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ALLELOPATHIC EFFECTS OF EXTRACTS OF DIFFERENT ORGANS OF WEEDS ON STRAINS OF BARLEY

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ABSTRACT

Because most of crop plants and weeds have allelopathic effects, analysis of these effects on plants in crop alteration and successive planting is highly significant. In this regard, the present study tries to analyze the allelopathic ability of different parts with two concentrations of two weeds of Ryegrass and *Sinapis arvensis* in affecting the rate of growth of two barley strains, *Valfajr* and *Rehane*, in a completely random plan with four repetitions in a greenhouse. Test factors consisted of two barley stains (Valfajr and Rehane), three weed organs (root, stalk, leaf) and four concentrations of extracts of different weed organs (25, 50, 75 and control or distilled water). After the preparation of extracts of different weed organs with different concentrations, their effect on growth characteristics of barley plant was evaluated. Finally, the herb height, length of spikes, number of leaves, number of seeds inside the herb, the weight of one thousand seeds (grams) and output of seed for each herb (grams) were measured. Also, the above two seeds had significant effects on the two strains of barley and could influence growth characteristics of barley. Based on the results of present study, one can argue that "Ryegrass" and *Sinapis arvensis* can strongly affect germination, growth and performance of barley through production of chemical materials with allelopathic properties and lead to unfavorable growth and product output.

Keyword: weeds, barley, allelopathic, extracts, organs.

INTRODUCTION

The term Allelopathy refers to the release of chemical materials by a plant and the prevention of growth by nearby plants. Reduction of plant growth might be due to competition for water, nutrients, light, dioxide carbon, or release of toxic substances from some of their parts (Mohsenzade, 2000). Allelopathic compounds are classified as secondary herbaceous materials or minor products of metabolic pathways of plants. One of the known cases of allelopathy is the preventive effects of *Amaranthus Retroflexus* which reduces the leaf area, height, and dry weight of corn in all stages of growth (Meghiati, 2003). Such materials are washed away from the branches and leaves of plants or their remains or they are secreted by roots into the environment (Hakimi Maibodi and Sodaizade, 2005).

Allelopathic materials inside plant organs, when released, can highly influence vital phenomena such as photosynthesis (Yung *et al.*, 2002; Tiffany *et al*., 2004; Shahid-Sedighi and Aref-Alzaman, 2005) cellular respiration (Inderjit, 2003; Bargus *et al*., 2004), meiosis (Hejazi, 2000) and absorption of water and nutrients (Tiffany *et al.*, 2004). For example, prevention of phosphor absorption by cucumber roots is related to the concentration of phenolic acid inside root rhizosphere of root (Inderjit, 2003).

Modern agriculture tries to minimize damage to the environment through reducing chemical materials and minimizing soil erosion, while maximizing production for each unit of area. Allelopathy can lead to the increase of production and implementation of sustainable agriculture. The phenomenon of allelopathy can be analyzed in crop rotation, management of plant survival, tillage operations, and biological attack against weeds (Baghestani and Zand, 2004).

The objective of present study, too, is to identify the effects of extracts of different organs of weed with diverse concentrations on growth elements of two strains of barley and to define the position of each one of these tested plants in the rotation. The investigations by researchers showed that successive planting of rice crop, due to the existence of phenol compounds in the remains of this plant, can reduce performance up to 25%, which is due to the property of self-poisoning of this plant. From among the most important phenol compounds identified during testing of remains of rice plant, one can point to vanillic acid, frolic acid, P-coumaric, P-hydroxy Benzoic and Butyric (Pourrostami, 2005). In this regard, based on a report by Khorasani Nejad *et al*. (2009), existence of self-poisoning in cucumber has been verified. Based on this report, maximum growth reduction was related to extracts of cucumber roots.

