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Effect of the Residues of the Medicinal Plant *Sideritis scardica*, on Weed Flora in an Organic Sunflower Crop

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Abstract. In the present study, there were studied the effects of plant residues of a widely known aromatic plant (*Sideritis scardica* Griseb) on weed flora and first growth of a sunflower crop. A field and a pot experiment were conducted in Agricultural University of Athens. In particular, the field experiment was conducted under organic conditions, while in the pot experiment special attention was given to the first early growth of sunflower plants under the effect of plant residues. Our results showed that there was a significant effect of plant residues on weed flora and the producted biomass, especially during the first crucial growth stages of sunflower. Particularly, the incorporation of *S. scardica* residues resulted to a lower number of different weed species (low richness) and an intense effect on most weed species. The pot experiment revealed that sunflower seed germination was not affected by the incorporation of *S. scardica* residues. Thus, the activity of *Sideritis sp*. residues was adequately selective (and desirable), since there was not observed any negative effect on sunflower growth.

Keywords: aromatic plants, residues, allelopathy, weed control

INTRODUCTION

Residues of several crops can contribute to integrated weed management systems since their biomass is often produced at high levels and it provides partial weed control, especially during the early stages of crop growth by causing both physical and chemical interference and creating an unfavorable environment for weed germination and establishment (Mohler and Teasdale 1993; Teasdale 1996). Moreover, crop residues remaining on the soil surface or incorporating can significantly reduce weed emergence (Buhler *et al*., 1996; Vidal and Bauman, 1996).

Among the widely studies studied aromatic and medicinal plants, *Sideritis* (also known as ironwort, mountain tea and shepherd's tea) includes plants well known for centuries to man for their noticeable medicinal properties. These species are abundant in Mediterranean regions, with *Sideritis scardica* Griseb. beeing one of the most important among the endemic species of Greece.

Moreover, several aromatic, medicinal and other plants were found to release toxic substances in the environment either through root exudation or decay of their plant residues (Borner, 1960; Chon and Kim, 2004). Although there are many reports on weed suppression by plant residue residues and mulches, weed suppressive ability is strongly affected by plant species (or cultivar) and environmental conditions (Kobayashi, 2004; Dhima *et al*., 2006). In any case, relative studies for crops with enhanced weed suppressive properties are very important in order to reduce herbicide inputs and increase crop yields.

Although numerous studies have examined the effect of cover crop residues on weed suppression, however information on residue effects of *S. scardica* on weed density and biomass and sunflower response at the first early growth stages under the greek conditions is lacking and this was the objective of the present study.

MATERIALS AND METHODS

One field and one pot experiment were conducted during 2012 in the experimental field of Agricultural University of Athens (37^o 59′01.83″ N, 23^o 42′07.37″ E). The soil was a clay loam, whose physicochemical characteristics (0- to 15-cm depth increment) were clay 352 g kg^{-1}, silt 457 g kg^{-1}, sand 191 g kg^{-1}, pH (1:1 H_2O) 7.36, $CaCO_3$ 12 g kg^{-1} and organic matter content of 24.4 g kg^{-1}.

Planting of a sunflower hybrid (Sanay MR) occurred on 3 May of 2012. This is an hybrid commonly used in Greece, and it was planted in rows (70 and 20 cm distances between and within rows).

The experiment was arranged in a randomized complete block design with three replicates and two treatments: a) incorporation of *S. scardica* residues (5.41 kg per plot) and b) Untreated (without any incorporation). Plot size was 4.3 by 5 m. Irrigation and other common cultural practices were conducted as needed during the growing season, while the residues of the medicinal plant came from organically cultivated plants in Greece.

The number and dry weight of the dominant weeds were assessed. A wooden square quadrat (40 × 40 cm) was placed at random three times in each plot. Weeds in the 40 × 40 cm area were counted for each species present, and fresh and dry matter were determined. Weed assessments were made at 51, 63 and 77 days after sowing (DAS) as follows:

1. Density per unit area (no. m^{-2}).
2. Dry weight (g m^{-2}). Weeds were cut and roots were discarded. The remaining material was placed in paper bags in an oven at 70^oC for 48 h.

The species diversity of weeds was characterized using the Shannon-Weiner index (H) (Krebs, 1978; Booth *et al*., 2003):

$$H = -\sum (Pi)(\ln Pi)$$

where *Pi* is the fraction of the weed density belonging to the *ith* species in a given group. The index is increased either by having additional unique species, or by having greater species evenness. The population has a maximum index only when each species in the population is evenly represented. Simpson index was also used (Onaindia, 2004). For calculation of these indices, the software Bio DAP was used.

A pot experiment was also conducted in the greenhouse of Agricultural University of Athens. The experiment was also arranged in a randomized complete block design with eight replicates (pots of 15 L) for each of the two treatments (as in the field experiment). Measurements on seed germination and seedling emergence of sunflower were taken while plant height was also recorded.

Statistical analysis of the results was performed using one-way ANOVA, while mean comparison was performed using Fisher's least signification different (LSD) test at $P < 0.05$ by means of Statsoft package (1996).

RESULTS AND DISCUSSIONS

In some cases, the fresh and dry biomass of the weeds was significantly reduced after *S. scardica* incorporation. In particular, this effect was significant especially until 77 DAS, while later no differences were revealed. However, this finding is of great importance, since weed control is crucial especially at the first early growth stages of the crop (Tab. 1).

