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EFFECT OF DIFFERENT FERTILIZATION REGIMES ON THE WEED COMMUNITY IN SWISS CHARD

SUMMARY

Weed community of Swiss chard was studied in plots with different fertilization regimes. Fertilization doses correspond to 50% (F50), 100% (F100) and 150% (F150) nutrient demand of Swiss chard. Sinousia consists of 29 species, out of 26 genera and 17 families, among which dominant are: *Sorghum halepense*, *Solanum nigrum*, *Kickxia spuria*, and *Atriplex patula*. The analysis of the biological spectrum indicates the dominance of therophytes with 75.8%, while hemicryptophytes contribute the spectrum with 17.2%. Considering the effect of fertilizers on the crop growth and weediness, general conclusion is that fertilizers benefit both the crop and weeds, but increased doses of fertilizers had better effect on the crop yield than on weediness. The average crop yield was highest in the regime F150, as well as total weediness F150. However, analysing the species abundance, cover per single plot and crop yield in each regime of fertilization, some deviations are noticed. Such as, in the plots No 10 (belongs to F100) and No 17 (belongs to F150) the total weed cover was 10%. In eight plots which belongs to F50 the weed cover exceeded this value.

Keywords: weed community, fertilization, Swiss chard

INTRODUCTION

Fertilisation is considered as one of the powerful tools in managing weeds (Liebman and Mohler, 2001), with precondition of exact choise of time and way of application of the fertilizers (Blackshaw et. al., 2004). In general, process of fertilization increases total biomas production in filed, but not exclusively crop production. Some studies shown that weeds might be more effective than crops in capturing nutrients added as fertilizers (Santos et al., 1998; Blackshaw et al., 2003), while in others crops are more effective (Dusky et al., 1996; Dhima and Eleftherohorinos, 2001).

Alhtough in Mediterraena cuisine Swiss chard is frequently used, in the global market it is treated as one of the neglected vegetable species, which production area is not commercially important (Pokluda and Kuben, 2002). Similar situation is present in Montenegro. The crop is grown only in Zetsko-

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Bjelopavlićka plain on rather small areas and mostly distributed in the southern part of the country, where the tradition in its consumption still exists (Knežević et al., unpublished data).Taking into account its good nutritional values (Santamaria et al., 1999a, 1999b) and medicinal properties – the extract of this plant when administered by gavage may reduce blood glucose levels by regeneration of the B cells (Bolkenta et al., 2000), its production might increase in the future. Up to know research on Swiss chardwere focused on morphological characteristics, yield, content of mineral elements and nutritional quality (Malý et al., 1998; Santamaria et al., 1999a, 1999b; Pokluda and Kuben, 2002; Smith et al., 2001; Miceli and Miceli, 2001), salt tolerance (Shannon et al., 2000), while weed research were rather neglected. The aim of this research is to determine the dynamics of weed infestation in Swiss chard cultivated in crop rotation with different levels of mineral fertilizing.

MATERIAL AND METHODS

The Swiss chard was grown in the field of Green House Jovović company, in Bjelopavlićka Plain, site Sige (42.553191° N latitude and 19.149113° E longitude). The soil is intesively used for vegetable production, has high content of total carbonate and alkaline reaction (Knežević et al, 2014). The results of soil analysis (samples taken before fertilization) are shown in Table 1.

An experiment with randomized design was conducted in the period March-July 2014. The experimental field contained 28 plots - nine plots treated with three different level of fertilization (labelled as F50, F100 and F150) and one control plot without fertilization and irrigation (C). Plot area was 10.5 m^2. Fertilization doses corresponded to 50%, 100%, and 150% of commercial recomendations for Swiss chard, which were 100-120 kg/ha N, 80-120 kg/ha P_2O_5, and 100 kg/ha K_2O per season. Fertilization amounts of NPK fertilizer 11:11:21 were 200 kg/ha, 400 kg/ha, and 600 kg/ha. Additional nutrient fertilization, in amounts 35 kg/ha, 70 kg/ha, and 105 kg/ha for various treatments, was applied by watering with the same volume of appropriate solution twice during vegetation. The solution was prepared by dissolving of NPK 24:8:16 and NPK 15:30:15 in ratio 2:1. Irrigation amount of 60 mm of water was applied uniformly at all plots, excluding control plot, during the season.

The investigation of the weed community was carried out in the second half of May and early June 2014. Herbicides were not used in this period. In each plot all weed species, weed density (number of individuals per m^2), the cover of single weed species and total weed cover were recorded.The cover is estimated with original cover-abundance scale of Braun-Blanquet extended to a combined cover-abuncance scale by Barkman *et al*. (1964). Total weed cover is given in percents (%). Weed species were identified by Domac (1994). Life form classification is performed according to Raunkier, elaborated and updated by Ellenberg and Mueller-Dombois (1967) and, for our circumstances, modified by Stevanović (1992).

