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ALLELOPATHIC EFFECT OF RYEGRASS (*LOLIUM PERSICUM*) AND WILD MUSTARD (*SINAPIS ARVENSIS*) ON BARLEY

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Abstract

Most crop plants and weeds have allelopathic effects and analysis of these effects on plants in crop alteration and successive planting is very important. In this research the allelopathic ability of different parts and concentrations of two weeds, *Lolium Persicum* (Ryegrass) and *Sinapis arvensis* (wild mustered), on growth characteristics of two barley varieties was studied in the greenhouse using a completely randomized design with four replications. Test factors consisted of two barley varieties (Valfajr and Rehane), three weed organs (root, stalk, leaf) and four concentrations of extracts of 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, seedling length, rootlet length caulicle length, wet weight of seedling, dry weight of seedling 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 (*Lolium Persicum*) and wild mustard (*Sinapis arvensis*) can strongly affect germination, growth and performance of barley through production of chemical materials with allelopathic properties, leading unfavorable growth and product yield.

Key words: Allelopathic, *Lolium Persicum*, *Sinapis arvensis*, Organs, Barley

Introduction

Pest management of insects, diseases and weeds is an integral part of production, while weed management has an important position as one of the major limiting factors. Although using herbicides to control weeds have shown some success, unsatisfactory controls and concerns such as resistance and environmental pollution are the main challenges that make unclear the future use of chemical control methods for weeds (Shinwari *et al*., 2012). Due to the diverse nature and high adaptability of weeds, weed management programs require the use of diverse methods. Investigations show that as the concentration of aqueous extract of Bersim clover increase, radicle length sometimes increases as well and sometimes decreases; so, for instance, in the full concentration, Rye radicle length is zero whereas Valfajer radicle length in 0.5 in complete concentration. In response to concentrations of 0.25 of the aqueous extract, a study found that the radicle lengths of Ivy, Amaranth, Rye, and Valfajer, respectively, decreased 76% and 73%, increased 1/4%, and the control decreased 67%. An investigation done on the allelopathic potential of barley on germination and growth of Valfajer and Foxtail revealed the significant effect of barleys and used concentrations on the germination and radicle and plumule lengths of weeds seeds; increased concentration leads to decrease in germination percentage, as well as radicle and plumule lengths of both weeds. Germination and growth of broad leaf weed seedlings were more sensitive than the narrow leaf weed.

One of the main problems that agricultural production faces is weeds that interfere with crop growth and production. These weeds compete with plant species for water, light, nutrients, and space. The weeds produce chemical compounds called *allelochemicals*. Barley (*Hordeum vulgare* L.) has been considered a competitive crop against weeds (Dima & Eleftherohorious, 2005; Colpas *et al*., 2003; Dima *et al*., 2010). Rice (1984) defined allelopathy as the beneficial or inhibitory effects of one plant on another, by releasing allelochemicals. Weeds can adapt to a wide range of environments and compete with barley growth, resulting in its reduced growth and productivity (Burleigh *et al*., 1988). Labafi *et al.,* (2006) used the equal-compartment-agar-method to study the wheat cultivars allelopathic potential on weeds seedling growth of oats and hairy vetches. Compared to hairy vetch, the oat was largely influenced by allelochemicals produced by wheat seedling. On the other hand, compared with plumule, the weed radicles showed greater sensitivity to wheat seedling allelochemicals. Jerônimo *et al.,* (2005) studies also showed the inhibitory effects of wheat mulch on some broadleaf weeds. Jobidon (1991) investigations also revealed the same findings.

Aqueous extracts of wild mustard also prevent *Malva parviflora* from growing. The decayed remains of mustard leaves and stems contribute to the growth of barnyard grass. When the seed is placed in pods of the plant, some volatile substances are given off from the bottom part, which prevents mustard seed germination within the fruit. The presence of some allelopathic substances leads to reduction of mustard growth; for example, the extract of oat root significantly reduces the growth of mustard, while mustard extract increases the weight of oat's aerial organ. Aqueous extracts of sunflower leaves reduce mustard seed germination by 75%, while stem extract of this plant has less effect on mustard growth.