Tab. 1

Total fresh and dry matter of weeds sampled in the field experiment

Sampling date	Fresh weight (g)			Dry weight (g)	
	S. scardica	Untreated		*S. scardica*	Untreated
51 DAS	598.8 b	1406.29 a		125.27 b	249.31 a
63 DAS	651.76 a	708.16 a		147.39 a	157.56 a
77 DAS	1151.96 b	1537.48 a		206.67 b	294.87 a
94 DAS	907.09 a	848.76 a		315.67 a	286.95 a
115 DAS	510.36 a	628.47 a		265.61 a	307.61 a

Note: Different letters between treated with *S. scardica* and untreated plots denote significant differences (LSD test, $P < 0.05$) within each sampling date.

Concerning the values of the Shannon-Weiner (H) index, in some cases there were significant differences between the two treatments (Tab. 2). During the first growth stages, the highest values were recorded in plots with *S. scardica* incorporation, whereas weed flora had high species evenness. However, this trend was reversed at the last sampling. According to Booth *et al*. (2003) this index is increased because of emergence of additional unique species and that was the case in our experiment, with late emergence of several weeds. Moreover, it has to be noted the progressively reduced trend during the experimental period for Shannon-Weiner index in the plots of *S. scardica* (reduced richness), while the opposite picture was revealed for Simpson index. This can be attributed to the fact that *S. scardica* progressively controlled and eliminated several weed species, however specific weeds such as *Amaranthus retroflexus* and *Setaria viridis* were favored and finally dominated (resulting to a high Simpson index).

Tab. 2

Shannon-Weiner and Simpson indices for the weed community of the field experiment

Sampling date	Shannon-Weiner index			Simpson index	
	S. scardica	Untreated		*S. scardica*	Untreated
51 DAS	1.49 a	1.22 b		0.28 a	0.44 a
63 DAS	1.39 a	1.49 a		0.33 a	0.28 a
77 DAS	1.32 a	1.11 b		0.32 a	0.40 a
94 DAS	0.66 a	0.74 a		0.66 a	0.57 a
115 DAS	0.56 b	1.11 a		0.70 a	0.38 b

Note: Different letters between treated with *S. scardica* and untreated plots denote significant differences (LSD test, $P < 0.05$) for each index within each sampling date.

The results of our pot experiments revealed that the incorporation of S. scardica residues in the soil did not cause any negative impact on seed germination and seedling emergence of sunflower (data not shown). Moreover, the first growth of sunflower plants was not significantly different from that of the control (Fig. 1). It is also noticeable that from 30 DAS sunflower plants after *S. scardica* incorporation were slightly higher than the untreated ones, probably because of a potential enhancing effect of the residues. Such a positive effect of several allelochemicals at low concentrations has been also reported, since the magnitude of the effect seems to be a combined matter of rate, plant part, conditions and species (Travlos and Paspatis, 2008).

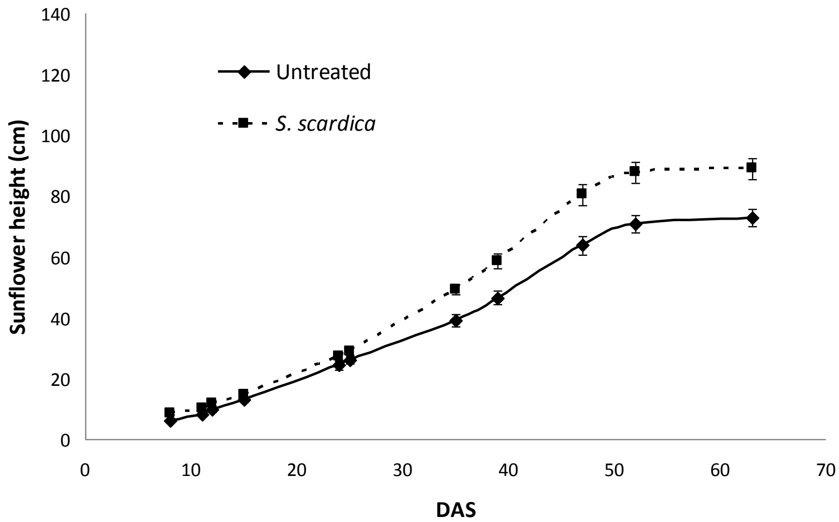

Fig. 1. Time course of sunflower height during the experimental period (pot experiment). Vertical bars denote the standard errors of the means.

Previous studies have shown that *Sideritis* species contain several allelochemicals; terpenes, phenols, flavonoids and many other chemical compounds with various effects (Rios *et al*., 1992; Akcoş *et al*., 1999; Küpeli *et al*., 2007) and this noteworthy phytotoxicity action shown by our studies can be plausibly attributed to the presenve of these allelochemicals.

CONCLUSION

S. scardica residues showed a clear phytotoxic activity against several common and noxious weed species. There were noticeable differences among the several weeds regarding their response to phytotoxical effects of mountain tea, however, the incorporation of *S. scardica* residues resulted to a lower number of different weed species (low richness). Moreover, the absence of negative effects on sunflower crop give to the method gives the method the necessary selectivity. Taking all the above into account and under the view of organic agriculture, integrated weed management and development of more environmentally feasible methods of weed control, the indicated allelopathic activity of plants like *S. scardica* could be exploited and accomplished with future studies focusing on the identification and isolation of the responsive allelochemicals and additional field experiments.

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