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Original scientific paper

Variation in allelopathic tolerance of vetch cultivars to *Sorghum halepense* L. (Pers.) extracts

Natalia Georgieva*, Ivelina Nikolova and Valentin Kosev

Institute of Forage Crops, 89 General Vladimir Vazov Str., Pleven, Bulgaria
**Corresponding author: imnatalia@abv.bg*

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SUMMARY

Using allelopathic tolerance of crops and cultivars is considered a promising supplement to weed control strategies. In order to evaluate the allelopathic tolerance of vetch cultivars to *Sorghum halepense* extracts in germination and initial growth of the crop, a multi-factorial lab experiment was carried out based on a completely randomized design with four replications. The experimental factors were nine vetch cultivars ('Liya', 'Lorina', 'Moldovskaya', 'Obrazets 666', 'Asko', 'Violeta', 'Viola', 'Beta WP', and 'Panonskaya'), two aqueous extracts (of shoot and root biomass of *S. halepense*) and four concentrations of the extracts (1.0%, 5.0%, 10.0% and distilled water as a control). An analysis of variance showed a significant influence of the studied factors. The results revealed variation in responses of the nine cultivars to the allelopathic effect of *S. halepense*. The extracts applied at different concentrations had a significant inhibitory effect on seed germination (from 2.8 to 27.3% for different cultivars), germ length (from 4.6 to 48.7%) and germ weight (from 3.6 to 34.0%). The lowest concentration (1.0%) also had a stimulating effect on growth parameters, most pronouncedly in two cultivars ('Beta WP' and 'Viola'). Total effects of the weed extracts on seed germination and initial development selected 'Beta WP', 'Violeta' and 'Obrazets 666' as the most tolerant cultivars, as opposed to 'Liya' and 'Panonskaya', which were more sensitive. The cultivars with seeds that have greater biomass per 1000 seeds, higher seedling vigour index and protein content were found to be less sensitive to the suppressing effect of *S. halepense* extracts. These cultivars can be successfully used in organic fields with high density of *S. halepense* or in a conventional production system with a reduced use of herbicides.

Keywords: Allelopathy; Vetch; Sorghum; Germination

INTRODUCTION

Weeds are one of the main problems facing agricultural production (Al-Johani et al., 2012). They are able to compete intensively with crops because of their high adaptive potential and are consequently considered as one of the most important factors reducing yields. Besides competition with crops, weeds decrease growth and yield of crops by exuding allelochemicals (Khanh et al., 2006). Economic damage due to weeds has been estimated at more than 100 billion dollars globally (Shahrokhi et al., 2011).

Approximately 250 weed species cause serious problems in growing agricultural crops (Alam et al., 2002). *Sorghum halepense* L. (Pers.) is considered as one of the most

threatening weeds (Follak & Essl, 2012; Rout et al., 2013) and it has been widespread in arable fields in Bulgaria in recent years (Hristoskov, 2013). Its allelopathic properties are well-known (Kalinova et al., 2012; Šebetić, 2016). The main allelochemicals that it contains are: chlorogenic acid, phenolic compounds, *p*-hydroxybenzeldehyde and *p*-coumaric acid (Zohaib et al., 2016). Allelopathic substances are released into the environment in different ways, either by being washed away from plant tissues by rain and dew or through excretion from plant roots (Mohasel et al., 2006). They disturb germination and crop growth, which leads to lower yields (Rizvi & Rizvi, 1992).

The use of aleopathy is a natural and environment-friedly approach to weed control (Cheema & Ahmad, 1992). According to Ray and Hastings (1992), the phenomenon of allopathy can be manipulated either by increasing the toxicity of a crop to a weed or by increasing the tolerance of a crop to weeds. Either approach requires a variation in toxicity or tolerance of a crop. Kruse et al. (2000) reported significant variations among genotypes and varieties in their tolerance to different weeds. The use of allelopathic tolerance of crops and varieties is considered by some researchers (An et al. 1998, Kruse et al., 2000) as a promising supplement to current weed control strategies, especially in organic farming (Olofsdotter, 1998).

