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Full Length Research Paper

Winter wheat cultivars responses to allelopathic potential of wild barley (*Hordeum spontaneum* Koch) extracts

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Greenhouse and laboratory studies were conducted to examine the effects of allelopathic potential of wild barley shoot and root extracts on seed germination and seedling growth of five winter wheat cultivars. Plant materials containing 1.8, 3.6, 5.4, 7.2, 9.0 g shoot, and 3, 6, 9, 12, 15 g root were soaked in distilled water for 24 h. Then, the extracts were collected and filtered. Shoot and root extracts decreased germination percentage significantly and increased mean germination time partially only in Shiraz cultivar. The extracts at 80 and 100% concentrations reduced seedling growth parameters including shoot and radicle length and number of seminal roots. Root allelochemicals performed the more inhibitory effects than shoot ones. Darab-2 cultivar was the most tolerant and Shiraz cultivar was the most sensitive to wild barley extracts. Radicle length appeared to be the most sensitive morphological trait for allelopathic assessment of wheat seedling.

Key words: Plant interactions, allelopathy, wild barley, wheat, growth, extract.

INTRODUCTION

Interference between weeds and crops is one of several ecological topics that have two competition and allelopathy (Iqbal et al., 2003). Competition between weeds and crops occurs when some factors such as water, nutrients, or sunlight, is insufficient to meet the needs of both the weed and the desired plant. Allelopathy is any direct or indirect, inhibitory or stimulatory effect by one plant on another through the production of chemical compounds that escape into the environment (Gibson and Liebman, 2003).

Water extracts from tops, roots, or seeds of number of crop and weed species have been found to inhibit seed germination or early seedling development (Cope, 1982). This effect on germination may occur through a variety of mechanisms including reduced mitotic activity in roots and hypocotyls, suppressed hormones activity, reduced rate of ion uptake, and decreased permeability of cell membranes (Jefferson and Pennacchio, 2003). Many of the phytotoxic substances that are suspected of causing germination and growth inhibition have been identified from plant tissues and soils. These substances are termed allelochemicals (Turk and Tawaha, 2003).

In agricultural systems allelopathy can be part of the interference between crops and between crops and weeds and may affect the economical outcome of the plant production. Both crop and weed species with allelopathic activity are known (Kruse et al., 2000; Kula, 2006).

The inhibitory effects of shoot and root extract of weeds are well known on germination and seedling growth of crops (Inderjit, 2001). It is known that the barley plant parts have allelopathic potential effects on other plants (Bhowmick and Doll, 1984). The allelochemicals in cultivated barley (*Hordeum vulgare* L.) have only minor differences with its wild species (Bertholdsson, 2004). The phenolics are in aqueous extract of barley residues, but gramine (N, N-dimethyl-3-amino-methyl indole) and hordenine (N, N-dimethyl tyramine) have a main allelopathic effect (Borner, 1960). However, it was found that both the seeds and plants of barley produce allelopathic substances capable of inhibitory action in the complete absence of any such physical competition

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Table 1. Effect of wild barley shoot extracts (%) on radicle length of 5 winter wheat cultivars.

Cultivars	Extract concentration (%)					
	0	20	40	60	80	100
Shiraz	3.40^{ab*A**}	3.20^{abA}	3.20^{aA}	2.69^{abAB}	2.52^{abAB}	2.34^{bcB}
Chamran	2.90^{bA}	2.50^{bAB}	1.90^{bB}	1.90^{bB}	1.80^{bB}	1.80^{cB}
Darab-2	3.60^{abA}	3.40^{aA}	3.40^{aA}	3.30^{aA}	3.20^{aA}	3.20^{aA}
Cross Azadi	4.01^{aA}	3.70^{aA}	3.60^{aA}	3.40^{aAB}	3.00^{aAB}	2.70^{bB}
Falat	3.60^{abA}	3.50^{aA}	3.40^{aA}	3.10^{aA}	2.90^{aA}	2.90^{bA}

* Means within each column with the same letters (small letters) are not significantly different at the 5% level according to Duncan's new multiple range test. ** Means within each row with the same letters (capital letters) are not significantly different at the 5% level according to Duncan's new multiple range test.

Table 2. Effect of wild barley root extracts (%) on radicle length of 5 winter wheat cultivars.