Table 1. Soil parameters (before fertilization)

Label of plot	pH (H_2O)	pH (KCl)	$CaCO_3$ (%)	Total N (%)	Humus (%)	Available P_2O_5 (mg/100 g)	Available K_2O (mg/100 g)	EC (µS/cm)
1F100	7.60	7.04	3.3	0.278	5.89	6.2	23.0	155.0
2F50	7.55	7.02	2.8	0.263	6.10	4.9	22.0	158.2
3F100	7.70	7.17	2.3	0.252	5.74	4.2	23.4	158.8
4F100	7.70	7.20	4.7	0.248	5.50	3.8	20.6	145.8
5F50	7.70	7.21	21.4	0.254	5.77	5.0	21.3	156.1
6F150	7.77	7.25	21.9	0.236	5.21	6.8	19.9	146.0
7F150	7.76	7.27	10.9	0.255	5.95	5.3	23.0	167.9
8F150	7.88	7.35	21.4	0.245	6.10	5.8	22.3	163.3
9F50	7.91	7.35	6.7	0.236	5.86	3.8	21.8	150.3
10F100	7.93	7.34	21.9	0.228	5.95	9.4	18.7	150.7
11F50	7.90	7.32	21.9	0.222	5.06	20.1	18.7	150.1
12F100	7.87	7.31	23.8	0.216	4.91	21.6	16.2	145.4
13F100	7.95	7.38	26.2	0.206	4.94	16.6	19.2	155.4
14C	7.94	7.40	26.2	0.216	4.73	7.6	20.4	153.4
15F50	7.79	7.20	3.8	0.280	6.25	7.9	32.7	158.8
16F150	7.77	7.23	2.8	0.291	6.19	11.6	32.7	157.4
17F150	7.77	7.27	3.3	0.284	6.01	12.5	30.4	152.4
18F150	7.75	7.28	4.7	0.285	5.92	11.2	30.4	158.2
19F50	7.93	7.35	6.7	0.284	5.53	10.3	32.7	166.3
20F100	7.97	7.38	11.9	0.271	5.39	8.0	23.0	157.6
21F50	7.91	7.37	19.0	0.263	5.06	5.3	22.0	161.6
22F100	7.90	7.41	30.9	0.237	5.15	6.1	20.6	149.5
23F100	7.78	7.21	38.1	0.208	4.85	8.3	19.2	154.6
24F50	7.80	7.22	38.5	0.237	4.79	9.4	17.3	148.2
25F150	7.91	7.35	39.0	0.229	3.50	13.8	16.9	149.1
26F150	7.88	7.35	35.7	0.224	2.60	18.8	17.6	154.6
27F150	8.00	7.46	32.4	0.227	2.93	12.7	18.7	158.6
28F50	8.00	7.48	33.3	0.227	3.05	8.2	18.5	153.7

The descriptive statistical analysis (minimum, maximum, mean and standard deviation) of the data was performed by SPSS.

RESULTS AND DISCUSSION

Floristic composition and taxonomic spectrum.

The structure and number of weed species found in the Swiss chard during investigation are shown in Tables 2, 3 and 4. Weed sinousia of Swiss chard in Montenegro consists of 29 species, out of 26 genera and 17 families. Families *Poaceae* and *Scrophulariaceae* are dominant and represented with 4 species each, *Fabaceae* with 3, *Asteraceae, Chenopodiaceae, Euphorbiaceae*, and *Geraniacaae* with 2 species each, while others have one representative each.

Such taxonomical spectrum differs from the one of the sinousia of other crops investigated in Montenegro: i) maize- *Poaceae* (4 species) *Polygonaceae* (3 species), *Brassicaceae, Chenopodiaceae,* and *Plantaginaceae* (2 species each), *Amaranthaceae, Caryophyllaceae, Convolvulaceae, Fabaceae, Lamiaceae, Scrophylariaceae* (1 species each) (Jovović, 1998); ii) potato- *Asteraceae* (8 species), *Lamiaceae* (5 species), *Fabaceae, Poaceae, Polygonaceae* (4 species each), *Scrophulariaceae* (3 species), *Brassicaceae, Caryophyllaceae, Chenopodiaceae, Euphorbiaceae* (2 species each), *Amaranthaceae, Apiaceae, Boraginacea, Convolvulaceae, Equisetaceae, Geraniaceae, Primulaceae, Rosaceae, Rubiaceae, Solanaceae, Violaceae* (1 species each) (Stešević and Jovović, 2005). Speaking in the term of dominant species in Swiss chard sinousia the most abundant were *Sorghum halepense, Solanum nigrum, Kickxia spuria* and *Atriplex patula,* while in maize crop *Chenopodium album, Amaranthus retroflexus* and *Polygonum aviculare* prevailed (Jovović 1998). In the potato crop dominant weeds were *Convolvulus arvensis, Anthemis arvensis* and *Sonchus arvensis* (Stešević and Jovović, 2005).

