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Allelopathic effects of wheat and barley on emergence and seedling growth of some weed species

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Key words: Allelopathy, barley, seedling growth, weed species, wheat.

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Abstract

In order to elucidate the allelopathic effects of wheat (*Triticum aestivum* L.) and Barely (*Hordeum vulgar* L.) on emergence and seedling growth of some weed species (*Rumex crispus* L., *Datora stramonium* L., *Sisiymbrium irio* L., *Dausus carota* L., *Peganum harmala* L., *Cardaria draba* L., *Hordeum spontaneum* L., *Avena ludoviciana* L., *Chenopodium album* L., *Plantago lanceolata* L., and *Amaranthus retroflexus* L.) under field condition an experiment was carried out as RCB design with three replications at Research Farm of the Faculty of Agriculture, University of Tabriz, Iran. Results showed *H. spontaneum* and *S. riro* have stimulatory effect on emergence percentage of wheat. However, these weeds species have inhibitory effect on EP of barley. Means root length of wheat by beside of *H. spontaneum* and *A. ludoviciana* were increased. However, root length of barley by beside of these weeds was significantly affected and reduced. Seedling of wheat has inhibitory effect on fresh weight of root of *H. spontaneum*. But, barley has stimulatory effect on this weed specie. *D. stramonium* by neighboring of wheat has the lowest shoot fresh weight. In contrast, SFW of this weed specie was improved by beside of barley seedling. Also, seedling of *H. spontaneum* and *C. draba* in the presence of wheat was produced the lowest root dry weight. Therefore, the response of wheat and barley were differently against the allelopathic material of weed species. In contrast, these crops had various effects on those weeds.

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Introduction

Weeds are unwanted and non-economic plants that compete with crop for survival and reproductively. Not only might the natural competition for achieving the suitable light, water and nourishment lead to decrease the growth of plant also, other elements and factors like allelopathy item would influence on growth and yield (Misawa and Goodbody, 1996).

In common definition, the allelopathy is any direct or indirect, useful or useless effects of plants on other ambient plants by germinating and growing via created chemical material and transmittal (Rice, 1984). Allelopathy is characterized by a reduction in plant emergence or growth reducing their performance in the association (Florentine *et al.,* 2006). Many species of weeds, as well as crop plants, are known to be allelopathic. Allelochemicals are secondary metabolites present as soluble compounds or in a volatile state in different plant organs (Rice, 1984).

Some studies have shown that various species possess the allelopathic potential to suppress weed specie (Dadkhah and Assadi, 2010; Dadkhah, 2012). Guenzi and McCalla (1966) found phytotoxicity of phenolic acids, particularly *p*-coumaric acid, from residues of wheat and other cereals. Allelopathy in cereals (cultivated and wild plants of the *poaceae* family) was attributed mostly to hydroxamic acids (Sanchez-Moreiras *et al.,* 2004). Allelopathic effects of wheat straw to corn (*Zea mays* L.) and cotton (*Gossypium hirsutum* L.) was also reported by Opoku *et al.,* (1997).

Future weed control might consist of multiple integrated strategies, of which one might be making crops suppress weeds themselves by improved allelopathy and competition (Rice, 1984). Allelopathy is a natural technique that may be considered as a tool for biological weed control and in crop production (Cheema and Khaliq, 2000).

The readily visible effects of allelochemicals on the growth and development of plants include inhibited or retarded germination rate, root or radicle and shoot or coleoptile extension and led to production of swelling or necrosis of root tips and increased number of seminal roots (Rice, 1974). The chemicals have harmful effects on the crop in the eco-system resulting in the reduction and delaying of germination, mortality of seedlings and reduction in growth and yield (Mcworthier, 1984; Herro and Callaway, 2003). Understanding the response of crop to allelopathic plants potential for weed control is very important, because we have a complex agro-ecosystems that allelopathy plays an important role in their, among crop-crop and crop-weed covers. Interactions between plant communities may be harmful or useful. So found agro-ecosystems member interactions in seed germination and seedling growth periods can be help us to input useful composition of crops seed to minimize of the presence of weeds in crop-weed communities. In integrated weed managements (IWM) we are interested in the inhibition of weeds seed germination and their seedling growth by crops through the production of allelochemicals. Therefore, this research was undertaken to evaluation seed and seedling growth characteristic of wheat and barley seeds as allelopathic crops against some weed species seeds affected by allelopathic substance.

