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Phenological and Production Characteristics of Some Strawberry Varieties in the Region of Skopje

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Abstract

Phenological and production characteristics have been observed on 17 strawberry varieties. The earliest flowering was observed in Honeoye and Eris (5 April). The latest flowering variety is Onda (13 April). Eris, Honeoye, Madlen and Onda are varieties with the earliest time of ripening period (12–14 May). The latest ripening period was registered in Evita, Tethis, Favette, Senga Sengana, Idea and Camarosa (17–18 May). Belrubi has the largest fruits (36.2 mm high, 32.6 mm wide and 39.1 mm thick). Senga Sengana has the smallest dimensions (27.8x25.7x22.8mm). The fruit mass ranged from 5.7g (Senga Sengana) to 11.1g (Madlen). The highest yield per plant was observed in Pocahontas (575.1g) and Evita (550.7g), while the lowest in Favette (297.9g). The yield per acreage ranges from 8,276 kg/ha (Chandler) to 17,770 kg/ha (Pocahontas).

Key words: strawberry, variety, blooming, ripening, productivity, weight, yield.

Introduction

The recommendation of an assortment list is fairly dynamic and prone to changes and it requires continuous tracking, introduction and research, which necessitates the regular selection of the best commercial varieties (Mišić i Nikolić, 2003). In recommending the strawberry varieties, their phenological and productivity characteristics are well studied by various authors, who have made classifications by ripening group, starting from the early varieties to the late ones, classifications according to fruit mass, yield, quality of fruits and a different level of resistance to disease (Nenadović-Mratinić et al. (2006), Nikolić et al., (2007), Faedi et. al. (2000).

Annual strawberry production in the Republic of Macedonia is around 3-5000 t, mainly based on Senga Sengana and partially Pocahontas. Production is on the open

field, with no adequate and quality, but mixed planting material which produces low and unequal yields (6.15 t/ha).

The aim of this paper is to examine the phenological and production characteristics of 15 introduced high quality strawberry varieties and to improve the assortment in the R. Macedonia.

Materials and methods

The analysis was performed in an experimental orchard of the Agricultural Institute in Skopje during 2002–2004. The experiment was established in the second half of September 2001, with a frigo virus-free planting material, in three repetitions in a line, consisting of 30 plants of each repetition (variety). The cultivation system was an open field, in two-row lines (long plots method), on black polyethylene foil at distance of 40x30 cm. The plants were irrigated with controlled quantities of water, through the drop-by-drop system. The soil was homogeneous, alluvial, possessing a good water-air regime, suitable for strawberry growing. The agrochemical composition of the soil consisted of 0.93-2.05% hummus, 9.32-10.38mg/100g N, 14.3-21.1mg/100g P_2O_5, 10.06-22.2 mg/100g K_2O, 6.49-7.25% $CaCO_3$, pH 7.93-8.19 in H_2O and 7.4-7.63 in KCl. Based on the analyses, the soil has been ameliorative fertilised with mineral and organic fertiliser from California worms. Phenological and pomological characteristics were observed on 15 strawberry varieties introduced from Italy*:* Idea, Camarosa, Belrubi, Evita, Honeoye, Tethis, Onda, Chandler, Miranda, Paros, Elsanta, Eris, Madlen, Favette and Marmolada, and two standard varieties: Senga Sengana and Pocahontas. The following characteristics were studied: time and period of flowering and ripening, fruit weight (g), dimension of fruit (mm), yield per plant (g) and yield per acreage (kg/ha). Analyses of variance were performed with a significance level of 95% and 99%, followed by an LSD – test.

Results and discussion

The studied varieties of strawberry started to blossom (Table 1). The average blossoming period is 27 days, while the full blossoming period amounts to 37 days. The Honeoye and Chandler have the shortest blossoming period (24 days), while Evita, Marmolada and Camarosa had the longest (30 days). The earliest blossoming was noted in 04 (March 30). The same year saw the longest blossoming period (44 days). In accordance with the beginning of blossoming, the examined varieties of strawberry have been divided into 3 groups: early- blossoming varieties (April 5-7 on average): Honeoye, Eris, Madlen, Evita, Chandler, Belerubi and Tethis; medium – blossoming (April 8-10): Marmolada, Elsanta, Pocahontas, Paros, Favette and Miranda and late-blossoming varieties (April 11-13): Camarosa, Senga Sengana, Idea and Onda. The Madlen variety did not blossom in 2002, due to the late planting which resulted in the inability of the fruits to produce a timely differentiation of floral buds.

Tab.1. Time of blooming
Vrijeme cvjetanja

No	Cultivar	Year	Date		Number of days
			Beginning	End	
1	Honeoye	2002	5.04	29.04	25
		2003	11.04	30.04	20
		2004	30.03	25.04	27
		Average	5.04	28.04	24
2	Eris	2002	5.04	30.04	26
		2003	11.04	30.04	20
		2004	30.03	27.04	29
		Average	5.04	29.04	25
3	Madlen	2002	/	/	/
		2003	12.04	4.05	23
		2004	31.03	2.05	33
		Average	6.04	3.05	28
4	Evita	2002	6.04	7.05	32
		2003	12.04	5.05	24
		2004	31.03	4.05	35
		Average	6.04	5.05	30
5	Chandler	2002	6.04	28.04	23
		2003	12.04	1.05	20
		2004	2.04	29.04	28
		Average	6.04	29.04	24
6	Belrubi	2002	7.04	2.05	26
		2003	12.04	3.05	22
		2004	2.04	1.05	30
		Average	7.04	2.05	26
7	Tethis	2002	7.04	6.05	30
		2003	12.04	4.05	23
		2004	3.04	4.05	32
		Average	7.04	4.05	28
8	Marmolada	2002	8.04	7.05	30
		2003	12.04	7.05	26
		2004	3.04	5.05	33
		Average	8.04	6.05	30
9	Pocahontas	2002	7.04	8.05	32
		2003	13.04	4.05	22
		2004	5.04	4.05	30
		Average	8.04	5.05	28
10	Elsanta	2002	11.04	7.05	26
		2003	13.04	6.05	24
		2004	4.04	4.05	31
		Average	9.04	6.05	27
11	Paros	2002	11.04	7.05	27
		2003	14.04	5.05	22
		2004	5.04	6.05	32
		Average	10.04	6.05	27
12	Favette	2002	9.04	6.05	28
		2003	15.04	6.05	22
		2004	5.04	6.05	32
		Average	10.04	6.05	27
13	Miranda	2002	9.04	8.05	30
		2003	15.04	7.05	23
		2004	7.04	10.05	34
		Average	10.04	8.05	29
14	Camarosa	2002	11.04	9.05	29
		2003	15.04	9.05	25
		2004	7.04	12.05	36
		Average	11.04	10.05	30
15	Senga Sengana	2002	10.04	6.05	27
		2003	15.04	7.05	23
		2004	7.04	7.05	33
		Average	11.04	7.05	28
16	Idea	2002	12.04	7.05	26
		2003	15.04	6.05	22
		2004	8.04	8.05	31
		Average	12.04	7.05	26
17	Onda	2002	14.04	11.05	28
		2003	16.04	8.05	23
		2004	8.04	9.05	32
		Average	13.04	9.05	28
Average		2002	9.04	6.05	28
		2003	13.04	5.05	23
		2004	4.04	4.05	31
		02/04	7.04	5.05	27
Blooming interval		2002	4.04	11.05	37
		2003	11.04	9.05	29
		2004	30.03	12.05	44
		02/04	5.04	11.05	37

Tab.2. Time of ripening
Vrijeme zrenja

No	Cultivar	Year	Date		Number of days
			Beginning	End	
1	Eris	2002	15.05	8.06	25
		2003	12.05	12.06	32
		2004	9.05	13.06	36
		Average	12.05	11.06	31
2	Madlen	2002	/	/	/
		2003	13.05	11.06	30
		2004	11.05	15.06	26
		Average	12.05	13.06	28
3	Honeoye	2002	21.05	7.06	18
		2003	12.05	11.06	31
		2004	9.05	15.06	38
		Average	14.05	11.06	29
4	Onda	2002	16.05	11.06	27
		2003	13.05	11.06	30
		2004	14.05	15.06	33
		Average	14.05	12.06	30
5	Elsanta	2002	23.05	5.06	14
		2003	12.05	11.06	31
		2004	10.05	12.06	34
		Average	15.05	9.06	26
6	Paros	2002	23.05	7.06	16
		2003	13.05	11.06	30
		2004	12.05	14.06	34
		Average	16.05	11.06	27
7	Marmolada	2002	21.05	11.06	22
		2003	13.05	12.06	31
		2004	12.05	12.06	32
		Average	15.03	12.06	28
8	Chandler	2002	16.05	9.06	25
		2003	13.05	6.06	25
		2004	15.05	12.06	29
		Average	15.05	9.06	26
9	Pocahontas	2002	16.05	7.06	23
		2003	15.05	14.06	31
		2004	15.05	17.06	34
		Average	15.05	13.06	29
10	Miranda	2002	22.05	4.06	14
		2003	13.05	11.06	30
		2004	13.05	15.06	34
		Average	16.05	10.06	26
11	Belrubi	2002	16.05	8.06	24
		2003	16.05	11.06	27
		2004	16.05	15.06	31
		Average	16.05	11.06	27
12	Evita	2002	18.05	9.06	23
		2003	16.05	11.06	27
		2004	17.05	16.06	31
		Average	17.05	12.06	27
13	Tethis	2002	19.05	10.06	23
		2003	16.05	8.06	24
		2004	17.05	13.06	28
		Average	17.05	10.06	25
14	Senga Sengana	2002	16.05	7.06	23
		2003	17.05	16.06	31
		2004	18.05	15.06	29
		Average	17.05	13.06	28
15	Favette	2002	19.05	9.06	22
		2003	17.05	11.06	26
		2004	17.05	12.06	27
		Average	18.05	11.06	25
16	Idea	2002	16.05	3.06	19
		2003	18.05	12.06	26
		2004	19.05	16.06	29
		Average	18.05	10.06	25
17	Camarosa	2002	1.06	9.06	9
		2003	18.05	14.06	28
		2004	20.05	20.06	32
		Average	26.05	14.06	20
Average		2002	19.05	8.06	21
		2003	15.05	11.06	28
		2004	14.05	15.06	33
		02/04	16.05	11.06	27
Ripening interval		2002	15.05	11.06	28
		2003	12.05	16.06	36
		2004	9.05	20.06	43
		02/04	12.05	16.06	36

Tab. 3. Dimension of fruit (mm)
Dimenzije ploda (mm)

No.	Varieties	Average dimension of fruit 2002-2004, mm											
		2002			2003			2004			2002 / 2004		
		Hight	Widthe	Thickness	Hight	Widthe	Thickness	Hight	Widthe	Thickness	Hight	Widthe	Thickness
1	Idea	30,4	29,3	26,7	30,2	28,2	24,9	34,0	31,5	28,6	31,5	29,7	26,7
2	Camarosa	28,9	34,1	31,2	28,1	31,1	27,8	32,0	35,7	32,0	29,7	33,6	30,3
3	Belrubi	39,8	37,1	34,3	31,5	28,2	24,2	37,2	32,4	28,6	36,2	32,6	29,1
4	Evita	41,9	28,4	25,6	41,0	25,2	25,5	41,7	29,6	25,6	41,5	27,7	25,6
5	Honeoye	30,8	29,7	28,3	30,1	27,9	25,4	31,8	31,2	29,0	30,9	29,6	27,6
6	Tethis	34,9	29,8	27,5	32,1	29,3	26,2	35,0	31,7	28,7	34,0	30,3	27,5
7	Chandler	35,1	32,0	28,0	23,2	20,3	17,3	33,3	29,1	25,6	30,5	27,2	23,6
8	Onda	33,3	33,8	30,4	29,9	30,4	25,8	32,9	35,0	28,3	32,0	33,1	28,1
9	Pocahontas	26,3	28,3	26,0	28,3	27,1	24,2	32,0	31,8	28,7	28,9	29,1	26,3
10	Senga Sengana	26,6	24,1	21,7	28,8	26,5	22,7	28,1	26,4	23,9	27,8	25,7	22,8
11	Miranda	34,7	36,8	34,7	29,8	31,0	28,8	31,2	33,9	30,2	31,9	33,9	31,2
12	Paros	35,2	36,8	33,0	30,2	29,1	26,0	33,0	31,9	28,9	32,8	32,6	29,3
13	Elsanta	35,1	40,7	37,7	28,8	28,0	24,9	26,7	26,1	24,0	30,2	31,6	28,8
14	Eris	35,8	36,6	33,5	29,3	28,4	25,2	29,1	26,9	25,2	31,4	30,6	28,0
15	Madlen	/	/	/	33,0	31,3	27,5	35,8	33,1	30,5	34,4	32,2	29,0
16	Favette	32,0	32,2	29,8	32,3	29,5	26,1	27,4	26,6	24,3	30,6	29,4	26,7
17	Marmolada	34,6	34,6	32,3	33,1	30,7	26,9	29,8	28,2	25,6	32,5	31,2	28,3
	Average	33,5	32,8	30,0	30,6	28,4	25,3	32,4	30,7	27,5	32,1	30,6	27,6

LSD 0,05=2,21 LSD 0,01=3,15

Tab. 4. Fruit mass (g); yield g/plant and yield kg/ha
Masa ploda (g); prinos g/biljci i prinos kg/ha

N°	Varieties	Fruit mass, g				Yield g/plant					Yield kg/ha				
		2002	2003	2004	2002 / 2004	2002	2003	2004	2002 / 2004	2003 / 2004	2002	2003	2004	2002 / 2004	2003 / 2004
1	Idea	11,8	6,2	9,5	8,6	59,0	209,7	641,5	272,8	417,5	2772	9888	28512	13724	19349
2	Camarosa	17,1	7,8	12,0	10,4	4,8	283,8	736,1	311,8	503,7	212	13293	32716	15407	23130
3	Belrubi	14,8	6,9	12,3	11,3	30,3	122,3	872,5	306,4	486,5	1446	5516	38775	15246	22192
4	Evita	14,0	5,7	8,9	7,7	33,5	320,6	789,4	366,7	550,7	1495	15733	35084	17438	25692
5	Honeoye	12,1	5,9	9,2	8,3	15,4	210,4	861,8	349,9	530,2	652	9625	38300	16192	24022
6	Tethis	17,2	5,3	12,3	10,7	70,4	155,4	684,4	209,1	407,3	3102	7951	30418	13823	19486
7	Chandler	15,3	3,0	9,2	9,5	91,4	217,0	429,4	140,6	323,2	4414	1329	19086	8276	10310
8	Onda	19,2	7,2	11,9	10,4	80,3	245,7	791,7	285,9	454,1	3615	11240	35186	16680	23275
9	Pocahontas	11,9	4,9	9,5	7,3	27,1	359,3	804,4	381,7	575,1	1300	16257	35752	17770	26061
10	Senga Sengana	7,6	4,8	6,6	5,7	20,6	400,6	471,4	262,6	434,1	993	18481	20952	13475	19848
11	Miranda	16,7	10,0	10,3	10,3	27,1	293,9	595,3	294,3	440,9	1156	13119	26457	13578	19775
12	Paros	15,3	7,9	10,8	9,7	10,0	239,9	590,2	229,5	401,3	431	10969	26230	12543	18689
13	Elsanta	18,7	6,6	9,0	7,4	10,6	302,7	382,3	188,6	326,7	453	13533	16989	10325	15278
14	Eris	13,7	7,0	8,2	7,6	21,4	432,1	613,3	279,0	501,8	980	19262	27486	15910	23329
15	Madlen	/	10,2	12,2	11,1	0,0	412,0	513,7	280,1	458,9	/	18701	22832	13844	20838
16	Favette	15,1	7,2	9,8	8,7	98,7	294,5	306,1	205,0	297,9	4526	13691	13662	10626	13787
17	Marmolada	18,3	7,8	10,6	9,4	92,5	352,2	400,7	248,0	367,5	4059	15691	18953	12901	16900
	Average	15,0	6,7	10,0	8,7	40,8	282,5	652,5	277,8	445,5	1859	12605	27494	13986	20116
		LSD 0,05=1,29 LSD 0,01=1,74				LSD 0.05=21.82 LSD 0.01=29.34					LSD 0.05=1640,12 LSD 0.01=2250,17				

This corresponds with the tests of Selamovska (2006) conducted at the same time and at the same location with the strawberry varieties, namely Senga Sengana and Pocahontas, concluding that the optimal planting period in the Skopje region is around 15 August. Kiprijanovski (2001) concludes that Pocahontas blossoms in the first decade of April in the Skopje region, with duration of 20 to 24 days. According to Veleva and Tešić (1973), Senga Sengana begins to blossom in the second decade of April, while according to Blagojević (1999) this happens in the first half of May, with a duration of around 20 days. Paunović et. al. (1974) state that Pocahontas has medium-length duration of blossoming. According to Milivojević (2003), in the region of Belgrade, Marmolada, Elsanta and Senga Sengana start blossoming in the third decade of March, while the blossoming comes to a close in the first decade of May. It reaches very high average values for the blossoming duration from 46 to 47 days. Regarding Honeoye, Stanisavljević et al. (1997) point out that it has a long blossoming period of 35 days, stretching from the middle of April to the second decade of May, while Senga Sengana begins to blossom several days later. Dénes (1997) determines the commencement of blossoming of the Elsanta and Senga Sengana varieties on the 24 and 25 April, respectively, with both varieties blossoming periods coming to a close on 30 May.

The varieties have a fruit ripening from 12 May to 16 June, in an interval of 36 days (Table 2). Early ripening varieties (beginning from 12 to 14 May) are: Eris, Honeoye, Madlen and Onda. Medium-ripening varieties (beginning from 15 to 16 May) are Elsanta, Paros, Marmolada, Miranda, Chandler, Pocahontas and Belrubi. Late ripening varieties (beginning from 17 to 18 May) are Evita, Tethis, Favette, Senga Sengana, Idea and Camarosa. According to Milivojević (2003), the average ripening of Marmolada, Elsanta and Senga Sengana lasts from 18 May to 6 June, with duration of 20 days. According to Selamovska (2006), Pocahontas ripens from 12 May to 5 June, while the Senga Sengana from 15 May to 8 June, with a ripening interval from 24 to 25 days. Blagojević (1999) places the ripening period between 23 May and 10 June, with an average duration of 17 days.

In 2002, the average fruit weight of the examined varieties was 15.0 g, twice as much as in 2003 (6.7 g) (Table 4). The average for 2002/2004 was 8.7 g. Most varieties have large fruits (9-14g), namely: Belrubi, Madlen, Tethis, Camarosa, Chandler, Onda, Miranda, Paros and Marmolada. Medium sized fruits (7-9 g) are found with Idea, Evita, Honeoye, Pocahontas, Elsanta, Eris and Favette. Only the standard variety Senga Sengana has small fruits (5-7 g).

According to Milivojević (2003), in the region of Belgrade, the fruit weight with the Marmolada reached 14.6 g, Elsanta had 14.10 g and Senga Sengana 8.01 g. Nenadović-Mratinić et. al. (2006), ascertained a fruit weight of 9.73g by Evita, 10.60g Favette, 11.04g Eris, 11.66g Madlen. Blagojević (1999) achieved a high average weight of the fruit amounting to 16.6g, with a variation of 13.5g Senga Sengana to 20.3g Red Gauntlet. Kiprijanovski (2001) ascertains average fruit weight values of 8.48g (from 8.11g Pocahontas to 8.86 g Red Gauntlet).

The average size of the fruit with the examined varieties amounts to: 32.1x30.6x27.6mm (Table 3). The largest fruits were measured in 2002. Belrubi is the variety with the largest fruit, while the smallest is the control Senga Sengana (Table 3).

Under unchanged growing conditions and technology, the genotype is a decisive factor in the ampleness and quality of the yield. The year 2002 saw the least amount of yield, amounting 40.8 g per plant (Table 4) as a result of late planting. In order to judge the yield and for the needs of further analysis of the varieties, we examined the average yield in the regular years of 2003 and 2004. The average yield amounted to 445.5 g. In the category of high-yield varieties (>500g/plant) are: Pocahontas, Evita, Honeoye, Camarosa and Eris. The Moderately high-yield varieties (400-500g) includes: Idea, Belrubi, Tethis, Onda, Senga Sengana, Miranda, Paros and Madlen. The medium yield category (300-400g) includes: Elsanta, Marmolada and Chandler, while Favette (297.9g) is the only low-yield variety (200-300g).

According to Kiprijanovski (2001), in Skopje, Pocahontas produces 414.0 g/plant. Kaska et al. (1993) determined a very high yield for Chandler of 739.19. This variety produced the least amount of yield in our research (140.6 g/plant). Chandler showed to be extremely sensitive to root diseases and a large number of plants wilted. Mišić i Nikolić (2003) (quote according to Nikolić, 2007) note that the Elsanta has an extremely high yield which varies between 500 to 1000 g/plant. According to Türemiş et.al. (1997) the average yield of the varieties planted with frigo materials amounted to 502.8 g/plant, while the ones with fresh materials yielded 361.1 g/plant. The lowest average yield was measured in 2002 (Table 4). The yield in 2003 amounted to 12,605kg/ha, while in 2004 it was at its highest at 27,494kg/ha. The category of very high-yield varieties (>30t/ha) was not reached by any of the varieties. The distribution was as follows: high yield (20-30t/ha): Pocahontas, Evita, Camarosa, Belrubi, Honeoye, Eris and Onda; medium yield (10-20t/ha): Idea, Onda, Favette, Tethis, Senga Sengana, Miranda, Paros, Elsanta, Madlen and Marmolada; low yield (5-10t/ha): Chandler and extremely low yield (<5t/ha) was also left empty. The highest average yield within the tested period was achieved by the following varieties: Pocahontas, Evita, Onda and Honeoye. The Chandler variety produced the lowest yield, followed by Elsanta and Favette.

Dénes (1997) determined yield of 2.0 kg/m^2 with Elsanta and 1.74 kg/m^2 with Senga Sengana. Stanisavljević et. al. (1997) determined the highest yield with Senga Sengana (36,286 kg/ha), Blagojević (1999) 22.55 t/ha and Milivojević (2003) 22.8 t/ha.

Conclusion

1. Early- blossoming varieties are Honeoye, Eris, Madlen, Evita, Chandler, Belerubi and Tethis, medium – blossoming are Marmolada, Elsanta, Pocahontas, Paros. Favette and Miranda and late-blossoming varieties are Camarosa, Senga Sengana, Idea and Onda.

2. The varieties with early ripening time are Eris, Honeoye, Madlen and Onda. Medium-ripening varieties are Elsanta, Paros, Marmolada, Miranda, Chandler, Pocahontas and Belrubi. Late ripening varieties are Evita, Tethis, Favette, Senga Sengana, Idea and Camarosa.

3. The fruit weight varied from 5.7 (Senga Sengana) to 11.1g (Madlen).

4. Pocahontas and Evita had the highest yield per plant, while the lowest was observed in Favette.

5. The yield per acreage ranged from 8,276 kg/ha *Chandler* to 17,770 kg/ha *Pocahontas*.

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Fenološke i produktivne karakteristike nekih sorti jagode u regiji Skoplja

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Sažetak

Proučavane su fenološke i prozivodne karakteristike 17 sorti jagoda. Najranije vreme cvetanja utvrđeno je kod sorti Honej i Eris, 5-tog aprila. Najkasnije cveta Onda, 13-tog aprila. Sorte sa najranijim početkom sazrevanja su Eris, Honej, Madlen i Onda od 12-tog do 14-tog Maja. Sorte koje najkasnije sazrevaju su Evita, Tetis, Favet, Zenga zengana, Idea i Kamarosa, od 17-tog do 18-tog Maja. Belrubi ima najveće plodove 36,2x32,6x39,1mm. Zenga zengana ima najmanje plodove 27,8x25,7x22,8 mm. Prosečna masa plodova varira od 5,7 kod Zenga zengana do 11,1g kod Madlen. Najveći prinos po biljci imaju Pokahontas 575,1g i Evita 550,7g, a najmanji Favet 297,9g. Prosečan prinos po jednici površine iznosi od 8276 kg/ha kod Čandler do 17770 kg/ha kod Pokahontas.

Ključne reči: jagoda, sorta, cvetanje, sazrevanje, produktivnost, masa, prinos.

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Rootstock Influence on Apple Canopy Architecture Under High Radiation and Temperature

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Abstract

Beside its typical and optimal area of cultivation in the central and northeast Albania, in the last decade, apple cultivation has been spread into the Western Plain, to benefit from the advantages of earliness and vicinity to the main markets. The scope of this research was to study the canopy architecture of five main cultivars grown in this region, 'M. Gala', 'Gold Delicious', 'Starking', 'Fuji' and 'Pink Lady' on M9 rootstock. The study was carried out from 2010-2011 in a 6-year old orchard, located at an altitude of 3 m, with 3.7 x 1.2 m distances in French axe system. The following measurements were made in 5 trees per cultivar: diameter of the rootstock, scion and two main branches at 1.5 m height, number of spurs, bourses and shoots, length of woody shoots and fruit set. Global radiation, temperature and humidity were recorded.
The data shows a noticeable difference in rootstock/scion growth between the five cultivars tested. These differences are higher in the combination M9/'M. Gala' and 'M9/'Pink Lady', with an affinity index of 0.49 and 0.52, respectively (< 0.6). The same trend is observed also with the diameter of the main branch, with partial incompatibility, which also modifies the other elements of canopy architecture, vegetation and reproductive growth. Changes are observed in 'M. Gala', with a small diameter of the main branch (14.7 mm), but with a higher number of fruiting shoots (18 fruiting shoots) and fruit set (45.3 fruits/ twig). It is followed by 'Fuji' and 'Gold'. Although 'Starking' has a higher diameter (16.4 mm) of main branches, it forms more vegetation shoots and a small fruit set (20.8 fruits/ twig). There is a significant correlation between the branch diameter and the fruit set per twig. In conclusion, we can state that these cultivars show different behaviour towards M9 rootstock which has a significant effect on the elements of canopy architecture and fruit set.

Key words: affinity index, fruit set, vegetation growth, fruit growth, fruit set.

Introduction

Apple, which is generally cultivated in temperate and cold areas, has had large expansion in the coastal lowlands throughout the last decade, by using clonal rootstocks and mainly M9 – EMLA.

The purpose of this research was to study the behaviour of the five most disseminated cultivars in the Western Plain of Albania, namely 'M. Gala', 'Golden Delicious', 'Starking', 'Fuji' and 'Pink Lady' on M9 rootstock and the influence of the latter on canopy elements and production. Reciprocal effects are seen in the development of vegetative and reproductive elements, duration of phenological stages as well as the quantity and quality of production. This enables us to broaden our knowledge on rootstock selection and choice of best cultivars for the Lushnja region.

Materials and methods

The five cultivars chosen for this research, 'M. Gala', 'Golden Delicious', 'Starking', 'Fuji' and 'Pink Lady' on M9 rootstock are the most common in the coastal lowlands. The orchard was planted in 2006 in Lushnja. It is located at 3 m of altitude, with planting distances 3.7 x 1.2 m. The system is French axe.

Five trees for each cultivar were labelled and the following measurements were carried out: (i) Rootstock and scion diameter (10 cm above and under the grafting line); (ii) Diameter of two main branches at 1.5 m from soil level; (iii) Length of vegetative shoots; (iv) Number of spurs, bourses and brindles; (v) Number of fruits set per branch; (vi) Data where statistically analysed using the Tukey – Kramer test for $\alpha = 0,05$.

Results and discussion

The results show that, five years after planting in the orchard, there is a slight visible difference in development of rootstock/scion for the five cultivars under study (Table 1). The highest change is found in the combination M9/ 'M. Gala' and 'M9/'Pink Lady', with affinity indices of 0.49 and 0.52, respectively, which is less than 0.6 (Figures 1 and 2). For the other cultivars, although with different values from each other, the affinity index is above 0.6, which is within the acceptable limits for clonal rootstocks and mainly for M9.

These results clearly show partial incompatibility between the two components, which has an effect on modification of other canopy elements (shoots of different categories) as well as on vegetation and production. The same principle was also observed for the diameter of the main branches, where 'M. Gala' is the smallest. Even for this index, no significant differences were observed for cv. 'Golden Delicious' and 'Pink Lady'.

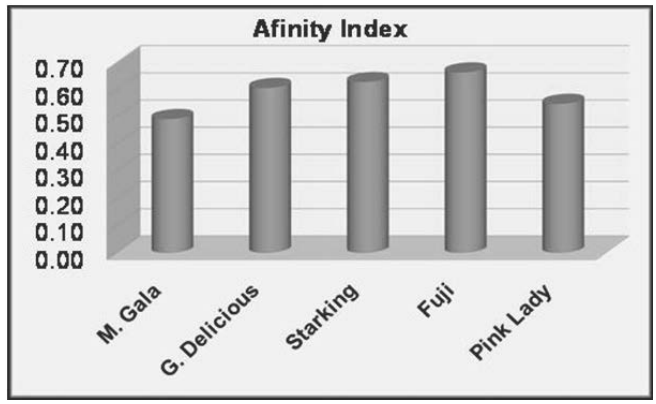

Fig. 1. Affinity index by cv.
Indeks afiniteta po sortama

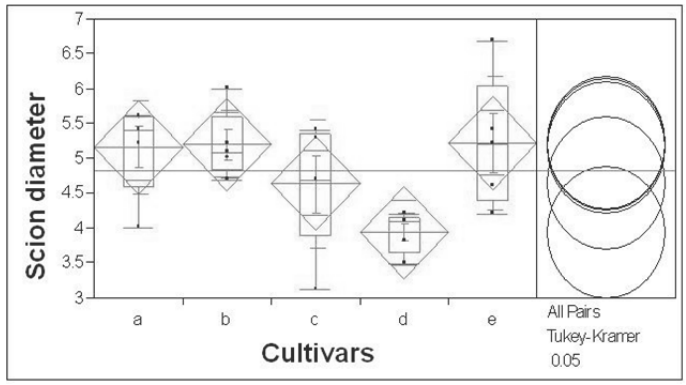

Fig. 2. Scion diameter by cv.
Prečnik kalema po sortama

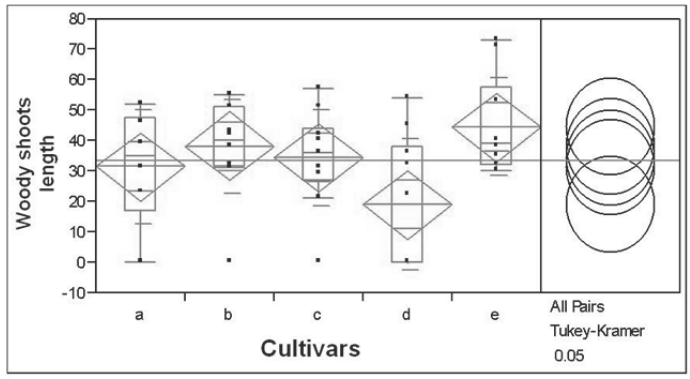

Fig. 3. Comparison of vegetative shoot length by cv.
Poređenje dužine vegetativnih izdanaka po sortama

Tab.1. Biometric measurements of canopy elements
Biometrijska mjerenja elemenata krošnje

Cultivar	Diameter (mm)		Affinity Index	Number of shoots				Woody branches length (cm)	Branch diameter (mm)	Fruits formed
	rootstock	scion		Spurs	Bourses	Brindle	Woody			
'M. Gala'	40	19.7	0.49	79	5	49	5	189	14.7	45.3
'G. Del.'	42.5	25.8	0.61	59	12	50	12	483	15.4	39.8
'Starking'	36.9	23.2	0.63	47	14	31	14	600	16.4	20.8
'Fuji'	39.3	26.1	0.66	48	19	52	19	811	15.7	41.8
'Pink Lady'	47.4	26	0.55	34	16	45	16	660	15.5	27.6

Vegetative shoots

The dwarfing effect was also observed by the amount of vegetative growth of the trees. The lowest number of vegetative shoots per tree was found in cv. 'M. Gala', while the highest number in cv. 'Fuji' and 'Pink Lady'. Their annual growth follows the same principle, with cv. 'Fuji' and 'Pink Lady' having the highest values. 'Golden Delicious' and 'Starking' showed a similar growth although significantly different from each other, while 'M. Gala' had the weakest growth (Figure 3).

Fruiting shoots

Modifications of structural elements of the canopy were distinguished by referring to the fruiting shoots; spurs, bourses and brindles. Data shown in Figures 6, 7 and 8 showed that cv. 'M.Gala' forms a much higher number of spurs and bourses, while cv. 'Fuji' and 'Pink Lady' with a higher vegetative growth, had fewer fruiting shoots.

It was interesting to find that cv. 'Starking', which is known for its reduced growth, had more vegetative shoots than 'Golden Delicious' and less than 'Fuji' and 'Pink Lady' under high radiation and temperature regime in Lushnja. In this context, it has fewer bourses and brindles, while having the same number of spurs like cv. 'Fuji'. In other conditions, on the same rootstock (M9), cv. 'Starking' has reduced vegetative growth and high reproductive growth (Figure 4).

Fruit set

The development of more fruiting elements in the entire canopy was reflected in the quantity of fruits set per cultivar. Data shown in Figures 5 and 6 prove the same principle. Significant changes are seen at 'M. Gala', with a smaller diameter of the main branch, but with more fruiting shoots and fruit set (45.3 fruits/branch), followed by 'Fuji' and 'Golden Delicious' cultivars. 'Starking', although with a higher diameter of the main branches, forms more vegetative shoots and fewer fruit sets (20.8 fruits/branch) (Figure 5, 6).

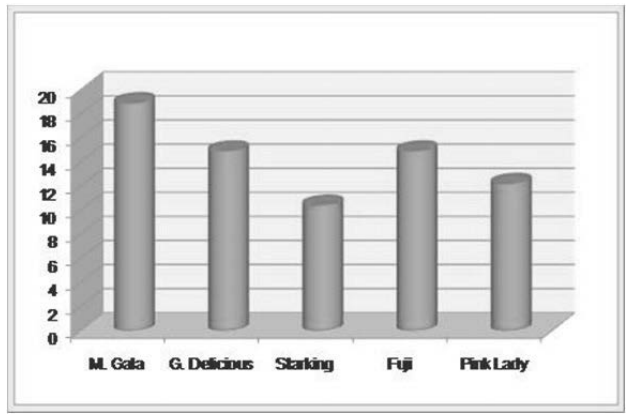

Fig. 4. Number of fruiting shoots by cv.
Broj rodnih izdanaka po sortama

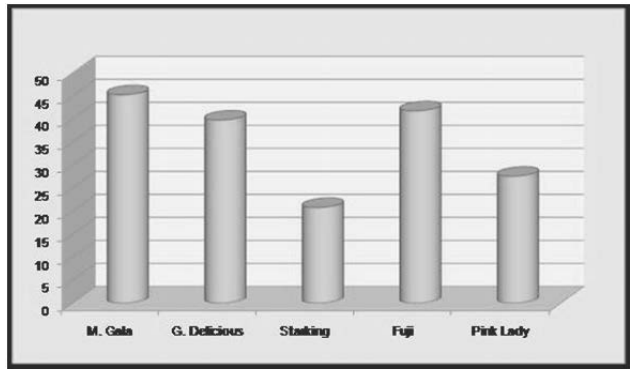

Fig. 5. Number of fruits set by cv.
Broja zametnutih plodova po sortama

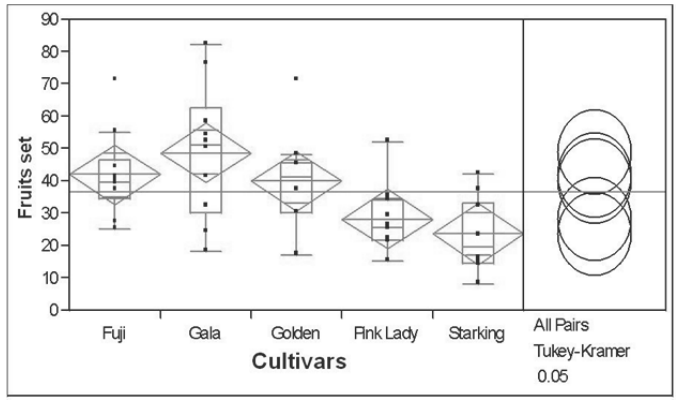

Fig. 6. Variability level for fruit set index by cv.
Nivo varijabilnosti za indeks zametanja ploda po sortama

The correlation between the fruiting shoots diameter and fruit set is interesting (Figure 7). The cultivar that forms stronger branches ('Starking' in our case) has fewer fruits.

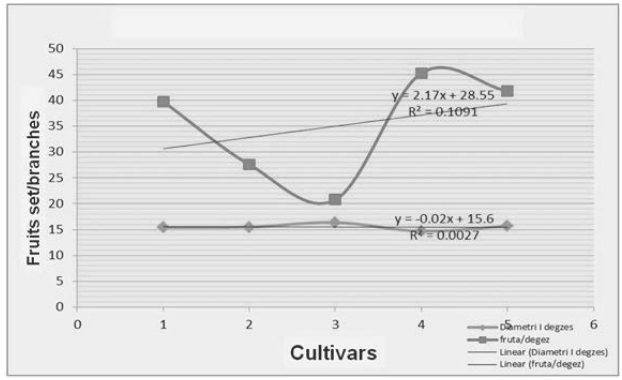

Fig. 7. Correlation between shoot diameter and fruit set
Korelacija između prečnika izdanka i zametanja ploda

Conclusion

In conclusion we can state that:

- M9 rootstock has a significant effect on the architectural elements of the canopy as well as productivity.
- In combination with 'M. Gala', the dwarfing effect is higher, accompanied by reduced vegetative growth and higher development of fruiting shoots in the first years of the orchard.
- Cv. 'Starking' in Lushnja on M9 has good vegetative growth but delays the formation of fruiting shoots.
- For all cultivars, there is a significant correlation between the diameter of the main branches and fruiting.

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Uticaj podloge na oblik krošnje jabuke pod visokim zračenjem i temperaturom

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Sažetak

Pored tipičnog i optimalnog regiona za uzgoj voća u centralnoj i sjeveroistočnoj Albaniji, u toku posljednje dekade se uzgoj jabuka proširio na Zapadno polje kako bi se iskoristile prednosti rane berbe i blizine glavnih tržišta. Cilj ovog istraživanja bio je da se ispita oblik krošnje kod pet glavnih sorti ovog regiona i to: 'M. Gala', 'Zlatni delišes', 'Starking', 'Fuji'i 'Pink Lady' na M9 podlozi. Istraživanje je sprovedeno u periodu od 2010–2011. godine u voćnjaku starom 6 godina i smještenom na visini od 3 m, sa razmakom sadnje 3,7x1,2m, sa vertikalnim vretenom kao uzgojnim oblikom. Obavljena su sljedeća mjerenja na 5 stabala po sorti: prečnik podloge, kalema i dvije glavne grane na visini od 1,5m, broj izdanaka i lastara, dužina drvenastih izdanaka i zametnutih plodova. Praćeni su globalno zračenje, temperatura i vlažnost. Podaci pokazuju primjetnu razliku u rastu podloge/kalema između pet ispitivanih sorti. Ove razlike su veće za kombinaciju M9/'M. Gala' i 'M9/'Pink Lady', sa indeksom afiniteta od 0,49 i 0,52, (< 0.6). Isti trend je registrovan i za prečnik glavne grane, sa djelimičnom nekompatibilnošću, koji takođe modifikuje druge elemente oblika krošnje, vegetativnog i reproduktivnog rasta. Promjene su primjećene kod sorte 'M. Gala', sa malim prečnikom glavne grane (14,7 mm), ali sa velikim brojem rodnih izdanaka (18 rodnih izdanaka) i zametnutih plodova (45.3 plodova/ grančici). Zatim slijede sorte 'Fuji' i 'Gold'. Iako sorta 'Starking' ima veći prečnik (16,4 mm) glavnih grana, ona formira više rodnih izdanaka i manji broj zametnutih plodova (20,8 plodova/ grančici). Postoji značajna korelacija između prečnika grane i zametanja plodova po grančici. Može se zaključiti da se ove sorte različito ponašaju prema M9 podlozi koja ima znatan uticaj na elemente oblika krošnje i zametanje ploda.

Ključne riječi: indeks afiniteta, zametanje ploda, vegetativni rast.

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Influence of *Diflufenican* the Herbicide on Some Biological Traits of Bulgarian Common Bean Cultivar Plovdiv 15M

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Abstract

Three-year trials (2006-2008) were conducted in order to determine the influence of the herbicide *diflufenican* (trade name – Pelikan 50 CK) on certain biological traits of Bulgarian common bean cultivar Plovdiv 15 M. The herbicide was applied in the doses of 200, 250 and 300 ml/ha after the sowing and before the growth of the plants. It has been found that the traits related to the height of the plant, number of fruit-yielding branches, pods and seeds, mass of the seeds and average length of 10 pods per plant were influenced by different doses of the herbicide, by the year and the interaction between these two factors. A 300 ml/ha dose treatment differs most from other variants in the conducted clustering as a result of its strong influence on the traits: number of seeds, fruit-yielding branches and mass of the seeds per plant. The highest stability indices have been obtained for the traits related to the mass of the pods per plant, which showed greater stability regarding the treatment with the herbicide.

Key words: biological traits, diflufenican, herbicides, *Phaseolus vulgaris* L.

Introduction

Today, pesticides are used at large scale and are considered an important part in modern systems for growing of crops, mainly due to direct benefits - primarily economic that they create for the benefit of farmers. Pesticides are used to boost the yield, they make production more profitable and the deliveries - more secure. Among the most commonly used types are: insecticides - to combat insects, herbicides - to fight weeds, fungicides - to combat yeast, fungus, mildew and others.

Pesticides affect fundamental processes in living organisms and can cause adverse effects on non-target organisms, human health and the environment. Despite the existing regulatory framework, undesirable amounts of certain pesticides can be found in the environment, especially in soil, air and water, as well as in food products (so-called "pesticide residues"). Recent scientific discoveries show that some

pesticides, even in very small amounts, are able to impair the functioning of the endocrine system.

White bean is not a strong competitor with weeds, and weed interference can result in large yield losses in the crop (Malik et al. 1993; Chikoye et al., 1995). Weeds also interfere with harvest efficiency and may stain white bean, resulting in reduced market value (Burnside et al., 1998; Bauer et al., 1995; Urwin et al., 1996). Therefore, weed management is very important for profitable white bean production.

Several herbicides commonly used in dry bean (Phaseolus vulgaris) production have been reported by growers and other researchers to be phytotoxic to adzuki bean (Powell et al., 2004). Sikkema et al. (2006) found that dimethenamid caused up to 37% visual injury and reduced plant height, shoot dry weight and yield 27, 59 and 52%, respectively. S-metolachlor caused up to 34% visual injury and reduced plant height, shoot dry weight and yield 27, 48 and 48%, respectively. Clomazone caused 53% visual injury and reduced plant height, shoot dry weight and yield 47, 84 and 78%, respectively. Imazethapyr caused up to 6% visual injury; however, this injury was transient with no adverse effect on plant height, shoot dry weight, seed moisture content and yield of adzuki bean. Based on these results, dimethenamid, S-metolachlor and clomazone applied as pre-emergence (PRE) do not have an adequate margin of crop safety for use in adzuki bean at the doses evaluated. However, imazethapyr applied PRE has an adequate margin of crop safety for weed management in adzuki bean production in Ontario at the doses evaluated.

Bentazon applied once or twice (to simulate a spray overlap in the field) at 840 g ai/ha and imazethapyr applied at 37.5 g/ha caused minimal injury (6% or less) in pinto and SRM bean and had no adverse effect on plant height, shoot dry weight, seed moisture content, and yield. Imazethapyr applied twice at 37,5 and all single and repeat applications containing 75 or 150 g/ha caused 15 to 44% injury to dry bean. These injuries were persistent and reduced plant height by as much as 21% and shoot dry weight by as much as 34%, but caused no adverse effect on maturity and yield, except for imazethapyr applied twice at 150 g/ha, which delayed maturity and reduced yield by 16% (Soltani et al. 2008).

The aim of this study was to investigate the effect of the action of *diflufenican* herbicide (trade name - Pelican 50 CC) on some biological traits in Bulgarian common bean variety Plovdiv 15 M.

Materials and methods

Three-year trials (2006-2008) with Bulgarian common bean cultivar Plovdiv 15 M were conducted. Sowing was carried out during the period 10 to 15 April, and trials were done by the block method in four replicates. Fighting weeds was carried out using soil herbicide *diflufenican* by the following schedule:

A. Control (K1) - untreated and not trenched area;
2. Industrial control (K2) - untreated area with 2-3 hoeing;
3. *Diflufenican* - 200 ml / ha;

4. *Diflufenican* - 250 ml / ha;
5. *Diflufenican* - 300 ml / ha.

