Acta Bot. Croat. 63 (2), 113–123, 2004

CODEN: ABCRA 25
ISSN 0365–0588

Vineyard weed flora in the Jastrebarsko area (NW Croatia)

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Vineyard weed flora was surveyed over the wider Jastrebarsko area (a part of Plešivica Mountain, north-west part of Croatia), a well known wine-growing area. The survey was carried out in the years 2001 and 2002, in ten vineyards at six different localities.
A hundred and nine (109) weed species were noted. The presence of segetal weeds such as *Amaranthus retroflexus* L., *Chenopodium album* L., *Stellaria media* (L.)Vill. was recorded in well cultivated vineyards. In addition, ruderal weed species such as *Ambrosia artemisiifolia* L. were found in vineyards, coming in from surrounding habitats. The species *Arctium lappa* L., *Artemisia vulgaris* L. and the others prevail in neglected and abandoned vineyards.
It is interesting to record findings of *Amaranthus retroflexus*, *Artemisia vulgaris*, *Capsella bursa – pastoris* (L.) Med. and *Daucus carota* L. because these species have result in bad grape and wine quality.

Key words: vineyard, weed, segetal weeds, ruderal weeds, Jastrebarsko, flora, Croatia

Introduction

Vineyard weed flora in the north-west part of Croatia has been subject to little research (HULINA 1979, PLAVŠIĆ-GOJKOVIĆ et al. 1986). As compared with the investigations of PLAVŠIĆ-GOJKOVIĆ et al. (1986) there have been a lot of changes in the vineyards probably due to intensified anthropogenic activities. Some of the vineyards were abandoned and some have been newly established, and the agricultural technology has been changed. Consequently, weed flora has also been changed. This was the main reason for conducting research into weed flora in the vineyards in the Jastrebarsko area.

The surveyed area, Jastrebarsko, is situated on the Plešivica hills in the north-west part of Croatia (Fig.1), an area suitable for viniculture due to orographic and soil characteristics as well as meteorological conditions.

In the geological structure dolomites are predominant, and limestones are much less in evidence. Rendzinas, which developed on the dolomite bedrock, are a dominant pedotaxon

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(MAYER and VRBEK 1995). In the Laškovec area (a part of the Jastrebarsko area) there is usually a very high level of underground water, which that creates a very moist habitat.

The macroclimate in the wine-growing Jastrebarsko area is of the continental, Central European type, with an average annual amount of precipitation of 924 mm. An average annual temperature was of between 9.4 and 10.9 °C. The insolation is also a very important factor and average annual exposure to the sun's rays is 1912 hours. Vineyards were planted up to an altitude of 400 m, at an inclination of 10% to more then 40% on the west and south exposed slopes of Plešivica hills.

Vineyards cover approximately 1600 ha on the west and south exposed slopes of the Plešivica hills (LJUBLJANOVIĆ 2001).

The type of tillage was the same for the majority of vineyards, but there are different types of viniculture cultivation. Traditional vineyards have viniculture around stakes, while the new ones have a modern viniculture system with wire. Weed management practice applied in those vineyards was to hoe up once a year. Many vineyards have an inter-row cover crop or other cover that is mown as mulch, for decreased soil erosion. Some vineyards were fertilized with rotted manure in autumn and with chemical fertilizers in spring, other vineyards were well fertilized only with rotted manure. In the last years, there is much less herbicide in use. However, a lot of different fungicides are in use, because diseases are also a special problem in the vineyards.

The differences between intensive and extensive viniculture, such as fertilizing and the agricultural techniques applied, have an impact on the appearance and growth of weeds (HULINA 1979).

Weeds are problem in vineyards. They are competitors to the grape vine for water, nutritive matters and light. Plants of the grape vine can be shaded by twining species that also obstruct photosynthesis, reduce yield and stimulate the development of different diseases. Twining species such as *Calystegia sepium* (L.) R.Br. or *Convolvulus arvensis* L. can obstruct the growth of sprouts. In very wet season the negative effects of increasing the level of soil moisture retained by weeds appear, and in addition an increased level of air moisture stimulates the development and expansion of different diseases. Furthermore, in weedy vineyards, husbandry practices are implemented with difficulty (i.e. tillage).

