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SEASONAL DYNAMICS OF THE WEED POPULATION IN ESTABLISHED ALFALFA (*Medicago sativa* L.) IN PELAGONIA REGION, REPUBLIC OF MACEDONIA

Zvonko Pacanoski[1]

ABSTRACT

Survey of seasonal dynamics of the weed population in established alfalfa was conducted during 2006-2008 in Pelagonia region Republic of Macedonia. The objective of this study was to identify weeds of importance and to determine qualitative and quantitative structure of weed population in individual cuts and years of growing in established alfalfa. The weed population consisted mainly of perennial and annual winter grasses and some broadleaf weeds. Weed species and weed density decreases from the first to the fourth cut, but increases with the years of alfalfa growing, from second to the fourth year. During the floristic research in all years of alfalfa growing, 36 weed species were registered and determined. Anthemis cotula (average of 11.5 plants m^{-2}), Digitaria sanguinalis (14.3) and Millium vernale (27.5) were the most dominant weeds in the second, third and fourth year of alfalfa growing, respectively. From the taxonomic aspect, the weed flora was distributed in 11 families. Twenty five weed species were dicotyledons and 11 weeds were monocotyledons. The most abundant species were from the families Poaceae and Asteraceae (11 weed species). Therophytes were dominant life form category (24 weed species), although their number significantly decreased from first to fourth cut every year. The number of hemicryptophytes increased with the years of alfalfa growing, from second to the fourth year. Only the presence of geophytes was more or less constant, regardless of cuts and year of alfalfa growing. Detected weed population indicated habitat with favorable thermal and light regimes, slightly acid to neutral soil pH, moderately moist and medium to high supply of nitrogen and nitrogen-containing compounds.

Key words: Weed population, life forms, ecological indices, Lucerne.

INTRODUCTION

Alfalfa (*Medicago sativa*) is one of the most important forage legumes cultivated in the world. Unlike annual cropping systems, alfalfa management differs greatly due to its perennial habit of growth. The alfalfa crop remains in the field for several growing seasons and

[1] Faculty for Agricultural Sciences and Food, Skopje, R. Macedonia E-mail: zvonko_lav@yahoo.com

harvested several times each season. Therefore, specific management practices in alfalfa will affect floristic composition of the weed population (Kojić and Šinžar, 1985). In seedling alfalfa (the first year of growing) the weed population consists mainly of annual spring and summer broadleaf weeds (Pavlović *et al.,* 2004; Kostov and Pacanoski, 2006). Terophytes are the most dominant life form category in the first year of the alfalfa growing (Pavlović *et al.,* 2004; Kostov and Pacanoski, 2006). During the next years of alfalfa growing (established alfalfa), quantitative and qualitative structure of weed population is changed (Mladenović, 1979; Knežević, 1981). The weed population consists mainly of perennial and annual winter grass and some broadleaf weeds (Johnson, 2006). The presence of terophytes decreases, but the presence of the other life form categories (hemicryptophytes, hamephytes and geophytes) increases (Knežević, 1981; Pavlović *et al.,* 2004). Cutting has considerable effect on the dynamics of the seasonal development of weed population in established alfalfa, as well. Each cut is characterized by specific weed population (Nikolić, 1976; Banjska, 1977). Taking into consideration all previous mentioned facts, the objective of this study was to identify seasonal dynamics of the weed population in established alfalfa in Pelagonia region and to determine qualitative and quantitative structure of weed population with detailed taxonomic analysis and life form spectrum analysis as a basis for planning effective weed control measures, especially proper herbicides choice.

MATERIALS AND METHODS

The field studies were conducted during 2006-2008 in established alfalfa (second, third and fourth year) in Pelagonia region Republic of Macedonia on Molic-vertic gleysol cumuligleyic (Filipovski, 2006) with 27.10% coarse, 47.30% fine sand, 25.60% clay+silt, 1.46% organic matter and pH 6.0. The research activities were carried out in herbicide non treated alfalfa fields. In these fields, the marked areas were 0.5 ha in size where the total weed species composition was found out. Detailed weed population analysis were made in $1m^2$ plots, 8 replicates placed evenly on each marked area, before every cuts. The collected plant material was identified by using appropriate literature i.e. keys for identification (Kojić, 1981; Domac, 1984; Klapp and Optiz von Beberfeld, 1990). Floristic analysis of the weed species includes: analysis of life forms and analysis of eecological indices were run. Life forms were determined according to Kovačević (1976) and Oberdorfer (2001). Ecological indices for each species were recorded following Kojić and Janjić (1994).

