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Evaluation the allelopathic effects of aerial and underground extract of sunflower (*Helianthus annus* L.) on germination charactristics and seedling growth of Hoary cress (*Cardaria draba*)

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ABSTRACT

The weeds create economic damage in crops with interfere in crops growth and abundance in agronomic systems. The One of most important items in create interference, is the phenomenon of allelopathy. In order to evaluate the effects of sunflower aqueous extracts, air and underground organs and the mixture of them on the germination and growth of Hoary cress weed seedlings, the experimental randomized complete block design with 13 treatments and 3 replications was conducted in Research Laboratory of the Faculty Agriculture, Birjand University in 2009. The test treatments consist of sunflower aqueous extracts, air and underground organs and mixture of them (equal to) four levels of 25, 50, 75 and 100 volumetric percentage plus control treatment (distilled water). The results of this experiment showed that the aqueous extracts in different organs of sunflower and the applied concentration had the significant effects on the germination and growth of Hoary cress weed seedling characteristics compared to control ($p<0.01$) was such that by increasing the concentration of aqueous extracts of sunflower various organs significantly decreased the germination percentage, length of radicle and coleoptile and seedling fresh weight. The application of the 100 volumetric percentage to the mixture extract of air and underground organs decreased to zero the seedling fresh weight and the length of the coleoptile. The estimation of three-parameter logistic model to lift used in this research showed that the air, underground and mixture organs of sunflower, in 97.34, 89.34 and 18.1 percentage of aqueous extract decreased the 50 percentage to maximum germination rate which in fact show more severe effects of the mixture organs of sunflower to compare the air and underground organs. based on orthogonal comparison in the aggregate assessed that the Sunflower mixed aqueous of air and underground organs extract had more preventative effects than the separate extracts on germination percentage, germination rate, length of radicle and coleoptile and seedling fresh weight of Hoary cress.

Key words*:* Allelopathy, Sunflower, Seed germination, Aqueous extract, Hoary cress

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INTRODUCTION

The allelopathy is result of production biologically active molecules by growing plants or remains of them, which might do a direct or indirect effect after change the shape and enter to environment, on the growth and development

of the same species or any other species (Seigler, 1996). The allelochemical materials, includes those chemicals materials in plant that apply the physiological activities on plants or microorganisms (Kiemnec and Mcinnis, 2002). Use of the allopathic attribute of the plants can play an important role in the management of weed and control them. These plants produce secondary metabolites that through to its surroundings apply the negative effect on germination and growth of adjacent plants and limit their growth and density. Therefore, the use of these types of plants or remains can decrease the consumption of herbicides (Leather, 1993). Open from late sunflower was known as a successful allelopathic crop (Wilson and Rice, 1968). The use of sunflower in crop rotation significantly reduces the consumption of herbicides and so suppression weeds (Semidey, 1999). Sunflower allelochemical materials reduces growth and biomass of weeds *Chenopodiom album* l., *Coronopus didymus*, *Medicago Polymorpha*, *Rumex denatus* and *Phalaris minor Retz* and the effect of these substances is more impressive on the Hoary cress and broad leaf weeds (Narwal et al, 1999).

Some studies proves that when the dried leaves of sunflower are mixed with the soil, prevent to emergence of soya and sorghum and or when the soil contains the remains of a sunflower, the rise and the number of tillers, biomass and seed yield of wheat finds significant reduction (Purvis and Jonis, 1990). The sunflower leaves aqueous extract prevent to germination of weed seeds of wild mustard (*Sinapis arvensis*) (Bogatek and Yaneccko, 2006). Some researchers proven that the allelopathy effects of sunflower on the cotton through sunflower mulch shoot is very intense and makes the plant heavily reduce density in present and stop growing, small branches, leaves and reduction them thereby reducing the crop yield (Sandhu, 1997). The durability of the allelopathic material of sunflower is about 9 to 12 weeks and 5 weeks in the first have very fast analyzing speed, so that often they are release during to this time of period. Therefore, some of the researcher suggests that 5 to 6 weeks after harvest of sunflowers should not proceed to the cultivation of other crops (Kohli and Pariana 1992). Due to the high potential of sunflower for weed control by allelopaty, this research performed to study the allelopathy of sunflower on seed germination and early growth of Hoary cress weed.