The herbicide was imported after sowing before germination of the crop. This treatment was done with a knapsack sprayer with a working solution 300-400 l/ha. The biometrical analysis was performed on 50 plants of each variant after harvesting, on the following parameters: plant height, height of betting on the first pod, number of fruit branches and seeds per plant, mass of pods with seeds, average length of 10 pods.

The data obtained were analysed in terms of the condition that the more variable the trait, the greater the influence was in the total genotypic variability. ANOVA, Principal Component Analysis (Philippeau, 1990) and clustering of variants were performed, depending on the quantitative traits studied (Ward, 1963).

Results and discussion

Results, presented in Table 1 and 2, show that plant height for all the variants was highest in 2006.

No difference in plant height, in both control variants, was found in the three years of the study.

It is noteworthy that in 2006 and 2008 the treatment with the *diflufenican* herbicide in 250 ml/ha dose resulted in increasing plant height in comparison to the controls and treatment with other applied doses of the herbicide. There were no warranted differences in all variants compared to the control (K1).

The height of betting on the first pod was a relatively permanent trait that was not affected much by growing conditions (Svetleva, 2003). In our study, the exception was 2007 when the control (K1) showed relatively lower scores compared to the other variants. It was evident in our study that this trait was not significantly influenced by the application of *diflufenican* .

Traits - mass of plant with pods, number of fruit-yielding branches, pods and seeds per plant as well as mass of seeds per plant were crucial for the formation of the yield (Svetleva, 2003).

Our study showed that the number of fruit-yielding branches remained constant during the three years of investigations. This means that it was not significantly affected by the environmental conditions and treatment with application of the herbicide.

It is noteworthy that the number of seeds per plant varies more than the number of pods per plant. The average length of 10 pods per plant is a conservative trait, which depends more on the genotype of the plants than on the environmental conditions and the herbicide applied.

Tab. 1. Biometrical evaluation of some quantitative traits in common bean cultivar Plovdiv 15 M after application of the herbicide *diflufenican* in the period 2006 – 2008

Biometrijska evaluacija nekih kvantitativnih karakteristika sorte graha Plovdiv 15 M nakon primjene herbicida diflufenikana u periodu od 2006-2008. godine

Year	Variant / Trait	K 1	K 2	Herbicide *diflufenican* in doses:		
				200 ml/ha	250 ml/ha	300 ml/ha
2006	Height of plant, cm	77,87	77,90 n.s.	77,02 n.s.	87,07 n.s.	80,35 n.s.
2007		68,85	68,72 n.s.	69,42 n.s.	70,90 n.s.	72,27 n.s.
2008		72,92	73,17 n.s.	73,22 n.s.	79,45 n.s.	76,42 n.s.
2006 2007 2008	$GD_{5\%}$ = 28,64 $GD_{1\%}$ = 39,60 $GD_{0,1\%}$ = 54,74		$GD_{5\%}$ = 9,67 $GD_{1\%}$ = 13,37 $GD_{0,1\%}$ = 18,49		$GD_{5\%}$ = 16,36 $GD_{1\%}$ = 22,63 $GD_{0,1\%}$ = 31,28	
2006	Height of betting on the first pod, cm	8,17	8,00 n.s.	7,57 n.s.	7,90 n.s.	7,55 n.s.
2007		8,55	10,97 ++	10,55 ++	9,22 n.s.	9,12 n.s.
2008		8,20	9,47 +	9,10 n.s.	8,57 n.s.	8,37 n.s.
2006 2007 2008	$GD_{5\%}$ = 1,49 $GD_{1\%}$ = 2,06 $GD_{0,1\%}$ = 2,85		$GD_{5\%}$ = 1,32 $GD_{1\%}$ = 1,82 $GD_{0,1\%}$ = 2,52		$GD_{5\%}$ = 1,12 $GD_{1\%}$ = 1,56 $GD_{0,1\%}$ = 2,15	
2006	Mass of plant with pods, g	20,10	24,90 n.s.	18,25 n.s.	21,35 n.s.	17,62 n.s.
2007		47,85	66,47 n.s.	72,85 +	71,77 +	64,92 n.s.
2008		33,97	43,20 n.s.	43,52 n.s.	44,12 n.s.	46,55 n.s.
2006 2007 2008	$GD_{5\%}$ = 16,96 $GD_{1\%}$ = 23,45 $GD_{0,1\%}$ = 32,42		$GD_{5\%}$ = 21,11 $GD_{1\%}$ = 29,20 $GD_{0,1\%}$ = 40,36		$GD_{5\%}$ = 14,27 $GD_{1\%}$ = 19,74 $GD_{0,1\%}$ = 27,28	
2006	Number of fruit-yielding branches	7,25	9,65 n.s.	7,47 n.s.	9,87 n.s.	7,10 n.s.
2007		7,37	9,25 n.s.	8,80 n.s.	7,87 n.s.	8,82 n.s.
2008		7,30	9,47 n.s.	8,10 n.s.	8,85 n.s.	7,92 n.s.
2006 2007 2008	$GD_{5\%}$ = 5,92 $GD_{1\%}$ = 8,19 $GD_{0,1\%}$ = 11,32		$GD_{5\%}$ = 2,70 $GD_{1\%}$ = 3,74 $GD_{0,1\%}$ = 5,17		$GD_{5\%}$ = 3,17 $GD_{1\%}$ = 4,39 $GD_{0,1\%}$ = 6,06	

Note: $GD_{5\%}$ (+), $GD_{1\%}$ (+ +), $GD_{0,1}$ (+ + +), n.s. - less than $GD_{5,0\%}$

With few exceptions, there were not warranted differences between the two controls (K1 and K2) and the application of *diflufenican* herbicide in different doses.

Of the conducted investigations (Tables 1 and 2), it was evaluated that application of the *diflufenican* herbicide at 200, 250, 300 ml/ha doses had no significant influence on the studied biometrical traits of common bean.

Based on the conducted ANOVA analysis (Table 3), it was shown that the height of betting on the first pod and mass of the plant with pods per plant were more strongly influenced by the interaction between variants of treatment and the years of growing. In all other traits: plant height , number of fruit-yielding branches, pods and seeds, mass of seeds per plant and average length per 10 pods were influenced by the application of *diflufenican* herbicide, the year of cultivation and the interaction between these indicators.

Tab. 2. Biometrical evaluation of some quantitative traits in common bean cultivar Plovdiv 15 M after application of the herbicide *diflufenican* in the period 2006 – 2008

Biometrijska evaluacija nekih kvantitativnih karakteristika sorte graha Plovdiv 15 M nakon primjene herbicida diflufenikana u periodu od 2006-2008. godine

Year	Variant / Trait	K 1	K 2	Herbicide *diflufenican* in doses:		
				200 ml/ha	250 ml/ha	300 ml/ha
2006	Number of pods per plant	10,00	13,35 n.s.	10,25 n.s.	13,22 n.s.	9,82 n.s.
2007		11,30	14,55 n.s.	13,40 n.s.	12,67 n.s.	13,77 n.s.
2008		10,62	13,92 n.s.	11,80 n.s.	12,95 n.s.	11,77 n.s.
2006 2007 2008	$GD_{5\%}$ = 7,96 $GD_{1\%}$ = 11,02 $GD_{0,1\%}$ = 15,23		$GD_{5\%}$ = 4,92 $GD_{1\%}$ = 6,80 $GD_{0,1\%}$ = 9,40		$GD_{5\%}$ = 4,47 $GD_{1\%}$ = 6,18 $GD_{0,1\%}$ = 8,55	
2006	Number of seeds per plant	29,82	39,47 n.s.	28,90 n.s.	35,10 n.s.	27,10 n.s.
2007		33,87	44,27 n.s.	44,27 n.s.	38,15 n.s.	46,72 n.s.
2008		31,85	41,85 n.s.	36,57 n.s.	36,60 n.s.	36,90 n.s.
2006 2007 2008	$GD_{5\%}$ = 27,48 $GD_{1\%}$ = 38,01 $GD_{0,1\%}$ = 52,54		$GD_{5\%}$ = 15,21 $GD_{1\%}$ = 21,04 $GD_{0,1\%}$ = 29,08		$GD_{5\%}$ = 16,08 $GD_{1\%}$ = 22,24 $GD_{0,1\%}$ = 30,75	
2006	Mass of seeds per plant, g	10,10	15,00 n.s.	8,30 n.s.	10,20 n.s.	10,35 n.s.
2007		8,10	9,77 n.s.	9,60 n.s.	7,92 n.s.	11,52 n.s.
2008		9,05	12,35 n.s.	8,92 n.s.	8,30 n.s.	10,90 n.s.
2006 2007 2008	$GD_{5\%}$ = 12,35 $GD_{1\%}$ = 17,09 $GD_{0,1\%}$ = 23,62		$GD_{5\%}$ = 4,00 $GD_{1\%}$ = 5,54 $GD_{0,1\%}$ = 7,65		$GD_{5\%}$ = 5,75 $GD_{1\%}$ = 7,95 $GD_{0,1\%}$ = 10,99	
2006	Average length per 10 pods, cm	8,12	8,15 n.s.	7,95 n.s.	7,92 n.s.	7,95 n.s.
2007		7,92	7,90 n.s.	7,67 n.s.	7,75 n.s.	8,20 n.s.
2008		8,02	8,00 n.s.	7,77 n.s.	7,82 n.s.	8,07 n.s.
2006 2007 2008	$GD_{5\%}$ = 1,23 $GD_{1\%}$ = 1,70 $GD_{0,1\%}$ = 2,36		$GD_{5\%}$ = 0,70 $GD_{1\%}$ = 0,97 $GD_{0,1\%}$ = 1,34		$GD_{5\%}$ = 0,74 $GD_{1\%}$ = 1,03 $GD_{0,1\%}$ = 1,42	

Note: $GD_{5\%}$ (+), $GD_{1\%}$ (+ +), $GD_{0,1}$ (+ + +), n.s. - less than $GD_{5,0\%}$

The main objective of any breeding program is the creation of cultivars combining high productive potential and good quality characteristics under different environmental conditions, and resistance to diseases, pests and weeds. Of particular importance are newly created cultivars that have high plasticity and stability, which can be a good indicator for determining future yields and quality (Dimova et al., 2006). As the Allard and Bradshaw (1964) showed cultivars, which manifested good genotypic productivity under different climatic conditions, are characterised by greater general flexibility.

Table 4 presents average values and indices of stability (Ysi) of the eight quantitative traits studied in common bean cultivar Plovdiv 15 M after the application of diflufenican herbicide. Based on the results obtained, it can be seen that the ranking varies by studied trait that shows the influence of different treatments on the manifestation of studied traits.

Tab. 3. Influence of treatment with the herbicide *diflufenikan* and years of common bean cultivar Plovdiv 15 M growing
Uticaj tretiranja herbicidom diflufenikanom i godine uzgoja sorte graha Plovdiv 15 M

Indicators / Variants	Years		Variants		Interaction	
	$F_{exp.}$	F_{table}	$F_{exp.}$	F_{table}	$F_{exp.}$	F_{table}
Height of plant, cm	3,20	2,82	2,57	0,50	2,15	0,07
Height of betting on the first pod, cm	21,43	3,20	3,91	2,57	2,15	1,60
Mass of plant with pods, g	93,65	3,20	3,65	2,57	2,15	1,90
Number of fruit-yielding branches	3,20	0,01	2,57	1,11	2,15	0,28
Number of pods per plant	3,20	1,02	2,57	1,19	2,15	0,19
Number of seeds per plant	3,20	2,38	2,57	0,81	2,15	0,31
Mass of seeds per plant, g	5,11	0,32	3,76	1,01	2,93	0,26
Average length per 10 pods, cm	3,20	0,22	2,57	0,47	2,15	0,12

The highest indices of stability were obtained for the mass of plants with pods, which indicates greater stability of this trait to the treatment with the herbicide, applied in three different doses. The height of the plants showed the highest stability after treatment with the herbicide in doses of 250 and 300 ml/ha, while for the other traits the highest indices of stability were shown in the control variants. The most variable were the mass of a plant with pods and number of seeds per plant.

It is known that the success of any breeding work depends on the selection of parental pairs with good combining ability. It is believed that the use of such parents in hybridisation increases the chances of favourable combining in a genotype of the traits defining their productivity.

To determine the genetic distance of used parental aiming prospective planning of hybridisation, cluster analysis is applied (Ward, 1963). For the selection of future parents, however, it is not sufficient to characterise them only as genetically distant. It is necessary to determine whether they are carriers of complementary traits that could contribute to the greatest extent to raising productivity and/ or quality of the hybrid.

The cluster analysis and principal component analysis can be applied for separation of the genotypes by degree of their genetic proximity and identifying some of the main components determining the critical behaviour of important complex traits such as yield and quality. Too often, however, these two analyses are used alone, thus not making full use of information from them.

Tab. 4. Stability of some quantitative traits in common bean cultivar Plovdiv 15 M after application of the herbicide diflufenikan
Stabilnost nekih kvantitativnih karakteristika sorte graha Plovdiv 15 M nakon primjene herbicida diflufenikana

VARIANTS	Average value of the trait	Ranking of the trait	Correction of the rank	Rank coeffi-cient	Stability Variation	Coeffi-cient of stability	Index of stability (Ysi)
Height of plant, cm							
K1 (control)	72,96	1	- 1	0	- 3,98	0	0
K2 (industrial control)	73,26	3	- 1	2	- 3,40	0	2
Pelikan CK 200 ml/ha	73,23	2	- 1	1	4,24	0	1
Pelikan CK 250 ml/ha	79,14	5	1	6	62,38	- 2	4 +
Pelikan CK 300 ml/ha	76,34	4	1	5	1,00	0	5 +
Height of betting on the first pod, cm							
K1 (control)	8,30	1	- 1	0	3,19	- 4	- 4
K2 (industrial control)	9,48	5	2	7	1,68	- 2	5 +
Pelikan CK 200 ml/ha	9,08	4	1	5	1,73	- 2	3 +
Pelikan CK 250 ml/ha	8,56	3	- 1	2	3,46	0	2 +
Pelikan CK 300 ml/ha	8,34	2	- 1	1	- 0,29	0	1
Mass of plants with pods, g							
K1 (control)	31,23	1	- 2	- 1	295,81	- 2	- 3
K2 (industrial control)	38,04	2	- 1	1	540,62	- 4	- 3
Pelikan CK 200 ml/ha	45,48	5	1	6	178,49	0	6 +
Pelikan CK 250 ml/ha	44,64	4	1	5	- 16,32	0	5 +
Pelikan CK 300 ml/ha	41,44	3	1	4	51,03	0	4 +
Number of fruit-yielding branches							
K1 (control)	7,30	1	- 1	0	- 0,73	0	0
K2 (industrial control)	9,48	5	1	6	- 0,11	0	6 +
Pelikan CK 200 ml/ha	8,12	3	- 1	2	1,62	0	2
Pelikan CK 250 ml/ha	8,85	4	1	5	6,89	- 2	3 +
Pelikan CK 300 ml/ha	7,90	2	- 1	1	3,44	- 2	- 1
Number of pods per plant							
K1 (control)	10,63	1	- 1	0	- 0,61	0	0
K2 (industrial control)	13,94	5	1	6	- 0,42	0	6 +
Pelikan CK 200 ml/ha	11,81	3	- 1	2	1,94	0	2
Pelikan CK 250 ml/ha	12,94	4	1	5	8,23	- 2	3 +
Pelikan CK 300 ml/ha	11,78	2	- 1	1	6,58	- 2	- 1
Number of seeds per plant							
K1 (control)	31,84	1	- 1	0	28,13	0	0
K2 (industrial control)	41,86	5	1	6	15,74	0	6 +
Pelikan CK 200 ml/ha	36,58	3	- 1	2	40,65	0	2
Pelikan CK 250 ml/ha	36,51	2	- 1	1	47,68	0	1
Pelikan CK 300 ml/ha	36,90	4	1	5	155,64	- 2	3 +
Mass of seeds per plant, g							
K1 (control)	9,08	3	- 1	2	- 1,83	0	2 +
K2 (industrial control)	12,38	5	1	6	21,90	- 2	4 +
Pelikan CK 200 ml/ha	8,86	2	- 1	1	11,15	- 2	- 1
Pelikan CK 250 ml/ha	8,80	1	- 1	0	- 0,36	0	0
Pelikan CK 300 ml/ha	10,90	4	1	5	8,40	- 2	3 +
Average length of 10 pods per plant, cm							
K1 (control)	8,02	4	1	5	- 6,02	0	5 +
K2 (industrial control)	8,01	3	1	4	7 ,67	0	0
Pelikan CK 200 ml/ha	7,78	1	- 1	0	2 ,43	0	0
Pelikan CK 250 ml/ha	7,83	2	- 1	1	- 1,33	0	1
Pelikan CK 300 ml/ha	8,07	5	1	6	0,22	- 2	4 +

Joint application of cluster analysis and principal component analysis (Principal Component Analysis - PCA) as complementary methods in the selection process allows to determine what the best combination is between parental couples

which would come to obtain results corresponding to the maximum set in the selection program's purposes (Dimova, Bojinov, 2002).

Using cluster analysis, the groups were defined in our investigations, grouping studied variants according to their similarity and distance, taking into account the complex influence of eight quantitative traits analysed in common beans.

The cluster analysis was performed with average data from three years of study.

It is assumed that the various traits that were included in the basis of the cluster analysis with varying severity were involved in the differentiation of the remoteness of different variants. Principal component analysis (PCA) allows determination of varying severity of the traits responsible for separation of different variants in clusters.

Moreover, the higher coefficient of variation of a trait within the investigated group, its power of influence was greater. The principle of the PCA is that if the data includes "n" number of quantitative traits, variants can be presented in maximum in the "n"-dimensional space if all observed traits between them are with a correlation coefficient of zero (Philippeau, 1990). However, since such cases are the exception, rather simple analysis ends with fewer dimensions. Most often new axes are added until they become sufficient to reflect on about 90% of the observed variation in the experience.

In PCA, the first coordinate axis is constructed so that the sum of variance projections of separate traits is to be the greatest. Then the trait with the highest correlation coefficient to this axis will have the biggest share in explaining of the total variation in a population and hence the separation of genotypes in different clusters.

The results of the cluster analysis are shown in Fig. 1. It can be seen that the five variants of treatment were grouped in two cluster groups, treatment with *diflufenican* herbicide in a dose of 300 ml/ha is in a separate cluster group.

Applied alone, the cluster analysis shows the distribution of different variants of treatment and relative distances between them, but does not explain the reasons of obtained clustering.

It was possible to get an idea of the main factors affecting the separation of the variants by application of the principal component analysis (Table 5). In performing this analysis, of the possible eight components corresponding to the studied traits, the analysis was conducted only on the third since the first three components explained 90% of the total variation.

From the eight studied traits, the results of the survey allow to determine those which had most influence on the clustering of the variants. It is noteworthy that the found correlation coefficients of the first component are the highest. Such traits as the number of seeds per plant, mass of the seeds and number of fruit-yielding branches have the highest correlation coefficients with the first principal component; therefore they are with the largest relative weight in the distribution of variants presented in the dendrogram.

Correlation coefficients for the second and third component are significantly lower compared with the first component.

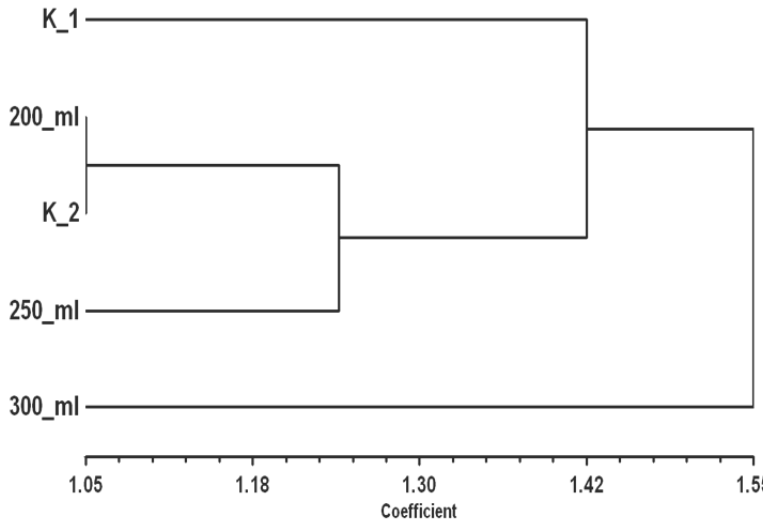

Fig. 1. Clustering of the variants by the Ward method.
Variants: 1) Control (K1), 2) Industrial control (K2),
3) Diflufenican - 200 ml/ha; 4) Diflufenican - 250 ml/ha;
5) Diflufenican - 300 ml/ha.
Klastering varijanti po Ward-ovoj metodi.

Tab. 5. Principal Component Analysis
Analiza glavnih komponenata

TRAITS	Components		
	1	2	3
Variants	0,850	- 0,502	0,087
Height of plant, cm	0,646	0,226	0,728
Mass of plants with pods, g	0,846	- 0,519	0,062
Height of betting on the first pod, cm	0,734	- 0,074	0,675
Number of fruit-yielding branches	0,814	0,459	- 0,166
Number of pods per plant	0,767	0,236	- 0,586
Number of seeds per plant	0,935	0,173	- 0,302
Mass of seeds per plant, g	0,767	0,629	- 0,043
Average length of 10 pods, cm	- 0,566	0,749	0,340

Conclusion

Based on the conducted study, the following conclusions can be drawn:

1. The application of *diflufenican* herbicide at different doses, the year of cultivation and the interaction between these indicators influenced the manifestation of the traits - plant height, number of fruit-yielding branches, number of pods, number of seeds per plant, mass of seeds and average length of 10 pods per plant.

2. The application of *diflufenican* herbicide in a dose of 300 ml/ha differs most from the other variants of conducted clustering as a result of its strong influence on the number of seeds per plant, mass of seeds and number of fruit-yielding branches.

3. The highest indices of stability were obtained for the mass of plants with pods, indicating greater stability of this trait on the application of *diflufenican* herbicide.

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Uticaj herbicida *diflufenikana* na neka biološka svojstva bugarske sorte graha Plovdiv 15M

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Sažetak

Sprovedena su trogodišnja istraživanja (2006-2008. god.) da bi se odredio uticaj herbicida *diflufenikana* (trgovačko ime– Pelikan 50 CK) na neka biološka svojstva bugarske sorte graha Plovdiv 15 M. Herbicid je primjenjivan u dozama od 200, 250 i 300 ml/ha nakon sjetve a prije rasta biljke. Ustanovljeno je da su na osobine vezane za visinu biljke, broj grana sa mahunama, broj mahuna i zrna, masa zrna kao i prosječnu dužinu 10 mahuna po biljci uticale različite doze herbicida, zatim godina uzgoja kao i interakcija ova dva faktora. Tretiranje dozom od 300 ml/ha najviše se razlikuje od drugih varijanti u sprovedenom grupisanju kao rezultat velikog uticaja na sljedeće osobine: broj zrna, grana sa mahunama i masa zrna po biljci. Najviši indeksi stabilnosti dobijeni su za svojstvo vezano za masu mahuna po biljci, koje je pokazalo veću stabilnost u odnosu na tretiranje herbicidom.

Ključne riječi: biološke osobine, diflufenikan, herbicidi, *Phaseolus vulgaris* L.

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Investigation of the Efficiency and Selectivity of Some Herbicides Applied on Cape Gooseberry (*Physalis peruviana* L.)

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Abstract

The main goal of the present paper was to study the possibilities for application of herbicides during vegetation of cape gooseberry. Herbicides Afalon 100 and 150 ml/da and Agil 85 and 150 ml/da were applied at the moment of the beginning of bud formation on the Plovdiv variety. The control was not treated, but it was hoed. Twenty days later, species, number and weight of weeds; number of dead cape gooseberry plants; weight, diameter and length of fruits (in botanical maturity) were investigated. Productivity and chemical components were determined. The highest effectiveness, lowest weed number and weight were observed when using Afalon 150 ml/da which controls annual dicotyledon weeds. Total weeds weight decreased mainly due to Afalon. The highest percentage of dead plants was established after application of 150 ml/da Afalon. The highest productivity was established in control. Investigated herbicides, Afalon and Agil, did not demonstrate satisfactory selectivity in cape gooseberry.

Key words: cape gooseberry, herbicides, fruit, selectivity, yield.

Introduction

Cape gooseberry is a new vegetable crop in Bulgarian agriculture. It has tasty fruits, very good storability and attractive shape. These traits make the crop suitable for growing, especially on small-scale farms and in order to enrich diversity of fresh vegetable production on the market. In many countries, investigations concerning growing cape gooseberry in different climatic conditions have recently been held such as Argentina (Cerri, 2006), Hungary (Paksi et al., 2007), New Zealand and India (McCain, 1993), etc.

Further studies about technological practices are concerned with problems of fertilisation, growing of transplants and sowing time. Crawford (2004) pointed out that cape gooseberry is very adaptive to different soil types, although it prefers well sunlit places. The same conclusion, namely that this crop is not very demanding in terms of soil conditions, was also reported by Chernok (1997). Crawford (2004) established that the cape gooseberry seeds germinate fast and this is a good prerequisite for seed propagation. Nevertheless, R. McCain (1993) recommends that for it is better to propagate it from seedlings to achieve successful growth. In South Australian conditions, Kendall (2008) emphasised that the quantities of nitrogen fertilisation have to be very preise in cape gooseberry.

The studies about weed control in *Physalis peruviana* L. are very limited and insufficient. Plaza, G. A. and y M. Pedraza (2007) carried out experiments with the aim to establish various herbaceous plants associated with cape gooseberry (*Physalis peruviana* L.) in Colombia. They observed that the most frequently found species are *Polygonum nepalense, Rumex crispus*, *Pennisetum clandestinum* and *P. nepalense*. Auld, B.A. and Medd R.W. (1992) examined some herbicides in the field with cape gooseberry as Glyphosate, Lontrel and Tordon 75-D in conditions of South Australia and found that Glyphosate in 1 l/100 l water was the most effective against weeds. Hussey, B.M.J et al (1997) also found that Glyphosate yielded very good results in weed control. Hernándo-Bermejo and León (1994) reported that some species of gender *Physalis* showed resistance to 2,4-D amine herbicide. To reduce weeds in cape gooseberry, McCain (1993) recommended drop by drop irrigation.

The main goal of this paper was to investigate the possibilities for application of herbicides during vegetation of cape gooseberry.

Materials and methods

The experiments were carried out in the Experimental fields of the Department of Horticulture at the Agricultural University, Plovdiv, Bulgaria during 2009-2011 with the first Bulgarian variety of cape gooseberry Plovdiv. The plants were grown by transplants sown in the middle of March in an unheated plastic house and transplanted in the middle of May by scheme 70×50 cm. The experiments were conducted in four replications using 8 m^2 plots. Conventional technology was applied for the field production during the middle period of growing season in the south Bulgarian conditions.

At the beginning of flower bud formation, the following herbicides were applied: Afalon 45 CK (linuron 450 g/l) in the concentration of 100 ml/da and 150 ml/da and Agil 100 EK (propaquizafop 100 g/l) in the concentration of 85 ml/da and 150 ml/da by using intended 60 l/da water solution. The control variant was not treated, but it was hoed two times. Twenty days after herbicide application, the number and weight of the different weed species per sq. m. as well as perished cape gooseberry plants were established. The weight, length and diameter of fruits were measured in the full botanical maturity. The dry weight, total sugar, total acid and vitamin C were

analysed by using the methods described by Stambolova et al. (1978). The productivity was also determined. Statistical analyses were done according to ANOVA.

Results and discussion

In the experimental areas with cape gooseberry, the following weeds were mainly observed: Purslane - *Portulaca oleraceae* L., Johnson Grass - *Sorghum helepense* L., Chingma Abutilon - *Abutilon theofrasti* Med., Beet root - *Amaranthus retroflexus* L., Bindweed – *Convolvulus arvensis* L., Creeping Thistle - *Cirsium arvense* Scop., Fat Hen - *Chenopodium album* L. and Black Nightshade - *Solanum nigrum* L.

The results concerning the effectiveness of herbicides are shown in Table 1. The application of Agil herbicide in cape gooseberry did not cause sufficient reduction of weeds. The lowest total number of weeds was counted in Afalon 150 ml/da. In this variant annual dicotyledon weeds amounted to 3.5 per sq. meter. This herbicide had high impact on *Portulaca oleraceae* L., *Chenopodium album* L., *Amaranthus retroflexus* L. and *Solanum nigrum* L. In a 100 ml/da dose, the number of the above mentioned weeds was significantly higher and reached 6.5 nr./m^2. Agil controlled only annual and perennial monocotyledon weeds. Therefore, the density of weeds in the experimental plots was 91.6 (Agil 80 ml/da) whereas in higher doses, they amounted to 78.6. Statistical significance was established.

Tab. 1. Number of weeds per sq. m., average 2009-11
Broj korova po m^2, prosjek 2009-2011. god.

Variants	Total	Annual weeds *Jednogodišnji korovi*					Perennial weeds *Višegodišnji korovi*		
		Portulaca oleraceae L.	*Chenopodium album* L.	*Abutilon theofrasti* Med.	*Amaranthus retroflexus* L.	*Solanum nigrum* L.	*Sorghum helepen-se* L.	*Convolvulus arvensis* L.	*Cirsium arvense* Scop.
Control	61.5	8.1	4.0	6.2	1.8	6.3	10.2	3.3	10.6
Afalon 100 ml/da	46.0	0.9	0.4	3.8	0.8	0.6	17.0	9.2	13.3
Afalon 150 ml/da	42.4	0.0	0.0	3.3	0.1	0.1	17.3	8.6	13.0
Agil 80 ml/da	91.6	33.0	5.2	10.2	4.8	10.8	4.6	10.5	12.5
Agil 150 ml/da	78.6	25.1	5.0	10.8	4.7	11.2	0.0	9.4	12.4
LSD $p_{0.05}$	18.3	8.2	4.5	4.8	2.9	3.9	6.8	3.6	4.2

The weight of the weed (Table 2) treated with Afalon was lower than in the control. The results indicate that in both doses of this herbicide the decrease was 15-17%. Higher density of weeds in variants with Agil also determined higher total weight. In a dose of 80 ml/da, the values of this parameter were two times higher in comparison with the control. In the next dose of this herbicide, the change in weed weight in comparison to non-treated plants was by 42% from the above.

Tab. 2. Weight of weeds in growing of Cape gooseberry, average 2009-11 (g/m^2)
Težina korova prilikom uzgoja peruanske jagode, prosjek 2009-11. god. (g/m^2)

Variants	Total	Annual weeds *Jednogodišnji korovi*					Perennial weeds *Višegodišnji korovi*		
		Portulaca oleraceae L.	*Chenopodium album* L.	*Abutilon theofrasti* Med.	*Amaranthus retroflexus* L.	*Solanum nigrum* L.	*Sorghum helepensisi* L.	*Clematis recta* L.	*Cirsium arvense* Scop.
Control	775.1	186.2	88.3	53.7	4.3	81.3	320.1	3.8	37.4
Afalon 100 ml/da	648.8	32.1	15.4	27.3	1.9	7.9	501.2	40.5	22.5
Afalon 150 ml/da	657.7	0.0	0.0	23.5	0.2	1.3	579.6	31,4	21,7
Agil 80 ml/da	1570.6	1030,7	156.8	50,5	12.3	117.7	148,2	27.2	27.2
Agil 150 ml/da	1101.0	586,2	256.8	89.4	12.2	123.2	0,0	17.1	16.1
LSD $p_{0.05}$	156.8	48.3	25.8	12.5	6.4	35.7	19.8	10.2	16.4

The applied herbicides did not demonstrate good selectivity (Table 3). The biggest percentage of dead cape gooseberry plants was recorded using higher concentration of Afalon and Agil, 23.85% and 18.85%, respectively. Lower doses cause perishing of 13.33% and 11.42%, respectively. Decrease in fruit weight was observed after using of the herbicides. This was especially found in the variants with higher quantity of herbicides - with 32.2% and 26.3% for 150 ml/da Afalon and Agil, respectively. The diameter and length of fruits also decreased, but to a lesser degree. The influence of herbicides was stronger regarding the second parameter in the variant Agil 150 ml/l, where length was smaller by 34.6%.

The most important assessment of the effect of each agricultural practice is its influence on productivity (Table 4). After application of the herbicides, the yield of cape gooseberry was lower in comparison to control. The highest decrease was obtained in Afalon 150 ml/da, by 47.6%, followed by the lower concentration, by 39.8%. The yield was least decreased in 80 ml/l da Agil, but there was also significant reduction towards the non treated plants. On the one hand, this is related to the reduced number of plants as a result of their perishing due to the herbicides effect. On the other hand, decreased fruit weight also affects productivity. The highest density of weeds in

variants with Agil is also one of the main reasons of reduced yield. The content of chemical components in cape gooseberry fruit was slightly affected under the influence of herbicides.

Tab. 3. Perished plants and morphological fruits characteristics of cape gooseberry, 2009-11
Uginule biljke i morfološke karakteristike ploda peruanske jagode, 2009-11. god.

Variants	Perished plants (%)	Weight (g)	Diameter (cm)	Length (cm)
Control	0	5.62	1.98	3.5
Afalon 100 ml/da	13.33	5.02	1.93	2.8
Afalon 150 ml/da	23.85	4.25	1.98	3.0
Agil 80 ml/da	11.42	4.84	1.91	3.1
Agil 150 ml/da	18.85	4.45	1.92	2.6
LSD $p_{0.05}$	6.4	0.55	0.25	0.64

Tab. 4. Productivity and content of chemical components of cape gooseberry, average 2009-11
Produktivnost i sadržaj hemijskih komponenti peruanske jagode, prosjek 2009-11. god.

Variants	Productivity kg/da	Dry matter (%)	Total sugar (%)	Total acid (%)	Vitamin C mg%
Control	258,5	13.7	3.9	1.12	30.2
Afalon 100 ml/da	184,9	15.7	4.5	1.28	32.8
Afalon 150 ml/da	175.1	13.3	3.8	1.62	34.5
Agil 80 ml/da	208.1	14.2	4.1	1.35	29.8
Agil 150 ml/da	199.2	14.0	2.9	1.42	31.3
LSD $p_{0.05}$	28.7				

Conclusion

The total weight and density of weeds was lowest in application of both investigated doses of Afalon.

Afalon herbicide primarily influenced the plants from *Chenopodium album* L., *Portulaca oleraceae* L., *Amaranthus retroflexus* L. and *Solanum nigrum* L., while Agil mostly affected weeds of Sorghum *halepense* L.

The highest percentage of dead plants was established after application of 150 ml/da Afalon, followed by the same dose of Agil.

The productivity of plants treated with studied herbicides was lower in comparison to the control.

The investigated herbicides, Afalon and Agil, did not demonstrate good selectivity in cape gooseberry.

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Ispitivanje efikasnosti i selektivnosti nekih herbicida primjenjenih na peruanskoj jagodi (*Physalis peruviana* L.)

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Sažetak

Glavni cilj ovog rada je bio da se ispitaju mogućnosti primjene herbicida tokom vegetacije peruanske jagode. Herbicidi Afalon 100 i 150 ml/da kao i Agil 85 i 150 ml/da su primjenjeni na sorti Plovdiv u trenutku početka formiranja pupoljaka. Kontrolni uzorak nije tretiran, nego je okopavan. Dvadeset dana kasnije, ispitivane su vrste, broj i težina korova; broj uginulih biljaka peruanske jagode; težina, prečnik i dužina plodova pri botaničkoj zrelosti. Utvrđena je produktivnost i hemijske komponente. Najveća efikasnost, najniži broj korova i težina ustanovljeni su pri korištenju Afalona 150 ml/da koji kontroliše jednogodišnje dikotiledonske korove. Ukupna težina korova je opala uglavnom zahvaljujući Afalonu. Najveći procenat uginulih biljaka je ustanovljen nakon primjene Afalona 150 ml/da. Najveća produktivnost je ustanovljena kod kontrolnog uzorka. Ispitivani herbicidi Afalon i Agil nisu pokazali zadovoljavajuću selektivnost kod peruanske jagode.

Ključne riječi: peruanska jagoda, herbicidi, plod, selektivnost, prinos.

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External, Internal and Sensory Qualities of Table Eggs as Influenced by Two Different Production Systems

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Abstract

This study was conducted to determine the effects of two production systems (organic vs conventional cages) on egg quality parameters during the late laying period. The effects of a production system were investigated on external and internal quality and on the sensory attributes. The eggs produced in organic system had paler yolks ($P<0.001$) and thinner egg shells ($P<0.05$) than the eggs produced in the cages. Overall sensory quality was improved in eggs deriving from hens allocated in cages. Differences between organic and cage eggs indicated lower redness and higher yellowness ($P<0.001$) in organic eggs than in cage eggs. The organic eggs were characterised by a higher content of α-linolenic and docosapentaenoic acid ($P<0.05$) and lower content of linoleic acid ($P<0.05$) than the eggs from cages. The ratio of omega fatty acids, n-6/n-3, was most favourable in the organic eggs (5.93:1). In the cage eggs, the ratio n-6/n-3 was significantly ($P<005$) higher (955:1).

Key words: laying hens, table eggs, quality, cages, organic.

Introduction

The quality of eggs is influenced by characteristics that are appropriate from the point of view of consumers. Consumers look forward to freshness, smell, shell colour and yolk colour. The quality of eggs is determined by microbiological, hygienic, sensory and technological qualities as well. Nowadays, the nutritional quality and healthiness of table eggs are particularly in favour with consumers. Moreover, they are interested in production systems and welfare of laying hens. In the EU member countries, the breeding in conventional cages has been forbidden since 2012. The so-called enriched cages and less intensive production systems like barn, free range and organic are allowed. The prohibition of conventional cages would contribute to hen welfare and health, which will further on contribute to better quality of products.

Therefore, we studied the impacts of two production systems (organic and conventional) on some physical and sensory characteristics of eggs as well as fatty acid composition.

Materials and methods

Pullets from Slovenian Prelux-G strain were housed in a barn system with litter till age 18 weeks when 113 pullets were moved to conventional cages and 50 pullets to free range on an organic farm. In each cage a hen had 1287 cm^2 of floor space. Hens in conventional cages were fed with complete feeding mixture for laying hens while in the organic system two thirds of a diet represented feeding mixtures from maize, triticale, wheat, rye, oats and oilseed and one third of a diet was commercial organic feed for laying hens. Eggs were sampled three times: at the end of July, at the beginning of September and at the end of September. At first sampling, the hens were 69 weeks old, at the second one 75 weeks and at the third one 78 weeks, whilst eggs were divided into three subsamples. The physical characteristics were measured on eggs from the first subsample; sensory attributes were measured on eggs from the second subsample and fatty acid composition of yolk from the third one (Table 1).

Tab. 1. Number of analysed eggs per sampling and per group of studied characteristics
Broj analiziranih jaja po uzorkovanju, ispitivanoj grupi i analiziranim osobinama

Production system	Sampling	Physical characteristics	Sensory attributes + pH of egg white and yolk + yolk colour	Fatty acid profile of egg yolk
Conventional cages	1	15	21 (three replications)	3
	2	15	7	3
	3	15	7	/
Organic	1	15	21 (three replications)	3
	2	15	7	3
	3	15	7	/

Physical characteristics were measured on one-day old eggs, whilst sensory attributes of fresh and hard boiled eggs on four-day old eggs. The fatty acid content was determined only in eggs from subsample of first and second samplings. Each sample was analysed in duplicate. Physical characteristics of eggs were measured by calliper (width and height), mechanical micrometer (shell thickness) and electronic apparatus (Technical Services and Supplies, York, England) that include reflectometer, scales, tripod micrometer and colorimeter. The incidence of blood and meat spots was noticed and the share of eggs with meat and blood spots was calculated but this characteristic was not included into statistical analysis. Sensory attributes were determined by a team of four trained panellists. The samples were coded. The quantitative descriptive analysis was used to evaluate sensory attributes in the same order as they were perceived.

We used a non-structural numerical scale. In the 1 – 7 scale, 1 point means that the trait is not expressed or that it is unacceptable, while 7 points mean that the trait is strongly or excellently expressed. pH value was measured by combined glass electrode type 8431 connected to pH meter (ISKRA Ma 57219). Instrumental analysis of yolk colour of hard boiled egg was performed by using the chromameter Minolta CR 200b with computer DATA DP 100. Fatty acid content of yolk was determined by gas chromatography according to Park and Goins (1994). The effect of production system on studied characteristics was statistically evaluated by SAS/STAT (SAS User's Guide, 2000) programme package.

Results and discussion

The studied physical characteristics of eggs from two production systems showed statistically significant differences only in yolk colour and shell thickness (Table 2).

Tab. 2. Differences in physical characteristics between conventional and organic eggs
Razlike u fizikalnim osobinama jaja iz konvencionalnog i organskog sistema držanja

Characteristic	LSM ± SE		Difference ± SE	p – value
	Conventional	Organic		
Shape index	73,94 ± 0,46	73,00 ± 0,46	0,94± 0,65	0,1535
Shell colour (%)	37,73 ± 0,87	37,64 ± 0,87	0,09 ± 1,23	0,9426
Egg weight (g)	64,08 ± 0,64	64,46 ± ,64	-0,38 ± 0,90	0,6719
Albumen height (mm)	6,65 ± 0,17	6,25 ± 0,17	0,39 ± 0,25	0,1138
Haugh units	78,89 ± 1,37	76,18 ± 1,37	2,71 ± 1,94	0,1662
Yolk colour (Roche)	13,11 ± 0,12	11,13 ± 0,12	1,98 ± 0,17	<0,0001***
Shell thickness (mm)	0,35 ± 0,00	0,33 ± 0,00	0,01 ± 0,00	0,0262*

LSM= least squares mean; SE=standard error

Yolk colour of conventional eggs was significantly more intensive, by two units according to Roche colour fan, which is due to the fact that hens were fed with complete feeding mixture that contains natural and synthetic pigments in quantities and proportions that result in desired yolk colour which is not the case in organic production. Hidalgo et al. (2007), Minelli et al. (2007) and Kucukyilmaz et al. (2012) reported on higher yolk yellowness from conventional eggs in comparison to yolks from organic eggs. Conventional eggs had thicker shell. The effect of production system on shell thickness cannot be easily explained. Rizzi et al. (2006) and Mugnai et al. (2009) found thicker shells in organic eggs in comparison to conventional eggs, but on the other hand Hidalgo et al. (2007) reported on diverse results.

In conventional eggs, the incidence of meat and blood spots (46,7 %) was higher than in organic eggs (40,0 %). Some meat and blood spots were big but also

smaller spots were also found. In literature data, external characteristics of eggs produced in different production systems differ considerably, which might be due to differently formed experiments, not to mention environmental effects in diverse production systems that affect some of the egg traits.

Fifteen studied sensory attributes determined in fresh and hard boiled eggs from two production systems demonstrated statistically significant differences in nine attributes (Table 3).

Tab. 3. Sensory differences between conventional and organic eggs (Wilcox's test)
Razlike u senzornim osobinama jaja iz konvencionalnog i organskog sistema držanja (Wilcox-ov test)

Sensory trait (points)	p-value	Conventional system		Organic system	
		$\bar{X}$	sd	$\bar{X}$	sd
FRESH egg					
Appearance (1 – 7)	0,9133	6,58	0,42	6,60	0,36
Smell (1 – 7)	0,0193*	7,00	0,00	6,84	0,29
Other smells (1 – 7)	1,0000	1,00	0,00	1,00	0,00
Yolk shape (1 – 7)	0,2063	6,50	0,47	6,24	0,63
Yolk consistency (1 – 7)	0,0248*	6,58	0,42	6,18	0,53
Albumen consistency (1 – 7)	0,5801	5,95	0,40	5,66	1,46
HARD BOILED egg					
Smell (1 – 7)	0,0090**	6,29	0,45	5,89	0,36
Other smells (1 – 7)	0,0726	1,03	0,11	1,21	0,38
Colour steadiness in yolk (1–7)	0,0080**	5,97	0,56	5,42	0,58
Texture (1 – 7)	0,0034**	6,34	0,33	5,95	0,44
Taste (1 – 7)	0,0019**	6,45	0,37	6,05	0,33
Extra tastes (1 – 7)	0,2974	1,03	0,11	1,10	0,27
After taste (1 – 7)	0,0254*	1,24	0,54	1,50	0,44
Total impression (1 – 7)	0,0051**	6,26	0,30	5,92	0,38
Yolk colour (1-15)	<0,0001***	14,42	0,51	9,31	1,70

$\bar{X}$ =mean, sd = standard deviation

Conventional eggs differed significantly from organic eggs regarding smell of fresh egg, yolk consistency in fresh egg, smell of hard boiled egg, yolk colour steadiness in hard boiled egg, texture, taste and after taste in hard boiled egg, total impression and yolk colour of hard boiled egg. All the above attributes were better in conventional eggs. Yolk colour in hard boiled conventional eggs (Table 3) was for 1,3 units darker, and in organic eggs for 1,8 units lighter in comparison to fresh eggs (Table 2).