Some of the vineyards are small family estates for personal use and the others are large vineyards of vine growers famous for a high quality of wine production. White grape varieties such as Graševina, Kraljevina and Štajerska belina and red varieties such as Portugizac and Frankovka dominate the preferences of the growers. Inter-row cover crops in vineyards have a significant influence on the vigour of the grapevine (reducing the vigour), which is connected with chemical composition and the organoleptic evaluation of the wine. (KAROGLAN KONTIĆ et al. 1999). In addition, some weed species a have deleterious influence on the quality of wine (HULINA 1998).

Hence, knowledge of weed flora composition and its changes due to geographical and climatic conditions and husbandry management could benefit weed management. In our research, we investigated the weed flora of vineyards.

Materials and Methods

The wine-growing area Jastrebarsko includes two regions: Plešivičko – Okićko and Svetojansko – Slavetičko. In the Svetojansko – Slavetičko region the vineyards at the Bukovac and Petrovina locations were chosen and in the Plešivčko – Okićko region, the Laškovec, Prhoč, Prilipje, Zdihovo locations (Fig. 1).

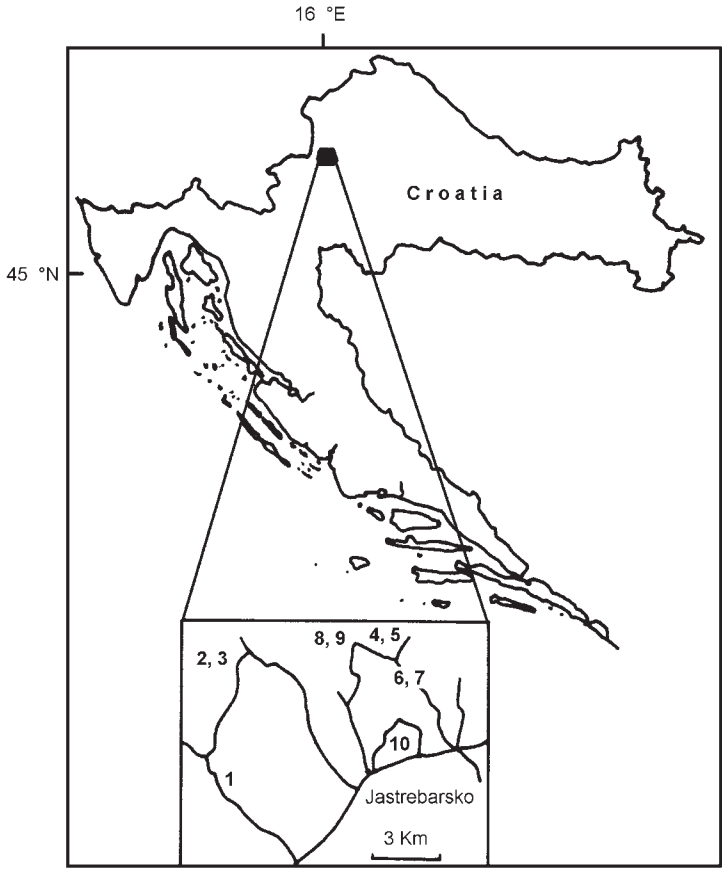

Fig. 1. Investigated area: Plešivica and Jastrebarsko with investigated localities (1 – 10). 1 – Petrovina; 2,3 – Bukovac; 4,5 – Laškovec; 6,7 – Prhoč; 8,9 – Prilipje; 10 – Zdihovo

Two vineyards were investigated at each of the four different localities (Bukovac, Laškovec, Prhoč and Prilipje). One of them was cultivated in the manner of traditional viniculture (on stakes) and the second was cultivated in the manner of modern viniculture (along a wire espalier). The researched vineyards varied in size from 0.15 to 1.2 ha. In total, 4.27 ha of vineyards were surveyed and the presence of weed species was recorded on the total area.

Field observations were carried out every two weeks during the growing season in which the floral composition was researched.