Materials and methods

In order to elucidate the allelopathic effects of wheat (*Triticum aestivum* L.) and barely (*Hordeum vulgar* L.) on some weed species under field condition an experiment was carried out as complete randomized block design with three replications at Research Farm of the Faculty of Agriculture, University of Tabriz, Iran. Weed species were included curlydock (*Rumex crispus* L.), datura (*Datura stramonium* L.), London rocket (*Sisiymbrium irio* L.), Carrot (*Daucus Carota* L.), harmel (*Peganum harmala* L.), horay cress (*Cardaria Draba* L.), Wild barley (*Hordeum spontaneum* C. Koch.), oat (*Avena ludoviciana* L.), lamb·s squarters (*Chenopodium album* L.), buckhorn plantain (*Plantago lanceolata*

L.), and reed root pigweed (*Amaranthus retroflexus* L.) on emergence and seedling growth factors.

Twenty seeds of wheat and barley or different weed species without another seeds as control were sown in each pot filled with soil (loam). Then, for survey effects of the neighboring wheat and barley on percentage and rate of emergence and seedling growth factors of weed species, numbers of 20 seeds of each weed species were regularly sown between the 20 seeds of wheat or barley in separate pots. Then, pots were placed in field condition and seedling emergence was counted every day up to 18 days after sowing. Rate of seedling emergence was calculated according to Ellis and Roberts (1980) with slight modification:

$$ER=\frac{\sum n}{\sum D.n}$$

Where n is the number of seedling emerged on day D, D is the number of days from the beginning of the test and ER is the mean emergence rate. Then emergence percentage was also determined.

At the end of test number of root, and length and fresh weight of root and shoot were measured. Root and shoot of each sample were then dried in an Oven at 80 °C for 24 hours and mean dry weight of root and shoot for each treatment at each replicate was determined.

All the data were analyzed on the basis of experimental design, using MSTATC and SPSS-16 softwares. The means of each trait were compared according to Duncan multiple range test at P≤0.05 and standard error values. Excel software was used to draw figures.

Results and discussion

Emergence percentage and rate

Emergence percentage (EP) of *H. spontaneum*, *D. stramonium*, *R. crispus*, *P. lanceolata*, and *A. rethroflexus* were decreased by beside of wheat. However, EP of *D. carota*, *C. draba*, *S. irio*, and *C. album* by neighboring of wheat were significantly increased. Maximum stimulatory effect of wheat was detected on *D. carota* and *C. draba*, which ranged from 23.53 and 58.33 to 100 and 100 %, respectively. The highest inhibitory effect of wheat was obtained on *A. rethroflexus* and *C. album*, which ranged from 93.33 and 88.33 to 60 and 43.33 %, respectively. Seedling of wheat in the presence of *H. spontaneum*, *A. ludoviciana*, *R. crispus*, *P. harmala*, and *S. irio* has more EP than control. But, *D. carota* and *C. draba* by beside of wheat have minimum EP (Fig. 1a).

EP of barley was decreased in the presence of *D. stramonium*, *D. carota*, *S. irio*, *P. harmala*, and *C. album*. However, EP of barley was increased by beside of *A. ludoviciana*, *D. stramonium*, and *R. crispus*. Seedlings of *A. ludoviciana*, *D. stramonium*, and *R. crispus* in the presence of barley seedling have the highest EP however, *C. draba*, *S. irio*, *P. harmala*, *C. album*, and *P. lanceolata* by neighboring of barley has the lowest EP (Fig. 1b).

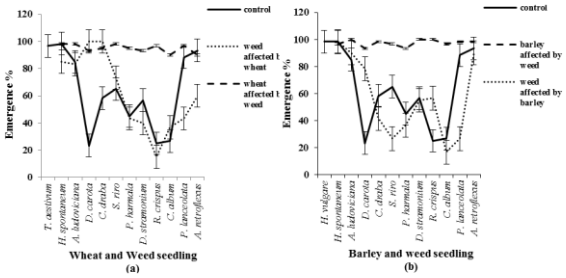

Fig. 1. Reciprocal differences in emergence percentage (EP) of wheat (a) and barley (b) against some of weed species. The results are means ±SE.

