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Determination of Allelopathic Effect of Some Invasive Weed Species on Germination and Initial Development of Grain Legume Crops

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SUMMARY

During the 2006-2007 period, the allelopathic effect of cold water extracts from *Amaranthus retroflexus* L., *Chenopodium album* L., *Erigeron canadensis* L. and *Solanum nigrum* L. on seed germination and initial development of *Glycine max* L., *Pisum sativum* L. and *Vicia sativa* L. was studied under laboratory conditions in the Institute of Forage Crops, Pleven. It was found that: water extracts from fresh and dry biomass of *A. retroflexus, Ch. album, E. canadensis* and *S. nigrum* had an inhibitory effect on seed germination of *G. max, P. sativum* and *V. sativa,* the inhibition rate for the extracts from fresh biomass varying from 28.8 to 81.5% and for the extracts from dry weed biomass it was from 26.8 to 89.2%; The values of LC_{50} varied from 13.5 to 72.2 g l^{-1} for the extracts from fresh biomass and from 7.0 to 84.1 g l^{-1} for the extracts from dry weed biomass and they could be conditionally grouped in the following ascending order: *A. retroflexus* < *S. nigrum* < *E. canadensis* <*Ch. album* and for extracts from dry biomass: *A. retroflexus* < *E. canadensis* < *Ch. album* < *S. nigrum; P. sativum* was the most sensitive to the allelopathic effect of the extracts from fresh and dry weed biomass - LC_{50} varied from 13.5 to 21.6 g l^{-1}, followed by *V. sativa* - LC_{50} from 26.0 to 11.7 g l^{-1} and *G. max* had relatively the lowest sensitivity - LC_{50} was from 46.6 to 56.7 g l^{-1}.

Keywords: Allelopathic effect; Weed; Extracts; Inhibition; Seed germination

INTRODUCTION

Annual late spring weeds are main invaders in the crops: soybean (*Glycine max* (L.) Merr.), spring forage pea (*Pisum sativum* L.) and spring vetch (*Vicia sativa* L.). They account for 58-92% of the total weed infestation. The dominant weed species in the studied fields are *Amaranthus retroflexus* L., *Chenopodium album* L., *Erigeron canadensis* L. and *Solanum nigrum* L. (Petrov, 1980; Marinov-Serafimov, 2005; Marinov-Serafimov and Dimitrova, 2007). Steven et al. (1984), Stoimenova (1990) and Nakova (2004) demonstrated that it was difficult to distinguish allelopathy from competition in the plant communities. According to Rice (1995), Grace and Tilman (1990), Inderjit and del Moral (1997), and Willis (2007), the nature of competitive

and allelopathic relation in agrophytocenoses is determined by many factors. The interaction between weeds and cultivated plants is simultaneous and/or subsequent with direct or indirect impact of one plant species on another, through synthesis of different chemical compounds – allelochemicals, that are released in the environment and have an inhibitory and/or stimulatory effect on the seed germination and development of many crops (Iqbal et al., 2003; Kadioglu et al., 2005; Verma and Rao, 2006; Aleksieva and Serafimov, 2008). In a number of studies (of Turk and Tawaha, 2002; Hoque et al., 2003; Vasilakoglou et al., 2006; Ashrafi et al., 2007 and Koloren, 2007) carried out in order to determine the allelopathic interference between weeds and cultivated plants, the extracted plant material from fresh (Gill et al., 2000; Adetayo et al., 2005; Kayode and Ayeni, 2009) or dry weed biomass (Moyer and Huang, 1997; Bruce et al., 1999) was used, the extract concentrations being much higher than those occurring in the agrophytocenoses during falling and decomposition of weed biomass in the soil. The discovery of main regularities in the allelopathic interaction between weeds and cultivated plants in the studied grain legume agrophytocenoses appears to be a major element of the theoretical basis for sustainable plant-growing production.

The objective of the study was to determine allelopathic effect of typical weed invaders on agrophytocenoses of soybean, pea and vetch on the seed germination and initial plant development.

MATERIAL AND METHODS

The study was conducted during the 2007-2009 period under laboratory conditions in the Institute of Forage Crops in Pleven, Bulgaria.

