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Allelopathic effects of water extracts of *Sorghum halepense* (L.) Pers., *Convolvulus arvensis* L. and *Cirsium arvense* Scop. on early seedling growth of some leguminous crops

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SUMMARY

In order to study the allelopathic effect of aboveground dry biomass of *Sorghum halepense, Convolvulus arvensis* and *Cirsium arvense* on seed germination and early seedling growth of *Pisum sativum* (L.), varieties Mir (winter form) and Kerpo (spring form); *Vicia sativa* (L.), variety Tempo, and *Medicago sativa* (L.), variety Dara, a laboratory experiment was conducted at the Institute of Forage Crops - Pleven. Four concentrations: 1.25, 2.5, 5.0 and 10.0% were applied to each weed biotype used to study allelopathic effects. The results showed that weed extracts significantly decreased germination percentage, shoot and root length (cm), shoot and root weight (g), and seed vigor index (SVI_1 and SVI_2) of the tested species. In general, the variable effects are related to the weed species and extract concentrations.

Keywords: Allelopathy; Weeds; Plant extracts; Leguminosae

INTRODUCTION

One of the problems studied in organic farming is weed control and interspecies relationships between crops and weeds. It requires a selection of more competitive crops or an increase in crop competitiveness in order to reduce weed competition.

Allelopathy is a direct or indirect, beneficial or harmful effect of one plant on another through the production of secondary compounds (allelochemicals) and their release into the environment in sufficient quantity to cause recordable effects (Cheema et al., 1998; Khalid et al., 2002; Aleksieva and Serafimov, 2008). Allelochemicals are synthesized and accumulated in different plant parts (root, stem, leaves, flowers and fruits, etc.) and released into the environment by evaporation, decomposition and elution of weed residues which have an inhibitory effect on the germination, growth and development

of a number of crops. In order to determine allelopathic relationships between weeds and crop plants, Moosavi et al. (2011) and Nouri et al. (2012) used plant extracts from dry weed biomass because such extracts had significantly higher concentrations than plants occurring in agrophytocenoses. The relatively low competitiveness of some legumes [*Pisum sativum* (L.) and *Vicia sativa* (L.)] during their early seedling growth, makes weeds a limiting factor in the production of grain and green biomass (Маринов-Серафимов and Димитрова, 2007). Holm et al. (1977) and Gustavsson (1997) described *Sorghum halepense*, *Convolvulus arvensis* and *Cirsium arvense* as species belonging to a group of "the world's worst weeds".

The purpose of this study was to determine the allelopathic effects of aboveground biomass of *S. halepense*, *C. arvensis* and *C. arvense* on seed germination and early seedling growth of *Pisum sativum* (L.), varieties Mir (winter form) and Kerpo (spring form); *Vicia sativa* (L.), variety Tempo, and *Medicago sativa* (L.), variety Dara.

MATERIALS AND METHODS

The experiment was conducted under laboratory conditions at the Institute of Forage Crops – Pleven during 2012 to study the allelopathic effects of *S. halepense*, *C. arvense and C. arvensis on the germination and* early seedling growth *of P. sativum, V. sativa and M. sativa*.

Plant and seed material: Aboveground biomass (leaves and stems) of *S. halepense*, *C. arvense* and *C. arvensis* was collected at the stage BBCH 65 (*Hess* et al., *1997).* All samples were cut to 0.5-3.0 cm length and dried to constant dry weight at 60 ± 3^0C and then ground. Seeds of *P. sativum*, varieties Mir (winter form) and Kerpo (spring form); *V. sativa*, variety Tempo, and *M. sativa*, variety Dara, were used in a germination test. The seeds were surface-sterilized for 20 minutes with 1% NaOCl (4% NaOCl commercial bleach), then rinsed three times with distilled water (Siddiqui et al., 2009).

Extraction procedure: Aqueous extract was prepared by soaking 100 grams of the powdered material of each weed (*S. halepense*, *C. arvense* and *C. arvensis)* in 1 L of distilled water at 24 ± 2^0C for 24 h. After that, cold aqueous extract was filtered using Whatman filter paper. The stock solution (10% w/v) was diluted appropriately with distilled water to give the final concentrations of 1.25, 2.5, 5.0 and 10.0%. Thymol ($C_{10}H_{14}O$) was added to each extract as a preserving agent (Marinov-Serafimov et al., 2007a).

