion

Sprouting is a stage of development which is characterized by the emergence of cotyledons. For a successful sprouting, it requires healthy seeds and enough heat and moisture. According to Pavlek P. (1978), the minimum temperature for the sprouting of cabbage seed ranges from 1 to 5˚C, the optimum is about 20°C and the maximum is 38˚C. Accordingly, the results (Table 1) in the first year's examined hybrids sprouted for 4 or 7 days, depending on the hybrid. *Pandion*, *mirror*, *jetma rz* and the standard *parel* sprouted for 4 days. Hybrid *kevin* sprouted one day later, while hybrid *nozomi* sprouted for 2 or 3 days later than the other hybrids. In the second year all hybrids sprouted for 5 days, except hybrid *nozomi* which sprouted two days later. Later sprouting for 2 days in all hybrids does not represent a significant difference and is mainly dependant on environmental conditions. In the two years of research, it should be mentioned that the hybrid *nozomi* sprouted later than the other hybrids. This is mainly due to the structure of the seed and the energy of germination, which is linked with the variety specificity (Cerne M., 1998).

Table 1. Length of vegetation period (days)

Hybrid	Days from sowing to sprouting		Days of vegetation (from transplanting to technological maturity)		Days of vegetation (from transplanting to technological maturity)
	Year		Year		
	2009	2010	2009	2010	Average
parel ø	4	5	73	74	73
kevin	5	5	76	76	76
mirror	4	5	76	76	76
nozomi	7	7	64	65	64
pandion	4	5	64	65	64
jetma	4	5	78	79	79

According to the data in Table 1, it can be concluded that depending on the type, vegetation period lasts differently, varying from interval 64 -78 days in the first, and 65-79 days in the second year. In the first year of the examination, the hybrids *nozomi* and *pandion* have the shortest vegetation period with 64 days, which is about 9 days shorter in comparison to the standard 73 days. The standard, *kevin* and *mirror* have the same vegetation period of 76 days. The *jetma rz* has the longest vegetation period (78 days). In the second year of research, the length of the vegetation period ranges between 65 - 79 days. *Nozomi* and *pandion* hybrids showed to have the shortest vegetation period, 65 days, 9 days earlier than the standard (74 days). The hybrid *jetma rz* (79 days) had the longest vegetation period. According to the average number of days of the vegetation period, it can be concluded that the hybrids *nozomi* and *pandion* are earlier and reach their technological maturity within 65 days. Compared with the standard variety, they have 9 days shorter vegetation period. It can be considered that the hybrid *jetma rz* was the latest and spends 79 days vegetation period, i.e. 4-5 days longer than the standard. *parel* in the both years had the same vegetation period, 73 to 74 days. It should be noted that the tested hybrids are able to stay in the field for a long time depending on external conditions. The economic value of the grown plants is characterized by their productivity, i.e. the realized yield. Cabbage is grown for its head, which is an indicator of its productive-commercial properties, determined by the mass of the head and other quantitative

characteristics, yield per unit area - hectare. The mass of the head is a varietal characteristic, but largely dependent on climate, soil and applied technology. The results obtained in terms of the average mass of a head are given in table 2.

Table 2. Average mass of the head (g)

Hybrids	$\bar{x}$	$S_{\bar{x}}$	Σ	VK	VS
parel ø					
2009	2185,82	60,72	470,31	0,22	1900,00
2010	2093,67	79,67	436,35	0,21	1600,00
Average	2139,74	70,19	453,33	0,21	1750,00
kevin					
2009	2161,50	60,80	470,96	0,22	1700,00
2010	2067,67	67,08	367,41	0,18	1500,00
Average	2114,58	63,94	419,18	0,20	1600,00
mirror					
2009	2133,83	54,72	423,83	0,20	1700,00
2010	2124,33	75,27	412,30	0,19	1500,00
Average	2129,08	65,00	418,06	0,20	1600,00
nozomi					
2009	2330,93	54,91	425,31	0,18	1850,00
2010	2300,33	60,25	330,02	0,14	1300,00
Average	2315,63	57,58	377,66	0,16	1575,00
pandion					
2009	2251,83	61,81	478,75	0,21	2100,00
2010	2074,67	84,48	462,74	0,22	1800,00
Average	2163,25	73,15	470,74	0,22	1950,00
jetma rz					
2009	1881,50	68,71	532,24	0,28	2000,00
2010	1802,80	79,83	437,26	0,24	1600,00
Average	1842,15	74,27	484,75	0,26	1800,00

By t-test at 0,05 probability, it was determined statistically that there are significant differences between *kevin* and *nozomi*, *kevi*n and *jetma rz*, while hybrid *jetma rz* has significantly less mass of the head than other hybrids, except *parel*, *mirror*, *nozomi* and *pandion* (Table 3).

Table 3. Difference between average values of the mass of the head (g)

Hybrids	*parel*	*kevin*	*mirror*	*nozomi*	*pandion*	*jetma*
parel	0,00	25,16	10,66	-175,89	-23,51	297,59
kevin		0,00	-14,50	-201,05	-48,67	272,43
mirror			0,00	-186,55	-34,17	286,93
nozomi				0,00	152,38	473,48
pandion					0,00	321,10
jetma						0,00

The economic value of the product obtained - spring cabbage, except of head mass is determined with total realized yield per unit area, or hectare. The values of the average yield per unit area (kg / hectare) of examined hybrids are given in the following table:

Table 4. Yield per unit area (kg/ha)

Hybrid	2009	2010	Average
parel ø	65574,50	62810,00	64192,25
kevin	64845,00	62030,00	63437,50
mirror	64015,00	63730,00	63872,50
nozomi	69928,00	69010,00	69469,00
pandion	67555,00	62240,00	64897,50
jetma	56445,00	54084,00	55264,50

In the first year of the examination, the highest yield was achieved by hybrid *nozomi* 69928.00 kg/ha, and right behind it is the hybrid *pandion* with 76555.00 kg/ha. The standard *parel*, in the first year of examination, achieved an average yield of 65574,50 kg/ha. From the average results of two years, it can be concluded that the highest yield was reached by the hybrid *nozomi* with a yield of 69928 kg/ha, while the hybrid *jetma rz* had a lower yield than the standard for about 10000 kg/ha.

Table 5. Difference between average values of yield in comparison to *parel* (t)

Hybrids	*parel*	*kevin*	*mirror*	*nozomi*	*pandion*	*jetma*
parel	0,00	0,73	-1,56	-4,35	-1,98	9,13
kevin		0,00	-0,83	-5,08	-2,71	8,40
mirror			0,00	-5,91	-3,54	7,57
nozomi				0,00	2,37	13,48
pandion					0,00	11,11
jetma						0,00

By t-test at 0,05 probability, statistically significant differences were determined between *kevin* and *nozomi* and *kevin* and *jetma rz*. The hybrid *jetma rz* has a significantly lower yield than other hybrids.

Conclusions

According to the research conducted on 6 hybrids of cabbage in two years, it can be concluded that:

- The hybrids *nozomi* and *pandion* are earlier and reach technological maturity within 65 days. In comparison to standard variety, they have 9 days shorter vegetation.
- In terms of head weight, there are statistically significant differences between Kevin and *nozomi*, *kevin* and *jetma rz*, while hybrid *jetma rz* has significantly less mass of head than other hybrids.
- The hybrid *nozomi* gave the most yield with 69928 kg/ha, while the hybrid *jetma rz* had a lower yield than the standard for about 10000 kg/ha.

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ПРОИЗВОДЕН ПОТЕНЦИЈАЛ НА НЕКОИ ИНТРОДУИРАНИ ХИБРИДИ ОД ЗЕЛКА ЗА ПРОЛЕТНО ПРОИЗВОДСТВО

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Апстракт
Целта на ова истржување е да се проучат вредностите и потенцијалите на неколку интродуирани хибриди пролетна зелка: Parel, Kevin, Mirror, Nozomi, Pandion и Jetma RZ, преку компаративно проучување на нивните биолошки, морфолошки и стопански својства. Добиените резултати од овие истржувања ќе послужат за одредување и препорака на овие хибриди кои ќе гарантират посигурно производство во регионот на Струмица. Според изведените двогодишни истражувања на шесте хибриди зелка и обработените резултати може да се заклучи дека хибридите Nozomi и Pandion се најрани и стасуваат до технолошка зрелост за 65 дена. Споредено со стандардот, тие имаат за 9 дена покус период на вегетација. Од просечните испитувања за двете години заклучено дека највисок принос има хибридот Nozomi со принос од блиску 70 t/ha, додека хибридот, Jetma RZ има најнизок принос.
Клучни зборови: зелка, хибриди, градинарство, морфолошки особини, принос.

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Review Article

THE USAGE OF SOME DECORATIVE REPRESENTATIVES OF PICEA MILL GENUS IN THE LANDSCAPE DESIGN IN SKOPJE (REPUBLIC OF MACEDONIA)

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Abstract
With the development of the landscape design in our region, the interest for decorative species has increased. The usage of already present ones became bigger and in the same time there were introduced numbers of new species, varieties and cultivars. So, there can be found many representatives of the Picea Mill genus which considering their physiological, ecological and specific morphological characteristics, form, texture and color, take their places on our green areas. The aim of this research is to point out the representatives of the Picea Mill genus that can be found in our region and also to determine their usage when designing the open green spaces. There are recommendations for the usage of some of them as elements or part of the elements of the landscape design. It was used the visual method for the research, which consider founding out and determination of the representatives of the Picea Mill genus in the green areas, garden centers and nurseries as well. So it was found out that the most present taxons of the Picea Mill genus are: *Picea abies, Picea abies 'Inversa Pendula', Picea abies 'Nidiformis', Picea glauca 'Conica', Picea omorica, Picea pungens, Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'*. Their frequent and complex usage in the design of the green areas, as focal points, solitary trees, in groups or as parts of stone gardens is due to the specific morphological characteristics as well their shape and height.
Key words: Picea, landscape design, decorative species, varieties, cultivars, morphological characteristics, form, texture, color, green areas.

Introduction

There are about fifty species that belong to Pinaceae family in the Picea genus and they are spread out in the cold regions of the north hemisphere. Their resistance on low temperatures, which can even go to minus 40°C, is surely one of the many other reasons for their presence in the green areas in Skopje. Recently, there have been more varieties and cultivars there with different specific morphological characteristics, considering the color of their leaves (needles) and the form of their habitus, making them interesting and attractive when designing parks and other types of green areas. Some representatives of this genus already exist in the open green spaces in Skopje such as: *Picea abies*, *Picea omorica*, *Picea pungens* and *Picea pungens 'Glauca'*. Recently, with the development of landscape design, new interesting species have been introduced, among which are some representatives of this genus with specific morphological characteristics. They can be found on various types of green areas: public parks, boulevards, squares, private gardens, etc. as specimen

plants, in plant grouping, as focal points and in alpineums and rock gardens as well. The dwarf forms considering their small dimensions and slow growth can be found in pots and jardinières. The ones with bigger dimensions are usually situated in the green areas.

In the garden centers in Skopje, there are mostly species from the countries that are successfully dealing with the problematic of nursing and export of decorative species such as Italy, Holland and in recent time Greece and Serbia. So in the designing of the green areas here (Skopje), beside the taxons that are already used and were produced in our nurseries, other representatives from Picea genus are also present, among which are: *Picea abies 'Inversa Pendula', Picea abies 'Nidiformis', Picea glauca 'Conica', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'*.

The present taxons in our plant-market are usually imported. Many of them are container-grown plants and there are some root balled (which are very rare) often intended as Christmas trees. They are: *Picea abies*, *Picea pungens* and *Picea pungens 'Glauca'*. The price is relatively expensive, but considering their ecological characteristics and the decorative value they have, the representatives of Picea genus are highly valued; the interest for them is big and nowadays they can often be present on smaller or bigger green areas.

Material and methods

This research is dealing with some decorative representatives of Picea Mill genus which are mostly used in the landscape design of the green areas in Skopje. The research was made in Skopje, in the green areas that are available for public use and in the bigger garden centers such as „Eko-Rast", „Foja-Ko", „Horti Ekspert" and „Green Planet" (the ones that import plant materials from abroad and from domestic producers and have big assortment of plants). The garden centers were interesting for this research because of the specific way of dealing with the plants, which means closer contact with them considering the fact that private gardens were not always available. But with special agreement from the owners, some of them were visited and researched, such as residential complex "St. Jovan", few private gardens and some balcony gardens too.

The research was made in spring and autumn, or more precisely in the period from April to June and October-November 2011 and 2012. This period was chosen because it is planting season and therefore the choice for plants in the garden centers is the biggest. The basic information for the imported species, varieties and cultivars of Picea genus are from declarations on the imported plant material, but for more details there had to be done cabinet work which would imply their determination. Further on, there had to be ascertained their morphological characteristics, resistance on low temperatures, their behavior in the places where they were located and the conditions needed for their successful growth, considering the specifics of the climate conditions in Skopje. The facts were presented in tables, from which further on concrete conclusions were made. This research determines the effects from their usage in the landscape design on the green areas, considering the specifics of the taxons as well as the type and the character of the green areas where they were planted. According to this, the relevant dates were presented with appropriate photos.

Results and discussion

The research of the decorative represents of the Picea Mill genus used in the landscape design in Skopje, shows that the most present taxons are: *Picea abies* (European spruce); *Picea abies 'Inversa Pendula'* (Weeping Norway spruce); *Picea abies 'Nidiformis'* (Birdsnest spruce); *Picea glauca 'Conica'* (Dwarf Alberta spruce); *Picea omorica* (Serbian spruce); *Picea pungens* (Blue spruce);

Picea pungens 'Glauca' (Colorado Blue spruce); *Picea pungens 'Glauca Globosa'* (Globe blue spruce) and *Picea pungens 'Hoopsii'* (Colorado spruce "Hoopsii").

Four of them, *Picea abies*, *Picea omorica*, *Picea pungens* and *Picea pungens 'Glauca'*, are already used in our green areas. The others are recently introduced, considering the development of the landscape designing nowadays, so these taxons are most present in the public green areas today. In the renewed ones and in certain new green areas, there are other registered representatives of Picea genus, but in relation with the previously mentioned ones, their number is very small. From the four taxons used in the green areas there, the presence of *Picea omorica* is the rarest. It can be found in some private gardens in the settlements Vodno, Centar, Taftalidze, which allows us to say that some of the species used many years ago are not part of the parks or other types of green areas today so we can say that they are not "in trend" nowadays. But some representatives of Picea genus are always actual and the interest for them, in spite many other varieties and cultivars on the market, is still big.

From ecological aspect, considering their growth, all researched taxons have equal or similar needs. They are sun-loving, but also shade tolerant in the same time, especially Picea *abies, Picea glauca 'Conica'* and *Picea pungens 'Glauca'*. They are resistant on low temperatures and can stand from - 30°C to - 40°C. They grow on wet to medium wet, but enough drained soils. Most of them grow well on locations with bigger moist in the air, *Picea abies, Picea abies 'Inversa Pendula', Picea abies 'Nidiformis', Picea glauca 'Conica', Picea omorica*, but the others *Picea pungens, Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'* are resistant on dry air and dry weather periods. *Picea omorica* is considerably resistant on polluted air opposite to *Picea abies* and its varieties and cultivars. *Picea pungens* can stand the urban climate more than the others; it can tolerate high temperatures and also dry and polluted air. The same characteristics have *Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'*, while *Picea glauca 'Conica'* cannot stand pollution, dryness and higher temperatures.The main task of this research, in spite of detection and determination of the representatives of Picea genus is to determine their role in the arranging of the green areas. It is confirmed that they can be found on various types of green areas (public and private): in the parks, boulevards, in front of the buildings, in private gardens, as parts of balcony gardens and in pots and jardinières too. Their usage on certain green areas, the functions they are fulfilling and the role they have in esthetic way (as element or part of the elements in the landscape design), depends on the dimensions they reach and the morphological characteristics of the taxons. In table 1 are given decorative representatives of Picea genus, their life forms and maximal growth as well. The life forms are determined according to the dendrology classification of the plants, trees and shrubs [16]. Maximal growth of the plants means maximal size dimensions that any of the taxons can reach both in height and width. It must be appointed that plants reach these dimensions in ideal conditions, or more specific, in their native regions. This relates to *Picea abies, Picea omorica, Picea pungens* and *Picea pungens 'Glauca'* and some of their varieties, which grow in different conditions in the urban area: altitude, humidity, air pollution, temperature amplitudes, etc. The optimal height of these plants is around 20 m.

Table 1. Life forms and maximal growth of the decorative representatives of Picea Mill genus

Ordinal number	Plant species	Life forms							Maximal growth	
		Trees				Shrubs				
		I size (very big, over 30 m)	II size big, from 20 to 30 m)	III size (from 10 to 20 m)	Low (from 5 to 10 m)	High (3–5 m)	Medium high (1,5–3 m)	Low (to 1,5 m)	Height	Width
1	*Picea abies*	√							30–50 m	4–5 m
2	*Picea abies 'Inversa Pendula'*			√					16–20 m	1–1,5 m
3	*Picea abies 'Nidiformis'*							√	0,5–0,7m	1,5 m
4	*Picea glauca 'Conica'*						√		3 m	1,0 m
5	*Picea omorica*	√							30–50 m	3 m
6	*Picea pungens*	√							30–50 m	5–6 m
7	*Picea pungens 'Glauca'*		√						26–30 m	5-6 m
8	*Picea pungens 'Glauca Globosa'*							√	1–1,5 m	1,5–2,0 m
9	*Picea pungens 'Hoopsii'*			√					10–16 m	3–5 m

Presented data in the table 1 shows that six taxons are trees, three of them *Picea abies*, *Picea omorica* and *Picea pungens* are in category of trees from I size that grow over 30 m high, one of them, *Picea pungens 'Glauca'* is in category of trees from II size that grow 20-30 m and *Picea abies 'Inversa Pendula'* and *Picea pungens 'Hoopsii'* are in category trees from III size that reach 10-20 m. height. Trees that grow 5-10 m in height are not registered here in this table. The rest three taxons are shrubs from which *Picea glauca 'Conica'* is on the list of medium-high shrubs that reach to 3 m and *Picea abies 'Nidiformis'* and *Picea pungens 'Glauca Globosa'* are in the category of small (short) shrubs that reach up to 1,5 m in height. The height as parameter is one of the main factors that define the presence of the taxons in the different types of the green areas. The big trees, although in urban conditions, can still reach up to 20 m of height and can be found in the bigger parks; those are the species such as *Picea abies 'Inversa Pendula'* and *Picea pungens 'Hoopsii'*. The ones with smaller dimensions are used in landscape design both in the bigger and smaller open green spaces (public and private). Shrubs are mainly in the private and smaller green areas. The basic morphological characteristics such as form, texture and color are factors that determine the usage of the plants in the landscape design. While their dimensions define their usage in the certain open green spaces, the morphological characteristics define their role, or more specific the usage of the concrete plant as element or as part of the composition in the landscape design.