Collection and Preparation of Plant Material: The seeds of the tested grain legume crops - soybean (*Glycine max* (L.) Merr., e.g. cv. Srebrina), spring forage pea (*Pisum sativum* L.,e.g. cv. Pleven 4), and spring vetch (*Vicia sativa* L., e.g. cv. Obrazets 666) - were taken from the operative collection of the Institute of Forage Crops, Pleven. The aboveground biomass of *Amaranthus retroflexus* L., *Chenopodium album* L., *Erigeron canadensis* L. and *Solanum nigrum* L. was collected at the phenological stage 7/71 (Hess et al.,1997) of the weeds from trial plots in a natural environment of weed infestation.

Plant Extracts: The aboveground biomass of available weed species was chopped together to the length of 0.5-3.0 cm (Ebana et al., 2001). Two kinds of weed extracts were prepared: A – from the fresh weed biomass, crushed in advance with quartz sand and B – from dry weed biomass, after drying to a constant dry weight at 55 ± 3^0C and grinding in grinder Retsch SM – 1 at a sieve size of 1.0 mm.

A hundred grams of dry and the same amount of fresh biomass from the available weed species were soaked in 1 l^{-1} distilled water. The samples prepared in such way from fresh and/or dry biomass of each weed species were cold extracted at a temperature of 24 ± 2^0C for 24 h in a shuttle apparatus at 240/60 c^{-1}.

The obtained extracts were decanted, filtered through filter paper and centrifuged in K24 centrifuge at 5000/60 s^{-1}. All available aqueous extracts were brought to weed biomass content of 5, 25, 50 and 100 g biomass per litre of distilled water (presented hereinafter in the text as g/l^{-1}) (Maigahani et al., 2007; Faravani et al., 2008). Thymol ($C_{10}H_{14}O$) was added to each extract as a preserving agent (Marinov-Serafimov et al., 2007).

Bioassays: A number of 100 seeds of *G. max*, *P. sativum* and *V. sativa* were put in plastic containers between filter paper. The seed surface was sterilized before use.

All available extracts, according to the weed biomass content, were pipetted at a ratio of 1:6 as against the seed mass (Marinov-Serafimov et al., 2007). Distilled water was used as a control. Each variant was laid out in five replications.

The samples were then placed in a thermostat-operated device at a temperature of 22^0C $\pm$ 2^0C for seven days.

The following characteristics were determined: Percentage of germinated seeds (%); Length (primary root + hypocotyl in cm), coinciding with the phenological stage 0/08 of the development of *G. max, P. sativum* and *V. sativa* (Weber and Bleiholder, 1990); The inhibition rate (IR) on seed germination and growth of primary seedling were calculated using the formula of Ahn and Chung (2000): [(Control-Aqueous extract)/ Control] x 100; The estimates obtained by application of the programme SPEARMAN were used to determine LC_{50} for weed extracts (Hamilton et al., 1978); The index of initial plant development=INDEX GERMINATIONS (GI) was determined by the formula of Gariglio et al. (2002): $GI = G/G_0 \cdot L/L_0 \cdot 100$; where: G – percentage of germinated seeds in the studied variant; G_0 – percentage of germinated seeds in the control variant; L – average length (cm) of the primary seedling in the studied variant transformed into percentage as against the control variant; L_0 – average length (cm) of the primary seedling in the control variant taken as 100%.

Statistical analysis: Statistical processing of the experimental data was conducted after preliminary

transformation of the percentage of germinated seeds using the following formula:

$$Y = arcsin\sqrt{(x_{\%} / 100)}$$

(Hinkelmann and Kempthorne, 1994). All experimental data were statistically processed using the software STATGRAPHICS Plus for Windows Version 2.1.

RESULTS AND DISCUSSION

The water extracts from aboveground fresh and dry biomass of *A. retroflexus*, *Ch. album*, *E. canadensis* and *S. nigrum* showed an inhibitory effect on the seed germination of *G. max, P. sativum* and *V. sativa*. The inhibition rate (IR) on the seed germination of the tested grain legume crops for the extracts from fresh biomass varied from 28.8 to 81.5% and for those from dry weed biomass from 26.8 to 89.2% (Table 1).