On the plots with treatmen F50 and F150 number of recorded species is 27, while tretment F100 has 26 species. Average number of species per treatment is: C – 15, F50 – 14.7, F100 – 14.1 and F150 – 15.1. The most abundant species in sinousia are *Sorghum halepense, Solanum nigrum, Kickxia spuria* and *Atriplex patula.* They comprised 67.3% of the total weediness. Ranking of dominant species (number of individuals per $m^{2)}$ differs between the treatments: in the C are *A. patula* (13,3/m^2) and *S. halepense* (10,5/m^2), in the F50 are *S. halepense* (12,8/m^2), *K. spuria* (4,1/m^2) and *S. nigrum* (2,6/m^2); in the F100 are *S. halepense* (12,9/m^2), *K. spuria* (3,8/m^2) and *A. patula* (3,4/m^2); and in the treatmen F150 are *S. halepense* (15,8/m^2), *S. nigrum* (6,9/m^2) and *A. patula* (2,9/m^2) (tab. 2, 3, 4). Although changes in the relative abundances of weeds caused differences in the community composition between plots without (C) and with different fertilizing regime (F50, F100 and F150), species composition was quite similar.

Additional remark considering floristic composition of sinousia is that up to this research *A. patula* and *K. spuria* were not consideres as troublesome agricultural weeds in Montenegro (Jovović, 1998; Stešević and Jovović, 2005; Caković *et al*., 2012).

Life forms.

The analysis of the total biological spectrum of the flora indicates the dominance of therophytes with 75.8%, the most dominant of which were T scap terophytes (51.7%). Hemicryptophytes contribute 17.2% to the biological spectrum, and geophytes (rhizomatous) 7%. The spectrum of life forms fits into the general biological spectrum of the flora of Bjelopavlići plain (Caković *et al.*, 2012). Considering the geographical position of this area and the environmental conditions that are under specific Mediterranean influence, and also bearing in mind that the use of cropping practices works in favour of the dominance of annual life forms (Armesto and Vidella, 1993), the predominance of therophytes in the biological spectrum is expected.

In the biological spectrum of vegetation participation of life forms is a bit different: annuals are dominant life form with 56,7 %. They are followed by geophytes with 41,8 % while hemicriptophytes participate the spectrum with 1,5 %. In the different treatments the biological spectrum of vegetation did not show significant variation

Weed density and weed cover.

Primary role of the nutrients is to promote crop growth, but very often it also benefit weeds (Di Tomaso, 1995). In our experiment the average crop yield was highest in the F150 (11.19±2.88SD kg/plot) > F100 (9.11±1.85SD kg/plot) > F50 (8.21±2.25SD kg/plot), as well as total weediness F150 (19.33%) > F100 (15.4%) > F50 (14.8%) > C (7%). Considering average weed density the decreasing order was a bit different F150 (41.3 ind/m^2) > C (36.9 ind/m^2) >F100 (33.7 ind/m^2) >F50 (32.3 ind/m^2). It is explained with the fact that number of individuals and the cover are not obligatory in positive correlation. Size of individuals recorded at the control plot was significantly smaller comparing to the fertilized ones, thus the cover value was lower. However, analysing the species abundance, cover per single plot and crop yield in each regime of fertilization, some deviations are noticed (tab. 2, 3, 4), such as, in the plots No 10 (belongs to F100) and No 17 (belongs to F150) the total weed cover was 10%. In eight plots which belongs to F50 the weed cover exceeded this value. Or the yield in plot 6 (belongs to F150) was rather low (6.95 kg). Due to the fact that such deviations is not possible to explain with biotic factors, such as competition between weed and crop, the answer migh be hidden in soil properties. Thus the future research should also include detailed soil analysis per each plot.