Allelopathic materials can affect the height of plants, too, and this effect is also shown in forest and meadow plants (Kohli *et al*., 2001; Yamasaki *et al*., 2001). The researchers showed that allelopathic materials of plants cause reduction of dry materials of farm plants such as wheat, corn, sunflower, and soybeans (BeresandKazinczi, 2000; Javadi *et al*., 2006). Existence of allelopathic effects caused by remains and extracts of most of strains of weeds and some farming plants can prevent germination and growth of other strains and intervene in some growth processes of plants leading to decline of product output (Oroji *et al.*, 2008). Among allelochemicals, cyclic compounds such as phenols, coumarines, flavonoids and tannins, derivatives of cinnamic acid, and coinnons are regarded as the most significant allelopathic materials.

Flavonoids, phenols, tannins, and glycosides are introduced as compounds which prevent germination (Kohli *et al*., 2001). Flavonoids were the first group of allelochemicals that prevent absorbed mitochondrial oxygen which stops the production of ATP in mitochondria and influence respiration (Maiqani, 2003). Slowing of cellulose synthesis by coumarines in epicotyl has been confirmed (Makeezadeh *et al*., 2008). Researchers have shown that coumarine and scopoletin reduce mitosis in grass roots (Barkosky and Einhellig, 2003). In a research, the saturated solution of coumarine in the root of onion and lily was found to prevent mitosis for about 2-3 hours and its primary effect was similar to Colchicine treatment. Coumarine also prevents entry of cells into mitosis stage (Maiqani, 2003). Reduction of root length reflects that lengthening of cells has been affected by allelochemical compounds, through gibberellin and indole acetic acid (Qasem, 1992). In this regard, areal part has more allelopathic activity compared with roots.

The purpose of present study is to identify disruptive allelopathic effects of extract and remains of organs of these two types of weeds in varied amounts on growth and production of barley.

MATERIALS AND METHODS

This test was done in the greenhouse of Islamic Azad University of Fasa within a controlled setting. To prepare aqueous extract of weed, plants were planted in the greenhouse and during blossoming; sampling was conducted from areal and underground organs. After washing samples with a huge amount of water, another washing was performed with distilled water. After separation of different organs (roots, stalks and leafs) from each other, the organs under study were dried in shadow and open air, and then they were milled.

To prepare stock, 1000 milligrams of distilled water was added to 100 grams of the intended powder and put on shaker for 24 hours and 130 RPM. The obtained solution was filtered through Wattman paper (no.1) and thinned to achieve cases of treatment (Mojab *et al*., 2009; Naseri *et al*., 2008). Duration of darkness and light periods was decided by daily length needed for the plant. The temperature of greenhouse during the test was17-33°on average, while relative humidity was between 35 to 65%. The test was run in a completely randomized design.

Test units included containers with a volume of 9 liters, height of 30 centimeters, and diagonal length of 25 centimeters. To the top of containers, a mixture of farm and sand soils was added with a ratio of 2.3 to 1.2. For each test unit (container), 20 barley seeds were planted in a depth of 3 centimeters and after stability of herbs, 5 herbs were kept in each container. After obtaining test cases, the extracts of different organs of two weeds *Sinapis arvensis* and *Ryegrass* in concentrations of zero (control), 25%, 50% and 75% with a mean volume of 20 milliliter were added to pots during growth period. To prevent accumulation of allelopathc material, pure water was used to wash containers once per month (Hilda *et al*, 2002). To clarify the effects of different test cases on growth of barley strains, measurements of characteristics such as height of herb, length of spikes, number of leaves per herb, weight of one thousand seeds (grams), and output of seeds per herb (grams) were made. The data collected were analyzed in SAS. After variance analysis, comparison of means by Duncan method was done atthe 5% level of possibility. Drawing plots was done in Excel. Treatment cases in the present test consisted of:

a) Two strains of barley planted in greenhouse (*Valfajr* and *Rehane*).
b) Three types of weed organs (root, stalk and lead)
c) Four concentrations of extracts of different organs of weed (distilled water, 25, 50 and 75)
d) Effects of extracts of two types of weed on two strains of barley
e) Repetitions based on necessity.