Bioassay for growth: Ten seeds (Hassan et al., 2012) of the test species (*P. sativum*, *V. sativa* and *M. sativa)* were placed between filter paper in 9.0 cm diameter Petri dishes. The Petri dishes were irrigated with extract solutions at ratios from 1:6 to 1:20 to the seed weight (Marinov-Serafimov et al., 2007b), and distilled water was used as control. Each treatment was replicated five times. Petri dishes were placed in a germinator at 22^0C ± 2^0 C for seven days. A biochemical analysis of the aboveground biomass was performed to determine the contents of: cyanogenic glucosides (Ермаков et al., 1987), total phenols (Swain and Hillis, 1959) and condensed tannins (Terrill et al., 1992). The pH of aqueous extract was determined with pH meter. Distilled water was used for the control.

Data analysis. Seedling performance was assessed through relative seed germination (RSG), relative elongation of root + shoot (RERS) and relative weights of root + shoot (RWRS) by the formulas of Asgharipour and Armin (2010):

RSG=(number of seeds germinated in extract/number of seeds germinated in control)×100;

RERS=(mean root+shoot elongation in extract/mean root+shoot elongation in control)×100;

RWRS=(mean root+shoot weight in extract/mean root+shoot weight in control)×100.

Mean time to germination (MTG) is an index of seed germination rate (Ellis and Roberts, 1981) and calculated by:

MTG=(∑(Dn))/(n), where n is the number of seeds that had germinated on day D and D is the number of days counted from the beginning of germination.

The seedling vigour index (SVI_1 and SVI_2) was calculated according to Abdul–Baki and Anderson (1973) by using the equations:

SVI_1=average shoot+root length (cm)×germination (%).

SVI_2=average shoot+root weight (g)×germination (%).

Speed of germination (SG) was computed by using the formula:

SG=N1/D1 + N2/D2 + N3/D3 +...+ Nn/Dn; where N1, N2, N3 ... Nn is the number of seedlings emerged on D1, D2, D3,... Dn days after sowing (Patil, 2007).

Statistical analysis: The collected data were analyzed using the software Statgraphics Plus for Windows Ver. 2.1. The percentage of germinated seeds in each variant was previously transformed by the formula:

$Y = \arcsin \sqrt{(x_{\%}/100)}$ (Hinnkelmann and Kempthorne, 1994). To determine the LC_{50} of weed extracts, the software Trimmed Spearman-Karber, Ver. 1.5, based on Hamilton et al. (1978), was used.

RESULTS AND DISCUSSION

The 1% extracts of aboveground biomass of *S. halepense, C. arvense* and *C. arvensis* showed inhibitory effects on seed germination of *P. sativum, V. sativa* and *M. sativa* ranging from 42.0 to 87.5% for all treatments (Figure 1). With increasing concentrations of weed extract (from 1.25 to 10.00%), the percentage of germinated seeds decreased from 12.50 to 58.00% in all treatments, compared with the control. Based on the percentage of inhibition of seed germination of *P. sativum*, *V. sativa* and *M. sativa* (depending on extract), two groups were conditionally formed: I - group from 27.89 to 31.12% (Kerpo, Mir and Tempo), and II - group over 40.93% (Dara). The variety Dara was an exception to this as the extract of *S. halepense* caused its 100% inhibition at the highest concentration. Very small seeds make contact with the aqueous extract easily, so that even low concentrations can cause an immediate negative effect (Shang and Xu, 2012).

The LC_{50} values were determined depending on the effect of concentrations of cold water extracts of *S. halepense*, *C. arvensis* and *C. arvense* on the germination of seeds of *P. sativum, V. sativa* and *M. sativa* (Table 1). The observed differences in test species can be attributed to genetic differences because comparison between them was performed at under identical conditions. Similar results had been reported by Einhellig (1996), Aleksieva and Serafimov (2008) and in both reports the cultivated plants and varieties showed different sensitivities to weed extracts, the allelopathic effect was species-specific and depended on concentrations.