In table 2 there are basic morphological characteristics (form, texture and color) of the registered decorative representatives of Picea genus.

Table 2. Basic morphological characteristics of the decorative representatives of Picea Mill

Ordinal number	Plant species	Basic morphological characteristics				
		Form	Texture			Color
			coarse	fine	Semi-fine	
1	*Picea abies*	Conical form	√			dark green
2	*Picea abies 'Inversa Pendula'*	Weeping (branches are directed downwards)			√	dark green
3	*Picea abies 'Nidiformis'*	Irregular round, dwarf form (top flat, compact)			√	Green
4	*Picea glauca 'Conica'*	Conical-pyramidal, compact		√		light green
5	*Picea omorica*	Conical form			√	dark green
6	*Picea pungens*	Pyramidal form	√			blue-green
7	*Picea pungens 'Glauca'*	Pyramidal form	√			silver-blue
8	*Picea pungens 'Glauca Globosa'*	Irregular round (more wide than high)	√			silver-blue
9	*Picea pungens 'Hoopsii'*	Pyramidal, compact	√			silver-blue

Data in table 2 show the morphological characteristics of the registered representatives of Picea genus. It is obvious that considering their form, high species such as *Picea abies* and *Picea omorica* have conical form, *Picea pungens, Picea pungens 'Glauca'* and *Picea pungens 'Hoopsii'* have pyramidal form and *Picea pungens 'Hoopsii'* has more compact habitus. *Picea abies 'Inversa Pendula'* has specific weeping form; it is slow-growing cultivar with branches directed downwards. Each of these cultivars of *Picea abies 'Inversa Pendula'* is unique and has high decorative value. *Picea glauca 'Conica'* has compact conical-pyramidal form and because of its small dimension it is called semi-dwarf. The smallest representatives from Picea genus, *Picea abies 'Nidiformis'* and *Picea pungens 'Glauca Globosa'* registered in the researched area have irregular round form. Related to the texture, only *Picea glauca 'Conica'* has fine texture, while *Picea abies 'Inversa Pendula', Picea abies 'Nidiformis'* and *Picea omorica* have semi-fine texture and the others, *Picea abies, Picea pungens, Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'* have coarse texture. Considering the color of the needles, the researched representatives from Picea genus have shades of green, blue-green and silver-green color. *Picea abies 'Nidiformis'* has green color of the needles, *Picea abies, Picea abies 'Inversa Pendula'* and *Picea omorica,* have dark-green needles and *Picea glauca 'Conica'* has light green color of the needles. *Picea pungens* has various shades of blue-green color. *Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'* have attractive silver-blue color of the needles.It is obvious that these representatives of Picea genus have various forms and colors with fine, semi-fine and coarse texture. There are high trees with green, blue-green and silver-blue color and small shrubs with irregular round forms with green and silver-blue color. In fact, the various forms and colors are the main reasons for the complex use of these taxons when designing various

categories green areas. In table 3 is shown the usage of the registered representatives of Picea genus as elements or as parts of elements in the landscape design of the green areas in Skopje.

Table 3. Representatives of Picea Mill genus as element or part of elements of landscape design

Ordinal number	Plant species	Usage in landscape design			
		Specimen plant	Plant grouping (tree groups)	Alpineum and rock garden	In pots and jardinières
1	*Picea abies*	√	√		
2	*Picea abies 'Inversa Pendula'*	√			
3	*Picea abies 'Nidiformis'*			√	√
4	*Picea glauca 'Conica'*			√	√
5	*Picea omorica*	√	√		
6	*Picea pungens*	√	√		
7	*Picea pungens 'Glauca'*	√	√		
8	*Picea pungens 'Glauca Globosa'*			√	√
9	*Picea pungens 'Hoopsii'*	√	√		

In the table 3 are shown tree representatives from Picea genus: *Picea abies, Picea abies 'Inversa Pendula', Picea omorica, Picea pungens, Picea pungens 'Glauca'* and *Picea pungens 'Hoopsii'* which are found as specimen plants. They are located in public green areas, bigger and smaller ones, in school yards, around churches, on boulevards, in the greenery of "Jane Sandanski" boulevard, Aerodrom settlement, in the green spaces in front of public objects, around blocks and in private gardens too. *Picea abies 'Inversa Pendula'* (Figure 1) can be found very rarely, often in very exclusive private gardens. *Picea pungens 'Hoopsii'* (Figure 2) is present in the private gardens and in front of some public buildings, in front of the Dentist office "Endomak" in Aerodrom settlement, in front of "Tobacco" on boulevard „ Krste Petkov Misirkov", near „University Library" etc.

Figure 1. *Picea abies 'Inversa Pendula'*

Figure 2. *Picea pungens 'Hoopsii'*

Figure 3. Tree group of *Picea pungens* and *Picea pungens 'Glauca'* – church „St. Arhangel and Michael" – Autocomanda

Figure 4. Tree group of *Picea pungens* and *Picea pungens 'Glauca'* – complex „St. Jovan" – Zlokukani

All mentioned species, except *Picea abies 'Inversa Pendula'*, form tree groups of three or more trees (plant grouping). The tree groups can be usually found on bigger green areas formed from *Picea abies, Picea pungens* and *Picea pungens 'Glauca'*, planted 2-5 m from each other. On figure 3 and 4 there is plant grouping from *Picea pungens* and *Picea pungens 'Glauca'*.

Picea abies 'Nidiformis', Picea glauca 'Conica' and *Picea pungens 'Glauca Globosa'* are very rare in the public green areas. These plants have smaller growth (shrubs) and are usually part of group, alpineum, rock garden or are simply planted in pots or jardinières. From the three of them the most present is *Picea glauca 'Conica'* that can be found in front of some public objects and small public green areas; for example, it is part of the greenery of the fountains in the beginning of Aerodrom municipality. *Picea glauca 'Conica'* and *Picea pungens 'Glauca Globosa'* are located in two balcony gardens in Karpos 2 settlement, near "Faculty of engineering "-Skopje and in boulevard „Oktomvriska revolucija" in the "Mi-Da Motors" complex.

Figure 5. *Picea glauca 'Conica'*- part of greenery in private garden –Centar municipality

Figure 6. *Picea glauca 'Conica'*- part of balcony garden in the "Mi-Da Motors" complex –Karpos 2 settlement

In the "Bonsai garden" which is part of the garden center "Horty Expert" there is a bonsai of *Picea pungens 'Glauca Globosa'* (Figure 7).

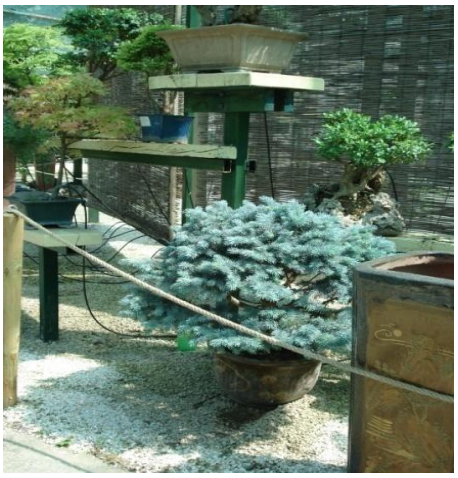

Figure 7. *Picea pungens 'Glauca Globosa'* bonsai

Figure 8. *Picea abies 'Nidiformis'*

Picea abies 'Nidiformis', Picea glauca 'Conica' and *Picea pungens 'Glauca Globosa'* are the most used in designing private gardens, usually as part of alpineums and rock gardens, for which they are most recommended.

Figure 9. *Picea pungens 'Glauca Globosa'* as part of alpineum – "Horty Expert"

All these representatives, whether they are used as different elements or as parts of elements in the landscape design are usually focal points in the areas they are located in. Some of them attract the attention with their color, for example the taxons with silver-blue color, *Picea pungens 'Glauca'*, *Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'* and others with their form, such as *Picea abies 'Inversa Pendula'* and *Picea pungens 'Hoopsii'*.

Conclusions

The research over the usage of some decorative representatives of the Picea Mill genus in the landscape design in Skopje brings out these conclusions:

- In the landscape design in Skopje the most present are these representatives from Picea genus: - *Picea abies* (European spruce), *Picea abies 'Inversa Pendula'* (Weeping Norway spruce), *Picea abies 'Nidiformis'* (Birdsnest spruce), *Picea glauca 'Conica'* (Dwarf Alberta spruce), *Picea omorica* (Serbian spruce), *Picea pungens* (Blue spruce), *Picea pungens 'Glauca'* (Colorado Blue spruce), *Picea pungens 'Glauca Globosa'* (Globe blue spruce) and *Picea pungens 'Hoopsii'* (Colorado spruce "Hoopsii").
- *Picea abies*, *Picea omorica*, *Picea pungens* and *Picea pungens 'Glauca'* are present in our green areas for many years and the other taxons are introduced later, with the development of the landscape design here (Skopje);
- The usage of the representatives of Picea genus on certain green spaces and the functions they are fulfilling or the role they have as element or part of elements in the landscape design, depends on the dimensions they reach and the basic morphological characteristics of the taxons themselves;
- Six of the registered taxons are trees, three of them *Picea abies*, *Picea omorica* and *Picea pungens* are in the category of trees over 30 m high, one, *Picea pungens 'Glauca'* in the category of trees 20-30 m high, and the rest two *Picea abies 'Inversa Pendula'* и *Picea pungens 'Hoopsii'* in the category of trees that reach 10-20 m high. The rest 3 taxons are shrubs from which *Picea glauca 'Conica'* belongs to the group of medium high shrubs that grow up to 3 m, while *Picea abies*

'Nidiformis' and *Picea pungens 'Glauca Globosa'* are in the category of small shrubs that reach 1,5 m in height;

- Considering the form, high growing species *Picea abies* and *Picea omorica* have conycal form, *Picea pungens*, *Picea pungens 'Glauca'* and *Picea pungens 'Hoopsii'* have pyramidal form and the last one (*Picea pungens 'Hoopsii'*) has even more compact habitus. *Picea abies 'Inversa Pendula'* has specific weeping form; *Picea glauca 'Conica',* compact conical-pyramidal form; and *Picea abies 'Nidiformis'* and *Picea pungens 'Glauca Globosa'* have irregular round form;
- Related to the texture, only *Picea glauca 'Conica'* has fine texture, *Picea abies 'Inversa Pendula', Picea abies 'Nidiformis'* and *Picea omorica* have semi-fine and *Picea abies, Picea pungens, Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'* have coarse texture;
- Green is the color of the needles of *Picea abies 'Nidiformis',* dark-green are the ones of *Picea abies, Picea abies 'Inversa Pendula'* and *Picea omorica,* and light green are the needles of *Picea glauca 'Conica'*. *Picea pungens* has various shades of blue-green color. The needles of *Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'* have attractive silver-blue color;
- The registered representatives of Picea genus in the landscape design in Skopje can be found in various categories of green areas, public and private, in balcony greening, as specimen plants, in tree groups (plant grouping), in alpineums, rock gardens and in pots and jardinières;
- *Picea abies, Picea abies 'Inversa Pendula', Picea omorica, Picea pungens, Picea pungens 'Glauca'* and *Picea pungens 'Hoopsii'*can be found as specimen plants. They are located on bigger and smaller green areas and in private gardens too;
- *Picea abies 'Inversa Pendula'* can be rarely found, usually in the exclusive private gardens, while *Picea pungens 'Hoopsii'* in the private gardens and in front of some public buildings;
- Groups of trees (plant grouping) are usually formed of *Picea abies, Picea pungens* and *Picea pungens 'Glauca'*, often in the public green areas;
- *Picea abies 'Nidiformis', Picea glauca 'Conica'* and *Picea pungens 'Glauca Globosa'* are very rare on the public green areas. They are often part of groups, alpineums, rock gardens, or are planted in pots and jardinières;
- All registered decorative representatives of Picea genus are very often used as focal points, mainly considering:
- The color of the needles of the taxons, the ones with attractive silver-blue color: *Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* and *Picea pungens 'Hoopsii'*
- and the form, exquisite example for that are *Picea abies 'Inversa Pendula'* and *Picea pungens 'Hoopsii'*.

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УПОТРЕБАТА НА НЕКОИ ДЕКОРАТИВНИ ПРЕТСТАВНИЦИ ОД РОДОТ PICEA MILL ВО ПЕЈЗАЖНОТО ДИЗАЈНИРАЊЕ ВО СКОПЈЕ (Р. МАКЕДОНИЈА)

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Апстракт

Со развојот на пејзажниот дизајн на нашите простори, интересот за декоративните растителни видови стана поголем. Употребата на веќе присутните е зголемена, а исто така внесени се и голем број нови видови, вариетети и култивари кои можат да успеат на нашето поднебје. Меѓу нив среќаваме поголем број претставници од родот Picea Mill кои благодарение на своите физиолошки, еколошки и специфични морфолошки карактеристик, форма, текстура, боја, завземаат сè почесто место на зелените површини кај нас. Целта на истражувањето е да се посочат претставниците од родот Picea Mill кои се среќаваат на нашите простори и притоа да се одреди нивната употреба во пејзажниот дизајн. Исто така дадени се препораки за употребата на поединечните таксони како поединечни елементи или дел од елементите во пејзажното дизајнирање. При истражувањето применет е визуелниот метод на пронаоѓање и детерминација на претставниците од родот Picea Mill на зелените површини, во поголемите градинарски центри и во расадниците. Со ова истражување констатирано е дека кај нас најчесто се среќаваат следниве претставници од родот Picea Mill: *Picea abies, Picea abies 'Inversa Pendula', Picea abies 'Nidiformis', Picea glauca 'Conica', Picea omorica, Picea pungens, Picea pungens 'Glauca', Picea pungens 'Glauca Globosa'* и *Picea pungens 'Hoopsii'*. Нивната честа и комплексна употреба во пејзажното дизајнирање на зелените површини како фокусни точки, солитери, дел од дрвни групи, алпинуми и слично, се должи на нивните специфични морфолошки карактеристики како и на различните форми и големини кои ги достигнуваат.

Клучни зборови: Picea, пејзажно дизајнирање, декоративни видови, вариетети, култивари, морфолошки карактеристики, форма, текстура, боја, зелени површини.

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Expert paper

CHARACTERIZATION OF BEEF TOMATO LANDRACES IN THE REPULBIC OF MACEDONIA

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Abstract
This research encompasses characterisation of domestic populations of tomato type known as "jabuchar". Fourteen domestic populations, that origin from several regions in Macedonia with various altitudes above sea level have been explored.Certain methodology of biological, morphological and reproductive characteristics of researched population has been used in order to meet the research aim. The results has shown differences in several parameters. According to the vegetation period (germination to aging) five populations have relatively short vegetation time of 103-105 days, unlike the other nine populations that have up to 115 days of vegetation period. When it comes to biological characteristics the fertilization percentage ranges from 46,8% at population No.2 up to 66.6% at population No.7. Significant differences amongst researched populations are registered at morphological characteristics, especially at the morphology of flower, form and size of the fruits, structure of the fruits, thickness of pericarp, crack appearance and green zone of the fruits and mass of the fruits which is 119gr at No.1 population up to 225 g at No.5 population. Also, there are significant variations at some morphological characteristics amongst populations and within them. The achieved results per plant and per hectare are considerably different amongst researched populations. Taking in mind the median, the yield of 7 populations is very small, and to other 7 the yield is higher by 24 or 27%. The final results obtained by more parameters, amongst researched domestic population of tomatoes, are divergent, which is of huge importance for selected activities.
Key words: tomato, morphological and biological characteristics, characterization, domestic populations.

Introduction

The tomato is one of the most widespread vegetable species in the world, as well as in our country. According to the FAO data, it is being grown in about 4 million hectares worldwide, and in R. Macedonia it is grown in the area of 9,000 - 10,000 ha. Tomato varieties are classified according to their biological and morphological characteristics, according to their purpose, way of growing, varieties that grow outdoors or in protected areas (indoors). In the period from 1994-1996, 112 autochthonous populations and local varieties of 11 species of garden plants have been sequenced and preliminary characterized. More recent research has been done within the frames of the Solanaceae international sequencing project in Southeastern Europe (SEED-net). The sequenced

samples have been documented with passport data. In addition, 27 local tomato populations have been characterized and stored in the Gene Bank at the Institute of Agriculture in Skopje.

Subject and Objective of the Research

Subject of the research is characterization of autochthonous populations of tomato type known as beef tomato ("*jabuchar*"). The objective of this research is studying the general biological and morphological characteristics, i.e. the occurrence and duration of particular stages of growth and development, duration of the vegetation period, percentage of fertilization, detailed description of several morphological traits. Furthermore, certain populations are to be selected from the obtained results in order to be used in selection processes for creating new genotypes in the overall production practice.

Material and methods

The experiment was placed in the location of Drachevo, where 14 autochthonous (local) populations of beef tomato ("*jabuchar*") were analyzed. The populations have been sequenced from different regions of Macedonia and stored in the Herbal Genes Bank at the Institute of Agriculture in Skopje. The sequenced populations belong to the group of indeterminate (high) varieties. The production took place outdoors with previous production of seedlings, planting them out at a distance of 80 cm between the rows and at 40 cm within the row, i.e. with proportional presence of 31,250 plants per hectare. During the vegetation, all necessary agrobiological and agrotechnical measures have been applied. Observations and registration of particular events - stages have been recorded at the research, in order to confirm the biological features of the plants, as well as biometrical measures and comparisons. For reaching the set objective, the biological, morphological and farming characteristics have been analyzed by defined methodology. Data has been analyzed and compared by accurately established methods. Regarding the biological characteristics, the following have been analyzed: days from sowing to germination, from germination to blooming, from blooming to the beginning of ripening, days from germination to the beginning of blooming (vegetation period), and percentage of fertilization.

Regarding the morphological characteristics, the following have been analyzed: leaf shape, number of leaves on the first (I) flower branch, number of flowers per plant, flower size, flower structure, fruit characteristics (size, shape, fruit surface, pericarp thickness, and number of chambers (locules) inside the fruit).

Regarding the production characteristics, the following have been analyzed: fruit number and mass per plant, yield per unit of area, coefficient of early ripening.

The characteristics have been processed according to international descriptors, and the obtained results have been processed by the variation and statistic method of Mudra. The yields have been processed by the Method of Analysis of Variance and by the LSD test on the level of 0.05 and 0.01.