With regard to weed biomass content in water extracts, it was evident that with increase of weed biomass content, the percentage of germinated seed decreased disproportionately in all test plants, as compared to the control variant, the differences being statistically significantly smaller at P=0.05. An exception was found for 5 g l^{-1} fresh and dry weed biomass from *A. retroflexus* in *P. sativum* and *G. max*, where the differences were statistically insignificant (Table 1). This relationship could be explained by the presence of glycol alkaloids and tannins in the studied extracts (Agarwal et al., 2002; Serafimov et al., 2005). It is known that glycol alkaloids and tannins exert strong toxicity with pronounced protoplasmic action (Karakyozov, 1960) and at higher concentrations they have a lethal effect on seed germination, whereas at lower concentrations they inhibit germination to a different extent, which is probably due to their lower content of glycol alkaloids and tannins.

Table 1. Effect of water extracts on germination of seeds of test plants,%

Species	Weed	Contents of the weed biomass in water extracts, g l^{-1}				
		0	5	25	50	100
		Fresh biomass				
Glycine max	*A. retroflexus*	79.5d (0.0)*	54.7c (31.1)*	45.0b (43.3)*	46.9b (41.0)*	33.2a (58.2)*
	Ch. album	79.5d (0.0)*	71.6c (10.0)*	45.0b (43.4)*	39.2b (50.6)*	0.0a (100.0)*
	E. canadensis	79.5d (0.0)*	58.9c (25.9)*	48.8b (38.6)*	48.8b (38.6)*	33.2a (58.2)*
	S. nigrum	79.5b (0.0)*	48.8a (38.6)*	45.0a (43.4)*	41.2a (48.2)*	37.3a (53.1)*
Pisum sativum	*A. retroflexus*	71.6b (0.0)*	45.0ab (37.1)*	33.2a (53.6)*	18.4a (74.2)*	15.0a (79.1)*
	Ch. album	716a (0.0)*	28.9b (59.6)*	31.1b (56.6)*	28.9b (59.6)*	0.0b (100.0)*
	E. canadensis	71.6e (0.0)*	50.8d (29.1)*	46.9c (34.5)*	18.4b (72.4)*	0.0a (100.0)*
	S. nigrum	71.6d (0.0)*	43.1c (39.8)*	31.0a (56.6)*	31.0a (56.6)*	33.2b (53.6)*
Vicia sativa	*A. retroflexus*	75.0d (0.0)*	63.4b (15.5)*	68.6c (8.6)*	18.4a (75.4)*	18.4a (75.4)*
	Ch. album	75.0e (0.0)*	63.0d (15.5)*	45.0c (40.0)*	24.1b (67.9)*	0.0a (100.0)*
	E. canadensis	75.0d (0.0)*	61.1c (18.6)*	21.4b (71.5)*	21.4b (71.5)*	0.0a (100.0)*
	S. nigrum	750e (0.0)*	56.9d (24.3)*	45.0c (40.0)*	21.4b (71.5)*	0.0a (100.0)*
Average		75.4 (0.0)	53.9 (28.8)	42.2 (44.2)	29.8 (60.6)	14.2 (81.5)
		Dry biomass				
Glycine max	*A. retroflexus*	79.5d (0.0)*	68.6d (13.7)*	58.9c (25.9)*	48.8b (38.6)*	37.3a (53.1)*
	Ch. album	79.5d (0.0)*	54.7d (31.1)*	39.2c (50.6)*	35.3b (55.6)*	33.2a (58.2)*
	E. canadensis	79.5d (0.0)*	68.6d (13.7)*	65.9c (17.1)*	63.4b (20.2)*	0.0a (100.0)*
	S. nigrum	79.5b (0.0)*	65.9c (17.1)*	39.2b (50.6)*	0.0a (100.0)*	0.0a (100.0)*
Pisum sativum	*A. retroflexus*	71.6b (0.0)*	43.1c (39.8)*	26.6b (62.9)*	0.0a (100.0)*	0.0a (100.0)*
	Ch. album	716a (0.0)*	46.9c (34.5)*	18.4b (74.2)*	18.4b (74.2)*	0.0a (100.0)*
	E. canadensis	71.6e (0.0)*	50.8d (21.9)*	45.0c (37.1)*	18.4b (74.2)*	0.0a (100.0)*
	S. nigrum	71.6d (0.0)*	42.1c (41.1)*	18.4b (74.2)*	18.4b (74.2)*	0.0a (100.0)*
Vicia sativa	*A. retroflexus*	75.0d (0.0)*	61.1d (18.6)*	50.8b (32.3)*	54.7c (27.1)*	31.1a (58.6)*
	Ch. album	75.0e (0.0)*	58.9d (21.5)*	33.2c (55.7)*	26.6b (64.6)*	0.0a (100.0)*
	E. canadensis	75.0d (0.0)*	57.0c (24.0)*	20.0b (73.4)*	20.0b (73.4)*	0.0a (100.0)*
	S. nigrum	750e (0.0)*	41.4c (44.8)*	24.4b (67.5)*	0.0a (100.0)*	0.0a (100.0)*
Average		75.4 (0.0)	54.7 (26.8)	36.7 (51.8)	25.3 (66.8)	8.5 (89.2)