The usual keys and iconography for identification were used (HEGI 1906–1931, HORVATIĆ and TRINAJSTIĆ 1967–1981, KNEŽEVIĆ 1988, TUTIN et al. 1993, DOMAC 1994). The spectrum of life forms for each species is based on GARCKE (1972). The results are presented in alphabetic order of families to which the species belong (Tab.1). Our taxonomic analysis includes the distribution of weeds on dicotyledons and monocotyledons, which is in practice well-known as »broad leafed« and »narrow leafed« weeds. The nomenclature of plants is according to EHRENDORFER (1973).

Tab. 1. The list of weed species in the vineyards in the Jastrebarsko area. Localities: 1 – Petrovina, 2 – Bukovac – wire, 3 – Bukovac – stakes, 4 – Laškovec – wire, 5 – Laškovec – stakes, 6 – Prhoč – wire, 7 – Prhoč – stakes, 8 – Prilipje – wire, 9 – Prilipje – stakes, 10 – Zdihovo. The list is supplemented with the life forms: H – hemicryptophytes, T – therophytes, G – geophytes, P – phanerophytes. Total – frequency of findings

No.	Family/Plant species	Life form	Localities										Total
			1	2	3	4	5	6	7	8	9	10	
	EQUISETACEAE												
1	*Equisetum arvense* L.	G				+							1
	ACERACEAE												
2	*Acer campestre* L.	P	+										1
	AMARANTHACEAE												
3	*Amaranthus lividus* L.	T			+								1
4	*Amaranthus hybridus* L.	T				+				+			2
5	*Amaranthus retroflexus* L.	T				+	+	+			+	+	5
	APIACEAE												
6	*Aegopodium podagraria* L.	H				+					+		2
7	*Daucus carota* L.	H	+		+	+		+				+	5
8	*Heracleum sphondyllium* L.	H									+		1
9	*Pastinaca sativa* L.	H										+	1
10	*Torilis arvensis (*Huds.) Link.	T										+	1
	ASTERACEAE												
11	*Achillea millefolium* L.	H	+	+	+			+	+		+		6
12	*Ambrosia artemisiifolia* L.	T	+					+				+	3
13	*Arctium lappa* L.	H										+	1
14	*Artemisia vulgaris* L.	H										+	1
15	*Centaurea jacea* L.	H			+			+					2
16	*Cirsium arvense* (L) Scop.	G		+		+		+		+		+	5
17	*Conyza canadensis* (L) Cronq.	T							+				1
18	*Erigeron annuus* (L) Pers.	H		+	+			+	+				4
19	*Leucanthemum maximum* (Ramond)DC	H				+							1
20	*Pulicaria dysenterica* (L.)Bernh.	H							+			+	2
21	*Tanacetum vulgare* L.	H						+					1
22	*Tussilago farfara* L.	G				+						+	2
	BORAGINACEAE												
23	*Symphytum officinale* L.	H									+		1