Table 1. Survey of researched populations

No.	Sequenc. number (code)	Local Names	Place / Location	Height above sea level
1.	PA2-0-1	Paste Tomato	Vil. Rajkova Kukja - Kumanovo	353
2.	PA2-0-2	Beef Tomato ("*dashak*")	Vil. Drachevo - Skopje	246
3.	PA2-0-3	Pepper-shaped Tomato	Vil. Drachevo - Skopje	611
4.	PA2-0-4	Red Beef Tomato	Vil. Pagarusha - Skopje	246
5.	PA2-0-5	Red Beef Tomato	Vil. Vartekica - Skopje	544
6.	PA2-0-6	Tomato	Vil. Dolono Kolichani - Skopje	559
7.	PA2-0-7	Red Beef Tomato	Vil. Zubovo - Strumica	198
8.	PA2-0-8	Bull's Heart (flat)	Vil. Chucher - Skopje	480
9.	PA2-0-9	Beef Tomato	Vil. Chucher - Skopje	480
10.	PA2-0-10	Bull's Heart (oval)	Vil. Chucher - Skopje	480
11.	PA2-0-11	Pink Beef Tomato	Vil. Vasilevo - Strumica	235
12.	PA2-0-12	Yellow Pear Tomato	Vil. Miletino - Tetovo	382
13.	PA2-0-13	Large Tomato	Vil. Miletino - Tetovo	382
14.	PA2-0-14	Tomato	Vil. Zhelino - Tetovo	418

Results and discussion

Biological Characteristics

The dynamics of growth and development is a variety feature. However, the complex of external conditions (temperature, light, soil conditions), the production technique, way of growing, etc., have a direct influence on the occurrence of certain stages. By the length of vegetation period (days of germination up to beginning of fruit ripening) 5 populations have relatively short period of 103-105 days, while the other 9 populations, being characterized as late, have up to 115 days of vegetation period. Regarding the phenological occurrences, the most characteristic ones, according to the days from germination up to ripening, are the populations with selection code PA2-0-1 having 106 in the year 2007 and 103 in the year 2008 - with the fewest days, compared to the population with selection code PA2-0-12 having 120 in the year 2007 and 108 days in the year 2008. Regarding the vegetation period for both years, the population with code PA2-0-4 has a vegetation period of 103 days, unlike the population with code PA2-0-9 with 115 days. The fertilization percentage shows how many of the formed flowers of the plant have been pollinated and fertilized. It is predominantly a variety feature, but it also depends on the growing conditions and technique. The fertilization percentage ranges from 46.8% in the sequencing number PA2-0-2 or Beef Tomato ("*dashak*"), up to 66.6% in PA2-0-12 under the local name Yellow Pear Tomato. According to the obtained results, there is no connection (dependence) between the number of flowers and the number of fruits per plant. The average number of fruits is about 14.1 per plant. The coefficient of variation is the highest in the population 2 - PA2-0-2 under the local name Beef Tomato ("*dashak*"), and lowest in the population 3 - PA2-0-3 under the local name Pepper-shaped Tomato. Regarding the fruit mass, the population 5 - PA2-0-5 or Red Beef Tomato has the largest fruits of 255 g., while the population 1 - PA2-0-1 or Paste Tomato has the smallest fruits of 119 g. The researched populations can be observed in two groups:

a) Fruits with mass of up to 150 g (1, 3, 4, 9 and 11);

b) Fruits with mass above 150 g (2, 5, 6, 7, 8, 10, 12, 13 and 14)

The population with ordinal number 1 (CV 17.48) has the lowest level of variation. The highest variation of fruit mass can be noticed in the population with ordinal number 5 (CV 53.09). According to the obtained median values about the fruit shape, the researched autochthonous populations have a medium flat shape, with index from 0.76 to 0.90 (1, 4, 6, 8, 9, 10, 12, 13 and 14). Three of the researched populations (no. 2, 5 and 7) have fruits with distinguishing flat shape, while the population under ordinal number 3 has oblong fruits. The population with ordinal no. 12 (CV 6.57%) has the most stable shape. The population with ordinal no. 11 has the highest coefficient of variation (CV 23.88), with fruits of oval shape. In general, regarding the fruit shape, the researched populations have a low coefficient of variation which implies that it is a stable characteristic.Fruits from the population no. 6 have the thickest pericarp with median value of 6.1 mm. Fruits from the population no. 11 have the thinnest pericarp (3.2 mm). The coefficient of variation (CV) has an average range of 21.87. According to the obtained results, except for the populations no. 3, 10, 11 and 13, the other researched populations have relatively low variation in the thickness of the pericarp. Regarding the organoleptic features of the fruit, the fruit hardness is relatively small. The cracks have slight to medium appearance. The green zone appearing around the fruit stem is a frequent occurrence and is also a variety feature and genetically inherited characteristic. Catfacing-high level of fruit deformity. The populations 4, 5, 13 and 14 have occurrence of a slight level of deformity (3), while in the population number 1 the deformity is of medium appearance (5). The fruit colour is various - red, pink and rarely orange and white.

Production characteristics

Tomato yield depends mainly on the variety, morphological and biological characteristics, way of growing - outdoors or in protected areas. The total yield depends on several elements, such as: number of flower branches, number of flowers, number of fruits along the flower branch and the plant, fruit mass, and other contributing to yield formation. Based on our research, the obtained yields per plant and per hectare significantly differ among the researched populations.

Table 2. Yield *t/ha*

Population	2007	2008	Median Value	CV	+ - of Ø	
					t	%
1	42.0	33.9	37.9	34.9	-9.9	79.3
2	44.0	36.0	40.0	41.7	-7.8	83.7
3	42.6	38.4	40.5	20.1	-7.3	84.6
4	44.8	37.0	40.9	37.4	-6.9	85.4
5	44.0	38.4	41.2	30.5	-6.6	86.1
6	48.0	44.2	46.1	24.0	-1.7	96.3
7	55.1	51.0	53.0	38.6	5.2	110.7
8	52.8	49.1	50.9	30.4	3.1	106.5
9	47.5	41.6	44.5	31.5	-3.3	93.1
10	53.8	48.0	50.9	33.2	3.1	106.3
11	55.1	49.3	52.2	27.9	4.4	109.0
12	61.8	56.9	59.3	34.2	11.5	124.1
13	63.4	58.4	60.9	35.3	13.1	127.2
14	55.7	48.5	52.1	36.5	4.3	108.8
Median Value Ø	50.7	45.0	47.90	32.2		
Coefficient of Variation CV	13.88	17.20				
LSD 0.05	2.37					
0.01	3.30					

Conclusions

The vegetation period (days from germination to the beginning of ripening) is a result of the occurrence and duration of particular stages of tomato growth and development. According to the obtained results, the researched populations under the ordinal no. 1, 2, 4, 5 and 10 have a relatively short vegetation period from 103 to 105 days. The other populations have longer period of up to 115 days.

As an important biological characteristic, the highest fertilization percentage is observed in the populations no. 7 and no. 12 (66.6%). The number of formed flowers per plant (having 6 flower branches) ranges from 25 in the population no. 5 up to 43 flowers in the population no. 11. The population no. 5 has the fewest fruits with an average of 10, as well as the fewest formed flowers. The population no. 11 has the highest number of fruits (average of 18), as well as the most formed flowers. Fruit shape and mass are the parameters for usual determination of the variety, i.e. the population. According to the obtained results, 9 populations have medium flat shape; three of the researched populations have distinguishing flat shape, and the population no. 3 has oblong fruits.

During the two years of research, the highest yield of 60.9 t/ha has been realized from the population under no. 13.

From the total of the obtained research results, according to the majority of researched parameters, it can be concluded that among the researched autochthonous tomato populations there is a significant divergence in the majority of analyzed characteristics. This occurrence is especially important for certain research objectives-selection processes.

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КАРАКТЕРИЗАЦИЈА НА АВТОХТОНИ ПОПУЛАЦИИ ДОМАТ (LYCOPERSICON ESCULENTUM, MILL.) ОД ТИПОТ ЈАБУЧАР ВО РЕПУБЛИКА МАКЕДОНИЈА

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Апстракт

Со ова истражување е извршена карактеризација на автохтони популации домат од типот јабучар. Проучувани се 14 автохтони популации кои потекнуваат од повеќе реони во Македонија, со различни надморски височини. За да се постигне поставената цел, според одредена методологија, анализирани се биолошките, морфолошките и производните карактеристики на испитуваните популации. Според добиените резултати, утврдени се одредени разлики на повеќе параметри. Според должината на вегетацискиот период (денови на никнење до почеток на зреење на плодовите), 5 популации се одликуваат со релативно кус период од 103 до 105 денови, додека другите 9 популации се карактеризираат како подоцни и до 115 дена вегетациски период. Од биолошките својства е значајна појавата дека процентот на оплодување се движи од 46,8% кај Популацијата бр.2 до 66,6% кај Популацијата бр.7. Во однос на морфолошките карактеристики, значајно е дека се утврдени релативно големи разлики меѓу испитуваните популации според морфологијата на цветовите, формата и големината на плодовите, структурата на плодовите, дебелината на перикарпот, појавата на пукнатини и зелена зона на плодовите, масата на плодовите која според средните вредности се движи од 119 g кај Популацијата бр.1 до 225 g кај Популацијата со бр.5. Исто така, утврдени се релативно високи варирања на некои морфолошки својства меѓу популациите и внатре во нив. Постигнатите приноси на единица растение и на хектар, значително се разликуваат меѓу испитуваните популации. Во однос на средната вредност од сите испитувани популации кај 7 популации приносот е помал, а кај другите 7 приносите се повисоки за 24, односно 27%. Според севкупните добиени резултати по повеќе испитувани параметри и извршената карактеризација, меѓу испитуваните автохтони популации домати, утврдена е одредена дивергентност, што е од посебно значење за селекциските активности.

Клучни зборови: домат, морфолошки и биолошки својства, карактеризација, автохтони популации.

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FIRST NODE SEED QUALITY IN DIFFERENT TOMATO GENOTYPES

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Abstract
Republic of Serbia is a significant producer of tomato seed for the domestic market and for export. This paper presents the results of the experiment with seven tomato genotypes, including five varieties and two indeterminate lines. In addition to the required mass of fruit per gram of seeds and seed mass per plant on the first node, we analyzed the germination energy, germination, and the absolute mass of natural seeds (first node). There was an average germination of 90,33%, where the determinate genotypes had a slightly lower percentage compared to the energies of indeterminate genotypes. Seed germination ranged from 89,66% in cultivar Knjaz, to 93,00% in high line V14. Seed obtained from the first node fruits of all genotypes had a high average of absolute seed mass (3,35 g). The results were statistically analyzed using analysis of variance. Taking into account legal norms, the seed of all the genotypes had a very high seed quality, which guarantee a stable and successful tomato production.
Key words: absolute seed mass, germination, seed, tomato.

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is the most commonly grown vegetable in the world, with a very wide distribution area of 4.338.834 ha (FAO, 2010). The world's largest tomato producers are China, USA, India, Turkey, Egypt, Russia, Italy and Mexico. In 2011. 20.229 ha in Serbia were planted under this vegetable, with an average yield of 9,82 t / ha (webrzs.stat.gov.rs). During the last 10 years, the area under this crop has not fluctuated much in the Republic of Serbia. In the structure of total vegetable consumption in Serbia, tomato has a share of 11,6% or 15,2 kg per capita per year (Vlahović and Puškarić, 2012). It is used as fresh, ripe fruit or as different processed products. Contemporary tomato production is based on the use of certified seeds of newly developed varieties and hybrids (Takač et al., 2005). In Vojvodina, and along the river valleys of central Serbia, there is a good combination of soil and plenty irrigation water as well as favourable climate. Fruit yields of 50-80 t / ha can easily be achieved in this area. Tomato growth type can be indeterminate, semideterminate and determinate. Indeterminate variety is characterized by unlimited, tall growth of the stemtrees and dense branching (Takač et al., 2007). Depending on the type of growth tomato can be produced in various ways and used for different purposes. Seed production takes place by direct seeding or from seedlings. Seed production and seed processing should be given special attention in order to improve the quality of seeds, which far exceed legal standards, ensuring safe and smooth production of seedlings sprouting in the open field (Takač et al., 2012). Substantial areas under tomato in Serbia and favourable climate for seed production are the basis of quality tomato production.

Material and methods

Seven tomato genotypes were selected for this study from the collection of the Institute of Field and Vegetable Crops in Novi Sad, Serbia. According to the type of growth, three varieties are determinate (Alparac, Bačka and Knjaz), while two cultivars (Pegaz and Novosadski jabučar) and two lines (V9 and V14) are indeterminate (Table 1). The experiment was conducted in a randomized complete block design with five replications, planting two rows of each genotype at the site was performed. Sowing for the production of seedlings was done on March 30. 2011 in greenhouse and planting on May 12. in the open field. Row spacing was 70 cm, while the distance between plants in a row was 50 cm. During the growing period, plants were watered regularly. Two interrow cultivations and hoeing were performed. Indeterminate genotypes were grown with support (peg) on a one stem. Fertilization experiment was carried out with mineral fertilizer AN in the amount of 250 kg / ha. Plant protection measures were regularly carried out.

In the experiment, the following parameters were monitored on the first node: the mass of fruit needed for one gram of seeds, Seed mass (per plant), germination energy, seed germination, absolute seed mass. Average, minimum and maximum values for these analyzed traits were calculated, while statistical significance was tested using LSD test.

Results and discussion

The mass of fruit needed for one gram of seeds

In the production of tomato seed the required amount of fruit for one gram or one kilogram of seed is a very important parameter. One kilogram of seed is obtained from 300-400 kilograms of fruit. (Gvozdenović et al., 2011). With heirloom varieties and populations of soft fruit, it takes a small amount of fruit for 1 kilogram of seed. In the newly developed determinate varieties, of firm fruit, the ratio is less favourable (Popović et al., 2012). This must be taken into account while contracting in the seed production i.e. the seed producer should not be paid the same price for one kilogram of seed. This is illustrated by the data shown in Table 1 where the greatest need of fruit mass was in the variety Bačka (552,7 g), significantly lower in V14 and Pegaz, and highly statistically significantly lower in Novosadski jabučar (287,4 g).

Seed mass

Seeds and seedlings are an important factor in high-quality production, especially in vegetable production (Ćirkova et al., 1989.). Tomato belongs to a group of plants with a high rate of multiplication, as illustrated by the fact that there are about 288 seed embryos in a tomato flower , whereas there are up to 8 in pea flower , 90 in sesame (Žučenko, 1990), and 80-100 in peppers (Gvozdenović et al., 1995). So one cannot always get a realistic picture of tomato seed production only by the sown area under this crop, especially if one takes into account that a part of tomato production comes the seedlings and another part from seeds. Seed yield of the cultivars and lines per plant at the first node ranged from 1,5 g for variety Backa up to 2,2 g in the line V9. The differences found were not statistically significant (Table 1).

Germination energy

Seed is the primary carrier of quality values and hereditary characteristics (Milosević and Ćirović, 1994). Seed is an immature dormant plant with a certain amount of food reserves and wrapped in hard pericarp. Germination energy is the percentage of germination of seeds that germinate in the first days of germination test. This time is different for different types of vegetables grown (4 days for salads, radishes, cucumbers and melons, 10 days for parsley and celery), while in the case of

tomatoes it is 5 days. As tomato seed ages, germination energy has a much sharper decline than the decline in the overall percentage of germination. The trial average germination energy was 90,33% and ranged from 86,66% in cultivar Knjaz to 93,00% in hybrid V14. On average, determinate genotypes had a lower germination energy compared to indeterminate genotypes. Highest germination was observed at tall line V14 (93,00%) (Table 2).

Table 1. The amount of seed on the first node of different tomato genotypes

Number	Genotype	The mass of fruit needed for one gram of seeds (g)	Seed mass per plant (g)
1.	V14	377,4	1,8
2.	Pegaz	334,7	2,1
3.	V9	472,0	2,2
4.	Novosadski jabučar	287,4	1,9
5.	Alparac	420,6	1,5
6.	Bačka	552,7	1,5
7.	Knjaz	439,8	2,1
	Average	412,1	1,9
	Min	287,4	1,5
	Max	552,7	2,2
	LSD(0,05)	168,5	0,9
	LSD(0,01)	227,4	1,2

Seed germination

Seed germination is the percentage of normally germinatedseeds, under certain conditions, determined by methods already established for each type of vegetable seeds. Tomato is a herbaceous plant which for some years retains high germination, even up to 5 years (Takač, 1997), unlike most other vegetable crops who rapidly lose viability. Onion and lettuce lose germination in two to three years (Lazić, 1987). According to Mladenovski and Mihajlovski (1994) seed after 20 years of storage in a hermetically sealed package with moisture percent of 5,77% had germination of 93,75%. According to the current legislation, seed that has purity of at least 97%, maximum moisture content of 12%, the presence of weeds of 0% and minimum germination of 75% can be marketed. Seed germination is one of the most important quality indicators. In order to compare the results obtained, it is necessary to standardize the method, including mediu,, germination conditions, the length of the investigation and the methods used to break dormancy. Depending on the species, seed germination lasts from 7 days (radishes, lettuce) to 28 days (parsley, parsnip), and the germination of tomato lasts for 14 days. If the soil conditions are almost ideal germination obtained in laboratory conditions is a good indicator of seed vigour, which can predict the field emergence (Durrant and Gumerson, 1990). Seed germination of the trial genotypes ranged from 89,66% in Prince to 93,00% in tall line V14. On average it amounted to 91,42% (Table 2). Here we highlight that the seed was not processed, i.e. the results given in germination energy and seed germination relate to the natural seed. Taking into account the legal norms, we see that the seeds of all genotypes had very high germination, which is the guarantee of a stable and successful seedling production,

and for determinate genotypes it is the guarantee of a rapid and uniform field emergence. Processing such seed would increase these indicators.

1000 seed weight

1000 seed weight or absolute seed mass (AM) is a very important indicator of the quality of seed. Seeds with higher AM have more reserve materials, they germinate faster and smoother, fight stress conditions easily, yield better developed plants and seeds, and are easily stored in a warehouse for longer periods. Seeds located closer to the handle of the fruit is heavier than seeds located on the opposite side. Sowing rate is determined based on germination and AM. In tomato seed production of aaverage 1000 seed weight is 2,7 to 3,3 grams (Gvozdenović et al. 2011). Year as a production factor affects this. The average absolute mass in 7 genotypes was 3,35 grams and varied in the range of 2,66 grams in Prince to 3,87 grams of indeterminate line V14 (Table 2). The data show that the tomato seeds collected from fruits of the first node had high absolute mass, which is one of the prerequisites for rapid and uniform germination. On the other hand, since larger seeds are more easily processed, seedsmen and seed processors store seeds without fear of decreased quality or seed germination.