a, b, c, d, e statistically proven differences in P=0.05* Degree of inhibition in the germination of seeds,%

Depending on the extract kind (fresh and/or dry weed biomass), IR on seed germination of the tested grain legume crops could be conventionally grouped into three groups (Table 1).

The first group (seed germination inhibition of 30-40%) – extracts from fresh and dry biomass of *A. retroflexus*, *E. canadensis* in *G. max*; Extracts from dry biomass of *A. retroflexus* in *V. sativa*.

The second group (seed germination inhibition of 41-60%) – including extracts prepared from fresh biomass of *A. retroflexus*, *Ch. album* and *S. nigrum* in *G. max* and *V. sativa* and dry biomass of *Ch. album* in *G. max* and *V. sativa*; Extracts from fresh biomass of *E. canadensis* and *S. nigrum* and dry biomass of *E. canadensis* in *P. sativum.*

The third group (seed germination inhibition of 61-80%) – extracts from fresh biomass of *A. retroflexus* and *Ch. album* in *P. sativum*; *E. canadensis* in *V. sativa*. Extracts from dry biomass of *A. retroflexus*, *Ch. album* and *S. nigrum* in *P. sativum* and extracts from dry biomass of *E. canadensis* and *S. nigrum* in *V. sativa*.

The studied grain legume crops reacted in a different way to the inhibitory effect of the weed extracts. *P. sativum* was most sensitive, followed by *V. sativa,* while the seeds of *G. max* were relatively the least sensitive.

The differences in the inhibitory effect of the extracts from fresh and/or dry weed biomass on seed germination of the test plants can be explained by diffusion of soluble allelochemicals during extraction of fresh and dry weed biomass on one hand (Jiménez-Osornio et al., 1996), and by the different content of crude protein in seeds, on the other hand (Kertikov, 1999, 2002, 2005; Marinov-Serafimov et al., 2005). Similar results were reported by Del Moral and Cates (1971) and Putnam et al. (1983) and according to them, during extraction from fresh weed biomass the allelochemicals are released, which does not occur during extraction from dry weed biomass.

The obtained results were analogous when determining LC_{50} on seed germination of *G. max*, *P. sativum* and *V. sativa* depending on the extract kind (Table 2).

Table 2. Water extracts from fresh and dry weed biomass that killed 50% (LC_{50}) of the test plants

Crop	Weed	$LC_{50\ at\ P=0.05}$	
		Fresh biomass	Dry biomass
Glycine max	*A. retroflexus*	65.2	84.1
	Ch. album	29.7	25.4
	E. canadensis	72.2	58.7
	S. nigrum	59.5	18.3
Pisum sativum	*A. retroflexus*	21.9	10.1
	Ch. album	<58.3*	9.2
	E. canadensis	29.4	27.2
	S. nigrum	13.5	7.5
Vicia sativa	*A. retroflexus*	37.7	<61.3*
	Ch. album	26.6	20.0
	E. canadensis	14.2	12.1
	S. nigrum	25.6	7.0

Note: * The proportion of deaths plants <50%

The LC_{50} values varied from 13.5 to 72.2 g l^{-1} for the extracts from fresh weed biomass and from 7.0 to 84.1 g l^{-1} for dry weed biomass and could be conventionally grouped in the following ascending order: *A. retroflexus* < *S. nigrum* < *E. canadensis* < *Ch. album* and for extracts from dry biomass: *A. retroflexus* < *E. canadensis* < *Ch. album* < *S. nigrum*. The differences in the LC_{50} values for the extracts from fresh and dry biomass of *S. nigrum* could be explained by variable allelopathic effect of the extract, probably resulting from change in its composition on one hand, and different sensitivity of the test plants, on the other hand. *P. sativum* was the most sensitive to the allelopathic effect of the extracts from fresh and dry weed biomass, with LC_{50} varying from 13.5 to 21.6 g l^{-1}, followed by *V. sativa* where LC_{50} was from 11.7 to 26.0 g l^{-1}, and *G. max* which had relatively the lowest sensitivity, with LC_{50} ranging from 46.6 to 56.7 g l^{-1}.

