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ALLELOPATHIC EFFECT OF DIFFERENT EXTRACT CONCENTRATIONS OF TWO VARIETIES OF BARLEY ORGANS ON RYEGRASS WEED AND WILD MUSTARD

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ABSTRACT

The use of cultivars with allelopathic potential is one of weed management techniques. With regards to importance and frequency of weed in barley fields, an experiment was conducted to evaluate allelopathy effect of different parts of barley in different extract concentration on weed germination as experiment in randomized complete block design with four replicates in 2013. Three levels of organ extracts including leaf, shoot, root extract of barley in four concentrations composing 25, 50, and 75(g/lit) were used. Distilled water was used as control. All extracts decreased germination and its components in weed. Greatest decreasing effect was belonged to leaf extract. Leaf and shoot plant extracts as 75 concentration inhibited weed germination. Ryegrass and Charlock seedling growth features were under investigation. The results showed that increasing barley plant concentration in both samples, compared to control, leads to the significant decrease in the seedling, radical and plumule lengths, wet and dry seedling weights of both weeds.

Keywords: allelopathy, mustard, barley, varieties, extract, organ, weed.

INTRODUCTION

Pest management of insects, diseases and weeds is integral part of production and the weed management has an important position as one of the major limiting factors. Although, using herbicides to control weeds showed 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. Due to the diverse nature and high adaptability of weeds, weed management programs require the use of diverse methods. Investigation showed that as the concentration of aqueous extract of Bersim clover increased, radicle length sometimes increased and sometimes decreased, so that in the full concentration the Rye radicle length was zero as well as the charlock radicle length in the 0.5 and complete concentration. In response to concentrations of 0.25 of the aqueous extract, the radicle lengths of Ivy, Amaranth, Rye, and Charlock respectively 76 and 73 percent decreased, 1/4 increased, and 67% of the control decreased (Kiarostami, 1382). An investigation, done on the allelopathic potential of barley on germination and growth of Charlock 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 the decrease in germination percentage, and radicle and plumule lengths of both weeds. Germination and growth of broad leaf weed seedlings were more sensitive than the narrow leaf weed (Jerônimo C. A. *et al*., 2005).

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 to be among the competitive crops against weeds (Dhima and Eleftherohorious, 2005; Dhima *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 and *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 with hairy vetch, the oat was largely influenced by allele chemicals produced by wheat seedling. On the other hand, compared with plumule, the weed radicles showed greater sensitivity to wheat seedling allelochemicals. Jerônimo and *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 prevents malva parviflora from growth. The decayed remains of mustard leaves and stems contribute to the growth of barnyard grass (Ericcson and Duke, 1978). 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 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 (Dul *et al*., 1997).

Wheat is one of the plants that have been subject of investigation since old times and the presence of the allelopathic has been proved in its straw and stubble. These compounds enter into environment through evaporation, leaching and decay. Straw and stubble extract of wheat affect differently on 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 sunberry.

Ridnoro Kallwe (2001) assessed 38 varieties of bread wheat and one variety of durum wheat for allelopathic potential difference on one-year ryegrass through using an aqueous extract of environment test. Both germination and growth of ryegrass rootlet by aqueous extracts of wheat stem are significantly prohibited and the values of prohibition among Figures were significantly different (Rizoy *et al*., 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 that Gabu had 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 ryegrass. Its rootlet growth was completely stopped at concentrations above 50%. Only 20% of ryegrass seed at a concentration of 50% were capable of germination, while seedling growth at the same concentration completely was stopped.

Allelochemicals are located 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, 1382).

However, in general, the leaves are the most important sources of allelopathic compounds and the roots significantly have fewer amounts of allelopathic compounds (Claka, 2006). Degradation of hormonal balance is considered as inhibitory effects of allelopathic compounds (Kolpas *et al*., 2003). Stop of minerals absorption, cell elongation, transpiration and enzymatic activity by allelopathic compounds lead to the postponement of plant growth (Alkavas and Shahala, 2005). Reduction of storage material transfer and energy shortages caused by allelopathic substances contribute to growth decreasing and nutrient accumulation in seedlings (Scordo *et al*., 2010; Yang *et al*., 2008).

Objectives

According to 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 barley extracts' allelopathyon germination and growth of weed.