Tab. 1. – continued

No.	Family/Plant species	Life form	Localities										Total
			1	2	3	4	5	6	7	8	9	10	
	BRASSICACEAE												
24	*Armoratia rusticana Gaert.*	H				+				+			2
25	*Brassica rapa* L.	T				+							1
26	*Capsella bursa – pastoris* (L) Med.	T		+		+	+			+	+		5
27	*Cardamine hirsuta* L.	H						+					1
28	*Diplotaxis muralis* (L.)DC.	T	+										1
29	*Rorippa sylvestris* (L.) Besser	H		+									1
	CARYOPHYLLACEAE												
30	*Arenaria serpyllifolia* L.	T		+									1
31	*Stellaria media* (L.)Vill.	T	+	+			+	+			+		5
	CHENOPODIACEAE												
32	*Atriplex patula* L.	T				+							1
33	*Chenopodium album* L.	T		+		+	+	+		+	+		6
34	*Chenopodium polyspermum* L.	T				+							1
	CICHORIACEAE												
35	*Cichorium inthybus* L.	H	+										1
36	*Crepis biennis* L.	H										+	1
37	*Picris hieracioides* L.	H			+	+		+	+				4
38	*Senecio vulgaris* L.	T				+	+	+					3
39	*Sonchus arvensis* L.	G		+	+		+	+					4
40	*Sonchus oleraceus* L.	T			+	+				+			3
41	*Taraxacum officinale* Wiggers	H	+									+	2
	CONVOLVULACEAE												
42	*Calystegia sepim* (L) R.Br.	G	+	+			+	+				+	5
43	*Convolvulus arvensis* L.	G		+	+		+		+				4
	CORNACEAE												
44	*Cornus sanguinea* L.	P										+	1
	DIPSACACEAE												
45	*Knautia arvensis* (L.) Coult.	H		+									1
	EUPHORBIACEAE												
46	*Euphorbia villosa* W.K.	H					+						1
47	*Euphorbia helioscopia* L.	T		+		+		+		+			4
	FABACEAE												
48	*Lathyrus pratensis* L.	H										+	1
49	*Lathyrus tuberosus* L.	G				+		+					2
50	*Lotus corniculatus* L.	H						+					1
51	*Medicago lupulina* L.	T			+	+							2
52	*Medicago sativa* L.	H				+							1
53	*Medicago falcata* L.	H						+					1
54	*Trifolium pratense* L.	H		+		+	+	+			+	+	6

Tab. 1. – continued

No.	Family/Plant species	Life form	Localities										Total
			1	2	3	4	5	6	7	8	9	10	
55	*Trifolium repens* L.	H		+	+	+		+					4
56	*Vicia cracca* L.	T	+									+	2
	GERANIACEAE												
57	*Geranium dissectum* L.	T	+										1
58	*Geranium molle* L.	T						+					1
	LAMIACEAE												
59	*Calamintha vulgaris* (L.)Druce	H			+								1
60	*Glechoma hederacea* L.	H									+	+	2
61	*Lamium maculatum* L.	H										+	1
62	*Lamium purpureum* L.	H	+	+	+		+			+	+		6
63	*Mentha arvensis* L.	H										+	1
64	*Prunella vulgaris* L.	H				+			+				2
65	*Salvia verticillata* L.	H				+							1
66	*Stachys palustris* L.	H				+						+	2
	LYTHRACEAE												
67	*Lythrum salicaria* L.	H	+									+	2
	MALVACEAE												
68	*Malva sylvestris* L.	H								+	+		2
	OXALIDACEAE												
69	*Oxalis fontana* Bunge	T					+						1
	PLANTAGINACEAE												
70	*Plantago lanceolata* L.	H		+				+				+	3
71	*Plantago major* L.	H			+			+					2
	POACEAE												
72	*Agropyron repens* (L.)P.B.	G					+	+					2
73	*Arrhenatherum elatius* (L.)J. et K.Presl.	H										+	1
74	*Cynodon dactylon* (L.)Pers.	G				+							1
75	*Dactylis glomerata* L.	H									+	+	2
76	*Echinochloa crus – galli* (L.) PB.	T	+			+	+	+					4
77	*Festuca arundinacea* Schreb.	H						+					1
78	*Lolium multiflorum* Lam.	T						+					1
79	*Poa pratensis* L.	H	+	+								+	3
80	*Poa trivialis* L.	H										+	1
81	*Setaria faberi* Herrm.	T				+	+						1
82	*Setaria glauca* (L.) PB.	T						+		+			2
83	*Setaria verticillata* (L.) PB.	T				+	+			+			3
84	*Sorghum halepense* (L.) Pers.	G				+	+						2
	POLYGONACEAE												
85	*Fallopia convolvulus* (L.) A. Love	T				+						+	2
86	*Polygonum aviculare* L.	T	+		+						+		3