The available weed extracts had a depressive effect on the growth of primary seedling of *G. max*, *P. sativum* and *V. sativa*. With increase of the extract concentration, the primary seedling growth decreased disproportionately in all test plants, as compared to the control variant, the differences being statistically significantly

smaller at P=0.05. An exception to the described relationship was observed at 5 g l^{-1} for extracts from fresh biomass of *A. retroflexus* in *G. max* and *P. sativum*, as well as for extracts made from dry weed biomass of *A. retroflexus, E. canadensis* and *Ch. album* in *G. max* and *E. canadensis* in *P. sativum*. The similar results were obtained in determination of the inhibition rate on the primary seedling growth depending on the kind and content of weed biomass in the water extracts (Table 3).

The inhibition rate on the seedling growth increased disproportionately with increase of weed biomass content in water extracts, on average from 28.3 to 85.8% for extracts from fresh weed biomass and from 31.0 to 93.6% for extracts from dry weed biomass (Table 3).

The mechanism of inhibition on the seedling growth caused by allelochemicals can be the result of reduced cell division and/or cell elongation (Iman et al., 2006).

Therefore, the seed germination can be considered as a relatively less sensitive period of the individual plant development, whereas the period of seedling growth is suitable for potential testing of the allelopathic effect of the studied extracts under laboratory conditions due to direct contact of the seedlings with the extracts during the bioassays.

Table 3. Effect of water extracts on growth of the primary germ in test plants (cm)

Crop	Weed	Contents of the weed biomass in water extracts, g l^{-1}				
		0	5	25	50	100
		Fresh biomass				
Glycine max	*A. retroflexus*	9.0b(0.0)*	9.6b (-5.2)*	3.9a (56.0)*	3.0a (66.5)*	2.6a (71.0)*
	Ch. album	9.0c (.0)*	10.9d (-20.9)*	9.1c (-1.4)*	6.5b (27.3)*	0.0a (100.0)*
	E. canadensis	9.0c (0.0)*	8.9c (0.9)*	6.0b (33.1)*	4.7ab (47.9)*	2.8a (69.3)*
	S. nigrum	9.0b (0.0)*	8.7b (3.1)*	7.0ab (21.6)*	7.0ab (22.3)*	4.5a(50.3)*
Pisum sativum	*A. retroflexus*	11.5c (0.0)*	4.7b (59.1)*	4.4ab (62.1)*	3.66ab (68.2)*	3.0a (73.9)*
	Ch. album	11.5e (0.0)*	9.1d (20.7)*	5.0c (56.4)*	3.0b (73.9)*	0.0a (100.0)*
	E. canadensis	11.5c (0.0)*	10,8c (6.2)*	8.9bc (22.7)*	6.3b (44.9)*	0.0a (100.0)*
	S. nigrum	11.5d (0.0)*	9.7c (16.1)*	6.3b (45.5)*	3.9a (66.4)*	3.8a (66.7)*
Vicia sativa	*A. retroflexus*	13.3c (0.0)*	10.9c (18.1)*	8.6bc (35.3)*	3.3ab (75.5)*	2.5a (81.5)*
	Ch. album	13.3c (0.0)*	7.2b (46.4)*	7.0b (47.9)*	1.9ab (86.0)*	0.0a (100.0)*
	E. canadensis	13.3b (0.0)*	3.5a (73.9)*	1.7a (87.1)*	0.5a (96.3)*	0.0a (100.0)*
	S. nigrum	13.3b (0.0)*	3.2a (75.8)*	3.1a (77.0)*	0.3a (98.0)*	0.0a (100.0)*
Average		11.3 (0.0)*	8.1 (28.3)*	5.9 (47.8)*	3.7 (67.3)*	1.6 (85.8)*
		Dry biomass				
Glycine max	*A. retroflexus*	8.9c (0.0)*	9.5c (-6.1)*	5.0b (43.9)*	4.3b (52.3)*	1.1a (87.4)*
	Ch. album	8.9d (0.0)*	5.0c (44.5)*	5.4c (39.3)*	4.2b (53.6)*	2.3a (74.7)*
	E. canadensis	8.9d (0.0)*	9.4d (-4.8)*	5.7c (36.4)*	3.9b (57.0)*	0.0a (100.0)*
	S. nigrum	8.9c (0.0)*	8.5c (5.1)*	3.6b (59.8)*	0.0a (100.0)*	0.0a (100.0)*
Pisum sativum	*A. retroflexus*	11.5c (0.0)*	10.0c (10.2)*	3.2b (72.2)*	0.0a (100.0)*	0.0a (100.0)*
	Ch. album	11.5c (0.0)*	11.4c (1.13)*	4.0b (64.9)*	3.3b (70.9)*	0.0a (100.0)*
	E. canadensis	11.5d (0.0)*	10.1d (6.2)*	7.4c (22.7)*	5.3b (44.9)*	0.0a (100.0)*
	S. nigrum	11.5c (0.0)*	5.6b (51.3)*	0.4a (96.4)*	3.9a (66.4)*	0.0a (100.0)*
Vicia sativa	*A. retroflexus*	13.3b (0.0)*	11.7b (12.5)*	5.5a (58.5)*	5.1a (61.6)*	5.2a (60.4)*
	Ch. album	13.3b (0.0)*	4.1a (69.3)*	3.2a (75.9)*	0.2a (98.3)*	0.0a (100.0)*
	E. canadensis	13.3b (0.0)*	3.0a (77.8)*	1.3a (90.3) *	0.4a (97.0)*	0.0a (100.0)*
	S. nigrum	13.3c (0.0)*	5.5b (58.6)*	3.3ab (75.6)*	0.0a (100.0)*	0.0a (100.0)*
Average		11.3 (0.0)*	7.8 (31.0)*	4.0 (64.5)*	2.3 (80.0)*	0.7 (93.6)*