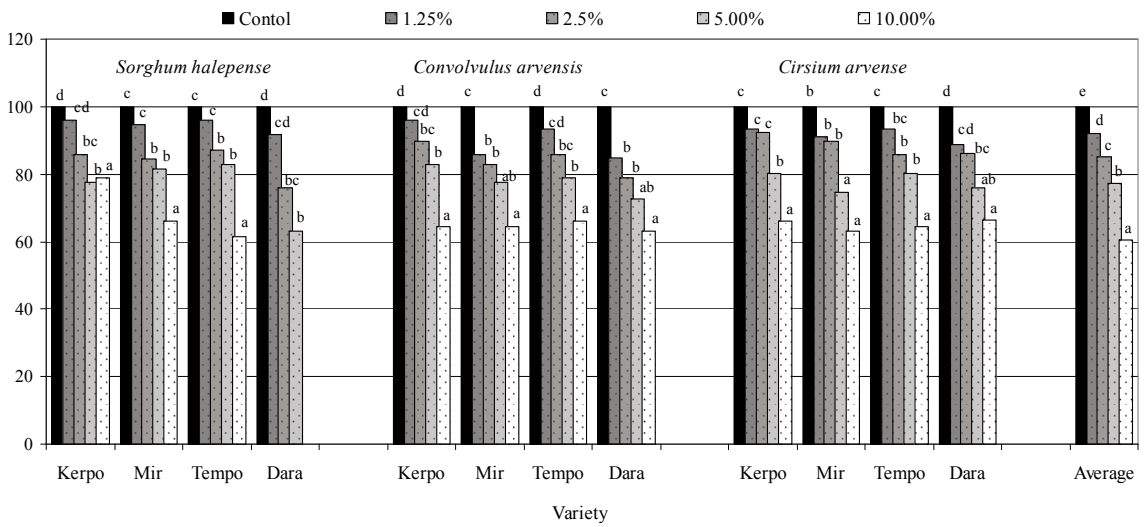

Figure 1. Influence of various concentrations of *S. halepense*, *C. arvensis* and *C. arvense* aqueous extracts on RSG of *P. sativum, V. sativa* and *M. sativa*

Table 1. Allelopathic effect of weed extracts on LC_{50}

Weeds	LC_{50}		
	Sorghum halepense	*Convolvulus arvensis*	*Cirsium arvense*
P. sativum var. Kerpo	70.71* (57.00**÷87.72***)	89.09* (56.70**÷139.99***)	82.49* (54.79**÷124.19***)
P. sativum var. Mir	96.90*(63.85**÷147.05***)	92.31* (66.47**÷128.20***)	91.70* (64.46**÷130.45***)
V. sativa var. Tempo	85.07*(66.13**÷109.42***)	96.22* (58.09**÷159.39***)	82.96* (62.55**÷110.07***)
M. sativa var. Dara	36.03*(29.89**÷43.44***)	74.92* (44.42**126.35***)	93.30* (41.99**÷127.34***)

* LC_{50}; ** - 95% Lower Confidence; *** - 95% Upper Confidence.

Germination of the seeds of test plants depended on concentration and pH of their extracts, ranging from 5.23 to 6.10 as shown in Figure 2.

It is well-known that all parts of weed plants (leaf, stem, root and fruit) have different allelopathic potentials (Alam and Islam, 2002; Tinnin and Muller, 2006). Weeds also exert allelopathic effects on seed germination and growth of plants by releasing water-soluble compounds into the soil that are possible allelopathic components (Ashrafi et al., 2007; Batish et al., 2007). These are mostly cyanogenic glycosides, total phenols and condensed tannins (Fateh et al., 2012). The inhibitory effect of weed extracts on the germination and initial growth of the test plants can be attributed to the presence of allelochemicals (Table 2). Biochemical analysis revealed that the content of total phenols, condensed tannins and cyanogenic glycosides in aboveground biomass varied depending on weed species.