MATERIAL AND METHOD

a) The experiment site: This study was done in Islamic Azad University of Fasa in 2012-2013.

b) Seeds collection: Two varieties of barley called VALFAJER and REIHANE were used in this study. Moreover the ryegrass and wild mustard weeds were collected from farms in Fasa one year ago and their germinations were tested before starting the main experiment.

c) Procedure: The experiment was done in laboratory, in design through 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 mentioned of weeds were investigated.

d) Weed seeds sterilization method: the seeds of weeds were disinfected by three minutes treatment in ethanol and, afterward, washed four times by sterile distilled water and for fifteen minutes by sodium hypochlorite twenty five percent and five times washing by sterile distilled water. The sterile seeds of weeds absorbed water for twenty four hours in distilled water and five hundred lux light in twenty five degree centigrade. Thereafter, in order to achieve seedling, the swollen seeds were cultured in Petri dishes with filter paper and were placed in germinator with twenty five centigrade temperatures for twenty eight hours.

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

f) Statistical methods: The data is analyzed with SAS software and Duncan's method is used for means comparison. Excel is used to draw graphs and also regression and correlation techniques along with three-parameter logistic model are used to explain the data.

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

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

The Petri dish lid was then closed by parafilm and the container is 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 AND DISCUSSIONS

Effects of Ryhaneh barley on ryegrass weeds: Different concentration of Ryhaneh barley caused one percent reduction of all other characteristic of weed significantly (Table-1). The different concentrations of 0, 25, 50, 75 by order, reduced the length of seedling, compared to the sample. The length of rootlet and caulicle were reduced. As the concentration increased, the already mentioned concentration caused these two factors reduction compared to the treatment of sample. The 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 *et al*., 1992).

Effects of Ryhaneh barley on wild mustard weeds: The results of analysis of variance Table show one percent impact of different concentration of Ryhaneh barley on growth characteristic of wild mustard weeds seedling (Table-2). The results of the seedling length comparison showed that concentration of 25, 50 and 75, compared with the treatment control, respectively reduced the seedling length. Interaction process of radicle length to the different concentration of Valfajer barley was the same as seedling length. The difference between treatments showed statistically significant difference. The mentioned concentration respectively leads to the reduction in the radicle length. Also reported the same findings Mighan *et al*., (1383).

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

The effect of valfajer barley on the charlock: results of the analysis of variance Table showed the one percent effect of different concentration of Valfajer on charlock seedling growth features (Table-4). The comparison results of the seedling length showed that concentration 25.50 and 75 respectively create a more significant reduction than the treatment control. Interaction process of radicle length to the different concentration of Valfajer barley was the same as seedling length and statistically there was significant difference between different treatments. Compared with the control, the mentioned concentration leads to the reduction. Investigation also revealed the same results (Rizvi *et al*, 1992) and Kiarostami (1382).

The length of rootlet and plumule

In treatment of seed and weed with different concentrations of barley extracts, the lengths of rootlet and plumule are achieved with significant differences observed in the treatment with distilled water (control). Weed seed treatment with different concentrations of the extracts of barley leads to a significant reduction of seedling components. By concentration increment, depressing effect on seedling growth is increased, so that even by application of first concentration extract (25), significant difference was observed between control and treatment. Also, the leaf extract has the greatest impact and the root has lower impact which can be seen in Tables 5 to 8. Thus, with increasing concentrations of all three organs (leaves, stems, and roots), reduction of growth component was clearly indicated. The decreasing effect of extract treatment on rootlet growth was more than plumule, but rootlet growth response to increasing concentrations of extract was similar to plumule and the most depressing effect of the treatment was the concentration of 75.

Table-1. Analysis of variance of Ryhaneh Barley variety affect on seedling characteristic of ryegrass weed.

S.O.V	Degree of freedom	Mean square seedling length	Rootlet length	Caulicle length	Wet weight of seedling	Dry weight of seedling
Organ	2	26.13**	12.58**	3.54^{ns}	0.15**	0.001**
Concentration	3	32.94**	6.46**	10.30**	0.02**	0.0002**
Organ × Concentration	6	4.40^{ns}	0.31^{ns}	2.75^{ns}	0.005**	0.00004*
Error	36	2.10	0.66	1.25	0.001	0.00001
CV%		15.55	21.81	20.04	11.42	12.45

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

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

S.O.V	Degree of freedom	Mean square seedling length	Rootlet length	Caulicle length plumule	Wet weight of seedling	Dry weight of seedling
Organ	2	15.13**	9.09**	12.50**	0.09**	0.001**
Concentration	3	18.49**	5.08**	5.41**	0.04**	0.0004**
Organ × Concentration	6	0.30^{ns}	0.07ns	0.10^{ns}	0.0005^{ns}	0.000004^{ns}
Error	36	0.20	0.10	0.08	0.0005	0.000005
CV%		7.29	8.61	10.22	10.78	10.46

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

Table-3. Analysis of variance of Valfajer Barley variety affect on seedling characteristic of ryegrass weed.