Tab. 1. – continued

No.	Family/Plant species	Life form	Localities										Total
			1	2	3	4	5	6	7	8	9	10	
87	*Polygonum lapathifolium* L.	T						+					1
88	*Rumex acetosella* L.	H	+										1
89	*Rumex conglomeratus* Muray	H									+		1
90	*Rumex crispus* L.	H	+		+		+		+				4
91	*Rumex obtusifolius* L.	H						+					1
	PORTULACACEAE												
92	*Portulaca oleracea* L.	T				+							1
	PRIMULACEAE												
93	*Anagallis arvensis* L.	T				+	+						2
	RANUNCULACEAE												
94	*Ranunculus repens* L.	H	+									+	2
	RESEDACEAE												
95	*Reseda lutea* L.	H				+							1
	ROSACEAE												
96	*Geum urbanum* L.	H										+	1
97	*Potentilla reptans* L.	H	+				+					+	3
98	*Rubus caesius* L.	P				+						+	2
	RUBIACEAE												
99	*Galium aparine* L.	T										+	1
100	*Galium mollugo* L.	H						+					1
	SALICACEAE												
101	*Salix alba* L.	P										+	1
	SCROPHULARIACEAE												
102	*Antirrhinum oronitum* L.	T									+		1
103	*Kickxia spuria* (L.) Dum.	T					+						1
104	*Linaria vulgaris* Mill.	G			+								1
105	*Veronica persica* Poir.	T		+			+				+		3
	SOLANACEAE												
106	*Solanum nigrum* L.	T			+		+	+		+			4
	URTICACEAE												
107	*Urtica dioica* L.	H										+	1
	VALERIANACEAE												
108	*Valeriana officinalis* L.	H				+							1
	VERBENACEAE												
109	*Verbena officinalis* L.	T				+		+					2

Results and Discussion

In the vineyards surveyed in the Jastrebarsko region a total of 109 weed species within 35 families were recorded, composed of 33 families of dicotyledons, 1 family of monocotyledons and 1 family of pteridophytes (Tab. 2).

Tab. 2. The list of families supplemented with the number of species and percentages of the total number of species (%)

Family	No. of species	% of total
Poaceae	13	11.93
Asteraceae	12	11.01
Fabaceae	9	8.26
Lamiaceae	8	7.34
Cichoriaceae	7	6.42
Polygonaceae	7	6.42
Brassicaceae	6	5.50
Apiaceae	5	4.59
Scrophulariaceae	4	3.67
Amaranthaceae	3	2.75
Chenopodiaceae	3	2.75
Rosaceae	3	2.75
Caryophyllaceae	2	1.83
Convolvulaceae	2	1.83
Euphorbiaceae	2	1.83
Geraniaceae	2	1.83
Plantaginaceae	2	1.83
Rubiaceae	2	1.83
Aceraceae	1	0.92
Boraginaceae	1	0.92
Cornaceae	1	0.92
Dipsacaceae	1	0.92
Equisetaceae	1	0.92
Lythraceae	1	0.92
Malvaceae	1	0.92
Oxalidaceae	1	0.92
Portulacaceae	1	0.92
Primulaceae	1	0.92
Ranunculaceae	1	0.92
Resedaceae	1	0.92
Salicaceae	1	0.92
Solanaceae	1	0.92
Urticaceae	1	0.92
Valerianaceae	1	0.92
Verbenaceae	1	0.92
	109	100.00

Our taxonomic analysis shows that weed flora was predominantly composed of dicotyledons with 87.15%. The rest were monocotyledons with 11.93% and only one species (*Equisetum arvense* L.), which belongs to the class Pteridophyta. The most important families according to the number of species were Poaceae, Asteraceae and Fabaceae. These findings reflect the influence of the indigenous flora (HULINA 1991).

In vineyards that were fertilized with rotted manure in autumn and with chemical fertilizers in spring *Capsella bursa*-pastoris, *Chenopodium* album, *Cirsium arvense, Euphorbia helioscopia* L.*, Trifolium pratense* and *T. repens* L. were recorded. In vineyards that were well fertilized only with rotted manure *Heracleum sphonyllium* L. and *Aegopodium podagraria* L. were recorded.

The findings of *Achillea millefolium, Daucus carota* and *Trifolium pratense* correlate with data by HULINA (1979) for vineyards that were hoed up once a year.

