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Original scientific paper

A study on the allelopathic tolerance of garden pea varieties to *Sorghum halepense* (L.) Pers. extracts

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SUMMARY

The present research study identified garden pea varieties with pronounced tolerance to the allelopatic action of *Sorghum halepense*. Nine varieties were selected to study the effects of shoot and root weed biomass, applied in three extract concentrations (1, 5 and 10%), on seed germination and initial germ growth. A variance analysis of data revealed significant influence ($p < 0.05$) of three studied factors (variety, type and concentration of extracts) on the investigated parameters. Statistically insignificant was only the influence of extract type (root/aboveground biomass) on seed germination. Based on absolute values of the allelopathic indicator RI, which determines the degree of allelopathic inhibition in terms of germination, germ length and weight in different varieties, the variation was as follows: from -0.30 to -0.04, from -1.31 to -2.96 and from -0.47 to 0.02. The total effect of allelopathic action of *S. halepense* on all studied parameters, presented as a GGE-biplot analysis, defined Pulpudeva and Puldin varieties as exhibiting higher tolerance, in contrast to Denitsa and Vyatovo, which were sensitive. Ran I, Mira, Musala and Vechernitsa occupied an intermediate position. Cultivation of allelopathic tolerant varieties is a promising addition to the current weed control strategy, especially in organic production.

Keywords: allelopathy, weeds, *Pisum sativum, Sorghum halepense*

INTRODUCTION

Allelopathy is a biological phenomenon of chemical interactions between organisms in an ecosystem and it should be taken into consideration when solving problems related to pest and weed control in sustainable agriculture (Macías et al., 2019). Allelopathic interactions of plants were observed back in the 4th century BC, but they received necessary attention of the scientific community and farmers only in recent years. In modern agriculture, allelopathy plays an important role in maintaining agroecosystem sustainability through the application of various environmentally-friendly strategies, such as cover crops, crop rotation, incorporation of plant residues, mulching, bioherbicides (Scavo et al., 2018), tolerant cultivars (Bakhshayeshan-Agdam & Salehi-Lisar, 2020; Khatri et al., 2020), etc. Moreover, with an increasing importance of organic farming and environmental protection, more and more attention will be paid to research of allelopathy, and physiological and ecological mechanisms of allelopathy are gradually becoming clearer (Cheng & Cheng, 2015).

Crops possessing allelopathic properties are numerous: they include arboreal and herbaceous species, as well as many weeds (Scavo et al., 2018). The ability to synthesize and release allelopathic compounds in the environment or to tolerate the presence of allelochemicals released by other plants may determine a species' ability to survive and reproduce (Trezzi et al., 2016). The most important allelochemicals include glucosinolates, terpenes, phenolic compounds, alkaloids, benzoxazinoids, sorgoleon, and momilactones (Jabran, 2017).

The allelopathic potential of crops may be used for weed control. This is possible by channeling the allelopathic activity of crops by several techniques. These techniques may include the cultivation of varieties that have allelopathic potential (Jabran, 2017) or varieties with high tolerance to weed species (Cheema & Ahmad, 1992; Cheema et al., 2002). Studies have been conducted to identify varieties with increased allelopathic tolerance to major weeds in crops such as wheat (Shao et al., 2019), corn (Baličević et al., 2014), lupine (Georgieva, 2019), vetch (Georgieva et al., 2018) and others.

The present study aimed to establish the allelopathic effect of different concentrations of *Sorghum halepense* extracts on the initial growth of garden pea varieties and to identify those with increased allelopathic tolerance.

MATERIAL AND METHODS

A laboratory study was carried out as a three-factor experiment at the Institute of Forage Crops (Pleven) in 2021. The first factor (A) included nine varieties of garden pea (*Pisum sativum* L.): Ran I, Pulpudeva, Musala, Denitsa, Skinado, Puldin, Mira, Vyatovo and Vechernitsa. The second factor (B) was *S. halepense* biomass (shoot or root), while three concentrations of weed extracts (1.0, 5.0 and 10.0%) were the third factor (C). Distilled water was used in control Petri dishes.