Nevertheless, when speaking about the weedeness degree of dominant species, following remarks are given. In the case of *Sorghum halepense,* it is shown that fertilizers increases the crop weediness, from 10.48 ind/m^2 in the control, to 23.52 ind/m^2 the treatment F50, to 121.72 ind/m^2 was in the treatment 100 and 149.11 ind/m^2 in the treatment F150 (tab. 2, 3, 4). Study of Dražić and Konstantinović (1996) showed the same regularlity, when nitrogen fertilizers are applied. Some other weeds from the sinousia like *Amaranthus retroflexus, Portulaca oleracea, Polygonum aviculare, Setaria viridis* etc. reacted the same way. This is also pointed out by Efthimiadoua *et al*. (2012) and Papastylianou *et al*. (2014). Opposite to this case, fertilizers can reduce crop weediness. Such case is reported for *K. spuria* (Salat *et al*. 2014). In our study treatment F50 caused rapid increase of weeding degree (from 2.10 ind/m^2 in control to 37.40 ind/m^2), while treatments F100 and F150 had opposite effects. The weedeness decreased from 35.74 ind/m^2 in F100 to 19.14 ind/m^2 in F150. It could be explained with the fact that F150 plots has bigger cover of aboveground part of the Swiss chard and taller weeds as *S. nigrum* and *A. patula*, thus the light conditions are infavorable for development of *Kickxia spuria.* Study of Lo Bianco (2007) and Puhui *et al*. (2011) pointed that fertilizing had no significant effect on plant biomass of either *A. patula* or *S. nigrum*. Our study did not show any clear pattern. In the case of *S. nigrum*, not even one induvidual was recorded on the control variant, while on F50 weeding degree was 23.53 ind/m^2, on the F100 it was 4.38 ind/m^2 and on the F150 it was 65.63 ind/m^2. Weedeng degree of *A. patula* increased from 13.3 ind/m^2 in C to 18.10 ind/m^2 in F50 to 32.09 ind/m^2 in F100 and than decreased on 26.19 ind/m^2 in F150.

Some studies shown that increase in the dose of fertilizer has positive effect on weed density, but negative on yield (Knežević *et al*., 2008). In our research increased doses of fertilizers had better effect on the crop yield than on weediness; this results inicated that swiss chard are better competitors for nutrients than are weed. As it is presented in table 4, the plots 16 and 17 had higher crop yield (16.05 kg and 15.05 kg, respectively) compared to other plots with the same regime of fertilization (F150), and in the same time lower weed cover (12% and 10%, respectively). Soil analyses conducted before the fertilization have shown that plots 16 and 17 has higer content of humus and nitrogen in comparison to other plots with the same regime of fertilization (Kneževic *et al.*, unpublished data). In such conditions, Swiss chard grows faster than weeds, thus it overcompetes them. Nevertheless, one plot in regime F150, the plot 6 had rather low yield of 6.95 kg, but this can not be explained with better weed competitivity, while the weed cover was only12%. However in this plot was recorded the lowest value of electical conductivity of soil, as a parameter of amount of salt in the soil, as well as relatively lower content of available macronutrients P and K. As it is concluded before, the answer migh be hidden in soil properties, thus the future research should also include more detailed soil analysis per each plot.

Table 2. Weed density and weed cover in the plots in the regim F50 (50%). n – average No of individuals per m^2. c – weed cover in the plot

Taxon Family Life form	Plot 2 n c	Plot 5 n c	Plot 9 n c	Plot 11 n c	Plot 15 n c	Plot 19 n c	Plot 21 n c	Plot 24 n c	Plot 28 n c	Total No of individuals in all F50 plots	Control n c	Total No of individuals in control
Anagalis arvensis Primulaceae v-a Mi-Mes T scap					0.29 +	0.19 +	0.38 +	0.67 1	0.57 1	22	2 1	20
Amaranthus retroflexus Amaranthaceae a-aut Mes-Alt T scap						0.29 +	0.48 +	1.33 1		22		0
Atriplex patula Chenopodiaceae aut Meg-Alt T scap	0.57 1	4.10 1	4.19 1	3.24 1	0.38 +	4.67 1	0.10 r	0.19 +	0.67 1	**190**	13.33 2a	**133**
Capsella bursa-pastoris Brassicaceae n-aut Mi-Meg T semiros		0.10 r	0.19 +		0.29 +	0.57 1	1.62 1	1.43 1	1.33 1	58	0.38 +	4
Chaenorrhinum minus Scrophulariaceae v-aut Mi-Mes T scap			0.10 r		0.10 +	0.10 r	0.10 r	0.10 r	0.19 +	7		0
Chenopodium album Chenopodiaceae a-aut Meg-Alt T scap						0.19 +	0.29 +			5		0
Convolvulus arvensis Convolvulaceae a SG herb rhiz		0.10 r	0.67 1	0.10 r	0.57 1	0.57 1	0.76 1	0.38 +	1.14 1	45	1.33 1	13
Cynodon dactylon Poaceae a-aut Mes-Mac H caesp						0.10 r		0.19 +		3		0
Euphorbia helioscopia Euphorbiaceae v Mi-Mes T scap	0.40 +		0.10 r			0.19 +		0.10 r		8	0.38 +	4
Euphorbia maculata Euphorbiaceae v-aut Mi-Mes T rept	0.30 +				3.81 1	0.86 1	0.48 +	0.29 +	0.38 +	64	0.48 +	5
Geranium columbinum Geraniaceae v-a Mes T semiros					0.10 r			0.29 +		4		0

