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VERTICAL DISTRIBUTION OF WEED SEED BANKS IN EXTENSIVE AND INTENSIVE METHODS OF GRAPEVINE CULTIVATION

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Abstract

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This study deals with the influence of herbicide application (glyphosate and glufosinate-ammonium), soil cultivation methods on the size and quantity of weed seed banks. The application of herbicides in a row (intra-row spacing) of the intensive vineyards studied as well as the cultivation between rows (inter-row spacing) affect the soil weed seed bank in the vineyard. The research was carried out in 2011 and 2012 in three different vineyard sites (Erdut, Subotica-Horgos and Fruska Gora vineyards) in intensive vineyards grown for commercial purposes, as well as in extensive vineyards. Samples were taken in ten replications from the inter-row and intra-row zones to the depth of 0-30cm of intensive and extensive vineyards. The samples were rinsed through copper sieves of specific diameters and dried at room temperature, after which the weed seeds were extracted and identified. The comparison of the two weed seed banks in the two methods of grapevine cultivation studied revealed the range of weed seed number in extensive and intensive vine growing within a one year period from 37.006 seeds/m^2 in the inter-row spacing of an intensive vineyard to 69.069 seeds/m^2 in a row of extensive vineyards at various localities. Despite the great diversity of the weeds, totaling 38 species, whose seeds were identified in the samples studied, only several species were predominant in number in comparison to other species: *Amaranthus retroflexus* L.*, Portulaca oleracea* L., *Chenopodium album* L., *Stellaria media* (L.) Vill. *Lamium purpureum* L. The germination of the seeds identified showed a significantly higher potential for the predominant weed species in comparison to others.

Key words: weed seed bank, grapevine, extensive, intensive

Introduction

Weed seed banks contribute to the spread of both annual (Steinmann and Klingebiel, 2004) and perennial weed species (Blumenthal and Jordan, 2001), which affects the spread of the weed community in general over the years. What has to be taken into account in the study of weed seed banks in soil is that they are only a part of a complex and dynamic system consisting of soil (Otto et al., 2007), plants, animals and microorganisms (Chee-Sanford et al., 2006). The main biological characteristics of weeds which enable their viability are high seed production, a high potential for vegetative propagation, and the potential for rapid expansion and adaptation to adverse ecological conditions (Konstantinović et al., 2012). Seeds can be dispersed mechanically by wind, water, animals or cultivation machinery, all of which contribute to the regular replenishment of weed seed banks. The most significant factor for the appearance of a new seed into the weed seed bank is the time when the seeds are released by the dominant weed species within the local plant communities (Konstantinović et al., 2008). Weed seed banks are the main reason for the continued presence of weeds in agricultural areas (Cousens and Mortimer, 1995). Weed growth is an ongoing problem in agricultural production, and their control is the main prerequisite for producing optimal yields and high quality products (Vasileiadis et al., 2007). Soil cultivation may have a significant impact on the distribution of seeds and soil profile (Anderson et al., 1998; Sosnoskie et al.,

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2006). Perennial agrofitocenoses, such as vineyards, may be less likely to undergo dramatic changes in weed seed banks, in comparison to annual agrofitocenoses, due to the lack of crop rotation, and the lesser degree of soil cultivation is usually accompanied by smaller amounts of mineral manures. In addition, weed density is limited due to the risk of soil compression during wet winter seasons. All of these factors can have an impact on the appearance of weeds and on the composition of seed banks (Anderson et al*.,* 1998; Clements et al., 1996; Le'ge`re et al., 2005; Smith and Gross 2006). Intensive mechanical processing of inter-row surfaces in vineyards reduces the number of weed species (Konstantinović et al., 2012). Annual fluctuation of outside factors significantly influences weed seedbanks (Harbuck et al*.,* 2009). According to its floristic composition and structure, the vineyard weed community is half way between the weed communities of crop fields and those of orchards (Konstantinović, 2011). Understanding the nature of seedbanks is a necessary prerequisite for studying plant population dynamics, or for setting up programs of weed control (Ambrosio et al., 2004). The grapevine (*Vitis vinifera* L.), of which numerous varieties are used for grape production, belongs to the family of *Vitaceae*-vine, which includes perennial climbing plants. Weeds growing in vineyards have a strongly negative influence on both new and established vineyards. Intensive production entails, in addition to all the agrotechnical operations for land cultivation, the use of herbicides. Agrotechnical measures include fall and spring inter-row land cultivation and cultivation during periods of vegetation. Extensive agricultural production requires relatively small investments in the production process, which are followed by relatively low results in output and value per area unit. Extensive vineyard cultivation involves all agrotechnical operations on a more or less reduced scale, without tilling between rows, but only mulching or cutting grass in the inter-row spacing, or intra-row hoeing, without the use of herbicides. Weed growth is a systematic problem in large-scale production, and its control is the main issue in obtaining an optimal yield of high quality products.