Wheat is one of the plants that have been a topic of investigation since old times and the presence of the allelopathic has been proved to exist in its straw and stubble. These compounds enter into environment through evaporation, leaching and decaying. Straw and stubble extract of wheat differently affect germination and

seedling growth of various weeds. For example, it stimulates germination in Carpetweed, barnyard grass, and claw grass, but it has prohibitive effect on growth and germination of tumbleweed and sun-berry.

Ridenour & Callaway (2001) assessed 38 varieties of bread wheat and one variety of durum wheat for allelopathic potential difference on one-year Ryhaneh, using an aqueous extract of environment test. Both germination and growth of Ryhaneh rootlet by aqueous extracts of wheat stem were significantly prohibited and the values of prohibition among figures were significantly different (Rizvi & Rizvi, 1992).

Kiarostami (2003) indicated that by concentration increment of aqueous extract of Iranian clover, the length of weed rootlet was decreased, so that the lengths of tendril and wild mustard reached to zero in response to complete concentration of aqueous extract.

Moreover, Kohli *et al.*, (2001) showed that wheat varieties have significant difference in producing poisonous substances, while Gabu has the most amount of allelopathy. These results also suggested that wheat extract is prohibitive for growth of wheat seedling and other plant varieties. Extract of wheat residues is highly (100%) toxic on the growth of Ryhaneh. Its rootlet growth was completely stopped at concentrations above 50%. Only 20% of Ryhaneh seed at a concentration of 50% were capable of germination, while seedling growth at the same concentration completely was stopped.

Allelochemicals are found in leaves, roots, stems, fruits, rhizomes, seeds, flowers, pollen, and seeds. Of course, their concentrations are different in terms of organ type. Some scientists recognized root and seed as main sources of allelochemicals (Mighany, 2003).

However, in general, the leaves are the most important sources of allelopathic compounds and the roots have considerably fewer amounts of allelopathic compounds (Claka, 2006). Degradation of hormonal balance is considered a inhibitory effect of allelopathic compounds (Colpas *et al.*, 2003). Stop of minerals absorption, cell elongation, transpiration and enzymatic activity by allelopathic compounds lead to the postponement of plant growth (EL-Khawas & Shehala, 2005). Reduction of storage material transfer and energy shortages caused by allelopathic substances contribute to decreasing growth and nutrient accumulation in seedlings (Escudero *et al.*, 2010; Yang *et al.*, 2008).

Objectives

Considering barley allelopathic effects on weeds, its economic importance, and attempts to enhance the performance of this valuable plant in field conditions, the aim of this study is to determine the harmful effects of various organs of weed extracts' allelopathy on germination and growth of barley.

Material and Method

This study was conducted in Islamic Azad University of Fasa, Iran, in 2012-2013.

Seeds collection: Two varieties of barley called *Valfajer* and *Reihane* were used in this study. Moreover, ryegrass (*Lolium Persicum*) and wild mustard (*Sinapis arvensis*) weeds were collected from farms in Fasa one year ago and their germinations were tested before starting the main experiment.

Procedure: The experiment was done in laboratory, through a Completely- Randomized Design (CRD) in four replications in Fasa Islamic Azad University laboratory. In this study, the allelopothic effects of two already mentioned varieties of barely on two already weed mentioned of were investigated.

Weed seeds sterilization method: the seeds of weeds were disinfected by a three- minute treatment in ethanol and, after that, washed 4 times by sterile distilled water and for fifteen minutes by sodium hypochlorite 25%, and 5 times by sterile distilled water. The sterile seeds of weeds absorbed water for 24 hours in distilled water and five hundred lux light at 25°C. Thereafter, in order to achieve seedling, the swollen seeds were cultured in Petri dishes with filter paper and were placed in germinator at 25°C for 28 hours.

Laboratory treatment (laboratory section): In this experiment 3 levels of organ extracts including leaf, shoot, root extract of weed in four concentrations including 25, 50, and 75 were used. Distilled water was used as control. The results of the study are reported below laboratory conditions.

Statistical methods: The data were analyzed in SAS software and Duncan's method was used for means comparison. Excel was used to draw graphs and also regression and correlation techniques along with three-parameter logistic model were used to interpret the data.