The highest number of species was found in two vineyards: one of them was abandoned (Zdihovo – 35 species), and the other was planted in the year 2002 (Laškovec – 38 species). Both were free of herbicide use. The abandoned vineyard also has species that were noted only in this vineyard (for example, *Arctium lapa* L., *Artemisia vulgaris* L., *Galium aparine* L., *Geum urbanum* L.). This confirms the findings of SENDTKO (1999), which concluded that the first five years after abandonment are characterised by ruderal species that come up from the seed bank or from propagule sources next to the former vineyards. *Cornus sanguinea* L. and *Salix alba* L. were also found in this vineyard.

The species *Stachys palustris* L. was recorded in the vineyard of Laškovec. This is an unusual species for vineyards, because it grows on wet soils (OBERDORFER 1949). But in Laškovec the soil has an impermeable layer that makes for a very moist habitat, which explains the finding of *Stachys palustris* in vineyard on the Jastrebarsko area.

It is interesting to point out the findings of *Amaranthus retroflexus* (5) *Artemisia vulgaris* (1), *Capsella bursa – pastoris* (5) and *Daucus carota* (5), because these species have a deleterious impact on grape and wine quality. The seeds of *Amaranthus spp*., containing phenols, have a particularly bad influence on the quality of wine (HULINA 1998). Also, the inter-row cover in vineyards has a significant influence on the chemical composition and organoleptic evaluation of the wine such as contents of sugar, must acidity and the balance of tataric and malic acids (KAROGLAN KONTIĆ et al. 1999). In ecological grape growing (KAROGLAN KONTIĆ and KAROGLAN TODOROVIĆ 1996) 41 species were recommended for the inter-row cover crop. Only 10 of these species were noted in our vineyards and only three species in more than three vineyards: *Trifolium pratense* (6), *T. repens* L. (4), *Poa pratensis* L. (3).

The very dangerous weed with an allergenic pollen *Ambrosia artemisiifolia* (ragweed), native to North America, is one of the most common weeds in Croatia. In the Jastrebarsko area, *Ambrosia artemisiifolia* expanded from ruderal habitats to habitats with hoe cultures such as vine and maize (TOPIĆ 1984)

The number of species mentioned here is in agreement with HULINA (1979) who determined 89 species in the viniculture areas, on the eastern part of Medvednica, in research into the impact of hoeing on vineyards weed flora. In addition, PLAVŠIĆ-GOJKOVIĆ et al. (1986) in the Jastrebarsko district noted 72 species in vineyards where herbicides were used and in those with classical farming techniques, especially hoeing. VRBEK (2000) determined 66 weed species in the vineyards in the wider Žumberak area. PUJADAS SALVÁ and

HERNÁNDEZ BERMEJO (1988) quote 119 species that were found in vineyards of southern Spain. There farmers make probably more extensive use of herbicides and ploughing in the Jastrebarsko area.

The spectrum of life forms of the weeds in the vineyards of the Jastrebarsko area shows the predomination of hemicryptophytes (51.38%), followed by therophytes (34.86%), geophytes (10.09%) and phanerophytes (3.67%) (Fig. 2). The domination of hemicryptophytes is in line with the continental Central European geographical position of Croatia, and also a consequence of extensive agriculture. We can also conclude that the finding of the highest number of therophytes in a new vineyard (Laškovec, Fig.3) is a consequence of intensive tillage.

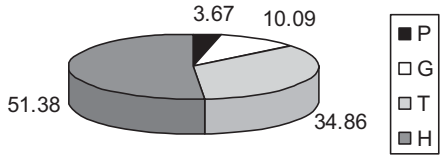

Fig. 2. The spectrum of life forms – total (H – hemicryptophytes, T – therophytes, G – geophytes, P – phanerophytes)

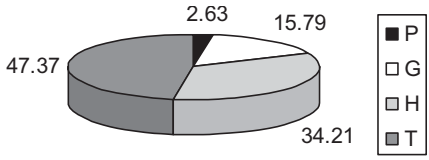

Fig. 3. The spectrum of life forms for Laškovec wire cultivation (H – hemicryptophytes, T – therophytes, G – geophytes, P – phanerophytes)

The existence of weed flora in vineyards as well as in the other agro-ecosystems is dependent on environmental conditions and the influence of agricultural techniques. No-plough tillage management has increased the abundance of weeds.

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