Materials and Methods

Soil sampling was carried out in locations of different vineyard areas: that of Subotica, Sremski Karlovci and Erdut, in 2011 and 2012. The depth at which samples were taken in each location was 0-30cm in the intensive and extensive vineyards. The sites researched are at the following coordinates: Subotica extensive vineyard (No 46º07'15,12"; E 9 º44'31,45") and intensive vineyard (No 46º05'26,63"; E 19 º46'37,71"), Erdut extensive vineyard (No 45º 31' 30,63"; E 19 º00'06,23") and intensive (No 45º30'24,70"; E 19 º00'29,52"). Sremski Karlovci location is in the Fruљka Gora vineyard area; an extensive vineyard was researched (No 45º11'14.17"; E 19 º55'34.90") and an intensive one (No 45º11'19.63"; E 19 º55'48.31").

The analysis of weed seed bank composition was carried out from selected samples taken from the selected vineyards of extensive and intensive grape cultivation. During spring and fall of both year's intra-row and inter-row soil sampling was carried out in order to determine the weed seed bank structure. The sampling of soil was done in ten replications, with a probe of the same volume. Each of the ten samples was taken from the depths 0-10, 10-20 and 20-30 cm. Each sample from one out of the three depth layers contained approximately 3 kg of soil, which was then sifted through copper sieves 0.25 mm in diameter. After that weed seeds were separated in the sample from plant and other material and the identification of seeds was carried out. Identifying the seeds and determining their quantity was carried out with microscopes and determiners. Data processing was done by Conn (1987) and Sharratt (1998) methodology. The weed seeds identified were disinfected in 0.1% solution of the fungicide Benomyl, and were subsequently placed in a climate chamber for germination under controlled conditions. The parameters of the climate chambers were set for 12 hours at 25°C under light (52.4 umol-m "- s" 1) and for 12 hours at 20°C without light, with air humidity of 65%. Petri dishes 100 x 90 mm were covered by polyethylene foils in order to prevent evaporation. The germination was checked every second day. It was considered that a seed has germinated when a small sprout has appeared. The measurement of the length of epicotyls and hypocotyls was carried out after 28 days on all germinated seeds in the climate chamber.

Chemical weed treatment at all three vineyard locations researched was carried out from 15 October to 26 October of each year studied with the herbicides based on active glyphosate inside rows, covering a strip 60 cm in width. The herbicide used was glyphosate applied at 2.6 l/ha for treating the strips in rows. Both years during spring, from 15 May to 9 July, the intra-row weeds were first treated with the herbicide based on glufosinate - ammonium, applied at 2.3 l/ha in vineyards at all three locations. The second treatment with the glufosinate - ammonium herbicide applied at the same amount was carried out from 20 July to 19 August both years. The number of cultivations of the inter-row spacing during vegetation depended on precipitation, which affected the growth of weeds. During vegetation periods in 2011 and 2012 cultivation was carried out four times.