Which totally included 192 containers under examination.

RESULTS AND DISCUSSION

The effect of extracts of organs of weeds *Ryegrass* and *Sinapis arvensis* on all properties analyzed was significant is such a way that the increase in extract concentration was followed by numerical reduction of all measured characteristics. The maximum height of barley, length of spikelet, and number of leaves were observed in control cases, whereas minimum values were found in a case with a concentration of 75%, which implies the effect of extract concentration on measured growth characteristics.

The effect of extract concentrations on the number of leaves showed that the number of leaves compared with control is significant for different concentrations of extract. However, the number of leaves reduced due to treatment with concentrations of 25%, 50% and 75% were 63.6%, 52.47%, and 51.39%, respectively compared to the control. These results report the effects of *Ryegrass* on *Rehane* barley (see Table-5), which is similar to the cases found in Tables 6-8.

The length of spike, as found for the height of the herb, showed a significant difference due to the increase of extract concentration in analyzed levels. Allelopathic intervention in the growth of areal parts (length of spike and height of herb) is a process which can influence all aspects of growth; for example, the reason for length reduction is interference of allelopathic compounds in cell division. This issue might lead to the decline of absorption of mineral materials and transfer of nutrients from the root to other parts of the plant (El-Khatib *et al.*, 2004).

In addition, this reduction of growth can be due to interference of allele chemicals in synthesis of proteins and hormones (De Neergard *et al*., 2000). Preventive activity of allele chemicals against growth of plants might be decrease of photosynthesis, which itself results in an decrease of Carbohydrates (Colpas *et al*., 2003). The number of seeds in *Rehane* herb in the control case was 30.80, which was significantly reduced due to treatment with different concentrations of *Ryegrass* extract. This reduction became more visible with the increase of the extract concentration (see Figure-5).

The highest weight of one thousand seeds in control condition was 39.46. Treatment case with extract of *Ryegrass* led to a significant decline of this property.

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The minimum reduction effect was observed in a concentration of 25%, whereas maximum effect was found out in 75%in such a way that the weight of one thousand seeds was reduced to 39.85 grams in the treatment with maximum concentration (Table-5).

The output of product for each herb of barley in reaction to concentrations of extracts of *Ryegrass* and *Sinapis arvensis* was similar to the effect of these materials on the weight of the one thousand seeds. In other words, the treatment of barley with different concentrations of *Ryegrass* led to a significant reduction of grain output. Such reduction due to extracts of weeds was very significant. The maximum grain output was obtained in the control group, and showed that the increase of extract concentration affected this factor, too, and resulted in its reduction (see Tables 5-8).

Roots have a less allelopathic potential compared to leaves but in some cases, the opposite is the case. Stalks have allelochemicals, too, and sometimes they are the main source of toxicity (Narwal *et al.*, 2005). This issue confirms the obtained results. Similar results including reduction of growth and accumulation of dry materials of wheat by aqueous extract of areal part and root of Cyndon dactolyn were found in reports of Alam *et al*. (2001) and Vasilakoglou *et al*. (2005). The extracts of this weed reduces the growth of barley and rice (Alam *et al*., 2001).

CONCLUSIONS

The general results of present study suggest that substances produced from areal organs and root of these two weeds influence the performance and growth of barley. The early growing stage of plant is the most sensitive stage to allelopathic compounds, as they can exert high effects at this stage. Severe reduction of plant growth can lead to the reduction of green level of farms and domination of weed in competition for environmental factors. So, one can argue that the effect of allelopathic compounds in the seedling stage has an important role to play in the fate of farming plants (El-Khatib *et al*., 2004). Phenol and coumarine acids existing in weeds can change aqueous ration of plant (Cruise *et al.*, 2000). This decline of osmosis pressure of cellular sap, in addition to affecting growth of different parts of plants such as length of areal part, can close stomata of the plant (Denegard and Porter, 2000).

