doi:10.14720/aas.2019.113.1.04 Original research article / izvirni znanstveni članek

The effect of weed frequency in the overall alfalfa (*Medicago sativa* L.) productivity, case study from Kosovo

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Received January 04, 2018; accepted January 25, 2019.
Delo je prispelo 04. januarja 2018, sprejeto 25. januarja 2019.

ABSTRACT

Alfalfa (*Medicago sativa* L.) represents an important leguminous forage crop in farming as well as in systems of animal husbandry. It is known for its wide usage for grazing, hay, silage as well as in the form of green manure and cover crop. Our study aims to assess the influence of weeds on quality and quantity of three different aged alfalfa plots. A list of registered weed plant species divided by harvesting periods on each of the surveyed plots is offered. The biomass productivity and its correlation to the effects of artificial fertilizers, alfalfa age and the frequency of weeds are provided. We concluded that using mineral fertilizers in a controlled manner will help to reduce considerably the amount of weeds and also that alfalfa crops will be best to be replaced after four years as its productivity will start afterwards to drop sharply, whereas the number and frequency of weeds will increase conversely.

Key words: alfalfa; weed management; forage crops

IZVLEČEK

UČINEK PLEVELOV NA PRIDELEK LUCERNE (*Medicago sativa* L.), VZORČNA ŠTUDIJA S KOSOVA

Lucerna (*Medicago sativa* L.) predstavlja v kmetijstvu pomembno krmno metuljnico kot integralni del živinorejskih sistemov. Njena uporabnost je zelo široka, od paše, priprave sušene krme, silaže, kot zeleno gnojilo in pokrovna rastlina. Namen te raziskave je oceniti vpliv plevelov na količino in kakovost pridelka lucerne na treh različno starih posevkih. Vključena je lista plevelov, ki so se pojavljali na teh ploskvah v odvisnosti od časa košnje. Produkcija biomase je prikazana v odvisnosti od učinkov gnojenja z mineralimi gnojili, starosti posevka in pogostosti plevelov. Na osnovi rezultatov lahko zaključimo, da lahko uporaba mineralnih gnojil na primeren način znatno zmanjša količino plevelov in, da je potrebno posevek lucerne zamenjati po štirih letih, ker njegova donosnost potem obdobju znatno upade, poveča pa se zapleveljenost.

Ključne besede: lucerna; upravljanje plevelov; krmne rastline

1 INTRODUCTION

Among all of the forage crops, alfalfa is considered to be one of the most important one due to being source of proteins, minerals, particularly vitamin A (Raoofi et al., 2014; Karimi, 2007) and also due to its verified role in improving soil structure as well as multiplier of other ecological functions and its unique ability to grow in semiarid areas (Gu et al., 2018; Zhao et al., 2004; Jefferson & Cutforth, 1997). Alfalfa's forage yield is entirely dependent on a variety of factors, like soil conditions, rainfall availability and soil moisture (Fan et al., 2016). This indicates its high water demand and also reflects its biological ability of nitrogen fixation (Shabani et al., 2017; Wang et al., 2018). Anyhow, one of the biggest challenges in alfalfa's yield productivity still remains the presence of weeds, which harshly compete with the main plant for sources of light, moisture and nutrients (Wilson, 1997). Besides of suppressing the overall alfalfa yield, weeds can also impact the densities of alfalfa stands (Becker et al., 1998). In many studies it has been proven that weed interference with alfalfa also causes reduction in quality as well as yield quantity, decreasing its trade price for about 46 % (Boschetti et al., 1998; Wilson & Burgener, 2009; Riley & Bradley, 2014) and its overall density by 20-30 % (Temme et al., 1979), all this being followed by drastic reduction of alfalfa nutritional values (Doll,

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1986). Weeds also do interfere with alfalfa in other aspects, like reducing alfalfas' edibility (Marten et al., 1987), seedling efficiency (Fischer et al., 1988) and also altering the forage normal composition, increasing as a result the drying time (Doll, 1986).

It has been noted that in particular, alfalfa seedlings are vulnerable to weed competition, as they are not impetuous enough to compete with weeds, and this, as with many other crops, results in reduced yields (Zimdahl, 2004; Wilson, 1981).