During spring of both years studied, from 3 March to 4 April, soil removal was carried out by the V-shaped vineyard plough, by adapting the blade for soil removal. In addition to machine soil removal, additional removal was carried out

by human workforce. The cultivation of inter-row spacing, the so-called 'dusting' (shallow plowing to the depth of 10-15 cm) in fruit bearing vines (10-22 years old) was carried out: the first from 6 to 23 May, the second from 2 to 23 June, the third from 1 to 19 July and the fourth from 7 to 27 August in both years studied (Table 1). The variety grown at all three locations is Italian Riesling, grafted on Kober 5BB. The intra-row planting distance is 0.5 m, and between rows it is 3.8 m in Erdut and Sremski Karlovci, while in Subotica the inter-row distance is 3.6 m, and inside a row it is 0.6.

In all three locations studied the precipitation pattern is the continental one, with a higher precipitation during the warmer half of the year. Most rain falls in June and May. June is characterized by 12-13% of the total annual precipitation. The lowest precipitation is in February and October, with the average 5-6% of total annual precipitation. The annual precipitation amount in the region in which all three grapevine areas are situated is 896 mm. The average annual temperature in all three areas is 10.9°C. The warmest month is July with the mean temperature from 11.0 to 22°C. At Subotica location, the soil type is alluvial, while in the other two locations it is brown forest soil.

The main objective of the study was to determine the quantitative and qualitative characteristics (the quantity and viability) of weed seeds in the arable soil layer (0-30 cm) at the investigated locations of Subotica, Sremski Karlovci and Erdut, in intensive and extensive grapevine cultivation (Table 1).

Results

At the locations of extensive and intensive vineyards studied 37 weed species were identified: *Portulaca oleracea* L., *Amaranthus retroflexus* L., *Stellaria media* (L.) Vill., *Chenopodium album* L., *Euphorbia helioscopia* L., *Polygonum persicaria* L., *Datura stramonium* L., *Setaria glauca* (L.) Beauv., *Solanum nigrum* L., *Stachys annua* L., *Geranium dissectum* L., *Veronica agrestis* L., *Euphorbia ciparissias* L., *Convolvulus arvensis* L., *Sinapis arvensis* L., *Viola arvensis* L., *Capsella bursa-pastoris* L., *Lamium purpureum* L., *Polygonum aviculare* L., *Papaver rhoeas* L., *Ambrosia artemissifolia* L., *Sorghun halepense* (L.) Pers., *Ajuga chamaepitys* L., *Bilderdykia convolvulus* L., *Setaria viridis* (L.) Beauv., *Veronica hederifolia* L., *Veronica polita* Poir., *Brassica rapa* L., *Echinochloa crus galli* L., *Iva xantifolia* (L.) Nutt., *Canabis sativa* L., *Poa annua* L., *Canabis canadensis* L., *Calistega sepium* L., *Chenopodium hybridum* L., *Cynodon dactylon* (L.) Pers., *Hibiscus trionum* L., *Viola tricolor* L. The average number of weeds in 2011 and 2012 in the extensive vineyards at the Erdut, Sremski Karlovci and Subotica locations in the soil profile 0-30cm is 54611, 52383 an 66052 seeds per m² respectively. The average difference in the number of seeds identified between intra-row and inter-row spacing in the extensive vineyards in all three locations was 944 seeds/m² more in the intra-row zones. The average difference in the number of seeds identified between inter-row and intra-row spacing in

Table 1

Treatments	Intra-row and inter-row agrotechnics	Time of weed eradication	
		year 2011	year 2012
Fall – spring cultivation	Cultivation (intra- and inter-row)	21 October - 17 November	12 October - 22 November
	Glyphosate (2.6 l/ha) (intra-row)	15-25 October	21-26 October
	Cultivation (intra- and inter-row)	3 March- 24 March	11 March – 4 April
Spring cultivation	Cultivation (inter-row)	6 -17 May	11-23 May
	Glufosinate - ammonium (2.3 l/ha) (intra-row)	15 May-1 June	21 May-9 June
Summer cultivation	Cultivation (inter-row)	2-15 June	14-23 June
	Glufosinate - ammonium (2.3 l/ha) (intra-row)	15 June-5 July	19 June-25 July
	Cultivation (inter-row)	1-14 July	8-19 July
	Glufosinat - ammonium (2.3 l/ha) (red)	20 July-15 August	25 July-19 August
	Cultivation (inter-row)	7-18 August	11-27 August

