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Germination and Growth of Wheat, *Triticum aestivum* (cv. Azar2) in Response to Pigweed, *Amaranthus retroflexus* L. Organs Extracts

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Abstract. In order to evaluate the allelopathic effects of aqueous extract of pigweed, *Amaranthus retroflexus,* different organs on germination and growth of wheat , *Triticum aestivum* cv. Azar2, an experiment was conducted as factorial based on completely randomized design with three replications in laboratory and greenhouse of Islamic Azad University, Miyaneh Branch. Experimental factors comprised pigweed organs at three levels (leaf, root and stem) and aqueous extract of pigweed organs at 2.5, 5 and 10% concentrations and distilled water was considered as a control. Traits including germination rate, root and stem length, and fresh and dry weight of wheat seedlings were measured. Results of analysis of variance showed significant effects of extract concentration and pigweed organs interaction on all above mentioned traits, except germination rate. Germination and initial growth of wheat were affected by pigweed organs' extracts in all studied concentrations. Allopathic effect of pigweed extracts on wheat germination and growth was increased with increasing extract concentration. According to the results, extracts of pigweed different organs showed the same toxic effect on wheat germination rate, stem length and seedling dry weight. However, the most adverse effects of pigweed allelochemicals on root length and dry weight of wheat seedlings were caused by pigweed leaf extract. Based on the results, Azar2 was recognized as very susceptible wheat cultivar to extracts of all weed organs and so, extension of its farming most probably will increase allelopathic induced damage of pigweed to wheat.

Key words: Allelopathy, Weed organs, Pigweed, *Amaranthus retroflexus*, Wheat, Azar2 cultivar.

1. Introduction

Weeds have high competition potential due to good adaptation with the environment and so, they are one of the most important factors that reduce crops yield (3). Economic damage of weeds in the world has been reported over than 100 billion dollars (15). Besides competition with crops, weeds reduce crops' growth and yield by releasing allelopathic substances (4).

Red-root pigweed, *Amaranthus retroflexus* is considered as one of the most hazardous weeds in all over the world and its allelopathic effects is well known. Pigweed extracts contains allelochemicals such as Aldehydes, Alkaloids, Apocarotenoids, Flavonoids, Steroids, Xyloids, Clerogenic acid and Saponyns (2). Allelochemical substances is secreted by aerial organs of pigweed and released to the soil through washing by rain or irrigation water (3, 5).

Weeds may disrupt germination and growth of agricultural crops by chemicals production leading to lower yield production (10). Allelopathy is an important mechanism in which plants disperse toxic substances in the environment as their competitive strategies (7, 8). Allelochemicals were released in different ways such as leaching from plant tissues by rain and dew and excretion from plant roots (9).

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Allelopathy is an important environmental friendly approach to weeds control, to yield increase and herbicide application reduction (10, 11).

Many researchers evaluated the allelopathic effects of pigweed on different crops. Pigweed extracts reduced soybean and corn growth (2). Reduced seed germination rate, stem length, root length and seedling dry weight has also been reported by extracts from pigweed stems and roots (5). Letournea *et al.* (1956) reported that the extract derived from pigweed in 2 grams dry matter in 100 ml water reduced seed germination and seedlings root length in wheat (11).

The present study was carried out for evaluation the allelopathic effects of different pigweed organs' extracts on germination and growth of barley cultivars to determine sensitive and tolerant cultivars to chemicals produced by pigweed.

2. Material and methods

2.4. Treatments

The research was carried out in Miyaneh Branch, Islamic Azad University as factorial based on completely randomized design with three replications in 2010. Experimental factors comprised pigweed organs at three levels (leaf, root and stem) and aqueous extract of pigweed organs at 2.5, 5 and 10% concentrations and distilled water was considered as a control.

2.5. Sampling and plant extract preparation

Pigweed was collected from fields of different crops in Miyaneh region and the weed leaves, stems and roots were blended separately after drying in an oven with 50˚C for 72 hours. For extract preparation, 10 grams of powdered plant material were suspended in 100 ml distilled water and mixed for 24 hours by a horizontal rotary shaker for producing uniform extract. Finally, centrifugation was performed using a Mikro-22R centrifuge (Hettich, Germany) at 6000 rpm for 30 minutes at 10˚C and the obtained extract was considered as 10% concentration.