Table 2. Seed quality on the first node of tomato

Number	Genotype	Germination energy (%)	Seed germination (%)	Absolute seed mass (g)
1.	V14	93,00	93,00	3,87
2.	Pegaz	91,33	91,66	3,44
3.	V9	91,66	92,00	2,74
4.	Novosadski jabučar	90,33	90,66	3,82
5.	Alparac	91,00	92,33	3,06
6.	Bačka	89,00	90,66	3,82
7.	Knjaz	86,33	89,00	2,66
	Average	90,33	91,42	3,35
	Min	86,33	89,00	2,66
	Max	93,00	93,00	3,87
	LSD(0,05)	3,19	1,87	0,10
	LSD(0,01)	4,43	2,60	0,15

Conclusions

Analysis of seven different tomato genotypes showed that the average weight of fruit needed for 1 gram of seeds is very different, and that this isa varietal characteristic. It ranged from 287,4 g in Novosadski jabučar up to 553,7 g in Bačka. Based on these results, determinate genotypes need more fruit for 1 g of seed (average 470 g) then indeterminate genotypes (on average 394 g). Seed yield of the first node of the analyzed varieties and lines per plant ranged from 1,5 g for variety Backa up to 2,2 g in the line V9.

Germination energy for determinate genotypes was on average slightly lower than for indeterminate genotypes, ranging from 86,66% in cultivar Knjaz, to 93,00% in tall line V14. Seed germination of all genotypes was 91,42% on average and ranged from 89,66% in cultivar Knjaz to 93,00% in tall line V14. Taking into account the legal norms, it can be concluded that the seeds of the first node

for all genotypes had very high germination, which is the guarantee of a stable and successful production.

The average absolute seed mass for all 7 genotypes was 3,35 g, in the range from 2,66 g (Knjaz) to 3,87 g (V14). The obtained results indicate that tomato seeds collected from fruits of the first node have a high absolute mass, which is one of the prerequisites for rapid and uniform emergence, as well as the possibility for seeds to be stored without worrying about the decline in the quality and seed germination.

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КВАЛИТЕТ НА СЕМЕТО ОД ПРВАТА НОДИЈА КАЈ РАЗЛИЧНИ ГЕНОТИПОВИ НА ДОМАТ

Вукашин Поповиќ, Адам Такаќ, Светлана Глоговац, Јелица Гвоздановиќ- Варга

Апстракт
Република Србија е значаен производител на семе од домати за домашниот пазар и за извоз. Во овој труд се прикажани резултати од експериметот со седум генотипови на домат, вклучувајќи пет сорти и две индетерминантни линии. Според потребната маса на плод на грам семе и маса на семе на растение од првата нодија, анализирани се енергијата на `ртење, `ртливоста и апсолутната маса на семето (прва нодија). Просечната `ртливост била 90,33%, при што детерминантните генотипови имаа незначително понизок процент споредено со индетерминантните генотипови. `Ртливоста на семето се движела од 89,66% кај сортата Књаз, до 93, 00% кај V14. Семето добиено од првата нодија од сите генотипови имало висок просек на апсолутна маса од 3,35 g. Резултатите биле статистички анализирани со примена на анализа на варијанса. Земајќи ги предвид законските норми, семето од сите генотипови имало многу висок квалитет, со што се гарантира стабилно и успешно производството на домати.
Клучни зборови: апсолутна маса на семе, `ртење, семе, домати.

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AGRONOMIC TRAITS OF SOME NEWLY PEPPER VARIETIES AND HYBRIDS IN REPUBLIC OF MACEDONIA

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Abstract
Pepper is one of the leading vegetable crops in production in open field and protected house especially plastics. In the recent years there is a tendency of introducing new varieties and hybrids. In this article 40 varieties and hybrids were examined in period 2005-2010 with the aim registration in national variety list and introducing in production. During investigation period stages of growth, average yields and main characteristics of the fruits were examined. All varieties and hybrids showed stable traits. Novosadska, Atris F_1, Silba F_1, Kaptur F_1 and Kapro F_1 gave better results in comparison with standard varieties for open field production, while Daras F_1, Donat F_1, Romatca F_1 and Ekstaza F_1 for protected houses.
Key words: pepper, hybrids, traits.

Introduction

Pepper is one of the leading vegetable crops in R. Macedonia. According state statistical office it is grown on 8475 hectares, with total production of 153.842 tones and average yield of 18,17 t / ha in open field and in protected houses for early crop production. In the review of the fresh vegetables value chain baseline screening for 2012 is stated that the production of pepper has increased 31% in 2010 in comparison with 2004 because of the use of new varieties and subsidies by the government. Still the leading variety for open field production is Kurtovska kapija generally used for processing. The production in protected area is mostly in plastics than in greenhouses. Predominant pepper varieties are: Fortese, Struma, Inferno (hot peppers) and Pinokio, Zlaten medal, Bela dolga, Sivrija (sweet peppers). Having in mind the vast diversity of the pepper and tradition of growing years ago the number of autochthonous populations for all types of pepper is 483 represented in 153 localities in the Republic of Macedonia (Bogevska Zvezda et. al, 2010). Also according the national variety list of Republic of Macedonia for 2008 there are 78 recognized species of which 53 are foreign, 23 local and two national. So far the number of new varieties is still growing so the aim of this study was to determine the value for cultivation and use of the new varieties and hybrids of pepper for open and protected production during 2005-2010.

Matherial and methods

For this study the experiments have been done on 40 varieties and hybrids of pepper for 2005-2010. The experiments in the open field were done in experimental fields at the Institute of agriculture in Skopje but for protected houses the experiments were done in glasshouses in four regions Sveti Nikole, Shtip, Kochani and Valandovo. In 2005 the research was done on 6 varieties in open field as follows: Inferno, Ringo F_1, Zlaten medal, Thoros F_1, Zlaten medal and Piran. The standard varieties were Inferno and Zlaten medal. The research was done in three replications with 12 m^2 experimental plot. They were grown from seedlings in semi hot beds and transplanted in rows 60x20cm. The technology was standard for growing pepper in open field. In 2006 the varieties Bel Kalvin, Novosadska, Sorok sari, Silba F_1, Stajkovski Kavardzik, Sweet ethem, Sweet banana, Zlaten medal and Piran were examined. Novosadska was compared with Bel Kalvin, Silba F_1 with Sorok Sari, Sweet ethem and Sweet banana with Stajkovski Kavardzik and Piran with Zlaten medal. The technology was the same as previous year and the year that follows. In 2007 Semerkand F_1 and Atris F_1 were compared with Kurtovska kapija. During the 2009 Tarsila F_1 and Rendo F_1 were compared with Bela Dolga and Galga F_1 with Kurtovska kapija. The technology was the same except the size of the experimental plot which was smaller 6 m^2 and the number of the plants per plot was 50. In 2010 five varietes were examined. BT Samsung 016, Kapija 1990 F_1 Kaptur F_1 Kapro F_1 were compared with Kurtovska kapija. The experiment procedure was the same as previous year. The varietal experiments in the protected houses were done in 2005, 2008 and 2009.

In the 2005 four varieties were examined on three different locations Sveti Nikole, Kochani, Stip - v. Karbinci. Daras F_1 was compared with the standard variety Sivrija and Donat F_1 with Zlaten medal respectively. It was used standard technology. The size of the experimental plot was 3,2 m^2 with 10 plants. The plants were transplanted in rows 80x40cm in 5 replications in Sveti Nikole and 3 in Kochani and Stip respectively. In 2008 there were two experiments in the glasshouses Anska reka, Valandovo. The diferences were in the choice of the variety of pepper. The tecnology was the same with experimental plot 6,4 m^2 and 40 plants per plot transplanted in rows 65x25 cm. The first experiment was with long pepper Ekstaza F_1 which was compeared with the standard variety Zlaten medal. The other research was on bell pepper variety Romatca F_1 compared with Blondy F_1. In the 2009 three varieties were examined in two locations Kochani and Stip. It was used common cultivation technology on experimental plot 4 m^2 with 16 plants per plot and space betweet the plants 80x30cm. The experiment was in 5 replications. Plants were regulary irrigated, fertilized and protected. During the production of all varieties grown in open field and protected houses data of the stages of growth, average yields and characteristics of the fruits were registered. The yields were statistically obtained and verified with LSD test.

Results and discussion

The date of stages of growth for the pepper varieties grown in open field are given in the table 1. All varieties in 2005 were sown and transplanted on the same date, 08.04.2005 and 06.06.2005 respectively. The differences were found in the sprouting date. Ringo F_1 sprouted one day later, Thoros F_1 8 days earlier and Piran 4 days earlier than the standard varieties. The grater difference in the date of first harvest gave the variety Thoros F_1. It was 8 days earlier than the Zlaten medal. The vegetation from sprouting to first harvest varies from 103 days in Thoros F_1 and Zlaten medal to 108 in Piran.

In 2006 the varieties Sweet ethem, Sweet banana and Piran sprout in the same time with the standards except Silba F_1 and Novosadska which were 4 days earlier than the standard varieties. There were differences in the date of the first harvest that contributed to differences in the vegetation. All tested varieties showed longer vegetation than the standards except Sweet banana which had the same days as the standard 110.

In 2007 the dates of growing stages were the same in all investigated varieties except the date of physiological maturity. The variety Semerkand F1 was 14 and Atris F1 31 days earlier than the standard variety Kurtovska kapija. In 2009 there were differences in the date of first harvest and date of technological and physiological maturity that result in differences in vegetation period which differ from 96 in Galga F_1 to 108 in Kurtovska kapija and Rendo F_1. In 2010 the variety BT Samsung 016 (95) was 20 days and Kapro F1 (102) and Kaptur F1 (102) 13 days earlier than the standard Kurtovska kapija (115). The variety Kapija 1990 F_1 (122) had 7 days more vegetation period. In the table 2 are given the productive traits of the investigated varieties in the open filed from 2005 to 2010 expressed in average yields.

All investigated varieties were more yielded than the standard varieties except the Sweet etham and Sweet banana in 2006 and Tarsila F_1 in 2009. The differences weren't significant. The higher significant differences in yield gave the variety Novosadska in 2006, Atris F_1 in 2007, Kaptur F_1 and Kapro F_1 in 2010.

In the table 3 are given the characteristics of the fruit of all examined varieties from 2005-2010.

Table 1. Stages of growth in open field production

Year	Variety	Date of sowing	Date of sprouting	Date of transplanting	Date of first harvest	Date of maturity		Vegetation from sprouting to first harvest
						Tech.*	Phys.**	
2005	Inferno ø	08.04.05	20.04.05	06.06.05	01.08.05	01.08.05	-	103
	Ringo F_1	08.04.05	21.04.05	06.06.05	03.08.05	03.08.05	-	105
	Zlaten medal ø	08.04.05	26.04.05	06.06.05	06.08.05	06.08.05	-	103
	Thoros F_1	08.04.05	18.04.05	06.06.05	29.07.05	29.07.05	-	103
	Zlaten medal ø	08.04.05	26.04.05	06.06.05	06.08.05	-	-	103
	Piran	08.04.05	22.04.05	06.06.05	04.08.05	-	-	108
2006	Bel Kalvin ø	12.04.06	01.05.06	30.05.06	12.08.06	12.08.06	01.09.06	104
	Novosadska	12.04.06	27.04.06	30.05.06	14.08.06	14.08.06	04.09.06	110
	Sorok sari ø	12.04.06	01.05.06	30.05.06	10.08.06	10.08.06	05.09.06	102
	Silba F_1	12.04.06	27.04.06	30.05.06	10.08.06	10.08.06	05.09.06	106
	Stajkovski Kavardzik ø	12.04.06	27.04.06	30.05.06	14.08.06	14.08.06	01.09.06	110
	Sweet ethem	12.04.06	27.04.06	30.05.06	15.08.06	15.08.06	01.09.06	111
	Sweet banana	12.04.06	27.04.06	30.05.06	14.08.06	14.08.06	30.08.06	110
	Zlaten medal ø	12.04.06	03.05.06	30.05.06	14.08.06	-	-	104
	Piran	12.04.06	03.05.06	30.05.06	18.08.06	-	-	108
2007	Kurtovska kapija ø	13.04.07	05.05.07	28.05.07	-	-	29.08.07	96
	Semerkand F_1	13.04.07	05.05.07	28.05.07	-	-	15.08.07	96
	Atris F_1	13.04.07	05.05.07	28.05.07	-	-	28.07.07	96
2009	Bela dolga ø	09.04.09	23.04.09	26.05.09	09.08.09	09.08.09	24.08.09	100
	Tarsila F_1	09.04.09	23.04.09	26.05.09	10.08.09	10.08.09	26.08.09	100
	Rendo F_1	09.04.09	23.04.09	26.05.09	12.08.09	12.08.09	21.08.09	108
	Kurtovska kapija ø	09.04.09	23.04.09	26.05.09	12.08.09	12.08.09	21.08.09	108
	Galga F_1	09.04.09	23.04.09	26.05.09	23.07.09	23.07.09	14.08.09	96
2010	Kurtovska kapija ø	25.04.09	15.05.09	12.06.09	22.08.09	03.09.09	15.09.09	115
	BT Samsung 016	25.04.09	15.05.09	12.06.09	18.08.09	12.08.09	01.09.09	95
	Kapija 1990 F_1	25.04.09	15.05.09	12.06.09	29.08.09	25.08.09	15.09.09	122
	Kaptur F_1	25.04.09	15.05.09	12.06.09	03.09.09	25.08.09	03.09.09	102
	Kapro F_1	25.04.09	15.05.09	12.06.09	13.09.09	03.09.09	10.09.09	102

*technological stage of maturity

**physiological stage of maturity

ø standard variety

"-"data not registered

Table 2. Average yield t/ha in open field production

Year	Variety	Average yield	+ - from ø	CV	LSD	
					0,05	0,01
2005	Inferno	44,0	ø	5,53	4,23	6,40
	Ringo F_1	50,5	6,5	4,15		
	Zlaten medal	37,7	ø	2,26		
	Thoros F_1	42,4	4,7	3,66		
	Zlaten medal	27,7	ø	3,07	3,75	4,87
	Piran	33,9	6,2	4,35		
2006	Bel Kalvin	30,3	ø	1,19	3,36	4,63
	Novosadska	43,6	13,3	9,14		
	Sorok sari	45,1	ø	5,33		
	Silba F_1	54,7	9,6	1,93		
	Stajkovski Kavardzik	42,0	ø	2,90		
	Sweet ethem	39,9	-2,1	3,90		
	Sweet banana	40,9	-1,1	4,44		
	Zlaten medal	45,8	ø	4,33	3,36	4,63
	Piran	51,2	5,4	3,67		
2007	Kurtovska kapija	41,1	ø	11,2	9,2	15,2
	Semerkand F_1	46,4	5,3	3,9		
	Atris F_1	54,7	13,6	4,2		
2009	Technological stage of maturity					
	Bela dolga	49,5	ø	7,47	7,88	11,47
	Tarsila F_1	45,1	-4,4	12,87		
	Rendo F_1	54,7	5,2	11,80		
	Kurtovska kapija	37,0	ø	4,11		
	Galga F_1	38,3	1,3	5,00		
	Physiological stage of maturity					
	Bela dolga	44,1	ø	7,71	7,88	9,41
	Tarsila F_1	45,9	1,9	7,11		
	Rendo F_1	48,0	3,9	3,63		
	Kurtovska kapija	29,8	ø	17,52		
	Galga F_1	35,0	5,2	3,77		
2010	Kurtovska kapija	22,8	ø	10,1	4,53	6,58
	BT Samsung 016	27,9	5,1	15,8		
	Kapija 1990 F_1	25,8	3,0	6,9		
	Kaptur F_1	50,7	27,9	4,2		
	Kapro F_1	39,9	17,1	5,1		

ø standard variety

Table 3. Characteristics of the fruit in open field production

Year	Variety	Mass in g	Index of fruit	Thickness of pericarp mm	Number of locules	Colour of fruit		Content of dry matters %	Fruit utilization %	Flavour of fruit
						Technological	Physiological			
2005	Inferno ø	49,2	4,7	3,0	2,1	light yellow	-	4,0	80	hot
	Ringo F_1	51,5	4,3	3,1	2,2	light yellow	-	3,9	83	hot
	Zlaten medal ø	54,7	3,2	4,0	2,1	yellowish green	-	5,1	79	mild
	Thoros F_1	83,7	3,4	4,1	2,2	light green	-	3,7	84	mild
	Zlaten medal ø	55,0	3,2	4,0	2,1	yellowish green	-	5,1	79	-
	Piran	51,0	3,8	4,2	2,0	yellowish green	-	5,0	83	-
2006	Bel Kalvin ø	43,9	0,60	6,0	3,3	light yellow	-	3,2	34,5	-
	Novosadska	44,7	0,63	8,2	2,8	light yellow	-	3,2	31,0	-
	Sorok sari ø	69,7	1,1	5,6	3,3	light yellow	-	3,4	53,2	-
	Silba F_1	87,0	1,1	6,1	3,4	light yellow	-	3,0	70,7	-
	Stajkovski Kavardzik ø	44,7	3,8	2,5	2,1	whitish yellow	-	3,9	35,7	-
	Sweet ethem	56,5	3,2	3,3	2,6	light yellow	-	3,4	45,2	-
	Sweet banana	67,5	4,0	3,1	2,6	light green	-	3,4	56,0	-
	Zlaten medal ø	67,0	3,2	3,4	2,4	yellowish green	-	3,8	73	-
	Piran	71,0	4,0	3,1	2,3	yellowish green	-	3,6	70	-
2007	Kurtovska kapija ø	97,5	2,4	4,3	2,3	-	dark red	6,9	76	mild
	Semerkand F_1	81,2	3,6	4,6	2,8	-	dark red	5,5	65	mild
	Atris F_1	103,0	3,1	4,5	3,3	-	dark red	6,4	84	mild
2009	Bela dolga ø	58,9	-	3,7	2,3	-	-	3,8	-	mild
	Tarsila F_1	53,2	-	2,8	2,5	-	-	3,8	-	mild
	Rendo F_1	112,0	-	3,1	3,1	-	-	3,8	-	mild
	Kurtovska kapija ø	113,0	-	2,2	2,2	-	-	4,5	-	mild
	Galga F_1	83,2	-	3,0	3,0	-	-	3,8	-	mild
2010	Kurtovska kapija ø	73,4	3,4	-	2,1	greenish white	dark red	7,3	56,5	-
	BT Samsung 016	66,7	2,8	-	2,5	white	light red	6,2	48,1	-
	Kapija 1990 F_1	78,4	4,4	-	2,1	green	dark red	6,3	63,0	-
	Kaptur F_1	73,9	4,5	-	3,1	green	dark red	6,4	98,0	-
	Kapro F_1	88,1	4,0	-	2,2	green	dark red	6,8	73,2	-

ø standard variety ; "-"data not registered

In 2005 the mass of the fruit ranged from 49,2 g in Inferno to 83,7 in Thoros F_1. The highest index of the fruit was obtained in the standard variety Inferno but the smallest 3,2 in Zlaten medela. The others values were as follows Thoros F_1 3,4, Piran 3,8 and Ringo F_1 4,3. The thickness of the fruit was 3,0 in Inferno and 4,2 in Piran which indicate that these varieties are medium fleshy peppers. The number of the locules was about 2. The colour in technological maturity was yellowish green in Zlaten medal and Piran, light yellow in Inferno and Ringo F_1 and light green in Thoros F_1. The content of dry matters is among 3,9 in Ringo F_1 to 5,1 in Zlaten medal. The utilization part was better in Ringo F_1 (83%), Thoros F_1 (84%) and Piran (83%) in comparison to standard varieties Zlaten medal (79%) and Inferno (80%).