Knowing all this, regrettably, weeds in forage crops have not had sufficient attention and this will surely lead to serious quality and quantity damages of alfalfa crop. Additionally, crop nutritional values for livestock feeding will also decrease, an issue that particularly in Kosovo has never been a subject of attention.

This study brings an insight of the weed effect and interference with alfalfa, identification of weed species and their distributional frequency before first, second and third harvest accordingly. Weeds direct affect alfalfa productivity, biomass levels and correlation of these values with alfalfa age, soil and ecological conditions of the given studied site.

2 MATERIAL AND METHODS

Weed survey on alfalfa land parcels was conducted during 2016, starting from April until the end of September. All of the recorded plant species (Annex 1) were identified based on Flora Europaea (Tutin et al., 1964 - 1980) and species naming has followed the Euro Med Checklist (Euro+Med, 2006) nomenclature. We have choosen three alfalfa plots (*Medicago sativa* L. em Vass. – K-22 'Kruševaćka' commercial cultivar) in the village of Zotaj (42º27.051 N, 021º06.854 E) – 20 km south from capital Prishtina. The site is characterized with continental climate, with a mean annual temperature of 10.5 ºC and mean monthly temperatures of 20.6 ºC (July) and –1.4 ºC (January). The mean annual precipitation from 1999 to 2016 was 590 mm, of which months with the highest amount of rainfall are May, October and November. We have analyzed in particular: weed species present, biomass at $1m^2$, alfalfa mass at $1m^2$, weed mass at $1m^2$, overall yield per land parcel as well as weed species composition in floristic terms. Plant material has been surveyd and collected in three different time perioids (first – April/May; second – June/July; third – August/September) – always just before the harvest.

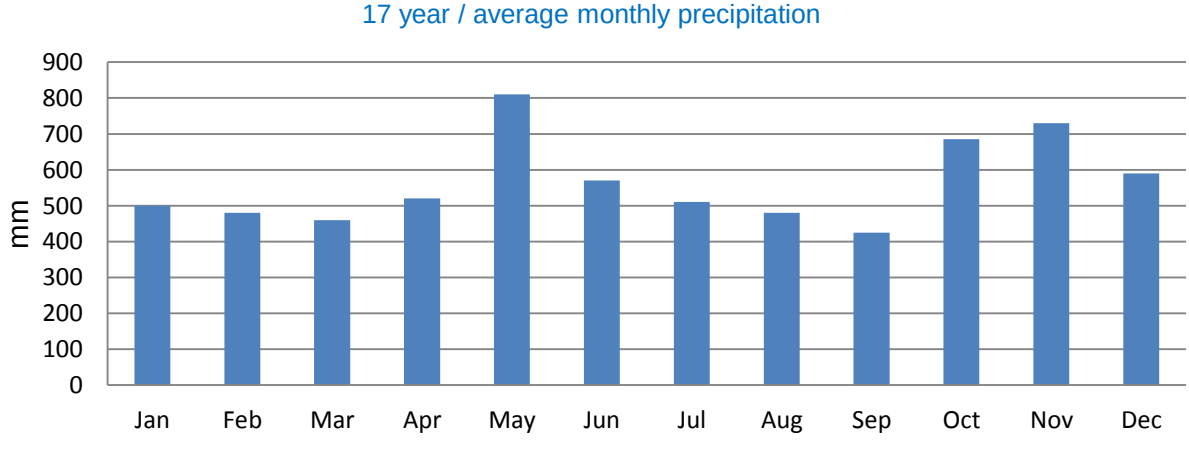

Figure 1: Rainfall data overview for a period of 17 years in Zotaj.

We have selected three alfalfa land parcels and on each of them we have made a total of ten measurements at $1m^2$ – repeatedly before first, second and third harvest. Parcel details are as following: Parcel 1 – sown with alfalfa 6 years ago, has not been treated with mineral fertilizers, previous agricultural crop was wheat, 240 m above sea level (a.s.l). Parcel 2 – sown with alfalfa 4 years ago, treated with mineral fertilizers, previously was ploughed land, 220 m a.s.l. Parcel 3 – sown with alfalfa 2 years ago, treated with mineral fertilizers, previously was ploughed land, 222 m a.s.l. All three parcels were really flat, so we could not indicate their exposition.