The yolk colour in fresh eggs was measured by colorimeter while in hard boiled eggs Roche colour fan was used. Albumen pH value and yolk pH value were measured in four-day old eggs hence the expected average pH values were higher than pH values in fresh eggs (immediately after laying). The pH value of albumen in

conventional eggs was 9,0±0,34 and in organic eggs 9,25±0,20 while the corresponding pH value of yolk was 6,14±0,09 and 6,37±0,32. Yolks of hard boiled eggs from different production systems statistically significantly differ in colour shade, which is shown by values a* and b* (Table 4).

Tab. 4. Differences in yolk colour of conventional and organic eggs (measured by Minolta)
Razlike u boji žumanca između jaja iz konvencionalnog i organskog sistema držanja (mereno sa Minoltom)

MINOLTA (CIE system)	LSM ± SE		Difference ± SE	p - value
	Conventional	Organic		
L* (lightness)	61,78 ± 1,04	59,36 ± 1,04	2,42 ± 1,47	0,1090
a* (redness)	10,03 ± 0,64	2,83 ± 0,64	7,19 ± 0,91	<0,0001***
b* (yellowness)	57,40 ± 1,73	67,00 ± 1,73	-9,59 ± 2,45	0,0004***

Yolk colour in conventional eggs was significantly more red and significantly less yellow in comparison to yolks from organic eggs. Similar results for intensiveness of red and yellow yolk colour from conventional and organic eggs were also reported by Minelli et al. (2007).

Organic eggs were characterised by a higher content of essential linolenic acid (18:3, n-3), and docosapentaenoic acid (22:5, n-3) and n-3 fatty acids and more favourable ratio of n-6 to n-3 fatty acids than conventional eggs. Conventional eggs contained more linoleic acid (18:2, n-6) which is an essential acid (Table 5). Different contents of fatty acids in eggs showed different contents of those acids in feeds that hens were fed on. Lopez-Bote et al. (1998) reported that organic eggs contained more n-3 (2.6 times) and less n-6 fatty acids in comparison to conventional eggs. It is well known that fresh fodder (grass, legumes) is rich in n-3 and poor in n-6 fatty acids. The total content of saturated fatty acids (SFA), mono unsaturated fatty acids (MUFA) and poly unsaturated fatty acids (PUFA) did not differ in eggs from both production systems. Similar results were found by Matt et al. (2009) who did not find significant differences in contents of SFA, MUFA and PUFA in eggs produced in conventional and organic production systems.

Conclusion

Eggs produced by Prelux –G hens of the same age in conventional and organic production systems differed significantly in external traits, namely intensity of yolk colour and thickness of shell. Yolks from conventional eggs were more yellow ($p \leq 0.0001$) and had thicker shell ($p=0.0262$) than organic eggs.

Fresh eggs from conventional cages achieved better marks than organic eggs in smell and yolk consistency while hard boiled eggs in smell, steadiness of yolk colour, texture, taste, total impression and yolk colour.

The redness in yolks of hard boiled conventional eggs was significantly higher while yellowness was significantly lower than in organic eggs.

Eggs produced by Prelux-G hens in organic production system had more favourable fatty acid composition than conventional eggs because they contained significantly more linolenic acid (18:3, n-3), docosapentaenoic acid (22:5, n-3) and total n-3 fatty acids. The ratio of n-6 to n-3 (5,93) fatty acids was more favourable in organic eggs than in conventional ones (9,55). Conventional eggs contained more linoleic acid (18:2, n-6).

Tab. 5. Different fatty acid contents in conventional and organic eggs
Razlike u sadržaju masnih kiselina u jajima iz konvencionalnog i organskog sistema držanja

Fatty acid*	p-value	Conventional		Organic	
		$\bar{X}$	sd	$\bar{X}$	sd
16:00	0,0671	26,13	0,09	25,35	0,50
16:1, n-7	1,0000	3,00	1,10	3,22	0,23
18:00	1,0000	9,52	2,40	9,04	1,02
18:1, n-9c; 18:1, n-9t; 18:1, n-12t; 18:1, n-7c	0,3123	38,05	3,63	39,80	2,31
18:2, n-6c	0,0304*	15,67	0,11	15,06	0,11
18:3, n-3	0,0304*	0,35	0,09	0,97	0,09
20:4, n-6	0,1124	3,49	1,53	2,20	0,64
20:5, n-3 (EPA)	0,4356	0,01	0,00	0,02	0,01
22:5, n-3	0,0304*	0,18	0,06	0,33	0,06
22:6, n-3 (DHA)	0,6650	1,58	0,72	1,63	0,46
SFA	1,0000	36,35	2,41	35,33	1,37
MUFA	1,0000	41,47	4,87	43,61	2,55
PUFA	1,0000	22,34	2,42	21,19	1,18
n-3 FA	0,0304*	2,20	0,66	3,06	0,44
n-6 FA	0,1124	20,03	1,81	18,01	0,74
EPA + DHA	0,6650	1,60	0,72	1,66	0,48
PUFA/SFA	1,0000	0,61	0,03	0,60	0,01
n-6/n-3	0,0304*	9,55	2,03	5,93	0,54

X =mean, sd = standard deviation; * % w/w of total fatty acids

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Spoljašnje, unutrašnje i senzorske osobine kvaliteta konzumnih jaja iz dva različita sistema držanja

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Sažetak

U ovom radu su izneti rezultati uticaja dva sistema držanja kokoši nosilja (organski uzgoj vs uzgoj u baterijskim kavezima) na parametre kvaliteta jaja u završnoj fazi nošenja. Ispitan je uticaj sistema držanja na spoljašnje i unutrašnje osobina kvaliteta jaja kao i na intenzitet senzornih svojstava. Jaja iz organskog sistema su imala svetliju boju žumanca ($P<0,001$) i tanju ljusku ($P<0,05$) u odnosu na konvencionalne kaveze. Što se tiče senzorskih svojstava najbolji rezultati ostvareni su kod nosilja, koje su držane u kavezima. Držanje nosilja u organskoj proizvodnji izazvalo je porast udela žute boje (b*) i istovremeno smanjenje udela crvene boje (a*) ($P<0,001$) u odnosu na kaveze. U poređenju sa jajima iz kaveza, veći sadržaj α-linolenske i dokozapentaenske kiseline i manji sadržaj linolne kiseline ($P<0,05$) zabeležen je u jajima iz organskog sistema. Najpovoljniji odnos omega-6:omega-3 kiselina utvrđen je u organskim jajima (5,93:1). U jajima iz kaveza odnos n-6/n-3 bio je statistički signifikantno ($P<0,05$) veći (9,55:1).

Ključne reči: kokoši nosilje, konzumna jaja, kvalitet, kavezi, organska proizvodnja.

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Implementation of the Programme for Conservation of Plant Genetic Resources in the Republic of Srpska from 2009 to 2012

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Abstract

The Programme for Conservation of Plant Genetic Resources in the Republic of Srpska was established in 2008. The main objective of the Programme is effective management of plant genetic resources through carrying out of continuous field inventories and collection, evaluation, exchange and conservation of germplasm. The Genetic Resources Institute, University of Banja Luka was appointed as a expert unit for coordination and implementation of the Programme. In the period from 2009 to 2011, the inventory was made for part of the area of the Republic of Srpska. An innovative approach was adopted for conservation of plant genetic resources by means of long-term seed preservation, *in vitro* conservation, morphological and molecular characterisation, as well as regular database updates. Contacts were established with producers for the purpose of on farm protection of local ecotypes and populations. An ex situ collection was established in the Botanic Garden for plant species that can not be conserved in the form of seeds. By the end of 2011, the Gene Bank had reached its full operation with 455 accessions in long-term storage (-18^{o}C), around 150 accessions in the working collection and 100 accessions in the field collection. With its 91 accessions, the Genetic Resources Institute is part of a European web-based catalogue of inventories of plant genetic resources (EURISCO). Having adopted the Programme, the Republic of Srpska has not only fulfilled one of the world's peremptory obligations to conserve biodiversity of agricultural crops, but also a moral obligation to future generations.

Key words: inventory, collection, characterisation, working groups, ex-situ and in situ conservation, EURISCO Catalogue.

Introduction

Genetic resources have lately been drawing more and more attention in terms of collecting, conserving, evaluating and usage. The scientific community is increasingly warning about genetic erosion of the overall germplasm. It has become clear that biodiversity is a foundation of our existence on earth therefore it is necessary to preserve the biological heritage both for the purpose of saving it from contingencies and disappearance of some species and making the resources available in the future.
Bosnia and Herzegovina, including the Republic of Srpska, has rich biological diversity (*Bosnia and Herzegovina – Land of Diversity*, 2008). Owing to people's migrations, trade and exchange, species and varieties grown by various cultures reached many different areas, but only those that had adjusted best to local conditions and provided satisfactory yields were used for further reproduction. Spontaneous crossing and natural selection under the impact of the environment led to creation of a number of valuable spontaneous ecotypes and new varieties in our region.

Diversity of plant and animal species ensures raw materials for the production of food, medical preparations and remedies as well as all other types of products that people need to survive. Biological diversity is a source of genetic material that enables development of new and enhancement of plant varieties for agricultural production.
As a result of increasing commercialisation of plant production, loss of traditional peasant households and migrations from rural areas, the genetic stock and biological diversity in the Republic of Srpska have been under the extreme jeopardy of vanishing completely.

Instruments for ensuring conservation of biodiversity in agriculture and food production include various international treaties, global action plans and others that play a significant role in the regulation of use, transfer, protection, management and trade in regards with biological diversity at the regional, national and international level.

The Convention on Biological Diversity of the United Nations recognises that signatory countries have sovereign rights over their resources and biodiversity. The signatory countries' obligations have been set out in article 6 of the Convention, which states that all member countries should, in accordance with their potential and capacities, among other things, set up national strategies, plans or programmes for protection and sustainable use of biological diversity. The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) entered into force in 2004. It represents a comprehensive treaty for sustainable agriculture and food security and whose objectives are the conservation and sustainable use of plant genetic resources for food and agriculture (PGRFA) and the fair and equitable sharing of benefits derived from their use.

The National Assembly of the Republic of Srpska adopted the Programme for Conservation of Plant Genetic Resources in the Republic of Srpska (hereinafter referred to as Programme) in June 2008 ("The Official Gazette of the RS" 59/08). It was set out in the Programme that the Genetics Resources Institute within the

University of Banjaluka was to be established as a coordinating institution for the implementation of the Programme. Having established this Programme that sets up the conservation and sustainable use of plant genetic resources, the Republic of Srpska is so far a unique example in the region when it comes to legal basis for the activities related to genetic resources.

Materials and methods

This paper presents the results of the implementation of the Programme in the period after it was laid down, i.e. from 2009 until the end 2011.

The main objective of the Programme is effective management of PGR through carrying out continuous field inventories and collection, evaluation of collected accessions, but also exchange and conservation of collected germplasm. The University of Banja Luka founded the Genetic Resources Institute in January 2009 while the Contract on the implementation of the Programme was signed with the University of Banja Luka in June 2009. The Plant Genetic Resources Committee, established in December 2008, laid down the Action Plan for the period 2009 - 2015.
The Programme activities are being carried out within the activities of 6 working groups: Cereal and Maize Working Group, Fruit and *Vitis* Working Group, Vegetables Working Group, Industrial Plants Working Group, Forages Working Group and Medicinal and Aromatic Plants Working Group. Apart from the Institute staff, associates from a number of institutions take part in the activities of working groups: Faculty of Agriculture in Banja Luka, Agricultural Institute of the Republic of Srpska, The Agency for the Provision of Consultancy Services in Agriculture, the Centre for Rural Development of the City of Banja Luka and representatives of municipal departments dealing with agriculture as well as associations of citizens and nature lovers.

The conservation and use of plant genetic resources is continuously evolving. It is widely accepted that conservation can be performed *in situ* and *ex situ* (Engels and Visser, 2003).

In situ conservation not only safeguards genetic variability of plant species, but it also enriches this variability by means of mutation, recombination and selection. Thus, this form of conservation enables continuous flow of the evolution process. The conservation of an area where populations of a particular species exist naturally and where they have developed their distinctive features is the main requirement for conservation of biological diversity. Protected areas have been highly recommended as the instruments for *in situ* conservation (Engels J.M.M., Visser, L. 2003).

Ex situ conservation implies sampling, transfer and storage of target taxon populations in the collection area whereas *in situ* conservation includes marking, management and monitoring of target taxons where they have been located. A key difference is reflected in the dynamic nature of *in situ* conservation in comparison to the static nature of *ex situ* conservation. The use of only one of these methods can not facilitate conservation of genetic diversity of any one of the plant species. Wherever possible, it is necessary to use the combination of the two aforementioned conservation

methods. *Ex situ conservation* refers to conservation of the components of biological diversity outside of their natural habitats (*The Convention on Biological Diversity*, 1992). It is the process of protecting an endangered plant and animal species outside of its natural habitat, e.g. by removing part of the population from a threatened habitat and placing it in a new location. Depending on the techniques used, *ex situ* conservation can take various forms, but the ones mostly used include: seed gene banks, field gene banks and *in vitro* conservation.

Results and discussion

In the period from 2009 until the end of 2011, significant results were accomplished at the republic, regional and international level as regards the implementation of the Programme.

An innovative approach to conservation of plant genetic resources by means of balanced application of both *in situ* and *ex situ* strategies of conservation is one of the most crucial outcomes resulting from the implementation of the Programme activities. From 2009 until 2011, the Institute was entirely equipped for conservation of plant genetic resources whereas the gene bank became fully operational in 2010 for long-term conservation of germplasm, which implies long-term conservation of the collected material at – 18°C.

Taking part in drafting of the Second Report on the State of the World's Plant Genetic Resources is an important result at the international level. The Second Report on the State of the World's Plant Genetic Resources[1] was published in 2009 by the Commission for Plant Genetic Resources within Food and Agriculture Organization of the United Nations (FAO UN, 2009). It is worth mentioning that the Republic of Srpska, that is BiH, joined ECPGR – The European Cooperative Programme for Plant Genetic Resources[2]. During this period of the Programme activities, 91 accessions of the Gene Bank of the Republic of Srpska were registered in the European Plant Genetic Resources Search Catalogue (EURISCO).

Making inventories. The first step and a main prerequisite towards conservation of PGR is to carry out field inventories. In the work conducted in regards with the Programme implementation so far, inventories were made for considerable part of the Republic of Srpska, resulting in 747 inventoried accessions (287 cereal and maize accessions, 89 forage accessions, 227 vegetables accessions, 58 accessions of medicinal and aromatic plants, 8 accessions of industrial plants and 78 fruit and vine accessions).

Conservation of plant genetic resources. The conservation of plant genetic resources within the Programme takes place in the form of *in situ* and *ex situ* conservation. One of the priority activities of the Programme for Conservation of Plant Genetic Resources in the Republic of Srpska is to establish a network of protected areas where endangered plant species would be conserved in their natural environment.

[1] www.fao.org/agriculture/crops/core-themes/theme/seeds-pgr/sow/en/#cr
[2] http://www.ecpgr.cgiar.org/

In the previous period, two such initiatives started with the aim to declare protected areas for conservation of genetic resources in both dynamic and developing state. The first initiative, unfortunately unfruitful although the study and harmonisation of the field state was completed, referred to the initiation of procedures to declare "Bukovica" locality as a protected natural area. The second initiative is reflected in the initiation of a procedure to protect "Univerzitetski grad" ("University Town") Park Complex together with other facilities covering 21 ha[3]. During 2010, the Genetic Resources Institute started analysing the state of the park in "University Town" Complex. Initial activities referred to evaluation of ligneous species in "University Town" Park. Positions of all trees were noted down and represented in a map. In May 2012, "University Town" Complex was protected on the basis of the Law on Nature Protection and categorised as – *Resource Management Area.*

A special form of *in situ* conservation, becoming more important lately, is on farm conservation. This type of conservation is of interest primarily in regards with field crops, having in mind that on farm conservation is to protect endangered plant species in their natural habitats and that it takes into consideration social and cultural factors such as traditional knowledge. *In situ* – on farm conservation includes maintenance of traditional cultivar crops or ecotypes and traditional growing systems (Hodgkin at all, 1993; Jarvis, 1999). In the course of activities undertaken so far for the purpose of Programme implementation, contacts were made with producers who are interested in this form of conservation of autochthonous field crops and growing systems. Most interest for on farm conservation came from vegetable, fruit and vine producers at the following locations: Gomiljani, municipality of Trebinje; Karanovac, municipality of Petrovo; Bančići, municipality of Ljubinje; Prusci, municipality of Novi Grad; Velika Bukovica, municipality of Doboj and Nožičko, municipality of Srbac.

A seed gene bank serves for *ex-situ* conservation of plant genetic resources in the form of seeds, by drying of the seeds until they reach low moisture level and storing them at low temperatures without losing vitality. Most key cropss being used as food are tolerant to seed drying until reaching low moisture level, thus being suitable for seed type of conservation. Currently, there are more than 1,500 gene banks and germplasm collections across the world, maintaining estimated 6,100,000 accessions (*The State of Food and Agriculture*, 1996). Conservation of the genetic diversity in the form of seeds is the most studied widely used and most suitable method of *ex situ* conservation (Hamilton, M.B, 1994). The seed gene bank of the Republic of Srpska became fully operational during 2010 when all necessary equipment was purchased for the preparation of seeds and long-term conservation (seed counter, germinator, phytothrone, bag sealer, moisture meter, drying chamber, refrigerators, freezers and chambers for long-term storage of seeds). Internationally established FAO/IPGRI standards for seed handling in gene banks are the guidelines that the Gene Bank of the Republic of Srpska also abides by in its procedures with the aim to conserve seeds in the best possible condition prior to storage and to maintain high germination before

[3] http://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mgr/PAO/Pages/Javni_uvid.aspx

entering the collection. Conservation of plant material in the seed form requires everyday laboratory work. Newly-arrived accessions are being prepared for storage at low temperatures through processes such as seed cleaning, seed germination tests (according to ISTA rules[4]), drying to the optimal moisture level (3-7%) in drying chambers at low temperatures and at low moisture level in the chamber (-25ºC and 10-15% relative moisture), then seed packing in three-layered aluminium bags and storing in freezers at -18°C. The accessions already in long-term storage are monitored daily. By the end of 2011, 455 accessions had been prepared for long-term conservation. The active, base and safety collections were formed in the Gene Bank of the Republic of Srpska, with the plan to move the safety collection somewhere else in the future, that is, to another gene bank. As a rule, minimum 1,000 seed grains are conserved for each accession, but in the case of poor germination and a small number of collected seed grains, if possible, recollection is recommended, or multiplication.

Multiplication of cereal and maize seeds is carried out on the fields of the Agricultural Institute of the Republic of Srpska; multiplication of vegetables seeds in cooperation with the Agency for the Provision of Consultancy Services in Agriculture whereas multiplication of forage crops seeds is performed on the fields of the Centre for Rural Development of the City of Banja Luka. Multiplication of the varieties with vegetative propagation (fruits, vine, potato and vegetable species reproducing in this way) implies multiplication of the collected material being conserved either in field collections or *in vitro* conditions. These activities are carried out at the Genetic Resources Institute.

Field gene banks as a form of *ex-situ* conservation are used for plant species that can not be conserved in the form of seeds. This primarily refers to those species that do not produce seeds and that reproduce vegetatively. They also include tropical and subtropical species, that is, plant species with high moisture seeds that can not tolerate drying well. In field gene banks, the plant genetic resources are kept as live plants that undergo continuous growth and require continuous maintenance. The plant material conserved in this way is easily available for evaluation, characterisation and generally for research of any kind. On the other hand, field gene banks are more expensive to maintain since they require more labour and more space for the maintenance of a collection. Part of the field gene bank of the Republic of Srpska has been situated in the Botanic Garden within the Campus of the University of Banja Luka since 2010. So far, the field gene bank contains autochthonous fruit varieties, with total of 62 trees of 31 autochthonous apple and pear varieties. 36 trees of 18 native apple varieties have been planted including: (*Malus* × *domestica* Borkh.): "Zelenika", "Senabija", "Bobovec", "Kanada", "Srebrenjača", "Cvjetača", "Ovčiji Nos", "Lederka", "Plemka", "Batulenka" ("Staklara"), "Kanjiske", "Habikusa", "Srebrenicka", "Sarenika", "Funtaca", "Sadicka", "Eriflana" and "Slatka Zelenika". In addition, 26 trees of native pear varieties (*Pyrus communis* L.) have been planted, too: "Medenka", "Huseinbegovaca", "Stambolka", "Urumenka", "Avranska", "Izmirska", "Batva", "Dugpalica", "Lederica", "Karamut", "Lubenicarka", "Ranka", "Kantarusa".

[4] http://www.seedtest.org/en/home.html

Another fruit variety collection is being set up in municipality of Cajnice and a field collection vineyard in the area of municipality of Trebinje.

In vitro conservation of plant genetic resources has become a complementary approach to conventional conservation methods. *In vitro* conservation is used to maintain the plant material for short, middle and long term in small space and under controlled sterile conditions. When material is conserved in this way, it is easily available for use and exchange is simplified. The Genetic Resources Institute has established a conservation methodology by using *in vitro* techniques in its gene bank. An *in vitro* lab work protocol was developed and, during 2010, procedures for *in vitro* conservation of garlic and onion were set up and working. Further, there have been experiments as regards vine conservation, prior to which multiplication *in vitro* takes place.

Development of molecular techniques. The elementary role of collecting and conserving plant genetic resources in the world is collection and safeguarding of vital genotype samples of various plant species. Introduction of molecular techniques and molecular markers is of importance and interest in maintenance and management of modern gene banks (Ivanović, V; Konstantinov, K. 2000). The Genetic Resources Institute has set up a protocol for molecular characterisation using RAPD method comprising five stages: DNA extraction, quantification of extracted DNA, RAPD primers polymerase chain reaction, electrophoresys and visualisation and analysis of the results. Characterisation of rye and some native varieties of pear has been done. However, the objective is to ensure conditions for characterisation using microsatellites.

Documentation. Collection forms and passport descriptors comprise main information noted down when inventorying and collecting accessions for a gene bank. These data are entered into a database each time an accession is conserved for a long-term period when each is assigned a unique accession number. An internal database has been created following the model of European Plant Genetic Resources Search Catalogue (EURISCO catalogue) so as to register accessions in the European catalogue more easily. By the end of 2011, 91 accessions of the Genetic Resources Institute were registered in EURISCO (http://eurisco.ecpgr.org/). Along with collection forms and passport descriptors, traditional knowledge and customs relating to inventoried accessions are also collected and recorded. Furthermore, recipes for preparation of dishes, beverages and tea are noted as well as specifics of traditional production and use of accessions. These data are also part of the internal database.

Conclusion

The Programme for Conservation of the Plant Genetic Resources in the Republic of Srpska was implemented according to the plan for 2009-2011 resulting in significant achievements in terms of inventorying, collecting and conserving the plant material.

During 2011, the Institute became fully operational technically and was equipped for carrying out all activities in regards with the Programme implementation.

So far, the Institute has an equipped laboratory for the analysis and preparation of seeds for short-term, mid-term and long-term conservation of seed collections, facilities for long-term conservation of seed collections, laboratory for *in vitro* multiplication and maintenance of the plant material, laboratory for morphological and molecular characterisation.

In order to carry out the Programme activities, an innovative approach is applied aiming at optimal use of complementary methods and all available techniques in conservation of plant genetic resources.

Taking into consideration that genetic resources are part and parcel of human heritage, the Republic of Srpska is obliged to keep on collecting, describing and maintaining valuable genetic resources for the generations to come and for their needs, but also to make them available to everyone through well-developed documentation and information systems.

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Реализација Програма очувања биљних генетичких ресурса Републике Српске у периоду 2009 – 2012. године

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Сажетак

Програм очувања биљних генетичких ресурса Републике Српске донешен је 2008. године. Основни циљ Програма је ефикасно управљање биљним генетичким ресурсима кроз перманентну инвентаризацију терена и колекционисање, евалуацију, размјену и конзервацију гермплазме. За имплементацију и координацију спровођења Програма задужен је Институт за генетичке ресурсе Универзитета у Бањој Луци. У периоду 2009. до 2012. године извршена је инвентаризација дијела Републике Српске, усвојен је иновативан приступ очувања БГР кроз дугорочно чување сјемена, *in vitro* конзервацију, морфолошку и молекуларну карактеризацију, те редовно ажурирање базе података. Успостављени су контакти са произвођачима у циљу on farm заштите локалних екотипова и популација. За биљне врсте које се не могу чувати у форми сјемена успостављена је *ex situ* колекција у Ботаничкој башти. Банка гена је крајем 2011. године постигла оперативност са 455 принова на дугорочном чувању (-18 ^{o}C), око 150 принова у радној колекцији и 100 принова у пољској колекцији. У Европском електронском каталогу инвентара о биљним генетичким ресурсима (EURISCO) пријављена је 91 принова Института за генетичке ресурсе.

Кључне ријечи: инвентаризација, колекционисање, карактеризација, радне групе, *ex situ* конзервација, EURISCO каталог.

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Growing *Pelargonium peltatum* and *Pelargonium x hortum* from Cuttings

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Abstract

Pelargoniums are plants from the family *Geraniaceae*, and one of the most popular summer flowering species that adorn balconies and windows of the houses and are present on the market since the 18th century. In Croatia, the most commonly grown are ivy-geraniums (*P. peltatum*) and zonal (*P. zonale*) geraniums. They reproduce vegetatively because propagating by seeds is expensive and only large horticultural companies can afford it. Every year new cultivars are produced, but geraniums still have a very simple genotype and are grown very successfully, adhering to a few basic rules for their cultivation. The aim of this study with the species *Pelargonium peltatum* and *Pelargonium x hortorum* was to assess the effects of the use of hormones to stimulate root growth when planting cuttings to obtain plants and to monitor the development of cuttings. The cuttings of two different types of pelargonium were treated with Rhizopon hormone to stimulate growth and rooting. Results showed that hormone therapy has no significant effect on growth of these geranium species. Differences between treated and control seedlings were very small, hormone-treated cuttings had faster growth of their roots, although at all stages of measuring the length of P. Peltatum cuttings was significantly higher compared to the P. x hortorum cuttings ($p=0.01$).

Key words: geraniums, cuttings, hormone therapy, rooting, seedlings.

Introduction

Geraniums are easily grown and propagated and that is why their cultivation and popularity have vastly expanded among the fans of flowers. Geraniums are mostly propagated vegetatively by cuttings. The first botanists have classified *Pelargonium zonale* (*Pelargonium x hortum*) in *Geranium* genus, but with further observation and

after differences were detected in relation to other members of this genus, they have established a new genus *Pelargonium*. Different flower structure clearly points to the fact that these are two separate genuses. Thus, a geranium flower has a regular shape with five petals of equal shape and size, and at pelargonium flower, the two upper petals are clearly separated from the bottom three (Pagliarini, 2003; Knežević, 2007.). The major groups of pelargoniums are flowering and scented-leaf pelargoniums. Flowering pelargoniums are further divided into two main groups: *Pelargonium zonale* (vertical) and *Pelargonium peltatum* (cascade and ivy-leaved). Pelargoniums are best grown on soil or substrates with a pH from 5.5 to 6.5 depending on the species. It is best to use specially prepared substrates for pelargoniums (Kessler, 1998.). Optimal values of EC (electrical conductivity) for pelargoniums are 1.0 - 2.5 mS/cm. Ivy-leaved pelargoniums have values from 1.5 to 2.5 mS/cm, while *zonale* pelargoniums include EC values from 1.0 to 2.0 mS/cm. With reduced fertilisation rate, the value of EC also reduces and vice versa, i.e. if it is necessary to increase the conductivity, pelargonium fertilisation should be increased as well (Whipker, 1998) (Table 1.).

Tab. 1. Display of the optimal amount of basic nutrients, PH and EC in the substrate during the cultivation of geranium (Whipker, 1998).
Prikaz optimalnih količina osnovnih hraniva i vrijednosti pH i EC u supstratu pri uzgoju pelargonija (Whipker, 1998.)

		Optimal values *Optimalne vrijednosti*	
	Measurment Unit *Mjerna jedinica*	Ivy-leaved *Buršljanolisne*	Zonale *Zonale*
pH		5,8 – 6,3	5,5 – 6,0
EC	mS/cm	1,5 – 2,5	1,0 – 2,0
Nitrogen *Dušik*	ppm	200 – 250	200 – 250
Phosphorus *Fosfor*	ppm	5 – 19	5 – 19
Potassium *Kalij*	ppm	150 – 250	150 – 250
Calcium *Kalcij*	ppm	50 – 100	50 – 100
Magnesium *Magnezij*	ppm	25 – 50	25 – 50

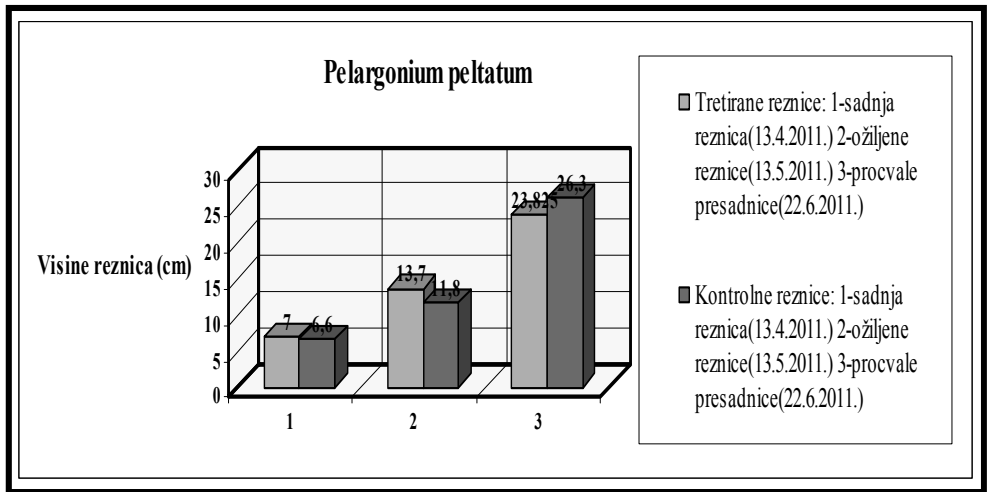
Through a period of intense growth and flowering (April-September), plants should be watered twice a month with water with addition of a complex liquid fertiliser for flowering (rich in nitrogen and iron, and then potassium and phosphorus and with microelements, NPK-Plantella 4:6:8). For better and bushy plant growth, it is advisable to cut short shoot tips periodically. If the plants start to elongate unnaturally, they should be treated with a growth retardant such as cikocel (CCC) and daminozide (ALAR) in concentration of 0.25 to 0.50 percent (Kessler, 1998). Geraniums are easily

propagated vegetatively by cuttings. Parent plants (the best plants are two years old) that we take cuttings from need to be healthy, strong and well-developed. The advantage of vegetative propagation is the production of new plants that are identical to the mother plant, which, when grown from seeds, cannot be achieved, and this is of great importance for the market (Lindgren and Toodle, 2002). Selected cuttings can be immersed in a hormone powder for faster rooting, but even without the use of hormones, reproductive success of cuttings is almost always 100%. Cuttings should be put in a place without direct sunlight. During the first two weeks of rooting, cuttings must be exposed to light of 1800-2800 lx, while subsequent exposure to light should be around 2800-3600 lx. For successful and faster rooting, cuttings need a daily temperature of 22 to 26°C and night temperatures 20-21°C. Planted cuttings should be watered regularly. After two weeks, they will begin to form roots, and after a month, the cuttings are rooted and can be transplanted into individual pots (Kessler, 1998). If there is not enough natural light, HID lamps are used as a supplementary light source. Young plants need weekly fertilisation (e.g. NPK 10-20-20, 150-200 ppm N) (Jauron., 1994). Propagation by seeds (generative) (Lindgren and Toodle, 2002.) is also possible, but is very expensive and usually only affordable to large horticultural companies that have their own seed banks that are used in the production of new varieties. Propagation by seeds is more common in upright pelargonium (*Pelargonium zonale*).

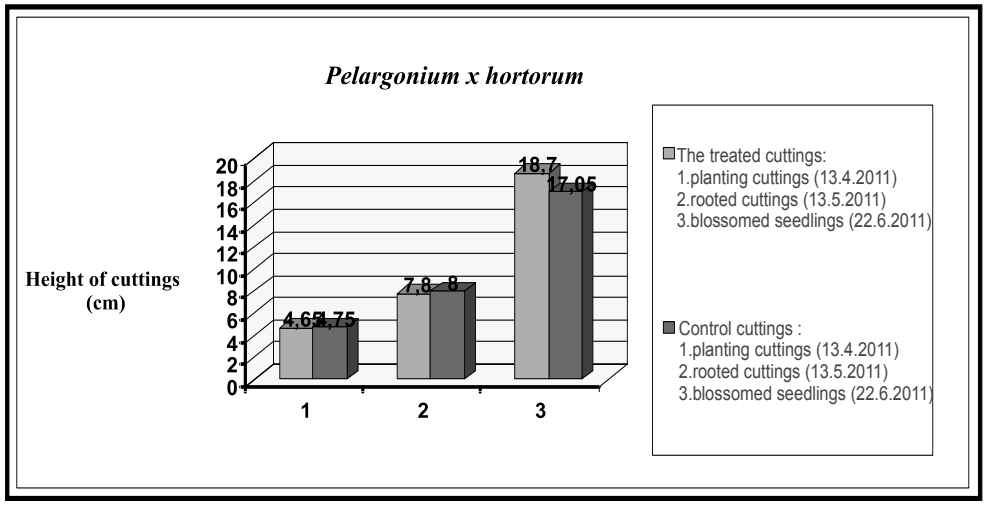
Materials and methods

The experiment was set on 13 April 2011 in a greenhouse on the Iljkić family farm, Josipovac, Croatia. Final sampling was performed on 22 June 2011 and thus the study was completed. The experiment was set up in a split-plot design with four replications for both species. A major factor was treatment with a rooting hormone whereas a sub factor referred to different types of pelargonium. For the production of seedlings, stem cuttings of mother plants of *Pelargonium peltatum* and *Pelargonium x hortorum* species were used. 20 cuttings were treated with a hormone for leaf and herbaceous cuttings, Rhizopon I (dust formulation, active substance, indole butyric acid 0.5%, of the Plantella manufacturer, The Netherlands), which serves as a means to stimulate root growth, or to root cuttings. The remaining 20 cuttings were used as a control. Before planting in the substrate, the base of cuttings was drenched in the Rhizopon hormone powder and control cuttings were planted in the substrate without the hormone. The procedure was the same for both types of pelargonium. Cuttings were planted in a multipot plate with 40 planting places, 530 x 310 x 60 mm, with holes for the cuttings size ø 53/33 x 55 mm and a volume of 78 ml per opening. Brill Type 4 substrate was used for planting. Brill Substrate-Type 4 is characterized by good drainage and buffering capacity due to the presence of particles of black peat in the composition and particle holding capacity and has a firm structure. This substrate contains 80% black peat, 20% white peat and NPK-1600g fertiliser/m^3 including microelements and molybdenum. Before the last sampling of seedlings, substrate was thoroughly removed around the roots of each one in order to be able to measure the total length of the plant and the length of the root. Each plant was weighed on a digital

scale, as well as their roots. The data were statistically analysed using analysis of variance and the differences between treatments specifically with F-test using a VVSTAT computer program (Vukadinović, 1994).



Graph. 1. Comparison of the height of treated and control cuttings (cm) at planting, rooting and flowering of *Pelargonium peltatum*
Usporedba visine tretiranih i kontrolnih reznica (cm) pri sadnji, ožiljavanju i cvatnji vrste Pelargonium peltatum



Graph. 2. Comparison of the height of treated and control cuttings (cm) at planting, rooting and flowering of Pelargonium x hortorum
Usporedba visine tretiranih i kontrolnih reznica (cm) pri sadnji, ožiljavanju i cvatnji vrste Pelargonium x hortorum

Results and discussion

Graphs 1 and 2 show the mean height values of cuttings, rooted plants and grown seedlings. Seedlings of *Pelargonium peltatum* species had twice the height in every measurement, rooted treated plants showed slightly better growth and blossomed transplants had a greater increase in control plants. In *Pelargonium x hortorum* seedlings, rooted cuttings were more successful in the control than in the treated ones, and blossomed transplants had better growth in treated plants (Kessler, 1998).

Tab. 2. Influence of treatment and cultivar on Pelargonia cuttings height during planting stage
Utjecaj tretmana i kultivara na visinu reznice Pelargonija tijekom sadnje

Variant (A)	Cuttings height (cm) *Visina reznica (cm)*		
	P. peltatum (B1)	*P. x hortorum* (B2)	Mean *Prosjek*
Tretment (A1) *Tretman(A1)*	6.950	4.640	5.795
Control (A2) *Kontrola (A2)*	6.575	4.735	5.655
Mean *Prosjek*	6.762	4.688	5.725

LSD	Cuttings height *Visina reznica*		
	Treatment (A) *Tretman (A)*	Cultivar (B) *Kultivar (B)*	Interactions *Interakcije* A x B
0,01	ns	0.4480	ns
0,05	ns	0.2958	ns

A statistical analysis showed that the height of the cuttings when planting was under statistically significant influence of the cultivars ($p = 0.01$). Cuttings of *P. peltatum* cultivars had 44.24% greater length than the *P. x hortorum* cultivar. The greatest length of the cuttings was 6.950 cm while the lowest was 4.735 cm (Table 4.).

Tab. 3. Influence of treatment and cultivar on the height of Pelargonia cuttings during rooting stage
Utjecaj tretmana i kultivara na visinu reznice Pelargonije tijekom ukorjenjavanja

Variant (A)	Cuttings height (cm) *Visina reznica (cm)*		
	P. peltatum (B1)	*P. x hortorum* (B2)	Mean *Prosjek*
Tretment (A1) *Tretman(A1)*	14.375	7.800	11.088
Control (A2) *Kontrola (A2)*	11.750	7.990	9.870
Mean *Prosjek*	13.063	7.895	10.478
	Cuttings height *Visina reznica*		
LSD	Treatment (A) *Tretman (A)*	Cultivar (B) *Kultivar (B)*	Interactions *Interakcije* A x B
0,01	ns	1.1344	2.1175
0,05	1.1148	0.7488	1.2737

Tab. 4. Influence of treatment and cultivar on the height of Pelargonia cuttings during flowering stage
Utjecaj tretmana i kultivara na visinu reznice Pelargonije tijekom cvatnje

Variant (A)	Cuttings height (cm) *Visina reznica (cm)*		
	P. peltatum (B1)	*P. x hortorum* (B2)	Mean *Prosjek*
Tretment (A1) *Tretman(A1)*	24.425	18.700	21.562
Control (A2) *Kontrola (A2)*	26.213	17.050	21.631
Mean *Prosjek*	25.319	17.875	21.5969
	Cuttings height *Visina reznica*		
LSD	Treatment (A) *Tretman (A)*	Cultivar (B) *Kultivar (B)*	Interactions *Interakcije* A x B
0,01	ns	3.7737	ns
0,05	ns	2.4910	ns

Treatment on rooting pelargonium cuttings gave significantly higher cuttings compared to the untreated cuttings ($p = 0.01$). It was also found that there was a statistically significant effect of cultivars ($p = 0.01$) on the length of cuttings, with the ones of *P. peltatum* being 65.45% higher compared to cuttings of *P. x hortorum*.

The maximum cuttings height recorded was 14.375 cm and belonged to the treated cuttings of *P. peltatum* cultivar while the lowest height, 7.800 cm, belonged to the treated *P. x hortorum*. During this part of the study, there was a statistically significant interaction between the examined factors. During the last phase of the study and the last sampling, a statistical analysis of the data revealed statistically significant effects of cultivars while the significance of treatment was not proved. The length of *P. peltatum* cuttings was significantly higher than in the *P. x hortorum* cultivar ($p = 0.01$). The greatest height of cuttings was found in the *P. peltatum* cultivar, the control cuttings, and totalled 26.213 cm. The minimum height of cuttings was recorded in control cuttings of *P. x hortorum*.

Upon a completion of the research, growth of the whole plant and root growth was determined on all pelargoniums. The results showed that the treated plants had slightly longer root growth, while the control plants had higher aboveground growth. According to the Kessler (1998) study, the hormone probably influenced root activity of treated cuttings. The resulting increase in the mean height of the above ground parts of plants and their roots in the *Pelargonium x hortorum* species showed a slightly higher increase of root and stem of treated cuttings the control once. Hormone effects induced early rooting of cuttings, so the above-ground part of the plant could start early with growth and development, that way treated seedlings showed better and stronger growth than the control seedlings (Table 3) (Kessler, 1998).

Conclusion

By analysing the results obtained experimentally, it was determined that the use of hormones for rooting did not achieve significant increase in the percentage of receipt cuttings because untreated cuttings tend to have the same success at reception, if grown in controlled conditions. Growth and development of the aboveground parts of plants was very successful even without hormone treatment, but treated plants still had better growth of the whole plant. At all measuring stages, the length of *P. peltatum* cuttings was significantly higher than in *P. x hortorum* ($p = 0.01$). Planted cuttings rooted after four weeks. *Pelargonium peltatum* had 100% reception of control cuttings, and 95% reception of treated cuttings. *Pelargonium x hortorum* had 100% reception of both control and treated cuttings. Both species had well-developed adventitious roots and achieved remarkable growth of the plants, and have blossomed with more flowers. During the experiment, there was no application of complex liquid manure or other fertiliser formulations. During the research, the plants were grown in containers so that the increase in height was greater than usual, and growth retardants were not applied because of the focus of research on the observation of root development. Seedlings were equally successful in terms of growth and development. Sampling showed very

little difference between the treated and control cuttings. From these experiment results, we can assume that pelargoniums are very simple genetic plants and that their vegetative propagation by cuttings and further growth and development can be very successful without application of growth hormones while maintaining optimal environmental growth conditions.

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Uzgoj *Pelargonium peltatum* i *Pelargonium hortum* iz reznica

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Sažetak

Pelargonije su biljke iz porodice *Geraniaceae* i jedne su od najomiljenijih vrsta ljetnjeg cvijeća koje ukrašava balkone i prozore kuća, a na tržištu su prisutne od 18. vijeka. U Hrvatskoj se najčešće gaje puzave pelargonije (*P. peltatum*) i uspravne pelargonije (*P. zonale*). Razmnožavaju se vegetativnim putem zato što je uzgoj iz sjemena skup i samo velika hortikulturna preduzeća mogu priuštiti takvo uzgajanje. Svake godine se proizvode nove sorte, ali geranijumi još uvijek imaju veoma jednostavan genotip i uspješno se uzgajaju na osnovu nekoliko osnovnih pravila ključnih za njihov uzgoj. Cilj ovog istraživanja vrsta *Pelargonium peltatum* i *Pelargonium x hortorum* bio je da se procijeni uticaj upotrebe hormona kojima se stimuliše rast korijena kada se sade reznice kako bi se dobile biljke i da bi se pratio razvoj reznica. Dva različita tipa reznica su tretirana hormonom Rizoponom kako bi se stimulisao rast i ukorjenjivanje. Rezultati su pokazali da hormonska terapija nema značajan uticaj na rast ovih vrsta geranijuma. Razlike između tretiranih i kontrolnih sadnica su bile veoma male pri čemu su renice tretirane hormonom imale brži rast korijena iako je u svim fazama mjerenja dužina reznica P. peltatum bila znatno veća od reznica P. x hortorum ($p=0.01$).

Ključne riječi: geranijumi, reznice, hormonska terapija, ukorjenjivanje, sadnice.

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The Productivity Analysis of Five Leading Potato Varieties in the Agroecological Conditions of a Mountainous Region in Montenegro

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Abstract

An analysis of genetic productivity potential of five leading varieties in Montenegro (Kennebec, Agria, Aladdin, Tresor and Riviera) was conducted during 2010 and 2011 in the municipalities of Žabljak region, on mountainous black soil at 1,500 meters of altitude. The highest number of tubers was found in a parcel planted with Tresor and Aladdin- 8.5, while the lowest number of tubers was found in Kennebec- 6.8 tubers per plant. Comparing to other tested varieties, Kennebec had a significantly lower number of tubers. On average, Kennebec and Tresor had the largest tubers (96 and 91 g), and differences found were statistically very significant. The biggest tuber yield was measured in Tresor – 32.5 t/ha, while the lowest tuber yield was in Agria and Riviera (24.0 and 25.2 t/ha). Tresor had significantly higher tuber production comparing to other varieties.