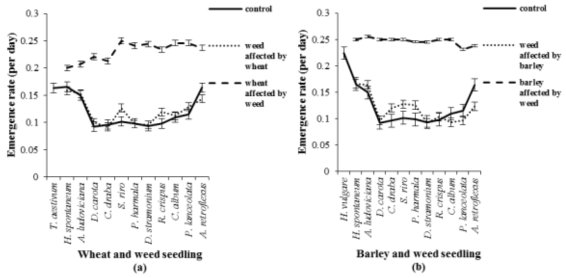

Fig. 2. Reciprocal differences in emergence rate (ER) of wheat (a) and barley (b) against some of weed species. The results are means ±SE.

As a result, seedlings of *H. spontaneum* and *S. irio* have stimulatory effect on EP of wheat while, these weeds have inhibitory effect on EP of barley. Also, EP of *R. crispus* was declined in the presence of wheat while EP of this weed was increased by beside of barley (Fig. 1a,b).

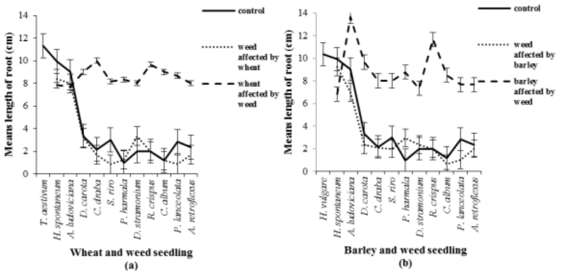

Fig. 3. Reciprocal differences in means root length (MRL) of wheat (a) and barley (b) against some of weed species. The results are means ±SE.

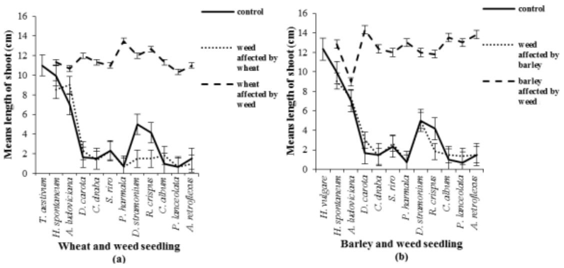

Fig. 4. Reciprocal differences in means shoot length (MSL) of wheat (a) and barley (b) against some of weed species. The results are means ±SE.

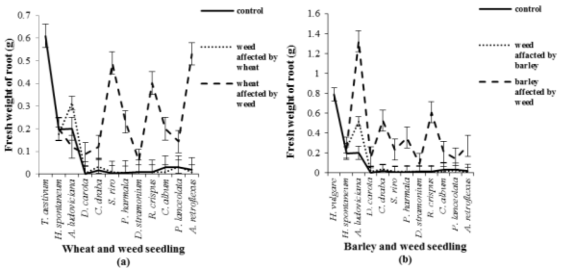

Fig. 5. Reciprocal differences in means root fresh weight (RFW) of wheat (a) and barley (b) against some of weed species. The results are means ±SE.

Emergence rate (ER) of *A. rethroflexus* in the presence of wheat was significantly declined. However, ER of *S. irio and R. crispus* by beside of wheat were increased. All weed species in this experiment has stimulatory effect on ER of wheat (Fig. 2a).

ER of *C. album*, *P. lanceolata*, *and A. rethroflexus* were decreased by beside of barley. But, *A. ludoviciana*, *C. draba*, *S. irio*, and *P. harmala* were showed maximum ER, compared with the control. Barley in the presence of all weed species also has more ER than control (Fig. 2b). The inhibitory effects of wheat and barley on EP and ER of some weed species could be attributed to release of allelochemical substance of these crops. These results are in conformity with those reported by Mc-Whorter (1984) and Nandal *et al.,* (1999). Rice (1984) and Porheydar-Ghafarbi *et al.,* (2012) reported that several crops such as wheat and barley have allelopathic effects on other crops. Liu and Lovett (1993) found lower germination of white mustard (*Sinapis alba* L.), when it was grown alongside germinating barley seeds. In contrast, some works showed that major of weed seedling have allelopathy material.