3 RESULTS AND DISCUSSION

Knowledge on abundance and distribution of weed species within a given landscape of an agroecosystem is a valuable goal for weed science. Abundance and distribution as measures of the number of individuals in an area and a measure of the geographical range of a weed species accordingly are essential units in this context. The study of weed population's abundance and distribution is helpful in determining how a population changes over time in response to discerning pressures applied by agronomic practices.

During our survey we continuously measured biomass level, alfalfa mass and weed mass at three selected plots of alfalfa and the obtained results are presented in three parts, according to the harvest. We have continually made ten relèves of $1m^2$ on each of the three parcels, at three different pre-harvest periods.

3.1 First preharvest

During the first preharvest period, we made our survey from 27th until the 29th of May 2016. Parcel one (alfalfa 6 years old), after ten relèves had on average 22.5 % weeds and 77.5 % alfalfa. Parcel two (alfalfa 4 years old), after ten relèves had on average 13.8 % weeds and 86.2 % alfalfa. Parcel three (alfalfa 2 years old), after ten relèves had on average 8.2 % weeds and 91.8 % alfalfa. Biomass production at the pre-first harvest period was as following: 1st parcel: 8.2 kg m^{-2}, 2nd parcel: 9.1 kg m^{-2}, 3rd parcel: 11.07 kg m^{-2} (Figure 2).

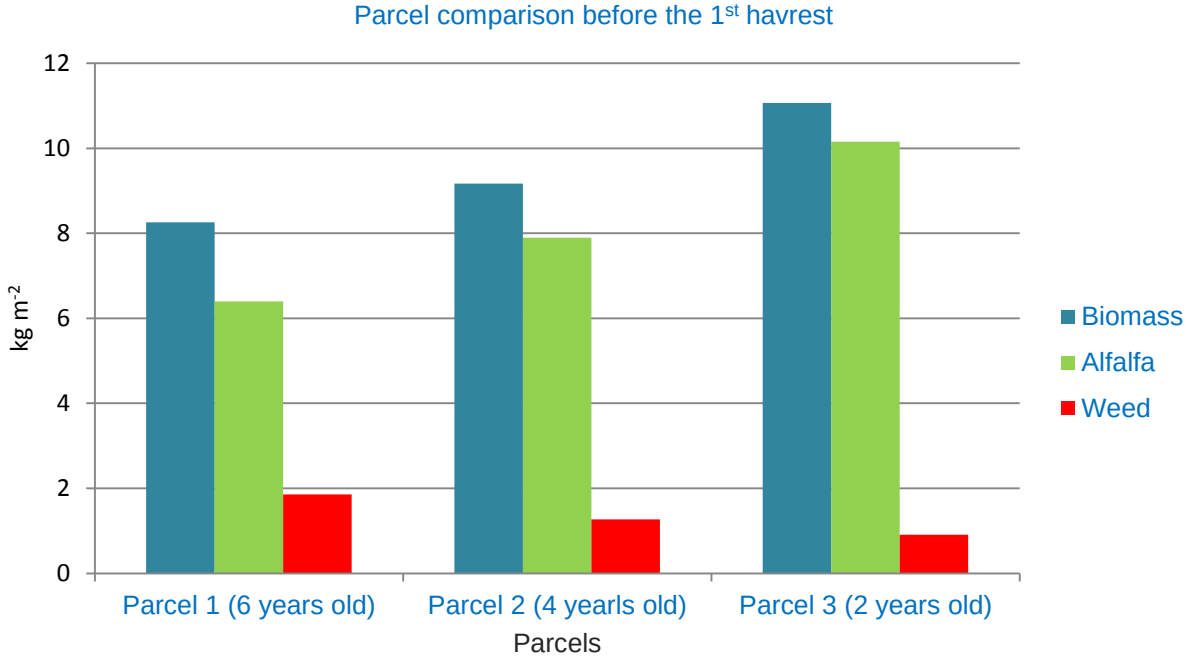

Figure 2: Parcel productivity comparison before the first harvest (kg m^{-2}).

3.2 Second preharvest

During the second preharvest period, we made our survey from 10th until the 12th of July 2016. Parcel one (alfalfa 6 years old) after ten relèves had on average 21.5 % weeds and 78.5 % alfalfa. Parcel two (alfalfa 4 years old), after ten relèves had on average 12.1 % weeds and 87.9 % alfalfa. Parcel three (alfalfa 2 years old), after ten relèves had on average 7.5 % weeds and 92.5 % alfalfa. Biomass production at the second preharvest period was as following: 1st parcel: 7.6 kg m^{-2}, 2nd parcel: 8.2 kg m^{-2}, 3rd parcel: 10.2 kg m^{-2} (Figure 3).