Research studies have been carried out to identify varieties with heigthened allelopathic tolerance for flax, barley (Ray & Hastings, 1992), wheat (Cheema et al., 2002), maize (Baličević et al., 2014), lupine (Georgieva et al., 2015), peas Georgieva & Nikolova (2016) and other crops, and investigation in this area deserves more attention.

The aims of this research were: 1) to estimate allelopathic effects of *Sorghum halepense* on germination and primary growth parameters of vetch; and 2) to identify vetch cultivars tolerant to the allelopathic substances released by the weed.

MATERIAL AND METHODS

Treatments

The experiment was carried out at the Institute of Forage Crops (Pleven, Bulgaria) in 2017 as a multi-factorial study based on a completely randomized design with four replications. The experimental factors were: factor A - nine vetch cultivars ('Liya', 'Lorina', 'Moldovskaya' and 'Obrazets 666' belonging to *Vicia sativa* L.; 'Asko', 'Violeta', 'Viola' and 'Beta WP' belonging to *Vicia villosa* L.; and 'Panonskaya' belonging to *Vicia pannonica* Crantz.); factor B - two aqueous extracts (of shoot and root biomass of *Sorghum halepense*); and factor C - four concentrations of aqueous extracts (1.0%, 5.0%, 10.0% and distilled water as a control).

Sampling and aqueous extract preparation

S. halepense was collected from organically managed fields in Pleven environs at the phenological stage BBCH 65 of the weed (Hess et al., 1997). Fresh shoot and root biomass were cut separately into 1 cm pieces, oven dried at 60°C to a constant dry weight, and ground into fine powder. For extract preparation, 100 g of powdered plant material was suspended in 1000 ml distilled water and mixed for 24 hours at 24±2°C on a rotary shaker to obtain a uniform extract (Norsworthy, 2003). The obtained extracts were diluted with distilled water to final concentrations of 1.0, 5.0 and 10.0%.

Bioassay tests

Twenty-five vetch seeds were placed in each Petri dish containing a filter paper, and 4 ml of each extract was added, while distilled water was used as a control. Petri dishes were kept in a thermostat at 22 ± 1°C for seven days. Seed germination percentage, seedling length (root and stem) (cm), and fresh weight of root, stem and germ (g) were recorded. Germination percentage was calculated using the formula: G = (germinated seeds/total seeds) × 100 (Treber et al., 2015); the percentage of inhibition was calculated according to Chung et al. (2003): % inhibition=[(control-extracts)/control] × 100; and the seedling vigour index (SVI, %) according to Abdul–Baki & Anderson (1973): *SVI*=average shoot+root length (cm) germination.

Experimental design and data analysis

The experiment was multi-factorial and based on a completely randomized design with four replications. The analysis of data was performed according to the GGEbiplot method using GenStat statistical software version 12.1.0.3338, and the software Statgraphics Plus for Windows Ver. 2.1

RESULTS AND DISCUSSION

The variance analysis showed that the factor „cultivar" had the greatest impact on seed germination and germ weight (21.6 and 43.2% of total variation, respectively), which was due to variable cultivar responses to the changes in environmental conditions (Table 1). Regarding germ length, the effect of weed extract concentrations was 36.3%

of total variation. The influence of extract type on the same parameters (germination, germ weight and germ length) was the weakest (from 0.8 to 3.5%), but still statistically significant. The interaction of cultivar with the type of extract (A × B) and its concentration (A × C), as well as among the three experimental factors (A × B × C) was statistically significant. There was no significant interaction only between the type of extract and concentration (B × C), which revealed a lesser influence of the stress factors on germ length and weight of the cultivars.

Seed germination

Although germination of seeds is an internally regulated process affected by genotype, external factors such as temperature, moisture, light and presence of chemical compounds also have a strong influence on this process (Kucera et al., 2005; Finkelstein, 2010). The results of the present experiment showed that the allelopathic effect of *S. halepense* extracts on seed germination varied among the studied vetch cultivars (Figure 1).