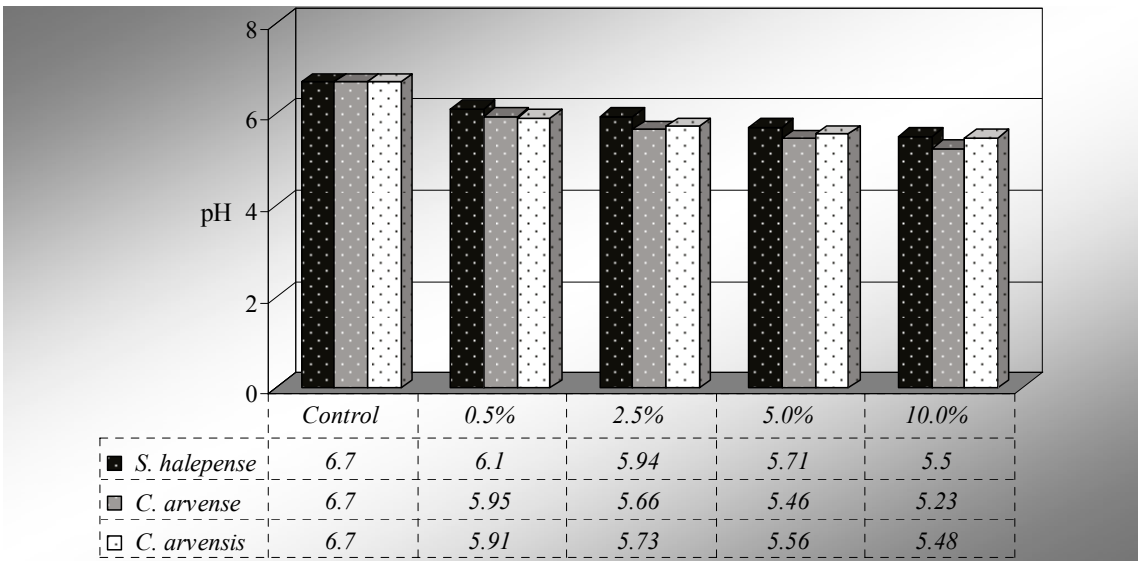

Figure 2. pH of the extracts depending on concentration and type of weed

Table 2. Biochemical analysis of aboveground biomass of *S. halepense, C. arvensis* and *C. arvense*

Weeds	Total phenols (relative units - extinctions)	Condensed tannins (%)	Cyanogenic glycosides (mg HCH/100g)
Sorghum halepense	0.505	1.01	30.23
Convolvulus arvensis	0.976	0.00	15.50
Cirsium arvense	0.734	0.00	3.49

Table 3. The effects of extracts on the germination of seeds of *P. sativum, V. sativa* and *M. sativa*

Cultivars	Weeds	y = a – b.√x	*r*	R^2	P
P. sativum var. Kerpo	*Sorghum halepense*	y = 44.5459 – 3.4603.√x	-0.916	0.957	0.05
	Convolvulus arvensis	y = 46.5298 – 4.9594.√x	-0.948	0.974	0.05
	Cirsium arvense	y = 46.1850 – 4.8120.√x	-0.956	0.978	0.05
P. sativum var. Mir	*Sorghum halepense*	y = 45.5889 – 4.7452.√x	-0.968	0.984	0.01
	Convolvulus arvensis	y = 44.2519 – 4.7903.√x	-0.993	0.997	0.01
	Cirsium arvense	y = 45.8192 – 5.3431.√x	-0.971	0.985	0.01
V. sativa var. Tempo	*Sorghum halepense*	y = 46.6211 – 5.3319.√x	-0.943	0.971	0.05
	Convolvulus arvensis	y = 45.5549 – 4.8588.√x	-0.985	0.992	0.01
	Cirsium arvense	y = 45.7318 – 4.9755.√x	-0.977	0.988	0.01
M. sativa var. Dara	*Sorghum halepense*	y = 48.6798 – 4.8557.√x	-0.914	0.956	0.05
	Convolvulus arvensis	y = 41.5489 – 4.8586.√x	-0.996	0.998	0.01
	Cirsium arvense	y = 42.4994 – 4.5343.√x	-0.995	0.998	0.01

The results confirm the findings of Agarwal et al. (2002), Iqbal et al. (2003), Fateh et al. (2012), Nouri et al. (2012) and Shang and Xu (2012), showing that allelochemicals have an inhibitory and/or lethal effects on seed germination, growth and development of crops. According to these authors, lower concentrations inhibit germination to different degrees, which is probably due to the lower contents of allelochemicals in them, while higher concentrations induce lethal effects on seed germination.

In addition, we detected a high negative correlation (r ranges from -0.914 to -0.995) between seed germination, and the concentration and pH of extracts (Table 3). The effects of the extracts on seed germination of *P. sativum, V. sativa* and *M. sativa* can be expressed as a function: $y = a - b.\sqrt{x}$.