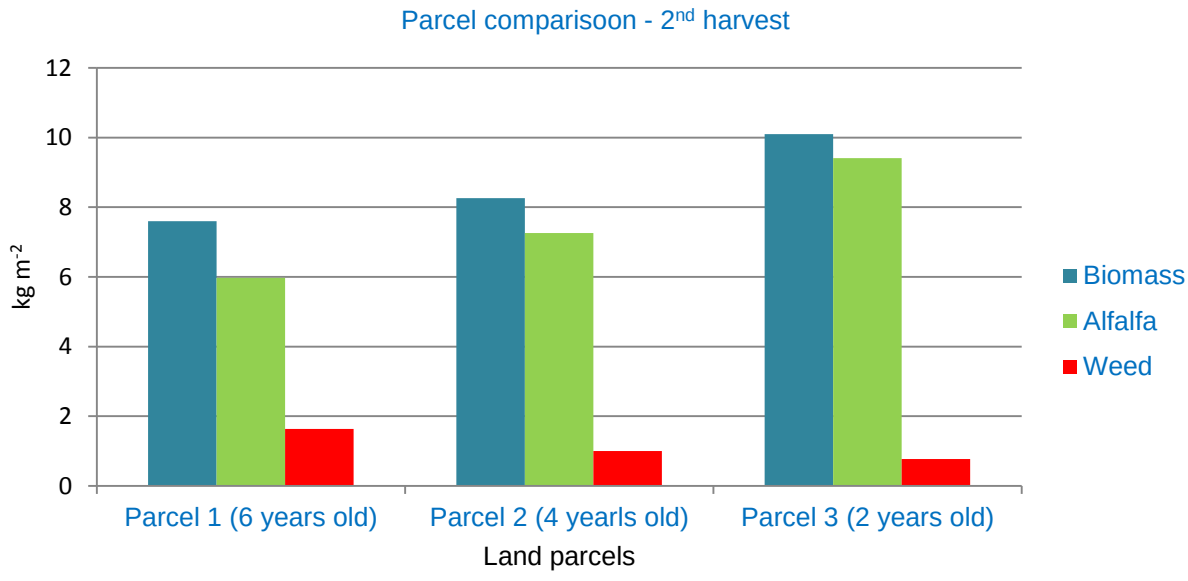

Figure 3: Parcel productivity comparison before the second harvest (kg m^{-2}).

3.3 Third preharvest

During the third preharvest period, we made our survey from 13th until the 15th of September 2016. Parcel one (alfalfa 6 years old), after ten relèves had on average 17 % weeds and 83 % alfalfa. Parcel two (alfalfa 4 years old), after ten relèves had on average 9.8 % weeds and 90.2 % alfalfa. Parcel three (alfalfa 2 years old), after ten relèves had on average 6.05 % weeds and 93.9 % alfalfa. Biomass production at the prethird harvest period was: 1st parcel: 5.8 kg m^{-2}, 2nd parcel: 6.4 kg m^{-2}, 3rd parcel: 8.7 kg m^{-2} (Figure 4).

Significant differences between parcels and preharvest times have been observed (Table 1) regarding the weed species composition, their distribution frequency and the distribution patterns as well as overall yield of alfalfa. Regarding the weed species present, significant differences have been observed between parcel one and parcel three, the same applies to their distribution frequency – and their frequency and presence was higher in the first preharvest time, compared to the third preharvest time..

Table 1: ANOVA statistical table

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	12.6	2	6.3	0.50	0.03	2.2
Within Groups	261.6	21	12.4			
Total	274.3	23				

Differences were also observed in the following aspects: there was much higher productivity of alfalfa in the first preharvest and a drastic reduction in the third preharvest. We have also noticed that the amount and frequency of weeds directly affects the reduction of alfalfa yield.