a, b, c, d, e statistically proven differences in P=0.05; * Degree of inhibition in the germination of seeds,%

The obtained experimental data confirmed the results of Turk and Tawaha (2002) and Ashrafi et al. (2007), according to which the impact of the allelochemicals already manifests during the seed germination, but it is more pronounced during the growth of primary seedlings of plants.

The index germinations (GI) depended on the same factors and followed the observed relationship pattern with regard to laboratory seed germination and growth of seedling of test plants (Table 4).

The performed analyses showed that the studied extracts from fresh and dry weed biomass provoked a suppressive and/or inhibitory effect on the initial plant development. With increase of the weed biomass content in the water extracts from fresh biomass, GI decreased by 53.6-6.1% on average and for the extracts from dry biomass this decrease rate reached 2.5%, as compared to the control variant. An exception to the described relationship was found only at 5 g l^{-1} for extracts from fresh biomass of *Ch. album* (108.9%) in *G. max*, as well as for the extracts made from dry weed biomass of *A. retroflexus* (91.5%) and *E. canadensis* (90.4%) in *G. max* (Tiquia et al., 1996). Therefore, the observed differences in the studied grain legume crops with regard to the allelopathic effect of the extracts could be also explained by genetic differences, because the comparisons between them were conducted at the same concentrations of the applied extracts.