Taxon Family Life form	Plot 2 n c	Plot 5 n c	Plot 9 n c	Plot 11 n c	Plot 15 n c	Plot 19 n c	Plot 21 n c	Plot 24 n c	Plot 28 n c	Total No of individuals in all F50 plots	Control n c	Total No of individuals in control
Geranium dissectum Geraniaceae v-a Mes T semiros	0.70 1	0.29 +	3.33 1	3.62 1		0.29 +			0.19 +	88	3.14 1	31
Kickxia spuria Scrophulariaceae a Mes-Meg T scap	0.45 +	7.62 2a	0.48 +	1.52 1	2.57 1	4.67 1	11.14 2a	7.43 2a	1.52 1	**392**	2.10 1	21
Lotus corniculatus Fabaceae v-aut Mes H scap										0.00	0.10 r	1
Mentha longifolia Lamiaceae a Mes-Meg H scap	1.48 1						1.05 1	1.52 1		42		0
Medicago lupulina Fabaceae v Mes-Mac T scap	0.48 +				0.29 +	0.57 1	0.19 +			16	0.19 +	2
Plantago lanceolata Plantaginaceae v-a Mi-Meg H ros						0.29 +		0.10 r		4		0
Poa anua Poaceae n-a Mi-Mes T caesp										0		0
Polygonum aviculare Polygonaceae a-aut Mi-Mes T rept	3.90 2a	1.05 1	0.48 +	1.14 1	2.19 1	0.95 1	1.14 1	1.24 1	2.38 1	152	0.76 1	8
Portulaca oleraceae Portulacaceae a Mes T scap					0.48 +				0.29 +	8		0
Trifolium repens Fabaceae v-aut Mi-Mes H rept					0.19 +		0.19 +	0.48 +		9		0
Senecio vulgaris Asteraceae n-v Mes-Meg T scap	0.57 +	0.57 1		0.10 r	0.10 r		0.10 r	0.19 +	1.14 1	29	0.19 +	2

Taxon Family Life form	Plot 2 n c	Plot 5 n c	Plot 9 n c	Plot 11 n c	Plot 15 n c	Plot 19 n c	Plot 21 n c	Plot 24 n c	Plot 28 n c	Total No of individuals in all F50 plots	Control n c	Total No of individuals in control
Setaria viridis Poaceae a-aut Mes-Mac T scap							0.29 +	0.29 +	0.29 +	9		0
Solanum nigrum Solanaceae a-aut Mes-Mac T scap					1.05 1	4.38 1	3.14 1	6.10 1	8.86 2a	**247**		0
Sonchus asper Asteraceae v-a Mes-Alt T scap					0.29 +	0.38 +	0.29 +	0.57 1		16		0
Sorghum halepense Poaceae a-aut Mes-Meg G rhiz	5.52 2m	7.62 2m	8.10 2m	6.67 2m	7.71 2m	19.52 2a	25.71 2a	19.33 2a	15.24 2a	**1212**	10.48 2a	**105**
Stellaria media Caryophyllaceae n-aut Mi-Meg T rept									0.10 r	1	0.19 +	2
Veronica arvensis Scrophulariaceae v-a Mi-Mes T scap					7.24 1	6.38 2m	2.19 1	2.10 1	0.48 +	193		0
Veronica persica Scrophulariaceae n-aut Mi-Mes T scap	2.67 1	0.67 +	1.90 1	2.38 1	2.86 1	1.33 1	2.10 1	2.57 1	3.33 1	208	1.90 1	19
Total No of individuals per m^2	17.04	22.09	19.5	18.7	30.7	46.47	51.7	46.85	38.1	∑ 3054	19.33	∑ 370
No taxa	11	9	10	8	18	19	20	21	17		15	
Weed cover (%)	12	12	12	10	17	17	20	17	17		7	
Swiss Chard yield (kg of aboveground part)	9.95	8.55	5.35	4.75	12.05	8.75	8.45	9.05	7.07		4.65	

Table 3. Weed density and weed cover in the plots in the regim F100 (100%). n – average No of individuals per m^2. c – weed cover in the plot