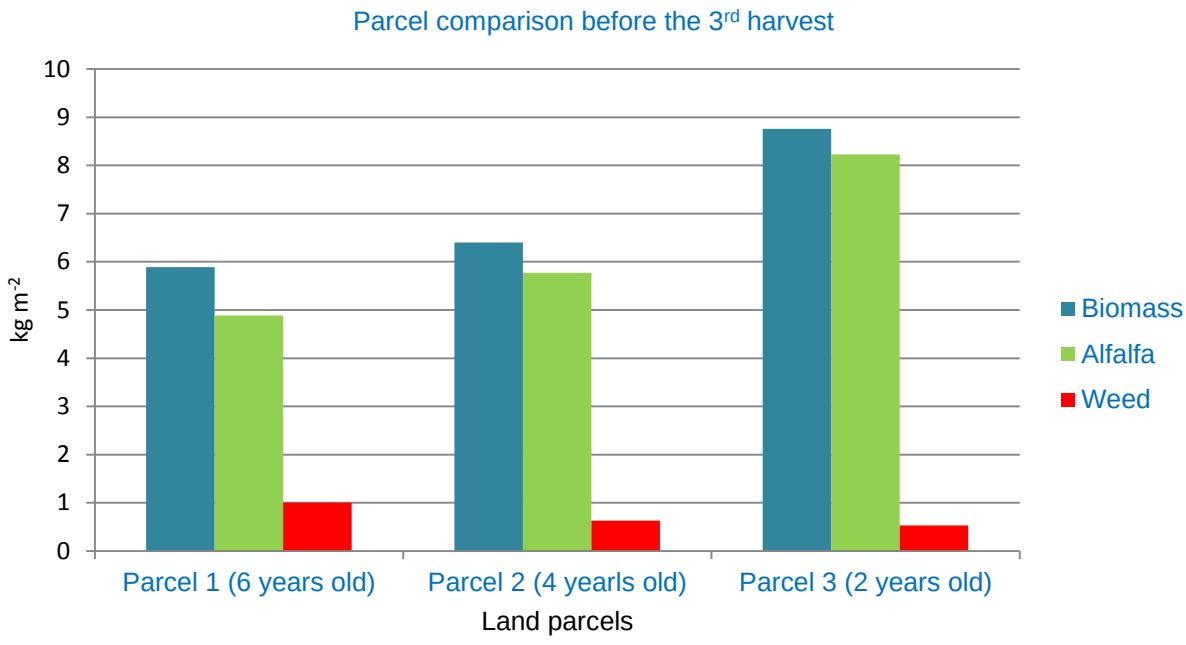

Figure 4: Parcel productivity comparison before the third harvest (kg m^{-2})

It was observed that the number and frequency of weed distribution is directly related to the age of alfalfa stands. As older the alfalfa stand is, the greater will be the number of weeds on that given parcel. The role of mineral fertilizers is also important to be noted here, as it has been observed that alfalfa parcels that were not treated with fertilizers, the frequency of weeds vas much higher.