MATERIALS AND METHODS

This experiment was performed in the year 2009 in the research Laboratory of the Faculty Agriculture, in Birjand University, in order to evaluate the effect of aqueous extract air, underground and mixture organs of sunflower on the germination and growth of seedling Hoary cress weed, the experimental randomized complete block design was conducted with 13 treatments and 3 replications. The test treatments consists of aqueous extract the air and underground organs of sunflower and mixture of them (equal to) four levels of 25, 50, 75 and 100 volumetric percentage plus control treatment (distilled water). In order to prepare aqueous extract, the sunflower plants in 2008 in the yellowing back of the head stage collected, of the research farm in Faculty Agriculture of Birjand University and after washing with water, air and underground organs was dried in shade and dry environment condition and then grinding. In order to Prepare a desired and base solution powder, the 50 grams for each organ separately Were prepared, air, underground and their mixed than add 500 ml of distilled water for 24 hours with 130 rounds per minute take at shaker and after passing through the smooth direction of Fabric Filter and obtain the desired treatment in the experiment were diluted. Each treatment includes a 6 cm diameter Petri dish for disinfection, initially Smeared with detergents and then washed with water. For each treatment 20 healthy seeds of Hoary cress weed were counted and take in each Petri dish on the filter paper and each of them 6 ml water extract Was shed from different parts of the sunflower in circumstances where all the parts of the impregnated filter paper, Then the door of the Petri dish Closed with Teflon and Exposed in thermal conditions with the incubator machine 15/25 ° C and in the optical conditions 12/12 hours (night & day). In order to the counting of germinated seeds determining seed germination speed of Hoary cress set on a daily basis. The criteria for seed germination 2 ml exit from seeds.

Counting as long as the number of seeds germinated up to three consecutive days in each sample was fixed. In order to measure the speed of germination was used of Maquer equation (Hartman et al, 1990)

$$R_s = \sum_{i=1}^{n} \frac{S_i}{D_i}$$

R_s = Maquer germination speed (number of seed per day).
S_i = the number of germinated seeds to i" counting.
D_i = the number of days to i" counting

In addition, to evaluate the allelopathic potential of different organs of sunflower for reducing the percentage of Hoary cress seeds germination, used from logistic model, according to the three- parameter equation:

$$Y = a/[1+(x/x_{50})^b]$$

In this equation:
Y = Percentage of germination in concentration of aqueous extract *X*
a = Maximum percent of germination.
X_{50} = Concentration of aqueous extract required for 50% inhibition of germination.
b = Indicator the slope of germination reduction in the effect by increasing the concentration of aqueous water extracts.

At the end of the experiment with using of every ten random sample from each treatment, length of radicle and coleoptile and seedling fresh weight was measured. For the analysis of data was used from the SAS software. The averages comparison lift based on Duncan's test at the 5% level. There was used for draw graphs from Excel and Sigma Plot softwares.

RESULTS AND DISCUSSION

The effect of different concentrations of air organs extracts of sunflower on seed germination characteristics of Hoary cress

In this study, the aqueous extract of sunflower air organs significantly decreased all traits of Hoary cress (Table 1). Inderjit, (2002) believes that low concentrations of allelopathic materials may have the positive or negative effects on target plant but at the top concentrations always has a hindering role. Concentrations of 25, 50, 75 and 100 volumetric percentage extract of the air organs were decreased 6.42, 14.25, 24.54 and 54.14 percentage germination of Hoary cress compared to the control treatment. The speed of germination at 25, 50, 75 and 100 volumetric percentage extracts of air organs decreased 0.89, 2.83, 4.18 and 9.42 seeds per day for Hoary cress equivalent of 13.9, 44.2, 65.46 and 84.66 percent compared to the control treatment.