2.6. Laboratory tests

To investigate the allelopathic effect of weed organs' extracts on germination of Azar2 wheat cultivar, wheat seeds were disinfected superficially by 70% ethanol for 1 minute and by 2.5% sodium hypochlorite solution for 3 minutes and then were washed four times by sterile distilled water. Twenty seeds were placed in Petri dishes with sterile filter paper inside and 5 ml of the extract were added on and incubated in 25 ± 1 ˚C in dark condition. Petri dishes were sealed with Parafilm for reducing evaporation. Seed germination percentage was recorded after 15 days incubation.

2.7. Greenhouse studies

Twenty wheat surface sterilized seeds were planted in pots (20 cm diameter) filled with autoclaved (121 ˚C, 15 minutes), sand, soil, peat (1:1:1) soil mixture and then incubated in a greenhouse at 25 ± 3 ˚C temperature and 70 ± 5% relative humidity. After four days, emerged plants were abated to 10 by selecting equally well-developed seedlings. Every three days, the seedlings were irrigated with 2.5, 5 and 10 % aqueous extracts of pigweed organs and plants irrigated with distilled water was considered as check plants. Fifteen days after, root and stem length and fresh and dry weight of wheat seedlings were measured.

2.8. Experimental design and data analysis

The experiment was conducted as factorial based on completely randomized design with three replications. The data were analyzed using GLM procedure by SAS software and Duncan's multiple range test was used for mean comparisons at 1% probability level.

3. Results and discussion

According to results of variance analysis (table 1), there was significant difference among different pigweed organs' extracts for root length and seedling fresh weight. The effect of pigweed extract

concentrations and the interaction of pigweed organs with extract concentration were significant on all growth related traits at 0.01 probability level.

Table 1: Mean squares of germination and growth related characteristics of Azar2 wheat cultivarin response to different concentrations of pigweed organs' extracts.

Source of variation	df	Mean squares				
		Germination	Root length	Stem length	Seedling fresh weight	Seedling dry weight
Weed organ	2	3.29 ^{ns}	599.15**	254.31^{ns}	0.1760**	0.00004^{n}
Extract concentration	3	66.47**	14400.31**	23591.39**	0.1752**	0.00082**
Organ*Concentration	6	2.2 ^{ns}	304.12**	1025.95**	0.0118**	0.00086**
Error	24	1.89	42.35	243.21	0.0010	0.00002
Coefficient of variation (%)		19.42	7.68	10.19	11.49	12.77

**, ns: significant at 1% probability level and non significant, respectively (Duncan's multiple range test).

3.1. Seed germination

Results showed high sensitivity of wheat (cv. Azar2) seeds germination to allelochemicals of pigweed organs extracts. Seed germination percentage was decreased substantially by 5 and 10% extract concentrations of pigweed organs (Fig.1). However, there was no significant difference between concentration of 2.5% and the control (distilled water). Seed germination inhibition caused by 10% concentration was considerable, so that only 20% of seeds were able to germinate (80% inhibition).

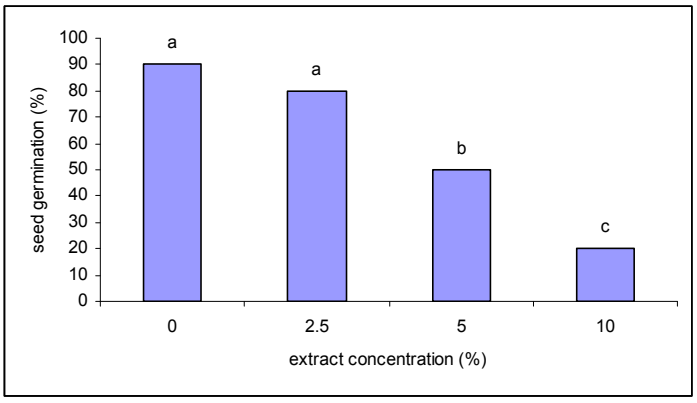

Fig. 1: Effect of different extract concentrations of pigweed organs on wheat (cv. Azar2) germination rate

3.2. Root length

Table (2) shows the effect of different concentrations of pigweed organs extracts on root length of Azar2 wheat cultivar. The results revealed an increased allelopathic effect of pigweed organs extracts with increasing their concentrations. Pigweed leaf, stem and root extracts at 10% concentration reduced wheat root length up to 74.51, 60.31 and 64.90%, respectively. In the other word, the most wheat root length inhibition was caused by pigweed leaf extract.

3.3. Stem length

According to the table (2), higher concentrations of pigweed organs' extracts caused more allelopathic effects on wheat stem length. Pigweed leaf extract at 10% concentration caused as high as 47.53% reduction in wheat stem length. The trait was also reduced by 10% concentration of weed stem and root extracts up to

54.71 and 53.47%, respectively. Results revealed that extract of all pigweed organs tested had much allelochemicals at 5 and 10% concentrations and they showed the same effect on wheat stem length, statistically.