the intensive vineyards in all three locations was 1036 seeds/m^2 more in the intra-row zones. The results of the estimation of the coefficient correlation between the variable MR-INT (inter-row zone in the intensive vineyards) and R-INT (intra-row zone in the intensive vineyards), which indicates the number of seeds per square meter between rows in intensive vineyards at 0 - 10 cm, 10 - 20 cm and 20 - 30 cm, are shown in Tables 2, 3 and 4 respectively. The coefficient estimations show that the correlation coefficient between the number of seeds per square meter in the layers 0 – 10 and 10 – 20 is 0.470745 at the Subotica location, 0.803557 at the location of Sremski Karlovci and 0,598888 at the location of Erdut, and its statistical significance is 0.05. The estimations of the expected values show that the number of seeds in the layer 0 – 20 cm is rather even and that it decreases in the layer from 20 to 30 cm. The correlation estimation of extensive vineyards does not indicate such homogeneity in layers as was found in all three locations in intensive vineyards.

The analysis of difference between the number of seeds in extensive and intensive vineyards per square meter, which was performed by a T-test, showed that there is no statistical significant difference in the locality of Subotica. Table 5 shows the results of the statistical analysis of the seed number in the location of Subotica. The estimated probability of the

Table 2

	Means	Std. Dev.	R-INT (0-10)	R-INT (10-20)	R-INT (20-30)
R-INT (0-10)	2,404,601	7,536,371	1,000,000	**0.470745**	-0.238223
R-INT (10-20)	2,185,276	5,112,683	**0.470745**	1,000,000	-0.049705
R-INT (20-30)	1,698,773	4,268,332	-0.238223	-0.049705	1,000,000

R-INT – intra-row zones in intensive vineyards. Marked correlations are significant at p < ,05000 N=20

Table 3

	Means	Std. Dev.	MR-INT (0-10)	MR-INT (10-20)	MR-INT (20-30)
MR-INT (0-10)	1754.601	541.5406	1	**0.803557**	0.11783
MR-INT (10-20)	1730.675	592.3809	**0.803557**	1	0.061152
MR-INT (20-30)	1455.521	503.6652	0.11783	0.061152	1

MR-INT – inter-row zones in intensive vineyards. Marked correlations are significant at p < ,05000 N=20

Table 4

	Means	Std. Dev.	MR-INT (0-10)	MR-INT (10-20)	MR-INT (20-30)
MR-INT (0-10)	1,575,153	4,147,199	1,000,000	**0.598888**	0.071330
MR-INT (10-20)	1,543,252	5,563,449	**0.598888**	1,000,000	0.274804
MR-INT (20-30)	1,395,706	6,054,608	0.071330	0.274804	1,000,000

MR-INT – inter-row zones in intensive vineyards. Marked correlations are significant at p < ,05000 N=20

Table 5

Variable	T-test for Dependent Samples (Sremski Karlovci) Marked differences are significant at p < ,05000							
	Mean	Std. Dv.	N	Diff.	Std.Dv. Diff.	t	df	p
R-EKST	5,472,178	8,573,150						
MR-EKST	5,004,601	9,770,903	20	4,675,768	1,095,144	0.517531	19	0.610759
R-INT	4,884,969	1,006,221						
MR-INT	4,753,375	1,261,090	20	1,315,944	1,282,425	-0.163941	19	0.871509
R-EKST	5,472,178	857,315						
R-INT	**4,884,969**	**1,006,221**	**20**	**5,872,089**	**1,093,626**	1,475,714	19	0.156401
MR-EKST	5,004,601	977,090						
MR-INT	4,753,375	1,261,090	20	2,512,265	1,569,331	1,307,512	19	0.206641