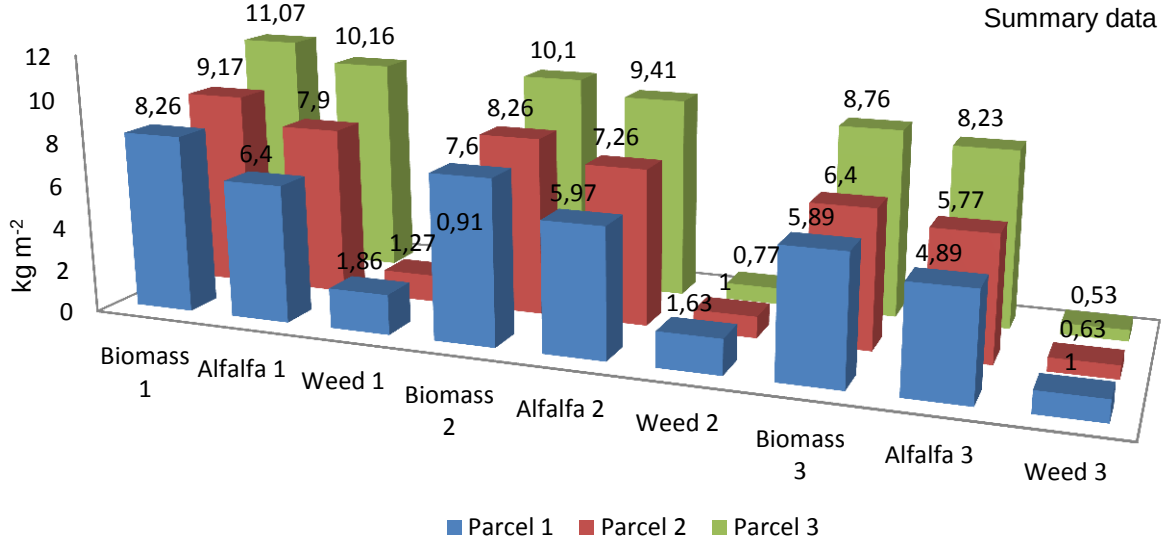

Figure 5: Summary chart of biomass, alfalfa and weed data for all three parcels during three (1, 2, 3) preharvesting periods

4 CONCLUSIONS

Weed frequency is higher during the spring months due to the favorable ecological conditions such as sufficient humidity, solar radiation and biology of weed species. Higher alfalfa yield is expected during the four years from sowingand afterwards a yearly based decrease on yield will be noticed. During the all three pre-harvest periods, the number and frequency of weeds was always higher at the parcel one (alfalfa 6 years old), compared to parcels two and three. Alfalfa productivity was higher at parcel three (alfalfa 2 years old) compared to parcels two and especially parcel one. Predominant weed plant families were: Poaceae (1st pre-harvest), Fabaceae (2nd pre-harvest) and Asteraceae (3rd pre-harvest) while less represented families were Caryophyllaceae (2 %) and Violaceae (1 %) – Figure 5. In total 71 plant species of weeds were recorded (Annex 1) in the surveyed plots. A correlation (Figure 5 & Figure 6) between the increased presence of weeds and the lack of mineral fertilizers has been noted. Biomass productivity was for 29.9 % higher at parcel three, compared to parcel one – which indicated that younger alfalfa is far more productive. As a general conclusion of this work we can state that based on the obtained results in our selected parcels, alfalfa is recommended to be cultivated for up to four years but no longer due to the optimal productivity rates.