Shoot and root biomass of *S. halepense* was collected at the flowering stage. It was dried to constant dry weight at 60 °C and ground (Chon & Nelson, 2001). To prepare the extracts, an amount of 100 g of ground plant material was suspended in 1 l of distilled water at 24 ± 1 °C for 24 hours. The obtained extracts were filtered and brought to final concentrations of 1.0, 5.0, and 10.0%. Thymol as a preservative was added in the amount of 1 g/l to each extract. One hundred and five seeds of each pea variety were portioned out into Petri dishes (9 cm diameter) containing filter paper. Each Petri dish received 8 ml of pipetted aqueous extract. The dishes were placed in a thermostat at 22 °C ± 1 °C for 7 days. The following parameters were reported: germination (%), germ length (root and stem) (cm), germ weight (root and stem) (g), and inhibition (%). Germination percentage was calculated using the formula: % germination = (germinated seeds/total number of seeds) × 100, and the inhibition percentage (I, %) was determined using a formula of Chung et al. (2003): % inhibition = [(control-extracts)/control] × 100. The following equations were used to calculate allelopathy indicators: $RI=1-C/T(T\geq C)$ and $RI=T/C-1(T\leq C)$, where C is the control value, T is the processing value, $RI>0$ indicates promotion, and $IR<0$ indicates inhibition. The absolute values are consistent with the intensity of allelopathy action (Zhang et al*.,* 2015). Tolerance index (TI) was determined by an adapted formula of Tahseen and Jagannath (2015). The received data were analyzed using GGEbiplot (PBSTAT 1.2), and the software product Statgraphics Plus for Windows Ver. 2.1.

RESULTS

The data variance analysis revealed significant influence ($p < 0.05$) of the three studied factors (excluding the type of extract on germination) on seed germination rate, and germ length and weight of nine garden pea varieties (Table 1). The "variety" factor was decisive for seed germination (47.6% of total variation), while weed extract concentration had the strongest influence in terms of germ growth and biomass accumulation, 59.8 and 61.0% of total variation, respectively. The interaction of factors A × B, A × C, and A × B × C was statistically significant for all considered parameters, as the A × C interaction had the highest effect. For all studied parameters, the B × C interaction was the weakest and statistically insignificant.

Germination

Aqueous extracts of *S. halepense* showed a general tendency to inhibit seed germination of the tested pea varieties (Figure 1). Also, it was observed that the increasing concentrations of extracts also increased their suppressive effect. Exceptions were found in Pulpudeva and Puldin varieties, in which none of the three concentrations of aboveground biomass (1, 5 and 10%) had negative impact on seed germination, and it also occurred in some other varieties (Denitsa, Skinado, Mira) to which the lowest concentration of 1% also had no pronounced negative effect. Based on the calculated average effects of six weed extracts on the germination process, decrease in germination in

Table 1. Analysis of variance for seed germination and germ growth in garden pea varieties

Causes of variation	Degrees 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
Parameters		Germination, %			Germ length, cm			Germ weight, cm		
Total	287	82336.2		100.0	3640.4		100.0	1.59332		100.0
Factor A- variety	8	39179.1	4897.4	47.6*	466.5	58.31	12.8*	0.19192	0.0240	12.0*
Factor B - type of extract	1	121.2	121.2	0.1	10.2	10.21	0.3*	0.01557	0.0156	1.0*
Factor C - concentration of extracts	3	17070.1	5690.0	20.7*	2175.4	725.11	59.8*	0.97129	0.3238	61.0*
A×B	8	3500.6	437.6	4.3*	69.5	8.69	1.9*	0.01990	0.0025	1.2*
A×C	24	14587.9	607.8	17.7*	290.5	12.10	8.0*	0.15830	0.0066	9.9*
B×C	3	86.7	28.9	0.1	16.6	5.54	0.5	0.00526	0.0018	0.3
A×B×C	24	4910.7	204.6	6.0*	147.9	6.16	4.1*	0.06426	0.0027	4.0*
Error	216	2880.0	133.3	3.5	463.9	2.15	12.7	0.16600	0.00077	10.4