Weed extracts had negative effect on the growth of roots and shoots of the test plants (Tables 4, 5, 6 and 7). Generally, root and shoot length reacted with a significant difference at the 5% level. Exceptions were found for the lowest extract concentrations in the variants *S. halepense - P. sativum* var. Kerpo; *S. halepense - P. sativum* var. Mir; *C. arvensis - V. sativa* var. Tempo; *C. arvense - V. sativa* var. Tempo and *C. arvense - M. sativa* var. Dara, where the differences were nonsignificant.

It can be inferred from the screening results that the degree of inhibition of root and shoot growth depends on the type of extract used and the applied concentration. The most sensitive was *M. sativa* var. Dara (24.96-100.00%), followed by *P. sativum* var. Kerpo (14.76-93.78%), while relatively low sensitivity was seen in *V. sativa* var. Tempo (10.67-88.80%) and *P. sativum* var. Mir (9.24-84.46%).

There was a general trend of fresh biomass reduction in all studied variants, depending on the type and concentration of weed extracts. An exception to such dependence was observed at the lowest applied concentration in the variants *P. sativum* var. Kerpo - C. *arvense* and *V. sativa* var. Tempo - *S. halepense*, which exerted a small stimulatory effect.

The mean germination time of *P. sativum, V. sativa* and *M. sativa* significantly increased in all treatments compared to the control (Tables 4, 5, 6 and 7). The extract of *S. halepense* showed maximum MGT values in all crops. SG, SVI_1 and SVI_2 values decreased statistically with increased extract concentration.

Table 4. The effects of aqueous extracts of *S. halepense, C. arvensis* and *C. arvense* on the germination of *P. sativum* var. Kerpo

Weeds	Treatment concentrations (%)	*RERS*	%	*RWRS*	%	*MGT*	*SG*	SVI_1	SVI_2
S. halepense	0	14.30 c	100.00	0.2664 c	100.00	2.53 a	20.17 e	1430.00 e	26.04 e
	1.25	12.19 c	85.24	0.2618 c	98.27	2.70 b	15.50 d	1171.77 d	24.24 d
	2.5	7.98 b	55.80	0.1988 b	74.62	2.81 c	11.83 c	683.58 c	17.03 c
	5.0	5.79 b	40.49	0.1588 b	59.61	3.08 d	8.50 b	448.97 b	12.31 b
	10.0	0.89 a	6.22	0.0668 a	25.08	3.46 e	7.67 a	70.24 a	5.27 a
C. arvensis	0	14.30 c	100.00	0.2664 c	100.00	2.53 a	20.17 e	1430.00 e	26.04 e
	1.25	9.92 b	69.37	0.2366 bc	88.81	2.87 b	16.50 d	953.57 d	22.16 d
	2.5	8.95 b	62.59	0.2232 bc	83.78	3.10 c	13.50 c	802.09 c	20.00 c
	5.0	7.00 a	48.95	0.2192 b	82.28	3.18 d	11.17 b	580.93 b	18.19 b
	10.0	3.33 a	23.29	0.1576 a	59.16	3.33 e	11.17 a	214.81 a	10.17 a
C.arvense	0	14.30 d	100.00	0.2664 c	100.00	2.53 a	20.17 e	1430.00 e	26.04 e
	1.25	8.78 c	61.40	0.2668 c	100.15	2.78 b	17.33 d	821.22 d	24.15 d
	2.5	7.49 bc	52.38	0.2414 bc	90.62	2.87 c	17.00 c	690.82 c	22.26 c
	5.0	5.66 b	39.58	0.2002 ab	75.15	3.13 d	10.67 b	454.42 b	16.07 b
	10.0	2.67 a	18.67	0.1788 a	67.12	3.17 e	3.83 a	176.29 a	11.81 a

Means sharing the same letters in a column do not differ significantly at 0.05 probability level according to LSD test.