In 2006 the mass of the examined varieties varied from 43,9 g in Bel Kalvin to 87,0 in Silba F_1 depending on the type of pepper. The index of the fruit was 0,60 in Bel Alvin to 4,0 in Sweet banana and Piran. The biggest thickness showed the bell pepper Silba F_1 (6,1mm). The least thickness (3,1) was obtained from the varieties Sweet banana and Piran. The colour in technological stage of maturity was whitish yellow in Stajkovski kavardzik, yellowish green in Zlaten Medal and Piran, light green in Sweet banana. The others had light yellow colour of the fruits. The content of dry matters was in the range of 3,0 % in Silba F_1 and 3,9 % in Stajkovski kavardzik. The utilization part depends on the variety and according this the biggest fruit utilization had the standard variety Zlaten medal (73%). The values of the fruit utilization in the others varieties varied from 31,0% in Novosadska to 70,7 in Silba F_1.

In 2007 the mass of the three examined varieties was 81,2 g in Semerkand F_1, 97,5 g in Kurtovska kapija and 103, 0 in Atris F_1. The index of the fruit was 3,6 in Semerkand F_1, 3,1 in Atris F_1 and 2,4 in Kurtovska kapija. The thickness of the fruit was about 4 in all three varieties. The number of the locules was 2,3 in standard variety Kurtovska kapija, 2,8 in Semerkand F_1 and 3,3 in Atris F_1. The fruits of all varieties were in physiological maturity dark red and mild. The content of dry matters was in favor of the control variant (6,9%). The best fruit utilization showed Atris F_1 (84%).

In 2009 five varieties were investigated. Tarsila F_1 and Rendo F_1 were compared with Bela dolga and Galga F_1 with Kurtovska kapija.The fruit mass varies from 53,2 in Tarsila F1 to 113,0 in Kurtovska kapija. Galga F_1 was better in the thickness of the fruit and number of the locules in comparison to standard variety. Tarsila F_1 and Rendo F_1 had the same dry matter content and more locules than the standard variety Bela dolga. All varieties had mild flavour.

In 2010, BT Samsung 016, Kapija 1990 F_1, Kaptur F_1, Kapro F_1 were compared to Kurtovska kapija.

The average mass of the fruits varied from 66,7 g in BT Samsung 016 to 88,1 g in Kapro F_1. Kapija 1990 F_1, Kaptur F_1, Kapro F_1 had bigger index of the fruits. Kapija 1990 F_1 and the standard variety Kurtovska kapija had the same number of the locules. The others showed bigger number of the locules in comparison to standard. All varieties had the lower content of dry matters. Kapija 1990 F_1 (63,0%), Kaptur F_1 (98,0%), Kapro F_1 (73,2%) showed better fruit utilization than the standard variety Kurtovska kapija (56,5%).

The varietal experiment was done in protected houses in 2005, 2008 and 2009. Eleven varieties were grown to assess the agronomic traits.

In 2005 Sivrija (standard variety), Daras F_1, Zlaten medal (standard variety) and Donat F_1 were examined in three different locations Sveti Nikole, Kochani and Shtip. Date of the sowing was the same as well as date of the transplanting depending of the location. In Sveti Nikole Daras F_1 and Donat F_1 were little bit later than the standard varieties. In Kochani these varieties had the same

vegetation period in comparison to standards 124 days. In Shtip Daras F_1 (136) was ten days later than the standard variety Sivrija (126). Donat F_1 (134) was five days later than the standard variety Zlaten medal (129).

In 2008 Zlaten medal (standard variety), Ekstaza F_1, Blondy F_1 (standard variety) and Romatca F_1 were examined in one location in glasshouses Anska reka in Valandovo. The date of the stages of growth as date of sowing, data of sprouting, date of transplanting was the same that resulted in the same number of the days from sprouting to first harvest (156).

In 2009 three hot varieties of pepper were studied in glasshouses in two locations Kochani and Shtip. HV 410 F1 and Kais had more or less the same number of days from sprouting to first harvest in the two locations. The stages of growth in the protected houses are given in the table 4. The average yields of the examined varieties are given in the table 5. The data of the yields in Stip for 2009 is not recorded. All the investigated varieties were more yielded than the standard varieties in all locations and years of research. It can be noticed that the differences are significant especially for 2005 where the varieties Daras F_1 and Donat F_1 in the three locations gave significant more yields in comparison with the standard varieties Sivrija nad Zlaten medal.

The characteristics of the fruit in the protected houses are given in the table 5. The data for the 2009 in the Shtip region are not registered. The average mass of the fruit in Daras F1 (60g) and Donat F1 (90g) was bigger than the standard varieties Sivrija (30 g) and Zlaten medal (80g) in the region Sveti Nikole for 2005. The index of the fruit was 6,5 in Daras F_1 and 5 in Donat F_1. In Kochani the characteristics of the fruit were more or less the same. In the region Shtip there were differences in the mass of the fruit. The average mass of the fruit in Daras F1 and Donat F1 was 51 g and 42 g respectively.

In 2008 for the Valandovo locations the characteristics of the fruit are given in the technological and physiological stage of maturation. The two different varieties Ekstaza F_1 (long type) and Romatca F_1 (bell pepper) were compared to standard varieties Zlaten medal and Blondy F_1.The mass of the fruits was bigger in the technological stage than in the physiological stage of maturity. The index of the fruit, thickness of the fruit and the number of the locules differ slightly in the two stages of the maturation.

Table 4. Stages of growth in protected houses

Year	Variety	Date of sowing	Date of sprouting	Date of transplanting	Date of first harvest	Vegetation from sprouting to first harvest
2005	Region of Sv. Nikole					
	Sivrija	4.12.04	19.12.04	21.02.05	21.04.05	125
	Daras F_1	4.12.04	14.12.04	21.02.05	21.04.05	128
	Zlaten medal	4.12.04	21.12.04	21.02.05	21.04.05	123
	Donat F_1	4.12.04	17.12.04	21.02.05	21.04.05	125
	Region of Kochani					
	Sivrija	6.12.04	26.12.04	17.01.05	10.04.05	124
	Daras F_1	6.12.04	12.12.04	17.01.05	15.04.05	124
	Zlaten medal	6.12.04	14.12.04	17.01.05	10.04.05	124
	Donat F_1	6.12.04	12.12.04	17.01.05	15.04.05	124
	Region of Shtip - v. Karbinci					
	Sivrija	17.01.05	04.02.05	25.04.05	10.06.05	126
	Daras F_1	17.01.05	25.01.05	25.04.05	10.06.05	136
	Zlaten medal	17.01.05	01.02.05	25.04.05	10.06.05	129
	Donat F_1	17.01.05	27.01.05	25.04.05	10.06.05	134
2008	Region of Valandovo					
	Zlaten medal	03.01.08	08.01.08	09.04.08	-	156
	Ekstaza F_1	03.01.08	08.01.08	09.04.08	-	156
	Blondy F_1	03.01.08	08.01.08	09.04.08	-	156
	Romatca F_1	03.01.08	08.01.08	09.04.08	-	156
2009	Region of Kochani					
	Inferno F_1	21.12.08	30.12.08	-	05.05.09	128
	HV 410 F_1	21.12.08	29.12.08	-	03.05.09	126
	Kais	21.12.08	30.12.08	-	05.05.09	128
	Region of Shtip					
	Inferno F_1	20.12.08	27.12.08	-	14.05.09	138
	HV 410 F_1	20.12.08	27.12.08	-	13.05.09	137
	Kais	20.12.08	26.12.08	-	09.05.09	133

"-"data not registered

In 2009 in the location of Kochani the average mass of the fruit was as follows: 111 g in the standard variety Inferno F_1, 108 g in HV 410 F_1 and 98 g in Kais. There were very small differences in the index of the fruit which was about 4. The thickness of the pericarp was 1 mm in Inferno F_1, 0,8 mm in HV 410 F_1 and 1,1 mm in Kais. The number of the locules was 3 in all varieties. The flavor of the fruit in these varieties was hot.

Table 5. Average yield t/ha in protected houses

Year	Variety	Average yield	+ - from ø	CV	LSD	
					0,05	0,01
2005	Region of Sv. Nikole					
	Sivrija	43,2	ø	4,37	5,88	8,24
	Daras F_1	64,6	21,4	4,65		
	Zlaten medal	75,1	ø	7,06		
	Donat F_1	106,7	31,6	4,29		
	Region of Kochani					
	Sivrija	58,9	ø	2,15	4,64	7,02
	Daras F_1	74,4	15,5	2,76		
	Zlaten medal	61,2	ø	1,73		
	Donat F_1	77,9	16,7	5,77		
	Region of Shtip – v. Karbinci					
	Sivrija	32,9	ø	5,33	3,37	5,11
	Daras F_1	49,3	16,4	1,33		
	Zlaten medal	46,6	ø	1,75		
	Donat F_1	53,7	7,1	6,63		
2008	Region of Valandovo					
	Zlaten medal	38,53	ø	4,48	6,81	12,50
	Ekstaza F_1	44,50	5,98	7,65		
	Blondy F_1	40,68	ø	8,31	9,37	17,19
	Romatca F_1	48,80	8,13	6,56		
2009	Region of Kochani					
	Inferno F_1	82,0	ø	1,70	1,89	2,75
	HV 410 F_1	87,7	5,7	1,30		
	Kais	88,0	6,0	2,10		
	Region of Shtip					
	Inferno F_1	-	-	-		
	HV 410 F_1	-	-	-		
	Kais	-	-	-		

ø standard variety

"-"data not registered

Table 6. Characteristics of the fruit in protected houses

Year	Variety	Mass in g	Index of fruit	Thickness of pericarp mm	Number of locules	Colour of fruit	Flavour of fruit
2005	Region of Sv. Nikole						
	Sivrija	30	5,0	-	-	light yellow	mild
	Daras F_1	60	6,5	-	-	light yellow	mild
	Zlaten medal	80	2,9	-	-	green	mild
	Donat F_1	90	5,0	-	-	light yellow	mild
	Region of Kochani						
	Sivrija	42	5,3	2,3	2-3	yellow	mild
	Daras F_1	65	6,7	2,5	2-3	light green	mild
	Zlaten medal	75	5,3	3,3	2-3	light green	mild
	Donat F_1	87	5,1	3,5	3-4	yellow	mild
	Region of Shtip - v. Karbinci						
	Sivrija	53	6,7	3,3	2	yellow	mild
	Daras F_1	51	6,2	2,5	3	light green	mild
	Zlaten medal	58	3,6	3,5	3	light green	mild
	Donat F_1	42	5,1	2,5	3	yellow	mild
2008	Region of Valandovo						
	Technological stage of maturity						
	Zlaten medal	80	2,54	3	3	light green	mild
	Ekstaza F_1	95	4,35	2	4	light green	mild
	Blondy F_1	145	1,20	6	5	light yellow	mild
	Romatca F_1	204	1,55	7	4	light yellow	mild
	Physiological stage of maturity						
	Zlaten medal	50	4,10	2	3	intensely red	mild
	Ekstaza F_1	55	5,20	1	4	intensely red	mild
	Blondy F_1	100	1,30	4	7	intensely red	mild
	Romatca F_1	140	1,28	4	4	intensely red	mild
2009	Region of Kochani						
	Inferno F_1	111	4,8	1,0	3	green	hot
	HV 410 F_1	108	4,3	0,8	3	light green	hot
	Kais	98	4,3	1,1	3	light green	hot
	Region of Shtip						
	Inferno F_1	-	-	-	-	-	-
	HV 410 F_1	-	-	-	-	-	-
	Kais	-	-	-	-	-	-

"-"data not registered

Conclusions

All newly pepper varieties which were grown in the open field and protected houses showed stable agronomic traits. It can be concluded that all of these are suitable for production in open field and

protected areas. Novosadska, Atris F_1, Silba F_1, Kaptur F_1 and Kapro F_1 gave better results in comparison with standard varieties for open field production, while Daras F_1, Donat F_1, Romatca F_1 and Ekstaza F_1 for protected houses.

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АГРОНОМСКИ КАРАКТЕРИСТИКИ НА НЕКОИ ПОНОВИ СОРТИ И ХИБРИДИ ОД ПИПЕРКА ВО РЕПУБЛИКА МАКЕДОНИЈА

Богевска Звезда, Агич Рукие, Биљана Ристовска, Афродита Ибушоска, Маргарита Давитковска, Игор Иљовски

Апстракт

Пиперката е една од водечките градинарски култури во производството на отворено и во заштитени простори посебно пластеници. Во последните години постои тенденција на воведување на нови сорти и хибриди. Во овој труд беа истражени 40 сорти и хибриди во период од 2005 до 2010 со цел регистрирање во националната сортна листа и воведување во производство. За време на истражувањата беа следени фазите на пораст, просечните приноси како и битните карактеристики на плодовите. Сите испитувани сорти и хибриди покажаа стабилни својства. Од испитуваните сорти на отворено подобри резултати во поглед на продуктивните својства во споредба со стандардот дадоа сортите Novosadska, Atris F_1, Silba F_1, Kaptur F_1 и Kapro F_1, додека за во заштитени простори сортите Daras F_1, Donat F_1, Romatca F_1 и Ekstaza F_1.

Клучни зборови: пиперка, хибриди, карактеристики.

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HORTICULTURE CROP PRODUCTION IN NORTH-WESTERN HIMALAYAS UNDER CHANGING CLIMATE SCENARIO

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Abstract
During the recent past, weather patterns all over the world have changed and Himachal Pradesh of North-Western Himalaya is no exception. The trend analysis of temperature and precipitation data was done by taking data of 1973-1990 from wet temperate and 1971-90 duration from sub temperate region as baseline which was further divided into two periods i) 1991-2000; ii) 2001-2011 and variation was analysed season wise. In the sub temperate region maximum temperature has increased in all the seasons, however highest increase of 3.11^{o}C was noticed in winter season during 2001-2011 period from the base years of 1971-90. The average minimum temperature was found to decrease over the base period of 1971-90. The maximum decrease of 1.3^{o}C over the base period was noticed in autumn season during the period of 2001-2011. In the region the period 2001-2011 experienced decrease in the rainfall during summer, spring and winter seasons, however, the maximum decrease of 115.23 mm was noticed in summer season. In wet temperate to dry temperate regions both maximum and minimum temperatures have increased and winters have become warmer. Among all fruits, apple is the main crop of the state occupying the place of pride in its economy. However, the rise in temperatures and decreased snowfall over years has adversely affected apple cultivation in the state. Earlier snowfall was a regular phenomenon in apple growing areas but since 1973-1985 (baseline) a reduction in the snow fall from 430 cm to 51.33 cm during the period of 2006-2010 was recorded. The un-conducive weather during fruit setting and development in apple has reduced the apple productivity of the region. Surprisingly, the orchards below 1500 m elevation have been rendered unproductive. In the sub- tropical climate of foothills of Himalayas the mango is an important crop and is being influenced by frequent frost events. The cold waves during winter months also found to influence the vegetable crops of the region. To adapt to changing climate farmers have shifted to cultivation of pomegranate, kiwi and off-season vegetables. In sub-tropical zone, the regular frost injury to mango plants has become common. The farmers of this zone have shifted to protected cultivation of flowers and vegetables to save their livelihoods. Therefore, accepting change and getting in tune with nature by following scientific mitigation and adaptation strategies seem to be the key to survival and prosperity of mountain farmers.

Key words: Apple, mango, vegetable crop, snowfall and frost.

Introduction

Horticulture in Himachal Pradesh consists of diverse farming activities viz. growing of fruits, vegetables and floriculture, which are cultivated in a wide range of production regions because of the diverse micro-climates. All horticultural crops are sensitive to temperature and commercial crops of the state e.g. apple in temperate and mango in sub-tropical region have specific temperature requirements for their growth and development. Based on temperature requirements, the fruit trees grown in Himachal Pradesh can be categorized into sub-tropical, sub-temperature/warm temperate and temperate.

Rising global temperature has triggered large-scale changes in the energy exchange processes affecting the atmospheric circulation and precipitation patterns (Fallot *et al*., 1997, Zhai *et al*., 1999, Beniston, 2003). The studies in Nepal Himalaya (Shreshtha *et al*., 2000) and upper Indus basin in the North Western Himalaya (Archer and Fowler, 2004) have shown minor and statistically insignificant variations in the precipitations in the last century. Air temperature is generally recognized as a good indicator of the state of climate globally because of its ability to represent the energy exchange process over the earth's surface with reasonable accuracy (Thapliyal and Kulshreshta, 1991). In the North-Western Himalayan region, very limited number of studies explaining the climate change in different mountain states e.g. Himachal Pradesh have been done for the want of adequate instrumental data. Hence, the present study was conducted to study changing climate situations and its impact on horticulture.

Material and methods

For better understanding of potential impacts of the climate change in data sparse state, trend analysis of temperature and precipitation data available from following two stations in Himachal Pradesh a true representative of North-Western Himalayas was done. Variations in temperature and precipitation was analysed season wise i.e. summer (June, July, August), autumn (September, October, November), winter (December, January, February) & spring (March, April, May). The meteorological data w.e.f. 1973-1990 for wet temperate and 1971-90 for sub temperate region was taken as baselines (Table 1). For better analysis of the climate conditions the data was divided into two periods i) 1991-2000; ii) 2001-2011 (Table 2 & 3).The snow fall data recorded in wet temperate region was grouped on five year basis and was compared with baseline period of 1973-1985. Survey was conducted in different parts of the state to identify the crops vulnerable to changing climate situations and to know the adaptation strategies being followed by the mountain farmers. During the survey impact of the climate on the major fruit and vegetable crops of the region was also recorded.