To prepare the aqueous extract of weed, plants are grown in the greenhouse and then at the flowering stage, the sampling of aerial and underground organs were executed, after being washed with water, washing with distilled water was also performed. After separating different organs (roots, stems and leaves), the organs were dried in shade and outdoors and then they were milled. For preparing stock,1,000 mg distilled water was added to 100 g of considered powder; it was placed 24 hours at 130 rpm on sugar and after being passed through No. 1 Whatman filter paper, it was diluted for achieving the desired treatments of the test.

For each treatment, 20 healthy seeds are counted from 2 desired barley and in each it was placed evenly of Petri dish on filter paper. Then 5 ML of aqueous extracts prepared from different parts of the weed was added to each one as such the filter paper was completely smeared with the extract.

The Petri dish lid was then closed by par film and the container was located in growth chamber with temperature condition of 15/25° C and the light condition of 12/12 hours (night / day).Finally, the test is measured using ten random samples of each experiment unit, plumule length, root length, wet weight and dry weight.

Results

Effects of ryegrass weed on Ryhaneh barley: Different concentrations of ryegrass weed caused 1% reduction of all other characteristics of barley significantly (Table 1). The different concentrations of 0, 25, 50, and 75, respectively, reduced the length of seedling, compared to the sample. The lengths of rootlet and caulicle were reduced. As the concentration increased, the already mentioned concentration caused reduction in these two factors compared to the treatment of sample. More reduction of rootlet toward caulicle might indicate that the elongation of cellules might be affected by the prevention from Gibberellins and in dole acetic acid actions by allelopothic factors (Rizvi & Rizvi, 1992).

Effects of wild mustard weed on Ryhaneh barley: The results of analysis of variance in Table 2 show 1% impact of different concentrations of wild mustard weeds on growth characteristic of Ryhaneh barley seedling (Table 2). The results of the seedling length comparison showed that concentration of 25, 50 and 75, compared to the treatment control, respectively, reduced the seedling length. Interaction process of radical length to the different concentration of Valfajer barley was the same as seedling length. The difference between treatments showed statistically a significant difference. The said concentration respectively led to reduction in the radicle length. Also reported the same findings Mighany (2003).

The effect of ryegrass weed on Valfajer barley: Various concentrations of reygrass led to a significant decrease of 1% in all measured features of the barley (Table 3). Concentration of 25, 50 and 75 respectively reduced seedling length more than the control. With the increasing concentration of weed, the radicle length will decrease so that the concentration mentioned above, compared to the control, respectively, showed a significant reduction. Based on the findings of some researches, various concentrations of barely create a competition for factors such as dissolved food and minerals.

Table 1. Analyses of variance of ryegrass weed effect on seedling characteristic of Ryhaneh Barley variety.

S.O.V	Degree of freedom	Mean square				
		Seedling length	Rootlet length	Caulicle length	Fresh weight of seedling	Dry weight of seedling
Organ	2	64.61*	16.31**	16.00ns	0.10ns	0.002ns
Concentration	3	49.37*	17.27**	14.24ns	0.39**	0.003ns
Organ × Concentration	6	0.01ns	0.01ns	0.00ns	0.002ns	0.0001ns
Error	36	14.97	2.53	5.66	0.05	0.001
CV%		20.15	17.24	23.89	18.27	22.38

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

Table 2. Analysis of variance of wild mustard weed effect on seedling characteristic of Ryhaneh Barley variety.

S.O.V	Degree of freedom	Mean square				
		Seedling length	Rootlet length	Caulicle length	Fresh weight of seedling	Dry weight of seedling
Organ	2	65.22**	16.72**	16.00**	5.54**	0.07**
Concentration	3	286.05**	50.62**	123.55**	7.07**	0.08**
Organ × Concentration	6	0.07**	0.07ns	0.00ns	0.59**	0.006*
Error	36	10.15	2.66	2.56	0.17	0.002
CV%		19.72	21.28	18.87	19.85	21.80

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

Table 3. Analyses of variance of ryegrass weed effect on seedling characteristic of Valfajer Barley variety.