Table 1. Analysis of variance for seed germination and germ growth of vetch cultivars

Cause of variation	Degree of freedom	Sum of squares	Mean square	Influence of factors	Sum of squares	Mean square	Influence of factors	Sum of squares	Mean square	Influence of factors
Indicators	Germination, %				Germ lehgth, cm			Germ weight, cm		
Total	287	59289.3		100.0	1683.8		100.0	0.0259		100.0
Factor A- cultivar	8	12829.1	1603.6*	21.6	511.0	63.9	30.3*	0.0112	0.0014	43.2*
Factor B - type of extract	1	2071.2	2071.2*	3.5	51.9	51.9	3.1*	0.0002	0.0002	0.8*
Factor C - concentration of the extracts	3	10020.5	3340.2*	16.9	611.8	203.9	36.3*	0.0056	0.0019	21.6*
Interaction										
A×B	8	3156.7	394.6*	5.3	41.1	5.1	2.4*	0.0005	0.0001	1.9*
A×C	24	10174.9	423.0*	17.2	189.6	7.9	11.3*	0.0019	0.0001	7.3*
B×C	3	2216.8	739.0*	3.7	20.7	6.9	1.2^{ns}	0.0002	0.0001	0.8^{ns}
A×B×C	24	3055.2	127.3*	5.2	71.6	3.0	4.3*	0.0011	0.0000	4.2*
Error	216	15764.8	73.0	26.6	185.9	0.9	11	0.0052	0.0000	20.1

LSD at 0.05 probability level

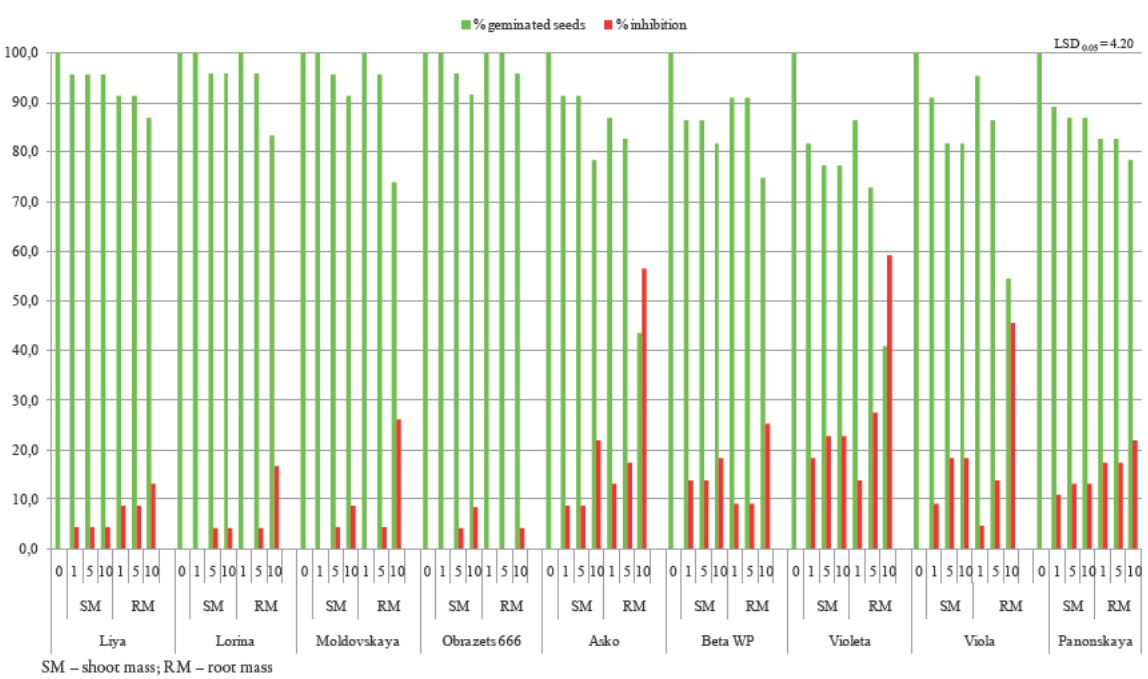


Figure 1. Influence of water extracts of *Sorghum halepense* on seed germination of vetch cultivars

Concentrations increasing from 1.0 to 5.0 and 10.0% reduced seed germination of all cultivars on average 7.3, 10.9 and 21.9%, respectively, and the inhibitory effect of root biomass was more pronounced than that of shoot biomass. According to Muscolo et al. (2001), the inhibition of germination by allelochemicals results from respiratory inhibition, i.e. by discontinuing the action of respiratory enzymes and enzymes involved in the oxidative pathway of pentose phosphate. On the other hand, differences in allelopathic potential of different plant parts of weeds have also been revealed by other researchers (Shahrokhi et al., 2011; Fateh et al., 2012) and they were due to varying contents of allelopathic substances in the relevant organs.

