2011 3rd International Conference on Chemical, Biological and Environmental Engineering
IPCBEE vol.20 (2011) © (2011) IACSIT Press, Singapore

Tolerance of Five Sorghum Cultivars to Different Concentrations of Common Lambsquarters (*Chenopodium album*) Leaf Aqueous Extracts

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Abstract. To evaluate tolerance of five sorghum cultivars to common lambsquarters, *Chenopodium album*, leaf extract allelochemicals, an experiment was carried out as factorial based on completely randomized design with three replications. Experimental factors were sorghum genotypes compressing of three broomcorn (*Sorghum vulgare* var. *technicum*) landraces (Khaleseh, Galboos, Yengabad) and two *Sotghum bicolor* cultivars named Speedfid, and Kimia) and lambsquarters leaf extract concentrations at four levels (2.5, 5, 7.5 and 10%) and distilled water was considered as control. Germination and initial growth traits, including percentage of seed germination, radicle and plumule length, fresh and dry weight of seedlings were measured. Results of analysis of variance showed significant effects of factors and their interactions on all above mentioned traits. Germination and initial growth of all sorghum genotypes and cultivars were affected by lambsquarters extracts in all studied concentrations. Allopathic effect of the weed extracts on studied traits was increased with extract concentration increasing. Concentrations of 7.5 and 10% completely prevented germination of all sorghum studied genotypes. Kimia was the only cultivar that could germinate at 5% concentration. Khaleseh and Galboos were not able to germinate and to grow even at 2.5% concentration, and so were considered as the most susceptible cultivars. Consequently, Kimia was the most tolerant cultivar to allelochemicals of lambsquarters leaf extract. Also, Speedfid was more tolerant in germination, radicle length and seedling dry weight than Yengabad cultivar.

Keywords: allelopathy, Sorghum bicolor, Sorghum vulgare, broomcorn

1. Introduction

Allelopathy includes chemical reaction between plants. It is defined as beneficial or hazardous effects of an organism on the other one (1, 13). This phenomenon is an important mechanism in which plants disperse toxic substances in the environment as one of their competitive strategies. Allelochemicals were released in different ways such as leaching from plant tissues by rain and dew and excretion from plant roots (5). Allelopathy is an important environmental friendly approach to weeds control, to yield increase and herbicide application reduction (6, 12).

Weeds can disrupt crops germination and growth through allelochemical production (9). Up to 250 weed species cause serious problems in agriculture (14). Weeds have high competition potential due to good adaptation with the environment and so, they are one of the most important factors that reduce crop yield (3). Economic damage of weeds in the world has been reported over 100 billion dollars (15).

Lambsquarters, *Chenopodium album*, is considered as one of the world problematic weeds that cause serious damage to different crops (7, 16). After establishment in the field, lambsquarters increase its population rapidly as high seed production capacity. It is very resistant to drought stress and competes with crops by effectively moisture absorption from the soil. Lambsquarters have also high resistance to herbicides (16).

Allelopathic effect of lambsquarters is well known and it is responsible in increasing its damage to crops' yield. Extract of different organs of this weed contains allelochemicals such as Aldehydes, Alkaloids,

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Apocarotenoids, Flavonoids, Steroids, Xyloids, Clerogenic acid and Saponyns (15). The mentioned compounds reduce yield severely by influencing main physiological processes of crops (13).

In this study, the effects of extracts from lambsquarters leaves were evaluated on germination and initial growth of five sorghum cultivars to introduce tolerant cultivar to weed allelochemicals for reducing herbicide application rate.

2. Material and methods

2.1 Treatments

The research was carried out in Miyaneh Branch, Islamic Azad University laboratory as factorial based on completely randomized design with three replicates in 2010. The first factor consisted of five sorghum genotypes compressing of three broomcorn (*Sorghum vulgare* var. *technicum*) landraces (Khaleseh, Galboos, Yengabad) and two *Sotghum bicolor* cultivars named Speedfid, and Kimia, and the second factor was four *Chenopodium album* extract concentrations (2.5, 5, 7.5 and 10 percent) and distilled water was used as control.

2.2 Sampling and plant extract preparation

Lambsquarters were collected from fields of different crops in Miyaneh region and the weed leaves were blended after drying in 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 22 R centrifuge (Hettich, Germany) at 6000 rpm for 30 minutes at 10˚C and the obtained extract was considered as 10% concentration. Other concentrations (2.5, 5 and 7.5%) were prepared by adding distilled water.

2.3 Bioassay tests

Sorghum 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 sorghum seeds were placed in Petri dishes with sterile filter paper inside and 5 ml extract were added on and incubated in 25 ± 1 ˚C in dark condition. Petri dishes were sealed with Parafilm for reducing evaporation and microbial contamination. Seed germination percentage, radicle and plumule length and seedling fresh and dry weight were recorded after 15 days incubation.

2.4 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 the results, the effect of lambsquarters extract concentrations (Factor A), different sorghum cultivars (Factor B) and their interaction (A*B) on all measured traits including seed germination percentage, radicle and plumule length and seedling fresh and dry weight was significant at 1% probability level (Table 1).