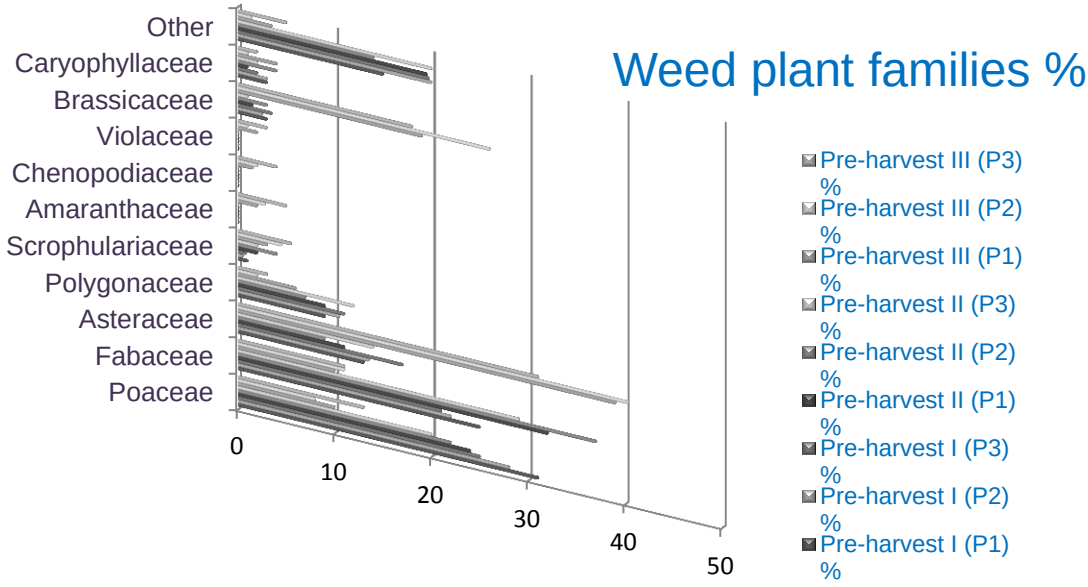

Figure 6: Plant families of weed species according to their pre-harvest time

Annex 1. List of registered weed plant species in three studied alfalfa parcels

Family	Species	Parcel 1			Parcel 2			Parcel 3		
Asteraceae	*Taraxacum officinale* Web.	+			+			+		
	Artemisia vulgaris L.	+		+	+			+		
	Anthemis arvensis L.	+					+			
	Erigeron canadensis (L.) Cronquist	+			+			+		
	Crepis capillaris (L.) Wallr.	+		+		+				
	Matricaria chamomilla L.	+			+			+		+
	Sonchus oleraceus L.	+			+			+		+
	Ambrosia artemisiifolia L.		+					+		
	Cirsium arvense (L.) Scop.	+			+					
	Achillea millefolium L.	+		+				+		
	Cichorium intybus L.		+							
	Galinsoga parviflora Cav.	+			+			+		
Poaceae	*Agropyrum repens* Beauv.				+					
	Bromus inermis Leyss.	+				+				
	Bromus sterilis L.	+			+					
	Cynodon dactylon Pers.							+		
	Digitaria sanguinalis Scop.	+			+					
	Dactylis glomerata L.	+			+					
	Hordeum murinum L.	+					+			
	Lolium perenne L.		+		+					
	Poa annua L.	+			+					
	Poa trivialis L.	+			+			+		
	Poa pratensis L.	+								
	Triticum aestivum ssp. *aestivum* L.		+		+				+	
	Avena sativa L.				+					
	Bromus hordeaceus L.	+			+					
	Setaria viridis (L.) P. Beauv.	+		+	+					
	Festuca pratensis Huds.	+								
	Sorghum halepense (L.) Pers.	+				+				
Polygonaceae	*Persicaria lapathifolia* (L.) Del.		+							
	Rumex crispus L.	+			+					
	Fallopia convolvulus (L.) Á. Lö.	+		+			+			
	Polygonum aviculare L.				+					
Amaranthaceae	*Amaranthus retroflexus* L.		+		+			+		
	Beta vulgaris L.	+			+			+		
Convolvulaceae	*Convolvulus arvensis* L.	+		+		+		+		
Chenopodiaceae	*Chenopodium album* L.	+					+		+	
	Chenopodium hybridum L.	+			+					
Brassicaceae	*Capsella bursa-pastoris* (L.) Medik.	+		+	+	+			+	
	Myagrum perfoliatum L.	+			+					
	Barbarea vulgaris W.T. Aiton		+			+				+
Fabaceae	*Trifolium repens* L.	+			+			+		
	Trifolium pratense L.	+			+			+		
	Onobrychis arenaria (Kit.) DC.	+					+		+	
	Melilotus officinalis (L.) Pallas	+		+	+			+		
	Vicia lutea L.	+				+				
Caryophyllaceae	*Silene vulgaris* (Moench.) Garcke	+	+	+	+		+	+		
	Stellaria media (L.) Vill.	+		+	+			+		
	Silene alba Mill.	+		+	+				+	
Asparagaceae	*Hosta plantaginea* (Lam.) Asch.	+			+					
Plantaginaceae	*Plantago major* L.	+		+	+	+		+		
	Plantago lanceolata L.		+			+				+
	Veronica persica Poirr.	+			+			+		
	Veronica agrestis L.	+		+	+			+		
Geraniaceae	*Geranium sanguineum* L.		+			+				+
	Erodium cicutarium L.		+			+			+	
	Geranium dissectum L.	+	+		+		+	+		
Lamiaceae	*Stachys palustris* L.	+			+			+		
	Salvia nemorosa L.	+			+		+		+	
	Glechoma hederacea L.		+			+		+		
	Stachys annua L.	+			+			+		
Solanaceae	*Solanum nigrum* L.	+			+			+		
Malvaceae	*Malva sylvestris* L.	+			+		+	+		
	Hibiscus trionum L.		+		+					
Apiaceae	*Orlaya grandiflora* (L.) Hoffm.	+			+			+		
	Conium maculatum L.		+			+		+		
Verbenaceae	*Verbena officinalis* L.	+	+		+			+		
Papaveraceae	*Papaver rhoeas* L.	+			+			+		
Violaceae	*Viola sororia* Willd.		+			+				
Euphorbiaceae	*Euphorbia salicifolia* Host.			+					+	
	Euphorbia esula L.		+			+			+	
Total no. of species	**71**									

* Each column within a parcel indicates the pre-harvest period.

5 ACKNOWLEDGEMENTS

We thank the two anonymous reviewers whose comments and suggestions helped improve and clarify our initial manuscript.

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