The length of radicle with increasing concentrations of aqueous extract of air organs was so that the process of reduction of 25, 50, 75 and 100 volumetric percentage extract of the air organs were decreased, 0.03, 0.1, 1.77 and 2.47 cm respectively is equivalent to 1.18, 3.93, 69.28 and 97.40 percent for Hoary cress relative to control treatment. The decrease of radicle length may indicate this point that cells by preventing the action of gibberelin and indole acetic acid by allelopathy are under the impact of this factors (Qasem, 1992).

length of coleoptile was in concentrations of 25, 50, 75 and 100 volumetric percentage extract air organs for 25 and 50 volumetric percentage increased 0.06 and 0.05 cm compared to the control treatment, but in 75 and 100 volumetric percentage the length of Hoary cress coleoptile 1.45 and 2.53 cm equivalent to 50.69 and 88.46 percent decreased because the increasing length of the coleoptile for concentrations of 25, 50 percent for Hoary cress due to Stimulatory and mobility has allelochemical materials Sunflower in low concentrations and high concentrations in the inhibitory material for this weed. Also, like the other traits, the fresh weight of Hoary cress seedling Influenced by sunflower extract with increasing concentrations of study about the process was reducted. The Ghiazdowsk et al (2007) results showed that the effect of sunflower allelopathy on seed germination of mustard were like to this results. Sunflower leaf extracts application in circumstances which reduced the germination percentage, germination rate, the length of the radical and coleoptile. In the case of sunflower air deterrence effects organs towards the underground organs can be said because the flowers are strong Reservoir sink, the high transfer more of material from the root towards the leaves. So the concentration of secondary metabolites in roots is reduced. In addition, the phenolics materials and secondary metabolites that are responsible for the activity of allelopathy in sunflower have more concentrations in leaves (Bernat, et al., 2004).

Table 1- The allelopatic effect of different concentrations aqueous extracts of sunflower aerial organs on the seed germination and growth characteristics of Hoary cress seedling

concentrations extracts (volumetric percentage)	fresh weight of seedling (mg)	length of coleoptile (cm)	length of radicle (cm)	speed of germination (seed per day)	percentage of germination
control	242/4 [a]	2/86 [c]	2/86 [a]	39/6 [a]	95 [a]
aerial organs 25%	220/3 [ab]	2/92 [a]	2/52 [a]	5/5 [a]	88/9 [ab]
aerial organs 50%	218/86 [ab]	2/91 [bc]	2/44 [a]	3/56 [b]	81/66 [ab]
aerial organs 75%	192/6 [b]	1/47 [de]	0/77 [bc]	2/21 [cd]	71/66 [bc]
aerial organs 100%	119/7 [c]	0/336 [f]	0/066 [d]	0/98 [ef]	41/66 [d]

The average in each column that contains least one same letter there have not significant difference in the based Duncan test at 5% probability.

The effect of different concentrations of sunflower extracts underground organs on seed germination characteristics of Hoary cress

The effect of different concentrations extracts of the following underground organs of sunflower on specific attributes of Hoary cress plantlets that was been measured was less than air organs (Table 2). Concentrations of 25, 50, 75 and 100 volumetric percentage extract of sunflower underground organs decreased the 1.84, 5.26, 43.86 and 51.85 percentage respectively germination of Hoary cress, compared to control treatment. The speed of germination process by increasing the concentration of extract also showed a reduction. The concentrations of 25, 50, 75 and 100 volumetric percentage extract of underground organs decreased the speed of Hoary cress germination to 0.34, 0.12, 3.74 and 4.8 seed per day equivalent of 1.09, 1.87, 58.52 and 75.11 percentage relative to control treatment. The length of the radicle in Hoary cress decreased at 25, 50, 75 and 100 volumetric percentage extract underground organs of sunflower, 0.08, 0.42, 1.48 and 1.6 cm respectively equivalent to 3.14, 16.53, 58.26 and 62.99 percentage compared to control treatment. The length of coleoptile for Hoary cress in concentrations of 75 and 100 volumetric percentage was 1.09 and 1.27 cm respectively equivalent to 38.11 and 48.03 percentage was reduced compared to control treatment, but in concentrations 25 and 50 volumetric percentage, showed a reduction 0.62 and 0.56 cm rather than control treatment and perhaps due to the inhibitory effect of allelochemical materials of sunflower for stimulation of length the radicle of Hoary cress. The seedling fresh weight for Hoary cress was decreased in all concentrations. It seems that the sunflower allelochemicals will stir hormonal balance between ethylene and ABA. The balance of two hormones controls the seeds germination and the growth of radicle and coleoptile (Ghiazdowsk et al, 2007).