R-INT – intra-row zone in intensive vineyards. Significant at p < ,05000 N=20; R-EKST – intra-row zone in extensive vineyards. Significant at p < ,05000 N=20; MR-INT – inter-row zone in intensive vineyards. Significant at p < ,05000 N=20; MR-EKST – inter-row zone in extensive vineyards. Significant at p < ,05000 N=20

first order error in all variants is higher than 0.05, which is not sufficient to discard the null hypothesis. The results point to a higher quantity and greater size of weed seed banks in the extensively cultivated vineyards in comparison to the quantity and size in the intensively cultivated ones. The highest number of seeds per m^2 in one year researched was found inside a row in an extensive vineyard in Subotica, in the soil profile 0-30 sm. These included the following weed species: *Amaranthus retroflexus* L. (22031), *Ambrosia artemisiifolia* L. (1239), *Stellaria media* (L.) Vill. (9650), *Sorgum halepense* (L.)Pers. (1718), *Portulaca olereaca* L. (9012), *Cynodon dactylon* (L.) Pers. (1356), *Setaria viridis* (L.)Beauv. (399), *Setaria glauca* L. (239), *Stachys annua* L. (239), *Lamium purpureum* L. (4957), *Polygonum aviculare* L. (80), *Chenopodium album* L. (15952), *Echinochloa crus galli* L. (1718), *Hibiscus trionum* L. (80), *Datura stramonium* L. (399).

The analysis of the difference in the number of seeds in the extensive and intensive vineyards per square meter was performed by a T-test in order to determine the statistical significance of expectations at dependent samples. The random variable-EKST was used for modeling the number of seeds per square meter in the extensive vineyards, while the random variable R-INTEN was used for modeling the number of seeds per square meter in the intensive vineyards. Table 6 shows the results of the statistical analysis of the number of seeds at the location of Sremski Karlovci. The estimated first order error is 0.02678, which is lower than 0.05, and is therefore sufficient to discard the null hypothesis. In other words, it was determined that the difference in the expected number per m^2 of 587.2089 is statistically significant at 0.05. The lowest number of seeds per m^2 was found at the location of Erdut in inter-row zones in the intensive vineyard in the soil profile 0-30 cm on average for one year studied. The following weed species were identified: *Amaranthus retroflexus* L. (7018), *Stellaria media* (L.) Vill. (4785), *Chenopodium album* L. (6221), *Portulaca olereaca* L. (10128), *Solanum nigrum* L. (1515), *Lamium purpureum* L. (2872), *Sorgum halepense* (L.)Pers. (718), *Viola trcolor* L. (80), *Convolvulus arvensis* L. (1595), *Brassica rapa* L. (559),

Table 6

Variable	T-test for Dependent Samples (Sremski Karlovci) Marked differences are significant at p < ,05000							
	Mean	Std. Dv.	N	Diff.	Std.Dv. Diff.	t	df	p
R-EKST	5,472,178	8,573,150						
MR-EKST	5,004,601	9,770,903	20	4,675,768	1,095,144	1,909,399	19	0.071429
R-INT	4,884,969	1,006,221						
MR-INT	4,753,375	1,261,090	20	1,315,944	1,282,425	0.458903	19	0.651510
R-EKST	5,472,178	857,315						
R-INT	4,884,969	1,006,221	20	5,872,089	1,093,626	2,401,258	19	0.026735
MR-EKST	5,004,601	977,090						
MR-INT	4,753,375	1,261,090	20	2,512,265	1,569,331	0.715922	19	0.482746

R-INT – intra-row zone in intensive vineyards. Significant at p < ,05000 N=20; R-EKST – intra-row zone in extensive vineyards. Significant at p < ,05000 N=20; MR-INT – inter-row zone in intensive vineyards. Significant at p < ,05000 N=20; MR-EKST – inter-row zone in extensive vineyards. Significant at p < ,05000 N=20