Table 2: Means for root length, stem length and seedling fresh weight of Azar2 wheat cultivar in response to different extract concentrations of pigweed organs in greenhouse.

Pigweed organ	Extrac concentration (%)	Root length (cm)	Stem length (cm)	Seedling fresh weight (gr)
Leaf	0	134 ^{a}	195.33 ^{b}	0.34 ^{cd}
	2.5	89 ^{c}	179.33 ^{bc}	0.25 ^{ef}
	5	61.16 ^{ef}	113.50 ^{ef}	0.14 ^{g}
	10	34.16 ^{g}	102.50 ^{f}	0.7 ^{h}
Stem	0	140.66 ^{a}	244.33 ^{a}	0.37 ^{c}
	2.5	67.43 ^{de}	139.66 ^{de}	0.17 ^{g}
	5	62.50 ^{ef}	126.00 ^{ef}	0.15 ^{g}
	10	55.83 ^{ef}	110.66 ^{ef}	0.14 ^{g}
Root	0	144.33 ^{a}	226.33 ^{a}	0.68 ^{a}
	2.5	101.33 ^{a}	161^{cd}	0.45 ^{b}
	5	74.50 ^{d}	131.50 ^{ef}	0.29 ^{de}
	10	50.66 ^{f}	105.33 ^{f}	0.23 ^{f}

Means with the same letters are not significantly different at 5% probability level (Duncan's multiple range test).

3.4. Seedling fresh weight

According to the table (2), extracts of all tested three pigweed organs significantly reduced wheat seedling fresh weight at all concentrations studied. Based on the results, the trait inhibition was increased at higher pigweed extract concentrations, so that 10% leaf extract decreased wheat seedling fresh weight as high as 79.42%. Pigweed leaf, stem and root extracts caused the same statistical effect on wheat seedlings fresh weight at 5% concentration. However, leaf extract was more allelopathic than stem extract at 10% concentration. Stem extract was also more effective than root extract at this concentration.

3.5. Seedling dry weight

Figure (2) shows a decreasing trend of wheat seedlings dry weight by increasing concentrations of pigweed organs. All concentrations reduced the trait, significantly. Pigweed extract at 10 % concentration caused the most inhibition in wheat seedling dry weight as well as the other growth related traits measured.

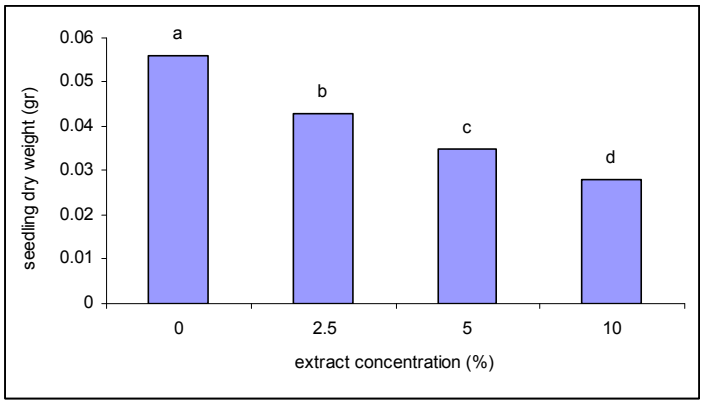

Fig. 2: Effect of different extract concentrations of pigweed organs on wheat (cv. Azar2) seedling dry weight

4. Conclusion

This study demonstrated that allepathic substances derived from pigweed organs such as Saponins, Phenolic and Benzoic acid compounds significantly reduced germination and growth of Azar2 wheat cultivar. Considerable reduction of wheat seeds germination by pigweed extracts have also been reported by other researchers (2). Extracts derived from different organs of pigweed have reduced corn and sugar beet seeds germination up to 60.8 and 53.4%, respectively (2). According to Mirshekari (2003), pigweed roots and

stems' extracts reduced germination and growth of sorghum plants. Significant inhibition of pigweed extracts on root growth of corn, beans and squash have also been reported (8). Allelopathic effect of pigweed extracts on seedling fresh weight of barley, canola, sugar beet and corn have also been reported (2).

Growing susceptible wheat cultivars to pigweed allelochemicals may results in an increased herbicides application rate duo to decreasing weed economic injury level (EIL). Based on the results, it seems that planting Azar2 cultivar may increase allelopathic induced damage of pigweed to wheat.

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