S.O.V	Degree of freedom	Mean square				
		Seedling length	Rootlet length	Caulicle length	Fresh weight of seedling	Dry weight of seedling
Organ	2	62.06**	15.02**	16.02**	0.08ns	0.001ns
Concentration	3	210.31**	56.33**	49.02**	0.78**	0.008**
Organ × Concentration	6	0.03ns	0.02ns	0.02ns	0.0008ns	0.00ns
Error	36	6.89	2.64	3.43	0.05	0.001
CV%		16.31	21.02	22.19	17.39	22.49

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

The effect of wild mustard weed on Valfajer barley: results of the analysis of variance in Table 4 showed 1% effect of different concentrations of reygrass on Valfajer seedling growth features (see Table 4). The comparison results of the seedling length showed that concentration 25, 50 and 75 respectively created a more significant reduction than the treatment control. Interaction process of radicle length to the different concentrations of Valfajer barley was the same as seedling length, and there was a statistically significant difference between different treatments. Compared to the control, the concentration mentioned above led to reduction. Other Investigations, too, revealed the same results (Kiarostami, 2003; Rizvi & Rizvi, 1992).

The length of rootlet and plumule: In treatment of seed and barley with different concentrations of weed extracts, the lengths of rootlet and plumule were achieved with significant differences observed in the treatment with distilled water (control). Barley seed treatment with different concentrations of the extracts of weed led to a significant reduction of seedling components.

As concentration increased, depressing effect on seedling growth was increased, so that even by application of first concentration extract (25), a significant difference was observed between control and treatment. Also, the root extract had the greatest impact and the shoot had lower impact, which can be seen in Tables 5-8. Thus, with increasing concentrations of all three organs (leaves, stems, and roots), reduction of growth component was clearly observed. The decreasing effect of extract treatment on rootlet growth was more than that of plumule, but rootlet growth response to increasing concentrations of extract was similar to that of plumule and the most depressing effect of the treatment was the concentration of 75.

The effect of different concentrations of the extracts of different organs of the barley root and shoot growth is illustrated in Figs. (1-8). The figures show that the growth of these two organs are affected by concentration and multiple organ So as to decrease with increasing concentration in both organs are visible and significant differences are observed compared to control. The different extracts from different organs of an impact on this process are managed so that root the greatest impact and leaf extract shows minimal impact.

Table 4. Analysis of variance of wild mustard weed effect on seedling characteristic of Valfajer Barley variety.

S.O.V	Degree of freedom	Mean square				
		Seedling length	Rootlet length	Caulicle length	Fresh weight of seedling	Dry weight of seedling
Organ	2	64.00**	16.00**	16.00**	0.49**	0.04**
Concentration	3	308.45**	133.82**	41.89**	18.47**	0.12**
Organ × Concentration	6	0.00ns	0.00ns	0.00ns	0.06ns	0.004ns
Error	36	8.56	2.02	2.55	0.18	0.002
CV%		16.73	16.51	18.00	17.07	21.19

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

Table 5. The comparison of the average interaction of organ type and the concentration of weed extract ryegrass on the measured characteristic of barley Ryhaneh variety.

Organ	Concentration extract (g/lit)	Seedling length	Rootlet length	Caulicle length	Fresh weight of seedling	Dry weight of seedling
Leaf	0	19.00 ab	9.25 abc	9.75 ab	1.41 a-d	0.17 a
	25	18.55 ab	8.50 bcd	10.05 ab	1.26 a-d	0.14 a
	50	16.73 ab	8.73 a-d	8.00 b	1.21 bcd	0.14 a
	75	14.55 b	6.50 d	8.05 ab	1.02 d	0.13 a
Shoot	0	21.00 ab	10.25 ab	10.75 ab	1.51 ab	0.18 a
	25	20.55 ab	9.50 abc	11.05 ab	1.36 a-d	0.14 a
	50	18.55 ab	9.55 abc	9.00 ab	1.27 a-d	0.15 a
	75	16.55 ab	7.50 cd	9.05 ab	1.07 cd	0.14 a
Root	0	23.00 a	11.25 a	11.75 ab	1.61 a	0.19 a
	25	22.55 a	10.50 ab	12.05 a	1.46 abc	0.18 a
	50	20.80 ab	10.80 ab	10.00 ab	1.32 a-d	0.16 a
	75	18.55 ab	8.50 bcd	10.05 ab	1.15 bcd	0.15 a

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

Table 6. The comparison of the average interaction of organ type and the concentration of weed extract wild mustard on the measured characteristic of barley Ryhaneh variety.