RESULTS AND DISCUSSION

Unlike seedling alfalfa, the weed population in established alfalfa in Pelagonia region was consisted mainly of perennial and annual winter

grasses and some broadleaf weeds. The number of weed species and weed density decreases from the first to the fourth cut, but increases with the years of alfalfa growing, from second to the fourth year (Tables-1, 2 and 3). During the floristic research in the second year of alfalfa growing, 20 weed species were registered and determined (Table-1). Maximum weed species were recorded in the first cut (12) followed by the second and third (8). Minimum weed species were counted in the fourth cut (7). The highest weed density was registered in the first cut (152.8 plants m^{-2}). Weed density in the second and third cut was similar (28.3 and 23.5 plants m^{-2}, respectively), while in the fourth was lowest (13.9 plants m^{-2}). The average weed density for all cuts was 54.7 plants m^{-2}. The most numerous weeds in the second year of alfalfa growing were: *Anthemis cotula* (average of 11.5 plants m^{-2}), *Cirsium arvense* (9.3), *Taraxacum officinale* (6.3) and *Alopecurus myosuroides* (6.0). Sheaffer and Wyse (1982) found that *Taraxacum officinale* is very problematic weed in stands of dormant alfalfa in Minnesota. *Cirsium arvense* is one of the most troublesome perennial weeds in established alfalfa grown, particularly for seed production (Mesbah and Miller, 2003).

Twenty eight weed species were found during the third year of alfalfa growing (Table-2). Number of weed species was qualitatively and quantitatively the most expressed in the first cut. It included 15 species with weed density of 218.5 plants m^{-2}. Weeds number and weeds density in the other cuts were significantly lower. In the second cut 11 weed species were registered, and weed density was 56.9 plants m^{-2}. Nine weed species were determined in third and fourth cuts, respectively. Weed density in the third cut was slightly higher in comparison with second cut, because of dominance of *Digitaria sanguinalis* (50.3 plants m^{-2}). Weed density was lowest in the fourth cut (27.6 plants m^{-2}). The average weed density for all cuts was 94.1 plants m^{-2}. The most abundant weeds in the third year of alfalfa growing were: *Digitaria sanguinalis* (average of 15.0 plants m^{-2}) and *Alopecurus myosuroides* (14.3).

In the fourth year of growing, established alfalfa was weedy with 25 weed species (Table-3). Similar to previous years, maximum weed species were recorded in the first cut (16) followed by the second and third (11), respectively while, minimum species were counted in the fourth cut (10). The highest weed density was registered in the first cut (276.7 plants m^{-2}). The weed density in the other cuts was significantly lower (61.7; 46.0 and 33.7 plants m^{-2} in the second, third and fourth cut, respectively). The average weed density for all cuts was 104.5 plants m^{-2}. The most dominant weed in the fourth year of alfalfa growing was *Millium vernale* (average of 27.5 plants m^{-2}). Similar results were obtained by Banjska (1977) and Knežević (1978).

Table-1. Floristic composition of the weed population in established alfalfa in Pelagonia region (second year).

Family	Weeds species	Life form	Cuttings					Ecological indices of species				
			I	II	III	IV	Mean	T	L	F	R	N
			No. m^{-2}									
Asteraceae	*Anthemis cotula*	T	45.5	0.5	-	-	11.5	4	4	2	3	3
Asteraceae	*Taraxacum officinale*	H	25.8	-	0.3	1.3	6.9	3	4	3	3	4
Asteraceae	*Cirsium arvense*	G	24.5	5.3	2.0	5.5	9.3	4	3	3	3	4
Poaceae	*Alopecurus myosuroides*	T	23.8				6.0	5	4	2	3	3
Brassicaceae	*Capsell bursa-pastoris*	T	11.0	-	-	-	2.8	3	4	2	3	4
Poaceae	*Apera spica-venti*	T	9.5	-	-	-	2.4	4	3	3	2	4
Asteraceae	*Lactuca scariola*	T	6.8	-	-	-	1.7	5	4	2	3	3
Scrophulariaceae	*Veronica hedirifolia*	T	2.5	-	-	-	0.6	4	3	3	3	4
Fabaceae	*Vicia striata*	T	1.0	-	-	-	0.3	5	3	2	4	3
Poaceae	*Bromus molis*	T	1.0	-	-	-	0.3	4	4	3	3	4
Asteraceae	*Tanacetum vulgare*	H	0.8	1.8	-	-	0.6	4	4	2	3	3
Poaceae	*Poa trivialis*	T	0.8	-	-	-	0.2	3	3	3	3	4
Asteraceae	*Cichorium intybus*	H	-	2.5	-	-	0.6	4	5	2	4	3
Asteraceae	*Erigeron Canadensis*	T	-	6.5	3.3	2.5	3.0	4	4	2	3	3
Asteraceae	*Chondrila juncea*	H	-	6.5	1.8	-	2.1	5	4	2	3	3
Plantaginaceae	*Plantago major*	H	-	3.3	0.8	1.3	1.4	3	4	3	3	4
Asteraceae	*Sonchus asper*	T	-	2.0	-	-	0.5	4	4	3	4	4
Poaceae	*Digitaria sanguinalis*	T	-	-	6.3	1.8	2.0	4	4	2	3	2
Poaceae	*Setaria viridis*	T	-	-	5.5	1.0	1.6	4	4	2	3	4
Poaceae	*Echinochloa crus-galli*	T	-	-	3.5	0,5	1.0	4	3	3	3	5
	Total weed species	20	12	8	8	7						
	Total weeds (No. m^{-2})		152.8	28.3	23.5	13.9	54.7					