The tested cultivars of *V. sativa* exhibited a higher tolerance of the activity of aqueous extracts since their inhibitory effects on seed germination ranged from 2.8 to 7.2%, in contrast to *V. villosa*, in which the effects ranged from 14.8 to 27.3%. 'Obrazets 666' and 'Lorina' stood out with their highest tolerance. In a similar experiment, Baličević et al. (2014) also observed different degrees of tolerance of maize hybrids to *Convolvulus arvensis* water extracts. The percentage inhibition of germinated seeds in the Bc 574 hybrid was 24.9%, while it was twice as high (50.7%) in the hybrid OSSK. Comparing two soybean cultivars in terms of their sensitivity to *Polygonum lapathifolium*, Treber et al. (2015) reported that germination of the variety 'Sanda' was suppressed to a greater extent than that of 'Ika'.

Stem and root elongation

Parameters of growth in the early stages of crop development are considered as important characteristics that define the weed-crop relationships (Jönsson et al., 1994). It is well known that allelochemical compounds isolated from different plant parts have inhibitory or stimulating influence on acceptor plants and their intensity depends on their concentration (Sikora & Berenji, 2008). As a whole, the data presented in Table 2 indicate that stem and root elongation of vetch cultivars were negatively influenced by concentration increase. The smallest stem and root length (1.84 and 1.96 cm, respectively) were observed at the highest concentration of both aqueous extracts of *S. halepense*. It should be noted here that root elongation of vetch plants was suppressed to a greater extent (decrease by 55.4% on average compared to control treatment) than stem elongation (decrease of 38.6% on average), which according to Esmaeili et al. (2012) was a result of the direct contact of root with the allelochemicals, compared to the aboveground biomass. In similar experiments, Alam and Shaikh (2007) observed a higher sensitivity of roots to aqueous extracts of *Chenopodium murale* in rice, while Fateh et al. (2012) reported the same for millet and basil regarding water extracts of *Convolvulus arvensis*. Under the conditions of our present experiment, the lowest concentration (1.0%) had a stimulating effect on root length and/or stem length of all cultivars except 'Liya' and 'Lorina'. This activity was particularly prominent in 'Obrazets 666', 'Beta WP' and 'Viola', in which the growth of germ (root + stem) under the influence of 1% extract of *S. halepense* shoot biomass was respectively 21.0, 77.3 and 70.0%, compared to the relevant controls. Averaged values for the different cultivars showed a low inhibitory effect (4.6 and 6.6% on average) of the extracts, i.e. a high respective tolerance of 'Beta WP' and 'Obrazets 666'. In contrast, sensitivity was exhibited by three cultivars: 'Liya', 'Asko' and 'Panonskaya', with inhibitory effects of 48.7, 32.6 and 32.2%.

Weight of root and shoot

An et al. (1998) found the reduction in root growth to affect both physiological and biological functions of the plant, such as its supporting function that provides contact with soil, absorption of water and other important nutrients necessary for plant growth and development. This resulted in a reduction in fresh and dry weight of the species studied. Our results indicated that all nine tested cultivars decreased their fresh weight after treatment with the aqueous extracts of *S. halepense* as the tendencies were similar to those established with regard to root and stem elongation. In most genotypes (except in 'Lorina', 'Asko' and 'Panonskaya'), 1% concentration, especially from the weed shoot biomass, had no effect whatsoever or only a slight one (either inhibiting or stimulating) on the weight of stem and root in vetches. This finding is consistent with reports by other authors (Lin et al., 2004; Valera-Burgos et al., 2012), according to which aqueous extracts of plant parts at low concentrations had no or little effect on germination and initial plant development, but when increasing the extract concentration, growth parameters showed an essential reduction.