LSD at 0.05 probability level

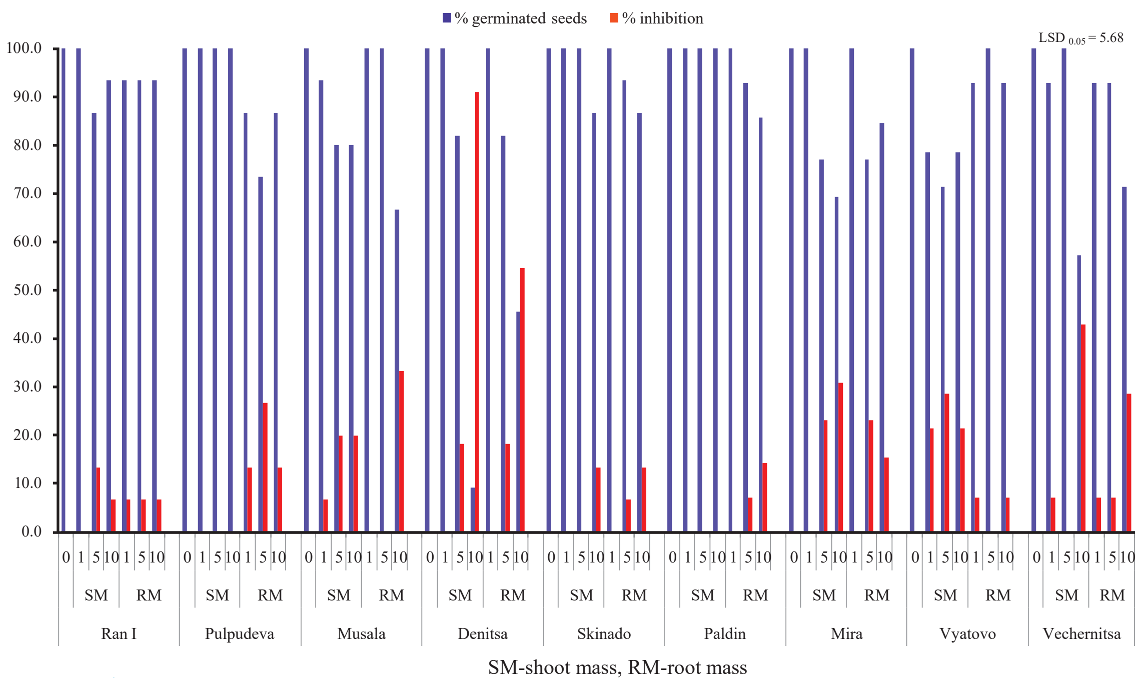


Figure 1. Influence of water extracts of *Sorghum halepense* on seed germination in pea garden varieties

different varieties varied from 6.7 to 90.9%. As a result of concentrations increasing (from 1 to 5 to 10%), the decrease was on average 3.5, 9.9 and 20.6%, while extract type (aboveground or root biomass) caused no significant difference, and it was 12.1 and 10.5%, respectively. The allelopathic indicator RI, which determines the degree of allelopathic inhibition, ranged from -0.067 to -0.909 (Table 1). The lowest average values of variety RI were demonstrated by Puldin, Skinado and Pulpudeva (-0.036, -0.056, -0.089), and the highest by Denitsa (-0.303).

Germ length

As a whole, data in Table 2 show the greatest germ length in the control variants of all garden pea varieties. Maximums were noted for Puldin and Vyatovo varieties, and minimums for Denitsa and Vechernitsa. Compared to control data, the differences in all treated variants were statistically significant, except for the 1% concentration of shoot biomass on Pulpudeva, Musala and Vechernitsa, and 1% concentration of root biomass on Vechernitsa.

Table 2. Influence of *Sorghum halepense* extracts on germ length and fresh biomass accumulation in garden pea varieties