Cultivars	Extract concentration (%)					
	0	20	40	60	80	100
Shiraz	4.00^{a*A**}	3.80^{aAB}	3.50^{aAB}	3.20^{aAB}	2.80^{aB}	2.80^{aB}
Chamran	4.16^{aA}	3.90^{aA}	3.90^{aA}	3.60^{aA}	3.40^{aA}	3.30^{aA}
Darab-2	3.50^{aA}	3.40^{aA}	3.30^{aA}	3.20^{aA}	3.00^{aA}	2.90^{aA}
Cross Azadi	4.00^{aA}	4.00^{aA}	3.60^{aA}	3.60^{aA}	3.30^{aA}	3.20^{aA}
Falat	4.00^{aA}	3.60^{aAB}	3.40^{aAB}	3.40^{aAB}	3.20^{aAB}	2.30^{aB}

* Means within each column with the same letters (small letters) are not significantly different at the 5% level according to Duncan's new multiple range test. ** Means within each row with the same letters (capital letters) are not significantly different at the 5% level according to Duncan's new multiple range test.

(Overland, 1966). Both living and dead barley roots were found to have inhibitory effects, but living roots were much stronger and a much higher concentration of substances was found in the living root, indicating an active secretion by living plants. Under natural field conditions both sources of the inhibitor would be important (Overland, 1966).

MATERIALS AND METHODS

Mature and green wild barley shoot and roots were collected from wheat fields and dried in an oven for 48 h at 48℃ f or shoot and 48 h at 55℃ for roots.

Aqueous shoot and root extract preparation

The wild barley shoot and root were chopped to 1 to 2 cm long pieces containing 1.8, 3.6, 5.4, 7.2, 9.0 g shoot and 3, 6, 9, 12, 15 g root were soaked in 1000 ml distilled water for 24 h at 24 to 25℃. After 24 h, the extracts were collected and filtered through 3 layers of whatman #2 filter paper and used for conducting experiments.

Winter wheat (*Triticum aestivum* L.) seeds of 5 cultivars including Shiraz, Chamran, Darab-2, Cross Azadi, and Falat were sterilized by soaking in 1% sodium hypochlorite and then thoroughly rinsed with deionized water. Twenty five seeds were placed on 9 cm Petri-dishes containing filter paper whatman #2. Eight ml of the shoot and root extracts at different concentrations were added to each Petri-dish. Control dishes contained 8 ml deionized water. The dishes were incubated at 25℃. After 7 days, the radi cle length, shoot length, number of seminal roots and germination percentage of 5 seedlings in each Petri-dish was measured and compared to check. Each experiment was conducted in a completely randomized design (CRD) with 3 replications.

RESULTS AND DISCUSSION

Wild barley shoot extract had inhibitory effect on radicle length in all cultivars (Table 1). The severest inhibitory effects were observed at 40, 60, 80, and 100% shoot extract concentrations in Chamran cultivar. The reduction was 34.48, 34.48, 37.93, and 37.93%, respectively compared to check (Table 1). Radicle length reduction in Shiraz and Cross Azadi cultivars was significant in terms of statistics only at 100% shoot extract concentration and it was 31.18 and 32.67%, respectively in two cultivars (Table 1).

Wild barley root extract reduced radicle length of Shiraz cultivar significantly 30 and 30% at 80 and 100% root extract concentrations compared to check (Table 2). The significant reduction was observed in radicle length of Falat cultivar only at 100% root extract concentration and it was 42.5% (Table 2).

The inhibitory effect of wild barley shoot extract on shoot length was observed in all cultivars. The significant reduction at 100% shoot extract concentration was 35.59, 22.58 and 22.03% in Shiraz, Darab-2 and Falat cultivars respectively compared to check (Table 3). Wild barley root extract reduced shoot length of all cultivars, but not

Table 3. Effect of wild barley shoot extracts (%) on shoot length of 5 winter wheat cultivars.

Cultivars	Extract concentration (%)					
	0	20	40	60	80	100
Shiraz	5.90^{a*A**}	5.70^{aA}	5.30^{aA}	4.90^{bAB}	4.00^{cB}	3.80^{cB}
Chamran	6.70^{aA}	6.60^{aA}	6.40^{aA}	6.20^{aA}	6.10^{aA}	6.10^{aA}
Darab-2	6.20^{aA}	5.90^{aAB}	5.90^{aAB}	5.70^{abAB}	5.50^{abAB}	4.80^{bcB}
Cross Azadi	6.20^{aA}	6.00^{aA}	5.90^{aA}	5.70^{abA}	5.60^{abA}	5.50^{abA}
Falat	5.90^{aA}	5.80^{aA}	5.50^{aAB}	5.10^{abAB}	4.70^{abcB}	4.60^{bcB}

* Means within each column with the same letters (small letters) are not significantly different at the 5% level according to Duncan's new multiple range test. ** Means within each row with the same letters (capital letters) are not significantly different at the 5% level according to Duncan's new multiple range test.