In the present experiment, the stimulating effect of 1% extract of *S. halepense* shoot biomass was strongly expressed in two of the cultivars – 'Beta WP' and 'Viola', where germ (root + stem) weight exceeded the respective controls by 33.9 and 47.6%. With raising extract concentration, the negative effect of weed extracts on germ weight increased, and at 10% it reached average values from 14.5 to 46.8% for the different cultivars.

Table 2. Influence of *Sorghum halepense* extracts on length and fresh biomass accumulation in germs of vetch cultivars

Cultivar	Type of *S. halepense* extract	Concentration %	Parameter					
			Root length cm	Stem length cm	Germ length cm	Root weight g	Stem weight g	Germ weight g
'Liya'		0	5.08	4.92	10.01	0.016	0.027	0.042
	Shoot mass	1.0	4.24	3.29	7.53	0.016	0.027	0.043
		5.0	3.07	2.44	5.51	0.011	0.017	0.028
		10.0	2.82	1.88	4.69	0.013	0.020	0.033
	Root mass	1.0	2.62	2.66	5.28	0.017	0.024	0.042
		5.0	2.33	2.03	4.36	0.014	0.019	0.032
		10.0	1.50	1.92	3.42	0.014	0.019	0.033
'Lorina'		0	5.12	3.982	9.10	0.016	0.025	0.040
	Shoot mass	1.0	4.51	3.008	7.52	0.013	0.018	0.031
		5.0	4.21	3.017	7.23	0.011	0.018	0.029
		10.0	3.18	2.625	5.80	0.011	0.017	0.028
	Root mass	1.0	4.68	3.992	8.67	0.010	0.022	0.032
		5.0	2.38	2.954	5.33	0.010	0.012	0.022
		10.0	2.68	2.138	4.81	0.010	0.010	0.020
'Moldovskaya'		0	3.80	3.12	6.92	0.018	0.030	0.048
	Shoot mass	1.0	4.01	2.47	6.48	0.018	0.023	0.041
		5.0	3.08	2.45	5.54	0.013	0.017	0.030
		10.0	2.10	2.33	4.43	0.012	0.019	0.031
	Root mass	1.0	3.64	2.60	6.24	0.016	0.026	0.042
		5.0	2.66	2.30	4.96	0.015	0.024	0.038
		10.0	1.41	1.72	3.14	0.009	0.018	0.027
'Obrazets 6666'		0	4.23	2.89	7.12	0.010	0.013	0.023
	Shoot mass	1.0	5.26	3.35	8.61	0.010	0.013	0.023
		5.0	3.53	2.79	6.32	0.010	0.011	0.021
		10.0	2.82	2.68	5.50	0.010	0.010	0.020
	Root mass	1.0	4.24	3.77	8.01	0.011	0.013	0.025
		5.0	3.92	2.89	6.80	0.010	0.010	0.020
		10.0	2.01	2.64	4.65	0.010	0.009	0.019
'Asko'		0	4.36	3.26	7.62	0.013	0.023	0.036
	Shoot mass	1.0	4.15	3.94	8.09	0.013	0.021	0.034
		5.0	3.65	3.21	6.86	0.011	0.015	0.026
		10.0	1.45	1.87	3.31	0.008	0.011	0.018
	Root mass	1.0	3.11	3.10	6.21	0.011	0.014	0.024
		5.0	1.64	2.30	3.94	0.010	0.012	0.022
		10.0	0.68	1.73	2.41	0.010	0.010	0.020
'Beta WP'		0	4.34	3.46	7.80	0.010	0.014	0.024
	Shoot mass	1.0	7.55	6.27	13.83	0.011	0.021	0.032
		5.0	3.23	3.30	6.53	0.010	0.013	0.023
		10.0	2.26	3.12	5.38	0.010	0.010	0.020
	Root mass	1.0	4.19	5.05	9.23	0.010	0.014	0.024
		5.0	2.20	4.01	6.20	0.010	0.011	0.021
		10.0	1.26	2.20	3.46	0.009	0.009	0.018
'Violeta'		0	4.31	3.34	7.65	0.012	0.011	0.023
	Shoot mass	1.0	3.41	3.42	6.82	0.010	0.013	0.023
		5.0	2.75	2.56	5.31	0.010	0.009	0.019
		10.0	2.05	2.18	4.23	0.010	0.008	0.018
	Root mass	1.0	3.71	4.29	8.00	0.011	0.015	0.026
		5.0	2.53	3.53	6.06	0.010	0.014	0.024
		10.0	1.91	1.49	3.40	0.010	0.009	0.019
'Viola'		0	3.22	1.93	5.15	0.014	0.014	0.028
	Shoot mass	1.0	5.01	3.74	8.75	0.019	0.022	0.041
		5.0	2.20	1.74	3.93	0.011	0.010	0.020
		10.0	2.17	1.74	3.91	0.009	0.011	0.021
	Root mass	1.0	2.15	1.24	3.40	0.011	0.008	0.018
		5.0	1.53	1.21	2.74	0.011	0.009	0.020
		10.0	0.80	1.06	1.86	0.008	0.006	0.015
'Panonskaya'		0	1.48	2.48	3.97	0.012	0.017	0.028
	Shoot mass	1.0	1.91	1.68	3.60	0.011	0.012	0.022
		5.0	1.04	1.62	2.66	0.010	0.011	0.021
		10.0	0.56	1.68	2.24	0.009	0.009	0.018
	Root mass	1.0	2.12	1.36	3.48	0.009	0.010	0.019
		5.0	1.58	0.88	2.46	0.009	0.009	0.018
		10.0	1.49	0.20	1.69	0.009	0.004	0.014
LSD at the 0.05 probability level								
Factor A			0.135	1.129	0.215	0.0010	0.0005	0.0007
Factor B			0.063	0.061	0.101	0.0004	0.0002	0.0003
Factor C			0.090	0.086	0.143	0.0002	0.0003	0.0004
A×B×CP=0.1%			0.376	0.361	0.598	0.0003	0.0014	0.0019