Taxon **Family** **Life form**	**Plot 1** **n** **c**	**Plot 3** **n** **c**	**Plot 4** **n** **c**	**Plot 10** **n** **c**	**Plot 12** **n** **c**	**Plot 13** **n** **c**	**Plot 20** **n** **c**	**Plot 22** **n** **c**	**Plot 23** **n** **c**	**Total No of individuals in all F100 plots**	**Control** n c	**Total No of individuals in control**
Anagalis arvensis Primulaceae v-a Mi-Mes T scap							0.29 +	0.67 1	0.67 +	16	2 1	20
Amaranthus retroflexus Amaranthaceae a-aut Mes-Alt T scap							5.71 2m			57		0
Atriplex patula Chenopodiaceae aut Meg-Alt T scap	1.84 1	1.20 1	2.10 1	1.14 1	7.24 2a	13.9 2a	3.52 1	0.48 +	0.67 +	**320**	13.33 2a	**133**
Capsella bursa-pastoris Brassicaceae n-aut Mi-Meg T semiros	0.40 +	0.30 +	0.32 +	0.30 +	0.29 +	0.38 1	0.57 1	2.67 1	3.24 1	84	0.38 +	4
Chaenorrhinum minus Scrophulariaceae v-aut Mi-Mes T scap						0.10 r	0.10 r	0.10 r		3		0
Chenopodium album Chenopodiaceae a-aut Meg-Alt T scap	0.30 +				0.57 1			0.19 +		10		0
Convolvulus arvensis Convolvulaceae a SG herb rhiz	1.70 1	1.24 1	0.57 1	0.19 +	0.67 1	1.43 1	0.57 1	0.76 1	0.76 1	78	1.33 1	13
Cynodon dactylon Poaceae a-aut Mes-Mac H caesp										0		0
Euphorbia helioscopia Euphorbiaceae v Mi-Mes T scap								0.38 +	0.19 +	5	0.38 +	4
Euphorbia maculata Euphorbiaceae v-aut Mi-Mes T rept						0.29 +	0.29 +	0.29 +	0.10 r	9	0.48 +	5
Geranium columbinum Geraniaceae v-a Mes T semiros	0.94 1	1.05 1				0.10 r	0.10 r		0.10 r	12		0

Taxon **Family** **Life form**	**Plot 1** **n** **c**	**Plot 3** **n** **c**	**Plot 4** **n** **c**	**Plot 10** **n** **c**	**Plot 12** **n** **c**	**Plot 13** **n** **c**	**Plot 20** **n** **c**	**Plot 22** **n** **c**	**Plot 23** **n** **c**	**Total No of individuals in all F100 plots**	**Control** **n** **c**	**Total No of individuals in control**
Geranium dissectum Geraniaceae v-a Mes T semiros		1.05 1	1.71 1	4.38 1	3.71 1	4.86 1		0.10 r		158	3.14 1	31
Kickxia spuria Scrophulariaceae a Mes-Meg T scap	0.90 1	1.20 1	3.62 1	0.90 1	0.84 1	1.14 1	4.76 1	12.67 2a	9.71 2a	**357**	2.10 1	21
Lotus corniculatus Fabaceae v-aut Mes H scap									0.10 r	1	0.10 r	1
Mentha longifolia Lamiaceae a Mes-Meg H scap	1.94 1		0.29 +				0.19 +	1.43 1		38		0
Medicago lupulina Fabaceae v Mes-Mac T scap	0.29 +	0.19 +	0.32 +			0.48 +	0.10 r	0.19 +		16	0.19 +	2
Plantago lanceolata Plantaginaceae v-a Mi-Meg H ros								0.10 r	0.10 r	2		0
Poa anua Poaceae n-a Mi-Mes T caesp										0		0
Polygonum aviculare Polygonaceae a-aut Mi-Mes T rept	3.21 2a	1.71 1	1.90 1	1.33 1	1.81 1	3.14 2a	0.57 1	1.71 1	1.24 1	166	0.76 1	8
Portulaca oleraceae Portulacaceae a Mes T scap										0		0
Trifolium repens Fabaceae v-aut Mi-Mes H rept		0.57 1					0.29 +	0.38 +	0.38 +	16		0
Senecio vulgaris Asteraceae n-v Mes-Meg T scap	0.38 +			0.38 +		0.1 r	0.38 +	0.29 +	0.19 +	17	0.19 +	2

Taxon Family Life form	Plot 1 n c	Plot 3 n c	Plot 4 n c	Plot 10 n c	Plot 12 n c	Plot 13 n c	Plot 20 n c	Plot 22 n c	Plot 23 n c	Total No of individuals in all F100 plots	Control n c	Total No of individuals in control
Setaria viridis Poaceae a-aut Mes-Mac T scap								0.19 +	0.76 1	9		0
Solanum nigrum Solanaceae a-aut Mes-Mac T scap							2.95 1	0.48 +	0.95 1	**43**		0
Sonchus asper Asteraceae v-a Mes-Alt T scap							0.76 +	0.19 +	1.24 1	22		0
Sorghum halepense Poaceae a-aut Mes-Meg G rhiz	8.20 2a	9.52 2a	8.57 2a	6.67 2m	8.00 2a	15.9 2a	25.33 2a	20.95 2a	18.57 2a	**1217**	10.48 2a	**105**
Stellaria media Caryophyllaceae n-aut Mi-Meg T rept	0.30 +					0.29 1				6	0.19 +	2
Veronica arvensis Scrophulariaceae v-a Mi-Mes T scap	0.20 +	0.10 r	0.31 +				3.90 1	7.52 2m	10.95 2m	230		0
Veronica persica Scrophulariaceae n-aut Mi-Mes T scap	3.62 1	1.43 1	0.67 +	1.52 1	1.05 1		3.14 1	0.57 1	1.62 1	136	1.90 1	19
Total No of individuals per m^2	24.21	18.5	20.37	16.8	24.2	42.1	53.5	52.3	51.52	∑ 3028	19.33	∑ 370
No taxa	14	11	11	9	9	13	19	22	19		15	
Weed cover (%)	15	12	12	10	15	15	20	20	20		7	
Swiss Chard yield (kg of aboveground part)	10.35	12.45	9.75	8.85	6.75	6.55	8.75	10.25	8.35		4.65	