Table 5. The effects of aqueous extracts of *S. halepense, C. arvensis* and *C. arvense* on the germination of *P. sativum* var. Mir

Weeds	Treatment concentrations (%)	*RERS*	%	*RWRS*	%	*MGT*	*SG*	SVI_1	SVI_2
S. halepense	0	16.02 c	100.00	0.2558 c	100.00	2.47 a	20.67 e	1602.00 e	24.64 e
	1.25	14.54 c	90.76	0.2436 c	95.23	2.57 b	18.83 d	1378.84 d	22.54 d
	2.5	9.62 b	60.05	0.2178 bc	85.14	2.63 c	19.00 c	811.25 c	18.37 c
	5.0	8.31 b	51.87	0.1904 b	74.43	2.95 d	14.33 b	678.45 b	15.54 b
	10.0	2.49 a	15.54	0.0776 a	30.34	3.27 e	9.33 a	164.41 a	5.12 a
C. arvensis	0	16.02 c	100.00	0.2558 b	100.00	2.47 a	20.67 e	1602.00 e	23.58 d
	1.25	11.16 b	69.66	0.2552 b	99.77	2.65 b	18.17 d	1031.36 d	25.13 e
	2.5	12.77 bc	79.71	0.2517 b	98.40	2.68 c	17.00 c	971.81 c	21.72 c
	5.0	10.82 b	67.54	0.2140 b	83.66	2.89 d	13.83 b	652.13 b	16.59 b
	10.0	7.10 a	44.32	0.1678 a	65.60	3.06 e	10.92 a	291.57 a	10.82 a
C. arvense	0	16.02 c	100.00	0.2558 bc	100.00	2.47 a	20.67 e	1602.00 e	23.58 e
	1.25	12.76 b	79.65	0.2470 bc	96.56	2.59 b	17.67 d	1160.24 d	22.10 d
	2.5	10.42 b	65.04	0.2178 b	85.14	2.75 c	18.17 c	933.83 c	19.52 c
	5.0	6.22 a	38.83	0.2016 b	78.81	2.83 d	17.17 b	464.97 b	15.07 b
	10.0	3.82 a	23.85	0.1440 a	56.29	3.13 e	5.17 a	240.51 a	9.07 a

Means sharing the same letters in a column do not differ significantly at 0.05 probability level according to LSD test.

Table 6. The effects of aqueous extracts of *S. halepense, C. arvensis* and *C. arvense* on the germination of *V. sativa* var. Tempo

Weeds	Treatment concentrations (%)	*RERS*	%	*RWRS*	%	*MGT*	*SG*	SVI_1	SVI_2
S. halepense	0	19.02 d	100.00	0.1800 c	100.00	2.74 a	17.33 e	1902.00 e	19.22 e
	1.25	15.78 c	82.97	0.1812 c	100.67	2.84 b	14.33 d	1517.05 d	17.56 d
	2.5	13.86 c	72.87	0.1800 c	100.00	3.00 c	12.17 c	1205.63 c	14.75 c
	5.0	11.17 b	58.73	0.1680 b	93.33	3.00 c	10.83 b	927.00 b	13.11 b
	10.0	2.13 a	11.20	0.0644 a	35.78	3.00 c	2.00 a	130.77 a	3.95 a
C. arvensis	0	19.02 d	100.00	0.1804 b	100.00	2.74 a	17.33 e	1902.00 e	16.04 d
	1.25	16.02 b	84.23	0.1762 b	97.67	2.85 b	14.67 d	1498.40 d	18.10 e
	2.5	14.01 b	73.66	0.1634 b	90.58	2.93 c	10.67 c	1200.11 c	14.00 c
	5.0	9.29 a	48.84	0.1100 a	60.98	2.86 d	5.33 b	733.16 b	8.68 b
	10.0	7.37 a	38.75	0.1100 a	60.98	3.00 e	0.67 a	486.77 a	7.49 a
C. arvense	0	19.02 c	100.00	0.1804 bc	100.00	2.74 a	17.33 e	1902.00 e	16.04 d
	1.25	16.99 c	89.33	0.1732 bc	96.01	2.87 b	17.00 d	1589.13 d	16.03 d
	2.5	12.80 b	67.30	0.1728 bc	95.79	2.95 c	13.67 c	1096.27 c	14.80 c
	5.0	9.25 b	48.63	0.1532 b	84.92	2.87 b	8.58 b	742.64 b	12.30 b
	10.0	4.54 a	23.87	0.1148 a	63.64	3.00 d	2.67 a	292.93 a	7.41 a

Means sharing the same letters in a column do not differ significantly at 0.05 probability level according to LSD test.

The results of the present study indicate allelopathic effects of *P. sativum, V. sativa* and *M. sativa* in several leguminous crops. The weed extracts contained water soluble compounds to varying degrees. Those compounds may be released by rain or irrigation and dissolve in water under field conditions. However, natural conditions in organic farming are, more complicated than laboratory bioassays (Mubeen et al., 2011). Therefore, field experiments are necessary before drawing final conclusions on the allelopathic effects of these weed species.