Table 7

Variable	T-test for Dependent Samples (Erdut) Marked differences are significant at p < ,05000							
	Mean	Std. Dv.	N	Diff.	Std.Dv. Diff.	t	df	p
R-EKST	5,287,730	1,600,497						
MR-EKST	5,634,663	1,555,052	20	-346,933	1,850,537	-0.838422	19	0.412218
R-INT	4,769,325	1,358,004						
MR-INT	4,514,111	1,355,308	20	2,552,145	1,694,254	0.673662	19	0.508639
R-EKST	5,287,730	1,600,497						
R-INT	4,769,325	1,358,004	20	5,184,047	1,796,230	1,290,690	19	0.212297
MR-EKST	5,634,663	1,555,052						
MR-INT	4,514,111	1,355,308	20	1,120,552	1,670,436	2,999,971	19	0.007362

R-INT – intra-row zone in intensive vineyards. Significant at p < ,05000 N=20; R-EKST – intra-row zone in extensive vineyards. Significant at p < ,05000 N=20; MR-INT – inter-row zone in intensive vineyards. Significant at p < ,05000 N=20; MR-EKST – inter-row zone in extensive vineyards. Significant at p < ,05000 N=20

Veronica agrestis L. (320), *Chenopodium hybridum* L. (638), *Euphorbia ciparissias* L. (559).

The differences in the number of seeds inside rows of the extensive and intensive vineyards were determined by a T-test. The random variable MR-EKST was used for modeling the number of seeds per square meter in extensive vineyards, while the random variable MR-INTEN was used for modeling the number of seeds in intensive vineyards. Table 7 shows the results of statistical analysis of the number of seeds in the locality of Erdut. The estimated first order error is 0.007362, which is lower than 0.05, and is sufficient to discard the null hypothesis. In other words, it was determined that the difference in the expected number of seeds per m^2 of 1120.552 is statistically significant at 0.05.

Figure 1 shows the number of seeds identified at the locality of Erdut in all 20 samples during the two year research period. Statistical difference was found in the number of weed seeds per m^2 in the intra-row spacing of extensive vineyards as well as in the intra-row spacing of intensive vineyards. The variations in the quantity of seeds for all 20 samples can be seen, as well as their deviation from the mean value, represented by the line. Figure 2 shows the number of seeds identified at the locality of Sremski Karlovci in all 20 samples and their deviation from the line representing the mean value of all samples. The y-axis of the Figures 1 and 2 represents the number of seeds for each sample and the x-axis represents the number of samples.

The results obtained by measurements of length of the most numerous weed seeds in the seed bank (Figure 3) show that the mean length of the longest epicotyl was found at the location of Subotica in the weed species *Amaranthus retroflexus* L. (9.725 mm), which also had the longest hypocotyl (20.625 mm). The lowest hypocotyl length was found at the locality of Subotica in the weed species *Lamium purpureum* L. (1.56 mm) which also had the shortest epicotyl – 1.12 mm.

Discussion

The systems with lower-scale cultivation tend to have considerably more seeds in the surface layer soil than the intensively cultivated systems (du Croix Sissons et al., 2000; Dyer 1995). This study also showed that in the extensively cultivated vineyards there are more weed species identified than in the intensive vineyards in all three locations studied. The density of weed seeds in arable soil is always composed of several dominant weed species in high amounts and several species in moderate or smaller amounts (Cardina et al., 1991). In the locations of extensive and intensive vineyards researched, but primarily in the intensive ones, the following weed species were predominant: *Amaranthus retroflexus*

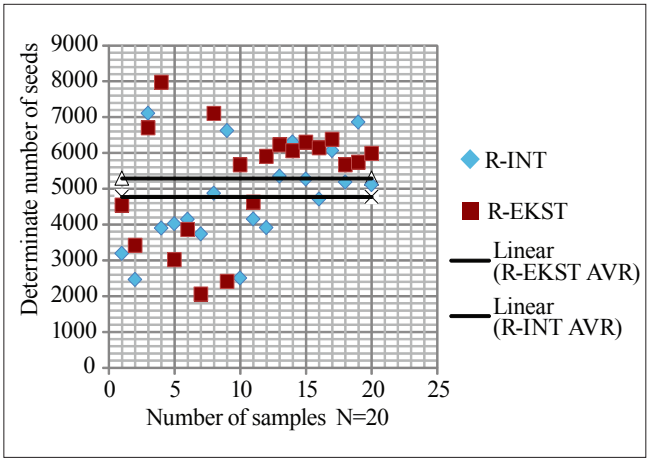

Fig. 1.