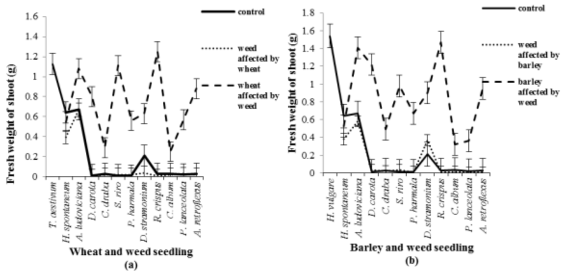

Fig. 6. Reciprocal differences in means shoot fresh weight (SFW) of wheat (a) and barley (b) against some of weed species. The results are means ±SE.

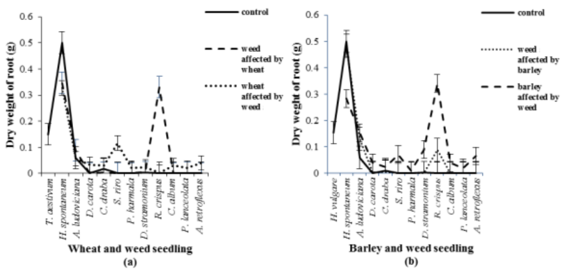

Fig. 7. Reciprocal differences in means root dry weight (RDW) of wheat (a) and barley (b) against some of weed species. The results are means ±SE.

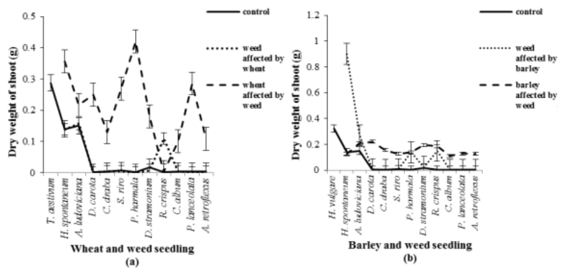

Fig. 8. Reciprocal differences in means shoot dry weight (SDW) of wheat (a) and barley (b) against some of weed species. The results are means ±SE.

Means length of root and shoot

Means root length (MRL) of *H. spontaneum*, *A. ludoviciana*, *S. irio*, *P. lanceolata*, and *A. rethroflexus* were decreased in the presence of wheat. However, *D. stramonium* by beside of wheat has minimum MRL. In contrast, MRL of wheat were declined in the presence of all weed species (Fig. 3a).

Seedlings *of H. spontaneum*, *A. ludoviciana*, *D. carota*, *S. irio*, and *P. lanceolata* by beside of barley seedling have the lowest MRL. However, this index of *P. harmala* and *D. stramonium* was increased in the presence of barley. Also, MRL of barley seedling were significantly increased in the presence of *H. spontaneum* and *D. stramonium*. As a result, *H. spontaneum* and *A. ludoviciana* have significantly stimulatory effect on MRL of wheat, while these weeds by neighboring of barley have inhibitory effect on MRL (Fig. 3b).

Means Shoot lengths (MSL) of *H. spontaneum*, *D. stramonium*, *R. crispus*, and *A. rethroflexus* were declined by beside of wheat. However, MSL of *A. ludoviciana*, *D. carota*, *and C. album* were increased. In contrast, wheat in the presence of *D. carota*, *P. harmala*, *D. stramonium*, and *R. crispus* have more MSL than control (Fig. 4a).

MSL of *H. spontaneum* and *R. crispus* were decreased by neighboring of barley. However, MSL of *A. ludoviciana, D. carota, C. album,* and *P. lanceolata* was increased. In contrast, barley by beside of *A. ludoviciana* has minimum MSL, while *D. carota* had stimulatory effect on MLS of barley (Fig. 4b). As a result, of *D. carota* have stimulatory effect on both wheat and barley. Also, MSL of *D. carota* was improved by beside of wheat and barley (Fig. 4a,b). This suggesting that the reduction in root and shoot growth may have been a reflection of delayed germination rather than due to a direct effect of an allelochemicals.