Table 1. Location of weather data stations

S. No.	Region	Altitude (m)	Latitude/Longitude	Data Period
1	Wet temperate	2300	$31^0$06'N/$77^0$10'E	1973-2011
2	Sub temperate	1275	30.02^{o}N/77.05^{o}E	1971-2011

Results and discussion

Climate change scenario of sub temperate and wet temperate zone

In sub temperate region, during the period from 2001-2011 maximum temperature has increased in all the seasons, however highest increase of 3.11^{o}C was noticed in winter months from the base years of 1971-90 which was followed by 1.57^{0}C increase in spring season (Table 2). Whereas, the

average minimum temperature was found to decrease over the base period of 1971-90. The maximum decrease of 1.3^{o}C was noticed in autumn season during the period of 2001-2011 followed by 1.24 ^{o}C in winter season in the same period over the base years of 1971-90. In the region, the decade 2001-2011 experienced decrease in the rainfall during summer, spring and winter seasons, however, the maximum decrease of 115.23 mm was noticed in summer over the base period followed by 88.31mm in spring and 25 mm in winter season. However, an increase in rainfall to the tune of 53.37mm was noticed in the autumn season of the same decade over the base period. The sub temperate region as a whole is therefore, experiencing scanty rains during winter, summer and spring months resulting water scarcity which is affecting the crops.

In wet temperate region of high hills of North-Western Himalayas, the maximum temperature during the period 1991-2000 and 2001-2011 compared over the baseline 1973-1990 has shown increase in all the seasons (Table 3). Among both the decades studied the highest increase of 3.98^{0}C in maximum temperature was recorded during the period from 2001-2011 in winter season which was followed by spring season in the same decade. The perusal of data presented in the table 3 indicated that in this part of Himalayan region winters have become warmer. In the 2001-2011 decade a rise in minimum temperature in the range of 0.88 to 1.74^{0}C was noticed, however the highest increase (1.74^{0}C) over the base period in this parameter was recorded during spring season. The total rainfall was found to decrease during summer and spring months of both the decades. The highest decrease of 97.2 mm was recorded during summer season of 2001-2011 period. Wet temperate hills of this part of Himalayas have experienced drastic reduction in snowfall since the base line period of 1973-1985 (Figure 1). In the baseline period, the region used to receive average snow fall of 430 cm beginning from November i.e. early winter season. It has now squeezed to about 51.33 cm during the period of 2006-2010 and in the months of January and February only. Non-availability of early winter snowfall in March is inducing early flowering in temperate fruit crops due to early warming effect.

Table 2. Season wise decadal changes in mean maximum, minimum temperature (^{0}C) and total rainfall (mm) with respect to baseline 1971-1990 in sub-temperate region of North-Western Himalayas.

Season	Maximum Temperature			Increase/ Decrease (+/-)		Minimum Temperature			Increase/ Decrease (+/-)		Total Rainfall			Increase/ Decrease (+/-)	
	1971-1990	1991-2000	2001-2011	1991-2000	2001-2011	1971-1990	1991-2000	2001-2011	1991-2000	2001-2011	1971-1990	1991-2000	2001-2011	1991-2000	2001-2011
Winter	17.43	18.42	20.54	+0.99	+3.11	4.25	3.5	3.01	-0.75	-1.24	156.9	171.2	131.98	+14.22	-25.00
Spring	27.23	26.97	28.8	-0.26	+1.57	12.38	12.48	12.60	+0.10	+0.22	224.8	163.8	136.52	-60.95	-88.31
Summer	29.23	28.9	29.48	-0.33	+0.25	19.89	19.81	19.47	-0.08	-0.42	687.3	674.1	572.15	-13.00	-
Autumn	25.47	25.46	26.57	-0.01	+1.10	12.16	11.75	10.86	-0.41	-1.30	141.6	175.8	195.04	+34.15	+53.37

Table 3. Season wise decadal changes in mean maximum, minimum temperature (^{0}C) and total rainfall (mm) with respect to baseline 1973-1990 in high hill wet temperate region of North -Western Himalayas

Season	Maximum Temperature			Increase/ Decrease (+/-)		Minimum Temperature			Increase/ Decrease (+/-)		Total Rainfall			Increase/ Decrease (+/-)	
	1973-1990	1991-2000	2001-2011	1991-2000	2001-2011	1973-1990	1991-2000	2001-2011	1991-2000	2001-2011	1973-1990	1991-2000	2001-2011	1991-2000	2001-2011
Winter	10.14	11.97	14.12	+1.83	+3.98	1.79	1.75	3.25	-0.04	+1.46	80.19	87.11	81.34	+6.92	+1.15
Spring	18.91	20.67	21.71	+1.76	+2.80	8.79	8.65	10.53	-0.14	+1.74	235.3	228.39	194.69	-6.98	-40.68
Summer	22.46	23.64	23.67	+1.18	+1.21	14.13	14.13	15.01	-	+0.88	777.9	767.73	680.79	-10.26	-97.2
Autumn	19.0	20.51	20.41	+1.15	+1.41	9.05	8.91	10.30	-0.14	+1.25	180.5	185.95	200.09	+5.45	+19.59

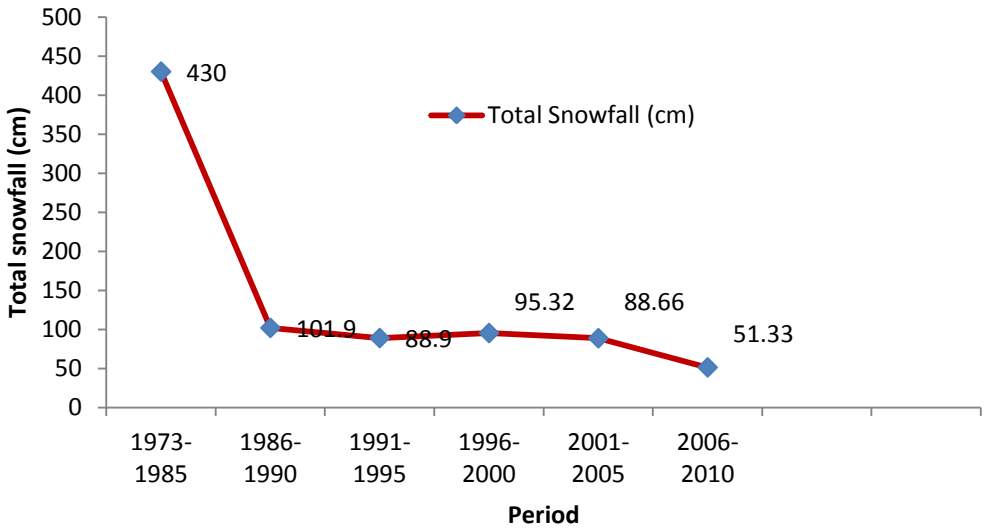

Figure 1. Snowfall pattern of wet temperate region of North-Western Himalaya

Fruit and vegetable crop production under changing climate conditions

The distribution of horticulture crops in the region is influenced mainly by climate than any other factor. Rising temperatures, reducing snowfall and rainfall events as well as changes in monsoon pattern is affecting horticulture and is a matter of serious concern for farmers of North-Western Himalayan region. Climate change is projected to affect the horticultural crops and these impacts can be at any stage of crop growth and development, thus influencing the quality and yield.

Apple is the predominant temperate fruit crop of North-West Himalayas. Winter temperatures and precipitation especially in the form of snow are very crucial for induction of dormancy, bud break and ensuring flowering in apples. Apple requires minimum of 1200 chilling hours during winters for yielding a good crop especially for standard cultivars like Royal Delicious. Short chilling hours during winters result staggered, delayed, sparse flowering and ultimately low productivity. Early winter chilling has more beneficial effect on productivity as compared to late chilling contribution. Cumulative effect of more than 1600 chilling hours, good snow and well distributed winter rains resulted in a good crop year of 1998 and 2011. In contrast during 1999 and 2009 only about 958 chilling hours were received which were supplemented by late snow and rains in January-February and almost dry and warm early winter resulted in a poor crop year.

Flowering period is the most sensitive stage of plant development in apple so far as climatic conditions are concerned. The flowering in the largely grown apple variety Royal Delicious occurs in the month of April during 4th to 26th April. During this period the ambient air temperature should remain between 18-22^{0}C. However, the temperature fluctuations and hails coinciding with full bloom result poor fruit set in apple. The bud break and petal fall is the most sensitive stage in apple when hail can reduce the prospective of good crop to almost off year. During 1996, 1998 and 2011 the temperature at the time of flowering remained in the optimum range and mild rains during post bloom period and no hails resulted good crop. In contrast the maximum temperature from 24-27^{0}C during flowering and dry as well as desiccating bloom period resulted in poor apple crop during 1999 and 2009. In the year 1997 and 2012 the hails coinciding full bloom resulted in poor fruit set.

In addition to this spring frost coinciding the flowering flushes especially the full bloom affects the fruit set adversely (Table 4).

Due to more rise in temperature during winters in wet temperate regions, apple cultivation has been impacted adversely, especially in mid altitudinal range of 1500 m – 2000 m amsl. The rise in temperature and reduced snowfall (Table 3 and Figure 1) has made this part of region vulnerable to climate change as result apple farming has been abandoned in the area falling upto 1500 m amsl. Awasthi *et al*. (1986) have also indicated that irregular bearing behavior of apple variety Starking Delicious is largely influenced by climatic conditions. The rise in temperature however, has created more moderate conditions for apple cultivation in Lahaul-Spiti and Kinnaur districts. This can be viewed as positive impacts of climate change in dry temperate climate above an elevation of 2472 m amsl.

The air temperature, cold wave and frosts are decisive factors in plant growth and development of subtropical fruit like mango. This crop is very sensitive to frost. Mango grows well in temperatures ranging from 23.8-29.4^{0}C. The temperature during inflorescence is crucial. Cool temperatures and frosting during inflorescence development reduce the number of perfect flowers drastically. However, it can tolerate temperatures as high as 48^{0}C during the period of fruit development and maturity. In mango, low temperature (2 to 11.5 ^{o}C), high humidity (> 80%) and cloudy weather in January & February months found to delay panicle emergence. The unseasonal erratic rains and increased frost events is affecting mango production in the subtropical regions of North-Western Himalayan region. In low hills – sub-tropical zones the regular frost events may be due to the increased gap between maximum and minimum temperature has affected the mango orchards. During the year 2006-2007 mortality of mango plants due to frost ranged between 40-83 %. The impact of the frost was noticed more on younger plantations as compared to the older ones.

The succulent vegetable crops are highly sensitive to climate conditions like heat, drought and cold waves. The rise in temperature affects crop duration, flowering, fruiting, ripening and quality with reduced productivity and economic yield. In tomato which is one of the major commercial crop this region, the high temperatures after pollen release decreased fruit setting, yields and seed set even when pollen was produced under optimal conditions. High temperature above 28^{0}C noticed to induce maximum flower and fruit drop in tomato. However, in high altitudes vegetable yields are expected to increase due to small increase in temperature as a result of increased length of growing period. Not only the high temperatures but low temperatures have also influenced vegetable production in the region. The cold wave during December 2002 and January 2003 noticed to cause considerable damage to brinjal, tomato and potato crops of the region.

Adaptation strategies

With apple production being greatly affected, mountain farmers are steadily moving towards other crop options. Farmers have shifted to cultivation of pomegranate, kiwi and vegetables like tomato, peas, cauliflower, cabbage and broccoli etc. In subtropical low hill region production of mango is being greatly affected by frequent occurrence of frost. Farmers in order to save their livelihoods have opted for protected cultivation of vegetables and flowers in a big way.

Table 4. Apple crop performance with respect to changing weather conditions in wet- temperate region of North-Western Himalaya

Good Crop Year	Weather Conditions
1996 and 1998	Well distributed winter rains Maximum temperature at flowering remained 18-22 ^{0}C Spring rains were in post bloom period Mild rains just before bloom period
2010-2011	Well distributed winter rains
Poor Crop Year	
1997	Hails coinciding full bloom resulted poor fruit set
1999	Dry and warm early winters Late snowfall/rainfall, less chilling hours Maximum temperature at flowering was in the range of 24-27 ^{0}C Bloom period remained dry and desiccating
1999	Dry and warm early winters Late snowfall/rainfall, less chilling hours Maximum temperature at flowering was in the range of 24-27 ^{0}C Bloom period remained dry and desiccating
2009-2010	Late and less snowfall and drought conditions resulted poor crop
2011-2012	Hails coinciding full bloom and fruit development stage resulted poor fruit set and poor quality of the left over crop

Conclusions

The rising temperature and reduced precipitation is bound to impact horticultural crops of the region. The impacts can be at any stage of crop growth and development, thus influencing the quality and yield. There is an urgent need to focus attention on studying the impacts of climate change on growth, development, yield and quality of horticultural crops. The focus should also be on development of adaptation technologies and quantify the mitigation potential of horticultural crops. Changing climate in North-Western Himalayan region brought forth new problems and questions, the solutions to which will be generated by combining farmers' ingenuity and new technologies. However, accepting change and getting in tune with nature seems to be the key to survival and prosperity of the mountain farmers.

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ХОРТИКУЛТУРАТА ВО СЕВЕРОЗАПАДНИ ХИМАЛАИ ВО ИЗМЕНЕТИ КЛИМАТСКИ УСЛОВИ

Бардвај Сатиш Кумар, Шарма Сом Дев

Апстракт

Во текот на изминатиот период, временските услови во целиот свет се менуваа и Химачал Прадеш од Северо-Западни Хималаи не е исклучок. За анализа на трендот на температурите и врнежите беа користени податоци за периодот 1973-1990 во влажно-умереният регион и за периодот 1971-1990 во суб-умереният регион како базни, дополнително се разгледувани два периода i) 1991-2000; ii) 2001-2011 а варијацијата е анализирана по сезони. Во суб-умереният регион максималната температура е зголемена во сите сезони, но сепак најголем пораст во однос на базниот период 1971-1990 од 3.11^{o}C е забележан во зимската сезона во периодот од 2001-2011. Просечната минимална температура се намалила во базниот период 1971-1990. Максимално намалување од 1.3^{o}C во однос на базниот период е забележан во есенската сезона во периодот од 2001-2011. Во овој регион во периодот 2001-2011 било утврдено намалување на врнежите во летната, пролетната и зимската сезона, иако, максимални намалувања од 115,23 mm биле забележани во летната сезона. Во влажно умерените и сушно умерените региони и максималните и минималните температури се зголемиле и зимите станале потопли. Јаболкото е главна култура на државата и претставува гордост на економијата. Сепак, порастот на температурите и намалувањето на снежните врнежи во текот на годините има негативно влијание врз производството на јаболко во државата. Порано снежните врнежи биле редовна појава во областите каде што се одгледувало јаболкото, но во периодот 1973-1985 (базен) било забележано намалување на снежната покривка од 430см на 51,33 см во периодот 2006-2010. Непогодните временски услови за време на развојот на јаболкото и формирањето на плодовите допринеле за намалување на продуктивноста на јаболката во регионот. Изненадувачки, овоштарниците под 1500 метри надморска височина биле непродуктивни. Во субтропската клима, на подножјето на Хималаите, мангото е важна култура но на него влијаат појавите на чести мразеви. Се оценува дека појавата на студени бранови во текот на зимските месеци исто така влијаат на градинарските култури во регионот. За да се прилагодат на променливите климатски услови земјоделците се преориентираа кон одгледување на калинка, киви и зеленчук вон сезона. Во субтропската зона, оштетувањата од мраз кај мангото станаа вообичаени. За да опстанат, земјоделците во оваа зона се префрлија кон одгледување на цвеќе и зеленчук во заштитени простори. Затоа, клучот за опстанок и просперитет на земјоделците во планинските подрачја е прифаќањето на промените и усогласувањето со природата преку следење на олеснувањата кои ги нуди науката и прилагодливите стратегии.

Клучни зборови: јаболко, манго, градинарски култури, снежни врнежи, мраз.

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Review Article

RECENT TRENDS IN VEGETABLE AND FLOWER CROP PRODUCTION IN REPUBLIC OF MACEDONIA

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Abstract
Vegetable and floriculture sectors in the country are considered as of great importance due to their growth and export potential, as well as potential for increase of their global competitiveness. Macedonia has around 50000-60000 ha under vegetables in the country. Most of the vegetable production is sold as fresh on the export and domestic market. The fresh vegetables industry plays an important role in the national agriculture and country economy as large portion of the export income in agribusiness comes from the vegetables sales. The fresh vegetable contributes with approximately 10% to the national GDP on annual basis. The production of fresh vegetables is either done on open field or production in glasshouses and/or plastic houses. The main fresh vegetables produced in glasshouses and exported are tomato, cucumber and pepper. The production of fresh vegetables is pretty regional and almost 80% is an output of the Southeastern Macedonian region. However in a total vegetable production (both for fresh consumption and for processing) beside the Southeastern region, other big producer, especially of processing pepper is the Pelagonija region. All the regions in the country produce vegetables, but quite smaller quantities of pepper or tomato. Production of flowers and ornamental plants at present in R. Macedonia is modest. The most important is the production of annual and biannual flowers, organized in southern part of the country and in Skopje. In this group several varieties of pot flowers can be added as the production is realized in plastic tunnels. It is estimated that around 6 to 8 million pieces of flower bed varieties were produced in the previous period. The production of cut flowers is small and organized on family farms mostly located in Gevgelija region. Ornamental and outdoor plants are produced in few nurseries offering large scale and high quality varieties.
Key words: vegetables, flowers, production, trends.

Vegetable production

Conditions for vegetable and flower crop production - the comparative advantages of the territory of the Republic of Macedonia significantly cause vegetable production to be one of the most important areas in agriculture. Centuries of tradition, climatic and soil advantages, and specific high quality and reputation gained in the wider region are the basis for successful production and marketing of vegetable products.