Organ	Concentration extract (g/lit)	Seedling length	Rootlet length	Caulicle length	Fresh weight of seedling	Dry weight of seedling
Leaf	0	21.18 ab	9.68 ab	11.50 ab	1.95 de	0.25 cd
	25	12.98 cd	5.43 cd	7.56 cd	1.73 def	0.17 de
	50	12.40 cd	5.15 d	7.25 cd	1.35 ef	0.16 e
	75	9.73 d	6.08 cd	3.65 e	1.16 f	0.15 e
Shoot	0	23.18 a	10.68 a	12.50 a	2.95 b	0.35 b
	25	15.11 c	6.55 cd	8.56 c	2.73 bc	0.27 c
	50	14.65 cd	6.40 cd	8.25 c	1.37 ef	0.16 e
	75	12.23 cd	7.58 bcd	4.65 e	1.24 f	0.16 e
Root	0	25.18 a	11.68 a	13.50 a	3.95 a	0.45 a
	25	17.11 bc	7.55 bcd	9.56 bc	3.23 b	0.37 b
	50	16.40 bc	7.15 bcd	9.25 bc	2.15 cd	0.26 c
	75	13.73 bc	8.08 bc	5.65 de	1.56 def	0.20 cde

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

Table 7. The comparison of the average interaction of organ type and the concentration of weed extract ryegrass on the measured characteristic of barley Valfajer variety.

Organ	Concentration extract (g/lit)	Seedling length	Rootlet length	Caulicle length	Fresh weight of seedling	Dry weight of seedling
Leaf	0	18.50 abc	9.00 abc	9.50 a-d	1.61 ab	0.18 abc
	25	15.75 cde	7.75 bcd	8.00 b-e	1.15 c	0.13 cd
	50	13.75 def	6.50 cde	7.25 c-f	1.14 c	0.14 bcd
	75	8.63 g	3.88 f	4.75 f	1.05 c	0.11 d
Shoot	0	20.50 ab	10.00 ab	10.50 ab	1.64 ab	0.19 ab
	25	17.50 bcd	8.50 a-d	9.00 a-d	1.16 c	0.14 bcd
	50	15.75 cde	7.50 bcd	8.25 b-e	1.15 c	0.15 a-d
	75	10.38 fg	4.88 ef	5.50 ef	1.07 c	0.12 cd
Root	0	22.50 a	11.00 a	11.50 a	1.74 a	0.20 a
	25	19.50 abc	9.50 ab	10.00 abc	1.31 bc	0.15 a-d
	50	17.75 bcd	8.50 a-d	9.25 a-d	1.25 c	0.16 a-d
	75	12.63 ef	5.88 def	6.75 def	1.18 c	0.13 bcd

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

Table 8.The comparison of the average interaction of organ type and the concentration of weed extract wild mustard on the measured characteristic of barley Valfajer variety.

Organ	Concentration extract (g/lit)	Seedling length	Rootlet length	Caulicle length	Fresh weight of seedling	Dry weight of seedling
Leaf	0	21.48 abc	12.03 a	9.45 abc	4.21 a	0.30 c
	25	16.13 def	7.50 bcd	8.63 bcd	2.16 bc	0.19 ef
	50	15.25 efg	7.00 cde	8.25 bcd	1.77 bcd	0.21 def
	75	9.10 h	3.93 f	5.18 e	1.20 d	0.13 f
Shoot	0	23.48 ab	13.03 a	10.45 ab	4.31 a	0.40 b
	25	18.13 cde	8.50 bc	9.63 abc	2.19 bc	0.19 def
	50	17.25 c-f	8.00 bcd	9.25 abc	2.29 b	0.21 def
	75	11.10 gh	4.93 ef	6.18 de	1.50 cd	0.16 f
Root	0	25.48 a	14.03 a	11.45 a	4.41 a	0.50 a
	25	20.13 bcd	9.50 b	10.63 ab	2.34 b	0.27 cde
	50	19.25 b-e	9.00 bc	10.25 ab	2.37 b	0.27 cd
	75	13.10 fgh	5.93 def	7.18 cde	1.60 cd	0.20 def