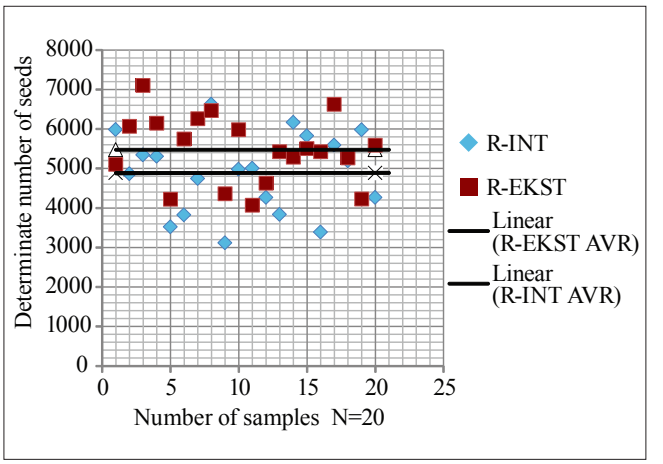

Fig. 2.

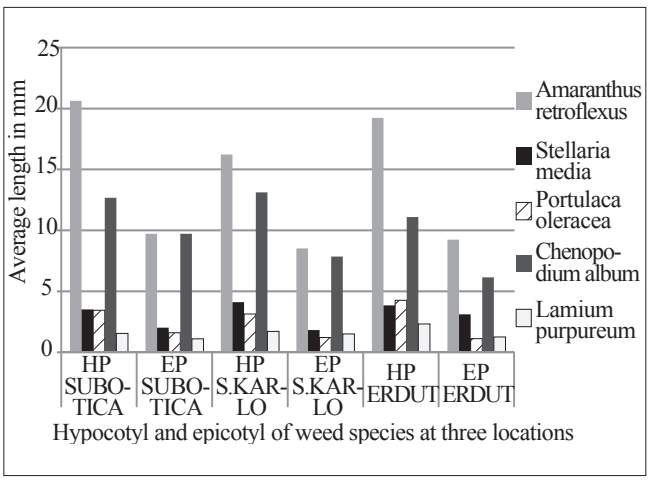

Fig. 3.