Key words: potato, variety, number of tubers, tuber size, yield.

Introduction

According to the planted area, potato is the leading crop in Montenegro. Potato crops are present with more than 20% in the total production structure on arable land (Jovović, et al., 2012a). Along with production of ware potatoes, seed potato production is present in the mountainous region of Montenegro (Jovović et al., 2011; Milošević et al., 2004). At higher altitudes, light intensity is higher (Van der Zaag, 1992) and the usage of solar radiance is higher as well (Pereira et al., 2008). Altered spectral radiation and lower daily air and soil temperatures prolong vegetation period of potato

crop, leading to the development of high-quality tubers. The mountainous region of Montenegro is considered the lowest southern point where it is still possible to produce high-quality seed potatoes. Abundance of solar radiation and low cloudiness make this area ideal for potato seed production. Therefore, the production of seed potatoes has been expanding in recent years. Expansion of seed potato crops is also present in Žabljak, a city at 1,450 a.s.l. and an urban settlement at the highest altitude in the Balkans (Jovović et al., 2012a).

Agro-ecological conditions across potato growing regions are very different, thus the reaction of some varieties is different as well (Momirović et al., 2000). The systematic study of different genotypes at a number of locations is very important because in this way a wider selection of varieties adapted to the given specific conditions is possible (Yang, 2002). Productivity of a variety is a function of its adaptability to environmental conditions, thus it is very important to create varieties that will, in a wide range of environmental factors, be able to provide high yields consistently (Haldavankar et al., 2009).

Potato yields in Montenegro are very unstable and very susceptible to meteorological conditions (Jovović *et al.,* 2002). Choosing adequate varieties would help to overcome adverse impact of vegetation (ecological) factors, especially the soil water-air regime, high air temperatures and shorter growing season in mountainous areas. The aim of this research was to determine genetic potential of five leading potato varieties and examine their reaction in specific conditions of alpine climate in the mountainous region in Montenegro.

Materials and methods

The study of genetic yield potential was conducted for five leading potato varieties in Montenegro (Riviera, Tresor, Kennebec, Aladdin and Agria) in two consecutive years, 2010 and 2011, at Žabljak, mountainous chernozem soil type, at an altitude of 1,500 m. Experiments were conducted in a randomised block design with 4 replications, and the surface of basic plot was 21 m^2. Potatoes were planted manually on 28 May 2010 and 14 May 2011, at a distance of 70 x 33 cm, and the density obtained was 43,300 plants per hectare. Agro-technological practices were standard for potato crops. Potato tubers were harvested on 15 September 2010 and 25 September 2011.

Determination of the tuber number and their mass was done by taking average sample of 10 plants in each repetition after full maturation of canopy. The potato yield in this experiment was determined by measuring the tubers in each elementary plot, and then the yield per hectare was calculated.

Soil of the experimental field (Table 1) has the acid reaction (pH in water is 5.91, and in nKCl 4.85), low quantity of carbonate (2.05%) and high humus content (7.32%). Available phosphorus is deficient (6.2 mg/100 g), while the supply of potassium is very good (23.5 mg/100 g of soil). To achieve high and stable yields on this land, it is necessary to calcify it and increase fertilisation with phosphorus.

Meteorological data are presented in Table 2. The statistical analysis was done using factorial analysis of variance (ANOVA) and differences between mean values were determined by LSD test.

Tab. 1. Chemical characteristics of mountainous black soil on the experiment field
Hemijske osobine planinske crnice na eksperimentalnom polju

Depth (cm) *Dubina (cm)*	pH		$CaCO_3$	Humus *Humus*	Soluble mg/100 g *Rastvorljivi mg/100g*	
	H_2O	nKCl	%	%	P_2O_5	K_2O
0-40	5.91	4.85	2.05	7.32	6.2	23.5

Tab. 2. Meteorological conditions during the experiment
Meteorološki uslovi tokom eksperimenta

Year *Godina*	Month *Mjesec*					Average *Prosjek*
	May	June	July	August	September	
	Air temperature (^{0}C) *Temperatura vazduha (^{0}C)*					
2010	9.2	14.1	16.0	17.1	10.7	13.4
2011	8.8	13.9	15.9	16.5	14.1	13.8
	Amount of rainfall (mm) *Količina padavina (mm)*					Total *Ukupno*
2010	163	93	35	20	82	393
2011	162	43	76	53	113	447

Results and discussion

The number of tubers is highly dependent on the number of primary shoots that are formed on a single potato plant, affecting the average production of tubers per plant and total yield per unit area (Broćić et al., 2000). Table 3 shows that the highest number of tubers in trials was formed in Tresor and Aladdin - 8.5 (9.3 and 7.2 in 2010, 7.7 and 9.9 in 2011, respectively), while the smallest number of tubers was in Kennebec - 6.8 (7 in 2010, and 6.6 in 2011). In two-year average, the Kennebec variety had a significantly lower number of tubers in comparison to all other investigated varieties, while significant differences in the number of tubers was found between Tresor and Aladdin and the Agria variety. Bugarčić et al. (2000) state that best varieties for achieving high and stable yields are the ones that form about 10 tubers per plant.

Although the shape and size of tubers are varietal characteristics, they vary widely and are influenced by a number of environmental factors. The number and size of tubers is highly dependent on the number of shoots that are formed in a single plant, so if the number of primary shoots is higher, the number of formed tubers will be higher, but not their mass (Đokić, 1996). The results of measurements show that the tubers with the highest average tuber weight were measured in the Kennebec and Tresor varieties (96 and 91 g) and the lowest in Aladdin (70), Agria (72) and Riviera

(74). An analysis of the average tuber weight showed statistically significant differences between Kennebec and Tresor and all other varieties.

Tab. 3. Yield and yield components of potatoes in the experiments
Prinos i komponente prinosa krompira u eksperimentima

Variety *Sorta*	Year *Godina*	Average tuber number/plant *Prosječan broj krtola/biljka*	Average tuber weight (g) *Prosječna težina krtole (g)*	Tuber yield (t ha^{-1}) *Prinos krtola (t ha^{-1})*
Riviera	2010	9.1	53	21.1
	2011	7.1	95	29.2
	Average *Prosjek*	8.1	74	25.2
Tresor	2010	9.3	60	24.2
	2011	7.7	122	40.7
	Average *Prosjek*	8.5	91	32.5
Kennebec	2010	7	76	23.2
	2011	6.6	116	33.1
	Average *Prosjek*	6.8	96	28.2
Aladdin	2010	7.2	59	18.3
	2011	9.9	82	34.8
	Average *Prosjek*	8.5	70	26.6
Agria	2010	9.1	58	22.8
	2011	6.7	86	25.1
	Average *Prosjek*	7.9	72	24.0

	2010.		2011.		2010-11.	
	$LSD_{0.05}$	$LSD_{0.01}$	$LSD_{0.05}$	$LSD_{0.01}$	$LSD_{0.05}$	$LSD_{0.01}$
Average tuber number	0.825	1.127	0.678	0.927	0.555	0.758
Average tuber weight (g)	7.051	9.639	11.654	15.930	6.997	9.564
Tuber yield (t.ha^{-1})	1.442	1.971	3.003	4.105	1.365	1.865

In order to ensure high and stable potato production, it is necessary to have information on different types of interaction between a genotype and the environment. This means that the knowledge on the reactions of different potato varieties in different growing conditions is more important than the knowledge on their genetic potential (Jovovićet al., 2012b). The highest yield of tubers in the two-year average was measured in Tresor - 32.5 t.ha^{-1}, while the lowest was in Agria and Riviera (24.0 and 25.2 t.ha^{-1}). The analysis of variance showed that the potato tuber yield differences observed between Tresor and all other tested varieties were statistically highly significant. Statistically justified differences were measured between the Kennebec variety and Agria and Riviera, and between varieties Aladdin and Agria. Significant

influence of genotype and meteorological conditions on potato tuber yield during the experiments is stated in the papers by Bugarčić et al. (1997), Đorđević (2000), Broćić et al. (2000), Milić and Bogdanović (2007) and Jovović at al. (2012a).

Significantly higher yield and average tuber weight were measured in 2011in all studied varieties of potato. This is explained by the fact that that year was wetter and distribution of rainfall was more favourable. In 2010, precipitation amounted to 393 mm in the potato growing season, while in the same period of 2011, 447 mm were measured. As in July and August 2011 (phase of intensive tuber building), precipitation was 74 mm higher than in 2010, the obtained results were expected. More favourable air temperature and sufficient rainfall in 2011 caused longer potato growing period and thus higher yields.

Bearing in mind that this study was conducted in environmental conditions of alpine climate where winters are long and cold, and summers short and cool, the results are satisfactory. For these reasons, the study of potato in this area should be continued, as the adverse environmental effects could be significantly diminished by adequate selection of varieties.

Conclusion

Based on the results of a two-year study of the top five potato varieties in the mountainous region of Montenegro, the following conclusions were made:

1. The highest yield in the two-year average was found in the Tresor variety (32.5 $t.ha^{-1}$), while Agria and Riviera had the lowest yields (24.0 and 25.2 $t.ha^{-1}$). Compared with other varieties, Tresor gave significantly higher tuber yield.
2. Tresor and Aladdin had the biggest number of tubers– 8.5, while Kennebec had the lowest number of tubers – 6.8. In the two-year average, Kennebec had a significantly lower number of tubers compared to all other varieties studied.
3. The highest average mass of tubers was measured in lots planted with Kennebec and Tresor (96 and 91 g), while the lowest mass was found in Aladdin (70), Agria (72) and Riviera (74). The analysis of average tuber mass showed statistically very significant differences between Kennebec and Tresor and all other varieties studied.
4. This research showed that successful potato production can be organised in Žabljak, but the genotype x environment interaction study should be conducted in order to identify stable genotypes with high yields.

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Ispitivanje produktivnosti pet vodećih sorti krompira u Crnoj Gori u agroekološkim uslovima visoko planinskog područja

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Sažetak

U radu su prikazani rezultati dvogodišnjih proučavanja pet vodećih sorti krompira u Crnoj Gori u uslovima visoko planinskog područja Crne Gore. Najveći broj krtola utvrđen je na parcelama gdje su sađene sorte Tresor i Aladin– 8.5, dok je najmanji broj evidentiran kod sorte Kennebec – 6.8 ktrola/biljci. Kennebec je u poređenju sa ostalim testiranim sortama imao značajno manji broj krtola. Sorte Kennebec i Tresor dale su prosječno najkrupnije krtole (96 i 91 g), a ustanovljene razlike u poređenju sa ostalim varijantama označene su veoma značajnim. Najveći prinos krtola izmjeren je kod sorte Tresor - 32,5 t/ha, dok su najmanji prinos dale sorte Agria i Riviera (24,0 i 25,2 t/ha). Tresor je u poređenju sa svim proučavanim sortama imao značajno veću produkciju krtola.

Ključne riječi: krompir, sorta, broj krtola, veličina krtole, prinos.

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Morphometric and Anatomical-Histometric Characteristics of two Varieties of the Species *Solanum lycopersicum* L. Infected by Cucumber Mosaic Virus

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Abstract

Viruses induce different external and internal symptoms on plants. Our investigations showed that the occurrence and the appearance of symptoms is a result of interaction of a specific virus and its host plant within concrete conditions of the environment. There are many literature data on the impact of viruses on the cell and its organelles and changes in tissue and organs, their structure and function, but very little data on the quantification of most of these changes. Therefore, in this study we determined some morphometric parameters (internode length, stem height, leaf area and weight) and some anatomical-histometric parameters (leaf thickness, upper and lower epidermis thickness, palisade tissue thickness, spongy tissue thickness, mesophyll thickness, area of upper and lower epidermis cells, area of palisade and spongy parenchyma cells, main nerve height and width and vascular bundle height, width and area of the main nerve) of two varieties of tomato plants (var. Saint Pierre and var. Novosadski jabučar) infected by 746-07 isolate of cucumber mosaic virus (746-07-CMV). The results show that the virus exerted influence on all investigated parameters, with some differences depending on the combination of virus/tomato variety. As a consequence of reduction of internodes length and stem height for both varieties, stagnation in growth occurred in higher percentage for the variety of Novosadski jabučar. Area and thickness of leaves were abortive in growth; they had thinner palisade tissue and its cell surface. From this, one may conclude that the productive ability of plants was reduced.

Key wards: variety, *Solanum lycopersicum* L., cucumber mosaic virus, morphometric characteristics, anatomical - histometric characteristics.

Introduction

Symptoms of virus diseases caused by viruses are induced by changes which they create in plant's cells; the infected cells are changed physiologically, which may be seen in the histological and the morphological substance of plants (Kurstak, 1981; Matthews, 1993; Juretić, 2002). Viruses bring about the *external* symptoms, visible to the naked eye, as well as the *internal* symptoms, visible in cells, at the level of plant tissue and organs. Symptoms of virus diseases are diverse and may be classified according to different criteria. They are most commonly grouped into three basic categories: the first arise according to changes in colour, the second are a consequence of histopathological changes, and the third arise from patho-morphological changes (Juretić, 2002). The generally accepted opinion among virologists and phytopathologists is that majority of symptoms may be specific for the given virus and its plant host, that is, their occurrence and appearance are a result of interaction of the specific virus/ specific host, in specific conditions of the environment.

The literature is fairly rich with data about impact of viruses on cell structure and function as well as about modifications in tissue and organs of plants as a result of the following: disruptions in division of cells (histogen changes), in growth and configuration of cells (histotrophical changes), in appearance of new tissue (neoplasmatic changes), in conversion of one tissue into another (metaplasmatic changes), in appearance of specific pathological bunches (structural changes) and death of cells (necrogen changes). On the other hand, there are few data of quantification of these changes, that is, morphometric and anatomical-histometric parameters concerning these changes (see Matthews, 1993; Hata and Francki, 2004; Bald, 2009). This is the reason why, in this investigation, we tried to designate some morphometric and anatomical-histometric parameters for two varieties of tomato infected with 746-07-CMV, and to deduce whether these parameters might be connected with a specific relationship between a virus and its host.

Materials and methods

In our investigation we used two varieties of the species *Solanum lycopersicum* L. (var. Saint Pierre and var. Novosadski jabučar) and 746-07-CMV, obtained by Branka Krstić, the Faculty of Agriculture, Belgrade, which was proved to belong to IA subgroups of the strains of cucumber mosaic virus (Krstić and Vico, 2004).

The soil for the growth of plants was sterilised in the autoclave at the temperature of 120^0C during four hours. Then the soil rested for 8 days, mixing temporarily, and then it was placed into an intergrowth casket, and the seed was added. Fifteen days later, the tomato plants were replanted into jars with sterile soil. The plants were infected by the infective juice which was extracted from the leaves of systematically infected plants of *Niciotiana glutinosa* L. with an additive of 0.2 M of the phosphate buffer pH 7.2 in the rate of m1/g of the leaves mass. For this purpose, the standard method of mechanical inoculation was used (Krstić and Tošić, 1994). The

inoculation was performed when the plants developed 4-5 leaves (21-day old tomato plants). The experimental infected plants, as well as the healthy plants were grown and sustained in the controlled laboratorial conditions (22-25 ^{0}C, 14 h photoperiod).

Systematically infected plants of both varieties, 40-day old, as well as healthy plants of the same seniority were taken for analysis. For morphmetrical measurement, fresh plant material was used, whereas for anatomical-histological measurement, material conserved in 50% alcohol ethanol was used.

The presence of a virus in the inoculated plants was determined on the basis of visible symptoms.

Out of morphometric parameters, the internode length, the stem height and the leaf area and weight were determined. The leaf area was determined by the method of contour of leaf on the paper (Petrović i Štrbac, 1996). The method is based on proportionality between the known mass and the area of paper, and mass and area of paper which is obtained by cutting the contour of lamina: $M_h : M_j = P_h : P_i$, where M_h is the mass of paper, M_j - the mass of paper clip, P_h - the area of paper and P_i-the area of lamina (leaf area). Solving this proportion by P_i, we calculated the leaf area.

To perform anatomical-histological analyses of leaf, the main nerve included, we used leaves from the medial part of the plant by the same insertion. Leaves of diseased plants exhibited symptoms of a systematic infection. All analysed parameters were determined in the same histological sections. We analysed 30 cross cuts of leaves taken from five different plants. Permanent histological preparations were made by the paraffin technique (see Blaženčić, 1994) which included: handling the material in fixative, cutting the material by the microtome so that the thickness was 20 micrometers, and, finally, double colouring by safranin and alcian blue. The following parameters were measured: the leaf thickness, the upper and lower epidermis thickness, the palisade tissue thickness, the spongy tissue thickness, the mesophyll thickness, the area of the upper and lower epidermis cells, the area of the palisade and spongy parenchyma cells, the main nerve height and width and the vascular bundle height, width and area of the main nerve. The cuts of leaves were done by using OLIMPUS VANOX AH 2 microscope, with 10x40 magnification, using the OLYMPUS IMAGE ANALISER software package. Computer image processing has enabled precise measurement of the length of straight and curved lines, surfaces, volume and diameter. The obtained results were statistically treated by Maple 10 statistical package. For all investigated parameters, the following elements were calculated: the arithmetical means and the standard deviations of samples, the difference between arithmetical means of infected and healthy plants. Significance of the difference between arithmetical means was investigated by t-test with the level of significance of 95%. The zero hypothesis about equality of arithmetical means was tested. The supposed level of significance gave the critical p value of $p=0.05$. In the case of $p<0.05$, there was a statistically significant difference between observed parameters, and then the zero hypothesis was rejected, while in the case $p>0.05$, there were no significant differences, and the zero hypothesis was accepted.

Results and discussion

There are different methods to check the presence of a virus (see Abad et al., 2000; Juretić, 2002). In this paper, the presence of 746-07-CMV in the inoculated plants was detected by visual examinations of characteristics symptoms that the virus produces in leaves of *Solanum lycopersicum* L. (see Kaper and Waterwopt, 1981; Palukaitis et al., 1992). Minor deviations in the appearance and the intensity of symptoms were observed between plants of Saint Pierre and Novosadski jabučar. This may be connected with a specific virus/host relationship, which is in accordance with numerous investigations regarding variations of symptoms that a virus produces in different hosts (see Walkey, 2005).

Morphological characteristics

The results of the conducted investigations show that there exist differences in the internode length and the stem height between infected and healthy plants of both varieties (Tab. 1), which means that the virus generates stagnation in the growth of plants. The stagnation expressed in percentage is greater for the var. Novosadski jabučar (Tab. 4) and is statistically significant Tab. 1). From Table 1, one may conclude that the value of standard deviation for the height of a stem is greater for infected plants of both varieties comparing with the healthy control plants.

There is an evident difference in the leaves area and weight between diseased and healthy plants of both varieties and these differences are statistically significant. The percentage of decrease in leaf area is higher for var. Saint Pierre, comparing to Novosadski jabucar, while weight values are reverse (Tab. 4).

In the available literature, there are no exact numerical indicators about the impact of CMV on the mentioned parameters, but indirectly, from description of symptoms referring to depression in growth of plants and impact of infection on different degrees of shrinkage of leaves up to its thread appearance (Šutić, 1987; Erić and Grbelja, 1990; Palukaitis et al., 1992; Juretić, 2002; Palukaitis and Garcia-Arenal, 2003; Erić et al. 2007), one may conclude that these parameters tend to decrease.

Anatomical-histometrical characteristics

Leaves are vegetative organs which are very sensitive and apparently react to the impact of many viruses expressing different outside and inside symptoms (Šutić et al., 1999; Bald, 2009). The intensity, that is, the expressiveness of symptoms in the same environmental conditions, depends on relations of the given virus and its host plant, which has also been proved in our investigations. The results of measurements of anatomical-histological parameters of a leaf and its statistical analysis show that there are differences in values of these parameters for investigated varieties of tomato (Tab. 2 and 3).

It is shown, in the Table 2, for the var. Saint Pierre that there are statistically significant differences in 8 out of 15 parameters, comparing infected and healthy

plants. The trend of decreasing was detected for: the leaf thickness, the mesophyll thickness, the spongy tissue thickness, the main nerve width, and the increasing trend was detected for: the thickness of both epidermis, the main nerve height, and the area of its vascular bundle. The remaining parameters showed no statistically significant differences.

Tab. 1. Statistical values of some morphometric characteristics of diseased (b) and healthy (z) plants
Statističke vrijednosti nekih morfometrijskih karakteristika oboljelih (b) i zdravih (z) biljaka

			$\bar{x}$	Sx	Sxy	Cs	Cp	Ci	ns*
Solanum lycopersicum L. var. Saint Pierre	stem height in cm *dužina stabljike u cm*	b	57.98	6.8174	3.48	0.8858	0.4026	12.6055	ns
		z	61.46	5.5397				-5.6455	
	internode length in cm *dužina internodije u cm*	b	4.84	4.8359	0.28	0.4427	0.6697	-1.1784	ns
		z	5.12	5.1538				1.7384	
	leaf area in cm^2 *površina lista u* cm^2	b	59.68	18.2282	19.2	3.4296	0.0013	30.7346	*
		z	78.89	21.5690				8.0062	
	leaf weight in g *težina lista u g*	b	0.97	0.0404	0.15	16.1389	1.389×10^{-18}	.1685	*
		z	1.13	0.2286				-1310	
Solanum lycopersicum L. var. Novosadski jabučar	stem height in cm *dužina stabljike u cm*	b	55.74	5.1665	14.9	4.4945	0.0020	22.5458	*
		z	70.64	5.3158				7.2542	
	internode length in cm *dužina internodije u cm*	b	4.75	4.7466	1.31	2.0713	0.0721	-.1484	ns
		z	6.06	6.0552				2.7684	
	leaf area in cm^2 *površina lista u* cm^2	b	72.02	15.0589	18.3	3.4497	0.0013	29.2064	*
		z	90.16	22.0608				8.0062	
	leaf weight in g *težina lista u g*	b	0.96	0.0985	0.20	8.2718	1.389×10^{-10}	.2548	*
		z	1.16	0.0751				.1550	

Meaning: $\bar{x}$: arithmetical mean; Sx: standard deviation; Sxy: difference of arithmetical means; Cs: computed statistics; Cp: p-value; Ci: interval of significance for level 95%; ns: there are no statistical differences; *: there are statistically significant differences.

Tab. 2. Statistical values for the anatomical-histological parameters of leaves of diseased (b) and healthy (z) plants of the species *Solanum lycopersicum* L. var. Saint Pierre
Statističke vrijednosti anatomsko-histoloških parametara lista oboljelih (b) i zdravih (z) biljaka vrste Solanum lycopersicum L. *var. Saint Pierre*

		$\bar{x}$	Sx	Sxy	Cs	Cp	Ci	ns *
leaf thickness *debljina lista*	b z	76.9637 84.7710	7.1489 8.3388	7.8073	3.8346	0.0003	3.7291 11.8856	*
upper epidermis thickness *debljina gornjeg epidermisa*	b z	6.8633 6.1187	0.6146 0.8821	-0.7447	-3.7938	0.0004	-3.5074 -1.1386	*
lower epidermis thickness *debljina donjeg epidermisa*	b z	4.7647 4.1853	0.7461 0.6574	-0.5793	-3.1902	0.0023	-0.2157 -0.9430	*
palisade tissue thickness *debljina palisadnog tkiva*	b z	20.7667 20.8283	3.7004 2.8522	0.0617	0.0723	0.9426	1.7715 -1.6481	ns
spongy tissue thickness *debljina sunđerastog tkiva*	b z	44.5690 53.4603	7.4576 8.3271	8.8913	4.3566	5.5350 x 10^{-5}	12.9777 4.8050	*
mesophyll thickness *debljina mezofila*	b z	64.6333 74.1163	8.5041 7.7038	9.4830	4.5265	3.0683 x 10^{-5}	13.6774 5.2886	*
area of upper epidermis cells *površina ćelija gornjeg epidermisa*	b z	52.8273 54.4333	5.3611 6.8013	1.6060	1.0157	0.3142	4.7747 -1.5627	ns
area of lower epidermis cells *površina ćelija donjeg epidermisa*	b z	37.6180 38.0960	5.6653 5.5982	0.4780	0.3287	0.7435	3.3888 -2.4328	ns
area of palisade tissue cells *površina ćelija palisadnog tkiva*	b z	94.8297 100.845	13.5347 9.7574	6.0153	1.9746	0.0535	12.1261 -.9547	ns
area of spongy tissue cells *površina ćelija sunđerastog tkiva*	b z	84.0913 88.3460	9.5959 10.0425	4.2547	1.6777	0.0988	9.3312 -.8218	ns
main nerve height *visina glavnog nerva*	b z	481.321 440.427	36.1868 42.1267	-40.8937	-4.0332	0.0002	-20.5879 -61.1995	*
main nerve width *širina glavnog nerva*	b z	425.584 475.360	71.6866 50.7566	49.7767	3.1039	0.0031	81.9531 17.6003	*
vasc. bundle height of m.n. *visina vaskularnih snopića*	b z	155.372 151.445	13.2630 6.5385	-3.92667	-1.4545	0.1532	1.5205 -9.3738	ns
vasc. bundle width of m.n. *širina vaskularnih snopića*	b z	250.363 247.537	30.1808 29.1717	-2.8260	-0.3688	0.7137	12.5145 -18.1665	ns
vasc. bundle area of m.n. *površina vaskularnih snopića*	b z	38152.4 35407.2	5926.64 4461.44	-2745.19	-2.0269	0.0476	-29.6997 -5460.676	*

Remark: thickness, height and width are given in µm, and area in μm^2

Tab. 3. Statistical values for the anatomical-histological parameters of leaves of diseased (b) and healthy (z) plants of the species *Solanum lycopersicum* L. var. Novosadski jabučar

Statističke vrijednosti anatomsko-histoloških parametara lista oboljelih (b) i zdravih (z) biljaka vrste Solanum lycopersicum L. *var. Novosadski jabučar*

		$\bar{x}$	Sx	Sxy	Cs	Cp	Ci	ns *
leaf thickness *debljina lista*	b z	70.9970 71.1990	9.9284 8.3565	0.2020	0.0853	0.9324	4.9476 -4.5436	ns
upper epidermis thickness *debljina gornjeg epidermisa*	b z	5.8270 5.3987	0.9965 0.7915	-0.4283	-1.8435	0.0706	$.3726x10^{-1}$ - .8939	ns
lower epidermis thickness *debljina donjeg epidermisa*	b z	4.5316 3.9943	0.6795 0.6568	-0.5373	-3.1143	0.0029	- .1919 - .8827	*
palisade tissue thickness *debljina palisadnog tkiva*	b z	14.8077 16.9167	3.0226 1.7549	2.1090	3.3051	0.0018	3.3930 .8250	*
spongy tissue thickness *debljina sunđerastog tkiva*	b z	45.8313 44.8893	6.8556 7.7993	-0.9420	-0.4969	0.6212	2.8543 - 4.7383	ns
mesophyll thickness *debljina mezofila*	b z	60.6383 61.7277	9.2093 7.9939	1.0893	0.4893	0.6265	5.5479 -3.3693	ns
area of upper epidermis cells *površina ćelija gornjeg epidermisa*	b z	37.4760 40.4803	3.5426 4.2424	3.0043	2.9772	0.0043	5.0256 .9830	*
area of lower epidermis cells *površina ćelija donjeg epidermisa*	b z	34.0480 30.1930	5.2995 3.6799	-3.8550	-3.2727	0.0019	-1.4910 -6.2190	*
area of palisade tissue cells *površina ćelija palisadnog tkiva*	b z	62.9647 67.1650	10.6561 13.6704	4.2003	1.3273	0.1899	10.5429 -2.1422	ns
area of spongy tissue cells *površina ćelija sunđerastog tkiva*	b z	58.6180 58.6420	8.3273 8.3974	0.0240	0.0111	0.9912	4.3461 -4.2981	ns
main nerve height *visina glavnog nerva*	b z	389.254 368.296	38.8702 38.4474	- 20.9587	-2.0997	0.0401	-.9779 -40.9395	*
main nerve width *širina glavnog nerva*	b z	430.690 415.763	57.7382 42.5104	-14.9277	-1.1403	0.2592	11.3251 -41.1804	ns
vasc. bundle height of m.n. *visina vaskularnih snopića*	b z	132.027 124.743	14.4360 10.2233	-7.2837	-2.2553	0.0283	-.8037 -13.7637	*
vasc. bundle width of m.n. *širina vaskularnih snopića*	b z	260.408 246.381	35.1545 32.3227	-14.0263	-1.6088	0.1131	3.4291 -31.4819	ns
vasc. bundle area of m.n. *površina vaskularnih snopića*	b z	34503.0 27117.3	7323.02 5361.08	-7385.68	-4.4573	4.3195 $x\ 10^{-5}$	-4062.413 -10708.95	*

Data in Table 3 show that in the infected plants of var. Novosadski jabučar, the leaves were slightly less thick (71.00 μm), comparing with healthy plants (71.20 μm). Also, the mesophyll thickness was 60.64 μm for the infected plants and 61.73 μm for healthy ones. However, inside the mesophyll, there was decrease in the thickness of the palisade parenchyma which was statistically significant. Furthermore, the result of the statistical analysis showed that the infected plants had decreasing area of upper epidermis cells which was statistically significant, as well as the increase in the area and thickness of lower epidermis cells, the main nerve height, the vascular bundle height and area, which were also statistically significant. Differences among other parameters were not statistically significant.

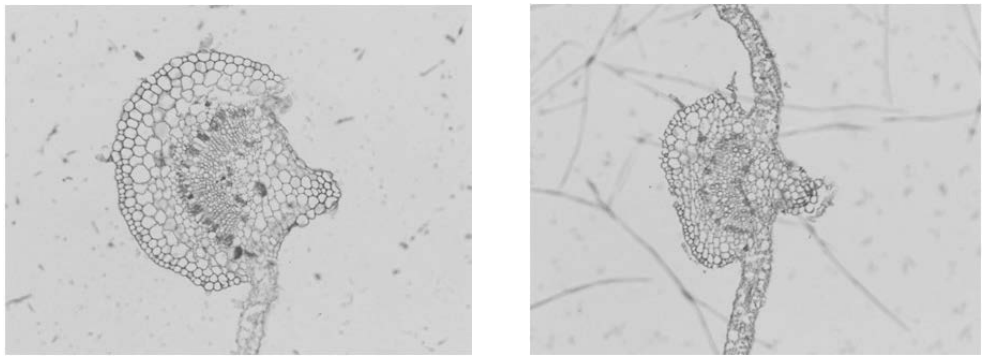
Tab. 4. Comparable values of some morphometric and anatomical-histological parameters of diseased (b) and healthy (z) plants
Uporedne vrijednosti nekih morfometrijskih i anatomsko-histoloških parametara oboljelih (b) i zdravih (z) biljaka

	Solanum lycopersicum L. var. Saint Pierre		*Solanum lycopersicum* L. var. Nov. jabučar	
Measured parameters	b	z	b	z
average of stem height	57.98	61.46	55.74	70.64
% decreasing of stem height	5.6622		21.0929	
average of leaf area	59.6834	78.8865	72.0216	90.3300
% decreasing of leaf area	24.3427		20.2683	
average of leaf weight	0.9695	1.1289	0.9555	1.1604
% s decreasing of leaf weight	14.1199		17.6577	
average of leaf thickness	76.9637	84.7710	70.9970	71.1990
% decreasing of leaf thickness	9.2099		0.2837	
mesophyll thickness	64.6333	74.1163	60.6383	61.7277
% decreasing of mesophyll thickness	12.7543		1.7648	
palisade tissue thickness	20.7667	20.8283	14.8077	16.9167
% decreasing of palisade tissue thickness	0.2958		12.4669	
spongy tissues thickness	84.0913	88.3460	58.6189	58.6420
% decreasing of spongy tissue thickness	4.8160		0.0410	
area of palisade parenchyma cells	94.8294	100.845	62.9647	67.1650
% decreasing of area of palisade parenchyma cells	5.9649		6.2537	
vascular bundle area	38152.4	35407.2	34503.0	27117.3
% increasing of vascular bundle area	7.1954		21.4060	

The anatomical-histological analysis showed that the leaf thickness, the palisade parenchyma thickness and the areas of palisade parenchyma cells decreased under the impact of 746-07-CMV (Tab. 2 and 3), but decreased values of these parameters were not the same in percentage for both varieties.

The leaf thickness, the palisade tissue thickness and the area of palisade parenchyma cells exhibited the productive power of leaf (Barden, 1978; Nešković et al., 2003; Đurić, 2009). Its increasing values indicate a greater content of chlorophylls in a leaf, which increases total photosynthesis, that is, increases productivity. According to the fact that the photosyntetical tissue of infected plants is less developed, there is a smaller quantity of chlorophylls in its leaves. The result is a reduction in photosynthesis because the total photophosphorylation by which the light energy, using chlorophyll, converts into the chemical energy conjunct in molecules of ATP is reduced. In other words, less chlorophyll – less photophosphorylation, and, as a consequence, reduced photosynthesis, that is, reduced synthesis of organic substances (see Nešković et al., 2003). Besides, the impact of viruses on decrease in photosynthesis because of the decrease of quantity of chlorophylls in a leaf (see Šutić, 1987), they directly affect the process of photophosphorylation, that is, the process of producing energy by reducing the transport of electrons in chloroplasts (cit. Song et al., 2009).

In a number of recent investigations (van. Kooten et al., 1990; Rahoutei et al., 2000; Scharte et al., 2005), it has been shown that in virus infected plants the photosynthesis is reduced, and the reduction depends both on a virus and a host. Song et al. (2009) proved that tomato and cucumber plants infected by CMV virus had the reduced photosynthesis.



b z

Fig. 1. *Solanum lycopersicum* L. var. Novosadski jabučar – cross-section of main nerve with vascular bundles of infected (b) and healthy (z) plants

Solanum lycopersicum L. var. Novosadski jabučar – poprečni presjek glavnog nerva sa vaskularnim snopovima zaraženih (b) i zdravih (z) biljaka

For both investigated varieties of tomato, the increasing of vascular bundle area of the main nerve was statistically significant comparing to the same parameter for healthy plants (Tab. 2 and 3). As it is visible, on cross-sections, that the number of

vascular elements in bundle of infected plants increased (Fig.1), we suppose that the infection implies a loss of the function of existing vascular elements, so that the plant creates new vascular elements to obtain the conduction of assimilate and water, which implies increasing the vascular tissue area. Something similar happens with water stress for some plants (cit. Hoekstra et. al., 2001).

Conclusion

The investigation of the morphometric and the anatomical-histometric characteristics of two varieties of tomato infected with 746-07-CMV showed the following:

- The virus made impact on all examined parameters, with some differences depending on the combination of virus/tomato variety.
- Both varieties showed stagnation in growth, which was greater in percentage for var. Novosadski jabučar.
- Leaf area and thickness fell behind in development. They had thicker palisade parenchyma and smaller area of its cells, so that one may conclude that productive ability decreased.

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Morfometrijske i anatomsko-histometrijske karakteristike dvije sorte vrste *Solanum lycopersicum* L. zaražene virusom mozaika krastavca

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Sažetak

Virusi uzrokuju različite spoljašnje i unutrašnje simptome biljaka. Istraživanja su pokazala da je pojava i izgled većine simptoma rezultat interakcije određenog virusa i njegovog biljnog domaćina, u konkretnim uslovima sredine. U literaturi postoji veliki broj podataka o uticaju virusa na ćeliju i njene organele i na promjene u tkivima i organima, na njihovu strukturu i funkciju, ali vrlo malo podataka o kvantificiranju većine tih promjena. Zbog toga smo u ovom istraživanju određivali neke morfometrijske parametre (dužinu internodija i visinu stabljike, te površinu i težinu lisne plojke) i anatomsko-histometrijske parametre (debljinu liske, debljinu epidermisa lica i naličja, debljinu palisadnog tkiva, debljinu sunđerastog tkiva, debljinu mezofila, površinu ćelija epidermisa lica i naličja, površinu ćelija palisadnog i sunđerastog tkiva, visinu i širinu glavnog nerva i visinu, širinu i površinu provodnog snopića glavnog nerva) kod biljaka dviju sorti vrste *Solanum lycopersicum* L. (Saint Pierre i Novosadski jabučar), zaraženih izolatom 746-07 virusa mozaika krastavca. Rezultati pokazuju da je virus ispoljio uticaj na sve praćene parametara, uz određene razlike zavisno od kombinacije virus/sorta paradajza. Zbog skraćivanja internodija i stabljike, kod obe sorte ispoljen je zastoj u rastu ali je on procentualno veći kod sorte Novosadski jabučar. Listovi u razvoju zaostaju površinom i debljinom, imaju tanje palisadno tkivo i manju površinu njegovih ćelija, te se na osnovu toga može zaključiti da im je smanjena produktivna sposobnost.

Ključne riječi: varijetet, *Solanum lycopersicum* L., virus mozaika krastavca, morfometrijske karakteristike, anatomsko - histometrijske karakteristike.

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Policy Measures for Development of Rural Entrepreneurship: an Example of EU Financial Support for Local Infrastructural Investments in Poland

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Abstract

Implementing the objective of convergence, the European Union actively participates in the economic development process of individual countries and regions. This participation is expressed in the formation of principles of the structural and regional policy, as well as cohesion policy, which cover the offer of a wide range of instruments to support the development of business activity. The European Union policy in business activity development, particularly small and medium-sized enterprises, is undergoing a certain evolution. The assumed solutions drive towards extending the influence period of public funds. The direct financial instruments of support are diversified in order to limit the funds intended for venture grants, which in turn allows an increase in the involvement of financial engineering instruments. Furthermore, significant funds are designated for indirect support instruments associated with the creation of business environment. They include the broadly-understood technical and social infrastructure, covering the infrastructure of local significance, the development of which continues to be highly important to the competitiveness of enterprises located within the rural areas of Poland. Disproportions between rural and urban areas in infrastructural equipment are still present, even growing. Due to the above, this study aimed to define the scope of instruments used by the policy oriented towards the support of business activity development and to create a classification of the said instruments according to their mode of influence. The created classification also included infrastructure as one of the main factors in business activity development. Furthermore, the relationships between communal infrastructural investments and the changes in the number of business entities were subjected to evaluation. This approach aimed to answer the question of whether the distribution of public funds planned for communal investments affects the equalisation of the conditions of competition in both the rural-urban system and within rural areas. The implementation of the said objectives also included the following research methods:

studies of professional literature, descriptive analysis, comparative analysis and correlation analysis. The data of the Central Statistical Office, Bank of Regional Data, were used as empirical material. The research was conducted for the period 2006-2010. The conducted research indicates that the support for infrastructural development will not stop the process of the growing difference between rural and urban areas in terms of economic development. However, the subsidisation of the infrastructural investments with Union funds somewhat affects the levelling of the economic development differences among rural communities resulting from the changes occurring in the non-agricultural sectors of the economy. Utilisation of EU funds has led to a higher growth of the number of business entities, as well as own budget revenues. The infrastructural investments implemented within the scope of RDP 2007-2013 measure "Basic services for the economy and rural population" created a better business environment for approximately 5 million inhabitants of rural communities. Such situation leads to the conclusion that financial support to communal infrastructural investment is a very effective measure of business development.

Key-words: Entrepreneurship, Small and Medium Enterprises, EU policy measures, Infrastructural investments, Public support, Rural economic development.

Introduction

Implementing the objective of convergence, the European Union actively participates in the economic development process of individual countries and regions. This participation is expressed in the formulation of principles of the structural and regional policy, as well as cohesion policy, which cover the offer of a wide range of instruments to support the development of business activity. The official justification for such activities is to equalise the conditions of competition. However, the undertaken tasks are criticised by the representatives of certain economic trends. They believe that such activities disturb the conditions of competition, and the only regulating factor should be the market. However, the policy of the European Union has assumed that transfers of public funds and the associated multiplying effects should have a positive impact on economic development.

The European Union policy in business activity development, particularly of small and medium-sized enterprises, is undergoing a certain evolution. The assumed solutions drive towards extending the influence period of public funds. The direct financial instruments of support are diversified in order to limit the funds intended for grants for enterprises, which in turn allows an increase in the involvement of financial engineering instruments. Furthermore, significant funds are designated for indirect support instruments associated with the creation of business environment. They include the broadly-understood technical and social infrastructure, covering the infrastructure of local significance, the development of which continues to be highly important to the competitiveness of enterprises located within the rural areas of Poland. Disproportions between rural and urban areas in infrastructural equipment are still present, even

growing. Moreover, the improvement of agricultural labour efficiency creates the need to utilise surpluses in the labour force by the non-agricultural sectors of the economy. The unutilised labour resources in rural areas and their low mobility force the need to stimulate the development of business activity. These stimulants include public support to communal investments.

Due to the above, this study aimed to define the scope of instruments used by the policy oriented towards the support of business activity development and to create a classification of the instruments according to their mode of influence. The created classification also included infrastructure as one of the main factors in business activity development. Furthermore, the relationships between communal infrastructural investments and the changes in the number of business entities were subjected to evaluation. This approach aimed to answer the question of whether the distribution of public funds planned for communal investments affects the equalisation of the conditions of competition in both the rural-urban system and within rural areas. The implementation of the said objectives also included the following research methods: studies of professional literature, descriptive analysis, comparative analysis and correlation analysis. Local CSO Data Banks were used as empirical material.

The instruments of business activity development support policy

The professional literature contains a wide range of definitions of the term policy[5], which depend on the approach applied, i.e. official and legal, behavioural, functional, rational or post-behavioural. However, it generally means the exertion of influence on various areas of human activity by specific public authority organs. In the case of the policy supporting business activity development, this is the intervention of the state and the European Union in the area of production of private goods. According to the mainstream economists' opinion, this is an undesirable situation, since the only regulating factor should be the market. Due to the functioning market failures, such as externalities, information asymmetry, unemployment and lack of equilibrium, the European Union adopts the approach of active participation in the public sector in the development of business activity, particularly the sector of small and medium-sized enterprises. The official justification for the construction of a strategy and initiation of specific measures in this area is the equalisation of the conditions of competition.

Owing to the complex nature and scale of the issues associated with the development of business activity, the European Union applies a multidimensional approach to their solutions, since the occurring economic processes are the target of the activity of the cohesion policy, regional policy and structural policy. The measures falling under the cohesion policy focus on the levelling of differences in social and economic development and convergence between states and regions (Murzyn 2010). The definition of the regional policy indicates that it is a somewhat simplified

[5] Murzyn, D. 2010. The cohesion policy of the European Union and the process of reducing disproportions in Polish economic development. C.H. Beck. Warsaw, p. 46.

component of the cohesion policy, since its objective is the reduction of disproportion between the economies of individual regions within a given state. A rather different approach is applied in the case of the structural policy, since its objective is to change the existing structures of a given state's economy, e.g. resulting from the relationships between individual branches of the economy, which is meant to lead to an improvement in the resource allocation efficiency. However, the ability of the aforementioned policies to lead to an improvement in the resource allocation efficiency, when the instruments applied are public fund transfers, is a debatable issue. Nevertheless, each of these may have a significant influence on the development of the business activity, and in consequence on the distribution of the national revenue. However, it is difficult to define the durability of the effects achieved as a result of public fund transfers in terms of individual policies.

Therefore, the support for business activity development can be implemented under various policies, defined according to an approach to the issue, the areas of support or the types of instruments used for intervention. However, each case involves influence by the public sector on the production of private goods and services. The initiated activities also entail defined expenditures for the public-finance sector, which generally causes a reduction in the consumption of public goods. This creates the issue of effective public fund utilisation, which is closely associated with the type of instrument applied in the support. The type of instrument applied in the support determines both the scale of assumed activities aiming to develop business activity and the scale of limiting the consumption of public goods. The application of defined instruments of support can be substitutive or complementary in relation to the production of public goods. The first case sees a situation where the increased public expenditures for enterprises create a proportional reduction in the expenditures for the production of public goods, while the second case sees the production of public goods as a potential factor in enterprise development.

Due to the aforementioned conditions, the professional literature includes a classification of the instruments supporting the development of enterprises. The broadest depiction distinguishes the following instruments[6]:

- direct – associated with financial transfers or transfers of specific financial services by the public sector to enterprises fulfilling the defined selection criteria;
- indirect – affecting all enterprises through their business environment.