Table 2- The allelopatic effect of different concentrations aqueous extracts of sunflower underground organs on the seed germination and growth characteristics of Hoary cress seedling

concentrations extracts (volumetric percentage)	fresh weight of seedling(mg)	length of coleoptile(cm)	length of radicle (cm)	speed of germination (seed per day)	percentage of germination
control	242/4 [a]	2/86 [c]	2/54 [a]	6/39 [a]	95 [a]
underground organs 25%	241/8 [a]	3/48 [a]	2/46 [a]	6/32 [a]	91/66 [ab]
underground organs 50%	234/2 [a]	3/42 [ab]	2/12 [a]	6/28 [a]	90 [ab]
underground organs 50%	123/4 [c]	1/77 [d]	1/06 [b]	2/65 [bc]	53/33 [cd]
underground organs 100%	118 [c]	1/59 [de]	0/94 [b]	1/59 [de]	43/33 [d]

The average in each column that contains least one same letter there have not significant difference in the based Duncan test at 5% probability.

The effect of different concentrations of sunflower mixture extracts of air and underground organs of seed germination characteristics of Hoary cress

The concentrations of 25, 50, 75 and 100 volumetric percentage of mixed extracts were decreased the 64.92, 87.04, 87.24 and 96.49 percentage respectively for Hoary cress germination relative to control treatment (Table 3). The concentrations of 25, 50, 75 and 100 volumetric percentage of mixed extracts were decreased the speed of germination at 5.23, 5.96, 6.30 and 6.32 seed per day equivalent to 81.84, 93.27, 94.36 and 98.96 percentage respectively compared to control treatment. The length of the radicle with increasing the concentrations of aqueous extracts mixture of air and underground organs was decreasing process so that the concentrations of 25, 50, 75 and 100 volumetric percentage of mixed extracts were decreased the length of radicle to 1.61, 2.36, 2.38 and 2.53 cm

equivalent to 63.38, 92.91, 93.70 and 99.60 percentage relative to control treatment. T0 respect the given that concentrations of aqueous extracts mixture of air and underground organs through a mixing ratio (1: 1) the mentioned organs were collected, the results indicates that the lack of additive ability effects of extract in the above organs had been measured traits so that the amount of the measured traits in Hoary cress at different concentrations of aqueous extracts mixture of air and underground organs did not followed the ratio.

The allelochemical material from the mixed extract air and underground organs have more effects from every single one they have on the above parameters that indicate the synergist effects of this material. Leather (1993) also reported about the more inhibitory effects of mixtured extracts of air and underground organs effects rather than each alone extracts. In order to evaluate the deterrence effect of different organs of sunflower, three independent group (Orthogonal) comparison was performed between 1-The control to other air, underground and mixed of them 2- The air with underground organs and 3- compare, the mixture of air and underground organs with the air and underground organs separately for germination percentage, germination rate, length of radicle and coleoptile and seedling fresh weight (Table 4). The first comparison between the control with the other of the organs showed that the greatest deterrence effect of the aforementioned traits related to the case of a mixture of air and underground organs, compared to control patients and the results of the second comparison between ground and aerial organs, except for the percentage of germination and radicle length that was not significant, for the other of the aforementioned characteristics, the air organs was more deterrent than underground organs. The results of the third comparison between air and underground organs with mixed of them, except in the case of the length of radicle that was not significant in the other cases of the studied traits showed that most of the prohibition effect of the relating to the mixture of underground and air organs. In this way, it became clear that the deterrence effect of the mixture of air and underground organs of sunflower extract was more deterrence than separated extract of air or underground organs. The third comparison data showed that mixed extract in decrease the studied traits except radicle length was significantly ($p < 0.01$) more than the average effect of aerial and underground organs. This is the subject of an early hypothesis that confirmed the lake of additive ability extract effects.