Table 4. Effect of water extracts on the initial development (GI) of test plants

Crop	Weed	Contents of the weed biomass in water extracts, g l^{-1}									
		0	5	25	50	100	0	5	25	50	100
		Fresh biomass					Dry biomass				
Glycine max	*A. retroflexus*	100	72.4	24.9	19.7	12.1	100	91.5	41.6	29.3	2.9
	Ch. album	100	108.9	57.4	35.9	0.0	100	38.2	29.9	20.6	10.6
	E. canadensis	100	73.5	41.1	32.0	12.8	100	90.4	52.7	34.3	0.0
	S. nigrum	100	59.6	44.4	40.2	23.3	100	78.7	19.9	0.0	0.0
Pisum sativum	*A. retroflexus*	100	25.7	17.6	8.2	5.5	100	52.3	10.3	0.0	0.0
	Ch. album	100	32.0	18.9	10.5	0.0	100	64.8	9.0	7.5	0.0
	E. canadensis	100	66.5	50.7	14.2	0.0	100	62.5	40.5	11.9	0.0
	S. nigrum	100	50.5	23.7	14.6	15.5	100	28.7	0.9	0.7	0.0
Vicia sativa	*A. retroflexus*	100	69.3	59.2	6.0	4.5	100	71.3	28.1	28.0	16.7
	Ch. album	100	45.4	31.3	4.5	0.0	100	24.1	10.7	0.6	0.0
	E. canadensis	100	21.3	3.7	1.1	0.0	100	18.1	2.0	0.9	0.0
	S. nigrum	100	18.4	13.8	0.6	0.0	100	11.1	4.0	0.0	0.0
Average		100	53.6	32.2	15.6	6.1	100	52.6	20.8	11.2	2.5

CONCLUSIONS

The water extracts from fresh and dry biomass of *A. retroflexus*, *Ch. album*, *E. canadensis* and *S. nigrum* showed an inhibitory effect on the seed germination of *G. max, P. sativum* and *V. sativa,* the inhibition rate for the extracts from fresh biomass varying from 28.8 to 81.5% and for the extracts from dry weed biomass from 26.8 to 89.2%.

The values of LC_{50} ranged from 13.5 to 72.2 g l^{-1} for the extracts from fresh biomass and from 7.0 to 84.1 g l^{-1} for the extracts from dry weed biomass. For extracts from fresh biomass they could be conditionally grouped in the following ascending order: *A. retroflexus* < *S. nigrum* < *E. canadensis* <*Ch. album* and for extracts from dry biomass: *A. retroflexus* < *E. canadensis* < *Ch. album* < *S. nigrum*.

P. sativum was the most sensitive to the allelopathic effect of the extracts from fresh and dry weed biomass, with LC_{50} that varied from 13.5 to 21.6 g l^{-1}, followed by *V. sativa* where LC_{50} ranged from 26.0 to 11.7 g l^{-1} and *G. max* which had relatively lowest sensitivity, with LC_{50} ranging from 46.6 to 56.7 g l^{-1}.

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Utvrđivanje alelopatskog delovanja nekih invazivnih korovskih vrsta na klijanje i početni razvoj zrnastih mahunarki

REZIME

Tokom 2006. i 2007. godine, na Institutu za krmno bilje u Plavenu vršena su laboratorijska ispitivanja alelopatskog delovanja hladnih vodenih ekstrakata iz *Amaranthus retroflexus* L., *Chenopodium album* L., *Erigeron canadensis* L. i *Solanum nigrum* L. na klijanje i početni razvoj *Glycine max* L., *Pisum sativum* L. i *Vicia sativa* L. Utvrđeno je sledeće: vodeni ekstrakti iz sveže i suve biomase *A. retroflexus, Ch. album, E. canadensis* i *S. nigrum* delovali su inhibitorno na klijanje semena *G. max, P. sativum* i *V. sativa,* pri čemu je stepen inhibicije kod ekstrakata iz sveže biomase bio 28,8-81,5%, a kod ekstrakata iz suve biomase 26,8-89,2%; vrednosti LC_{50} su se kretale od 13,5 do 72,2 g l^{-1} za ekstrakte iz sveže biomase, odnosno od 7,0 do 84,1 g l^{-1} za ekstrakte iz suve biomase korova i uslovno bi se mogle prikazati u sledećem uzlaznom nizu kod ekstrakata iz sveže biomase: *A. retroflexus* < *S. nigrum* < *E. canadensis* <*Ch. album*, a kod ekstrakata iz suve biomase: *A. retroflexus* < *E. canadensis* < *Ch. album* < *S. nigrum*; najveća osetljivost na alelopatski efekat ekstrakata iz sveže i suve biomase korova uočena je kod *P. sativum* – vrednost LC_{50} se kretala između 13,5 i 21,6 g l^{-1}, a zatim kod *V. sativa* – LC_{50} je iznosila od 26,0 do 11,7 g l^{-1}, dok je *G. max* pokazala relativno najniži stepen osetljivosti – vrednost LC_{50} je varirala od 46,6 do 56,7 g l^{-1}.

Ključne reči: Alelopatsko delovanje; korov; ekstrakti; inhibicija; klijanje semena