Table 4. Weed density and weed cover in the plots in the regim F150 (150%). n – average No of individuals per m^2. c – weed cover in the plot

Taxon **Family** **Life form**	**Plot 6** **n** **c**	**Plot 7** **n** **c**	**Plot 8** **n** **c**	**Plot 16** **n** **c**	**Plot 17** **n** **c**	**Plot 18** **n** **c**	**Plot 25** **n** **c**	**Plot 26** **n** **c**	**Plot 27** **n** **c**	**Total No of individuals in all F150 plots**	**Control** n c	**Total No of individuals in control**
Anagalis arvensis Primulaceae v-a Mi-Mes T scap			0.10 r	0.48 +		0.29 +	0.86 1	0.48 +		22	2 1	20
Amaranthus retroflexus Amaranthaceae a-aut Mes-Alt T scap					0.10 r	6.57 2a	1.90 1			86		0
Atriplex patula Chenopodiaceae aut Meg-Alt T scap	2.86 1	2.70 1	0.48 1	0.19 +	0.57 1	3.14 1	0.57 1	2.19 1	14.48 2a	**272**	13.33 2a	**133**
Capsella bursa-pastoris Brassicaceae n-aut Mi-Meg T semiros	0.10 r		0.57 1	0.29 +	0.38 +	0.38 +	0.48 +	1.33 1	0.38 +	39	0.38 +	4
Chaenorrhinum minus Scrophulariaceae v-aut Mi-Mes T scap				0.10 r		0.10 r			0.10 r	3		0
Chenopodium album Chenopodiaceae a-aut Meg-Alt T scap				0.10 r	0.10 r					2		0
Convolvulus arvensis Convolvulaceae a SG herb rhiz	1.38 1	1.19 1	1.48 1		0.67 1	0.57 1	0.29 +	0.67 1		62	1.33 1	13
Cynodon dactylon Poaceae a-aut Mes-Mac H caesp										0		0
Euphorbia helioscopia Euphorbiaceae v Mi-Mes T scap			0.10 r			0.38 +		0.10 r	0.10 r	7	0.38 +	4
Euphorbia maculata Euphorbiaceae v-aut Mi-Mes T rept	0.10 r	0.10 r		5.67 2m	1.81 1	0.86 1		0.10 r	0.10 r	87	0.48 +	5
Geranium columbinum Geraniaceae v-a Mes T semiros								0.29 +	0.76 1	11		0

Taxon Family Life form	Plot 6 n c	Plot 7 n c	Plot 8 n c	Plot 16 n c	Plot 17 n c	Plot 18 n c	Plot 25 n c	Plot 26 n c	Plot 27 n c	Total No of individuals in all F150 plots	Control n c	Total No of individuals in control
Geranium dissectum Geraniaceae v-a Mes T semiros	3.81 1		3.52 1		0.19 +		0.38 +		0.76 1	114	3.14 1	31
Kickxia spuria Scrophulariaceae a Mes-Meg T scap	1.95 1	3.52 1		1.10 1	2.62 1	5.24 2m	2.48 1	2.86 1		**191**	2.10 1	21
Lotus corniculatus Fabaceae v-aut Mes H scap		1.90 1								0	0.10 r	1
Mentha longifolia Lamiaceae a Mes-Meg H scap	2.43 1						0.38 +			28		0
Medicago lupulina Fabaceae v Mes-Mac T scap	0.67 1		0.48 +	0.57 1	0.29 +	0.38 +				28	0.19 +	2
Plantago lanceolata Plantaginaceae v-a Mi-Meg H ros		0.48 +				0.10 r				1		0
Poa anua Poaceae n-a Mi-Mes T caesp	0.10 r									1		0
Polygonum aviculare Polygonaceae a-aut Mi-Mes T rept	0.52 1		1.30 1	2.29 1	0.62 1	1.33 1	2.57 2a	2.19 1		140	0.76 1	8
Portulaca oleraceae Portulacaceae a Mes T scap		0.48 +		0.48 +	0.29 +			0.38 +	2.67 1	13		0
Trifolium repens Fabaceae v-aut Mi-Mes H rept					0.29 +			0.38 +	0.19 +	7		0
Senecio vulgaris Asteraceae n-v Mes-Meg T scap	0.10 r		0.19 +		0.29 +	0.10 r	0.19 +	0.48 +	0.95 1	23	0.19 +	2