Table 3- The allelopathic effect of different concentrations aqueous extracts of sunflower mixture of air and underground organs on the seed germination and growth characteristics of Hoary cress seedling

concentrations extracts (volumetric percentage)	fresh weight of seedling (mg)	length of coleoptile (cm)	length of radicle (cm)	speed of germination (seed per day)	percentage of germination
control	242/4 ^{a}	2/86 ^{c}	2/54 ^{a}	6/39 ^{a}	95 ^{a}
mixture 25%	66/93 ^{d}	1/12 ^{e}	0/93 ^{b}	1/16 ^{ef}	36/66 ^{de}
mixture 50%	16/93 ^{e}	0/3 ^{f}	0/18 ^{cd}	0/43 ^{f}	16/66 ^{ef}
mixture 75%	12 ^{e}	0/15 ^{f}	0/16 ^{cd}	0/36 ^{f}	16/66 ^{ef}
mixture 100%	0 ^{e}	0 ^{f}	0/01 ^{d}	0/06 ^{f}	3/33 ^{f}

The average in each column that contains least one same letter there have not significant difference in the based Duncan test at 5% probability.

Evaluation of the characteristics of Hoary cress seed germination through three-parameter Logestic model

There was evaluated through of the three-parameter model final percentage of germination in seed germination studies. This model was justified the relationship between the different levels of aqueous extract in different organs at sunflower and germination of Hoary cress (Figures 1, 2 and 3). The X_{50} parameter that represents the amount of concentration that leading to lower final 50 percentage diminish of germination, in the case of different organs extract showed that the concentration of 18.1 volumetric percentage of mixed extracts were the 50 percentage decreased the germination of Hoary cress while the value of X_{50} for the aerial and underground organs of Hoary cress were equivalent of 97.34 and 89.34 percentage which represents a more and efficient effective mixture extracts of air and underground organs compared to alone the air and underground organs. The parameter b at model (which is represents the slope of the germination percentage reduction under the effects of increasing concentrations of the extracts) showed the maximum reduction of germination percentage in mixture extracts of air and underground organs and the minimum reduction was in the extract of air organs. But in the meantime there was not observed significant differences between the aerial and underground organs for germination percentage. The more slope tougher answers being different levels of concentration of aqueous extract was somehow represents the more sensitivity to the allelochemical.

Table 4-The group comparison between different organs of sunflower concentrations aqueous extracts on reducing the percentage of germination, germination rate, length of radicle and coleoptiles and seedlings fresh weight Hoary cress.

	First coefficients comparison	Second coefficients comparison	Third coefficients comparison	Average of germination percentage	Average of germination speed(seed per day)	Average of Radicle length(cm)	Average of Coleoptile length(cm)	Average of seedling fresh weight(mg)
control	-12	0	0	95	6/39	2/54	2/86	242/4
aerial organs	+1	-1	+1	70/97	3/06	1/44	1/89	187/86
underground organs	+1	+1	+1	69/58	4/21	1/64	2/56	179/35
mixture	+1	0	-2	18/32	0/50	0/32	0/39	23/96
Significant level for First comparison				0/0001	0/0001	0/7846	0/0001	0/0001
Significant level for Second comparison				0/7657	0/0001	0/2132	0/0001	0/2634
Significant level for Third comparison				0/0001	0/0001	0/4536	0/0001	0/0001