Table 1. Agroclimate regions

	Agroclimate regions	Types of soils	Climate conditions (temperature conditions)
I	**Submediterranan (40- 500 m altitude) subregions**: Gevgelia, Dojran, Valandovo, Demir Kapija, Strumica	- Alluvial - Delluvial - Meadow	Annual temperature Σ t^0 5200 ^{0}C Mean annual temperature $t^0$14.2^{0}C Days with $t^0 > 10^0$C 232-235 Days with $t^0 > 15^0$C 171-175
II	**Continental-submediterranean (100-600m altitude) subregions:** Tikvesh,Veles,Shtip, Kochani, Radovish, Parth of Strumica, Skopje, Kumanovo	- Alluvial - Delluvial - Rendsina - Meadow - Vertisols	Annual temperature Σ t^0 4650^{0}C Mean annual temperature $t^0$12.7^{0}C Days with $t^0 > 10^0$C 214-220 Days with $t^0 > 15^0$C 163-170
III	**Warm-continental 600-900m altitude subregions:** Polog, Kichevo, Struga, Ohrid, Pelagonija, Debar, Belchishte	- Alluvial - Delluvial - Rendsina - Vertisols - Reclaimed peat	Annual temperature Σ t^0 3975^{0}C Mean annual temperature $t^0$10.9^{0}C Days with $t^0 > 10^0$C 196-218 Days with $t^0 > 15^0$C 154-163
IV	**Cold-continental 900-1100m altitude subregions:** Kriva Palanka, Resen, Berovo, Delchevo	- Rankers - Brown- wood	Annual temperature Σ t^0 3790^{0}C Mean annual temperature t^0 9.0 Days with $t^0 > 10^0$C 166-190 Days with $t^0 > 15^0$C 136

Due to the relief, on the relatively small territory of the country, three modified types of climates are present (Mediterranean, Continental, Mountainous).There are favourable conditions for production of many vegetables. The analysis of the situation and potentials in the vegetable sector in the country from many aspects, such as the structure of area, products and production, as well as comparison with data and experience in this sector, provides an opportunity to set priorities and directions for development.

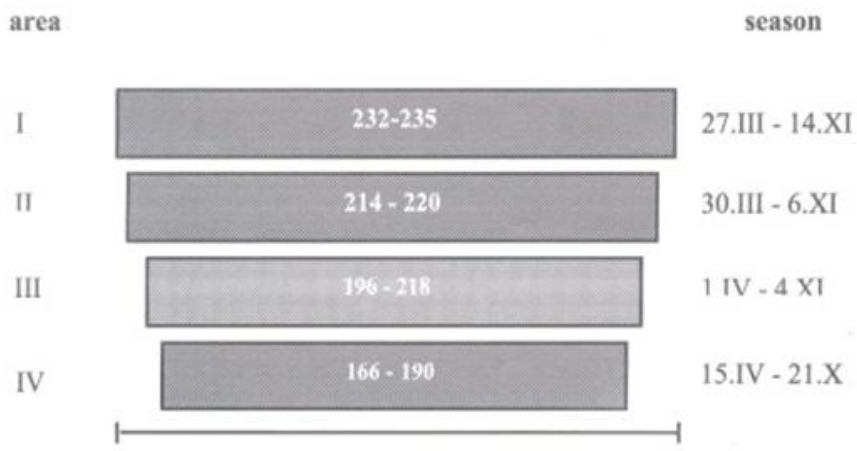

Figure 1. Duration of the season with T >10°C

Participation of vegetables in total value of agricultural production is 28.2% on average. Deviation from average + - 2.1 / 2.4

Table 2. Production of vegetables in time period 2005-2010

Production of vegetables	2005	2006	2007	2008	2009	2010
Crop products	78.4	77.0	73.8	68.8	72.2	74.1
Cereals (including seeds)	12.0	9.0	8.3	10.0	9.1	7.1
Industrial crops	9.2	7.3	6.5	4.3	7.3	8.1
Fodder crops	10.3	8.8	6.6	6.6	6.5	6.1
Vegetables	29.0	30.3	28.5	25.8	30.9	36.4
Potatoes (including seeds)	2.9	4.3	2.8	2.1	3.0	3.0
Fruit	11.1	11.9	13.1	12.9	11.0	10.3
Wine	3.9	5.5	8.0	3.9	4.4	3.1
Livestock products	21.4	22.8	25.8	30.9	27.5	25.4
Cattle	3.2	3.3	3.1	3.6	4.2	4.8
Pigs	3.4	3.2	4.9	4.3	4.41	4.4
Sheep and goats	1.0	2.8	2.0	1.9	2.1	1.9
Poultry	1.2	0.8	0.2	1.5	1.0	0.7
Milk	9.5	10.0	12.7	17.6	13.7	11.4
Eggs	2.7	2.5	2.7	1.7	1.7	1.8
Other agricultural products	0.4	0.3	0.2	0.2	0.5	0.3
Agricultural products	99.8	99.7	99.6	99.6	99.7	99.5
Agricultural services	0.2	0.3	0.4	0.4	0.3	0.5

In terms of area, of total 420,000 ha under arable land and gardens, vegetables are grown on more than 50,000 ha (12%), and after cereals (43%) is the largest area of a particular plant group. However, in the value of crop production, vegetable crops have the largest share (37.6%), while wheat covers 14.5%.

According to data from the Agricultural Census in 2007, the size of the plots at which vegetables are grown takes the following shares:

Size of the plots

Up to 0.50 ha	16,6 %
0.51 - 1.00	14.2 %
1.91 - 3.00	38.6 %
3.01 - 5.00	15.5 %
5.01 - 8.00	8.5 %
8.01 - 10.00	2.3 %
over 10.01	4.4 %

In the division parcels under 0.5 ha according to the size occupy 17% of the total area under vegetables, but they accounted for over 40% of the total. Out of over 22,674 entities that are dealing with vegetable production, only 643 are companies and over 97% are family farms. About 90% of the area under vegetables in the period 2005-09, belonging to following crops: potatoes, beans, cabbage, tomato, onions, watermelon, peppers, garlic, peas and cucumbers.

Vegetable crops in the period 2005-09 were grown on the following average area, production and yield by percentage share in the total production. Compared to countries that apply to major vegetable producers in the EU, on the territory of our country, despite the favorable conditions, the assortment is modest and fewer species are traditionally grown (mostly fruit, bulb and leafy vegetables).

Assortment - Despite relatively modest assortment of included species in vegetable production (49 and 21 type and subtype), the total number of recognized species is 886. On average for each type gardeners have availability of more than 18 varieties. Most of them are: tomato (150), potato (99), pepper (78), cabbage (72), onion (42), watermelon (41) salad (35), cauliflower (29) melon (27), cucumber (25), carrot (25), zucchini (19), endive (16), tomato (16), gherkin (15), peas (15), garlic (13), green beans (12), kale (12), radish (10), spinach (9), kohlrabi (9), leek (9), celery (9), broccoli (8), beans (8), decorative pumpkin (8), bottle gourd (8), brussels sprouts 5, parsley (5) and 15 other species and 5 eco-types. Out of this number, only 17 (1.9%) are domestic newly created varieties, mostly tomato (6), pepper, onion, cucumber and green beans (2), leek, spinach and peas (1).

Vegetable production in greenhouses - The total area of protected houses is changing in a very narrow boundary, averaging on about 4442 ha out of which under plastic houses is around 4,250 ha or 95.7%, while the glass houses are organized on 192 ha or 4.3% of the total area. Total production of the two types of protected houses is 302,830 t out of which 282,000 t or 93.1% from plastic houses, while the production in glass houses reaches 20,830 tons or 6.9%.

Table 3. Areas and total production in tonnes [t]

Vegetable crops		ẋ	%
Potato	Area (ha)	13.000	24
	Production, tones	191.000	25
	Yield (t/ha)	14.1	
Bean (including intercrop)	Area (ha)	13.500	24
	Production, tones	12.700	2
	Yield (t/ha)	9,4	
Cabbage	Area (ha)	3.950	7
	Production, tones	90.000	12
	Yield (t/ha)	22,8	
Tomatoes	Area (ha)	5.500	10
	Production, tones	125.800	17
	Yield (t/ha)	22,9	
Onion	Area (ha)	3.200	6
	Production, tones	37.500	5
	Yield (t/ha)	11,7	
Melons and watermelons	Area (ha)	6.300	11
	Production, tones	129.200	17
	Yield (t/ha)	20,5	
Pepper	Area (ha)	8.300	15
	Production, tones	141.200	19
	Yield (t/ha)	17	
Garlic	Area (ha)	1.000	2
	Production, tones	4.400	1
	Yield (t/ha)	4,4	0,6
Pea	Area (ha)	1.000	2
	Production, tones	2.100	0,3
	Yield (t/ha)	2,1	
Lentils	Area (ha)	100	0,2
	Production, tones	80	0,1
	Yield (t/ha)	0,8	
Cucumber	Area (ha)	1.400	2,5
	Production, tones	39.300	5
	Yield (t/ha)	26	

Effectiveness of the yields among the three leading crops grown in protected areas is in favor of glasshouses:

Table 4. Average annual production in greenhouses

Crops	Glasshouses [t/ha]	Plastic houses and tunnels [t/ha]
Tomato	99.2	60.0
Cucumber	150.0	100.0
Cabbage	35.8	33.0

Beside the cabbage where the difference is relatively small, only 2.8 t / ha or 8.5% in favor of glass houses for tomatoes the difference is highest; 39.2 t / ha, or 65.3%, and slightly lower in cucumber;50 t / ha or 50% more.

Vegetable consumption per capita - The consumption per capita in 2009 (data from SSO) amounted to 142.6 kg of fresh vegetables and 4.5 kg of processed vegetables. A total of 147.1 kg per capita vegetable used, 96.8% is consumed during the year fresh or processed in households and only 3.2% as a product of the processing industries.

Table 5. Vegetables consumption per capita

Vegetable product	Consumption per capita [kg]	Percentage of the total vegetable consumption
Potato	30.2	21.2
Pepper	28.5	20.0
Tomato	21.4	15.0
Cabbage	14.9	10.5
Melon	13.1	9.2
Onion	7.9	5.5
Beans	7.0	4.9
Legumes	1.4	1.0
Other	9.7	6.8

Processed vegetables - Vegetable needs as raw material for processing, according to the Macedonian Association of Processors (MAP) in the last period (2007-2009) averaged about 98,000 t. Most processing industries required; red pepper-type kapija around 47,000 tons or 48.0%, industrial tomato about 22,000 t or 22.5%, gherkins 5,000 tons or 5.1%, eggplant 4,600 t or 4.7%, beetroot 3,600 tons or 3.7%, cabbage 3,300 or 3.4%, peperoni 2,200 tons, or 2.3%, pepper-type bela kapija 2.300 t or 2.4%, pepper-type gamba 1,200 tons or 1.2% and onion 1.000 t or 1.0%.

The total amount is accounted on 92,200 t or 94.1% by these nine crops required for processing. Other vegetables that are required by processing industry in quantities are less than 1,000 tons per year (carrot, leek, green tomato, cauliflower, melon, green beans, broccoli, yellow pepper, onion, parsley, peas, etc). In the total amount they accounted 5,800 t or 5.9%.

Flower production

There is not a unified statistical data base neither for the domestic production neither for the trade with flowers, ornamental plants, seeds and seedling or bulbs and tubers. However, the growth in this sector is obvious: there are vast areas of public spaces decorated with flowerbeds almost in all Macedonian cities, the offer of bedding plants, cut flowers and flower pot plants is increasing and the number of companies dealing with landscaping and nursery sales is increasing .

The modest production of floriculture and ornamental plants at present in R. Macedonia is based on a long tradition. Until mid 80-ies of the last century, Macedonia was the main cut flower production

area, supplying the 22 million market of ex-Yugoslavia. In the last 15 years there is a trend of increasing number of private producers of flowers and ornamental plants.

According the statistics, in 2007 this production was developed on 691ha, but on small family farms, on the size of 1-3ha , even less than 0,5ha. In the last 15 years the most important are the production of : seasonal bedding plants, flower pot plants , cut flowers and ornamental plants.

Seasonal bedding plants - The production of seasonal bedding plants is of highest importance. This production becomes the most significant in the floriculture sector in R Macedonia.

Several producers became recognizable by quality products, investing and modernizing the infrastructure and equipment (Kitka in Skopje and Gradina Cvet in Vladevci). Recently they are the main suppliers of domestic market. The number of small producers of a vide range of products is also growing. No formal trade/distribution channel is organized by any of the respective producers. There is no evidence of the quantity of this production. It is estimated that in 2012 over 10 millions of seasonal bedding plants are produced. Cut flowers - Production of cut flowers (gerberas, chrysanthemums, callas, lilies, roses, alstromerias, irises) is small and seasonal, with modest quality and directed to the domestic market. This production is organized in plastic tunnels on family farms mostly located in Gevgelija, Skopje, Strumica and Bitola. The good example is the company Lilium from Bitola that has an average production of 100,000 stems of lilies, some calla and gladiola in plastic tunnels, export oriented.

Flower production and sales of cut flowers is not registered. However, some traders estimated that in summer period, this production cover close to 40% of domestic market. Seeds and seedlings for the above mentioned production are imported.Around fifty producers – professional farmers, work individually or through the registered companies. They all apply plastic tunnel production with drip irrigation, heating stations and small storage facilities. These producers trade their products either individually to the local flower shops or sell their products to the local distributors

Ornamental plants - Domestic production of ornamental and outdoor plants is organized by a number of private nurseries as well as several municipal public companies responsible for maintenance of the urban green areas such as Skopje, Bitola, Kavadarci, Strumica, Ohrid and Kumanovo. Three nurseries are big and important – the one in Tetovo region with 100ha and production of 300.000 tree, exported on the regional markets, then the nurseries in Bogdanci and Demir Kapija with diversified offer of outdoor plants of high quality for urban greenery and parks.

It is estimated that there are approximately 10-15 nurseries that traditionally produce limited range of outdoor plants with considerable variations in quality for local markets. The number of nurseries that import decorative trees and shrubs is increasing.

The nursery Hristovski in Bitola region, with production of approximately 150,000 rose trees per year, of which 1/3 is exported, has to be mentioned. Import and export of flowers and ornamental plants - There is only one Association of flower producers in the Country, in Gevgelija, established in 2005 with 28 individual members. The activities of the association are still very modest. Traders act mostly as importers specialized in particular segments. Most of the companies from this group are of small size and lack good storing / manipulation premises. However, there is one importer of pot plants with good storing facility, as well as one cut flowers importer/distributor that invested in cut flowers cold storage.

The import / export balance of the floriculture products in R. Macedonia fluctuates during the last years. For example in 2005 the value of the import was double of the size compared to the export, and in 2007, the values of the export and import were nearly identical. Export looks reasonably stable with the value of about 400,000 €. The import has a negative trend. In 2005 reached the value

of 755,000 € and in 2007 the value of the import vas only 416,000 €. It should be stressed that this reduction results from less imported outdoor trees. The value of imported cut flowers, especially roses, is increasing over the period 2005 – 2007. The roses are by far the most important cut flowers traded on domestic market.

Conclusions

Based on the presented data and brief analysis of vegetables and flowers production in the Republic of Macedonia, in order to increase the volume, quality, and competitiveness in this sector, the following suggestions and recommendations can be given:

- Farmers should be introduced to the biological properties of the varieties, their requirements, potential and required production technology. Over 900 varieties of vegetables are offered on the market, the most appropriate should be defined.
- To create positive interaction between the determining factors for yield, quality and earliness, a classification of vegetables and flowers, according to their biological needs is required. In some regions, larger quantities of a given vegetable, as it is the case with onion populations (buchinski gostivar), could be provide.
- Regulations for the implementation of appropriate healthy and certified seeds. Should be enforced. The last research showed the reduction of the yields and quality of certain vegetables, due to the low economic value of the seeds, or deformity of the seeds produced by the farmers themselves.
- Introduce the autochthony varieties that can be obtained, providing sufficient quantities of certain types that can create brand of vegetables of the Republic of Macedonia, and research the potentials for new varieties of flowers.
- It is recommended to improve the technologies for seedling production as the production of vegetables and flowers is growing.
- It is recommended to use the potentials in the South- Eastern and Central Vardar Region for early vegetable production in plastic houses, sector that should be governmentally supported.
- Introduce the IT in the process of planning, production, postharvest practices and distribution of vegetables, flowers and ornamental plants especially within the farmers.

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ПОСЛЕДНИ ТРЕНДОВИ ВО ПРОИЗВОДСТВОТО НА ЗЕЛЕНЧУК И ЦВЕЌЕ ВО РЕПУБЛИКА МАКЕДОНИЈА

Јанкуловски Данаил, Хаџи Пецова Стефанка, Мартиновски Ѓорѓи, Попсимонова Гордана, Агич Рукие

Апстракт

Секторот за градинарство и цвеќарство во нашата земја се од голема важност што се должи на нивниот пораст и извозен потенцијал, како и потенцијал за зголемување на нивната глобална конкурентност. Македонија има околу 50.000-60.000 хектари под зеленчук во земјава. Поголемиот дел од производството на зеленчук се продава за свежо на станските и домашните пазари. Индустријата за свеж зеленчук игра важна улога во националното земјоделството и македонската економија како резултат на приходот добиен од извозот во агробизнисот што доаѓа со продажбата на зеленчукот. Свежиот зеленчук придонесува со околу 10% од националниот БДП на годишна основа. Производството на свеж зеленчук е или на отворено или во стаклености и / или пластеници. Главни зеленчуци кои се произведуваат за свежо во стаклености и се извезуваат се доматот, краставицата и пиперката. Производството на свеж зеленчук е на регионално ниво и речиси 80% е од Југоисточна Македонија. Сепак во вкупното производство на зеленчук (и за свежа потрошувачка и за преработка) покрај Југоисточниот регион, други големи производители, особено за преработка на пиперката е Пелагонискиот регион. Сите останати региони во земјата произведуваат зеленчук, но количините од пиперка и домат се значително помали.

Производство на цвеќе и декоративни растенија во Република Македонија во моментов е скромно. Најважна е производството на едногодишните и двогодишните цвеќиња, организирани во јужниот дел на земјата и во Скопје. Во оваа група може да се додаде и саксиското цвеќе, бидејќи производството се реализира во пластеници. Се проценува дека во претходниот период беа произведени околу 6-8.000.000 различни видови на цветен расад. Производството на режен цвет е мало и организирано на семејни фарми главно лоцирани во регионот на Гевгелија. Декоративните растенија се произведуваат во неколку расадници кои нудат голем обем и висок квалитет на сорти.

Клучни зборови: зеленчук, цвеќе, производство, трендови.