The direct instruments of supporting business activity must be oriented towards various aspects of the enterprise's operations. They might involve issues associated with the founding of a company, its research and development activity, limited access to information, the initiation of investments or the internationalisation of the conducted activity. Therefore, this is a relatively large group of instruments, which includes the following:

- grants or subsidies for current or investment activity,
- subsidised credits and loans,

[6] Gancarczyk, M. 2010. Public support for MSP. C.H. Beck. Warsaw, p. 139.

- credit guarantees,
- guarantees to the suppliers of venture capital funds,
- public venture capital funds,
- consulting and training services,
- tax reductions and exemptions.

The classification of the above forms of business activity support into the group of direct instruments is determined by the application of company selection criteria. Some of the instruments listed above could also be included in the group of indirect instruments, if they are addressed to all enterprises or people intending to start business activity. However, due to the presence of the transfer of finances or services to the companies, they have been classified as direct. In the case of indirect instruments, the predominant classification criterion is the impact of the broadly-understood business environment. Due to this, the instruments in this group listed most frequently in professional literature include the following:

- administration solutions – leading to the limitation of bureaucracy,
- macroeconomic policy instruments – such as determination of interest rates,
- regulations on business activity initiation, operation and closure,
- the tax system,
- the social and health insurance system,
- unemployment benefits,
- the technical and social infrastructure,
- spatial planning.

Therefore, infrastructure is one of many indirect instruments used to support business activity. However, it is among the few instruments in this group, and the only one among those listed, to use Union funds within the scope of the cohesion policy conducted by the European Union or the domestic regional policy.

Infrastructure as an indirect instrument of supporting business activity development

Infrastructure is one of the many indirect instruments for the support of business activity development. The service provided by the infrastructure to other fields of the national economy is emphasised by basically all its definitions. An example of this is the definition by Andrzejewski (1974), who considers it as a group of basic installations and institutions necessary for the correct operations of the entire economy and the organisation of the lives of the population. The definition by K. Kuciński (1977) is also worth attention, as it is based on the theory of systems and presents infrastructure as a spatial system, i.e. a group of installations and institutions, as well as structures servicing the operations of basic spatial systems, facilitating satisfaction of social needs. The author believes that special significance of the infrastructure results from the fact that it integrates the serviced systems into a single structure.

The professional literature also contains definitions from the following authors:

- Z. Zajda (1974), who believes that the infrastructure includes the equipment and installations necessary for the operation of production sectors of the economy;
- Z. Dziembowski (1966), who states that the infrastructure services both the production and non-production fields of the economy and the population. He lists the following fields of infrastructure - installations in the areas of communication, transport, power engineering, irrigation and melioration, as well as institutions in the fields of law, safety and education;
- W. Kopaliński (1994), who defines infrastructure as *the "basic service institutions, installations and enterprises necessary for proper production operation of the fields of the economy (economic and social infrastructure)".*

These definitions indicate that correct development of every sector of the economy requires an adequately-formed infrastructure. The shortage of fundamental installations and institutions defined as infrastructure creates a serious barrier to socio-economic and ecological development. The appearance of individual infrastructure elements within a defined area both supports the already-existing business activity and influences the location of new ventures, for example by reducing costs incurred by the people undertaking such activities. However, the lower costs of, e.g. transport or water supply, are not the only reason for situating business ventures in areas with a more developed infrastructure. Its higher level may also determine the quality of human capital, the aesthetics of a given area as a place of residence, and the quality of the natural environment, or even influence cultural transformations of the local community.

Infrastructural investment financing sources

This study considers infrastructure as an indirect instrument of regional and structural policies which aims to support the development of the economy in rural areas. Therefore, the main objectives of the analysis include the possibilities of financing infrastructural investments in the field of the Operational Programmes implemented during the years 2007-2013, as well as the financial transfers from the programmes implemented during the years 2004-2006 made during this period. However, it should be noted that dynamic development of infrastructure – particularly technical infrastructure – in rural areas began as far back as the1980ss. Meanwhile, the nineties saw fairly strong diversification in infrastructure financing sources. Various financing instruments appeared during this period, allowing the local governments to obtain clear support for investment activities in the areas of expansion and modernisation of industrial installations. These instruments can be defined as various technical, organisational and legal means, specified in the appropriate contracts, standards and regulations, which serve to collect and distribute funds (Kulawik, 1999). They included the following:

1. "*Project finance*" – a financing method based on supplying funds by groups of institutions or a single financial institution for the financing of a defined investment venture, which was paid for by the said project;
2. Demonopolisation, deregulation and privatisation, as well as technical progress, as factors reducing the infrastructural capital needs. The technical and technological progress offers a limitation on the role of capital-consuming network systems for providing infrastructural services in rural areas (e.g. replacement of landline telephones with mobile telephones, and development of renewable energy). A similar example is neutralisation of sewage with bioproducts;
3. Foreign assistance and financing, including the following:
    a. The World Bank (long-term loans, 16-30 years),
    b. Prior to 1999, EBRD – the European Bank for Reconstruction and Development – assigned approximately 13% of its resources to Poland, influencing the investment funding valued at approximately 6 billion EURO,
    c. The European Investment Bank,
    d. The PHARE programme, which provided investment funds by financing expert research and feasibility analyses, also granted subsidies and credits and directly financed projects in the field of infrastructure. Within the scope of PHARE, during the years 1995-1999, Poland received over ECU 1 billion for the implementation of programmes deemed by Poland as priority, including 25% for infrastructural ventures,
    e. ISPA – a European Union programme aimed at improving the condition of transport infrastructure and protecting the environment,
    f. SAPARD – a pre-access support instrument for agriculture and rural areas,
    g. Prior to 1990, the European Fund for the Rural Development of Poland granted subsidies for the support of supplying rural areas with water and telephone networks;
4. During the years 1988-90, the Rural Water Supply Assistance Foundation subsidised the construction of waterlines and sewage systems; interest rate credits for this purpose were granted from 1991;
5. The Agency for Restructuring and Modernisation of Agriculture, which assisted in the development of technical, social and market infrastructure. Following the accumulation of personal funds, the communal authorities were able to seek assistance for the following types of investments:
    a. waterline construction (maximum subsidy between 25 and 35% of the cost, depending on the number of villages with a pipeline system in a given community),
    b. sewage system construction (up to 40% of the total cost),
    c. telephone network construction (up to 25% of the real cost),

d. road modernisation (subsidy up to 50% of the cost) or construction on the route of an existing road (up to 40%) as well as new road construction (30% of the cost).

The possibilities of financing the technical infrastructure development from so many sources significantly influenced the improvement in the infrastructural equipment of rural areas. Nevertheless, the investments made between the late eighties and now have still not satisfied the demand for technical infrastructure installations. Furthermore, there are continuing disproportions in the level of its development, both regionally and locally. The implemented investments have also failed to even out the differences in the infrastructural equipment in the rural-urban arrangement, and even failed to stop the growth progress of the above differences. Due to this, the implementation of the concept of rural economic development requires further support for infrastructural investments, since they are among the elements of improving territorial competitiveness, which attracts the location of business activity in a given area.

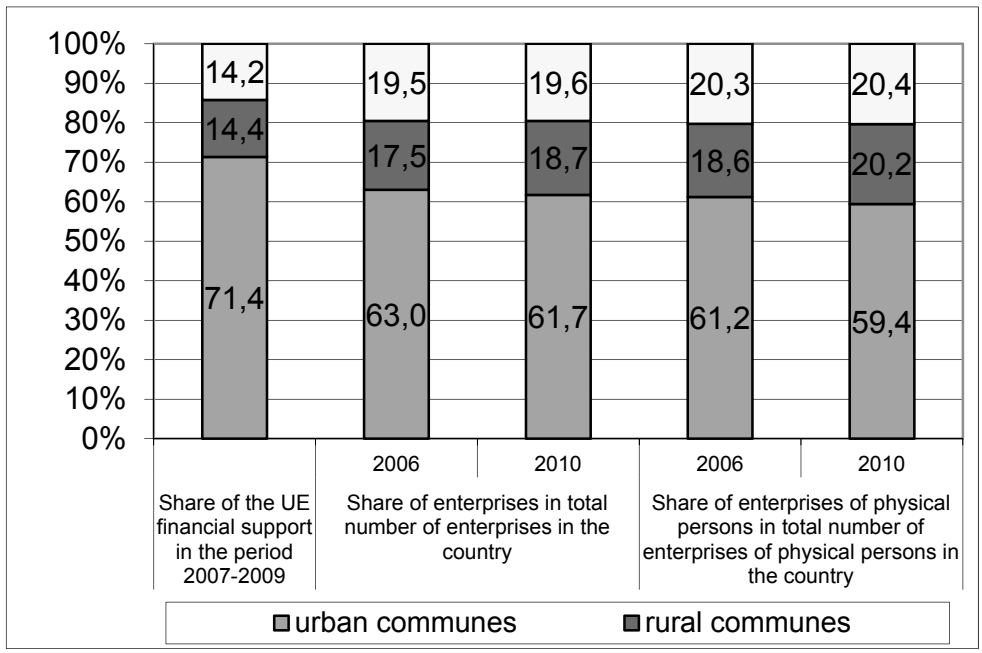
Relations between communal infrastructural investments and development of business activity

The maintenance and development of technical and social infrastructure elements is both a function and an obligation of the communal local government. A significant role in this development has been, and still is, played by finances from European Union funds. The additional sources for financing infrastructural investments are particularly important to the communities falling under rural areas, as their revenue is significantly lower than that of urban areas. For example, in 2009, the revenue of urban areas amounted to approximately PLN[7] 2.3 thousand per resident, while rural-urban communities achieved PLN 1.2 thousand, and rural communities only approximately PLN 1 thousand. In turn, low revenue of urban-rural and rural communities reduces the scale of their investments in the development of infrastructure. In consequence, the infrastructural equipment disproportions between urban and rural areas continue to grow. Therefore, the implementation of a concept of the economic and social development of social areas requires the transfer of additional public funds for infrastructural development. This transfer was made through the operational programmes for the years 2004-2006, and public financial support for infrastructural investments was also recognised in the Rural Development Programme for the years 2007-2013. Nevertheless, in the case of infrastructural development, the biggest role is played by the Regional Operational Programmes for the years 2007-2013 and the Development of Eastern Poland Operational Programme, which received a decisive majority of funds dedicated to this goal. In turn, part of these funds will be directed to the development of infrastructure in rural areas of a local nature. It is currently difficult to assess their scale, which largely depends on the activeness of local governments in obtaining European Union funds, and their ability to allot own

[7] 1 EUR ≈ 4 PLN

resources, as well as the competitiveness of trans-local projects. Nevertheless, these programmes are, and will continue to be, a significant source of financing rural infrastructure.

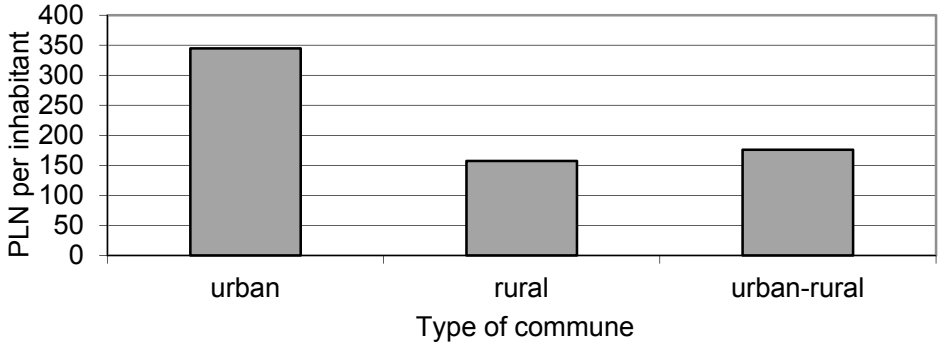
The research carried out indicates that during the years 2007-2009, communities obtained over PLN 8.7 billion for infrastructural investments from the European Union through operational programmes from the periods of 2004-2006 and 2007-2013. However, most of the said funds (over 71%) landed in urban areas, which hosted the locations of slightly over 63% of economic entities. Nevertheless, a growing number of economic entities are initiating activity in rural areas, since the share of enterprises registered within these areas out of the total number of domestic enterprises is rising (Fig. 1). It should be noted that this growth results mainly from the fairly dynamic development of business activity of physical entities organised as micro or small enterprises. Therefore, infrastructural investments are not the sole factor in business activity development – a significant impact on the development of rural business can be made by Union funds transferred with the assistance of direct means of support.



Source: own calculation on the basis of CSO (Central Statistical Office) data.

Fig. 1. The structure of communal investment funds from the European Union and business entities registered in the REGON system by community type
Struktura sredstava za komunalne investicije Evropske unije i poslovnih subjekata registrovanih u sistemu REGON po tipu zajednice

However, the analysis of EU funds obtained by communities for investments shows that disproportions in the basic infrastructure between urban and rural areas will continue to grow – on a national scale, the urban investments were not only higher in total, but also per one resident (Fig. 2). Therefore, the distribution of EU funds does not assist in levelling the differences in the accessibility of local infrastructure installations between rural and urban areas, but rather protracts the disproportion. In the long-term perspective, this may limit the pace of the territorial competition growth of rural areas, unless other factors balance the negative impact of this trend. Nevertheless, we should expect a limitation on the impact of the local infrastructure on the decisions in terms of locating business activity.



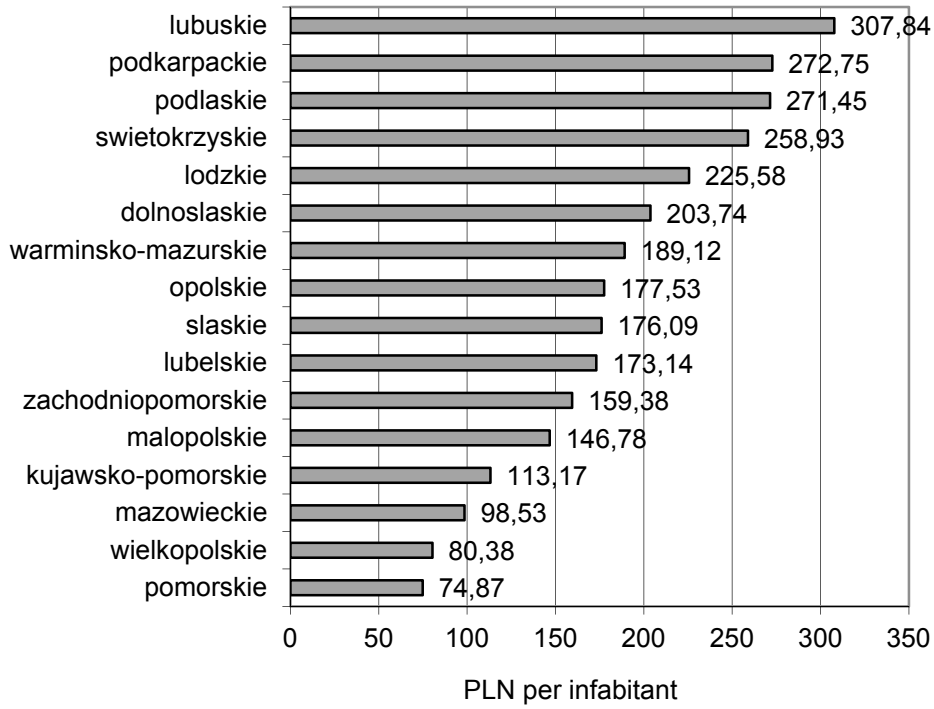
[*] *calculated per resident of a commune using Union support.*
Source: own calculation on the basis of CSO data.

Fig. 2. Funds obtained by communities from EU funds during the years 2007-2009[*]
Sredstva koja su zajednice dobile iz EU fondova tokom 2007-2009. godine[*]

Furthermore, the conducted research indicates that not all the communities considered as rural used EU funds during the years 2007-2009. Financial support for the infrastructural investments implemented was obtained by 71% of rural communities and approximately 80% of urban-rural communities, with respective population shares of the groups at 74% and 82%. Therefore, Union fund support was mainly directed to the communities with larger population. Nevertheless, these were the communities which produced a lower own revenues prior to obtaining support, with a 2006 average of PLN 796 per resident. During the same period, the communities which did not use the said support produced own revenues with an average level of PLN 844 per resident. The group of communities using European Union fund saw a support level proportionate to their own revenue. This is confirmed by the correlation analysis between the aforementioned variables – the correlation coefficient was statistically significant at 0.42. The communities using EU funds for infrastructural investments saw greater dynamics in own revenue growth; during the years 2006-2009, these revenues grew by over 34%, and only by 29% in other communities. The revenue growth[8] was higher in communities which obtained larger amounts for infrastructural

[8] The category „own revenues" does not include EU subsidies.

investments: the correlation coefficient between these variables was also statistically significant at the value of 0.52. In this context, the distribution of EU funds among rural areas can be seen as justified since it influences the levelling of the differences in the economic development of rural areas. However, it is difficult to determine whether this trend will be preserved after additional public fund transfers to rural areas are discontinued.

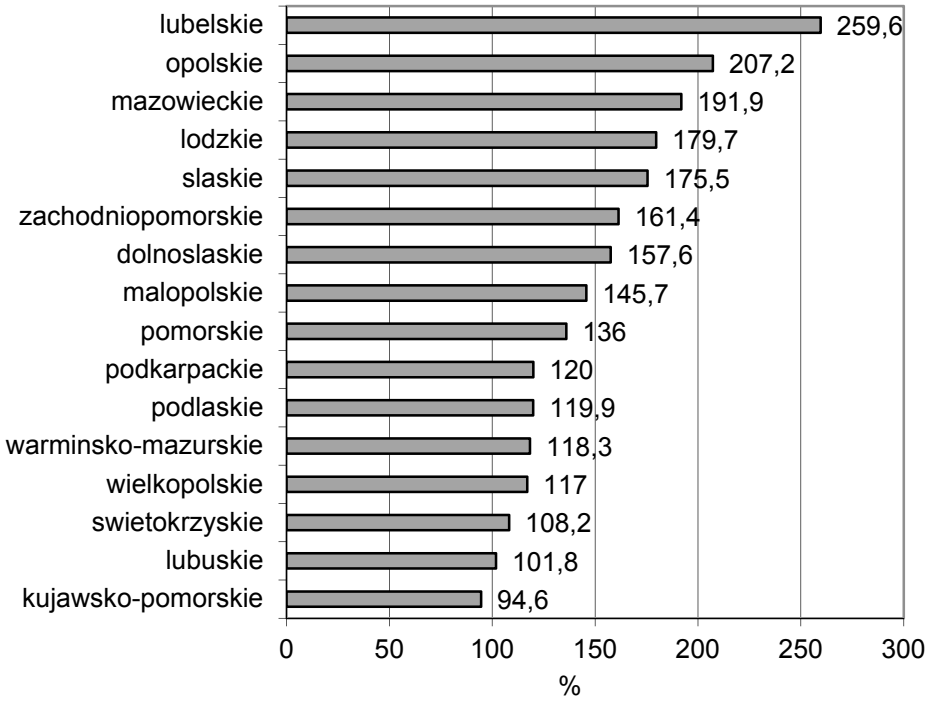


Source: own calculation on the basis of CSO data.

Fig. 3. EU funds obtained by rural-urban and rural communities for infrastructural investments during the years 2007-2009 by provinces
EU sredstva koja su dodijeljena ruralno-urbanim i ruralnim zajednicama za infrastrukturne investicije tokom perioda 2007-2009. godina po oblastima

The analysis of the diversity of expending European Union funds at the voivodeship level (Fig. 3) also confirms the positive impact of financial support on the levelling of differences in the economic development of rural areas. The relatively highest amounts were obtained by the communities of the rural areas in the following Voivodeships: Lubuskie, Podkarpackie, Podlaskie and Świętokrzyskie, all experiencing weak economic development. Therefore, the acceleration of business activity development in these voivodeships requires expansion of the scope and scale of the applied stimulating instruments, a role which is partially played by Union support for infrastructural investments. The other end of the scale was composed of such

voivodeships as Pomorskie, Wielkopolskie and Mazowieckie, with significantly higher level of business activity development in rural areas. In turn, the more developed business activity of the said voivodeships increases the communities' ability to generate infrastructural investments from their own budget. Therefore, a relatively lower level of Union support does not have to mean a smaller scale of communal investments. Nevertheless, the allocation of EU funds is compliant with the principle of levelling the disproportions among the regions. However, the actual objective of convergence depends not only on the distribution of resources among the regions, but also the scale of the said resources, which may turn out to be insufficient in the case of certain regions of Poland.



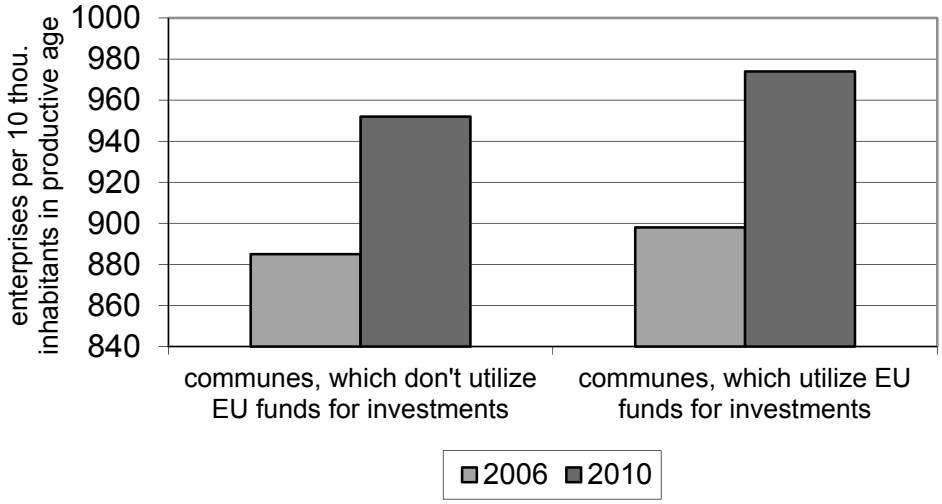
Source: own calculation on the basis of CSO data.

Fig. 4. Variation coefficient of the level of EU funds per resident obtained by rural-urban and rural communities for infrastructural investments during the years 2007-2009 by Voivodeship (provinces)

Koeficijent varijacije nivoa EU sredstava po stanovniku koja su dodijeljena ruralno-urbanim i ruralnim zajednicama za infrastrukturne investicije tokom perioda 2007-2009. godina po oblastima

Furthermore, the scale of communal investments was very different among all voivodeships (Fig. 4): the variability coefficient of the level of investment funds from the EU per resident was between 94% in the Kujawsko-Pomorskie voivodeship to

259.6% in the Lubelskie Voivodeship. It partially resulted from the level of their own revenue collected by the communities, since most voivodeships held a statistically-significant positive correlation between their own revenue amount and the amount of the obtained assistance. It means that the communities with higher revenues also initiated higher-scale investments. The Lubuskie and Świętokrzyskie voivodeships deserve particular attention. Besides a relatively high investment level, these voivodeships also saw a fairly low inside-regional variability. These dependencies may entail a more balanced development of business activity conducted in the communities of these regions.



Source: own calculation on the basis of CSO data.

Figure 5. Entities of physical persons in rural-urban and rural communities
Subjekti kao fizička lica u ruralno-urbanim i ruralnim zajednicama

The communities using Union support for infrastructural investments – during the period preceding the said support – gained lower own revenues, despite hosting the operations of a relatively larger number of business entities (Fig 5). Therefore, their faster revenue growth rate could have been caused by the growth in the revenue of businesses located within their area and the growth in the income of people employed in the said businesses. Furthermore, these communities saw a slightly faster growth in the number of business entities (Fig. 5). During the years 2006-2010, the number of business entities of physical persons in the said communities rose by 7.7%, and only by 6.5% in other communities. These dependencies confirm the stimulating role of the transfer of public funds for infrastructural investments in the development of existing business activity, as well as their impact on the founding of new businesses. This is confirmed by the correlation analysis between the level of investment expenditures originating from Union funds in individual communities and the number of business entities of physical persons, and its changes. The correlation coefficients between the

above variables reached, 0.39 and 0.33, respectively, and had statistical significance. However, infrastructural investments were not the only determinant of rural development, and, due to this, the correlation coefficients had a rather low value. It should be noted that the group of approximately 18% of urban-rural and rural communities, which used the support, recorded a drop in the number of business entities of physical persons during the period under study. Nevertheless, the dependency between the investment scale and the changes in the number of entities in this group of communities was very weak, with a correlation coefficient of –0.18. In turn, in the group of communities which recorded an increase in the number of entities, the dependency between infrastructural development and the development of non-agricultural business activity of physical entities was stronger than in the case of the entire population of communities using the EU support (a correlation coefficient of 0.38). This analysis indicates that some communities have strong barriers to the development of business activity, which level the positive impact of the infrastructure.

Conclusion

The conducted research indicates that the support to infrastructural development is among the main instruments of indirect influence on economic development. However, the properties of indirect instruments defined in the professional literature indicate that the influence of infrastructure on the development of economic activity is not limited to the entities satisfying certain criteria – as in the case of direct instruments. This influence covers all entities conducting business activity within a defined area. Therefore, the support for business activity development through infrastructural investments leads to the reduction in the unitary social costs of the said support and extends the period of their impact.

The possibility of subsidising communal infrastructural investments with European Union funds has a high significance in the economic development of rural areas due to the continuing and expanding disproportions in infrastructural equipment between rural and urban areas. For this purpose, the urban communities obtain significantly larger funds, expressed in both relative and absolute values. Thus, the instruments applied in the policy of the European Union will not stop the process of a growing difference between rural and urban areas. However, the communities with lower internal revenue obtained finances from Union funds. These communities achieved a higher growth rate and number of business entities, as well own budget revenue. Therefore, subsidisation of the infrastructural investments with Union funds somewhat affects the levelling of the economic development differences among rural communities resulting from the changes occurring in the non-agricultural sectors of the economy. However, we should remember that the infrastructure is not the only factor of this development.

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Mjere za razvoj ruralnog preduzetništva: primjer finansijske pomoći EU za investiranje u lokalnu infrastrukturu u Poljskoj

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Sažetak

Sprovodeći aktivnosti u cilju približavanja, Evropska unija aktivno učestvuje u procesima ekonomskog razvoja pojedinih zemalja i regiona. Ovo učešće se ogleda u formiranju prinicpa strukturalnih i regionalnih politika kao i kohezivne politike koje se odnose na veliki niz instrumenata podrške razvoju poslovnih djelatnosti. Politika Evropske unije za razvoj poslovnih djelatnosti, naročito malih i srednjih preduzeća, prolazi kroz određenu evoluciju. Pretpostavljena rješenja vode ka produženju perioda uticaja javnih sredstava. Direktni finansijski instrumenti podrške poprimaju različite oblike kako bi se ograničila sredstva namijenjena za preduzetničke grantove, što omogućava povećanje učešća instrumenata finansijskog inženjeringa. Nadalje, značajna sredstva se usmjeravaju za indirektne instrumente podrške vezane za kreiranje poslovnog okruženja. Oni uključuju opšte gledano tehničku i društvenu infrastrukturu, koja podrazumijeva infrastrukturu od lokalne važnosti, čiji razvoj ima veliki značaj za konkurentnost preduzeća i gazdinstava koja se nalaze u ruralnim područjima Poljske. Disproporcija između ruralnih i urbanih područja u pogledu infrastrukture je još uvijek prisutna i čak je u porastu. Zbog svega gore navedenog, ovo istraživanje je imalo za cilj da definiše domet instrumenata kojima se

koristi politika orjentisana ka podršci razvoju poslovnih aktivnosti i da se uradi klasifikacija pomenutih instrumentaa prema načinu uticaja. Stvorena klasifikacija je takođe uključila infrastrukturu kao jedan od glavnih faktora razvoja poslovnih djelatnosti. Štaviše, veza između investiranja u komunalnu infrastrukturu i promjena broja poslovnih subjekata bila je predmet evaluacije. Ovim pristupom se nastojalo odgovoriti na pitanje da li raspodjela javnih sredstava planiranih za komunalne investicije utiče na izjednačavanje uslova po pitanju konkurentnosti ruralno-urbanih sistema i u okviru ruralnih područja. Sprovođenje pomenutih ciljeva uključilo je i sljedeće istraživačke metode: izučavanje stručne literature, deskriptivnu analizu, komparativnu analizu i korelacionu analizu. Podaci Centralnog statističkog zavoda, odsjek za regionalne podatke, korišteni su kao empirijski materijal. Istraživanje je sprovedeno za period od 2006-2010. godine. Sprovedeno istraživanje ukazuje da podrška infrastrukturnom razvoju neće zaustaviti proces u kojem nastaju sve veće razlike između ruralnih i urbanih područja u smislu njihovog ekonomskog razvoja. Međutim, subvencionisanje infrastrukturnih investicija iz sredstava Unije donekle utiče na smanjenje razlika u ekonomskom razvoju među ruralnim zajednicama koje su rezultat promjena koje se dešavaju u nepoljoprivrednim sektorima privrede. Korištenje sredstava EU dovelo je do većeg rasta broja poslovnih subjekata kao i sopstvenih budžetskih prihoda. Infrastrukturnim investicijama sprovedenim u okviru mjera RDP 2007-2013. godine "Osnovne službe za privredu i ruralno stanovništvo" stvoreno je bolje poslovno okruženje za otprilike 5 miliona stanovnika ruralnih zajednica. Takva situacija vodi ka zaključku da je finansijska podrška komunalnim infrastrukturnim investicijama uspješna mjera privrednog razvoja.

Ključne riječi: preduzetništvo, mala i srednja preduzeća, EU mjere politike, infrastrukturne investicije, javna podrška, ruralni privredni razvoj.

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The agri-food sector in Poland - an analysis and assessment of CAP results in 2000-2011

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Abstract

The study will present a short analysis of the production and economic situation of the agri-food sector in Poland in the years 2000-2010. The assumptions of state intervention policy will be described, together with a presentation of some areas of the market fallibility and their influence on the effectiveness. The study will also discuss the results of implementing CAP policy in agriculture, the food industry and rural areas, after Poland's accession to the EU.

Keywords: agri-food sector, food industry, rural development programme, common agricultural policy, intervention policy, public support, market failure.

Market failure and interventionism

Present day global experiences prove that market and state must coexist, and that state interventionism should always be restricted to support the market, not replace it. The state should intervene only in cases where it has an advantage over the market mechanism, i.e. in the cases where the market fails to protect general social interests [Woś, 1995]. Intervention activities are deemed justifiable when the total cost of an intervention does not exceed the value of the losses and the lost profits resulting from the functioning of the market mechanism.

In the agricultural sector, intervention is effected through the engagement of the state and shaping ofagricultural prices, granting of investment subsidies, environmental protection, actions concerning the broadly-defined infrastructure of rural areas or by creating norms and standards. While explaining the reasons for state intervention in modern agriculture, J.E. Stiglitz [Stigiltz, 1987], J. Wilkin [Wilkin, 2002], S. Harris and R. Irwing point out the high risk to agricultural activity as well as the inefficiency of its prevention. The risk is the result of changing climate conditions,

a shortage of relevant information and the underdevelopment of agribusiness structures, including consulting. Other arguments behind the necessity of intervention in the agribusiness sector are:

- presence of costs and externalities,
- low price flexibility of supply,
- work efficiency rate lower than in other branches of economy,
- low mobility of the workforce employed in agriculture,
- necessity to supply public goods,
- implementation of the concept of sustainable development.

The instruments of state intervention in the food economy can be divided into two groups [Pohorile, 1964], i.e. the market type (referring to regulating supply and demand) and the non-market type (subsidies and grants, both direct and indirect). Market-based instruments, concerned with price support, favour the largest producers, especially the most productive and well-stocked ones. Therefore, they do not meet the criteria of justice and supporting the weaker as a reason for intervention [Rembisz, 2010]. Rural development programmes serve as examples of non-market instruments. As an instrument of state intervention policy, they offer a chance for stabilisation of structural policy conditions in a period of several production cycles, stimulating the desired changes in the field of area structures of agricultural holdings, improving the competitiveness of production, environmental protection and multi-functional development of rural areas. Thus, they are to be treated as basic instruments supporting the process of modernisation of agriculture and rural areas. Whether they are effective is another question.

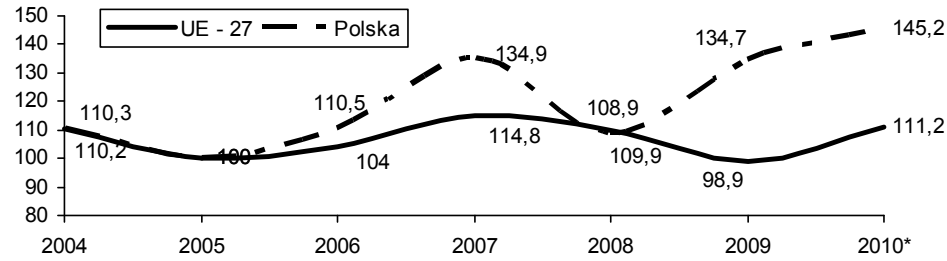
An analysis of the production and economic situation in the Polish agri-food sector

Polish agriculture is characterised, e,g. by a high employment rate, low efficiency of work and land, unfavourable agrarian structure and low income from agricultural activity. These problems have a direct impact on living conditions in rural areas. The necessary structural changes are a long and difficult process. The improvement in agricultural competitiveness depends on the development of the whole national economy. Integration within the EU and covering of Polish agriculture with the CAP helped to dynamise the process.

In the years 2000-2010 the number of people employed in agriculture was consistently falling, which allowed the growth of work efficiency and an increase in income from agricultural activity, although they are susceptible to large variability. This variability is directly connected with fluctuations in product prices, production resources and production volume. In 2005-2010, the real income from production factors per full-time agricultural worker in Polish agriculture grew by over 45%, and for the whole agricultural sector of the EU-27 - by 11.1% (Fig. 1).

Following accession to the EU, the dynamics of agricultural holding income growth was higher than in the remaining socio-economic groups. Farmers' real disposable income increased by 64.3%, whilst the value for all groups was 38.7%. The

growth in agricultural income was facilitated mainly by different forms of financial support within the CAP, aimed at the agri-food sector, agricultural holdings and rural areas.



Source: Florianczyk, 2011

Fig. 1. The dynamics of income from production factors per full-time agricultural worker at fixed prices (2005 = 100)
Dinamika prihoda proizvodnih faktora po stalno zaposlenom radniku u poljoprivredi po fiksnim cijenama (2005=100)

The processes of production concentration also continued, which resulted in 20% decrease in agricultural holdings number in 2000-2010 The highest (25%) decrease concerned the smallest holdings (1-5 ha of agricultural land), whilst the number of the largest holdings grew considerably (Table 1). The average area of an agricultural holding (with agricultural land > 1 ha) increased by 13% to ca. 9.5 ha of agricultural land. Nevertheless, the major part of agricultural land is still located in small and medium agricultural holdings (with an area of < 20 ha of agricultural land).

Tab. 1. Agricultural holdings by area groups (in 000)
Poljoprivredna preduzeća po veličini posjeda (u 000)

	Number of holdings (in thous.)		Share in %		2010/2002
	2002	2010	2002	2010	
<1 ha	977	715	33.30	31.39	0.73
1-5 ha	1,147	863	39.09	37.88	0.75
5-10 ha	427	352	14.55	15.45	0.82
10-15 ha	183	152	6.24	6.67	0.83
15-20	84	72	2.86	3.16	0.86
20-50	96	97	3.27	4.26	1.01
>50	20	27	0.68	1.19	1.35
Total	2,933	2,278	100	100	0.78
Average	5.76	6.82	-	-	1.18

Source: own compilation based on the data from Agricultural Census 2010, GUS (Central Statistical Office).

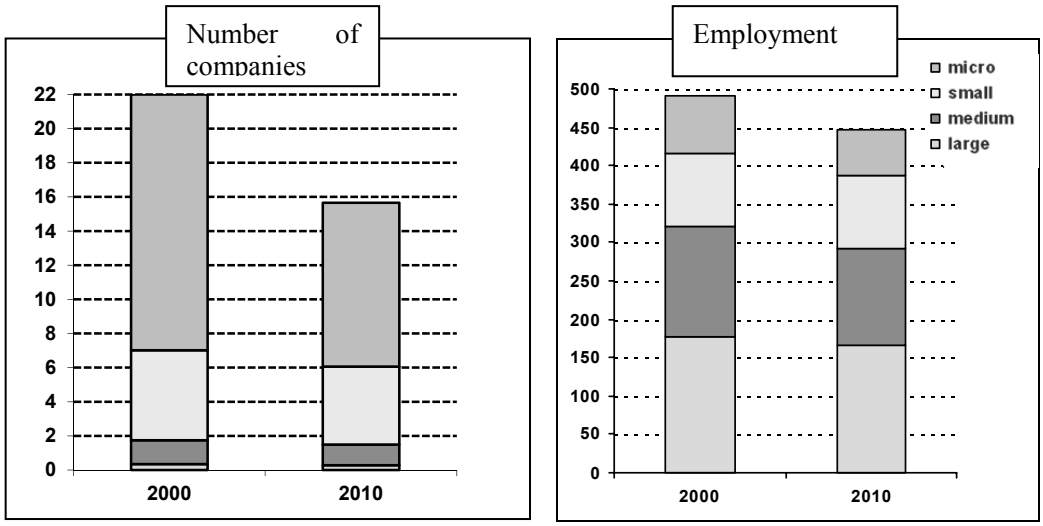
Changes in the agrarian structure were accompanied by changes in the production structure. The data from Agricultural Census 2010 indicate that, compared to the year 2010, grain cultivation decreased by 647 thousand ha, i.e. by 7.8%, and potato cultivation by 416 thousand ha (52%), whilst the area of industrial crops cultivation increased by 415 thousand ha (54.8%), as well as the area of fodder plants cultivation, by 338 thousand ha (60.1%). The increase in the industrial plant cultivation area results from the growing need for oilseed rape for energy purposes.

Changes were also visible in animal production – the inventories of pigs decreased by 18%, sheep by 22%, horses by 20% and poultry by 22%. In 2010, pigs were bred by 401,000 agricultural holdings, compared to 761,000 in 2002. The number of agricultural holdings breeding dairy cows fell by more than half from 874,000 agricultural holdings in 2000 to 424,000 in 2010. The reduction in farms and dairy cow inventories was the result of the introduction of milk production quotas and restricting its quality requirements. Agricultural holdings specialising in dairy cow breeding intensified their production, increasing the inventory from 3.3 to 6 cows per farm.

As regards the food industry, the period of Polish membership in the EU featured a revival in production, investment and trade. Industrial food production in 2004-2010 was developing at the average rate of 4.6% annually (6.3% until 2007). It was at a slightly quicker rate than the growth in GDP (4%), nearly twice as high as the growth in agricultural commodity production (2.5% a year), 2.5 times as high as the food, beverage and tobacco consumption growth (1.7%) and slightly lower than industrial production development in Poland (5.6%). In terms of competitiveness, the growth rate in food industry sales in Poland was among the highest in the EU (0.7% annually in the EU 27 member countries). These changes resulted in the strengthening of the Polish position on the European market. The value of the food sector production in Poland (ca. EUR 67 billion based on the currency purchasing power parity) equals ca. 7% of the value of food and beverage production in the EU 27 countries. The importance of the Polish food industry as a partner and competitor to the EU food and beverage producers is emphasised by the comparison of such indicators as:

- employment, which reaches 458 thousand in Poland, i.e. 10.6% of the EU 27 total employment;
- added value EUR 9.4 billion in Poland, i.e. ca. 7.0% of the EU 27 total value ;
- the number of companies, including microcompanies, 15.6% in Poland, i.e. 5.0% of companies in the EU 27.

These changes result in the consolidation of the industry. In the years 2000-2010, the number of operating food industry plants producing food and beverages was consistently decreasing (by ca. 30%) (Fig. 2). The largest fall in the number of companies was recorded in the microcompanies sector (by 36%), the smallest - among the small and medium-sized ones (13% in each group). In terms of competitiveness, the employment rate in the food industry fell (although to a smaller extent, by ca. 10%). The largest decline in employment was observed for microcompanies (by 22%), with a minimal reduction or even temporary growth (2003-2008) in the small enterprises sector.



Source: Own calculation on the basis of unpublished data from GUS and R. Urban 2005-2011

Fig. 2. The number of companies and employment rate in Polish food industry in the years 2000 and 2010 (in thousands)
Broj kompanija i stopa zapošljavanja u poljskoj prehrambenoj industriji 200. i 2010. godine (u hiljadama)

Tab. 2. Foreign trade in agri-food products (EUR million)
Spoljna trgovina poljoprivredno-prehrambenim proizvodima (milioni evra)

Year	2003	2005	2007	2008	2009	2010[a]	2010/2003
Exports,	4,010.4	7,028.0	9,942.5	11,421.6	11,277.6	13,263.1	330.8
of which to the EU-25/27	2,616.7	5,190.8	8,001.4	9,218.1	9,066.9	10,465.3	399.9
Import,	3,556.9	5,373.5	7,972.3	10,088.7	9,111.0	10,693.5	300.6
of which from the EU-25/27	2,175.9	3,388.1	5,347.4	7,023.0	6,320.4	7,277.6	334.5
Balance,	453.5	1,654.5	1,970.2	1,332.9	2,166.6	2,569.8	567.7
of which from the EU-25/27	440.8	1,802.7	2,654.0	2,195.1	2,746.5	3,187.7	723.2

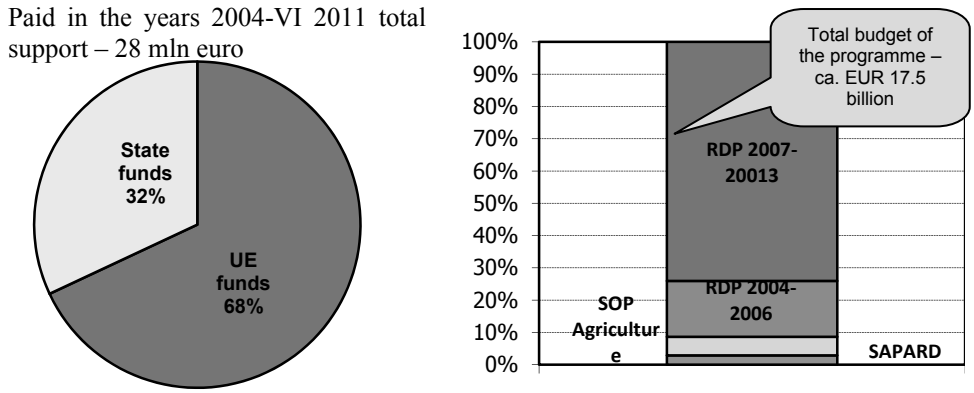
[a] *initial data*
Source: IAFE-NRI's compilation on the basis of unpublished data from the Analytical Centre of the Customs Administration (CAAC).

EU member countries are the largest and still-growing market for Polish agri-food products (growth from 63% of total exports in 2003 to ca. 80% in 2010). Since accession to the EU, Polish exports have increased nearly three and a half times, imports - three times, and the foreign trade balance for these products - nearly five

times (Table 2). The total agri-food trade was characterised by a higher exports than imports rate. This led to an increase in the positive trade balance from EUR 0.5 billion in 2003 to EUR 2.6 billion in 2010. The structure of the foreign trade in agri-food products is dominated by food products, and the results of their trade are of primary importance for generating the trade surplus. The share of finished products and semi-finished products in exports is still growing. Revenues from their sales in 2010 amounted to 84% of the exports of the whole Polish agri-food sector. For comparison, the share of processed products in agri-food imports equals 70% of the total trade.

The main assumption of the agricultural policy

The policy for the development of agriculture and rural areas in Poland has been based on several model solutions, starting from the concept of traditional and industrial agriculture, through environmentally-friendly agriculture, to induced development and sustainable growth [Woś, 2004]. The aims and mechanisms of the CAP and the individual qualities of the Polish agriculture indicate however that the permanent model of its development will be the dual model. Some farms, maintaining the basic requirements concerning environmental protection, implement methods of production ensuring high economic efficiency (industrial agriculture), while others use methods more friendly to the ecosystem, allowing the utilisation of available environmental and socio-cultural assets (sustainable agriculture).



Source: Own study based on budgets of the programmes.