Table 7. The effects of aqueous extracts of *S. halepense, C. arvensis* and *C. arvense* on the germination of *M. sativa* var. Dara

Weeds	Treatment concentrations (%)	*RERS*	%	*RWRS*	%	*MGT*	*SG*	SVI_1	SVI_2
S. halepense	0	6.09 e	100.00	0.0274 c	100.00	2.79 a	17.67 e	609.00 e	2.74 e
	1.25	4.53 d	74.38	0.0220 c	80.29	2.80 b	15.00 d	415.53 d	2.03 d
	2.5	3.12 c	51.23	0.0224 c	81.75	3.09 c	7.33 c	236.59 c	1.70 c
	5.0	1.46 b	23.97	0.0094 b	34.31	3.38 d	4.83 b	92.06 b	0.59 b
	10.0	0.0 a	0.00	0.0000 a	0.00	-	0.00 a	0.00 a	0.00 a
C. arvensis	0	6.09 b	100.00	0.0274 c	100.00	2.79 b	17.67 e	609.00 e	2.74 e
	1.25	3.81 a	62.56	0.0220 b	80.29	2.69 a	10.00 d	322.56 d	1.83 d
	2.5	3.02 a	49.59	0.0188 ab	68.61	3.23 c	8.33 c	238.06 c	1.48 c
	5.0	2.28 a	37.44	0.0168 a	61.31	3.25 d	7.67 b	165.91 b	1.22 b
	10.0	1.88 a	30.87	0.0156 a	56.93	3.67 e	5.00 a	118.54 a	0.98 a
C. arvense	0	6.09 c	100.00	0.0274 c	100.00	2.79 a	17.67 e	609.00 e	2.74 e
	1.25	4.57 c	75.04	0.0216 b	78.83	2.80 b	11.17 d	406.39 d	1.91 d
	2.5	3.77 b	61.90	0.0204 b	74.45	3.21 c	9.00 c	324.57 c	1.76 c
	5.0	2.68 b	44.01	0.0174 a	63.50	3.30 d	6.33 b	203.23 b	1.32 b
	10.0	1.77 a	29.06	0.0170 a	62.04	3.50 e	5.83 a	117.52 a	1.13 a

Means sharing the same letters in a column do not differ significantly at 0.05 probability level according to LSD test.

CONCLUSIONS

The tested extracts of *S. halepense, C. arvensis* and *C. arvense* demonstrated variable allelopathic effects on seed germination and early seedling growth of *P. sativum, V. sativa* and *M. sativa*. Such allelopathic effects depended both on the extract concentration and the weed from which that extract had been derived. Mean germination time of all test species significantly increased compared to the control, but the speed of germination and seedling vigour index (SVI_1 and SVI_2) significantly decreased. *S. halepense*, *C. arvensis* and *C. arvense* growing in farm fields should be controlled at an early stage to avoid their phytotoxic allelopathic effects.

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Alelopatski uticaj vodenih ekstrakta *Sorghum halepense (L.)* Pers., *Convolvulus arvensis* L. i *Cirsium arvense* Scop. na početni razvoj izdanaka nekih leguminoznih useva

REZIME

Kako bi se proučio alelopatski uticaj suve biomase nadzemnih delova biljaka *Sorghum halepense, Convolvulus arvensis* i *Cirsium arvense* na klijanje semena i početni razvoj izdanaka *Pisum sativum* (L.), var. Mir (ozima) i Kerpo (jara); *Vicia sativa* (L.), var. Tempo, i *Medicago sativa* (L.), var. Dara, izveden je laboratorijski eksperiment u Institutu za krmno bilje - Pleven. Četiri koncentracije - 1.25, 2.5, 5.0 i 10.0% - primenjene su na svaku korovsku vrstu kako bi se proučio alelopatski uticaj. Rezultati su pokazali da su ekstrakti korova značajno smanjili procenat klijanja, dužinu izdanaka i korena (cm), težinu izdanaka i korena (g) i indeks vigora semena (SVI_1 i SVI_2) testiranih vrsta. Uopšte, promenljivost delovanja zavisi od korovske vrste i koncentracije ekstrakta.

Ključne reči: alelopatija; korovi; biljni ekstrakti; Leguminosae