Also, allelopathic compounds can affect all phases of Nitrogen cycle, reduce the available Nitrogen of the plant, and generate a decline of leaf area (Adayer *et al*., 1999). In addition, allelopathic compounds limit cellular division and growth of different parts such as leaves (El-Khatib *et al*., 2004). Allelopathic compounds arrest the development of photosynthesis and respiration. Limitation of synthesis of proteins, photosynthesis pigments, and changing biosynthesis pathways (Yung *et al.*, 2002); modification of mitochondrial and cytoplast membrane; absorption of nutrients; barring cellular mitosis activity (Denegard and Porter, 2000);disorder of hormonal system and internal blocking of wood elements; along with disorder in transmission of materials (Kolpas *et al*., 2003); generating disorder of enzyme activity and increasing the amount of abscisic acid (Denegard and Porter, 2000) all lead to a general reduction of plant growth, flower opening, number of reproductive parts, inoculation and reproduction of endospermic cells, and reduction of transmitting assimilates into the cells. Therefore, in addition to effects on the growth of all plant parts, it leads to the reduction of number and weight of grains and consequently a sharp decline of the product output. The arrest of growth caused by allelopathic effects of important weeds such as *Ryegrass* and *Sinapis arvensis* on performance of seed and crop indexes led researchers to attempt to increase the performance of farming plants, especially strategic products such as wheat and barley at an international scale. It is an issue which deserves significant attention. Due to the fact that *Ryegrass* and *Sinapis arvensis* are among common weeds of barley farms, confirming negative allelopathic effects of these weeds or their remains shows that proper management of farms based on principles of sustainable agriculture helps control this weed, which reduces or removes the allelopathic competition with barley and provides suitable condition for growth of strategic plants.

Table-1. Analyses of variance the effect of ryegrass weeds on the characteristic of the Rehane Barley variety.

S.O.V	Degree of freedom	Mean square Barley length	Spike length	Number of leaf	Number of seed in shrub	1000 Kernels (g)	Yield seed in shrub (g)
Organ	2	116.11**	4.53**	4.21**	34.52**	2.89ns	0.07*
Concentration	3	4400.81**	40.25**	42.48**	1311.24**	34.28**	3.47**
Organ × Concentration	6	26.74ns	0.74*	1.43**	20.59**	2.59ns	0.01ns
Error	36	17.73	0.29	0.23	6.72	2.33	0.02
CV%		8.47	7.87	8.66	13.06	4.13	16.34

Ns, *, ** - Non significant and significant at the 5%, 1% level of probability.

Table-2. Analyses of variance the effect of wild mustard weeds on the characteristic of the Rehane Barley variety.

S.O.V	Degree of freedom	Mean square Barley length	Spike length	Number of leaf	Number of seed in shrub	1000 Kernels (g)	Yield seed in shrub (g)
Organ	2	147.59**	1.649**	1.87*	0.29ns	62.50*	3.69ns
Concentration	3	2094.57**	0.015ns	49.58**	21.10**	504.34**	65.52**
Organ × Concentration	6	28.79ns	0.03	1.88**	0.59ns	18.77ns	2.13ns
Error	36	26.97	13.71	0.47	0.85	14.85	1.35
CV%		8.04	1.649**	10.04	13.23	14.02	3.14

Ns, *, ** - Non significant and significant at the 5%, 1% level of probability.

Table-3. Analyses of variance the effect of ryegrass weeds on the characteristic of the Valfajr Barley variety.

S.O.V	Degree of freedom	Mean square Barley length	Spike length	Number of leaf	Number of seed in shrub	1000 Kernels (g)	Yield seed in shrub (g)
Organ	2	172.25**	4.41*	0.90ns	34.65*	0.14ns	0.13**
Concentration	3	1830.70**	39.16**	60.58**	1701.13**	285.35**	3.08**
Organ × Concentration	6	46.03*	0.94ns	0.45ns	4.92ns	2.30ns	0.02ns
Error	36	19.87	1.18	1.22	9.66	3.14	0.01
CV%		7.06	14.54	16.91	12.67	4.78	12.38

Ns, *, ** - Non significant and significant at the 5%, 1% level of probability.