Variety	Type of extract	Concen tration, %	GL, cm	GW, g	RI			TI	
					GR	GL	GW	GL	GW
Ran I		Control	11.14	0.281					
	Shoot mass	1.0	8.32	0.261	0.00	−1.22	−0.07	62	66
		5.0	5.11	0.135	−0.133	−1.98	−0.52		
		10.0	3.81	0.104	−0.067	−2.66	−0.63		
	Root mass	1.0	14.29	0.312	−0.067	0.28	2.31		
		5.0	5.58	0.173	−0.067	−1.82	−0.38		
		10.0	4.63	0.120	−0.067	−2.19	−0.57		
Pulpudeva		Control	10.42	0.301					
	Shoot mass	1.0	10.35	0.323	0.00	−0.91	2.16	72	68
		5.0	5.76	0.155	0.00	−1.63	−0.48		
		10.0	5.29	0.167	0.00	−1.78	−0.45		
	Root mass	1.0	14.88	0.268	−0.133	0.43	−0.11		
		5.0	4.14	0.146	−0.267	−2.27	−0.52		
		10.0	4.87	0.165	−0.133	−1.93	−0.45		
Musala		Control	10.13	0.235					
	Shoot mass	1.0	9.49	0.231	−0.067	−0.96	−0.02	56	75
		5.0	5.51	0.167	−0.200	−1.66	−0.29		
		10.0	3.97	0.141	−0.200	−2.30	−0.40		
	Root mass	1.0	6.39	0.220	0.00	−1.43	−0.06		
		5.0	6.43	0.221	0.00	−1.42	−0.06		
		10.0	2.22	0.071	−0.333	−4.12	−0.70		
Denitsa		Control	6.98	0.221					
	Shoot mass	1.0	4.38	0.151	0.00	−1.37	−0.32	60	55
		5.0	3.91	0.148	−0.182	−1.53	−0.33		
		10.0	0.50	0.003	−0.909	−11.96	−0.98		
	Root mass	1.0	8.88	0.192	0.000	0.27	−0.13		
		5.0	3.50	0.118	−0.182	−1.71	−0.47		
		10.0	4.05	0.115	−0.545	−1.48	−0.48		
Skinado		Control	9.29	0.221					
	Shoot mass	1.0	6.20	0.175	0.00	−1.34	−0.21	43	53
		5.0	3.49	0.111	0.00	−2.38	−0.50		
		10.0	2.15	0.056	−0.133	−3.87	−0.75		
	Root mass	1.0	5.85	0.143	0.00	−1.42	−0.35		
		5.0	3.42	0.116	−0.067	−2.43	−0.47		
		10.0	2.94	0.104	−0.133	−2.82	−0.53		
Paldin		Control	13.88	0.216					
	Shoot mass	1.0	11.22	0.211	0.00	−1.15	−0.02	54	86
		5.0	8.56	0.207	0.00	−1.50	−0.04		
		10.0	4.70	0.101	0.00	−2.74	−0.53		
	Root mass	1.0	9.37	0.238	0.00	−1.37	4.17		
		5.0	8.23	0.245	−0.071	−1.56	3.54		
		10.0	3.11	0.108	−0.143	−4.14	−0.50		
Mira		Control	9.97	0.199					
	Shoot mass	1.0	7.69	0.182	0.00	−1.17	−0.09	57	80
		5.0	5.53	0.138	−0.231	−1.62	−0.30		
		10.0	3.16	0.092	−0.308	−2.84	−0.54		
	Root mass	1.0	8.94	0.280	0.00	−1.00	4.56		
		5.0	5.25	0.161	−0.231	−1.71	−0.19		
		10.0	3.59	0.104	−0.154	−2.50	−0.48		
Vyatovo		Control	12.30	0.288					
	Shoot mass	1.0	8.76	0.201	−0.214	−1.29	−0.30	44	54
		5.0	4.12	0.108	−0.286	−2.74	−0.62		
		10.0	4.00	0.101	−0.214	−2.82	−0.65		
	Root mass	1.0	8.46	0.252	−0.071	−1.34	−0.12		
		5.0	4.21	0.150	0.00	−2.68	−0.48		
		10.0	3.25	0.123	−0.071	−3.48	−0.57		
Vechernitsa		Control	8.45	0.262					
	Shoot mass	1.0	8.75	0.233	−0.071	0.04	−0.11	71	62
		5.0	5.27	0.169	0.00	−1.41	−0.36		
		10.0	2.48	0.062	−0.429	−3.00	−0.76		
	Root mass	1.0	8.92	0.252	−0.071	0.06	−0.04		
		5.0	7.76	0.173	−0.071	−0.96	−0.34		
		10.0	2.90	0.091	−0.286	−2.57	−0.65		
LSD at the 0.05 probability level A×B×C			0.72	0.014					

GL - germ length, GW - germ weight, RI - allelopathy indicator, TI - tolerance index