Table 1. Mean squares of common lamsquarters extracts effect on germination and growth related characteristics of sorghum cultivars

Source of variation	Germination percentage	Radicle length	Plumule length	Seedling fresh weight	Seedling dry weight
Extract concentration	391.89**	428.41**	332.27**	0.047**	0.002**
Cultivar	35.98**	13.17**	21.15**	0.059**	0.003**
Concentration * Cultivar	22.52**	14.45**	13.30**	0.039**	0.002**

Error	0.16	0.27	0.30	0.0002	0.00002
Coefficient of variation (%)	11.97	17.35	19.36	2.22	0.71

**: significant at 1% probability level (Duncan's multiple range test)

According to table (2), all concentrations of lambsquarters leaf extract significantly reduced all characteristics studied. In all cultivars, germination rate and growth were reduced with increasing extract concentration, so that 7.5 and 10 percent concentrations completely prevented germination and growth of all sorghum cultivars. Lambsquarters extract was also very allelopathic even at 5% extract concentration, so that germination and growth of all cultivars, except Kimia, were completely inhibited. The extracts significantly reduced germination and initial growth of sorghum cultivars compared to check plants, even in the most diluted concentration (2.5 percent). Khaleseh and Galboos was not able to germinate even at the lowest concentration tested, and so were considered as the most sensitive cultivars to allelopathic materials of *C. album* extracts. Kimia was the most tolerant cultivar in terms of germination percentage, radicle and plumule length and seedling fresh weight, but it was in the same statistical group as Spidfid cultivar. Spidfid was also more tolerant than Yengabad in terms of seed germination percentage, radicle length and seedling dry weight.

On the whole, results of this research revealed considerable allelopathic effects of lambsquarters extracts on germination and initial growth of sorghum cultivars studied. According to Alam *et al.* (2001), weed extracts allelochemicals such as Tripenoids, Phenypropanoids, Quinons, Kumaryns, Flavonoids and Tannins which are generally releasing into the environment by means of discretion by plants and leaching, influence physiological processes of crops and severely reduce plants growth. Existing allelopathic materials such as Aldehydes, Alkaloids, Carotenoids, Flavonoids, Steroids and Saponins are well known in lambsquarters extract (8) and it have been demonstrated that the mentioned compounds could reduce yield through influencing main physiological processes of plants (10).

Chaniago *et al.* (2006) reported that allelopathic rate of weeds extract is related to its concentration. In the other word, increasing weed extract concentration could cause more reduction in plant respiration at germination stage and resulting in a reduced germination percentage.

Other researchers also demonstrated allelopathic effects of *C. album* on crops. According to Letournea *et al.* (1956), two grams lamsquarters dry matter in 100 ml water reduced wheat radicle length. In another experiment, lamsquarters extract did not have significant effect on wheat germination, but it reduced root and stem length and seedling dry weight (2). Anaya *et al.* (1987) also reported significant inhibition of lamsquarters extract on root growth of corn, beans and squash. Extracts of *C. album* also reduced seed corn and sugar beet germination and fresh weight of wheat, winter barley and rapeseed (8).

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Table 2. Mean comparisons of allelopathic effect of lambsquarters extracts on germination and initial growth of sorghum cultivars

Cultivars	Concentration (%)	Germination (%)	Radical length (mm)	Coleoptil length (mm)	Seedling fresh weight (gr)	Seedling dry weight (gr)
Spidfid	0	90 ^{b}	65.2 ^{c}	75.45 ^{b}	0.139 ^{b}	0.032 ^{b}
Kimia	0	90 ^{b}	61.87 ^{c}	57.50 ^{c}	0.133 ^{b}	0.021 ^{cd}
Khaleseh	0	100 ^{a}	121.42 ^{a}	88.43 ^{a}	0.092 ^{c}	0.016 ^{d}
Galboos	0	91.66 ^{ab}	107.64 ^{b}	76.26 ^{b}	0.083 ^{cd}	0.017 ^{d}
Yengabad	0	98.33 ^{a}	124.64 ^{a}	81.57 ^{ab}	0.30 ^{c}	0.019 ^{d}
Spidfid	2.5	43.33 ^{d}	3.24 ^{g}	3.77 ^{f}	0.058 ^{de}	0.034 ^{b}
Kimia	2.5	55 ^{c}	22.37 ^{e}	34.19 ^{e}	0.103 ^{c}	0.028 ^{b}
Khaleseh	2.5	0 ^{f}	0 ^{h}	0 ^{g}	0 ^{f}	0 ^{e}
Galboos	2.5	0 ^{f}	0 ^{h}	0 ^{g}	0 ^{f}	0 ^{e}
Yengabad	2.5	30 ^{e}	9.49 ^{f}	3.05 ^{f}	0.039 ^{e}	0.019 ^{d}
Spidfid	5	0 ^{f}	0 ^{h}	0 ^{g}	0 ^{f}	0 ^{e}
Kimia	5	58.33 ^{c}	40.34 ^{d}	47.11 ^{d}	0.77 ^{a}	0.165 ^{a}
Khaleseh	5	0 ^{f}	0 ^{h}	0 ^{g}	0 ^{f}	0 ^{e}
Galboos	5	0 ^{f}	0 ^{h}	0 ^{g}	0 ^{f}	0 ^{e}
Yengabad	5	0 ^{f}	0 ^{h}	0 ^{g}	0 ^{f}	0 ^{e}
Spidfid	7.5	0 ^{f}	0 ^{h}	0 ^{g}	0 ^{f}	0 ^{e}
Kimia	7.5	0 ^{f}	0 ^{h}	0 ^{g}	0 ^{f}	0 ^{e}
Khaleseh	7.5	0 ^{f}	0 ^{h}	0 ^{g}	0 ^{f}	0 ^{e}
Galboos	7.5	0 ^{f}	0 ^{h}	0 ^{g}	0 ^{f}	0 ^{e}

Yengabad	7.5	0 f	0 h	0 g	0 f	0 e
Spidfid	10	0 f	0 h	0 g	0 f	0 e
Kimia	10	0 f	0 h	0 g	0 f	0 e
Khaleseh	10	0 f	0 h	0 g	0 f	0 e
Galboos	10	0 f	0 h	0 g	0 f	0 e
Yengabad	10	0 f	0 h	0 g	0 f	0 e

means with the same letters in each column have no significant difference at 1% probability level