S.O.V	Degree of freedom	Mean square seedling length	Rootlet length	Caulicle length	Wet weight of seedling	Dry weight of seedling
Organ	2	47.20**	12.25**	7.15**	0.16**	0.001**
Concentration	3	14.15**	23.06**	13.60**	0.08**	0.0008**
Organ × Concentration	6	14.15**	0.70^{ns}	1.46*	0.002^{ns}	0.00003^{ns}
Error	36	0.79	0.31	0.54	0.002	0.00002
CV%		17.14	17.55	13.83	16.28	14.81

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

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

S.O.V	Degree of freedom	Mean square seedling length	Rootlet length	Caulicle length	Wet weight of seedling	Dry weight of seedling
Organ	2	31.39**	19.25**	16.20**	0.11**	0.001**
Concentration	3	19.75**	6.42**	5.05**	0.017**	0.0001**
Organ × Concentration	6	1.63**	0.19^{ns}	0.36**	0.0009^{ns}	0.000003^{ns}
Error	36	0.25	0.16	0.07	0.0007	0.000005
CV%		8.63	11.19	9.71	14.07	11.16

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 barley extract Ryhaneh variety on the measured characteristic of ryegrass weed.

Dry weight of seedling	Wet weight of seedling	Caulicle length	Rootlet length	Seedling length	Concentration extract (g/lit)	Organ
0.025 e	0.23 f	5.73 abc	3.60 cd	9.33 cd	0	Life
0.028 e	0.25 ef	5.03 cd	2.90 de	7.93 cde	25	
0.025 e	0.23 f	5.68 abc	3.05 de	8.73 cde	50	
0.025 e	0.23 f	5.38 bcd	2.03 e	7.40 de	75	
0.043 bc	0.42 bc	6.98 ab	4.65 abc	11.63 ab	0	Shoot
0.037 cd	0.35 d	5.88 abc	4.05 bcd	9.93 bc	25	
0.031 de	0.29 e	4.15 cd	3.08 de	7.23 de	50	
0.028 e	0.27 ef	3.78 d	2.88 de	6.65 e	75	
0.050 a	0.52 a	7.48 a	5.65 a	13.13 a	0	Root
0.047 ab	0.45 b	6.88 ab	4.98 ab	11.85 ab	25	
0.041 bc	0.39 cd	5.20 bcd	4.15 bcd	9.35 cd	50	
0.038 c	0.37 cd	4.88 cd	3.88 bcd	8.75 cde	75	

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 barley extract Ryhaneh variety on the measured characteristic of wild mustard weed.

dry weight of seedling	wet weight of seedling	caulicle length	rootlet length	seedling length	Concentration extract (g/lit)	Organ
0.023 de	0.21 de	2.90 cd	3.98 bc	6.88 b	0	Life
0.019 f	0.17 e	2.38 e	3.30 de	5.68 c	25	
0.012 gh	0.11 f	1.75 f	2.88 e	4.63 d	50	
0.011 h	0.10 f	1.08 g	2.25 f	3.33e	75	
0.029 c	0.28 c	3.25 c	4.33 b	7.58 a	0	Shoot
0.023 de	0.21 d	3.25 c	3.65 cd	6.88 b	25	
0.020 ef	0.17 e	2.73 de	3.20 de	5.93 c	50	
0.015 g	0.12 f	1.93 f	2.88 e	4.80 d	75	
0.039 a	0.38 a	4.25 a	5.20 a	8.05 a	0	Root
0.033 b	0.31 b	4.25 a	4.98 a	7.70 a	25	
0.030 c	0.27 c	3.73 b	4.18 b	6.68 b	50	
0.025 d	0.22 d	2.93 cd	3.90 bc	5.80 c	75	

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 barley extract Valfajer variety on the measured characteristic of ryegrass weed

dry weight of seedling	wet weight of seedling	caulicle length	rootlet length	seedling length	Concentration extract (g/lit)	Organ
0.034 cd	0.32 d	7.03 a	4.60 bc	11.63 a	0	Life
0.023 e	0.22 e	4.60 ef	2.35 fg	6.95 de	25	
0.019 e	0.19 e	4.45 f	1.85 fg	6.30 de	50	
0.016 e	0.14 e	3.08 g	0.75 h	3.83 f	75	
0.042 b	0.40 c	6.10 abc	4.50 bc	10.60 ab	0	Shoot
0.041 bc	0.38 cd	5.73 bcde	3.98 cd	9.70 b	25	
0.032 d	0.31 d	4.88 def	2.35 fg	7.23 de	50	
0.022 e	0.20 e	4.08 fg	1.70 g	5.78 e	75	
0.052 a	0.50 a	6.70 ab	5.50 a	12.20 a	0	Root
0.051 a	0.48 ab	6.73 ab	4.98 ab	11.70 a	25	
0.042 b	0.41 bc	5.88 abcd	3.35 de	9.23 bc	50	
0.032 d	0.30 d	5.08 cdef	2.70 ef	7.78 cd	75	