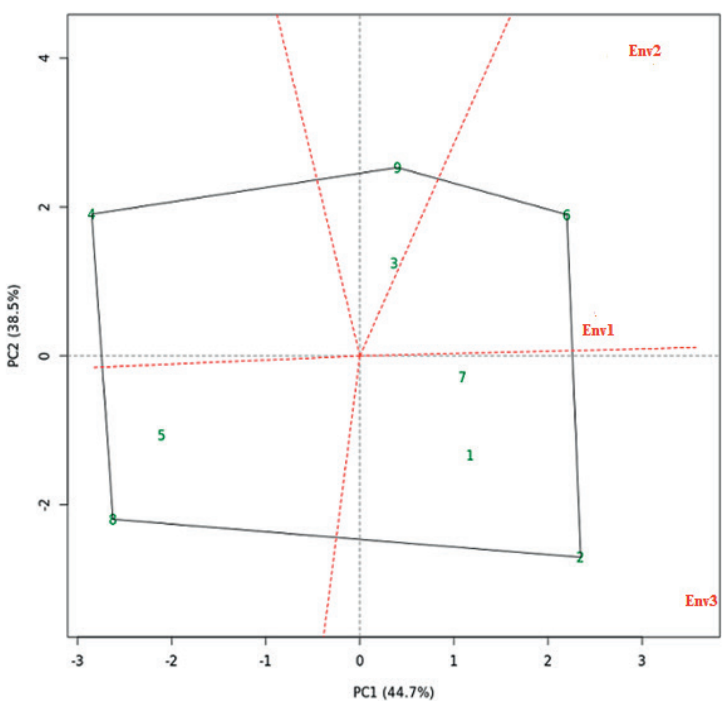
Similar to the previous parameter, treatment with weed extracts of aboveground and root biomass at 1, 5 and 10% concentrations resulted in average inhibition of germ length by 18.8, 48.9, 67.5%, and 7.1, 47.6, 65.9%, respectively. It is obvious that the shoot biomass extracts of *S. halepense* had significantly stronger suppressive effect than those from root biomass (Table 1), with inhibition values of 45.1 and 40.2%, respectively. The average data based on the „variety" factor, regardless of concentration and type of extract, showed that the least affected were Vechernitsa and Pulpudeva, in which the allelopathic indicator RI was -1.31 and -1.35, and the tolerance index (TI) 71 and 72%, respectively. In some varieties (Ran I, Pulpudeva, Denitsa, Vechernitsa), 1% concentration of root biomass had a weak stimulating effect (RI from 0.06 to 0.43). According to TI data regarding the considered parameter „germ length", the studied genotypes Ran I, Pulpudeva, Musala, Denitsa, Puldin, Mira and Vechernitsa can be defined as tolerant (TI <75%), and Skinado and Vyatovo as sensitive (TI <50%).

Germ weight

The analysis of data concerning the germ weight parameter shows that pea cultivars exhibited different degrees of sensitivity to the action of aqueous extracts of *S. halepense* (Table 2). Denitsa, Skinado and Vyatovo demonstrated greater sensitivity, as their reduction in seed weight ranged from 45.2 to 46.8%. The lowest sensitivity was shown by Puldin and Mira (with reductions of 14.2 and 20.0%), while Ran I, Pulpudeva, Musala and Vechernitsa occupied an intermediate position. Similar to the results for previous parameters, increasing concentrations of weed extract enhanced the inhibitory effect on germ weight with values of 7.2, 36.1 and 58.9%, respectively, while the type of extract (shoot or root biomass), although it was a factor with less influence, reduced germ weight, and average values were 38.0 and 30.1%. The mentioned percentages of inhibition of biomass accumulation in different varieties were in accordance with RI and TI values, which identified Puldin and Mira as highly tolerant (TI> 75%), and the other varieties as tolerant (TI <75%).

GGE-biplot analysis

The GGE-biplot method and PBSTAT 1.2 software product were used to assess the total effect of weed extracts on seed germination and initial germ development in pea varieties. Figure 2 clearly demonstrates essential differences in the susceptibility of studied genotypes to the allelopathic stress of *S. halepense*,



1 - Ran I, 2 - Pulpudeva, 3 - Musala, 4 - Denitsa, 5 - Skinado, 6 - Paldin, 7 - Mira, 8 - Vyatovo, 9 - Vechernitsa
Env1 (1.0% concentration of water extract of *S. halepense*), Env2 (5.0%), Env3 (10.0%)

Figure 2. GGE-biplot of allelopathic tolerance in garden pea varieties

as well as the degree of suppressing impact of Env 1 (1.0% concentration of *S. halepense*), Env 2 (5.0% concentration) and Env 3 (10.0% concentration). Among the nine tested varieties, the highest tolerance was demonstrated by Pulpudeva and Puldin, which are located at the terminal points on the right side of the graph. Denitsa and Vyatovo are positioned on the left side of the coordinate system, i.e. at the farthest points from the center, which defines them as varieties with low tolerance. Skinado, located on the left side of the coordinate system, can also be included in this group. Ran I, Mira, Musala and Vechernitsa occupy intermediate positions.