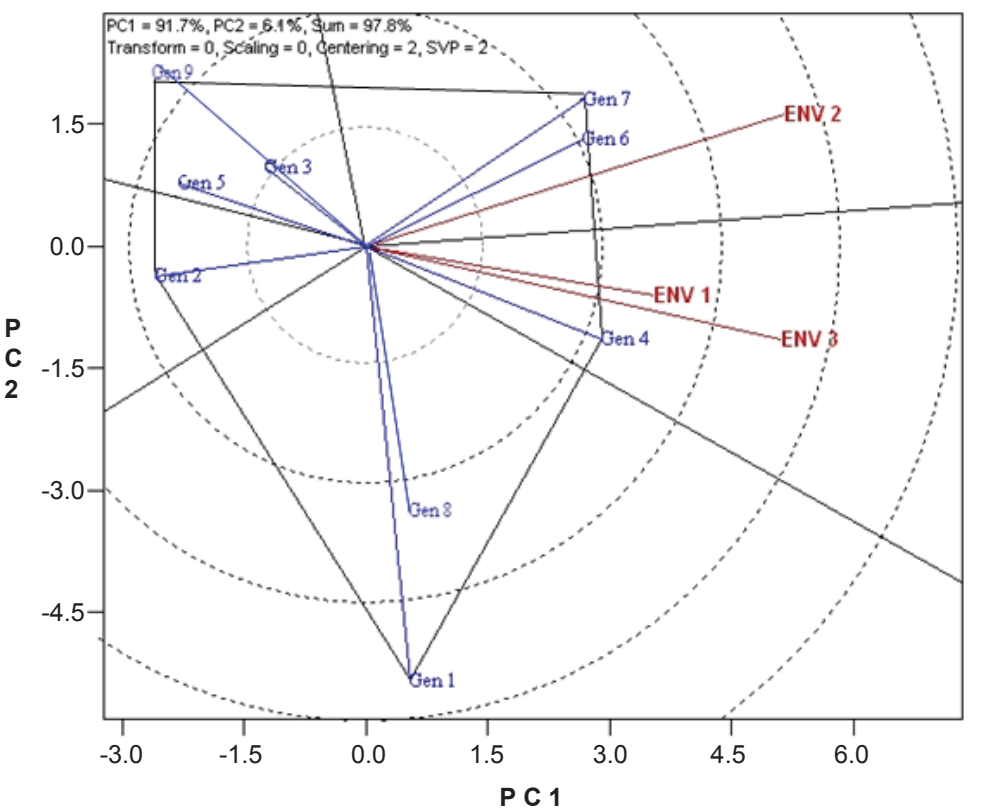
Sahoo et al. (2010) also reported a decrease in dry weight of chili, soybean, corn and rice after treatment with higher concentrations of aqueous extract of *Mangifera indica*. According to some researchers (El-Khatib et al., 2004; Batish et al., 2007; Zohaib et al., 2016), decline in plant weight might be due to an inhibition of carbohydrate and protein accumulation that causes a decrease in plant growth and development. In yet another study (Shao-Lin et al., 2004), the reduction in overall growth and development of plants was the result of inhibition of cell division and photosynthesis due to destruction of chlorophyll cells, which in turn resulted from the action of chlorogenic acid and p-coumaric acid (Rodzynkiewicz et al., 2006 ; Muzaffar et al., 2012), which were also among the basic allelochemicals in *S.halepense*.