L., *Portulaca oleracea* L., *Chenopodium album* L., *Stellaria media* (L.) Vill. and *Lamium purpureum* L. In all the samples inspected they made up more than 70% of the seeds identified. The weed seedbanks contain several dominant weed species, but *Amaranthus* sp. was one of the dominant species in all samples (Uremis et al., 2003). *Amaranthus retroflexus* L. was one of the most numerous at the locality of Subotica in both years of study, totaling 17876 seeds per m^2, in Sremski Karlovci 8533 seeds per m^2 in both years of study, while in the Erdut location the predominant weed species was *Portulaca oleracea* L. with 9655 seeds per m^2. As has been shown, there is no statistically significant difference in the amount of weed species identified in the relation between intra-row and inter-row zones in extensive and intensive vineyards in all three locations. By recombining the variants of intra-row and inter-row zones, the difference it was determined that there is a difference in size of weed seed banks in the intra-row and inter-row zones of both intensive and extensive vineyards. The seeds remain at the surface in the systems of small-scale soil cultivation, and are exposed to adverse conditions, which may decrease or increase their germination, depending on the species. This is in line with the previous research (Chauhan et al., 2006). The comparison of correlation between the sampled layers at depths 0-10, 10-20 and 20-30 cm shows that in the layers 0-10 and 10-20 cm the composition of the seeds identified is rather homogeneous in the intensive vineyards, both in intra-row and inter-row spacing. There are 38 weed species identified in the localities studied, which is almost the same as the number of species established in the study in the Napa Valley locality in California in the period 2003-2005, where 39 weed species were identified: *Amaranthus* spp., *Anagallis arvensis* L,. *Brassica rapa* L., *Calandrinia ciliata* (Ruiz and Pavo´n) DC, *Calendula arvensis* L., *Cardamine hirsuta* L., *Chamaescyce humistrata* (Engelm. ex. Gray), *Chenopodium album* L., *Cichorium intybus* L., *Convolvulus arvensis* L., *Conyza canadensis* (L.) *Epilobium brachycarpum* C. Presl., Erodium spp., *Gamochaeta purpurea* (L.), *Geranium carolinianum* L., *Hordeum jubatum* L., *Juncus bufonius* L. var. occidentalis., *Kickxia spuria* (L.) Dumort., *Lactuca serriola* L., *Lamium amplexicaule* L., *Lolium perenne* L. spp. Multiflorum., *Lythrum hyssopiflia* L., *Medicago polymorpha* L., *Oxallis stricta* L., *Picris echioides* L., *Plantego lanceolata* L., *Plantego major* L., *Poa annua* L., *Polygonum arenastrum* Boreau., *Polypogon monspeliensis* (L.) Desf., *Portulaca oleracea* L., *Raphanus raphanistrum* L., *Rumex crispus* L.,*Senecio vulgaris* L. Sonchus spp., *Stellaria media* (L.) Vill., *Veronica persica* Poir., *Vitis vinifera*., *Vulpia myuros* (L.) K.C. Gmel. (Steenwerth et al., 2010). Some of these weed species were also identified in our research, where the predominant weed species are also *Portulaca oleracea* L., *Amaranthus retroflexus* L., *Stellaria media* (L.) Vill., *Chenopodium album* L. However, the Steenwerth et al. 2010 study also includes the *Vitis vinifera* seed, while the total number of its seeds found in our research was 17, and therefore they were not included among the weed species and were not germinated in the climate chamber. The predominant weed species were *Portulaca oleracea* L., *Amaranthus retroflexus* L., *Stellaria media* (L.) Vill., *Chenopodium album* L. In the California location the weed species *Lamium amplexicaule* L. was identified, while in this study *Lamium purpureum* L. was found. *Digi,taria sanguinalis* (L.) Scop., *Portulaca oleraceae* L. i *Chenopodium album* L. are highly competitive summertime weeds, which prevent the balance of the plant cover, as has been shown in previous research (Gago et al., 2007). The weed species *Portulaca oleraceae* L. and *Chenopodium album* L. are also found in our study, where *Portulaca oleraceae* L. proved to be absolutely predominant due to the fact that it prevents plant cover balance, so that it has prevailed not only in the floristic composition, but in the weed seed bank generally for a number of years.

Conclusions

The results of this research show that the seed bank potential is high, with 38 weed species found and identified. The number of weed species in intensive vineyard inter-row and intra-row spacing is lower compared to extensive vineyards, which can be attributed to the application of agrotechnical weed management measures. It can be concluded that the intensive mechanical cultivation of inter-row spacing and the chemical intra-row actions have reduced the number of weed species, but they have also homogenized weed species in layers which are continuously cultivated at depth 0-20cm. The deeper layer 20-30 cm usually contains a smaller number of seeds, and is statistically considerably different from the first two layers. The number of weed seeds is also considerably lower in the intensive systems of grapevine cultivation than in the extensive systems. Except for five dominant weed species, the seeds of the other species showed a low or negative germination potential. The measurements of average epicotyl and hypocotyl length proved that the seeds with the highest germination potential also have the longest epicotyls and hypocotyls, and those are the seeds of *Amaranthus retroflexus* L. At the locations studied where no major change in the weed seed bank had occurred in the 0-30 cm soil profile, as is the case of extensive vineyards, it is recommended that the practice of weed management should be applied like that in the intensive vineyards. A long-term weed management practice would reduce the quantity of weed seed banks at least to the level of intensive vineyards, and thus the potential strength

of weed flora in perennial systems of extensive cultivation would also be reduced.

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