DISCUSSION

The results of this study showed that seed germination and initial growth parameters in garden pea varieties were negatively affected by aqueous extracts of *S. halepense*. According to the reported parameters, the studied varieties exhibited greater sensitivity during the period of initial germ growth and biomass accumulation (with inhibition rates from 27.5 to 56.9% and from 14.2 to 46.8%, or corresponding RI values from -1.31 to -2.96 and from 0.02 to -0.47), and less sensitivity during seed germination (from 3.6 to 30.3%, or RI from -0.036 to -0.155). It is known that *S. halepense*, which is one of the most common and harmful weeds in the country (Vasilakoglou et al., 2005; Hristoskov, 2013), has a pronounced allelopathic potential. Allelopathic substances have been found to inhibit cell division and elongation, respiration and photosynthesis, water and nutrient uptake, protein synthesis and metabolism, activity of antioxidant enzymes, etc. (Cheng & Cheng, 2015). Major allelochemicals that *S. halepense* contains include chlorogenic acid, phenolic compounds, *p*-hydroxybenzeldehyde, *p*-coumaric acid, „sorgoleone" and „dihydrosorgoleone" (Movahedpour et al., 2010; Butnariu, 2012; Zohaib et al., 2016). For example, chlorogenic acid in *S. halepense* inhibits the key enzyme λ-phosphorylase, which participates in seed germination (Einhellig, 1995). Sorgoleone and p-coumaric acid inhibit H-ATPase activity, which is associated with water and nutrient uptake, and the activity has been found in various legumes (peas, soybeans) (Hejl & Koster, 2004). Sorgoleone also reduces the number of cells in each period of cell division, damaging the tubules and resulting in the appearance of polyploid nuclei (Hallak et al., 1999). Phenolic compounds can reduce the activity of phenol-b-glucose transferase, thus inhibiting root growth (Cheng & Cheng, 2015), and disrupt the integrity of DNA and RNA, which in turn adversely affects protein biosynthesis and cell growth (Li et al., 2010).

Reactions to allelochemicals were species-specific and depended on concentration (An et al., 2008). Species specificity to allelochemical action has also been reported by Bakhshayeshan-Agdam et al. (2015), who observed stronger resistance to the action of *Amaranthus retroflexus* extracts in wheat and cucumber than in common bean and alfalfa. In our previous study (Georgieva et al., 2015), considerable differences were found in the sensitivity of *Lupinus albus* and *Lupinus luteus* to *S. halepense* extracts. For example, fresh biomass accumulation in the primary germ of *L. luteus* was inhibited 3.8-40.3% at weed concentrations of 2.5, 5.0 and 10.0%, which determined the species as more sensitive to *S. halepense* extracts. On the other hand, *L. albus* was resistant as no allelopathic effect of the extracts was detected. The results of the present study proved that the response to allelochemicals may also be varietal specific. The varieties exhibiting high tolerance were Puldin and Pulpudeva, in which the suppressive effect of weed extracts on germination and initial growth, presented in total, was the least pronounced (63.5 and 68.5%, respectively). In contrast, Denitza and Skinado sustained the most pronounced effect. This was confirmed by the GGE-biplot method evaluation However, further studies are needed to assess the allelopathic tolerance of pea varieties under field conditions. Cultivation of allelopathy tolerant species and varieties is a promising addition to the existing weed control strategy, especially in organic production. The varietal response of chickpeas to extracts of *Xanthium strumarium* and *Parthenium hysterphorus* was reported by Khan et al. (2019). The authors found high tolerance to the phytotoxic action of invasive weeds in Karak-II variety, followed by Karak-I, Karak-III, Fakhr-e-Thal and Chattan. In a similar experiment with alfalfa and birdsfoot trefoil genotypes, Valcheva et al. (2018) indicated the alfalfa variety Multifoliate and local birdsfoot trefoil populations LP1 and LP2 were characterized by increased tolerance to the allelopathic action of aqueous extracts of *Cuscuta epithymum*. In a comprehensive study, Shao et al. (2019) investigated the allelopathic effects of four weed species (*Descurainia sophia, Galium tricorne, Avena sativa,* and *Vicia sativa*) on seed germination, germ length and weight of ten wheat cultivars (Yannong 19, Yannong 21, Jimai 22, Lunong 116, Kaimai 18, Zhengmai 366, Wanmai 19, Wankenmai 1, Wanmai 50 and Wanmai 54). Based on a cluster analysis of allelopathic indicators (RI), the inhibition rate in Wanmai 19 was the weakest, and its resistance to weeds was the highest. Therefore, growing varieties with increased tolerance to allelopathic weed stress can reduce weed damage (Shahrokhi et al., 2011).