Table 4. Effect of wild barley root extracts (%) on shoot length of 5 winter wheat cultivars.

Cultivars	Extract concentration (%)					
	0	20	40	60	80	100
Shiraz	6.20^{a*A**}	4.80^{aA}	4.00^{aA}	3.60^{aA}	3.10^{aA}	2.30^{aA}
Chamran	4.80^{aA}	4.80^{aA}	3.90^{aA}	3.00^{aA}	3.00^{aA}	2.60^{aA}
Darab-2	5.10^{aA}	4.90^{aA}	4.60^{aA}	4.20^{aA}	3.70^{aA}	3.00^{aA}
Cross Azadi	5.10^{aA}	4.10^{aA}	3.90^{aA}	3.90^{aA}	3.50^{aA}	3.40^{aA}
Falat	4.70^{aA}	4.50^{aA}	4.10^{aA}	3.40^{aA}	3.20^{aA}	3.10^{aA}

*Means within each column with the same letters (small letters) are not significantly different at the 5% level according to Duncan's new multiple range test. ** Means within each row with the same letters (capital letters) are not significantly different at the 5% level according to Duncan's new multiple range test.

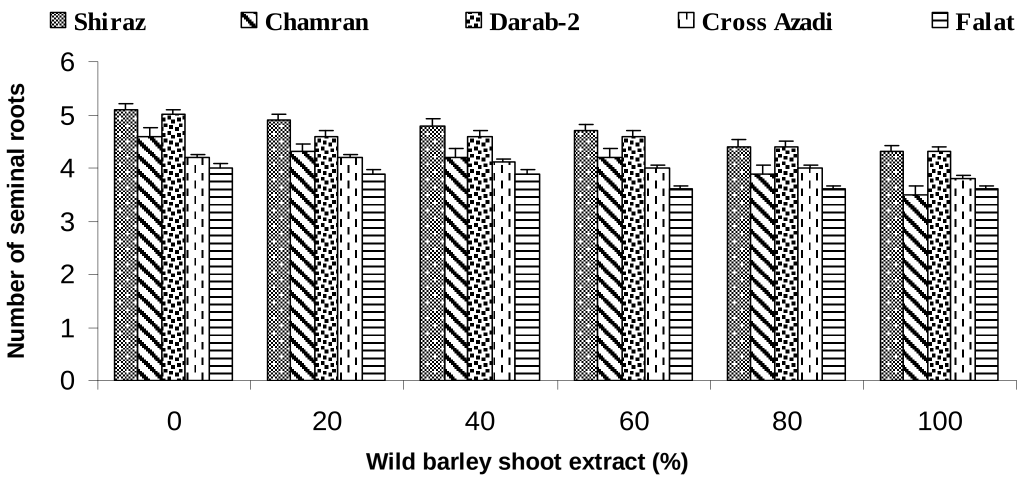

Figure 1. Effects of wild barley shoot extract (%) on the number of seminal roots of 5 winter wheat cultivars. The error bars show significant or non-significant differences between cultivars and wild barley extract concentrations in terms of determined factors.

significantly in terms of statistics (Table 4).

Number of seminal roots was reduced by wild barley shoot extract. The reduction was significant only at 100% shoot extract concentration in Chamran cultivar. The reduction was 23.91% (Figure 1). Shoot extract reduced seed germination percentage. The inhibitory effect was more in Chamran and Cross Azadi cultivars at 80 and 100% shoot extract concentrations (Figure 2). Seed germination reduction at 80 and 100% concentrations in Chamran cultivar was 52.14 and 57.32% and in Cross