Table-2. Floristic composition of the weed population in established alfalfa in Pelagonia region (third year).

Family	Weeds species	Life form	Cuttings					Ecological indices of species				
			I	II	III	IV	Mean	T	L	F	R	N
			No. m^{-2}									
Poaceae	*Alopecurus myiosuroides*	T	57.0				14.3	5	4	2	3	3
Poaceae	*Poa pratensis*	T	29.5				7.4	3	4	3	3	3
Asteraceae	*Chondrila juncea*	H	20.0	7.3	4.8	1.5	8.4	5	4	2	3	3
Brassicaceae	*Capsella bursa-pastoris*	T	19.8				5.0	3	4	2	3	4
Brassicaceae	*Arabidopsis thaliana*	T	19.5				4.9	3	4	3	3	3
Poaceae	*Millium vernale*	T	17.0				4.3	3	2	3	3	3
Poaceae	*Bromus molis*	T	16.0				4.0	4	4	3	3	4
Brassicaceae	*Thlaspi arvense*	T	12.5				3.1	3	3	3	3	4
Poaceae	*Apera spica-venti*	T	7.8				2.0	4	3	3	2	4
Poaceae	*Bromus arvensis*	T	4.8				1.2	4	3	2	3	3
Asteraceae	*Matricaria chamomila*	T	3.8				1.0	4	4	3	3	3
Asteraceae	*Tanacetum vulgare*	H	3.3	12.8	2.5		4.7	4	4	2	3	3
Asteraceae	*Lactuca scariola*	T	3.0				0.8	5	4	2	3	3
Asteraceae	*Anthemis cotula*	T	2.5				0.6	4	4	2	3	3
Asteraceae	*Cirsium arvense*	G	2.0	10.8	2.3	1.8	4.2	4	3	3	3	4
Plantaginaceae	*Plantago lanceolata*	H		0.8	0.8	2.3	1.0	3	3	2	3	3
Convolvulaceae	*Convolvulus arvensis*	G		0.5	3.0		2.0	4	4	2	4	3
Asteraceae	*Crepis setosa*	T		6.3			1.6	5	4	1	3	4
Asteraceae	*Erigeron canadensis*	T		0.5	2.0	1.8	1.1	4	4	2	3	3
Caryophilaceae	*Gypsophila muralis*	T		2.5	4.8		1.8	4	4	3	2	1
Poaceae	*Lolium multiflorum*	H		14.3			3.6	4	4	3	3	4
Asteraceae	*Taraxacum officinale*	H		0.8			0.2	3	4	3	3	4
Polygonaceae	*Rumex acetosa*	H		0.3			0.1	3	4	3	3	3
Poaceae	*Setaria viridis*	T			2.5	3.8	1.6	4	4	2	3	4
Poaceae	*Digitaria sanguinalis*	T			50.3	9.8	15.0	4	4	2	3	2
Plantaginaceae	*Plantago major*	H				1.3	3.2	3	4	3	3	4
Portulacaceae	*Portulaca oleracea*	T				1.5	0.4	4	4	3	3	4
Poaceae	*Echinochloa crus-galli*	T				3.8	1.0	4	3	3	3	5
	Total weed species	28	15	11	9	9						
	Total weeds (No. m^{-2})		218.5	56.9	73.0	27.6	94.1					

Table-3. Floristic composition of the weed population in established alfalfa in Pelagonia region (fourth year).