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

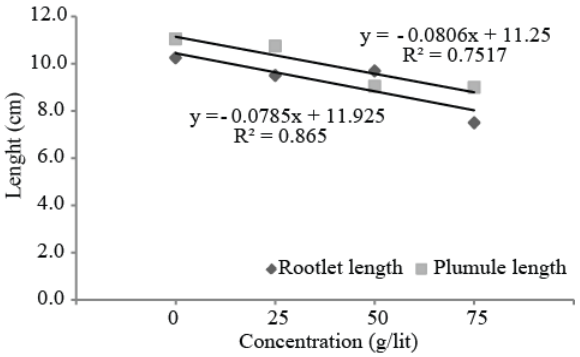

Fig. 1. Effect of different concentration ryegrass on growth of root and shoot Ryhaneh barley.

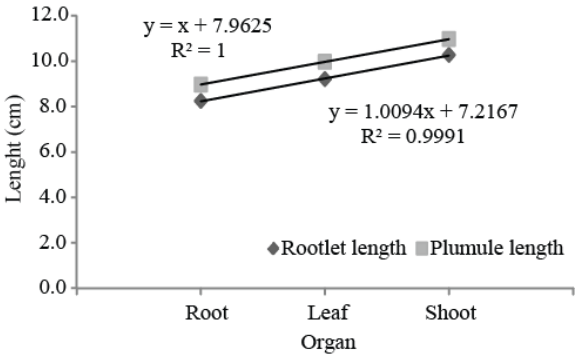

Fig. 2. Effect of concentration from different parts of ryegrass on the root and shoot growth of Ryhaneh barley.

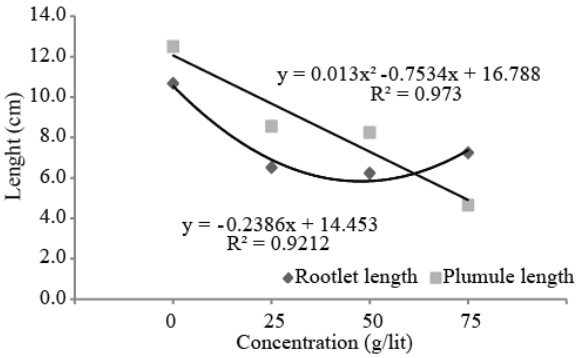

Fig. 3. Effect of different concentration Charlock on growth of root and shoot Ryhaneh barley.

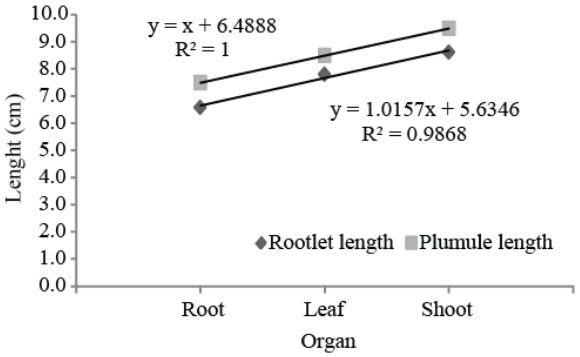

Fig. 4. Effect of concentration from different parts of Charlock on the root and shoot growth of Ryhaneh barley.

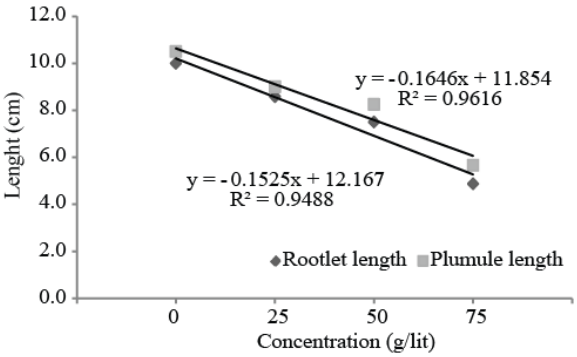

Fig. 5. Effect of different concentration ryegrass on growth of root and shoot Valfajer barley.