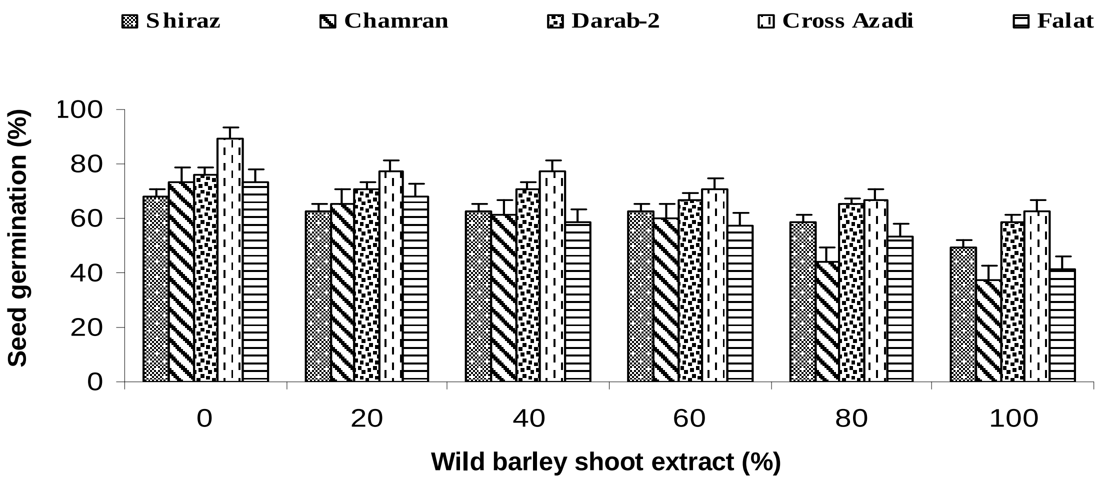

Figure 2. Effects of wild barley shoot extract (%) on germination percentage of 5 winter wheat cultivars.

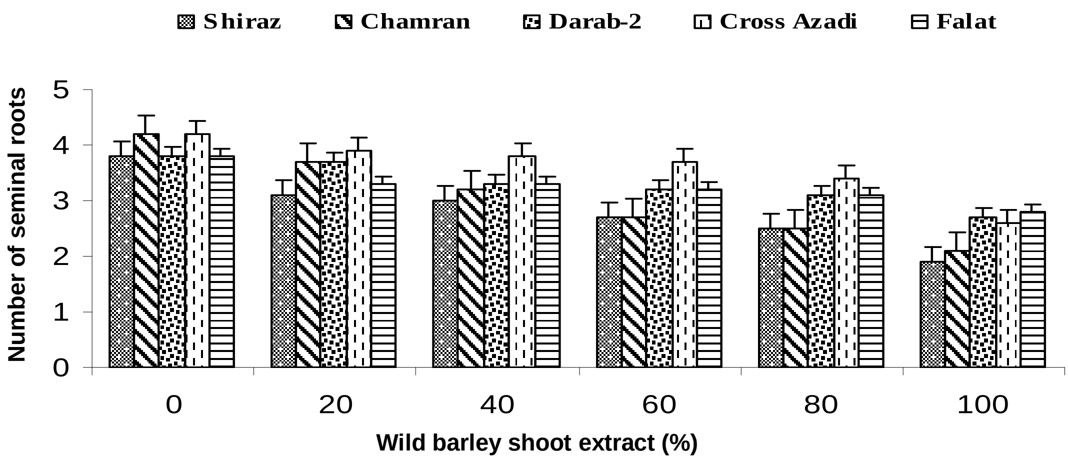

Figure 3. Effects of wild barley root extract (%) on the number of seminal roots of 5 winter wheat cultivars.

Azadi cultivar was 67.47 and 70.97% respectively (Figure 2).

Wild barley root extract reduced number of seminal roots of all cultivares, but not significantly in terms of statistics (Figure 3). Seed germination percentage reduced by root extract (Figure 4). The severest reduction was observed in Chamran cultivar at 40, 60, 80, and 100% extract concentrations. The reduction was 46.90, 50.00, 53.85, and 58.04% respectively (Figure 4).

Shoot and root extract of wild barley reduced seed germination, shoot and radicle growth, but the effect on the number of seminal roots was non significant. It is suggested that the number of seminal roots may be an invariable factor that was not affected by the allelopathic compounds (Turk and Tawaha, 2002). Water soluble inhibitors could be the reason of reducing the root and shoot length of wheat significantly. Cell division might have been affected which reduced the root and shoot lengths of wheat seedlings as allelopathic compounds are known to inhibit functioning of gibberellin and indole acetic acid (Wondimageanhu and Singh, 2005). Comparison between shoot and root extracts of wild barley showed that the allelochemicals in shoot extract had a less effects on seed germination and seedling growth than root extract (Meissner et al., 1989). Seed germination was delayed only in Shiraz cultivar by shoot allelochemicals. This result is in agreement with the results of Williams and Hoagland (Williams and Hoagland, 1977). They reported that most compounds only delayed germination and reduced competitiveness of plant.