Regarding the concentration of weed extracts and their effects on recipient plants, it should be noted that high concentrations were usually inhibitory and low concentrations were stimulating, a phenomenon known as hormesis (Hadacek et al., 2010). Regarding the experimental conditions, the concentrations of 5 and 10% had significant negative effects on the initial growth parameters, while 1% concentration of root biomass in Ran I, Pulpudeva and Denitsa varieties had a distinct stimulating action (in the range 27.3-2.8%) on germ length, and the action was statistically significant. The effect of 5% concentration of root biomass in Ran I, Puldin and Mira in relation to germ weight was similar as the stimulating effect in that case ranged from 10.4 to 40.4%.

CONCLUSIONS

The present study demonstrated inhibitory effects of shoot and root aqueous extracts of *Sorghum halepense* on seed germination and initial germ growth in garden pea varieties. The suppressing action increased with increasing extract concentration (1, 5, 10%).

The variance analysis of data showed significant influence ($p < 0.05$) of the three studied factors (variety, type and concentration of extracts) on the investigated parameters. Statistically insignificant was only the influence of extract type (root/aboveground biomass) on seed germination. Comparing data regarding the type of extracts it was found that the weed shoot biomass had a more pronounced inhibitory effect than root biomass.

The allelopathic indicator RI, which determines the degree of allelopathic inhibition regarding germination, germ length and weight, varied in different varieties as follows: -0.30 to -0.04, -1.31 to -2.96, and -0.47 to 0.02.

The total effect of *S. halepense* allelopathic action on all studied parameters, presented by GGE-biplot analysis, identified Pulpudeva and Puldin varieties as exhibiting higher tolerance, in contrast to Denitsa and Vyatovo, which were sensitive. Ran I, Mira, Musala and Vechernitsa occupied an intermediate position.

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Proučavanje otpornosti različitih sorti graška na alelopatsko delovanje ekstrakta *Sorghum halepense* (L.) Pers.

REZIME

U istraživanju su identifikovane sorte graška sa izraženom otpornošću na alelopatsko delovanje *Sorghum halepense*. Odabrano je devet sorti kako bi se ispitao uticaj ekstrakta biomase izdanka i korena, primenjenih u tri koncentracije (1, 5 and 10%), na klijanje semena i inicijalni rast klijanaca. Analiza varijanse je pokazala značajan uticaj ($p < 0.05$) tri ispitivana faktora (sorta, vrsta i koncentracija ekstrakta) na proučavane parametre. Kao statistički značajan pokazao se samo uticaj vrste ekstrakta (koren/nadzemna biomasa) na klijanje semena. Na osnovu apsolutnih vrednosti alelopatskog indikatora RI, kojim se određuje alelopatska inhibicija klijanja, kao i dužine i težine klijanaca kod različitih sorti, utvrđene su sledeće respektivne varijacije: od -0.30 do -0.04, od -1.31 do -2.96 i od -0.47 do 0.02. U okviru ukupnog alelopatski uticaja *S. halepense* na proučavane parametre, pokazanog GGE-biplot analizom, pokazalo se da sorte Pulpudeva i Puldin poseduju veću tolerantnost u odnosu na sorte Denitsa i Vyatovo, koje su osetljive. Ran I, Mira, Musala i Vechernitsa imale su srednje vrednosti. Gajenje alelopatski tolerantnih sorti predstavlja perspektivan doprinos postojećoj strategiji za suzbijanje korova, naročito u uslovima organske proizvodnje.

Ključne reči: alelopatija, korovi, *Pisum sativum*, *Sorghum halepense*