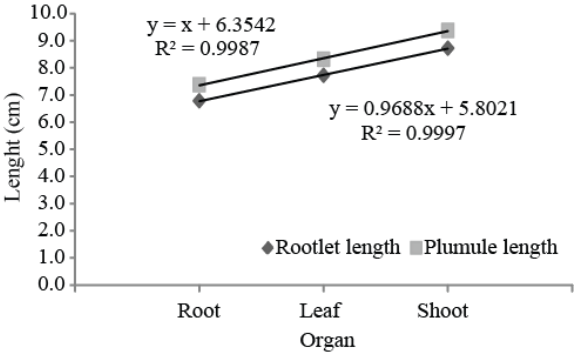

Fig. 6. Effect of concentration from different parts of ryegrass on the root and shoot growth of Valfajer barley.

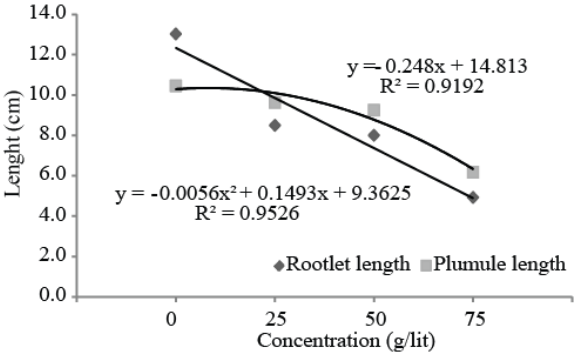

Fig. 7. Effect of different concentration Charlock on growth of root and shoot Valfajer barley.

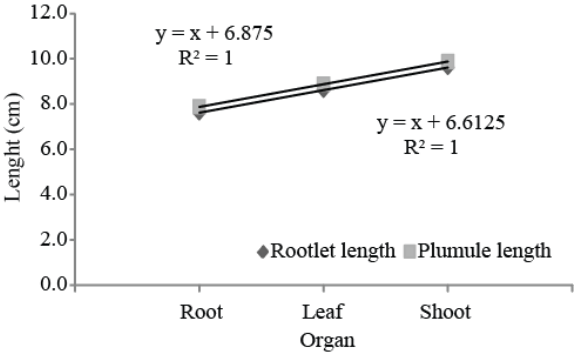

Fig. 8. Effect of concentration from different parts of Charlock on the root and shoot growth of Valfajer barley.

Discussion

The results of this study indicated that the produced materials of the aerial organs and root of weed, germination, rootlet and plumule, wet and dry weight of barley were affected, so in germination stage and seedling growth of barley, the obtained extract of weed in different concentrations contributed to a significant reduction of seedling growth, dry weight accumulation in seedling and all measurement factors. Produced materials of aerial organ and weed root affected germination and growth factors of Ryhaneh and Valfajer. This point can be a confirmation of various allelochemicals in weed organs and influence of different characteristics of these 2 barley. Also, this study demonstrates that there was a significant reduction in all characteristics of interest by increased concentration of weed aqueous extract. Interaction of organ type and the concentration of weed extract on measured characteristic of 2 barley are shown in Table 8. All factors including seedling have been affected by allelopathy materials. The preventing effect of allelochemical on germination is created through disintegration of cell metabolism with damage to little organs and metabolism of reserved proteins and enzyme activities which influence the transfer of reserved compounds during germination, finally contributing to the reduction of stored material accumulation in seedlings (Bogatek *et al*., 2005).

The obvious Allepoathic effects include postponing of rootlet and plumule (El-Khatib *et al*., 2004). Delay or arrest of mobility of reserved materials in seeds exposed to allelochemical could lead to a shortage of respiratory substrates products. Irregularities in breathing rate also lead to metabolic energy constraints and organization of cells. Thus, cells would not be capable of more efficient use of energy resources. So it can be observed that shorter rootlet and plumule growth are slower than the control plants (Mighany, 2003).

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