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 barley extract Valfajer variety on the measured characteristic of wild mustard weed

Dry weight of seedling	Wet weight of seedling	Caulicle length	Rootlet length	Seedling length	Concentration extract (g/lit)	Organ
0.016 f 0.014 ef 0.012 f 0.008 f	0.19 c 0.14 de 0.10 ef 0.07 f	2.85 c 2.28 d 1.23 e 0.80 f	3.53 d 2.88 e 2.10 f 1.83 f	6.38 d 5.15 e 3.33 f 2.63 f	0 25 50 75	Life
0.025 cd 0.023 de 0.021 ef 0.016 gh	0.22 bc 0.21 bc 0.19 c 0.14 d	3.25 c 3.08 c 2.83 c 2.05 d	4.50 bc 3.93 cd 3.58 d 2.73 e	7.75 c 7.00 cd 6.40 d 4.78 e	0 25 50 75	Shoot
0.035 a 0.033 ab 0.031 b 0.026 c	0.32 a 0.31 a 0.29 a 0.24 b	4.25 a 4.08 ab 3.83 b 3.05 c	5.50 a 4.93 ab 4.95 ab 3.73 d	9.75 a 9.00 ab 8.78 b 6.78 d	0 25 50 75	Root

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

The effect of different concentrations of the extracts of different organs of the barley root and shoot growth in Figures (1-8) is observed. 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 leaves the greatest impact and root extract shows minimal impact.

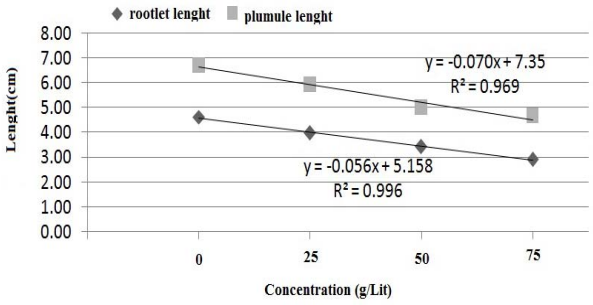

Figure-1. Effect of different concentration Ryhaneh barley on growth of root and shoot ryegrass.

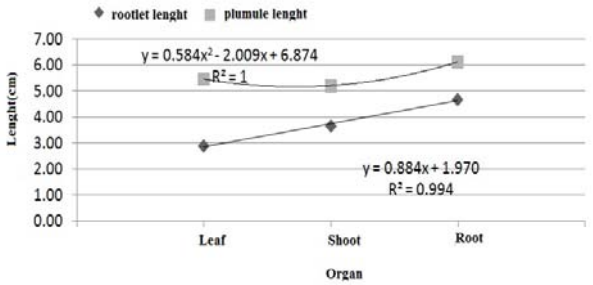

Figure-2. Effect of concentration from different parts of Ryhaneh barley on the root and shoot growth of ryegrass.

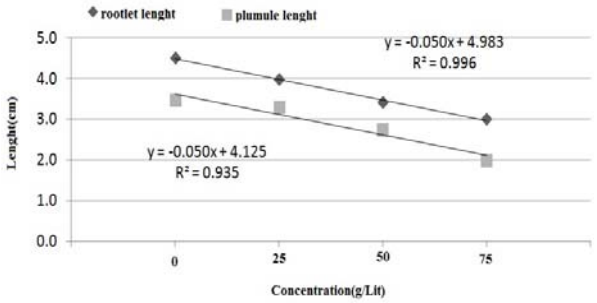

Figure-3. Effect of different concentration Ryhaneh barley on growth of root and shoot Charlock.