Family	Weeds species	Life form	Cuttings					Ecological indices of species				
			I	II	III	IV	Mean	T	L	F	R	N
			No. m^{-2}									
Poaceae	*Millium vernale*	T	109.8				27.5	3	2	3	3	3
Brassicaceae	*Arabidopsis thaliana*	T	54.0				13.5	3	4	3	3	3
Caryophilaceae	*Stellaria media*	T	28.5				7.1	3	3	3	3	4
Asteraceae	*Anthemis cotula*	T	26.3				6.6	4	4	2	3	3
Scrophulariaceae	*Veronica hederifolia*	T	22.0				5.5	4	3	3	3	4
Brassicaceae	*Thlaspi arvense*	T	15.3				3.8	3	3	3	3	4
Asteraceae	*Crepis setosa*	T	5.8				1.5	5	4	1	3	4
Poaceae	*Apera spica-venti*	T	3.5				0.9	4	3	3	2	4
Poaceae	*Alopecurus myiosuroides*	T	3.5				0.9	5	4	2	3	3
Asteraceae	*Tanacetum vulgare*	H	3.3	11.5	4.0	2.3	5.3	4	4	2	3	3
Poaceae	*Bromus molis*	T	1.8				0.5	4	4	3	3	4
Asteraceae	*Cirsium arvense*	G	1.5	10.5	5.8	4.3	5.5	4	3	3	3	4
Asteraceae	*Taraxacum officinale*	H	0.5	4.3	2.5	1.5	2.2	3	4	3	3	4
Poaceae	*Bromus arvensis*	T	0.3				0.1	4	3	2	3	3
Poaceae	*Lolium multiflorum*	H	0.3				0.1	4	4	3	3	4
Convolvulaceae	*Convolvulus arvensis*	G	0.3	1.5	2.8	1.5	1.5	4	4	2	4	3
Asteraceae	*Chondrila juncea*	H		7.8	5.8	4.8	4.6	5	4	2	3	3
Asteraceae	*Cichorium intybus*	H		2.8	2.0	1.0	1.5	4	5	2	4	3
Plantaginaceae	*Plantago lanceolata*	H		2.5			0.6	3	3	2	3	3
Apiaceae	*Daucus carota*	H			2.0		0.5	4	4	2	3	2
Rubiaceae	*Galium mollugo*	H		2.5		5.0	1.9	4	3	3	3	4
Caryophilaceae	*Gypsophila muralis*	T		2.8	3.0		1.5	4	4	3	2	1
Asteraceae	*Erigeron Canadensis*	T		2.0	1.8	1.5	1.3	4	4	2	3	3
Poaceae	*Setaria viridis*	T		13.5	4.0	3.0	5.1	4	4	2	3	4
Poaceae	*Digitaria sanguinalis*	T			12.3	8.8	5.3	4	4	2	3	2
	Total weed species	25	16	11	11	10						
	Total weeds (No. m^{-2})		276.7	61.7	46.0	33.7	104.5					

Taxonomic analysis of weed population in established alfalfa in Pelagonia region (Table-4) shows that all registered and determined weed species (36) belong to division *Angiospermae* (*Magnoliophyta*). Twenty five weed species were dicotyledons (class *Magnoliatae*) and 11 weed species were monocotyledons (class *Liliatae*). The weed flora was distributed in 11 families. The most abundant species were from the families *Poaceae* and *Asteraceae* (11 weed species). The weed species which belonging to these families are major problem of alfalfa stands establishment in Pelagonia region.

Table-4. Taxonomic analysis of weed population in established alfalfa in Pelagonia region.

Division	Class	Species		Family	Species	
		No	%		No	%
Angiospermae (Magnoliophyta)	Magnoliatae (Dicotyledons)	25	69.4	Apiaceae	1	2.8
				Asteraceae	11	30.6
				Brassicaceae	3	8.3
				Caryophilaceae	2	5.6
				Convolvulaceae	1	2.8
				Fabaceae	1	2.8
				Plantaginaceae	2	5.6
				Polygonaceae	1	2.8
				Portulacaceae	1	2.8
				Rubiaceae	1	2.8
				Scrophulariaceae	1	2.8
	Liliatae (Monocotyledons)	11	30.6	Poaceae	11	30.6