The cultivars whose capacity to accumulate fresh biomass was weakly influenced by the suppressive action of *S. halepense* extracts were 'Beta WP', 'Violeta' and 'Obrazets 666' (inhibitory effects of 3.6, 6.8 and 7.1%, respectively, compared to control variants), unlike 'Pannonskaya' and 'Asko', where the accumulation of fresh biomass was considerably reduced (by 34.0 and 33.6%).

As a whole, seedling germination was less inhibited (from 2.8 to 27.3% for different varieties) than the growth parameters: germ length and germ weight, from 4.6 to 48.7%, and from 3.6 to 34.0%, respectively.

GGEbiplot analysis

Figure 2 presents the summary effects of aqueous weed extracts on seed germination and initial plant development of the tested cultivars. The allelopathic effects of concentrations are ranked as Env3 (10.0% concentration of *S. halepense*) ≈ Env2 (5.0% concentration) > Env1 (1.0% concentration). The ideal genotype is the one with both high germination and high growth parameters. The center of concentric circles displays the position of this ideal genotype. Therefore, the cultivars 'Beta WP', 'Violeta' and 'Obrazets 666', which were very close to the ideal point in the biplot, on the right side of the graph, had the highest germination and growth parameters. The results therefore suggest that



Gen1-'Liya', Gen2-'Lorina', Gen3-'Moldovskaya', Gen4-'Obrazets 6666', Gen5-'Asko', Gen6-'Beta WP', Gen7-'Violeta', Gen8-'Viola', Gen9-'Panonskaya' Env1 (1.0% concentration of water extract of *S. halepense*), Env2 (5.0%), Env1 (10.0%)

Figure 2. GGEbiplot of allelopatic tolerance of vetch cultivars

the studied weed extracts had minimal allelopathic effects on these vetch plants, as they exhibited high tolerance. On the other hand, 'Liya' and 'Panonskaya' were located at the farthest points from the center of the concentric circles (for low germination and growth parameters), suggesting their high susceptibility. These results are consistent with those of Cheema et al. (2002) who reported that crops may respond differently to allelochemicals, and they evaluated the response of various wheat varieties to sorghum allelochemicals. Among four wheat varieties (Inqlab-91, Parwaz-94, Shahkar-95 and Punjab-96), Punjab-96 was found a superior variety as it showed the least sensitivity compared to all others. Shahrokhi et al. (2011) also found significant differences in the effects of aqueous extract of *Amaranthus retroflexus* on most measured parameters in five barley varieties ('Fajr 30', 'Nosrat', 'Valfajr', 'Reyhan', 'Kavir'). According to those results, 'Reyhan' and 'Kavir' demonstrated some tolerance to allelopathic effects of *A. retroflexus* in most traits (germination rate, radicle length, plumule length, fresh weight and dry weight of seedlings), compared to the others, and so their cultivation may cause reduced pigweed damage. The authors pointed that growing cultivars susceptible to allelopathic weed substances may result in increased herbicide application rates due to decreasing weed economic injury level (EIL).