Several enzymes like proteases, lipases and amylases play an important role during seed germination and seedling growth. Many enzymatic functions are inhibited by the presence of allelochemicals (Turk and Tawaha, 2002; Rice, 1984). In similarly result showed that radicle length was more sensitive than germination for detecting any allelopathic effect of wheat (Hedge and Miller, 1990). Liu and Lovett (1993) also found reduction in radicle length of white mustard (*Sinapis alba* L.), when it was grown by beside of germinating barley.

Fresh weight of root and shoot

Root fresh weight (RFW) of *H. spontaneum*, *C. album*, and *A. rethroflexus* were decreased in the presence of wheat. However, this quality at *A. ludoviciana* and *C. draba* was considerably improved. In contrast, RFW of wheat in the presence of all weeds species was significantly declined (Fig. 5a).

Seedling of *C. album* and *P. lanceolata* by beside of barley was produced the lowest RFW. However, RFW of *H. spontaneum* and *A. ludoviciana* was increased in this interaction (Fig. 5b). Thus, wheat has inhibitory effect on RFW of *H. spontaneum*. However, barley seedling has stimulatory effect on this weed specie. RFW of *A. ludoviciana* in the presence of wheat and barley seedlings was considerably increased. Wheat by neighboring of *A. ludoviciana* was produced the lowest RFW. But, this quality of barley was increased in this interaction (Fig. 5a,b).

The *H. spontaneum* and *D. stramonium* in the presence of wheat was produced the lowest shoot fresh weight (SFW). In contrast, all weed species have inhibitory effect on SFW of wheat (Fig. 6a).

The SFW of *H. spontaneum*, *A. ludoviciana*, *R. crispus*, *C. album,* and *A. rethroflexus* was declined by beside of barley. However, this quality in *D. stramonium* was increased. SFW of Barley by beside of all weed species was also significantly decreased (Fig. 6b). As a result, *D. stramonium* by beside of wheat has the lowest SFW. But, SFW of this weed specie was improved by beside of barley (Fig. 6a,b). Similar results were obtained by Yang *et al.,* (2002) after treatment of rice plant with three allelopathic phenolics. A number of studies have suggested that plant residues especially weed species affect the growth and development of other plants including crops by releasing allelochemicals into the immediate soil environment (Singh *et al.,* 2005; Batish *et al.,* 2006).

Dry weight of root and shoot

Seedling of *H. spontaneum* and *C. draba* in the presence of wheat was produced the lowest root dry weight (RDW). However, this quality in *A. ludoviciana* and *R. crispus* was improved by neighboring of wheat, as RDW of *R. crispus* was increased from 0.1 up 0.33 g. In contrast, RDW of wheat was increased by beside of *H. spontaneum*. However, RDW of wheat was declined by neighboring of other weed species (Fig. 7a).

The *H. spontaneum* and *C. draba* had the lowest RDW in the presence of barley. But, RDW of *A. ludoviciana* and *R. crispus* was increased by beside of this specie. Seedling of *H. spontaneum* and *A. ludoviciana* has stimulatory effect on RDW of barley. However, this quality of barley was declined by neighboring of other weed species (Fig. 7b).

Shoot dry weight (SDW) of *D. stramonium* was decreased, while *A. ludoviciana* and *R. crispus* was increased in the presence of wheat. In contrast, SDW of wheat was improved by beside of *H. spontaneum* and *P. harmala* (Fig. 8a).

The SDW of *H. spontaneum*, *A. ludoviciana*, *P. harmala,* and *R. crispus* was increased by neighboring barley (Fig. 8b). As a result, SDW of wheat was increased by beside of *H. spontaneum* and *P. hramala*. But, this quality in barley was declined in the presence of these species (Fig. 8a,b). Reduction in fresh weight of root and shoot led to decreases in RDW and SDW. Allelopathic components are potential inhibitors of germination, seedling growth, fresh weights and dry weights as reported by Herro and Callaway (2003), Siddiqui and Zaman (2004), and Siddiqui and Zaman (2005).

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