Although terophytes were the most dominant category in the life form spectrum of weed population in established alfalfa during all research period (24 weed species), their number significantly decreased from first to fourth cut every year (Table-5). Unlike terophytes, the number of hemicryptophytes increased with the years of alfalfa growing, from second to the fourth year (5, 7 and 8, respectively). Only the presence of geophytes was more or less constant, regardless of cuts and year of alfalfa growing (1 and 2, respectively). On the contrary, Pavlović *et al.*, (2004) found that the hemicryptophytes (55%) were predominance life form category in the established alfalfa in Čačak region. The other categories, terophytes and geophytes, paricipated with 42% and 3%, respectively. Similar results were obtained by Knežević, (1978) who concluded that in established alfalfa in eastern Slavonija and Baranja hemicryptophytes dominated in biological spectrum with 48.0%, followed terophytes with 44.2%, and other categories with 7.8%.

Domination of therophytes in established alfalfa indicates a high level of farm technology before alfalfa sowing: good soil cultivation, quality seed material, as well as adequate alfalfa spring sowing.

Table-5. Life form categories of weed population in established alfalfa in Pelagonia region.

				Life form categories		
				Therophytes	**Hemicryptophytes**	**Geophytes**
Years	2nd	**Cuts**	I	9	2	1
			II	3	4	1
			III	4	3	1
			IV	4	2	1
			Total	14	5	1
	3rd		I	12	2	1
			II	3	6	2
			III	4	3	2
			IV	5	3	1
			Total	19	7	2
	4th		I	11	3	2
			II	3	6	2
			III	4	5	2
			IV	3	5	2
			Total	15	8	2
Total (for all years)				**24**	**10**	**2**

Ecological indices for the weed population in established alfalfa in Pelagonia region are presented in Table-6. The analysis of the ecological index for temperature showed a predominance of species which have optimal growth in warm habitats, labelled with the index T_4 (20 species). Eleven weed species are adapted to moderately warm habitats and 5 weed species are adapted to very warm habitats (T_3 and T_5 indices, respectively). The average value of temperature index (3.8) confirmed that habitat has favourable thermal regime.

According to ecological index for light, 23 weed species were having optimal growth under full daylight (L_4 index). 11 weed species were adapted to semi-shade habitats (L_3 index). Non significant was number of species (1) adapted to very shade and very sunny habitats (L_1 and L_5 indices, respectively). The high light intensity at the studied habitat was indicated by the average value of light ecological index (3.7).

Ecological index for humidity (F) indicated that 20 weed species were mesophytes, labelled with the index F_3. They were adapted to moderately moist soils. Significant number of weed species (15) was sub-xerophytes, labelled with the index F_2, which were adapted to

relatively dry habitats. Only one species was adapted to dry habitats, labelled with the index F_1. The average value of humidity index (2.5) was an indication of moderate soil moisture.

The analysis of the ecological index for chemical reaction of soil (R) indicated predominance of weed species with index R_3 (30) which were adapted to soil with slightly acidic to neutral pH. Only few weed species (2 and 4, respectively) with indices R_2 and R_4 were adapted to soils with acid and alkaline pH. The average value of this ecological index (3.1) showed that chemical reaction of studied soil was slightly acidic to neutral.

Ecological index for the content of nitrogen and nitrogen-containing compounds (N) indicated predominance of weed species with indices N_3 and N_4, which mean they develop optimally in habitats with medium to high supply of nitrogen and nitrogen-containing compounds. Only one species was adapted to very low (N_1) and very high (N_5) contents of biogenous mineral substances, respectively. 2 weed species have optimal growth on soils with low content of nitrogen and nitrogen-containing compounds. The average value of this ecological index is 3.4. It means that studied soil have medium to high supply of nitrogen and nitrogen-containing compounds.

Table-6. Ecological indices for weed population in established alfalfa in Pelagonia region.

Ecol. value	Ecological indices of species									
	T		L		F		R		N	
	No. of species	%	No. of species	%	No. of species	%	No. of species	%	No of species	%
1	-	-	-	-	1	2.8	-	-	1	2.8
2	-	-	1	2.8	15	41.7	2	5.6	2	5.6
3	11	30.6	11	30.6	20	55.6	30	83.3	16	44.4
4	20	55.6	23	63.9	-	-	4	11.1	16	44.4
5	5	13.9	1	2.8	-	-	-	-	1	2.8
Average	**3.8**		**3.7**		**2.5**		**3.1**		**3.4**	

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