Taxon Family Life form	Plot 6 n c	Plot 7 n c	Plot 8 n c	Plot 16 n c	Plot 17 n c	Plot 18 n c	Plot 25 n c	Plot 26 n c	Plot 27 n c	Total No of individuals in all F150 plots	Control n c	Total No of individuals in control
Setaria viridis Poaceae a-aut Mes-Mac T scap									0.48 +	5		0
Solanum nigrum Solanaceae a-aut Mes-Mac T scap	0.30 +			0.29 +	1.90 1	1.43 1	38.10 2a	3.43 1	20.19 2a	**656**		0
Sonchus asper Asteraceae v-a Mes-Alt T scap					0.10 r	0.19 +	0.10 r	0.76 1	0.48 +	16		0
Sorghum halepense Poaceae a-aut Mes-Meg G rhiz	13.50 2a	14.50 2a	17.30 2a	17.90 2a	17.24 2a	17.33 2a	7.81 2m	23.05 2a	20.48 2a	**1491**	10.48 2a	**105**
Stellaria media Caryophyllaceae n-aut Mi-Meg T rept	0.19 +	0.10 r	0.10 r							4	0.19 +	2
Veronica arvensis Scrophulariaceae v-a Mi-Mes T scap		1.60 1	1.30 1	0.10 r	5.48 2m	5.62 2m	4.29 1	3.81 1	0.10 r	223		0
Veronica persica Scrophulariaceae n-aut Mi-Mes T scap	2.10 1	1.10 1	1.90 1	2.10 1	1.05 1	1.05 1	2.38 1	3.05 1	4.38 1	191	1.90 1	19
Total No of individuals per m^2	30	27.7	28.8	31.6	33.9	45	62.7	45.5	65.8	∑ 3723	19.33	∑ 370
No taxa	15	11	13	14	18	18	15	17	15		15	
Weed cover (%)	12	15	15	12	10	15	30	20	40		7	
Swiss Chard yield (kg of aboveground part)	6.95	10.85	9.45	16.05	15.05	12.55	9.85	10.25	9.75		4.65	

Analysis of the crop yield and weed cover in the plots wih regime of fertilization F50 shown similar results. Among the plots with fertilization regime F50 the highest yield was recorded in the plot 15 (12.05 kg) (table 2), where the content of humus was highest (table 1) and weed cover exceeded the average value for this regime of fertilization (17%). On the other hand, in the plot 11 (table 2) the yield was minimal (4.75 kg) and weed cover was the lowest (10%). Considering regime F100 (table 3), the highest yield was recorded in the plot 3 (12.45 kg), but, unlike other regimes (F150 and F50), the plot with highest yield didn’t have highest content of humus in the soil before the treatment (table 1). The highest humus content is reported for plot 10 (table 1), but the plot had lower crop yield (8.85 kg) and the lowest weed cover (10%) (table 3). This can be explained, as mentioned above, especially by the content of available potassium as well as soil EC which frequently positively correlated to crop yield. Thus, Knežević *et al*. (2014) found that the yield of Swiss chard was in positive significant relationship with available soil K. Namely, in soil of the plot 3 the highest content of available K and EC value were measured, but soil of the plot 10 had relatively lower content of K and EC value.

It is known that long term use of fertilizers changes the agroecological conditions for existance of the whole agrophytocoenosis and its separate components (Atanasova *et al*., 2009), thus our future investigations will be focused on this topic.

CONCLUSIONS

Weed sinousia of Swiss chard in Montenegro consists of 29 species, out of 26 genera and 17 families and in taxonomic spectrum it differes from the sinousia of other crops investigated in Montenegro. Dominant families in the specrum are Poaceae, Scrophulariaceae (4 species each) and Fabaceae (3 species). The most abundant species in sinousia are S. halepense, S. nigrum, K. spuria and A. patula. Up to this research A. patula and K. spuria was not consideres as troublesome agricultural weed in Montenegro. In the total weediness dominant weed species participate with 67.3%. Ranking of dominant species differs between the treatments, but athough changes in the relative abundances of weeds caused differences in the community composition between plots without (C) and with different fertilizing regime (F50, F100 and F150), species composition was quite similar.

The analysis of the total biological spectrum indicates the dominance of therophytes with 75.8%, while hemicryptophytes contribute the spectrum with 17.2%. Such spectrum of life forms fits into the general biological spectrum of the flora of Bjelopavlići plain.

Considering the effect of fertilizers on the crop growth and weediness general conclusion is that fertilizers benefit both the crop and weeds. The average crop yield was highest in the regime F150, as well as total weediness F150. Nevertheless our research has shown that increased doses of fertilizers had better effect on the crop yield than on weediness. However, analysing the species abundance, cover per single plot and crop yield in each regime of fertilization, some deviations are noticed, but in order to find proped explainations additional research are needed.

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