The results of germination studies investigated that water extracts of wild barley had more pronounced effects on radical growth than on hypocotyls growth

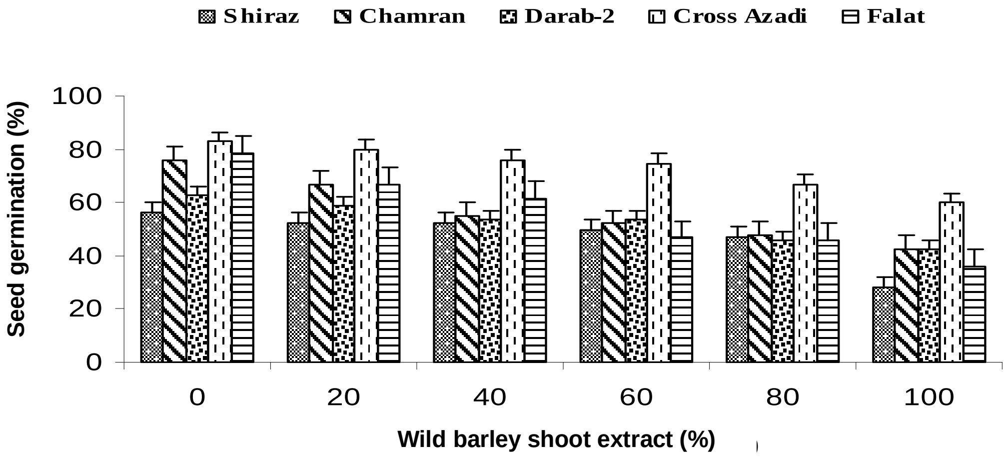

Figure 4. Effects of wild barley root extract (%) on germination percentage of 5 winter wheat cultivars.

(Kimber, 1973), probably, as roots are the first to absorb the allelochemicals of autotoxic-compounds from the environment. Comparison between five cultivars showed that Darab-2 cultivar was the most tolerant and Shiraz cultivar was the most sensitive to wild barley shoot and root extract.

We may conclude on the basis of these results, that most of the extracts of various parts of weeds under test contains water soluble compounds to a varying degree. These compounds may be released by rain or irrigation and dissolved in water under field conditions therefore wild barley present in fields should be controlled at early stage to avoid phytotoxic allelopathic effects of this weed.

REFERENCES

Bertholdsson NO (2004). Variation in allelopathic activity over 100 years of barley selection and breeding. Weed Res., 44: 78-86.

Bhowmick PR, Doll JD (1984). Allelopathic effects of annnual weed residues on growth and nutrient uptake of corn and soybean. Agron. J., 76: 383-388.

Borner J (1960). Liberation of organic substances from higher palnts and their role in the soil sickness problems. Bot. Rev., 26: 369-424.

Cope WA (1982). Inhibition of germination and seedling growth of eight forage species by leachates from seeds. Crop Sci., 22: 1109-1111.

Gibson LR, Liebman M (2003). A laboratory exercise for teaching plant interference and relative growth rate concepts. Weed Tech., 17: 394-402.

Inderjit S (2001). Soil Environmental effect on allelochemical activity. Agron. J., 93: 79-84.

Iqbal Z, Hiradate S, Noda A, Fujii Y (2003). Allelopathic activity of buckwheat: isolation and characterization of phenolics. Weed Sci., 51: 657-662.

Jefferson LV, Pennacchio M (2003). Allelopathic effects of foliage extracts from four *Chenopodiaceae* species on seed germination. J. Arid. Environ., 55: 275-285.

Kimber RWL (1973). Phytotoxicity from plant residues. II. The effect of time of rotting of straw from some grasses and legumes on the growth of wheat seedling. Plant Soil, 38: 347-361.

Kruse M, Strandberg M, Strandberg B (2000). Ecological effects of allelopathic plants-a review. National Environmental Research Institute, Silkeborg, Denmark. 66 pp. NERI Technical Report. NO. 315.

Kula NP (2006). Allelopathic interference of silver leaf night shade (*Solanum elaeagni folium* Cav.) with the early growth of cotton (*Gossypium hirsiutum* L.). M.Sc. Thesis, Dept. Plant Prod. Soil Sci., Faculty of Natural and Agricultural Science, University of Pretoria, Pretoria, 112 p.

Meissner R, Nel PC, Beyers EA (1989). Allelopathic effect of *Cynodon dactylon* infested soil on early growth of certain crop species. Appl. Plant Sci., 3: 125-126.

Overland L (1966). The role of allelopathic substances in the “Smother Crop” barley. Amer. J. Bot., 53(5): 423-432.

Turk MA, Tawaha AM (2002). Inhibitory effects of aqueous extracts of black mustard on germination and growth of lentil. J. Agron., 1: 28-30.

Turk MA, Tawaha AM (2003). Weed control in cereals in Jordan. Crop Protec., 22: 239-246.

Williams RD, Hoagland R (1977). Effect of naturally occurring compounds on seed germination. Allelopathic interactions. Proc. South. Weed Sci. Soc., 30: 372.

Wondimageanhu M, Singh M (2005). Allelopathic effect of parthenium (*Pathenium hysterophorus* L.) extract and residues on some agronomic crops and weeds. J. Chem. Ecol., 13: 1739-1747.