Fig. 3 Support for agriculture and rural areas in the years 2002-2011
Podrška za poljoprivredna i ruralna područja u periodu 2002-2011. godine

Integration with the EU has created new development conditions for agriculture and food industry in Poland. The food economy has been supported since 2002 by the funds of programmes co-financed from the EU budget, which permeate and complete each other. The combined value of public obligations, both those of the European Union and national ones, assigned to development of villages and rural areas

in SAPARD[9], RDP[10] 2004-2006, SOP "Agriculture"[11] and RDP 2007-2013[12], exceeds EUR 24 billion (excluding direct subsidies). The value of payments issued in the period 2002-VI 2011 (including direct subsidies) to the agricultural and food sector and rural areas is even greater and has already exceeded EUR 28 billion euro (Fig. 3). It consisted of the SAPARD payments – ca. EUR 1.1 billion, SOP "Agriculture…" – ca. EUR 1.6 billion, RDP 2004-2006 – ca. EUR 2.7 billion, RDP 2007-2013 – EUR 6.8 billion and almost EUR 16 billion of direct subsidies.

The SAPARD programme prepared the Polish agriculture and food sector for accession, especially within the field of adjustment to the requirements concerning the sanitation, hygiene and environmental protection of the EU. After the year 2004, in accordance with the National Development Programme (NDP), the strategic objectives of the agricultural policy became the improvement of the competitiveness of the agriculture and food sector, sustainable development of rural areas, improvement of the natural environment, and raising the quality of life and diversification of economy in rural areas. Most of the activities implemented in the years 2007-2013 are a continuation of the activities implemented in the previous programme periods. This proves the continuity of policy and consistency in implementing the intended objectives. This does not, however, mean that agricultural policy is internally coherent. The development of rural areas is also supported by cohesion policy programmes (concerning, e.g. infrastructure, entrepreneurship, environment) covering the nationwide area of Poland.

The effects of implemetation of the CAP on the agriculture and food industry

Until the accession of Poland to the EU, transformations in agriculture have been financed with the own funds of farms and the state budget. After accession, a significant share in financing of their development has been provided by EU funds. The most common type of support is direct subsidies. Each year they are used by ca. 1.4 mln farmers. Their rates depend on the currency exchange rate, according to which they are calculated (Table 3). An equally important source of income (independent of production, only on the location of the farm) is less favoured areas payments (LFA). Ca. 700 thousand farmers benefit from these subsidies each year, i.e. half of those receiving direct subsidies. The area of lands covered with the LFA support amounts to ca. 6.9 mln ha.

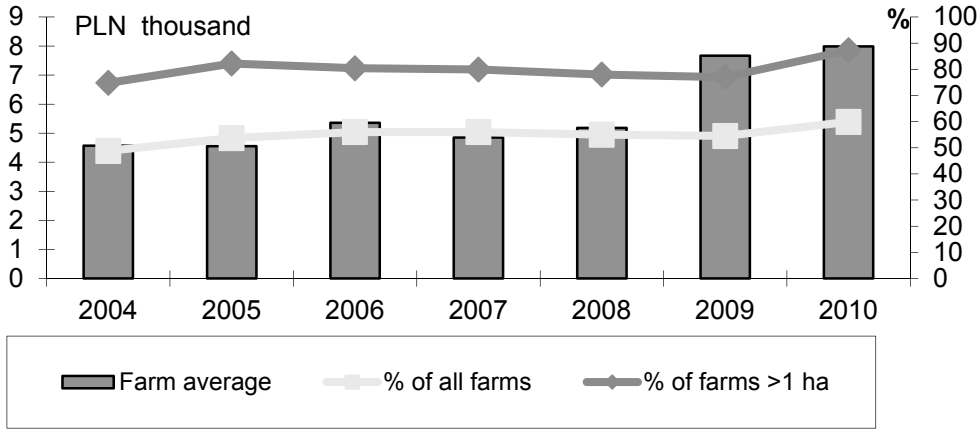
[9] *Special Accession Programme for Agriculture and Rural Development*
[10] Rural Development Programme for 2004-2006
[11] Sectoral Operational Programme "*Restrukturyzacja i Modernizacja Sektora Żywnościowego oraz Rozwój Obszarów Wiejskich 2004–2006*" (*„Restructuring and modernisation of the food sector and the development of rural areas (2004-2006)"*
[12] Rural Development Programme 2007-2013

The share of direct subsidies in the income of farms amounts to ca. 30%[13]. If one takes into account other types of direct subsidies, such as animal payments, or LFA, this share will be even greater. These payments are received by the farmers each year. Their methods of spending are not subject to being accounted for. The smaller farms most often assign the received subsidies for current needs and the means of production (fuel, fertilisers), while the bigger ones are used for investments as well.

Tab. 3. Rates of direct subsidies, in PLN/ha
Stope direktnih subvencija, u poljskih zlota/ha

	2004	2005	2006	2007	2008	2009	2010	2011
Single area payment	210,53	225	276,28	301,54	339,31	506,98	562,09	710,26
Complementary area payment	292,78	282,35	313,45	294,91	269,32	356,47	327,28	274,56
TOTAL	503,31	507,35	589,73	596,45	608,63	863,45	889,37	984,82
Exchange rate (1 euro = …PLN)	4,735	3,9185	3,9713	3,773	3,3967	4,2295	3,9847	4,405

Source: Own study based on the data of the Agency for Restructuring and Modernisation of Agriculture (ARMA).



Source: Own study based on the GUS and ARMA data.

Fig. 4 Direct subsidies – amount of payments and share in the number of farms
Direktne subvencije –iznos isplata i udio u broju farmi

An important source of aid for farms refers to funds assigned for investments. In order to obtain these, a farm has to prepare a business plan and obtain approval from the body managing the programme. The sources of financing of investments so far have been the following programmes: SAPARD, SOP "Restructuring", RDP 2004-2006 and RDP 2007-2013. The available funds were fully used. From 2002 the

[13] Own calculations based on FADN data.

activities aiming to improve the competitiveness of agricultural farms were utilised by a total of 15% of agricultural farms (Table 4). Most of it came from "The modernisation of farms" (6%), "Structural pensions" (5%), "Young farmers" (2.7%) and "The diversification of farming activities" (1.3%) measures. Comparing the amount of funds paid to the number of farms with more than 1 ha of agricultural land, it turns out that by means of the implementation of these four measures each farm in the country is entitled to more than EUR 2.7 thousand.

The inclusion of agricultural holdings in the CAP mechanisms contributed to the income improvement of most farmers. The fundamental significance for the increase in the level of farm income was held by subsidies (mainly in form of direct subsidies). The improvement in the competitiveness of agriculture is, however, dependent on transformations of a structural nature (which precondition the improvement in the efficiency of utilising production factor) and the development of the whole national economy, especially in the context of the capacity for creation of new jobs outside agriculture, also in the rural areas.

Tab. 4. Selected results of the implementation of measures by the SAPARD, RDP 2004-2006. SOP "Agriculture" and RDO 2007-2013 programmes combined
Odabrani rezultati sprovođenja mjera u okviru kombinacije programa SAPARD, RDP 2004-2006. godine, SOP "Poljoprivreda" i RDO 2007-2013. godina

Measure	Beneficiary	Funds paid in EUR mln	% of farms total	Amount of support per farm
Modernisation of agricultural farms	80,794	1,797	5.95	1,150
Facilitation of start for young farmers	42,310	434	2.71	278
Structural pensions	73,924	1,784	4.73	1,142
Diversification of agricultural activities	17,846	284	1.34	182
Total	214,874	4,298	14.73	2,751

Source: Own study based on the ARMA and GUS data; 1 EUR = 4 PLN

The food industry

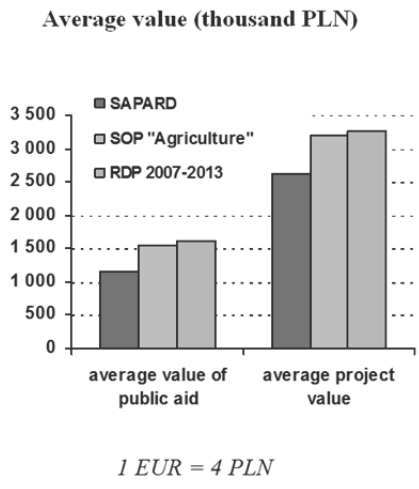
Privatisation of the sector, structural changes and investments modernising and adjusting the veterinary and sanitary norms and standards of the EU are a source of the success of food processing on the domestic and foreign markets. The total value of investments in the years 2000-2010 exceeded EUR 17 billion. The share of aid funds from the EU in this amount is, however, minor, and amounts to less than EUR 1 billion[14], and until the end of 2013 the value of payments will reach ca. EUR 1.7 billion. The financial means of the EU are, however, a catalyst for investments. In

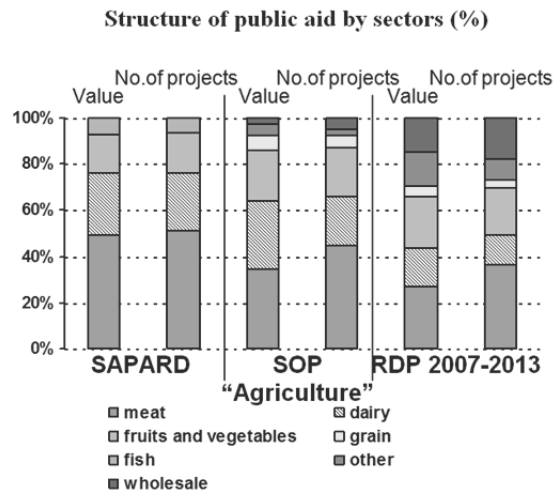
[14] PLN 4.1 billion until October 2011

order to receive co-financing, the entrepreneur has to employ his own funds, which as a result leads to a triple or quadruple increase in the final value of the investment.

In 2011, subsidies were used by almost all the lines of the food industry (including the wholesale trade), but the main beneficiaries of aid are meat, dairy and the fruit and vegetable industries. The amount of subsidies calculated per single investment project ranged from EUR 250 to 300 thousand. From the launch of the SAPARD programme until the end of June 2011, almost 3.5 thousand investment projects were implemented in more than 2.1 thousand processing plants. The effects of the aid, measured by the indicator of "survival" of a company on the market, are very satisfactory. Most of the entities which benefitted from EU aid still run production activities.

More than 40% of companies benefitting from investment aid are medium-sized enterprises, i.e. employing 50 to 249 employees. In the period 2002-2006, investments concentrated mainly on the adjustment to the sanitary and veterinary requirements of the EU (ca. 80% of value of the investment in meat and dairy industry). In the years 2004-2008, most of the investments (45% of the value) were already related to the improvement in the quality of production and the introduction of new products onto the market, while in the 2007-2013 programme – they mainly concentrated on the increase in added value (45% of the value) and the introduction of new products onto the market [Wigier, 2011]. Such changes in the types of investments prove the granting of priority by the processing plants to the activities increasing their competitiveness. The investments in the field of environmental protection are of a marginal nature.





Public aid plays a substantial, yet decreasing, role in the shaping of the pace and direction of investments in the food industry. It has definitely led to the reinforcement of the competitive position and increase in the exports of the Polish food industry on the market, especially in the EU countries. The state, taking over the role of

regulator, led to the imposing of certain behaviour in accordance with its own intentions. It supported and to a certain degree determined the directions of some investments. However, the substitution and income effect caused by public aid programmes led to decrease in efficiency. Considering the seat of the company (town/countryside), the distribution of companies benefiting from the support was roughly equal, so a conclusive influence on the equalisation of disproportions in development cannot be proved. It is natural that the basic markets for food industry companies are urban agglomerations. Rural areas are subject to activation through access to labour markets and purchase of agricultural materials. The beneficial effects of investment policies have been noted in areas such as improvement in the competitiveness of some entities in the agricultural and food sector, adjustment to the sanitary and veterinary requirements of the EU, support for structural transformations, and protection of the environment. However, public aid does not provide social justice and equality. The type of "environment" (urban or rural communities) is a factor which clearly differentiates projects in terms of the value of investment and the amount of its subsidising. The investments implemented in towns are definitely bigger than those implemented in rural areas. The engagement of public funds in private activity leads to the appearance of the "crowding out" effect.

Conclusion

Within the last decade, dynamisation of structural changes occurring in Polish agriculture, the food industry and in rural areas has taken place. The following should be recognised as the most important - decrease in the number of farms with simultaneous increase in the share taken by the largest farms; which bears a direct influence on the increase in the average farm area, the decrease in employment in agriculture and the progressing concentration and specialisation of production. Structural change is, however, slow and cannot be efficiently accelerated, due to the conditions outside agriculture.

In the food industry, investment growth started in 2003 and was connected to the necessity of modernisation and adjustment of the Polish food enterprises to the sanitary and veterinary requirements, as well as well-being of animals and protection of environmental standards in the EU. The investments implemented in the first period of EU membership allowed popularisation of obligatory quality management systems, ensuring the health safety of food. In the years 2008-2009, there was a slowdown in investment outlays, but already in the next year first signs of an upturn in this field were visible. Owing to the implemented investments, the Polish food industry is ranked among the most modern in Europe, and Polish companies can effectively compete with producers from the other EU countries.

The EU aid programmes facilitated modernisation of many farms and processing plants, an improvement in the safety and quality of food, an increase in the added value and innovativeness of production and an improvement in competitiveness on international markets. Changes in the agriculture and food industry are not only a result of including Poland in the CAP after EU accession, but to a large extent also of

the change in market conditions. The influence of individual instruments has varied, from the largest, direct subsidies, to the least significant, the semi-subsistence farm support programmes or structural pensions (minimum range).

The future strategy of development of agriculture should take into account the active process of polarisation of farms to agricultural and non-agricultural orientation. This polarisation concerns population, households and business entities (including farms) operating in rural areas, as does the trend towards mutual permeating of various spheres of economic activity. Support for the economic growth of rural areas with public funds should be based on the ambition to ensure implementation of the concept of shaping internal balance in these areas. It is based on the maximisation of net profits from economic growth with the simultaneous protection and long-term regeneration of the usefulness of natural resources – the concept of sustainable development.

Public aid plays a substantial, yet decreasing, role in shaping the pace and direction of investments in the food industry; it is still very significant in agriculture and in relation to protection of the environment. The state, taking over the role of a regulator, imposes certain behaviour in accordance with the intentions of the legislator. The beneficiaries of the programme, utilising public funds, are by definition in a privileged position in relation to those producers who do not benefit from such subsidies. The substitution and income effect caused by the analysed programmes is leading to a decrease in efficiency. The source of inefficiency is most often the substitution effect. The involvement of public funds in private activity also leads to the occurrence of the "crowding out" effect. Public aid, therefore, does not guarantee social justice and equality.

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Poljoprivredno-prehrambeni sektor u Poljskoj – analiza i procjena rezultata CAP u 2000-2011. godini

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Sažetak

U radu je prikazana kratka analiza proizvodnje i ekonomske situacije u poljoprivredno-prehrambenom sektoru u Poljskoj tokom 2000-2010. godine. Opisane su pretpostavke državne politike intervencije zajedno sa predstavljanjem nekih oblasti tržišnog pada i njihovog uticaja na efektivnost. Istraživanje se takođe bavi razmatranjem rezultata sprovođenja CAP politike u poljoprivredi, prehrambenoj industriji i ruralnim područjima nakon pristupanja Poljske EU.

Ključne riječi: poljoprivredno-prehrambeni sektor, prehrambena industrija, program ruralnog razvoja, zajednička poljoprivredna politika, politika intervencije, javna podrška, pad tržišta.

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The Content of NPK Nutrients in Vegetative Organs of Cauliflower (*Brassica oleracea var. botrytis* L.) Grown in Soilless Culture Technique

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Abstract

The experiment was carried out in a greenhouse in the Mediterranean Agronomic Institute of Bari (IAMB.) located in the southeastern Italy. The aim of this research was to evaluate macronutrient (NPK) status of cauliflower grown in three inert substrates (perlite, gravel and pozzolana). Nutrient losses were very low due to a good management practice and control of fertiliser application. The highest NPK nutrients application efficiency was obtained in phosphorus, 97.2%. Among nutrients, potassium was lost in the highest percentage (11.6%). Obtained losses did not cause high pollution of the soil and ground water.

Key words: nutrients, substrate, potassium, cauliflower.

Introduction

Controlled environment agriculture has gained in horticultural importance not only in vegetable and ornamental crop production but also in the production of plant seedlings, either from seed or through tissue culture procedures. One of the most important factors for a successful production in soilless cultures (hydroponics or substrate cultures) is water quality and its availability. The choice of irrigation water must be based mainly on quality, storage capacity and price (Van Assche and Vangheel, 1989).

The use of inert substrates in greenhouse vegetable production requires precise control of fertigation as inert substrates do not contain nutrients. The measurement of pH, EC and nutrients concentration in the leached solution indicates whether fertilisers

are being applied in excess or deficiency, and therefore allows the consecutive correction of the fertigation regime. It is recommended to collect the leached solution from containers and the solution that leaves drippers, and to compare both solutions on a daily basis (Scaife and Bar-Yosef, 1995). Since inert substrates were used in this experiment, leaching of accumulated salts with relatively small water quantity was allowed. This prevents precipitation of nutrients and changes in chemical reaction of inert substrates.

The elements particularly involved in the building up of salinity in the slabs include sodium and chloride. These ions are frequently present in the water supply, but are required by most plants in quite small quantities. In practice, most waters, the salinity of which does not exceed 2500 ppm, are suitable for the soilless growth of crops. Some waters do, however, contain small amounts of certain toxic elements, which would inhibit or have fatal effects on plant life. It is, therefore, always desirable to test the quality of water before using it (Douglas, 1990). Availability of micronutrients such as iron, manganese, zinc, copper, and boron can influence plant growth which can be reduced severely by high substrate and irrigation water pH. High pH water can cause salts to precipitate out of fertiliser stock tanks. Plant availability of essential nutrients (NPK) grown in hydroponics systems is the highest at the pH range 5.4 to 6.2 and it is recommended for most greenhouse crops (Bailey and Bilderback, 1998).

In hydroponics production of cauliflower, pH should range from 5.2 to 6.8 for irrigation water and 5.4 to 6.3 for substrate solution. Water pH levels above the desirable range hinder absorption of certain nutrients, which may cause toxicity (Jensen and Malter, 1995). Calcium and magnesium deficiencies can develop when pH is too low. There is a greater chance of ammonium toxicity problems in low pH conditions; and phosphorus leaching increases at a low pH. At the other end of the spectrum, pH above 6.2 can lead to problems such as chlorosis, an indication of iron deficiency. The level of pH and alkalinity (measured as carbonates and bicarbonates) of irrigation water affect pH levels within the growing media. These pH levels, in return, affect the absorption of certain nutrients by the roots and thus the health and vitality of a plant.

The fertiliser requirements of cauliflower are 200 $kg \cdot ha^{-1}$ N, 75 $kg \cdot ha^{-1}$ P and 225 $kg \cdot ha^{-1}$ K (Dellacecca, 1990). Starving the cauliflower plants from nitrogen can prevent curd initiation (Atherton et al., 1987). This is because the leaf area development is restricted and the plant cannot support generative growth. In plants growing in nitrogen deficient conditions physiological disorders like "buttons" can occur. Cauliflower requires high magnesium levels and shows deficiency symptoms readily when soils are too acid or the element is in short supply (Sanders, 1996). Potassium deficiency can also occur, causing shortening of internodes, thickening and curling of lamina, purple pigmentation along the leaf veins, inhibition of curd formation and floral bud necrosis (IFA, 1992).

Materials and methods

A cauliflower variety Fremont was grown. This variety has excellent weight, uniformity, density and colour. Self-wrapping leaves surround a deep domed white head. Cauliflower was grown in an open hydroponics system. The trial was carried out using three media: sand, pozzolana and perlite.

The total experimental area was about 93 m^2, with 31 m^2 for each individual substrate. Cauliflower seedlings were transplanted on 1 December 2004 with a distance of 50 cm on line and 40 cm between the lines giving a plantation density of 5 seedlings per m^2. The experiment layout is given in Fig. 1. Cauliflower harvest was done when it achieved full maturity (8 March 2005).

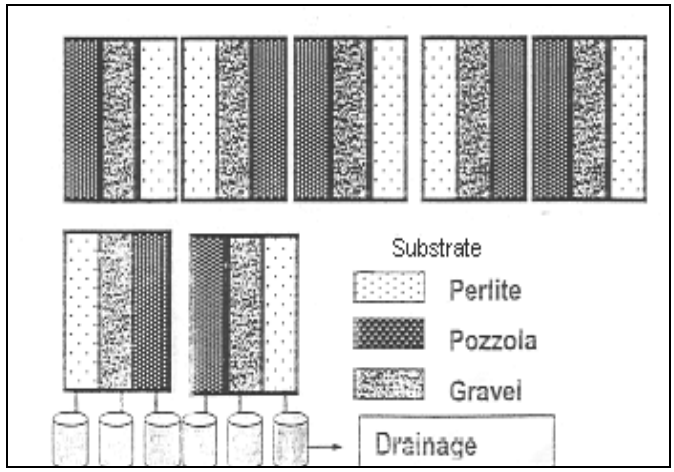

Fig. 1. Soilless culture experiment layout
Pregled eksperimenta hidroponskog uzgoja

A computerised Priva Nutriflex (version 1.0, 1995) was used to control, monitor and record information related to environmental conditions (total radiation), volume and irrigation frequency and finally pH and EC of the input nutrient solution. Thus, the computer was set to release the precise amount of stock nutrient solution input on weekly basis, adjusting the EC and pH values of nutrient solution to the pre-settled amounts.

The nutrient solution reaches plants throughout small polyethylene tubes, commonly named "spaghetti" tubes, connected on one end to the tube. On the other end, a plastic or lead weight anchors them to the base of each plant. These are self-compensating drippers giving 4 $l \cdot h^{-1}$ discharges. Crop water requirements were estimated on water balance basis. In our soilless culture system, two components were controlled: supplied amount of water and drainage volume.

To allow adequate leaching of the salts carried in the nutrient solution, a drainage volume between 20 to 30% of the irrigation volume was required. This was done by permanent control of substrate and drainage EC.

In this experiment, the same irrigation volume and water frequency were applied to three substrates. In the beginning, irrigation was applied three times a day. When plants start to grow more intensively, the number of irrigations was increased from 3 to 6 irrigations per day.

Table 1 shows the composition of macronutrient and micronutrient solution applied during the running of the cauliflower experiment..

Tab. 1. Cauliflower macro and micro nutrient solution composition (100 l)
Sastav rastvora sa makro i mikro hraniva za uzgoj karfiola (100 l)

Solution	Fertilisers	Quantity	
		until 21.02.'05	after 21.02.'05
A	Calcium nitrate (15,5% N, 20% Ca)	2 kg	
	Potassium nitrate (13,5% N, 46% K_2O)	0,5 kg	2 kg
	Iron chelates (4,5% Fe)	200 g	200 g
B	Potassium nitrate (13,5% N, 46% K_2O)	0,5 kg	
	Potassium phosphate (34 K_2O, 52% P_2O_5)	350 g	4 kg
	Micro elements	300 g	300 g

Every 10 days, NPK nutrients were analysed in drained solution, while in vegetative and radical organs of plants NPK content was analysed every 20 days.
The total nitrogen was analysed by an automatic distillation apparatus "Distillation links, UDK 140" using Kjeldhal method. Phosphorus was determined by Olsen method (method blue of molybdenum), while potassium was determined by photometry, using flame photometer (JENWAY PEP 7).

Statistical analyses were performed using one way Anova test and Duncan multiple range test.

Results and discussion

In this paper, an analysis of data that indicate the state of NPK nutrients during growing cycle of cauliflower grown in three inert substrates has been performed.

The N concentration in both vegetative and radical part during the cropping cycle is presented in Fig. 2.

Regarding the N concentration in the vegetative part and its variation during the cropping cycle, it followed more or less the same trend under the investigated substrates. Generally, in the cropping period between the 2^{nd} week till the 8^{th} week, N concentration was with fluctuating values without showing unique trend characterizing its status under the investigated substrates. This could be attributed to the differences in vegetative growth from one substrate to another. However, for all the investigated substrates, the vegetative growth attained its maximum nitrogen concentration values 10 weeks from transplanting when vegetative part was mostly developed. With the progress in cropping cycle 12 weeks from transplanting corresponding to the inflorescence head formation, there was a drastic drop in the nitrogen concentration,

reaching a value at harvest time more or less similar to the one measured at the earlier growth stage, 2 weeks from transplanting.

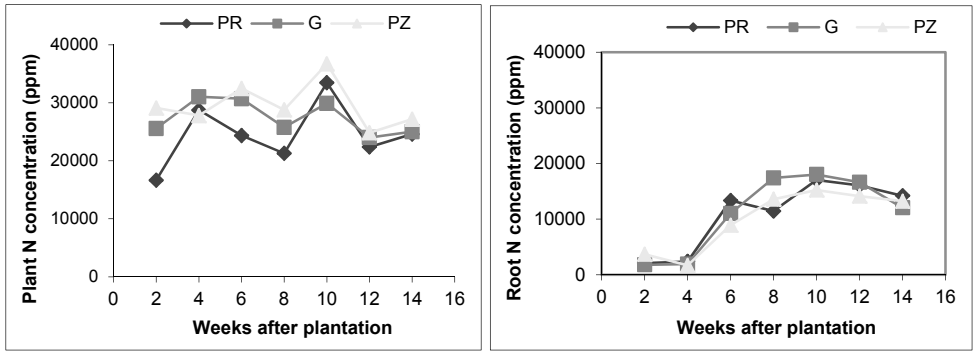

Fig.. 2. Evolution of N content in vegetative and radical part of cauliflower grown in three substrates

Razvoj sadržaja N u vegetativnim i korjenskim dijelovima karfiola uzgajanog na tri supstrata

Regarding the N concentration in the roots during the cropping cycle, it is clear that it followed a trend different from one concerning the vegetative part. Under the investigated substrates, at the earlier growth stages till the 4th week, N concentration was found in very small concentration with equal values under the investigated substrates. Two weeks later, in the 6th week, the N concentration in the roots was of relatively higher values with gradual increments reaching its maximum value on the 10th week, and then started gradually declining till the harvest time. The presence of N in the roots with concentration nearly 50% lower than in the vegetative part within the whole cropping cycle indicates high mobility of nitrogen and its transport to the vegetative growth with little accumulation in the roots.

Considering the total uptake of nitrogen in both vegetative and radical part under the investigated substrates, another picture will appear which is completely different from that regarding N concentration (Tab. 2.).

Tab. 2. Nitrogen exportation (mg·plant^{-1})

Unos azota (mg·biljka $^{-1}$)

Substrate	Perlite	Gravel	Pozzolana
Vegetative part	3961	4003	7229
Radical part	298	349	621
Total	4259 B	4352 B	7851 A

A, B – statistically significant difference on 0.01 probability level

The presented data indicate the highest N uptake is under pozzolana cultivation, which is significantly higher, 83% and 81%, than the one corresponding to perlite and gravel, respectively. This was also the case considering the N uptake by the

roots. Total N uptake by the plants varied greatly under the different investigated substrates. There is a significant difference in the N uptake by plants between the pozzolana substrate and both perlite and gravel, whereas under perlite and gravel N uptake was nearly at the same values without showing any significant differences.

The P concentration in both vegetative and radical part during the cropping cycle is presented in Fig. 3.

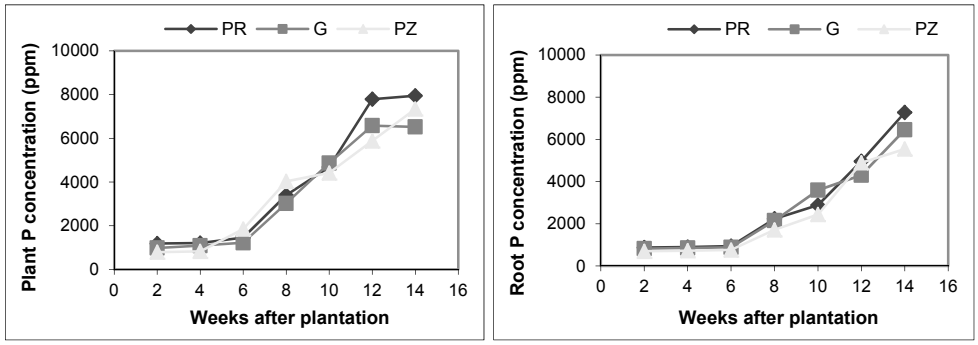

Fig. 3. Evolution of P content in vegetative and radical part of cauliflower grown in three substrates

Razvoj sadržaja P u vegetativnim i korjenskim dijelovima karfiola uzgajanog na tri supstrata

Regarding the P concentration in the vegetative part during the cropping cycle, it is quite clear that the trend it followed is similar under the investigated substrates. Phosphorus concentration was with low concentration and with a constant value in the early growth stages till the 6th week. With the progress in the vegetative growth, there was a gradual increment in its concentration reaching maximum values at the end of a vegetative cycle at the start of inflorescence head formation 12 weeks from transplanting, and then it kept nearly constant concentration until the harvest time.

Regarding the P concentration in the roots, it was characterized by a trend very similar to the vegetative part. However, the roots developed in the gravel substrates were with P concentration values slightly higher than the ones under perlite followed by those under pozzolana. Moreover, the presence of P concentration in the roots with the values very near to the ones of the vegetative part could be mainly attributed to its low mobility compared with other nutrients.

The P uptake in both vegetative and radical parts as well as the total P uptake is presented in Tab. 3.

Presented data indicate that among three substrates the highest P uptake was found to be under the pozzolana with values significantly 33% and 87% higher than the one obtained under perlite and gravel substrates, respectively. The same trend characterized the P uptake by roots. Under pozzolana, the P uptake by roots was with values 71% and 39% significantly greater than the ones under perlite and gravel substrates,

respectively. Statistically, there is a significant difference in the total P uptake by the plants under the investigated substrates.

Tab. 3. Phosphorus exportation (mg·plant^{-1})
Unos fosfora (mg·biljka^{-1})

Substrate	Perlite	Gravel	Pozzolana
Vegetative part	1279	1044	1953
Radical part	153	187	261
Total	1432 B	1231 C	2214 A

A, B, C – statistically significant difference on 0.01 probability level

The K concentration in both vegetative and radical part during the cropping cycle is presented in Fig. 4.

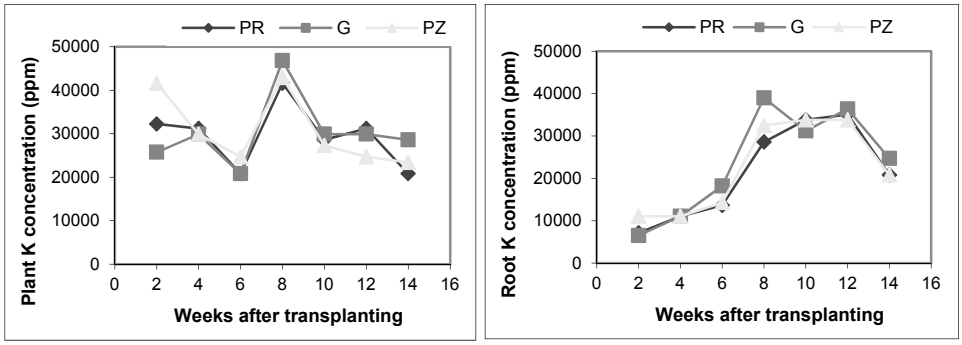

Fig.. 4. Evolution of K content in vegetative and radical part of cauliflower grown in three substrates
Razvoj sadržaja K u vegetativnim i korjenskim dijelovima karfiola uzgajanog na tri supstrata

The potassium status in vegetative part was fluctuating at the beginning of vegetative growth reaching its peak in the 8th week when inflorescence head formation started. With the progress in the cropping cycle, potassium concentration gradually decreased as harvest time was approaching due to potassium re-partition from leaves to formed heads.

In radical part, the first four weeks potassium concentration was more or less constant with slight increase and fluctuation after 6th week. Potassium reached its maximum values on the 8th week where roots were mostly developed, and then there was a gradual reduction in its values which continued till harvest time, but with concentration values nearly twice the ones at the initial growth stage.

Regarding the K uptake (Tab. 4.), it can be seen that K uptake followed a trend identical to the one concerning the N uptake under different substrates.

Similar to N and P uptake, the K uptake by the vegetative part is significantly 86% and 36% higher than the P uptake values under perlite and gravel substrates, respectively. This also holds true for the K uptake by roots, where the K uptake under

pozzolana was of values nearly twice that for the perlite and nearly 36% more than that under gravel. This was statistically confirmed indicating that there is a significant difference in the K uptake by the growing plants due to the variation in inert substrates.

Tab. 4. Potassium exportation (mg·plant^{-1})
Unos kalijuma (mg·plant^{-1})

Substrate	Perlite	Gravel	Pozzolana
Vegetative part	3349	4576	6224
Radical part	437	716	978
Total	3786	5292	7202

On the basis of an analysis of the nutrients uptake by different plant components as well as the total uptake, we can come to a conclusion that the N, P and K uptake differ greatly according to the growing substrate media. Generally, the uptake of the nutrients N, P and K were at values exceeding the ones obtained under gravel, and those obtained under gravel were slightly higher than the ones calculated under perlite. This, in other words, means that the efficient use of the N, P and K fertiliser under the soilless culture technique could vary according to the variation in the investigated substrates. This point is of paramount importance when deciding on the nutrient formula to be used under the different soilless substrates.

Drainage nutrient solution was analysed for its N, P and K concentration periodically every 10 days covering all the cropping period (Fig. 5).

Regarding the N nutrient, it is quite clear that maximum losses occurred at the earlier growth stages, where nutrients were added at levels exceeding the actual plant requirements. In the middle growth stages, there was a reduction in N concentration due to the development in vegetative growth, then with the progress of cropping period it again showed another increase in its value due to the increase in the number of irrigation and as a result of an increase in the added N to meet the N requirements of the intensive vegetative growth. With the progress in vegetative growth, N was absorbed in greater amounts and as a result its concentration in the drained solution was gradually decreasing which continued showing minimum values, hence starting from the 8th week, where vegetative growth was completed, at the start of inflorescence head formation N was added at lower doses till the harvest time. The data also indicate that in the solution drained from the gravel substrate due to its high drainability, nitrogen was found in concentrations relatively higher than those measured under perlite and pozzolana substrate where N concentration in the drainage nutrient from both was more or less of the same values. Regarding the P concentration in the drained nutrient solution, it is clear that during the cropping cycle it followed a trend opposite to the one of the nitrogen.

At the beginning of a growing cycle, phosphorus content in drainage water was showing the lowest values due to the highest consumption by plants. In that period the root system was established. Reaching the inflorescence head formation phosphorus needs of plants increased and thus phosphorus content went down in

drainage water. After the 7th week, phosphorus content in drainage water increased due to the changed nutrient solution and augmentation of phosphorus quantity.

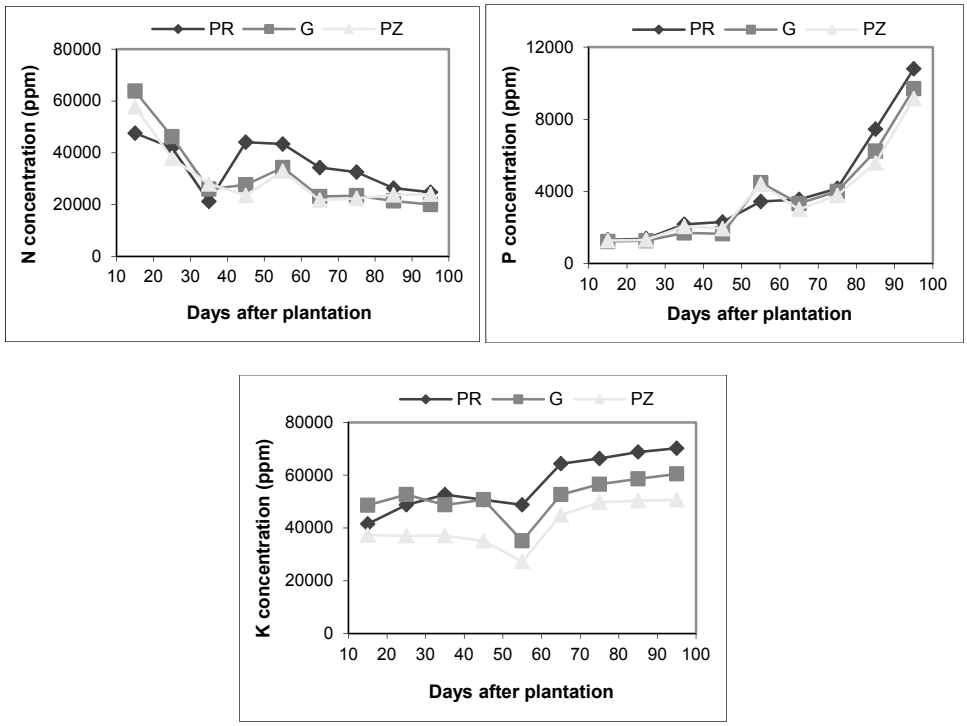

Fig. 5. Drainage water nutrient content during growing cycle
Sadržaj hraniva u procijednoj vodi tokom uzgoja

The potassium concentration in the drained solution during the cropping period followed a trend different from the ones concerning nitrogen and phosphorus.

Potassium content at the beginning of growing cycle was more or less constant until the 6th week where decline was recorded due to the intensive consumption by plants and the starting of inflorescence head formation. The minimum value was reached around 7th week. After that potassium content was rising again due to changed nutrient solution and augmentation of potassium quantity.

Nutrient balance was calculated using formula:

Nutrient balance = Input (fertilisers) – Output (fertilisers)

Nutrient balance as well as NPK nutrients efficiency is given in Tab. 5 and Tab. 6.

The presented data show that losses concerning the three elements N, P and K are very acceptable, where maximum losses in the case of K were only 11.6%.

Regarding the phosphorus, the losses were more or less negligible, only 3% of the added. This was also the case or the nitrogen being in losses not exceeding the 10%. In the soilless culture technique and particularly under the open system one of the problems is the concentration of nutrients in the drained solution and especially the nitrate concentration and its impact on the ground water quality. However, under appropriate nutrient management such problems can be avoided.

Tab. 5. Nutrient balance in hydroponics
Balans hraniva u hidroponskom uzgoju

Nutrient	Total drained (g)	Amount applied (g)	Total absorbed (g)
N	874	9100	8226
P	102,6	3640	3537,4
K	1345,5	11580	10234,5

Tab. 6. Nutrient efficiency
Efikasnost hraniva

Nutrient	Nutrient efficiency (%)	Losses (%)
N	90,4	9,6
P	97,2	2,8
K	88,4	11,6

In the mean time, the nutrient drained solution being with reasonable nutrient concentration and relatively low EC values can be reused safely for the irrigation of most crops without any deterioration in the soil productivity and crop production.

Conclusion

The highest nutrient consumption was recorded 8-12 weeks after cauliflower seedlings transplantation. Nutrient losses were reduced to a minimum because of possibility of precise control and manipulation of fertilisers, which can not be controlled in the traditional cultivation. From macronutrients used in this experiment, the highest losses were recorded in potassium (11.6%). The highest nutrient efficiency was achieved by use of phosphorus fertilisers that was about 97.2%.

Due to the good nutrient management, there have not been high nutrient losses, which in turn did not cause ground water pollution.

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Sadržaj NPK hraniva u vegetativnim organima karfiola (*Brasica oleracea var. botrytis* L.) gajenog na hidroponski način

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Sažetak

Eksperiment je sproveden u stakleniku Mediteranskog agronomskog instituta u Bariju (IAMB) koji se nalazi u jugoistočnoj Italiji. Glavni cilj ovog istraživanja je bio evaluacija sadržaja makrohraniva (NPK) u vegetativnim organima karfiola gajenog u tri inertna substrata (perlit, gravel i pozolana). Gubici hraniva su bili jako mali zahvaljujući dobrom upravljanju kao i kontroli primjene hraniva. Najveću efikasnost u primjeni hraniva je imao fosfor (97,2%), dok je najveći gubitak hraniva imao kalijum (11,6%). Dobijeni gubici nisu izazvali veliko zagađenje zemljišta i podzemnih voda.

Ključne riječi: hraniva, substrati, kalijum, karfiol.

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Possibility of Increasing Volume, Structure of Production and use of Domestic Wheat Seed in Agriculture of the Republic of Srpska

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Abstract

The objective of this research work was to explore the scope, structure and quality of production and use of domestic wheat in the RS. The subject of the research was to determine the production of wheat in the Republic of Srpska, the needs for seed wheat, determine the amount imported, and to identify measures to increase domestic production of seed wheat and to reduce imports. The analysis of commercial wheat production in the period 2006-2010 showed that the production took place in the average area of 44,017.6 ha, with an average yield of 3.28 t/ha and total production of 145,591 t. The highest level of wheat production was recorded in 2007 when it was 172,481 t, and a minimum production was in 2010 when it was 84,647 t. In the Republic of Srpska in 2010, the area under wheat amounted to 33,641 ha, which required about 8,410 tonnes of wheat seed, and only 4.27% of the quantities of seed wheat needed for the RS market were produced in the RS, the rest came from imports. According to the Indirect Taxation Administration data, the Republic of Srpska imported 125 t of wheat seed in 2009. The quantities of imported wheat vary considerably from year to year and are influenced by the weather in the sowing season and the prices on the market. Analysis of seed wheat in period 2006-2010 showed that the seed wheat occupied an average area of 128.8 ha, with the average yield of 4.06 t/ha and the total average production of 514.2 tonnes. The highest production was recorded in 2008 when it was 656.25 tonnes, and the lowest in 2010, 359.4 tonnes. Demand for wheat seed of the Republic of Srpska, based on five-year average, amounts to 13,205 tonnes, in which the domestic production share is 514 tonnes or 3.9%. The value of domestic wheat seed production in this period was BAM 393,616, and the value of missing quantities of seeds that are imported is BAM 9,824,152, based on the domestic price.

Key words: surface, wheat, age, yield, RS, needs, imports.

Introduction

Seed production is a complex activity within the agrarian sector, and it can be observed from the agricultural, economic and social point of view. Seed is playing the main role in reproduction and survival of plant species. Significance of seed as food for humans and animals, but also for industrial processing, is enormous.

According to data provided by Indirect Taxation Authority of BiH, in 2009 the Republic of Srpska imported 125 t of wheat seed. The value of imported quantities of wheat, according to prices, is BAM 96.250. Quantities of wheat that are imported significantly vary from year to year, and that is caused by the weather in the sowing season as well as the prices on the market.

To make this situation change in favour of the Republic of Srpska, it is of crucial importance to stimulate development of domestic varieties through selection and breeding work, and in accordance with that, increase produced quantities of high quality local seed.

Materials and methods

The main goal of this research is to study the structure of domestic production of wheat seed in the Republic of Srpska in order to determine the state and shortages of seed, so the apporopriate solutions are proposed that can reduce financial allocations for imports.

The subject of this research was to determine quantities of produced wheat seed in the Republic of Srpska, the overall need for wheat seed, quantities that are imported, and necessary measures in order to increase domestic production and reduce the imported quantities.

An analysis of production structure was performed in this research as well as the Republic of Srpska's needs for wheat seed and its level of production in the period from 2006 to 2010. Based on those analyses, this research proposed measures for improvement of wheat seed production.

Results and discussion

Production structure of wheat in Republic of Srpska

In the researched period, cereal production occupied the largest share of the Republic of Srpska sowing structure. According to produced quantities the most common field crop was maize and on the second place was wheat.

Wheat production in the five-year research period was organized on an average area of 44,017.6 hectares, with an average yield of 3.28 t/ha and total production of 145,591.8 t.

In the period under study, variations have been noted, both in terms of sown area under wheat and volume of production. The highest level of wheat production was recorded in 2007 – 172,481 t, and the lowest in 2010 – 84,647 t.

Tab. 1. Production of commercial wheat in the Republic of Srpska
Proizvodnja komercijalne pšenice u Republici Srpskoj

Wheat	2006	2007	2008	2009	2010	Average 2006-2010
Area (ha)	49 612	50 646	41 159	45 030	33 641	44 017,6
Production (t)	153 949	172 481	150 904	165 978	84 647	145 59178
Yield (t/ha)	3,1	3,4	3,7	3,7	2,5	3,28

Source: author's treatment

The Republic of Srpska's needs for seed according to the structure of production

Production of high categories of seed from domestic varieties of wheat (pre-basic seed, basic seed) has been conducted at the Agricultural Institute of the Republic of Srpska since 1970s. In 2010, the Institute produced 201.4 tonnes of basic seed of BL wheat varieties. Apart from this, PD "Semberija" from Bijeljina produced 158 tones of basic wheat seed. The total amount of seeds (359.4 t) is sufficient for sowing around 437.6 hectares (with sowing rate of 250 kg/ha). In 2010, area under wheat in the Republic of Srpska amounted to 33,641 ha, which required approximately 8,410 tonnes of wheat seed.

For approximately 50% of that amount, it is estimated that producers used their own uncertified seed.