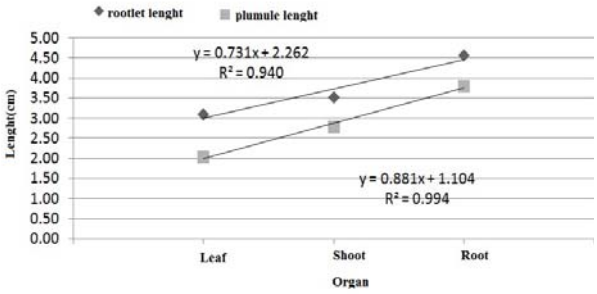

Figure-4. Effect of concentration from different parts of Ryhaneh barley on the root and shoot growth of Charlock.

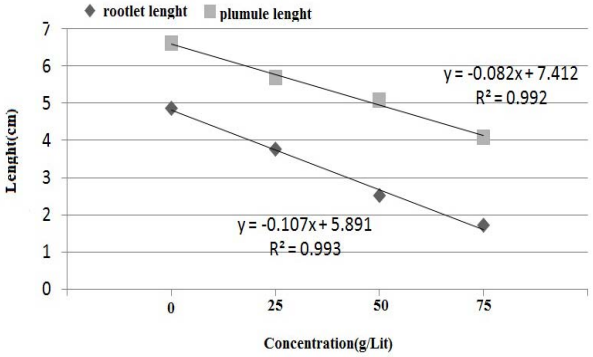

Figure-5. Effect of different concentration Valfajer barley on growth of root and shoot ryegrass.

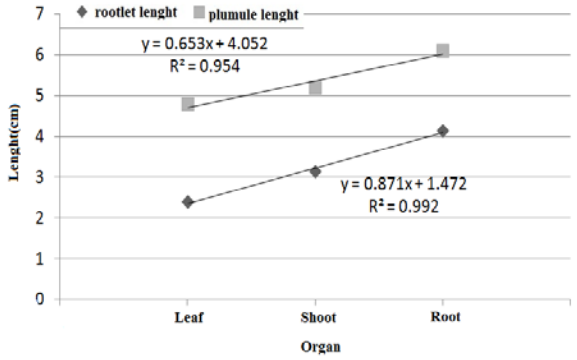

Figure-6. Effect of concentration from different parts of Valfajer barley on the root and shoot growth of ryegrass.

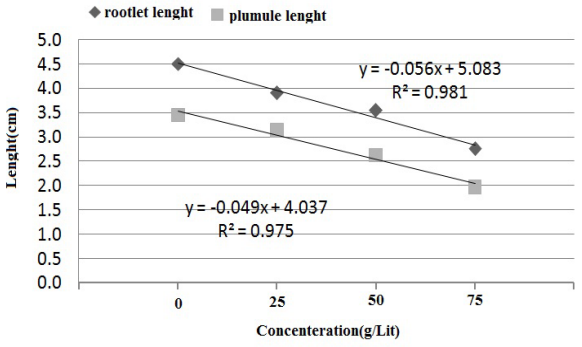

Figure-7. Effect of different concentration Valfajer barley on growth of root and shoot Charlock.

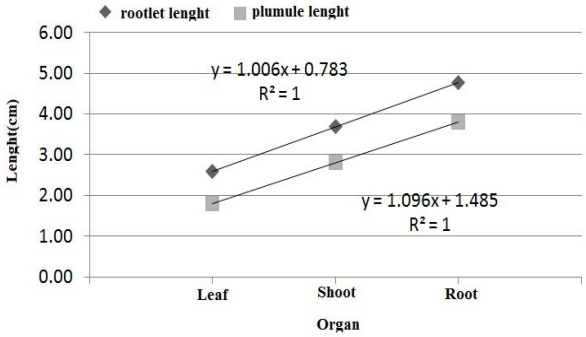

Figure-8. Effect of concentration from different parts of Valfajer barley on the root and shoot growth of Charlock.

DISCUSSIONS

The results of this study indicate that the produced materials of the aerial organs and root of barley, germination, rootlet and plumule, wet and dry weight of weeds was affected, so in germination stage and seedling growth of weed, the obtained extract of barley in different concentrations contribute to significant reduction of seedling growth, dry weight accumulation in seedling and all measurement factors. Produced materials of aerial organ and barley root affect germination and growth factors of ryegrass and wild mustard. This point can be a confirmation of various allelochemicals in barley organs and influence of different characteristics of these two weeds. Also, this study proves that there is a significant reduction in all considered characteristic by concentration increment of barley aqueous extract. Interaction of organ type and the concentration of barley extract on measured characteristic of wild mustard weed 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 contribute to reduction of stored material accumulation in seedlings (Bogatek, 2005).

The obvious Allepoatic effects include postponing of rootlet and plumule (El-Khatib, 2004). Delay or stop 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 were slower than the control plants (Mighany, 1382).

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