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Review paper

CURRENT STATUS AND FUTURE PERSPECTIVES OF VEGETABLE GENETIC RESOURCES IN R. MACEDONIA

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Abstract
Genetic stock of vegetables, especially indigenous populations and old varieties, created throughout the centuries as a result of a long tradition of growing, represent valuable material and represents a significant genetic potential. A part of these local populations and species are endangered and threatens danger of extinction caused by intense technological development in the vegetable production, introduction of foreign hybrids and degradation of domestic vegetable seed production. All this provides good basis for their inventory, collection, long-term preservation and opportunity for their multifunctional use in order to prevent further genetic erosion. In R. Macedonia, recent activities regarding the preservation of vegetable genetic resources are made within SEEDNET program during the period 2005-2010. Vegetable Working Group organized several collection missions, as a result 507 accessions from 29 vegetables crops were inventoried and collected. The percentage of the total number of collected accessions is as follow: 30% belong to pepper collections, 10.6%- tomato, 9.3%- melons, 9.4%-onions, pumpkins -7.8%, with the remaining 24 vegetable crops percentage is small and ranges from 0.1% to 5.9%. Collected seed accessions have been documented in the main data base with adequate passport data following EURISCO descriptors, and then evaluated and partially uploaded in EURISCO data base. Accessions are stored in the gene bank, equipped for long-term storage-18^{o}C and short-term storage +4 ^{o}C, located in the Institute of Agriculture in Skopje.
Key words: vegetable crops, genetic resources, conservation.

Introduction

Vegetable crops include a large number of species, mainly used as an essential complement to the daily diet, providing vitamins, minerals, fibre, specific amino acids and other active metabolites. Increasing the use of vegetables is considered to offer healthy benefits in all dietary situations. Some vegetables such as tomatoes, cabbages, watermelons and onions are among the most important crops according to total world production (FAO, 2001). Several authors have reviewed vegetable genetic resources in the last twenty years (Sloten, 1980; Crisp and Astley, 1988; Cross, 1998), largely emphasizing the need to accumulate and conserve in genebanks the genetic diversity that is most useful to breeders. One of the primary reasons to sustain conservation of plant genetic resources in genebanks is to prevent the loss of genetic diversity. Thus genebank material is becoming more attractive to breeders. At the same time, the management of collections can be based on better knowledge of the diversity in stock. The enhancement of the links between germplasm conservation and use will continue to depend, inter alia, on easy access to the genetic material (Magioni, 2004).

The Republic of Macedonia is small in territory (25713km^2), but the topography and the climatic conditions are very diverse. The specific climatic environment has caused creation of different vegetable landraces with certain degree of diversity (Martinovski Gj, Jankulovski D., 1994). They are cultivated in a traditional way in the garden, in a very small space in rural areas, without the use of pesticides. All this is a good basis for a more serious approach to research spicy vegetables in terms of inventory, collection, long-term conservation, and the possibility of their multipurpose use.
A part of these local populations and species are endangered and threatens danger of extinction caused by intense technological development in the vegetable production, introduction of foreign hybrids and degradation of domestic vegetable seed production (Agic et al, 2009.)
In the past, from 1969 to1973, several collecting missions were conducted in the Republic of Macedonia, as bilateral and international agreements, mostly with the USA. In lack of adequate storage facilities the collected germplasm from Macedonia was stored in gene banks at the National Seed Storage laboratory, Ford Collins, Colorado, USA.
The initiation of the SEED Net project in 2005 has facilitated and supported further national activities, along with forced cooperation among the countries in the region. In 2004 the SEEDnet program (South East European Development Network on Plant Genetic Resources) (http://www-seednet.cbm.slu.se), financed by Sida, was established with the purpose of supporting the countries in their efforts to establish and strengthen national and regional activities on PGR with special focus on conservation, utilization, collaboration and networking among the stakeholders at both national and regional levels. SEEDNet network was established, among the following partners: Albania, Macedonia, Kosovo, Serbia, Montenegro, Federation of Bosnia and Hercegovina, Republika Srpska, Croatia and Slovenia, Bulgaria, Greece, Romania, Hungary and Moldavia. The partners included in the network have to make active cooperation in the field of plant agro biodiversity conservation and use. The Institute of Agriculture, Skopje, was responsible for maintenance of all collections in genebank. Total storage capacity of the long-term storage chamber is 10 000 seed accessions, consisting of 30 vertical freezers (-18°C to -20°C). These capacity is fully sufficient for the activities planned in the next 5 years. Genebank was also equipped for preparation of seeds before storing. Infrastructure and capacities for seed collecting and storing were restructured, upgraded and improved, base, active and duplicate collections. Base and active collections are maintained at -18^{o}C. Temporary and working accessions are stored at +4^{o}C. Six working groups were established at the beginning of the project (cereals WG, vegetables WG, forage WG, industrial crops WG, fruit and Vitis WG and MAPsWG). They are organized and active both on national and on regional level. Academic staff from the Institute of Agriculture and Faculty of Agricultural science and food has participated in vegetable working group coordinated by curator. Within the first three years of the project lot of activities were performed for raising scientific, governmental and public awareness. Within this project, human capacities for conservation of PGR were upgraded through various trainings and workshops, organized by NGB, CBM, or by various education and research institutions in the countries participating in SEEDNet (Kratovalieva et al, 2009).

Material and methods

In order to achieve the strategic goals of SEEDNet vegetable working group, which are long-term conservation and sustainable utilization diversity of vegetable resources of East Europe through a well coordinated functional vegetable network, the activity from 2005-2010 are conducted at national and regional level.
Within the regional activities vegetable working group participated in three projects with titles:

1. Collection, Characterization and regeneration of indigenous onion (*Allium cepa* L.) and leek (*Allium porrum* L). germplasm for further ex-situ conservation, 2006- 2010“, as regional coordinator
2. South East European Solanaceae Germplasm Collection, Conservation and Sustainable Use, as a nacional coordinator
3. Pilot project of collecting the seed of local vegetable population by school children in some counties in Croatia and Macedonia, as a national coordinator

The achievement of these objectives and goal was foreseen through the following activities: inventorying of existing national vegetable genetic resources; compilation of regional list of Solanaceae genetic resources; national vegetable collecting missions; collected vegetable accessions multiplication and regeneration; national conservation's capacity evaluation; vegetable genetic resources characterization; regional vegetable database compilation. Implementation of certain activities is in accordance with international standards for gene bank prescribed by IPGRI (Guide to effective management of germplasm collections, IPGRI (Popsimonova et al. 2009). All passport data are being checked by the gene bank manager before uploading to EURISCO database. List of PGR in collections is prepared to be published in illustrated catalogue form (Kratovalieva et al, 2009).

Results and discussion

Vegetable Working Group organized several collection missions from 2005-2010, as a result 507 accessions from 29 vegetables crops were inventoried, collected, described and documented.

Inventorization and collection

During the collection expeditions we determined the target areas for inventory and collection of vegetable crops and fill out the collection forms and inventorying lists by EURISCO descriptors (passport data of all collections, recorded and computerized). Also, we were provided with all available information about traditional growing systems, local method of plant protection, utilization for consumption or as medical plants.

The large part of these vegetable accessions is represented by the mandate species where priority was given on old varieties and landraces, while minor vegetables are numerically much less represented. In mandatory list are included the species from the following families: Alliaceae, Brassicaceae, Solanaceae, Fabaceae, Cucurbitaceae, Asteraceae, Apiaceae, Chenopodiaceae. During the implementation of the Solanaceae projects several expeditions were conducted. A survey of Solanaceae genetic resources in R. of Macedonia was made by the participants of the VWG, focusing on tomato, pepper and eggplant. The visited places for Solanaceae collection is listed below: v. Sulan, v. Spas, v. Mogorce, v. Volino, v. Drslajca, v. Vak'v, v. Sermenin, v. Predjci, Predgradie, v. Veljusa v. Dobrejci, v. Dabile, v. Gradosorci, v. Zleovo. v. Gorno Lisice-Skopje, v. Grdovci-Kocani, v. Brazda- Skopje, v. Radovo- Strumica, v. Dobrejci- Strumica, v. Sopri-Valandovo. The percentage of the total number of collected accessions is as follow: 30% belong to pepper collections, 10.6%- tomato, 9.3%- melons, 9.4%- onions, pumpkins -7.8%, with the remaining 24 vegetable crops percentage is small and ranges from 0.1% to 5.9% (Table1.). From 2007-2010, the vegetable working group organized four collection missions in the South, West, Central, and South-West regions, mainly in rural areas, home gardens and traditional farms for the purpose of the Alliaceae project. As a result 48 onion accessions have been collected pungent types of onion produced by sets with yellow colour, and summer sweet onion landraces).

The other 21 were leek landraces with different light and dark green colour and a long stem. Each sample from the terrain is followed by: a unique collection number, GPS data, information about traditional method of cultivation and use, which are included in the Macedonian Collection form and photo documentation.

The detailed information for visited geographical localities with onion and leek is presented as follow: Struga- *v.Korosista, v.Vranista,* Ohrid- *v.Orman, v.Trebenista, v.Leskoec,* Bitola- *v. Lazec* Prilep- *v.Vogjani, v. Pasino Rufci* Gevgelija- *v.Prdejci , v. Mrzenci* Strumica- *v. Vasilevo, v. Dobrejci, v. Gradosorc, v.Veljusa v.S'cevo,* Skopje- *v.Gluvo, v. Dracevo, v. Lisice, v. Brazda* Kumanovo- *v. Dobrosane* Gostivar- *v. Gorna Banjica, v. Cajle* Debar- *v. Sulan, v. Spas* Valandovo- *v. Sopri.*

Passport data of vegetable genetic resources are well documented in Excel databases according to genebank standards, a database management system which is regularly updated and maintained. Database is not jet searchable on-line, but are our efforts for the future activities. Collected seed accessions have been documented in the main data base with adequate passport data following EURISCO descriptors, and then evaluated and partially uploaded in EURISCO data base.

EURISCO is a web-based catalogue that provides information about ex situ plant collections maintained in Europe. 72% of the vegetable accessions with passport data are uploaded in EURISCO data base. Accessions are stored in the gene bank, equipped for long-term storage-18^{o}C and short-term storage +4 ^{o}C, located in the Institute of Agriculture in Skopje.

Characterization

Characterization is mostly based on morphological description with the use of recommended IPGRI Descriptor lists, UPOV Guidelines for every accession for determination of important characteristics. So far, 114 accessions (22.52%) of the total number of accessions are characterized, based on morphological and phenological traits (Table 1, Figure1). Characterization is made in the following crops: tomatoes (50%), peppers (37,5%), beans (100%) of the total number of collected accession.

Table1. Status of the vegetable collection during period of 2005-2010 year

No	Latin name/ common name	No. of coll. acc.	% of total	No. of acc. in EURISCO	% of coll. acc.	No. of regenerated acc.	% of coll. acc.	No. of caracterizated acc.	% of coll. acc.
1.	Lycopersicon esculentum L./tomato	54	10.67	42	77.78	27	50	27	50
2.	Capsicum annuum L./ pepper	152	30.04	123	80.92	12	7.89	57	37.50
3.	Solanum melongena L./ eggplant	4	0.79	4	100		0		
4.	Citrullus lanatus (Thunb.) Matsum. & Nakai/ watermelon	21	4.15	3	14.29	18	85.71		
5.	Cucumis melo L./ melon	47	9.29	9	19.15	37	78.72		
6.	Cucumis sativus L./ cucumber	6	1.19	4	66.67		0		
7.	Cucurbita sp./ pumpkin,squash	40	7.91	14	35		0		
8.	Lagenaria siceraria (Molina) Standl./ bottle gourd	6	1.19	6	100		0		
9.	Allium cepa L./ onion	48	9.49	40	83.33	26	54.17		
10.	Allium porrum L./ leek	21	4.15	14	66.67	7	33.33		
11.	Brassica oleraceae var. capitata L./ cabbage	13	2.57	13	100		0		
12.	Raphanus sativum var major/ radish	2	0.40	2	100		0		
13.	Phaseolus vulgaris L./ bean	30	5.93	30	100	30	100	30	100
14.	Phaseolus vulgaris var vulgaris/ green beans	16	3.16	16	100		0		
15.	Vigna angularis (Willd.) Ohvi & H. Ohashi/ bean, adzuki	2	0.40	2	100		0		
16.	Lactuca sativa L./ lettuce	5	0.99	5	100		0		
17.	Petroselinum crispum (Mill.) Nyman ex. A. W. Hill/ parsley	5	0.99	5	100		0		
18.	Apium graveolns L. var rapaceum/ celery	4	0.79	2	50		0		
19.	Pastinaca sativa L./ wild parsnip	4	0.79	4	100		0		
20.	Beta vulgaris L. subsp. Vulgaris/ beet root	3	0.59	3	100		0		
21.	Spinacia oleraceae l./ spinach	4	0.79	4	100		0		
22.	Rumex patientia L./ patience-dock, greens	4	0.79	4	100		0		
23.	Abelmoschus esulentus L.(Moench)/ lady's Fingers	9	1.78	9	100		0		
24.	Ocimum basilicum L./ sweet basil	1	0.20	1	100		0		
25.	Daucus carota L./ carrot	1	0.20	1	100		0		
26.	Anethum graveolens l./ dill, caper	1	0.20	1	100		0		
27.	Pisum sativum/ pea	2	0.40	2	100		0		
28.	Brassica oleraceae var. italica L./ broccoli	1	0.20	1	100		0		
29.	Total	506		364	71.94	157	31.03	114	22.53

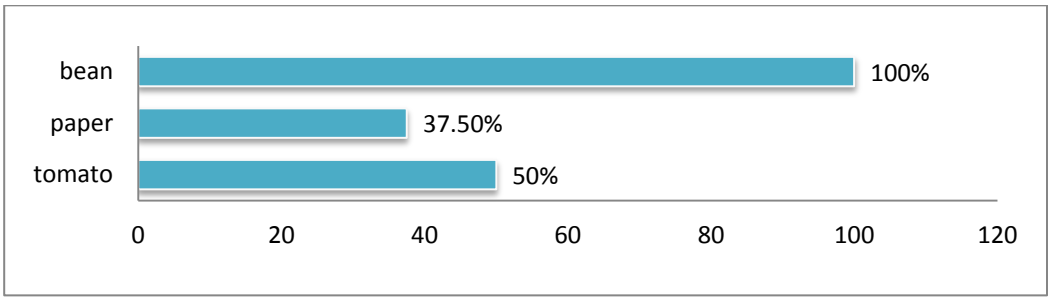

Figure 1. Distribution of the characterized accessions by crops

Regeneration

For multiplication needs, 157 accessions (31%) have been regenerated and were kept ex-situ and in the genebank. For that purpose the field trials were conducted. The percentage of the total number of regenerated accessions is as follow: 7.8% belong to pepper collections, leek 33%, 50%- tomato, 54%- onions, 78%- melons, 85.7%-watermelon, 100%-been (Figure 2). All data were properly documented in uploaded in on-line documentation system.

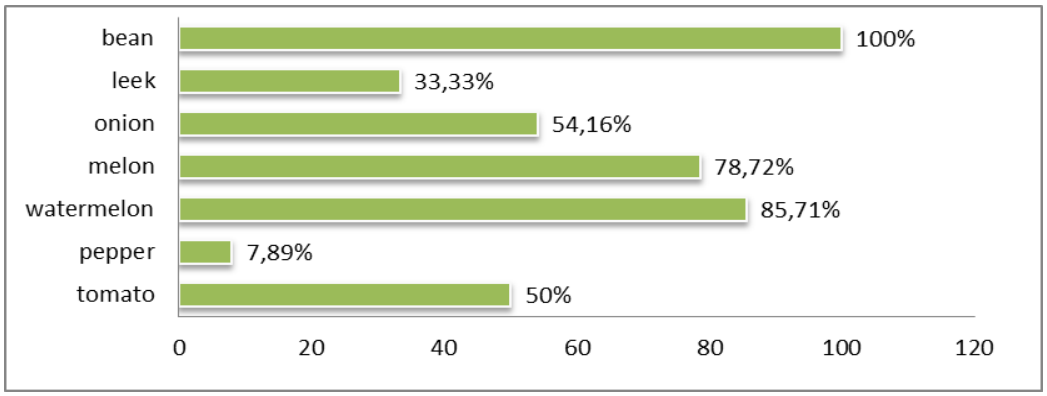

Figure 2. Distribution of the regenerated accessions by crops

Conclusions

During 2005-2010, SEEDnet project have enormously contributed to the management of vegetable genetic resources in South East countries, in national and regional level. Collaboration among the countries has been crucial for harmonization and transfer of the data and extends the scope of joint activities to the whole range of vegetable crops, obtained new knowledge tool for their conservation, long term preservation of accessions, strengthen collaborations and sharing responsibilities among vegetable working group. Future activities should be devoted to official establishment of National programme and strategy on PGRFA conservation on national level, followed by signing of International Treaty on PGR. Intensive pressure on Government for achievement of higher political awareness and continuous support in gene bank management (regeneration, characterization, evaluation of inventoried accessions, organization of mission for collection).

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СЕГАШНА СОСТОЈБА И ИДНИ ПЕРСПЕКТИВИ НА ГРАДИНАРСКИ ГЕНЕТСКИ РЕСУРСИ ВО Р. МАКЕДОНИЈА

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Апстракт

Генетскиот фонд од градинарски култури, особено автохтоните популации и стари сорти, створени низ векови како резултат на долгата традиција на одгледување, е вреден материјал и преставува значаен генетски потенцијал. Дел од овие локални популации и видови се загрозени и им прети опасност од изчезнување предизвикано од интензивен технолошки развој во градинарското производство, индродукција на странски хибриди и запоставување на домашно семепроизводство. Сето ова, дава добра основа нивно инвенторирање, колекционирање, долгорочна конзервација и можност за нивна повеќе наменска употреба, со цел да се спречи понатамошната генетска ерозија. Во Р. Македонија, понови истражувања во поглед на презервација на градинарските генетски ресурси се направени во рамките на СЕЕДНЕТ програмата, во периодот од 2005-2010 година. Работната група по градинарство организираше повеќе колекциони мисии, при што беа инвенторирани и колекционирани 507 примероци од 29 градинарски култури. Од вкупниот број колекционирани примероци процентуалната застапеност по култури е следна: 30% - пиперка, 10,6% - домати, 9,3% - дињи, 9,4% - кромиди, 7,8% - тикви, кај останатите 24 култури се движи од 0,1% - до 5,9%. Колекционираните семенски примероци се документирани во главната дата база со адекватни пасошки податоци по EURISCO дескриптори, а по направена проценка се препраќаат во базата на податоци EURISCO. Примероците се чуваат во ген банка, опремена за долгорочна чување на -18^{o}C и краткорочно чување на +4^{o}C, лоцирана во Земјоделскиот институт во Скопје.

Клучни зборови: градинарски култури, генетски ресурси, конзервација.