This implies that in 2009 the Republic of Srpska market needed to supply about 4,205 t of certified wheat seed. In 2010, the Agricultural Institute of the Republic of Srpska and PD "Semberija" produced only 4.27% of the total quantities of wheat seed needs. The remaining certified seed came from neighbouring countries, thus significantly outflowed the funds from the Republic of Srpska (RS). According to data provided by the Indirect Taxation Authority of BiH, in 2009 the RS imported 125 t of wheat seed. Quantities of wheat that are imported vary significantly from year to year, and that is conditioned by the weather in the sowing season as well as the prices on the market.

Production of wheat seed in the Republic of Srpska

The results of this research are presented in Table 2.

It is evident from Table 2 that wheat seed production occupies average area of 128.28 hectares, with an average yield of 4.06 t/ha and the total average production of 514.2 tonnes. The highest level of total production was recorded in 2008 – 656.25 tonnes, and the lowest one was in 2010 – 359.4 tonnes.

The Republic of Srpska's demand for wheat seed on the basis of five-year period average amounts to 13,205 tonnes, in which domestic production participates with just 514 tonnes or 3.9%. The value of domestic wheat seed production in the observed period was BAM 393,616 while the value of imported quantities of this seed, in domestic prices, was BAM 9,824,152.

Tab. 2. Total seed production of wheat in the Republic of Srpska
Ukupna proizvodnja sjemenske pšenice u Republici Srpskoj

Typs of production	2006	2007	2008	2009	2010	Average 2006-2010
Wheat						
Area (ha)	189	115	153,6	156	139	128,28
Production (t)	607,45	381	656,25	566,5	359,4	514,12
Yield (t/ha)	3,22	3,32	4,28	3,64	2,59	4,06

Source: author's treatment

Tab. 3. The balance of wheat seed production in the Republic of Srpska, 2006-2010
Bilans proizvodnje sjemenske pšenice u Republici Srpskoj, 2006-2010. godine

Year	Merkantile wheat production in Republic of Srpska		Seed production of wheat in Reublic of Srpska		Price of domestic seed	Value of the domestic seed production	Need for the seed sown area	Value of the demand for seed by domestic seed prices	Missing quantities of wheat	The total missing guantity of wheat
	H	t	h	t	(BAM/t)	(BAM)	(t)	(BAM)	(t)	(BAM)
2006	49 612	153 949	189	608	780	474 240	14 884	11 609 520	14 276	11 135 280
2007	50 646	172 481	115	381	850	323 850	15 194	12 914 900	14 813	12 591 050
2008	41 159	150 904	153	656	910	596 960	12 348	11 236 680	11 538	10 499 580
2009	45 030	165 978	156	567	490	277 830	13 509	6 619 410	12 942	6 619 410
2010	33 641	84 647	139	360	820	295 200	10 092	8 275 440	9 732	8 275 440
Average:	44 018	145 592	150	514	770	393 616	13 205	10 131 190	12 660	9 824 152

Source: author's treatment

Conclusion

A breeding programme without continuity, recognized and in production widely used varieties in the last ten years, cannot be considered as a serious breeding programme. Also, programmes focused on varieties that are producing small quantities of seeds, while at the same time the missing amounts are imported, cannot be considered as economically significant programmes.

Research results show the following conclusions:

- Wheat production in the research five-year period was organized on an average area of 44,017.6 hectares, with an average yield of 3.28 t/ha and total production of 145,591.8.
- In 2010, areas under wheat in the Republic of Srpska amounted to 33,641 ha, which required approximately 8,410 tonnes of wheat seed.
- According to data provided by the Indirect Taxation Authority of BiH, in 2009 our country imported 125 t of wheat seeds.
- Wheat seed production occupies an average area of 128.28 ha, with an average yield of 4.06 t/ha and a total average production of 514.2 tonnes.

- The value of domestic wheat seed production in the observed period was BAM 393,616 while the value of imported quantities of seed, in domestic prices, was BAM 9,824,152.

The research results indicate that most of wheat sown in the Republic of Srpska is performed with uncertified and imported seed, which results in low yields, poor quality of commercial goods and others.

Registration of the Republic of Srpska varieties and their introduction into production will have significant indirect effects. Seed producers will achieve higher profits, and farmers will raise their level of cultural practices, and thus, yields and profits.

The link between breeder - registration of varieties – seed producer – seed distribution - seed users is hardly functioning. There are many models in the region that can be successfully implemented in practice in the Republic of Srpska, even with the currently existing staff in public institutions and agricultural services in local communities. Education of producers through lectures, especially macro and demo experiments, media and written texts is a tested method of promoting and putting into use own seed. In simple terms, the producer must always have at his disposal all the information and seeds he needs.

The agricultural Institute of the Republic of Srpska in Banja Luka represents a good starting point for realisation of this research. First of all, the Institute has trained personnel and well equipped laboratories that are very good starting points for breeding and creation of new varieties, as well as for control of genetic purity. A biotechnological laboratory is equipped to perform part of breeding programme easily with the help of molecular markers, which is of great importance. Other segments of the Institute also have enough experience in certain breeding activities, especially in seed production.

With a quality programme, it is necessary to create a BL brand in seed production, which will be able to compete with seeds produced by other companies. Developed seed production should be a good starting basis for our country to integrate with the EU.

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Mogućnosti povećanja obima, strukture proizvodnje i upotrebe domaće sjemenske pšenice u poljoprivredi Republike Srpske

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Sažetak

Cilj rada je istraživanje obima, strukture i kvaliteta proizvodnje i upotrebe domaćeg sjemena pšenice u Republici Srpskoj. Predmet istraživanja rada je utvrđivanje proizvodnje sjemena pšenice u Republici Srpskoj, zatim potreba za sjemenskom pšenicom, utvrđivanja uvezenih količina, kao i utvrđivanja mjera za povećanje domaće sjemenske proizvodnje pšenice radi smanjenja uvoza. Analizom proizvodnje merkantilne pšenice u periodu 2006-2010. godine došlo se do podataka da se proizvodnja odvijala u prosjeku na površini od 44 017,6 ha, s prosječnim prinosom 3,28 t/ha i ukupnom proizvodnjom od 145 591,8 t. Najveći nivo proizvedene pšenice zabilježen je u 2007. godine kada je iznosila 172 481 t, a najmanja 2010. godine 84.647,00 t. U Republici Srpskoj u 2010. godini površine pod pšenicom su iznosile 33 641 ha, za što je potrebno oko 8.410 tona sjemenske pšenice, a proizvedeno je 4,27% sjemena od navedene količine pšenice potrebne za tržište RS, ostatak dolazi iz uvoza. Prema podacima iz Uprave za indirektno oporezivanje, u 2009. godini u Republiku Srpsku uvezeno je 125 t sjemenske pšenice. Količine uvezene pšenice značajno variraju od godine do godine, a uslovljene su vremenskim prilikama u sezoni sjetve i cijenama na tržištu. Analizom sjemenske pšenice u periodu 2006-2010. godine došlo se do podataka da je sjemenska pšenica zauzimala prosječnu površinu od 128,28 ha, prosječnim prinosom od 4,06 t/ha i ukupnom prosječnom proizvodnjom od 514,2 tona. Najveća proizvodnja zabilježena je u 2008. godini kada je iznosila 656,25 tona, a najmanja u 2010. godini 359,4 tona. Potrebe za sjemenskom pšenicom Republike Srpske na bazi petogodišnjeg prosjeka iznose 13 205 tone, u čemu domaća proizvodnja učestvuje sa 514 tone ili 3,9%. Vrijednost domaće sjemenske proizvodnje pšenice u posmatranom periodu je 393 616 KM, a vrijednost nedostajućih količina sjemena koje se uvoze po domaćim cijenama iznose 9 824 152 KM.

Ključne riječi: Površina, pšenica, godina, prinos, RS, potrebe, uvoz.

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Production of Bioenergy in the Posavina Region

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Abstract

This paper presents the results of the project titled "*Agricultural Biomass Cross-border Development of Energy in Posavina" - ABCDE Posavina* implemented within the IPA Cross-border Programme between Croatia and Bosnia and Herzegovina. Its main objective is to promote agro-bioenergy in rural economies by including utilisation of agricultural biomass for energy purposes in the Posavina region. The region includes Vukovar-Srijem County (VSC) in Croatia and four municipalities (Odžak, Domaljevac-Šamac, Orašje, Šamac) and Brčko District in Bosnia and Herzegovina (BiH). These areas represent valuable agricultural land with a good potential for economic utilisation. The analysis of agricultural biomass potential includes production of biogas in co-digestion of manure (cattle, pigs and poultry manure) and maize silage (input of maize silage is limited at 30% of feedstock mass) as well as biodiesel from oilseed rape and bioethanol from maize. Potential GHG savings are estimated for the biogas and biofuels use. Theoretical biogas energy potential is estimated at 1,386 TJ/yr for VSC and 574 TJ/yr for BiH. Based on the theoretical potential for generation of electricity and heat from biogas, total installed capacity in VSC would be 19.8 MW_e while 8.2 MW_e in BiH. The corresponding theoretical potentials for biodiesel production are 4,258 TJ/yr (VSC) and 1,415 (BiH) while for bioethanol these are 6,140 TJ/yr and 1,689 TJ/yr, respectively. It is assumed that 50% of total theoretical biogas potential and 30% of total theoretical biofuel potential are achievable. Annual GHG savings for biogas use are estimated at 31.30 ktCO2-eq (VSC) and 26.84 ktCO2-eq (BiH). Annual GHG savings due to biodiesel use are estimated at 37.46-64.22 ktCO2-eq (VSC) and 12.45-21.34 ktCO2-eq (BiH) and for bioethanol use at 54.02-92.61 ktCO2-eq (VSC) and 14.86-25.48 ktCO2-eq (BiH).

Key words: biomass, potential, cross-border development, Posavina region.

Introduction

This paper presents the results of *Agricultural Biomass Cross-border Development of Energy in Posavina* - ABCDE Posavina project that is being carried out within the IPA Cross-border Programme between Croatia and Bosnia and Herzegovina. The project aims to promote use of agricultural biomass for energy generation in Posavina. Target area spreads across 3,494 km^2 (~ 350.000 inhabitants) and includes Vukovar-Srijem County (VSC) in the Republic of Croatia (RC) and municipalities of Šamac, Domaljevac-Šamac, Orašje, Odžak as well as Brčko District in Bosnia and Herzegovina (BiH) (Figure 1).

Fig. 1. Project target area – the Posavina region
Projektom ciljano područje - područje Posavine

The total arable area in BiH amounts to 51,002 ha, whilst in Vukovar-Srijem County it covers around 154,856 ha (CORINE Land Cover Croatia). Quality agricultural land along with the tradition of field crop and animal production represent significant development resource of the region, but on the other hand, inadequate and fragmented production of low productivity does not allow full-scale development of economic potentials.

Using agricultural biomass for generation of electrical energy has various advantages in comparison with the use of fossil fuels, such as no greenhouse gas emissions, solving the issue of stable manure disposal, diversification of agricultural production, exploitation of degraded, less productive agricultural land, inducing rural development, using domestic energy resources, diversification of supply and reducing dependence on import, etc.[8,1]

Furthermore, it is important to underline that the European Union (EU) has defined the following objectives regarding renewable sources of energy (RSE) by *Directive 2009/28/EC*:

- The share of gross final consumption of energy from renewable sources in gross final consumption of energy shall amount to 20 percent by 2020
- The share of energy from renewable sources in all types of transport shall amount to at least 10 percent of the total energy in transport by 2020

Having laid down the *Energy Sector Development Strategy of the Republic of Croatia (NN 130/09)*, the RC adopted the said objectives. Moreover, the RC has established an incentive system for generation of electrical energy from RSE and the use of biofuels and other renewable fuels for transport purposes. In BiH, the *Law on Electrical Energy of the Republic of Srpska (The Official Gazette of the RS 66/02, 29/3, 86/03, 111/04)* and the *Law on Electrical Energy of the Federation of BiH (The Official Gazette of FBiH 41/02, 24/05, 38/05)* view generation of electrical energy from RSE in a positive way.

In regards with the reduction of greenhouse gas emissions, the EU set a target to reduce emissions by 20 percent in comparison to 1990, thus making it possible to achieve reductions by 30 percent providing that other countries (especially China, India, Brazil)[6,15] have accepted certain obligations. The RC and BiH have ratified the *United Nations Framework Convention on Climate Change (UNFCCC)* which aims to establish stable concentration of greenhouse gases in the atmosphere at a level that will prevent anthropogenic interference with the climate system. As one of the parties to Annex B of the Kyoto Protocol, the RC has committed to reduce greenhouse gas emissions by 5 percent during the first commitment period 2008-2012 in comparison with the 1990 baseline emissions.

Methodology

The analysis of agricultural production in Posavina has been carried out with the aim to evaluate the state and potentials for energy production (biogas, liquid biofuels) from agricultural raw materials.

Availability of agricultural land

To determine the area that can be used to grow biomass for production of energy, sustainability criteria have been applied. In addition, it was assumed that food and animal feed production still has to remain the primary use of agricultural land and that neither meadows and pastures nor environmentally valuable areas were to be used for energy crops.

On the basis of experience and literature data, to provide food for humans, including field crop and animal production, 0.16 ha of agricultural land is needed per capita.[17] When determining arable land available for energy crops in the region under study, the fact that Posavina is "a granary" both for the RC and BiH was also taken into account. Therefore, an assumption has been made that for food production it is necessary to ensure the area that corresponds to the share of agricultural land in the region concerned with the total agricultural land in each country.

To calculate available agricultural land for each target region, the following formula has been used:

$$P_{en} = \frac{(P_{Pos} - \frac{P_{Pos}}{P_{uk}} \times B_{st} \times 0{,}16) \times (P_{Pos} - P_{lp})}{P_{Pos}} \text{ [ha]}$$

Where:

P_{en} – available agricultural land for energy crops in the region under study [ha]
P_{Pos}– total agricultural land in the region under study [ha]
P_{uk}– total agricultural land in RC/BiH [ha]
P_{lp} – total meadows and pastures in the region under study [ha]
B_{st} – RC/BiH population
0.16 – agricultural area needed for production of food and animal feed in order to provide sustenance for one person [ha/cap]

Availability of raw materials

Availability of raw materials has been estimated based on the agricultural production and average values of biomass production suitable for energy purposes. In animal husbandry sector, amounts of stable manure produced on cattle, pig and poultry farms have been considered. The focus in field crop production is on growing maize (silage and grain) and oilseed rape. Also, for VSC, the estimate has been made in regards with biodegradable waste produced in slaughterhouses.

The priority was given to the disposal of manure. Thus, when calculating technical potential, it was assumed that part of the land available for energy crops (Pen) would be primarily used for silage maize needed for co-digestion i.e. biogas production, whereas the remaining land could have technical potential for biodiesel production using oilseed rape as well as bioethanol from maize.

Biogas production

The technical potential for biogas production implies biogas production by means of anaerobic digestion:

a) co-digestion of stable manure and silage maize
b) monodigestion of slaughterhouse waste

When calculations were made, a 30 percent silage mass share was estimated in the feedstock. The 30 percent share of silage will contribute to the increase in biogas yield, whereas at the same time it will not require too high land allocation for its production, thus it will add to sustainable use of the land.

Biogas/methane yields used to calculate energy potential are given in the table below.

Tab. 1. Feedstock properties for biogas production[19]
Karakteristike supstrata za proizvodnju bioplina

Feedstock	Share of organic dry matter in fresh matter (oDM)	Methane yield per unit of organic dry matter (p) [m^3CH_4/t oDM]
Pig manure(liquid)	0.22	250
Cattle manure (solid)	0.0595	280
Poultry manure (solid)	0.33	300
Maize silage	0.32	234
Slaughterhouse waste	0.15	500

To calculate the biogas production potential, the following formula has been used:

$$BP = m \times oST \times p \times k \quad \text{[kWh/g]}$$

Where:

BP – energy potential of produced biogas [kWh]
m – feedstock mass (biomass) for production of biogas at annual level in the region under study [t/yr]
oST– share of volatile dry matter in dry matter of the feedstock concerned
p – methane yield (CH_4) per mass unit of organic dry matter [m^3/t oDM]
k=10 – energy value of biomethane [kWh/Nm^3]

The above given formula is used to calculate production potential of single feedstock. In the case of co-digestion, it is necessary to sum the potentials of particular raw materials.

Biogas can be used as a fuel for generation of heat and/ or electrical energy. In the estimate of technical potential, generation of electrical and heat energy in cogeneration has been envisaged with efficiency factors at 36 percent for electrical and at 30 percent for heat energy.

Production of liquid biofuels – biodiesel and bioethanol

Oilseed rape has been considered as a raw material for production of biodiesel, and maize for production of bioethanol.

The potential for production of biodiesel and bioethanol was calculated according to the formula:

$$BG = \frac{P_{en} - P_{bp} \times p}{f} \times OV_{BD} \quad \text{[J/yr)}$$

Where:
BG – potential for biodiesel/ bioethanol production [J]

P_{en} – available agricultural land for energy crops for production of liquid biofuels in the region under study [ha]
P_{bp} – agricultural area needed for growing silage maize to be used for production of biogas in the region under study [ha]
p – annual yield of the raw material being considered [t/ha]
f – conversion factor for the raw material being considered
OV_{BD}– lower heating value of biodiesel/ bioethanol [GJ/t]

Values of conversion factors f for particular crops, i.e. quantities of particular types of raw materials needed for the production of 1 tonne of liquid biofuel are given in the table below:

Tab. 1. Quantities of raw materials needed for production of 1 tonne of biofuel
Količine sirovine potrebne za proizvodnju 1 tone biogoriva

Biodiesel (1t)[12] *Biodizel*	Bioethanol (1t)[13] *Bioetanol*
Oilseed rape (t) (wet 10%) *Uljana repica (t) (mokrina 10%)*	Maize (t) (dry process) *Kukuruz (t) (suhi postupak)*
2.45	3.26

It needs to be emphasised that in order to calculate the potential of liquid biofuel production it was assumed that the land available for production of liquid biofuels was to be used to grow a single crop (either oilseed rape or maize). Therefore, the biodiesel or bioethanol potential given herein using a single crop at the same time represents the total potential for the region concerned. The purpose of such a presentation is to provide indicators on possibilities without prejudice regarding crop selection or type of fuel to be produced.

Greenhouse gas emissions savings

The methodology used to calculate GHG savings during production and use of biogas is given below.

Methane emissions savings

The calculation is based on IPCC methodology for calculation of emissions in stable manure management sector.[11]

$$Emissions\ (kt\ CO_2\text{-}eq/yr) = Livestock\ number \times EF\ (kg\ (CH_4)/livestock\ unit\ annually) \times GWP \times 0.5 / 10^6$$

Emission factors, EF (kg (CH_4)/livestock unit annually), from National Greenhouse Gas Inventories RC[14] were used (Table 3). Global warming potential for

methane is 23, whilst it is assumed that it is possible to reduce methane emissions by 50 percent in case of biogas production from manure.[3]

Tab. 2. Emission factors for methane from stable manure management sector
Emisijski faktori za metan iz sektora upravljanje stajskim gnojem

	Dairy cows *Mliječne krave*	Other cattle *Ostala goveda*	Pigs *Svinje*	Poultry *Perad*
EF kg(CH_4)/livestock unit annually	6	4	4	0.012

Emissions of N_2O in stable manure management are not included in the calculation due to their considerable variability.[2,4]

Reduction of emissions due to generation of electrical and heat energy

The estimate is based on an assumption that electrical and heat energy generated from biogas with zero greenhouse gas emissions replaces the energy generated from other sources.

$$\textit{Emissions (kt } CO_2\textit{-eq/yr)} = \textit{Generated energy (kWh/yr) x EF (kg } CO_2\textit{/kWh)} / 10^6$$

Emission factors by kWh of electrical and heat energy are given in the table below.

Tab. 3. CO_2 emission factors in generation of electrical and heat energy[9]
Faktori emisija CO_2 u proizvodnji električne i toplinske energije

	RH	BiH
EF (kg CO_2/kWh)	0.349	0.887

Reduction of emissions caused by decrease in synthetic fertiliser production

The estimate is based on an assumption that up to 20 percent more efficient use of nitrogen is achieved when using digestate than when using fresh stable manure, which causes reduction of use i.e. production of fertilisers.[1]

$$\textit{Emissions (kt } CO_2\textit{-eq/god)} = \textit{Livestock unit number x Nitrogen emission (kg/LU annually) x 0.2 x EF (3.3 kg}CO_2\textit{-eq/kgN)} / 10^6$$

The emission factor used for production of synthetic fertilisers amounts to 3.3 $kgCO_2$-eq/kgN.[5]

Greenhouse gas emissions savings can be achieved by using biofuels in transport. *Directive 2009/28/EC* has also set out sustainability criteria in order to enable alleviation of adverse social and environmental effects. These criteria, inter alia,

include minimal reduction of greenhouse gas emissions when using biofuels in comparison with corresponding fossil fuels. Currently, reductions must be at least 35 percent, whereas the percentage shall go up to 50 percent in 2017 or 60 percent in 2018 for biofuels produced in facilities that will have started production in 2017 or later. In terms of motor biofuels, the Directive has set reference emissions for fuels at 83.8 g CO_2-eq/MJ.

Results

Input data for animal and field crop production in the region of Posavina are shown in the following tables.[7]

Tab. 4. Livestock unit (LU) number and quantities of manure at an annual level
Broj uvjetnih grla i količina stajskog gnoja na godišnjoj razini

Region *Područje*	Category *Kategorija*	LU number *Broj UG*	Production of stable manure (t/yr) *Proizvodnja stajskog gnoja (t/god)*
VSC	Cattle	32,283	306,366
	Pigs	14,080	113,062
	Poultry	511	4,849
Total		*46,874*	*424,277*
BiH	Cattle	5,884	55,849
	Pigs	7,441	59,752
	Poultry	4,957	47,042
Total		*18,282*	*162,643*

Tab. 5. Average annual yields of energy crops
Prosječni godišnji prinosi energetskih usjeva

Crop / *Usjev*	Municipality / *Općina*	Yield (t/ha) / *Prinos*
Oilseed rape *Uljana repica*	VSC	2.7
	BiH	2.3
Maize *Kukuruz*	VSC	7.1
	Domaljevac	5.0
	Odžak	5.5
	Orašje	4.6
	Šamac	5.8
	Brčko	4.6
Silage maize *Silažni kukuruz*	VSC	33.6
	Domaljevac	22.8
	Odžak	22.8
	Orašje	22.8
	Šamac	22.2
	Brčko	12.5

Theoretical potential for the production and use of biogas and liquid biofuels in the region is shown in the tables below.

Tab. 6. Theoretical potential for the production of biogas from agricultural biomass in Posavina
Teoretski potencijal proizvodnje bioplina iz poljoprivredne biomase u Posavini

Region *Područje*	Theoretical energy potential for biogas production *Teoretski energetski potencijal proizvodnje bioplina*		Theoretical energy potential for generation of electrical and heat energy using biogas *Teoretski energetski potencijal proizvodnje električne i toplinske energije iz bioplina*	
	Co-digestion (TJ/yr.) *Kodigestija*	Agricultural land needed for maize silage growing (ha) *Poljoprivredne površine potrebne za uzgoj kukuruzne silaže*	Cogeneration (GWh/yr) *Kogeneracija*	Total installed capacity (MW_e) *Ukupna instalirana snaga*
VSŽ	1,370.39	5,408	138.61 el. en. 115.51 heat en.	19.80
BiH	574.25	4,527	57.43 el. en. 47.86 el. en.	8.20

Tab. 7. Theoretical potential for the production of liquid biofuels from agricultural biomass in Posavina
Teoretski potencijal proizvodnje tekućih biogoriva iz poljoprivredne biomase u Posavini

Region *Područje*	Biodiesel from oilseed rape *Biodizel iz uljane repice*		Bioethanol from maize (dry process) *Bioetanol iz kukuruza (suhi postupak)*		Agric. land for growing raw material (ha) *Polj. površina za uzgoj sirovine (ha)*
	t/yr	TJ/yr	t/ yr	TJ/ yr	
VSŽ	115,067	4,257.50	227,402	6,139.86	104,413
BiH	38,243	1,415.02	62,633	1,689.07	41,101

It is important to underline that to make use of animal husbandry waste for energy purposes it is necessary to dispose of with adequate infrastructure and that cost-effectiveness of such use depends on waste volumes produced at individual farms (i.e. livestock unit number). As in Vukovar-Srijem County around 50 percent of the total livestock unit number of cattle, pigs and poultry are bred at larger farms, we can assume that 50 percent of the total available animal husbandry waste could be used for generation of energy. Accordingly, the total installed capacity in biogas cogeneration facilities would be 9.90 MW_e. Animal production in Bosnian Posavina is characterised by small farms, thus it is realistic to assume that a number of centralised biogas

facilities would be built (that would be provided with raw materials by a bigger number of farms). In this case, alongside well-organised centralised facilities and farmers, it would be possible to make use of 50 percent of available stable manure. Then, the installed capacity of biogas cogeneration facilities would be 4.10 MW_e.

As far as biofuel production is concerned, it is realistic to expect that available agricultural land will also be used for other purposes, besides energy use. Therefore, we can conclude that real potential for liquid biofuel production in Posavina could amount to 30 percent of the theoretical potential (Tab. 8).

Tab. 8. Achievable potential for liquid biofuel production from agricultural biomass in Posavina
Ostvarivi potencijal proizvodnje tekućih biogoriva iz poljoprivredne biomase u Posavini

Region *Područje*	Biodiesel from oilseed rape *Biodizel iz uljane repice*		Bioethanol from maize (dry process) *Bioetanol iz kukuruza (suhi postupak)*		Agric. land for growing raw material (ha) *Polj. površina za uzgoj sirovine (ha)*
	t/yr	TJ/ yr	t/ yr	TJ/ yr	
VSŽ	34,520	1,277.25	68,221	1,841.96	31,324
BiH	11,473	424.51	18,790	506.72	12,330

The total potential greenhouse gas emission reductions achieved by using biogas are shown in the table below.

Tab. 9. Greenhouse gas emission reductions when producing and using biogas
Uštede emisija stakleničkih plinova pri proizvodnji i korištenju bioplina

Region *Područje*	Emission reductions ($ktCO_2$-eq yr) *Uštede emisija*
VSŽ	31.30
BiH	26.84

Table 11. shows potential greenhouse gas emission reductions when using liquid biofuels.

Discussion and conclusion

There is a legal framework in the RC that encourages the use of electrical energy generated from RSE or use of RSE in transport, hence objectives have been set in accordance with the EU Directive 2009/28/EC. U BiH, as far as the use of RSE is considered laws have been laid down that view generation of electrical energy from RSE in a positive way, although bylaw acts that are to encourage its use are still to be laid down.

Tab. 10. Potential greenhouse gas emission reductions achieved by using biofuel in transport
Potencijalne uštede emisija stakleničkih plinova ostvarene korištenjem biogoriva u prijevozu

Minimal reductions *Minimalne uštede*	Biodiesel ($ktCO_2$-eq yr) *Biodizel*		Bioethanol ($ktCO_2$-eq yr) *Bioetanol*	
	VSŽ	BiH	VSŽ	BiH
35%	37,46	12,45	54,02	14,86
50%	53,52	17,79	77,18	21,23
60%	64,22	21,34	92,61	25,48

The region of Posavina disposes with abundant and quality agricultural land. However, inappropriate and fragmented production of low productivity does not allow the economic exploitation of these potentials. Moreover, the region is characterised by migrating and ageing population which hinders further development of agriculture. In VSC, owing to development of agricultural policies, land consolidation has been taking place throughout the last ten years, but the yields are still lower than in the Western Europe. The aforementioned points to the fact that there are significant capacities for enhancement of the field crop production in the region.

In Posavina, even though there are all prerequisites and the tradition of animal production, it is mainly small-scale and potentials are not sufficiently used for various reasons, such as constant change in animal feed prices, disorganised market and lack of selection work as well as insufficient farmers' knowledge on modern production, market, consumer requirements and environmental protection measures being imposed. Processing industry is rather underdeveloped in BiH, so the production under contracts does not exist, whilst farmers' associations, cooperatives or companies do not exist or are not particularly involved. In the area of VSC, there are slightly more favourable conditions both in terms of legal and financial support available to farmers and farm size in comparison with BiH. In VSC, animal husbandry production is characterised by the increase in number and quality of livestock unites per individual farms, this trend being especially evident in dairy cattle farms. It is worth noting that the field crop production has become hardly sustainable in Posavina, therefore one of the solutions is to integrate its forage base with livestock farming, which shall lead to the increase in total number of livestock units.

Envisaging the biogas production in co-digestion (manure and maize silage) and use of 50 percent of manure in the current production in VSC, the installed capacity of biogas cogeneration facilities is estimated at 9.90 MW_e. This estimate for BiH is at 4.10 MW_e. Based on the state of livestock production and results obtained on potential for biogas use, the construction of biogas facilities near bigger farms is recommended in VSC, whereas in BiH, due to farm size, it would be realistic to envisage the construction of a few centralised biogas facilities that would be supplied with feedstock by a number of farms.

Taking into account the current energy crops yields and utilisation of 30 percent of theoretical potential, the potential of biodiesel production using oilseed rape in VSC is estimated at 34,520 t/yr or bioethanol production using maize at 68,221 t/yr. The potential for the area under study in BiH is as follows: 11,473 t/yr for biodiesel and 18,790 t/yr for bioethanol.

Possible greenhouse gas emissions reductions regarding the production and use of biogas have been estimated at 31.30 $ktCO_2$-eq annually in VSC, whereas at 26.84 $ktCO_2$-eq annually in BiH. Depending on minimal emission savings, these reductions, which can be made by producing biofuels, range between 37.46-64.22 $ktCO_2$-eq annually for biodiesel or 54.02-92.61 $ktCO_2$-eq annually for bioethanol in VSC, whereas in BiH area under study they range between 12.45-21.34 $ktCO_2$-eq annually for biodiesel or 14.86-25.48 $ktCO_2$-eq annually for bioethanol.

To compare the above given emission savings, it is important to mention that the total greenhouse gas emissions in 1990 amounted to 31,440 $ktCO_2$-eq in RC[14] and 34,043.49 $ktCO_2$-eq in BiH[10], without taking into account forestry sector, land use and changing the land purpose. Moreover, the price of a tonne of CO_2 at the EU market of greenhouse gas emission units was 7.57 €[20] in December 2011. Having ratified the Kyoto Protocol, the RC committed to reduce greenhouse gas emissions by 5 percent in comparison with 1990 in the first commitment period 2008-2012, whereas BiH has not yet committed to reduce greenhouse gas emissions.

Sustainable production of biofuels, in line with sustainability criteria of the *EU Directive 2009/28/EC*, requires reduction of greenhouse gas emissions in transport, but on the other hand, it is necessary to pay attention to adverse effects primarily related to the use of agricultural land, increase in food and forage prices, different use of land and use of fertilisers, pesticides and water resources.[18,16]

Besides reducing greenhouse gas emissions, biogas use leads to other positive environmental effects such as waste use, reduction of foul odour, production of quality fertilisers and decrease in synthetic fertiliser use.[1] On the other hand, it is important to say that in the case when maize silage is used for production of biogas, attention should also be paid to adverse effects similar to those when growing energy crops for biofuel production.

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Proizvodnja bioenergije u Posavini

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Sažetak

Prikazani su rezultati projekta ABCDE Posavina (*Agricultural Biomass Cross-border Development of Energy in Posavina)* koji se provodi u okviru Programa prekogranične suradnje Hrvatska - Bosna i Hercegovina 2007.-2013. Glavni cilj projekta je promocija korištenja poljoprivredne biomase za proizvodnju energije u ruralnim područjima. Ciljanu regiju predstavlja Vukovarsko-srijemska županija (VSŽ) u Hrvatskoj te općine Odžak, Domaljevac-Šamac, Orašje, Šamac i distrikt Brčko u Bosni i Hercegovini. Područje karakterizira veliki potencijal za poljoprivrednu proizvodnju (raspoložive poljoprivredne površine, klimatski uvjeti, tradicija poljoprivredne proizvodnje i drugo). Provedena je analiza mogućnosti korištenja poljoprivredne biomase za proizvodnju energije u ciljanoj regiji. Procjena potencijala uključuje proizvodnju bioplina iz stajskog gnoja (goveda, svinje i perad) i kukuruzne silaže (udio kukuruzne silaže je ograničen na 30% ukupne mase sirovine) te biodizela iz uljane repice i bioetanola iz kukuruza. Na osnovu dobivenih rezultata su procijenjene uštede emisija stakleničkih plinova. Procjena teoretskog potencijala proizvodnje bioplina iznosi 1.386 TJ/god. za VSŽ i 574 TJ/god. za područje u BiH. Na osnovu procijenjenog teoretskog potencijala, ukupna instalirana snaga za bioplinska postrojenja iznosi 19,8 MW_e za VSŽ te 8,2 MW_e za područje u BiH. Za VSŽ teoretski potencijal proizvodnje biodizela iznosi 4.258 TJ/god. dok bioetanola iznosi 6.140 TJ/god. Za područje u BiH, teoretski potencijal iznosi 1.415 TJ/god. za biodizel odnosno 1.689 TJ/god. za bioetanol. Pretpostavlja se da je u regiji ostvarivo 50% teoretskog potencijala proizvodnje bioplina te 30% teoretskog potencijala proizvodnje biogoriva. Godišnje uštede emisija stakleničkih plinova za proizvodnju i korištenje bioplina su procijenjene na 31,30 $ktCO_2$-eq (VSŽ) i 26,84 $ktCO_2$-eq (BiH). Procjena godišnjih ušteda pri korištenju biodizela iznosi 37,46-64,22 $ktCO_2$-eq (VSŽ) i 12,45-21,34 $ktCO_2$-eq (BiH) odnosno 54,02-92,61 $ktCO_2$-eq (VSŽ) i 14,86-25,48 $ktCO_2$-eq (BiH) pri korištenju bioetanola.

Ključne riječi: biomasa, potencijal, prekogranična suradnja, regija Posavina.

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Determining Some Exterior and Interior Quality Traits of Japanese Quail Eggs (*Coturnix japonica*)

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Abstract

The aim of this research was to determine some exterior and interior quality traits of Japanese quail eggs. A total of 60 Japanese quail eggs were collected from two different farms near Novi Sad, and the eggs quality traits were tested in the laboratory of poultry science at the Department of Animal Science of the Faculty of Agriculture in Novi Sad. The egg weight, albumen weight, yolk weight, shell weight, shell breaking force, shell thickness, albumen height and egg yolk colour were determined. The external and internal egg quality traits of quail eggs from two farms in Serbia do not differ from the results of quality traits from other countries.

Key words: Quail, eggs, quality traits.

Introduction

Eggs of most bird species may have similarities in nutritional composition and potential food usage. However, information on egg quality characteristics and utilisation of egg for food and other purposes has been limited mostly to chicken eggs. Recently, Japanese quail (*Conturnix coturnix japonica*) has been important as a laboratory animal, due to its easy maintenance, early sexual maturity, shorter generation interval, high rate of egg production, but Japanese quail is also becoming more popular as a source of meat and eggs (*Punya Kumari, 2008*). Chicken egg has been very well studied for its quality as well as for its composition; however such information is not so abundantly documented in other poultry species (*Dudusola, 2010*). Among many quality characteristics, external factors such as cleanliness, freshness, egg weight and shell quality are important for consumer´s acceptability of shell eggs, and interior characteristics such as yolk index, albumen index, proportions of egg components and chemical composition are also important for egg production industry (*Song, 2000*). Information on egg quality characteristics has been limited mostly to chicken eggs.

Because of the growing interest in consumption of quail eggs in our country, and due to the lack of recent investigations in this direction, the aim of this paper was to enhance the knowledge on the quality of quail eggs, and to show the quality of quail eggs in our surroundings. In this study, external and internal quality traits of quail eggs from two different commercial farms will be presented.

Materials and methods

The investigation of egg quality traits was carried out at the Department of Animal Science of the Faculty of Agriculture in Novi Sad. The experimental material comprised eggs of Japanese quail (*Coturnix coturnix japonica*) of laying type in their first year of production taken from two commercial farms near Novi Sad. The quails in all three farms are kept in battery-cages. Examination of egg quality parameters was carried out on the random sample of 30 eggs per producer. The following egg quality traits (external and internal) were assessed:

Egg weight (g), yolk weight (g), albumen weight (g) and shell weight (g) were measured with analytic scale with 0.01 g accuracy.

To determine the proportions of egg parts, each egg was carefully broken and shell separated. Egg shell (not dried) was weighed and the relative weight calculated by relating the shell weight to the weight of the egg. An egg separator was used to separate the yolk from the albumen. Relative yolk weight was calculated in percentages by relating the yolk weight measured to the nearest gram to the whole weight of that particular egg and multiplied by 100. The albumen weight was calculated by subtracting the yolk and shell weights from the whole egg weight. The albumen weight relative to the individual egg weight was calculated.

Yolk index (%) was calculated according to the formula: Yolk index = yolk height (mm) x 100% / yolk width (mm).

Haugh units were calculated according to the formula (Haugh, 1937): HU = 100 log (H +7.57 -1.7 *$M^{0.37}$), H – average thick white height (mm), W – egg weight (g).

Shell breaking force was measured by an Egg Force Reader (Orka Food Technology Ltd, Israel). The stand of the device was modified for measuring quail eggs.

Egg yolk colour was determined according to Roche yolk colour fan (*Vuilleumier, 1969*).

Eggshell thickness (mm) was measured together with shell membranes at the equatorial part of the egg using a micrometer screw.

Based on the obtained data, statistical analysis was performed using ANOVA and Duncan post-hoc test (STATISTICA 8, Stat Soft Inc, 2007).

Results and Discussion

Table 1 presents results of egg quality traits. No significant differences were found in the egg weight and shape index between eggs derived from two producers.

The difference in shell breaking strength between farms A (1.72 kg) and B (1.63 kg) was not significant. No significant differences in shell thickness and shell weight between the two producers were found.

Tab. 1. Average values and standard deviation of external and internal egg quality traits of quail

Prosječne vrijednosti i standardno odstupanje od spoljašnjih i unutrašnjih osobina prepeličjih jaja

	Producer			
	A		B	
	X	Sd	X	Sd
Parameters				
Egg weight (g)	12,30	0,59	11,52	1,03
Shape index (%)	77,51	3,79	77,37	2,43
Breaking strength (kg)	1,63	0,38	1,72	0,33
Shell thickness (mm)	0,201	1,610	0,196	1,780
Shell weight (g)	1,80	0,26	1,73	0,20
Yolk weight (g)	3,42	0,49	3,72	0,42
Albumen weight (g)	7,08 [a]	0,38	6,07 [b]	0,67
Yolk colour (Roche)	7,6 [a]	2,32	13,6 [b]	0,97
Haugh Unit	86,1 [a]	3,02	83,65 [b]	3,27
Egg proportions (%)				
Yolk	27,71 [a]	2,85	30,00 [b]	3,34
Albumen	57,67 [a]	4,16	55,15 [b]	4,37
Shell	14,62	1,78	14,85	1,72

[a-c] Values within rows with no common superscript are significantly different ($P<0.05$)

For egg weight, no significant difference was found between farms, but for yolk and albumen weight, statistically significant differences were found between the farms. The weight of albumen was significantly different in the two farms. The difference between the highest and the lowest value was 1.01 g ($P<0.05$). Yolk, albumen and shell percentage were in the same relation as the weights of these parameters.

The most intensive yolk colour was recorded in eggs from Farm A (13.6 points), whereas quail eggs in farm B had just 7.6 points (Roche). Statistical differences were found between the farms.

The worst albumen quality (Haugh Unit) was recorded in eggs from farm A (83.65). Statistical difference was found between the Farm A and Farm B.

In this study, the average values that have been determined are similar to the results reported by *Nazligul et al.* (2001), *Ozcelik et al*. (2002), *Kul and Seker* (2004), *Nowaczewski et al.* (2010), but different from the results by *Odunsi et al.* (2007), *Ipek et al.* (2007), *Punya Kumari et al.* (2008), *Dudusola* (2009, 2010).

The mean egg weight in this experiment was similar to the results that were reported by *Dudusola* (2009, 2010). *Nowaczewski et al*. (2010), who analysed egg weight changes according to the age of experimental birds, found that the value of this trait in week 25 (10.91 g) was smaller than in week 9 (11.33 g), but about 1 g higher than in the results obtained by *Odunsi et al*. (2007), who evaluated three protein sources in the diets of growing and laying Japanese quails. The investigation from *Punya Kumari et al.* (2008) showed that mean egg weight from quail in 16th week of production was 13.71 which is more than 1 g higher compared to our results.

Shape index, shell thickness, albumen weight, yolk weight, Haugh Units and percentages of yolk and albumen were similar to the results reported by most researches *(Nazligul et al.,* 2001; *Ozcelik et al.*, 2002; *Kul and Seker,* 2004; *Punya Kumari et al.*, 2008; *Nowaczewski et al.* 2010).

The value of shell breaking strength of quail eggs was 1.63 and 1.72. This value was not compared to the results of other authors because these authors did not report the results of breaking strength. Generally it can be stated that the breaking strength is smaller compared to chicken eggs, which can as well be expected since the quail eggs have smaller weight and eggshell thickness.

The shell weight and percentage of shell in our investigation was bigger compared to the results of other authors (*Odunsi et al*., 2007; *Ipek et al.,* 2007; *Dudusola* 2009, 2010, *Nowaczewski et al.* 2010), because the shell weight was measured directly after the shell was broken and separated, and the mentioned authors measured it after drying.

In results from *Odunsi et al. (*2007) the yolk colour was lighter and in range between 1.2 and 1.5 points (Roche). In an investigation by *Punya Kumari et al.* (2008) the average yolk colour was 5.37, which is as well lighter than in our investigations, where the yolk colour was not uniform, and in the range between 7.6 and 13.6.

Conclusion

Generally, it can be concluded that the external and internal egg quality traits of quail eggs from two farms in Serbia do not differ from the results of quality traits from other countries. On the other hand, this investigation contributes to the development of science because it included some parameters, which have so far not been published in literature by other researchers from this area.

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Određivanje spoljašnjeg i unutrašnjeg kvaliteta jaja kod japanske prepelice (*Coturnix japonica*)

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Sažetak

Cilj ovog rada je bio da se ispitaju spoljašnje i unutrašnje osobine kvaliteta jaja japanske prepelice. Ukupno je bilo 60 jaja od dva različita proizvođača prepeličjih jaja u blizini Novog Sada a ispitivanje kvaliteta jaja je odrađeno u labaratoriji za živinarstvo na Departmanu za stočarstvo, Poljoprivredni fakultet Novi Sad. Ispitivani su sledeći parametri: masa jaja, masa belanca, masa žumanca, masa ljuske, čvrstoća ljuske, debljina ljuske, visina belanca i boja žumanca. Spoljašnji i unutrašnji parametri kvaliteta prepeličijih jaja sa dvije farme u Srbiji ne razlikuju se u odnosu na parametre kvaliteta iz drugih zemalja.

Ključne reči: prepelice, jaja, parametri kvaliteta.

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The Botanical Garden of the University of Banja Luka

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Abstract

The Botanical Garden of the University of Banjaluka is part of the "University City" complex sprawling over 5.3 ha. The complex began as the "Vrbas" Austro-Hungarian barracks at the end of the nineteenth century and it was used for military purposes until 2004. After being assigned to the University of Banja Luka in 2004, the area was allocated to the Genetic Resources Institute to make use of it. The Botanical Garden facilities are divided into three separate sections. In one section, the setting up of the botanical collections of genetic resources has begun. There is a fruit collection and preliminary characterization has also started on the accessions. In addition, *ex-situ* collections of vegetables, aromatic and medicinal plants and herbs, industrial and wild plants were designed. In the middle section, a pond was planned and the establishment of an arboretum collection was initiated, with representatives of autochthonous woody species. In the third section, green houses were designed and a building with gene bank facilities and laboratories was built. The Botanical Garden of the University of Banja Luka, as a place for *ex-situ* plant conservation, is of great importance for the conservation of biodiversity as well as for scientific research in this field.

Key words: ex-situ conservation, genetic resources, fruit collection, arboretum.

Introduction

Botanical gardens are unique facilities of regional and global importance within university centres. As a university city, Banja Luka, which has earlier been known for its green areas and tree alleys, has not yet had a similar facility. Owing to this fact, as well as to wide-ranging global importance of such places, there was an initiative to create a botanical garden within the "University City" complex.