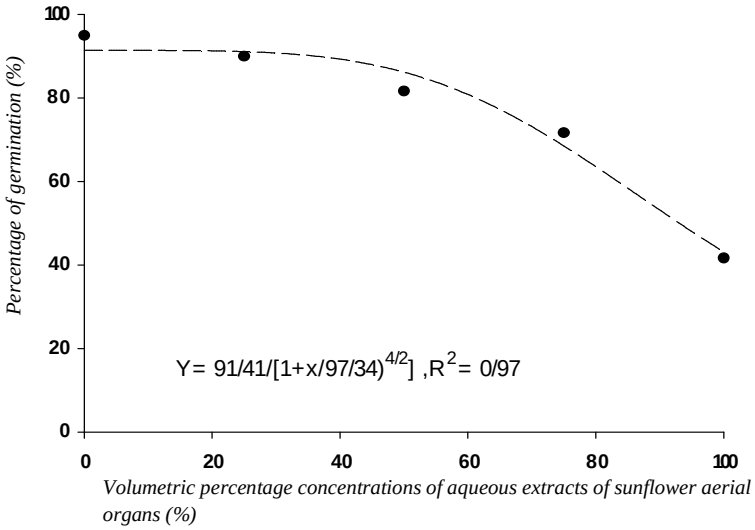

Figure 1: The final germination percentage of Hoary cress affected by different concentrations of aqueous extracts of sunflower aerial organs. The points represent averages of observed data and the lines resulting fitted with logestic model.

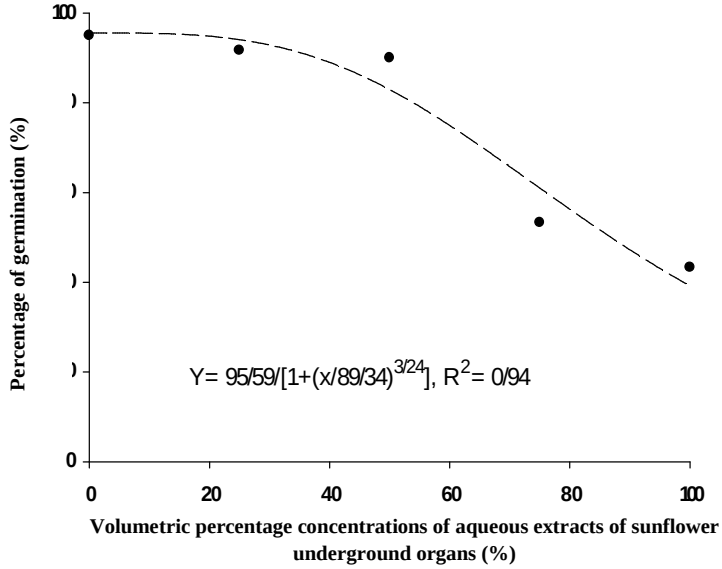

Figure 2: final germination percentage of Hoary cress affected by different concentrations of aqueous extracts of sunflower underground organs. The points represent averages of observed data and the lines resulting fitted with logestic model.

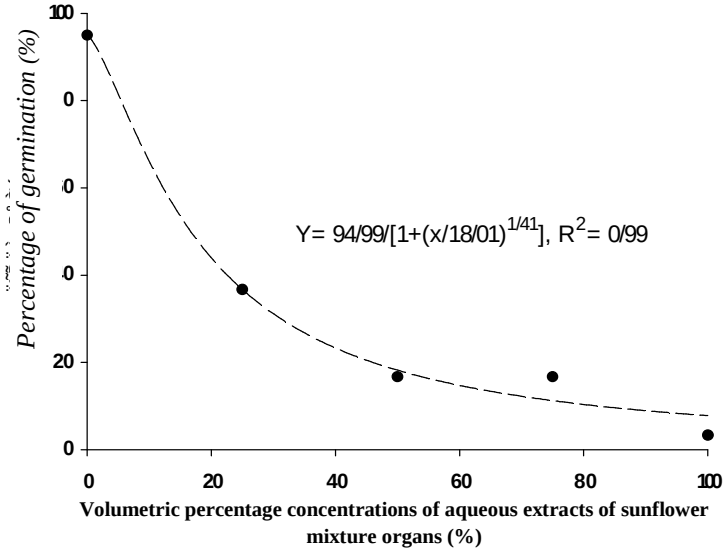

Figure 3: final germination percentage of Hoary cress affected by different concentrations of aqueous extracts of sunflower mixed air and underground organs. The points represent averages of observed data and the lines resulting fitted with logestic model.

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