The causes of sensitivity or tolerance of varieties, hybrids, and species to the allelopathic influence of weeds have not been fully revealed, and scientific literature is almost lacking in studies on this issue. The conducted experiment sought to clarify such dependencies regarding different morphological and biochemical parameters of the seed. Regarding seed germination, the analysis of data disclosed a negative correlation between the biomass of 1000 seeds of the tested cultivars and reducing effects of the weed extracts ($r = -0.851$). Regarding the inhibitory effect on growth parameters, negative correlations with the seedling vigour index SVI ($r = -0.672$) and seed protein content ($r = -0.702$) were found. The latter dependence was also noted in our previous study with peas (Georgieva & Nikolova, 2016) and it was due to an ability of the proteins to adsorb molecules of organic compounds to their surface (Filipovich, 1999).

CONCLUSIONS

The results of this study indicate a variation in responses of nine vetch cultivars (*Vicia sativa*, *V. villosa*, *V. pannonica*) to the allelopathic effects of aqueous extracts from shoot and root biomass of *Sorghum halepense*. The extracts applied at different concentrations (1.0, 5.0 and 10%) had significant inhibitory effects on seed germination (ranging from 2.8 to 27.3% for different cultivars), germ length (from 4.6 to 48.7%) and germ weight (from 3.6 to 34.0%). The lowest concentration (1.0%) also had a stimulating action on growth parameters, which was especially strong in two cultivars ('Beta WP' and 'Viola').

The data on overall activity of the weed extracts on seed germination and initial development showed high tolerance of the cultivars 'Beta WP', 'Violeta' and 'Obrazets 666', as opposed to 'Liya' and 'Panonskaya', which were more sensitive.

A correlative data analysis showed that the cultivars with greater biomass per 1000 seeds, higher seedling vigour index and protein content, had lower sensitivity to the suppressing effect of *S. halepense* extracts, in other words, they exhibited higher tolerance. These cultivars could be successfully used in organic fields with increased density of *S. halepens*e or in a conventional production system with reduced use of herbicides.

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Varijacije u alelopatskoj otpornosti više sorti grahorica na ekstrakte *Sorghum halepense* L. (Pers.)

REZIME

Smatra se da je alelopatska otpornost useva i sorti perspektivan doprinos strategijama za suzbijanje korova. Kako bi se ocenila alelopatska otpornost više sorti grahorica na ekstrakte *Sorghum halepense* u pogledu klijanja semena i početnog rasta useva, sproveden je multifaktorijalni laboratorijski eksperiment zasnovan na nasumičnom uzorku u četiri ponavljanja. Eksperimentalni faktori su bili: devet sorti grahorica ('Liya', 'Lorina', 'Moldovskaya', 'Obrazets 666', 'Asko', 'Violeta', 'Viola', 'Beta WP' i 'Panonskaya'), dva vodena ekstrakta (izdanak i koren *S. halepense*) i četiri koncentracije (1.0%, 5.0%, 10.0% plus destilovana voda kao kontrola). Analiza varijanse je pokazala značajan uticaj proučavanih faktora. Rezultati su pokazali varijacije u odgovoru devet sorti na alelopatsko delovanje *Sorghum halepense*. Ekstrakti koji su primenjeni u različitim koncentracijama imali su značajno inhibitorno delovanje na klijanje semena (2.8-27.3% za različite sorte), dužinu klice (4.6-48.7%) i težinu klice (3.6-34.0%).

Najniža koncentracija (1.0%) je takođe imala stimulativno delovanje na parametre rasta, najviše kod dve sorte ('Beta WP' i 'Viola'). Ukupni efekti ekstrakta korova na klijanje semena i početni razvoj pokazali su da su 'Beta WP', 'Violeta' i 'Obrazets 666' najotpornije sorte, za razliku od sorti 'Liya' i 'Panonskaya', koje su se pokazale kao osetljivije. Sorte koje imaju veću masu 1000 semena, veći indeks vigora izdanka i veći sadržaj protein pokazale su se kao manje osetljive na suzbijajuće delovanje ekstrakta *S. halepense*, odnosno kao otpornije. Te sorte mogu se uspešno koristiti u oganskoj proizvodnji sa povećanom gustinom korova *S. halepense*, kao i u klasičnom proizvodnom sistemu sa smanjenim korišćenjem herbicida.

Ključne reči: Alelopatija; Grahorice; Sorghum; Klijanje