The complex began as "Vrbas" Austro-Hungarian barracks at the beginning of the twentieth century and it was used for military purposes until 2004. By the decision of the Government of the Republic of Srpska, the area was allocated to the University of Banjaluka to make use of it. During 2004, rearrangements started as well as an initiative to found the Botanical Garden which was approved at the City Assembly of Banja Luka on 17 September 2004. From 2005 until 2008, thorough reconstruction and soil recultivation took place including the drafting and approval of a regulation plan that served as the basis for project documentation. In 2008 and 2009, further work on careful preparation of soil and planting of a number of forestry and ornamental dendrological material were done in the Botanical Garden. At the beginning of 2009, the Genetic Resources Institute was founded as an organizational unit of the University that was to use and manage the area of the Botanical Garden. In 2012, the "University City" complex was declared a protected area for resources management whereas the Genetic Resources Institute was assigned to manage this protected area. The complex is protected under the II and III degree regime (Institute for Protection of Cultural, Historical and Natural Heritage of the Republic of Srpska).

Object, materials and methods

Ecological characteristics of the location

The "University City" complex is situated east from the centre of Banja Luka, between the Vrbas River in the east and Vojvode Petra Bojovića Boulevard in the west, Vojvode Živojina Mišića Boulevard in the south and Banjalučko Polje in the north. It sprawls over 28.5 ha, out of which the Botanical Garden covers 5.3 ha.

In terms of relief characteristics, the area belongs to the Pannonian Plain rim with specific undulating terrain and fluvial terraces. The complex itself is situated on the left bank of the Vrbas River on the neogene fluvial terrace, slightly sloping towards east, that is, towards the Vrbas River bank. The natural soil in the area of research comprises alluvial deposits of considerable thickness (Stanivuković and Stupar, 2008.). The original relief was substantially altered at the time when the area was used as a military compound, thus the present pedologic state has undergone changes and become complex due to various anthropogenic influences. The absolute heights of natural terrain are around 156 m.

The climate conditions in Banja Luka can be described as moderate continental with relatively mild winters and warm summers. During the non-vegetation period, warm south westerly winds often occur causing a foehn effect and making snow melt rapidly in the winter period. The average annual air temperature for the period from 1961 to 1990 was 10.6°C whereas the average annual precipitation amounted to 1026 mm. January is the coldest month with average temperature of 0.7°C, while July is the hottest month with average temperature of 20.5°C. The average air temperature during vegetation period is 16.9°C. With 10.9°C mean temperature, spring is slightly warmer than autumn (10.8°C). Maximum precipitation during the year occurs in June and amounts to 111 mm, whereas the minimum has been recorded

in February (63 mm). During the vegetation period, precipitation amounts to 566 mm, 55.17% of total annual precipitation. Detailed characteristics of the climate in Banja Luka can be found in Table 1.

Tab. 1. Air temperature values and precipitation throughout a year (Stanivuković, Stupar, 2008)
Вриједности температуре ваздуха и количине паавина у току године (Станивуковић и Ступар, 2008.)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Temp. (°C)	-0,7	1,9	6,1	10,9	15,7	18,9	20,5	19,7	15,9	10,8	5,8	1,2	10,6
Precip. (mm)	69	63	79	87	98	111	95	93	82	72	91	86	1026

Based on the above mentioned climate indicators, we can conclude that in terms of climate the locality is very suitable for most woody and shrub species (Stanivuković and Stupar, 2008.).

Original vegetation

The garden area is located in the natural belt of climatogenic forests of sessile oak and hornbeam (*Querco-Carpinetum betuli*). Alluvial terraces with higher-moisture types of soils were mostly covered by common oak and hornbeam (*Carpino betuli – Quercetum roboris*) including the complex itself, whereas the river banks were under the forests of willows and poplars. (Stanivuković and Stupar, 2008).

Following a detailed land surveying record (1:500) and field prospection, dendrological vegetation was analysed with the aim to ascertain the current state-of-affairs and guidelines for renewal, that is, removal of trees.

The vegetation found in the area of the Botanical Garden was mainly of ruderal origin indicated by a great number of black locust trees (*Robinia pseudoacacia* L.) as a prevailing species, boxelder maple (*Acer negundo* L.) and myrobalan plum (*Prunus cerasifera* Ehrh.). Also, a number of honey locust trees (*Gleditsia triacanthos* L.) were identified that were part of the hedges at this location. Alongside the existing roads towards the campus, a number of Lawson cypress (*Chamaecyparis lawsoniana* (A. Murray) Parl.) trees were identified as well as northern red oaks (*Quercus rubra* L.), but also a Jeffrey pine tree (*Pinus jeffreyi* Balf.) and a paper birch tree (*Betula papyrifera* Marsh.), as very rare species in our ornamental woody flora (Urban Planning Institute of the Republic of Srpska).

Study

Because of its original purpose and considerable anthropogenic influence within the complex, it was necessary to make a detailed study on the current state-of-affairs prior to beginning any work on establishing of the Botanical Garden. The area intended for the Botanical Garden had been organized as part of military compound

with exercise facilities which had mostly been removed, except the concrete bottom of a pit used for immersion of army vehicles that was to remain and fit in within the water surface being planned.

As a consequence of a number of difficulties that left this location in quite a derelict state, there was a need for radical professional action, both growing and sanitary, as well as reconstruction and revitalisation of this area that resulted in a special study being made that encompassed the area of the Botanical Garden, that is, requirements for its establishment, protection, conservation and purposeful use of biodiversity for research and education (Genetic Resources Institute).

Taking into account the need for harmonisation of all the above listed functions of this facility and the then state-of-affairs, what followed was the study of environment conditions within the area planned for the establishment of the Botanical Garden including the analysis of necessary reconstruction and revitalisation work of the area concerned as well as the proposal of further measures for recultivation and enhancement of the said area with a specific purpose. After analysing the factors, natural and anthropogenic, for the establishment and development of the Botanical Garden, microclimatic factors of the location were considered primarily in regards with humidity and sun exposure, vicinity of the Vrbas River and potential water retention in the topsoil profile. As a final step, the best positions for planting of various plant species were determined in accordance with their biological requirements, planting dynamics and species specification being recommended. Also, the plan was made to remove and renew trees found at the location.

Results and discussion

The Botanical Garden area was divided into three sections according to the planning solution: a section for warehouse and mechanisation facility, gene bank and green houses; an arboretum and pond; botanical collections, alpinums and flower section. Surrounding the Botanical Garden, protection fence was planned and partly constructed with the main and additional gates. Carefully selected fertile humus substrate was spread all over the Botanical Garden whereby necessary soil alteration and levelling of terrain were done so the planting could start.

In the south section of the Botanical Garden at around 1.5 ha, botanical collections and alpinum have started being set up. Given the parcel size, botanical collections have been created as systematic collections. Furthermore, as various departments have their specific needs, the following are to be created, too: vegetables collection; medicinal and aromatic plants and herbs collection; field crops, industrial and edible wild plants collection. These collections will be completed successively, i.e. seasonally, by planting seedlings or transferring plants from their natural environment to a previously prepared parcel.

Moreover, a special collection of autochthonous apple and pear varieties was set up comprising 62 seedlings, out of which 38 apple and 24 pear seedlings (the collection contains 18 apple and 13 pear accessions).

In the middle part of the garden area, the forming of an arboretum collection and a pond has begun. Taking into account space limitation and educational intent, native woody species are primarily present including their green companions at the ground level. The whole arboretum area is divided into a number of sections whereas each section is further divided into bigger number of parcels that will be mutually separated by pathways. Each parcel contains close representatives of particular genera and families. Currently, the Botanical Garden has 215 trees of various age, out of which 174 deciduous and 41 coniferous encompassing 36 different taxons.

The second stage in the development of the Botanical Garden will aim at the setting up of a pond, alpinum, botanical collections and pathways. The pond and alpinums with specific vegetation are one more form of biological diversity, that is, a unique botanical, geological and ecological collection that is to complete the botanical collection.

Conclusion

Biological diversity, i.e., diversity of living organisms – within and between various species and ecosystems, is an important resource for human subsistence and plays a key role in the sustainable development. As regards the necessity and significance of conservation of biological diversity as a requirement for sustainable development and survival of people, botanical gardens, as part of a global system for conservation of biological diversity, are especially important in safeguarding endangered representatives of regional flora. Therefore, considering and designing them in this way, such as this one in Banja Luka, botanical gardens become regional centres of *ex-situ* conservation of endangered flora across the region.

A great number of educational institutions are immediate beneficiaries of such facilities, first of all the faculties of natural sciences and mathematics, forestry and agriculture, then secondary schools where biological and biotechnical disciplines are studied, but also overall student population. According to the definition, botanical gardens are collections of live plants and, apart from *ex-situ* conservation and propagation of endangered species, they mainly serve to improve knowledge of botany, that is to say they have an educational function. On the other hand, these kinds of facilities help raise ecological culture and awareness of the whole population. To see the plants from other parts of the world (exotic), a variety of quite unusual cultivars and hybrids is a possibility that openly encourages citizens to learn more about plants, to protect, grow and nurture them. In addition, these educational facilities primarily aim at gathering and directing as wide circle of people as possible towards particular actions as regards protection of nature and the environment. This is particularly crucial in urban areas with tendency of extensive expansion including Banja Luka.

All these activities are of public interest and, although it is sometimes difficult to explain why such activities are important for people and the community, projects like these require substantial support from the state and local administrations. It takes a lot of effort and endurance to start a botanical garden which slowly grows and thrives

but lives long and, only after 50 or 100 years, it can virtually shine out in the full sense of the word.

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Ботаничка башта Универзитета у Бањој Луци

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Сажетак

Ботаничка башта Универзитета у Бањој Луци, као дио комплекса "Универзитетски град", простире се на површини од 5,30 ha. Комплекс је настао као аустроугарска касарна "Врбас" крајем XIX вијека и све до 2004. године имао је војну намјену, када је додијељен Универзитету у Бањој Луци. Простор баште је дат Институту за генетичке ресурсе на коришћење. Садржаји Ботаничке баште подијељени су у три засебне цјелине. На једној цјелини започело је постављање ботаничких збирки генетичких ресурса. Подигнута је колекција аутохтоних воћака на којима је започета прелиминарна карактеризација, а пројектоване су *ex-situ* колекције поврћа; љековитих, ароматичних и зачинских биљака; ратарских, индустријских и самониклих јестивих биљака. У средњој цјелини пројектовано је језеро и започето је успостављање арборетумске збирке којој су заступљене аутохтоне дрвенасте врсте. У трећој цјелини пројектовани су стакленици и изграђен објекат у коме су смјештени банка гена и лабораторије. Ботаничка башта Универзитета у Бањој Луци, као мјесто за *ex-situ* конзервацију биљака има изузетни значај за очување биодиверзитета као и за научно-истраживачки рад у тој области.

Кључне ријечи: ex-situ конзервација, генетички ресурси, колекција воћака, арборетум.

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Studying the Content of Starch Correlated With Resistance to Low Winter Temperatures in Some Grapevine Varieties

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Abstract

Cryoprotectants are known as substances that are used for protection of biological tissue from freezing damage. Among the most important cryoprotectants are carbohydrates such as glucose, fructose, sucrose raffinose, starch. Starch is a carbohydrate commonly found in the plant tissue, and its concentration is in close relationship with other carbohydrates. This study is about determination of the starch concentration in four *Vitis vinifera* varieties: Vranec and Smederevka (subconvarietas balcanica Negr.) and Cabernet sauvignon and Chardonnay (subconvarietas gallica Negr.). The concentration of starch in vines is related to their point of cold hardiness. The study shows that the concentration of starch in balcanica varieties is lower than in gallica varieties. Therefore, the Vranec and Smederevka grapevine varieties are not resistant to low temperatures against varieties Cabernet sauvignon and Chardonnay which are tolerant.

Key words: Vitis vinifera, cryoprotectants, starch, low winter temperatures.

Introduction

Starch and soluble sugars (sucrose, glucose, fructose and myo-inositol) are the two main forms in which grapevine stores carbohydrate reserves (Mc Artney 1998). It is shown that the concentrations of starch and soluble sugar in all parts of the grapevine vary measurably over the growing season depending on vine phenology. According to Winkler and Williams, starch reserves are at their highest point in all aerial parts of the vine (canes, cordons, trunk and roots) at the end of the growing season. In the dormant season, starch concentrations start to decrease while the concentrations of soluble sugars start to increase (Winkler and Williams 1945, Williams 1996). These changes are related to the development of winter hardiness, where the increase of the

concentrations of soluble sugar from starch conversion acts as cryoprotectant against cold hardiness injury (Hamman et al. 1996). The conversion of carbohydrate reserves (starch) in the spring period is caused by the enzymatic transformation of starch into soluble sugars which can be observed by xylem fluxes of sucrose, glucose and fructose, with glucose as dominant (McArtney 1998).

An important factor in the increasing hardiness may be the sugar accumulation. Jennings and Carmichael's study from 1975 showed us that the concentration of sugar is not related to the changes in dormancy status but to the weather changes.

Sugar accumulation in acclimating plants can have many functions. Carbohydrates are known to lower the freezing point and to increase the osmotic potential. This kind of changes could reduce the amount of dehydration during extra-cellular freezing and save the cell from damage (Levit, 1980).

The agro-technical procedure is another important factor that impacts the concentration of carbohydrates in the dormant period. From the Winkler and Williams' study we can see that the defoliation and irrigation are of great importance for the cold hardiness of the vines.

Materials and methods

*Plant material***.** Four types of vine were analysed, two low resistant (Vranec and Smederevka) and two high resistant (Cabernet sauvignon and Chardonnay) grape varieties. Grapevines canes for the analysis were taken from the Macedonian national collection of grapevine trees. The experiment was made in 3 months period, from December 2011 to February 2012. The samples were taken 2 to 3 days after the lowest temperature has been broadcast, following the weather forecast of National Hydrometeorological service (location Zajcev rid).

The agro-technical procedures in the vineyard were standard. There was no irrigation during the vegetation period and there was no fertilisation in the vineyard.

The samples (vine canes) taken from the vineyard were cut in smaller pieces 5cm long, placed in vegeglas containers and dried in an oven for 24 hours at 105 ºC ±2 ºC. The dried canes were ground into fine powder with an electric mill.

For the starch analysis, 0.1g of ground tissue was extracted with 10ml of 80% ethanol at 80 ºC for 10 min. The samples were centrifuged at 2500rpm x 5min and the supernatant was thrown out. The plant material was reflux to evaporate the residual ethanol. 10 ml 0.1N NaOH was added to the material and extracted in water bath for 45min at 90 ºC. The samples were cooled down to 20ºC and neutralised with 0.1N HCl. The neutralised sample was transferred into 50ml volumetric flask. 1 ml 0.1 M iodine solution and 1ml of H_2O_2 were added and filled up to the mark with d. H_2O. After shaking them thoroughly the solution in the test tubes was allowed to stand for an hour for the starch iodide complex to be developed. The blank solution contains everything except the analysed sample. The developed starch iodide complex was spectrophotometrically read at 580nm. Starch purchased from Merch was used as the

standard for the construction of a calibration curve (R=0.9992) and the concentrations are expressed as starch equivalents (mg/g).

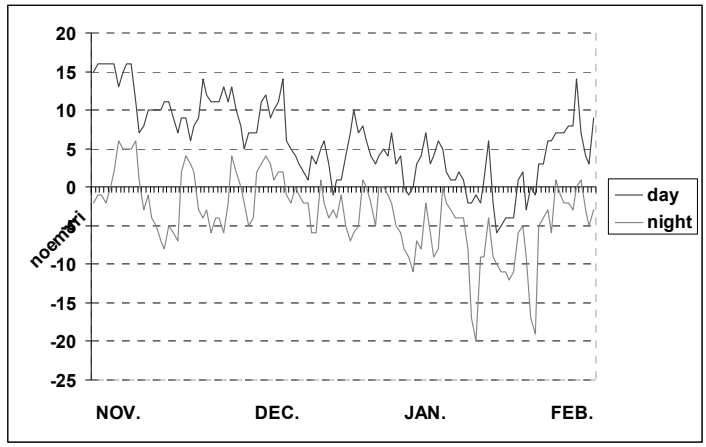


Fig.1. Day and night temperatures in the period of 5 months during winter 2011-2012.
Dnevne i noćne temperature u petomjesečnom periodu tokom zime 2011-2012. godine

Results and discussion

The resistance of the vine is closely related to the quantity of starch in the plant. During the dormant season, the concentration of starch varied among the different types of vine. After analysing the 4 varieties of Vitis vinifera (2 gallica and 2 balcanica varieties), the results that have been obtained in the period of 3 months are presented in Table 1. All the samples were analysed in triplicates.

Tab. 1. Starch dynamic in the canes of different grapevines (measured in %/DW)
Dinamika skroba u lastaru različitih sorti vinove loze (mjereno u %/DW)

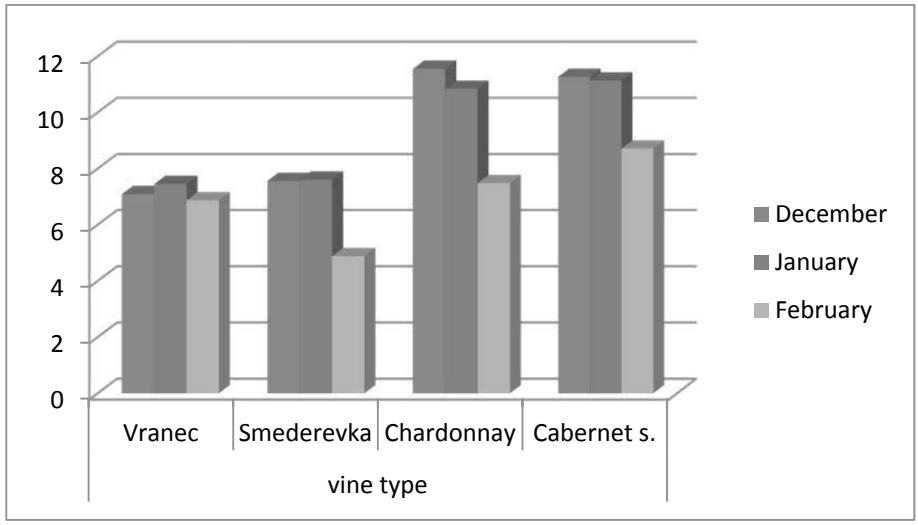
Month	Varieties			
	Vranec	Smederevka	Chardonnay	Cabernet sauvignon
December	7,09	7,56	11,55	11,27
January	7,45	7,60	10,84	11,13
February	6,87	4,88	7,48	8,71

The results shown in Table 1. are measured in percent for dry weight of the vine cane material.

Data from the analysis showed that the highest concentration of starch during the winter period is in December at the beginning of the dormant season. In this period, the concentration of starch in the high resistant types was between 11.27 – 11.55 % DW. On the other hand, the concentration of starch in the low resistant types was between 7.09-7.56 % DW. After the winter period, along with the temperature fall, the

concentration of starch decreased. In the period from January to February, they reached their minimum point. The concentration of starch in January was from 7.4 - 7.6% DW for the low resistant types and for the high resistant types from 10.8 - 11.2% DW. The lowest results were in February where the concentration of starch was from 4.8 - 6.8% DW for Vranec and Smedervka and for Chardonnay and Cabernet s. from 7.4 - 8.7% DW.

All these results about the starch dynamic are shown in Graph 1.



Graph. 1. Starch dynamic between different vine canes during the dormant season
Dinamika skroba u lastaru različitih sorti vinove loze tokom sezone mirovanja

Conclusion

We can conclude from this study that the concentration of starch is associated with the weather changes. The correlation between the temperature and starch value from December to February showed that the highest contents of starch were obtained during the highest temperatures and the lowest when the temperatures were at their minimum. The grapevine varieties resistant to low winter temperatures (Cabernet sauvignon and Chardonnay) accumulated more starch than the susceptible grapevine varieties (Vranec and Smederevka).

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Ispitivanje sadržaja skroba u vezi sa otpornošću na niske zimske temperature kod nekih sorti vinove loze

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Sažetak

Krioprotektanti su poznati kao tvari koje štite biološko tkivo od oštećenja nastalog smrzavanjem. U najvažnije krioprotektante ubrajaju se ugljeni hidrati kao što su glukoza, fruktoza, sukroza, rafinoza, skrob, itd. Skrob je ugljeni hidrat koji je tipičan za biljno tkivo, a njegova koncentracija je usko vezana za druge ugljene hidrate. Ovo istraživanje se bavi određivanjem koncentracije skroba u četiri sorte *Vitis vinifera*: Vranec i Smederevka (*subconvarietas balcanica* Negr.) kao i Cabernet sauvignon i Chardonnay (*subconvarietas gallica* Negr.). Koncentracija skroba u vinovoj lozi je vezana za njenu tačku otpornosti na niske temperature. Istraživanje pokazuje da je koncentracija skroba u sortama *balcanica* niža od *gallica* sorti. Stoga sorte Vranec i Smederevka nisu otporne na niske temperature nasuprot sortama Cabernet sauvignon i Chardonnay koje su otporne.

Ključne riječi: Vitis vinifera, krioprotektanti, skrob, niske zimske temperature.

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Naučna rasprava
Scientific discussion
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Život je svojstvo materije

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Biologija je danas izgubila mnoge svoje iluzije.
Ona više ne traži istinu. Ona stvara svoju istinu.
*(*Fransoa Žakob*)*

Sažetak

Život je svojstvo materije, kao i kretanje ili energija. Različita ili pojedina svojstva materije prožimaju se međusobno čineći sveopštu stvarnost u dinamički interakcijskom odnosu. Sveopšta egzistencija materije tako se nalazi između dva dijametralno suprotna stanja: od sažimanja i elementarne raspršenosti do potpuno kontrolisane i održive organizovanosti različitih asocijacija molekula, samoreprodukcije organizovanih struktura molekula, bioloških sistema i uspostavljanja intelekta. Svojstvo života tako nose sve čestice materije povezane u molekule bez obzira da li su inkorporirane u strukturnoj i funkcionalnoj organizaciji živih bića ili su trenutno u strukturno i funkcionalno indiferentnom životnom stanju. Uključivanjem bilo kojih čestica materije u metabolički proces aktivira se njihovo životno svojstvo, a oslobađanjem iz metabolizma ili gašenjem metaboličkih procesa (biološka ili metabolička smrt) čestice materije prelaze u životno indiferentno stanje. Dakle, materija bez obzira na formu i oblik egzistencije u sebi nosi svojstvo života, odakle i proizilazi zaključak da se materija ne može deliti na dve fundamentalno različite forme ili dva fundamentalno različita svojstva, živo i neživo.

Ključne reči: molekuli, polarnost, molekularni kod, evolucija.

Uvod

Definicija biologije uglavnom govori da je to kompleks nauka o životu, odnosno, da biologiju predstavljaju prirodne nauke o životu. Da, ali se pritom ne daje i definicija života, ili se samo usput konstatuje kako život predstavlja najvišu formu kretanja materije i da je priroda života još nedovoljno poznata da bi se mogla dati jedna njegova zadovoljavajuća i nesporna definicija. Čak se konstatuje i kako život nije naučni

termin? Zaista, da li je moguće da i danas biologija istražuje život iako pouzdano ne zna šta je to?

Kada je Robert Remak 1855. godine otkrio da ćelije nastaju isključivo deobom ćelija[15], ni u snu nije mogao pomisliti da je dirnuo u najneuralgičniju tačku odnosa nauke, filozofije i duhovnosti. Ništa manje nije bilo potresno ni otkriće Fridriha Mišera[16] 1869. godine, koji je dokazao prisustvo P_2O_5 molekula u svim jedrima ćelija, a potom je i prvi iz jedara izolovao i indentifikovao nukleinsku kiselinu. Zatim je Teodor Boveri[17], 1888. godine, opisao hromozome u deobi jedra u ćelijama morskog ježa, a Volter Saton[18] 1904. godine otkrio da se jedinice nasleđa nalaze u hromozomima. Potom, 1922. godi-ne, Tomas Morgan[19] je dao prvu mapu hromozoma, a Osvald Ejveri[20] je 1944. godine dokazao da je DNK genetički materijal koji se nalazi u hromozomima. Sposobnost Ro-zalin Frenklin[21], biofizičara i rendgen-kristalografa, dovela je do prvih difrakcionih slika strukture molekula DNK, a što je u konačnom dovelo do otkrića dvostruke spirale kao osnovne strukture DNK molekula. Štaviše, Rozalin je lično rekla Votsonu i Kriku da kičma DNK molekule mora biti sa spoljašnje strane što je bilo od ključnog značaja za njihov uspeh u sklapanju modela strukturne građe molekula DNK, 1952. godine. Zatim su Francis Krik[22] i drugi istraživači, 1960. godine, ustanovili redosled baza u moleku-lama DNK koje formiraju genetički kod, a Valter Gering[23] sa saradnicima je 1983. go-dine identifikovao homeoboks gene. Time su stvoreni svi neophodni preduslovi, pa je od 1986. godine počeo projekat Hjuman Genom, što je do 2003. godine dovelo do kom-pletnog dešifrovanja više različitih genoma sa tačnošću 99,99 %. Može se reći i da je tako sa tačnošću 99,99% potvrđena i molekularna osnova biološkog života.

Navedena hronologija nema za cilj da pokaže redosled ni važnost pojedinačnih otkrića u razvoju citologije ili genetike, već da pokaže kako se pitanje biološkog određenja ili definisanja života, svo ovo vreme nametalo ali se i gubilo između nepreglednog broja identifikovanih molekula i njihovih transformacija u metaboličkim procesima i molekularnoj građi ćelija, pa je time i ostalo po strani ozbiljnijih rasprava među biolozima.

Hronologija otkrića u organskoj hemiji, biohemiji, biotehnologiji, fiziologiji i ostalim biološkim disciplinama koje se odnose na metabolizam (čitaj molekularne procese u živim organizmima) samo bi dodatno potvrdila značaj otvaranja pitanja biološke definicije života.

[15] *Celula omne celula.* Robert Remak (1815 – 1865).
[16] Johan Friedrich Miescher (1844 – 1895), Bazel, Schweizerland.
[17] Theodor Boverei (1862 – 1915), Universidad Wurzburg.
[18] Walter Sutton (1877 – 1916)
[19] Thomas Hunt Morgan (1866 – 1945)
[20] Oswald Theodore Avery (1877 – 1955)
[21] Rosalind Elise Franklin (1920 – 1958)
[22] Francis Harry Compton Crick (1916 – 2004)
[23] Walter Jakob Gehring, University Basel, Schweizerland.

Biološki život kao genetičko svojstvo materije

Konstatacija da je život oblik postojanja živih bića, koja se može naći u većini udžbenika biologije, u osnovi je besmislena jer implicitno postavlja pitanje koji to oblik postojanja živih bića može biti izvan samog života? Druge konstatacije koje život definišu kao najvišu formu kretanja materije, najsloženiju i najznačajniju pojavu prirode itd., u osnovi predstavljaju samo konstatacije radi konstatacija. Definicija života koju je usvojila NASA[24], a koja kaže da je život samoodrživ hemijski sistem koji je u stanju da prolazi darvinističku evoluciju, u svakom slučaju predstavlja značajan iskorak, ali je ne dotiče srž biološke istine. Takođe, kada se figurativno kaže kako su ćelije kese pune molekula, a pod kesama se misli na membrane, ćelijske opne itd., onda se ovom konstatacijom podržava sugestija da molekulima u građi ćelije upravlja nešto, a to nešto, kao nešto neodređeno, implicitno i snažno sugeriše vezu sa Bogom i stoji na stanovištu podele materije na živu i neživu.

Dokazanom naučnom spoznajom da ćelije nastaju samo iz ćelija i da ćelije funkcionišu tako što ceo proces njihovog nastajana i razvoja kontroliše DNK, otvara se osnovno pitanje, pitanje odnosa biološkog života i molekula od kojih je on izgrađen, kao i molekula uopšte? Ovo pitanje ne traži posebnu naučnu obradu, pre svega zato što je takođe naučno dokazano da DNK predstavlja skupinu posebno organizovanih molekula. Znamo da DNK kontroliše sintezu proteina, znamo da to rade ribozomi po uputstvima iz DNK, u potpunosti smo ovladali pouzdanom sintezom veštački definisanih frakcija DNK i veštački sintetisanih ribozoma koji normalno funkcionišu i po tako dobijenom kodu sintetizuju proteine[25]. Takođe, potpuno su nam poznati gotovo svi metabolički procesi i transformacije molekula u anaboličkim i kataboličkim reakcijama. I? Konačno, više ništa ne stoji na putu prihvatanju činjenice da sve biološke forme života, pa time i sam biološki život, predstavljaju asocijacije molekula koje su organizovane i kontrolisane precizno određenim biološkim kodom koji takođe predstavlja posebno organizovanu asocijaciju molekula.

Ovde je sada neophodno da se razmotri pitanje koje je postavio Fransoa Žakob (1970): "Da li su molekuli živi"? Analize odnosa hemijskih zakonitosti u organizaciji materije i pitanja tih zakonitosti u živim sistemima, odnosno, šta se u biologiji manifestuje na hemijskom nivou a šta na biološkom nivou, u osnovi imaju pogrešan pristup jer se temelje na razdvajanju jedinstvenog procesa, a to je biološki život kao svojstvo materije.

Osnovna greška u raspravama o biološkom životu jeste u tome da se traži rešenje nastanka biološkog života iz nežive materije. Rasprave o tome, kao i podela materije na živu i neživu, praktično postaje bespredmetna jer je život svojstvo materije.

Podela materije na živo i neživo, a koja se odnosi na trenutnu asocijaciju molekula u datom prostoru i vremenu, pitanje je uslovne percepcije ali ne i pitanje svojstva materije. Ako je biološki život svojstvo materije, a forme života predstavljaju određenim molekularnim kodom organizovane asocijacije molekula, onda podela na živu i neživu materiju zaista nema smisla. Biološki život je potencijalno sadržan u svakoj čestici materije i samo je pitanje da li će ista biti životno aktivirana ili ne. Široko rasprostranjeno mišljenje da je život nastao iz nežive materije, u svojoj raspravi Addy Pross (2012) uzima kao tačno ili unutar jednog konceptualnog okvira kao ostvariv cilj. Iako ove konstatacije već jasno govore da je biološki život svojstvo materije, on se od ove spoznaje udaljava eksplicitnim stavom da su živo i neživo dve fundamentalno različite

[24] *Citira:* Addy Pross (2011).
[25] George M. Church, Prof. Health Sciences and Technology. Harvard University.

forme materije, što je pogrešno, jer se podela na živu i neživu materiju odnosi samo na organizacionu formu asocijacije molekula. Naime, biološki žive forme materije predstavljaju molekularnim kodom organizovane asocijacije molekula, a "nežive" forme materije ustvari predstavljaju biološki inertne asocijacije molekula. I u jednoj i drugoj skupini molekula važe isti fizičko-hemijski zakoni uspostavljanja i održavanja ovih asocijacija molekula. Već je istaknuto kako je hemijsko poreklo bioloških sistema i njihove građe, organizacije i funkcije u potpunosti dokazano. Biološki živi sistemi su građeni od poznatih hemijskih elemenata i njihovih strukturnih organizacija u molekule. Danas, praktično ne postoji ništa u samoj građi biološki živih sistema što nije poznato, od elementarnog sastava do molekularne organizacije i neposredne građe i funkcije. Nama još uvek nije poznato kako asocijacije molekula proizvode intelekt i koji je konačni cilj samoorganizovanja materije, odnosno, konačni cilj evolucije bioloških sistema, ali fundamentalna pitanja za definisanje osnove biološkog života, sva su tu pred nama. Pitanje inicijalne ogranizacije molekula u prve forme biološkog života na Zemlji sigurno je konkretno pitanje koje podrazumeva i poznavanje neposrednih uslova za inicijaciju i pojavu. Ako prihvatimo činjenicu da je život svojstvo materije, tada na pojavu konkretnih formi biološkog života na Zemlji možemo da gledamo nešto slobodnije. Naime, ako je život svojstvo materije, onda nije sporno da li su prve forme života inicirane neposredno na Zemlji ili su neke inicijalne komponente za aktiviranje života ili čak određeni prekurzori molekularnog koda života došli sa strane, odnosno, da su se očekivano našli tu u skladu sa stvaranjen konkretnih uslova za aktiviranje životnog svojstva materije na planeti Zemlji[26]. Nauka je dokazala molekularnu osnovu biološki živih formi i njihovu evoluciju koja je konkretizovana u kodu života – DNK. Ni jedna forma biološkog života nije nam poznata koja se razvija bez određenog molekularnog koda koji sadrži u sebi i na osnovu koga funkcioniše. Sasvim sigurno možemo reći da je prvi uslov za organizovanje materije u biološke životne forme, postojanje molekularnog koda prema kome se ove forme razvijaju i održavaju u biološkom životu. Takođe, razjašnjena je i molekularna građa samog koda, što je dovelo do toga da možemo u laboratorijskim uslovima da sintetišemo molekule DNK, i to prema postojećim matricama ili prema vlastitom nahođenju.

I konačno sledi očekivano pitanje koje izaziva i brojne kontraverze. Kako je us-postavljen prvi molekularni k□d prve životne forme koja je mogla da se podvrgne pro-cesu evolucije, uopšte ili konkretno ovde na Zemlji. Pre razmatranja ovog pitanja treba da konstatujemo da u kosmosu materija egzistira u veoma različitim organizacionim i termodinamičkim stanjima. Ako je život svojstvo materije on će se uvek ispoljti tamo gde se za tako nešto jave uslovi (čitaj neophodno stanje čestica materije). Materijalni - biološki kod (DNK) neosporno je molekularna struktura koja omogućava i kontroliše evoluciju života na Zemlji. Otvoreno je pitanje, kako dolazi do inicijalnog aktiviranja životnog svojstva materije u datom prostoru i vremenu, odnosno, kako se uspostavljaju inicijalne biološke forme života sa definisanim molekularnim kodom koji omogućuje njen opstanak i širenje u datom prostoru i vremenu. Odgovor na ovo pitanje trenutno ne postoji. Međutim, moguće je izvesti uopštavanje i zaključiti da je ovo pitanje i krajnji cilj evolucije. Naime, postojeće biološke forme života funkcionišu na osnovu DNK koda, i evolucija ovih bioloških formi života dovela je do nastanka intelekta, i to je nesporna činjenica. Konačna spoznaja načina organizacije molekula u takvu asocijaciju koja pre-dstavlja inicijalnu biološku jedinicu života sposobnu da se razmnožava i pokrene pro-ces evolucije u datim uslovima istovremeno će predstavljati

[26] Panspermija.

potpunu biološku istinu života. Ova istina ni na koji način neće dovesti u pitanje činjenicu da je biološki život svojstvo materije, jer se potpuna biološka istina upravo temelji na tom svojstvu.

Biološki život kao svojstvo molekula

Sasvim je nesporno da organizovani molekuli čine život. Konstatacija da su i kristali organizovani molekuli i da time ne čine biološki život, nije argument kojim se osporava životno svojstvo materije. Materija se organizuje u asocijacije molekula saglasno svom elementarnom i termodinamičkom stanju i sve postojeće ili moguće molekule i asocijacije molekula rezultanta su prevazilaženja elementarne neravnoteže i polarnosti molekula, odnosno, rezultanta su uspostavljanja stanja održive uravnoteženosti u datom prostoru i vremenu. Tako se metabolički procesi mogu opisati kao permanentno održavanje strukture – asocijacije molekula koje kontroliše DNK. Dakle, nesporno je da biološki život čine na odgovarajući način organizovani molekuli.

Ako znamo kako su molekuli organizovani u izgradnji bioloških sistema, a zna-mo da organizaciju molekula u ćeliji kontroliše DNK, jasno je da sledi pitanje da li su molekuli živi, i u konačnom šta je molekularno određenje života?

Pitanje organizacije molekula u formu biološkog života, prvo treba razmotriti pi-tanjem: Šta to organizuje atome u molekule? Odgovor na ovo pitanje već odavno je po-znat i dokazan u svim oblastima hemije. Atome u molekule organizuje elektrostatička nestabilnost između jezgra i spoljneg elektronskog sloja u datom vremenu i prostoru. Naime, svi atomi koji grade molekule[27] nalaze se u neravnoteži između svog spoljnjog elektronskog omotača i jezgre, i ovu neravnotežu nastoje umanjiti, odnosno, nastoje se stabilizovati pravljenjem kompromisnih asocijacija koje ustvari predstavljaju molekule. Dakle molekuli su trenutne i u datom vremenu i prostoru[28] najracionalnije moguće us-postavljene asocijacije atoma koje omogućavaju njihovu prosečnu međusobnu uravno-teženost. Međusobno pozicioniranje atoma u molekulima određuje energija međusobne stabilizacije atoma, čime je određena i struktura molekula, molekulska masa (uslov-ljena brojem i vrstom atoma) i polarnost, a time i sama održivost tako uspostavljenih asocijacija atoma, odnosno, molekula. Tako molekulu vode koji je ključni molekul života, možemo opisati kao elektrostatički stabilizovan atom kiseonika na čijoj površini plutaju dva protona[29]. Tajna ove molekule nije isključivo u polarnosti, iako je polarnost molekula faktor stabilizacije struktura višeg reda, osnovna funkcija molekule vode ba-zira se upravo na dva protona na površini potpuno stabilnog atoma kiseonika. Tako se uloga H_2O kao elementarne osnove održivosti molekularne strukture života vidi u nje-noj elementarnoj polarnosti ali i koordinatnoj uravnoteženosti u asocijacijama. Dakle, fa-ktor kontrole asocijacija

[27] Inertni atomi ne grade molekule jer imaju stabilnu konfiguraciju spoljnjeg elektronskog sloja. Naravno, kada se ova stabilnost bilo na koji način naruši ili dovede u pitanje, molekuli su i za ove atome kompromisno rešenje stabilizacije.

[28] Prostor i vreme su određeni termodinamičkim stanjem atoma (energetskim stanjem), gravitacijom (međusobnim privlačenjem, brzinom kretanja ili bilo šta drugo što ona predstavlja) i elektromagnetnim poljem, ma šta i ono predstavljalo.

[29] Elementarnu molekulsku polarnost čine protoni koje drže atomi sa stabilnom konfiguracijom svog spoljnog elektronskog sloja.

atoma i molekula je uspostavljanje ravnoteže i prevazilaženje polarnosti odnosno, uspostavljanje stanja održive uravnoteženosti u datom prostoru i vremenu.

Konačno, ako su kretanje i energija nesporna svojstva materije, ako su sva kretanja materije spiralna[30] i ako se energija može pretvarati iz jednog oblika u drugi, odnosno, ako je materija u permanentnoj strukturnoj i energetskoj neuravnoteženosti ili procesu kretanja ka uspostavljanju ravnoteže i prevazilaženju polarnosti, te ako su molekuli asocijacije atoma za uspostavljanje trenutne uravnoteženosti i prevazilaženje polarnosti u datom prostoru i vremenu (koji su opet determinisani strukturnom organizacijom i energetskim stanjem materije) i ako su biološki sistemi tvorevine tih istih atoma i molekula, sasvim je logično zaključiti da je život svojstvo materije koji će se uvek uspostaviti i razvijati tamo gde se za to budu stekli odgovarajući uslovi u datom prostoru i vremenu.

Da li su molekuli živi ili ne više je retoričko pitanje, a činjenica da molekuli u asocijacijama grade žive biološke sisteme sigurno nije dokaz da su molekuli živi, isto kao što egzistiranje jednih te istih molekula izvan bioloških sistema nije dokaz da su oni neorganski ili neživi. Međutim, imajući u vidu činjenicu da svi biološki sistemi nesporno predstavljaju asocijacije molekula čiji metablizam i evoluciju takođe kontroliše asocijacija molekula prepoznata kao kod života (DNK), kao i činjenicu da isti atomi i molekuli egzistiraju i u biološkim sistemima i izvan njih, i da se njihovi međusobni odnosi i interakcije zasnivaju na istim zakonitostima bez obzira u kojim asocijacijama egzistiraju, nesporni je dokaz da je život opšte svojstvo materije koje nose sve njene čestice.

Zaključna razmatranja

Ako znamo da sav život na Zemlji predstavlja određena asocijacija molekula organizovana prema kodu zapisanom opet u posebnoj asocijaciji molekula nazvanoj DNK, i ako znamo da sav biološki život na zemlji vodi poreklo od jedne izvorne forme DNK, zar to nije dovoljno da zaključimo kako je život elementarno svojstvo materije. Biološko svojstvo života nose sve čestice materije pa i sve molekule trenutno inkorporirane u strukturnoj organizaciji živih bića kao i one nove molekule koje će nastati sa novim asocijacijama atoma ili one molekule koje već postoje formirane i čekaju da budu neposredno uključene u datu organizaciju biološkog života.

Dakle, život je svojstvo materije, a biološke forme života su organizovane asoci-jacije molekula čija je organizacija regulisana opet molekularnim kodom u cilju održivo-sti samog koda u datom prostoru i vremenu, i njegovim razvojem do postizanja nivoa inteligentnih životnih formi. Nije potrebna naročita studioznost da bi se izveo zaklju-čak kako su inteligentne životne forme DNK koda jedan od ciljeva evolucije, te da na taj način biološki kod omogućuje sopstveno formulisanje na nivou onih životnih formi sa kojima može da se širi i održava kroz prostor i vreme. Ovakav zaključak nužno nam nameće sama biologija. Jednostavno, biološki život u formi organizovane asocijacije mo-lekula, kretanje materije i sve druge fizičko hemijske zakonitosti postojanja i održivosti materije moraju se objediniti u jedan opšti zakon prirode ili egzistencije materije.

[30] Kružno kretanje imaju objekti čija je osa rotacije statična, a ako se objekat u rotaciji i sam kreće stacionarne tačke u odnosu na osu rotirajućeg objekta u stvari se kreću spiralno.

Biološki kod života uobličen u DNK molekulama ne mora biti sveopšta moleku-larna forma koda života u Kosmosu. Različiti odnosi prostor – vreme – energija mogu uobličavati i različite kodove, različite strukture molekula, ali obrazac će uvek biti isti: molekularni kod → asocijacije molekula kao životna forma → evolucija (razvoj koda i životnih formi do intelekta) → samospoznaja na molekularnom nivou → novi moleku-larni kod biološkog života u datom prostoru i vremenu. Život kao svojstvo materije, tako se prepoznaje kao jedan od fundamentalnih oblika egzistencije materije kao asocijacije molekula organizovanih suprotno zakonima entropije, sposobnih da se organizuju i sa-moreprodukuju i tako pokrenu proces evolucije u datom prostoru i vremenu.

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Life is a property of matter

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Abstract

If it is known that the entirety of life on Earth is represented by the certain association of molecules organized in accordance to the code written in another separate association of the molecules named DNA, and knowing that all biological life on Earth originates from a single source form of DNA, is that not enough to conclude that life is elementary property of matter. Biological property of life is a feature born by all particles of matter, and also all molecules currently incorporated within the structural organization of living beings, as well as those new molecules which are going to be created with the new associations of atoms, or those molecules already formed and waiting to be directly included in the given organization of the biological life. Therefore, life is a property of matter, and biological forms of life are organized associations of molecules which organization is regulated with again another molecular code with goal of preservation of the code itself in the given time and space, and its development until achieving the level of intelligent life forms. There is no need to be especially studious in order to reach the conclusion that intelligent life forms of DNA code are one of the goals of evolution, so in that way the biological code enables its own formulation on the level of those life forms where it can thrive and spread through space and time. This conclusion is imposed by the biology itself. Simply, the biological life in form of organized association of molecules, movement of matter and all other physical and chemical laws of existence and preservation of matter have to be united into one general law of nature or existence of matter. Biological code of life shaped with the DNA molecules does not have to be the general molecular form of the code of life in the Universe. Different relations of time – space – energy can shape different codes, different structures of the molecules, but the pattern will always be the same: molecular code → associations of molecules as the living form → evolution (development of the living forms until the intellect) → self-cognizance in the molecular level → new molecular code of the biological life in the given time and space. Life as the property of matter is so recognized as one of the fundamental shapes of existence of matter as association of molecules organized contrary to the laws of entropy, capable to organize and self-reproduce and in that way to initiate process of evolution in a given space and time.

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Упутство ауторима

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

Категоризација радова

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

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

*Оригинални нучни рад*садржи необјављене научне резултате изворних научних истраживања.

*Претходно саопштење*садржи нове научне резултате које треба претходно објавити.

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

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

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

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

Припрема часописа за штампу

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

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

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

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

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

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

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

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

Кључне ријечи пажљиво одабрати јер оне сагледавају усмјереност рада.

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

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

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

Сви радови добијају УДК класификациони број и DOI (дигитални идентификатор објекта).

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

Рукописи радова и дискете се не враћају.