Table-4. Analyses of variance the effect of wild mustard weeds on the characteristic of the Valfajr Barley variety.

S.O.V	Degree of freedom	Mean square Barley length	Spike length	Number of leaf	Number of seed in shrub	1000 Kernels (g)	Yield seed in shrub (g)
Organ	2	418.51**	8.23**	7.52**	143.77**	44.83**	0.10**
Concentration	3	1792.38**	33.04**	43.30**	869.19**	207.68**	3.92**
Organ × Concentration	6	91.66**	1.85ns	1.47ns	23.38*	11.91**	0.01ns
Error	36	23.48	1.24	0.69	9.74	2.70	0.02
CV%		8.26	13.41	11.67	10.33	4.38	17.01

Ns, *, ** - Non significant and significant at the 5%, 1% level of probability.

Table-5. The comparison of the average of the effect of concentrate of ryegrass weed measured qualities of Rehane Barley variety.

	Mean					
Concentration	Barley length	Spike length	Number of leaf	Number of seed in shrub	1000 Kernels (g)	Yield seed in shrub (g)
0	76.27 a	9.44 a	8.27 a	34.80 a	39.46 a	1.52 a
25	49.69 b	6.57 b	5.26 b	18.37 b	36.72 b	0.76 b
50	41.14 c	5.68 c	4.34 c	15.49 c	35.91 b	0.55 c
75	31.78 d	5.46 c	4.25 c	10.73 d	35.89 b	0.27 d

At least one similar letter shows not significant difference in 5% level according to Duncan test.

Table-6. The comparison of the average of the effect of concentrate of wild mustard weed measured qualities of Rehane Barley variety.

Mean						
Concentration	**Barley length**	**Spike length**	**Number of leaf**	**Number of seed in shrub**	**1000 Kernels** (g)	**Yield seed in shrub** (g)
0	76.27 a	9.44 a	8.27 a	34.80 a	39.46 a	1.52 a
25	75.09 a	7.27 b	7.89 a	30.13 b	38.25 b	1.51 a
50	57.57 b	5.69 c	6.34 b	25.37 c	35.87 c	1.05 b
75	49.50 c	4.81 d	5.43 c	19.66 d	34.27 d	0.76 c

At least one similar letter shows not significant difference in 5% level according to Duncan test.

Table-7. The comparison of the average of the effect of concentrate of ryegrass weed measured qualities of Valfajr Barley variety.

Mean						
Concentration	**Barley length**	**Spike length**	**Number of leaf**	**Number of seed in shrub**	**1000 Kernels** (g)	**Yield seed in shrub** (g)
0	74.54 a	10.03 a	9.00 a	40.50 a	41.79 a	1.54 a
25	72.12 a	7.37 b	7.33 b	25.17 b	40.40 a	0.70 b
50	57.20 b	6.40 c	6.08 c	20.17 c	34.62 b	0.48 c
75	48.59 c	6.02 c	3.67 d	12.25 d	31.42 c	0.21 d

At least one similar letter shows not significant difference in 5% level according to Duncan test.

Table-8. The comparison of the average of the effect of concentrate of wild mustard weed measured qualities of Valfajr Barley variety.

Mean						
Concentration	**Barley length**	**Spike length**	**Number of leaf**	**Number of seed in shrub**	**1000 Kernels** (g)	**Yield seed in shrub** (g)
0	74.54 a	10.03 a	9.00 a	40.50 a	41.79 a	1.54 a
25	60.88 b	9.17 a	8.00 b	33.00 b	40.41 b	0.70 b
50	53.36 c	7.75 b	6.83 c	26.67 c	34.64 c	0.48 c
75	45.90 d	6.24 c	4.58 d	20.67 d	33.40 c	0.21 d

At least one similar letter shows not significant difference in 5% level according to Duncan test.

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