The study of Allelopathic potential in three species of *Glaucium* Mill. on *Sinapis arvensis* L.

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Abstract

Charlock (*Sinapis arvensis* L.) is a serious *weed* of agriculture, especially in spring sown crops. Genus *Glaucium* Mill. belongs to Papaveraceae and members of this genus have several alkaloids in laticiferes. The present research focuses on effects of aquatic extract of *Glaucium oxylobum*, *G. elegans* and *G. grandiflorum* on many physiological factors of Charlock. Laboratory studies were conducted to determine the seed germination and growth factors in charlock as affected by water soluble constituents of three species of *Glaucium*. Aboveground tissues of these plants were collected during flowering stage and dried. Five concentrations of aqueous extracts were used: full- strength (33.3 g lit^{-1}), three-fourth - strength (25 g lit^{-1}), half- strength (16.7 g lit^{-1}) and quarter- strength (8.3 g lit^{-1}) and blank (0 g lit^{-1}). Charlock seeds were placed in petri dishes containing the *Glaucium* extracts, or distilled water (control). Seed germination percent was calculated after ten days. In general seed germination of Charlock declined progressively with increasing concentration of the *Glaucium* extracts. According to our results, with increasing concentration of aqueous extract, Charlock growth factors such as root and shoot length, root and shoot fresh and dry weight were inhibited.

Keywords: alkaloid; allelopathy, *Glaucium*; growth factors; seed germination; *Sinapis arvensis*

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Introduction

Weed is a serious problem that damages most of the crops (Samad et al., 2008). Charlock (*Sinapis arvensis* L.) is a serious weed of agriculture, especially in spring sown crops. It is frequently found growing in colza fields (Haddadchi and Massoodi Khorasani, 2006) and it is more of a problem in spring-sown than autumn-sown crops (Clapham, 1987).

Allelopathy as a mechanism of plant interference in agro-ecosystems offers an opportunity to manage weeds in a crop sequence, but could also adversely affect crop yields and influence choice of rotation. Chemicals with allelopathic activity are present in many plants and in organs, including leaves, flowers, fruits and buds (Ashrafi et al., 2007, 2008; Inderjit, 1996; Mahall and Callaway, 1991; Putnam and Tang, 1986). Allelopathy is in fact an interference mechanism in which live or dead

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plant materials release chemical substances, which inhibit or stimulate the associated plant growth. Several researchers have shown that allelopathy plays an important part in weed and weed interaction (Jabeen and Ahmed, 2009).

Recent studies pay attention to allelopathic potential of *Glaucium oxylobum* Boiss. & Buhse, *G. elegans* Crantz and *G. grandiflorum* Boiss. & Huet on seed germination and root, shoot length as well as root, shoot fresh and dry weight of Charlock. Members of *Glaucium* contain several alkaloids in laticiferes such as *G.oxylobum*. Four major alkaloids include protopine, bulbocapine, corydine, isocorydine and three minor alkaloids are dihydrochlerythrine, angoline, isocorytuberine (Hadjiakhoondi et al., 1999). *G. elegans* contain aporphin group (glaucine, isoboioidine, isocorydine and corydine), protopine group (protopin and allocryptopin) and benzophenanthridine group (chelidonin, sanguinarine, chlerythrine, chlirubine) (Yakhontova et al., 1975). *G. grandiflorum* also contain alkaloids such as norchelidonine, dihydrochelerythrine, 8-acetonyldihydrochelerythrine, protopine, allocryptopine, tetrahydrojattorrhizine (coryplamine) and tetrahydropalmatine (El-afifi et al., 1986).

The purpose of this study was to determine the possible allelopathic effects of *Glaucium* on germination and growth factors *Sinapis arvensis* L.

Materials and Methods

To study the allelopathic effects of *Glaucium* aqueous extract on seed germination and seedling growth of *Sinapis arvensis* L., an experiment was carried out in Physiology Laboratory, Department of Biology, Islamic Azad University, Gorgan Branch, Iran. For breaking of dormancy in seeds, we applied several materials, namely, GA (10ppm, 300ppm, 1000ppm, 2000ppm); H_2SO_4; HCl and KNO_3 (0.28%). Charlock seeds were first surface-sterilized in 96% ethyl alcohol for 5 min and sterile seeds were imbibed in 10 mm of materials for 24 hr at 0° C, and afterward washed thoroughly to remove the external source of materials. The best result for breaking of dormancy was observed in GA (1000ppm) (Haddadchi and Massoodi Khorasani, 2006). Fifty seeds were incubated in extracts.

Glaucium oxylobum, *G. elegans* and *G. grandiflorum* plants were gathered in spring 2007-2008 from several places in north of Iran, and dried under shade for a few days. All of the specimen were saved and deposited in herbarium of Islamic Azad University, North Tehran Branch (*Glaucium oxylobum* 4007- IAUNT, *G. elegans* 4000- IAUNT, and *G. grandiflorum* 4002- IAUNT). The well dried plants were chopped into about 3 cm pieces with fodder cutter. Chopped plant material was dried in an oven at 90°C for 24 h (Shimifan LO-141). The oven dried shoots was ground in a grinder. 10 g of dried shoots was weighed (Scale: Mettler college -1300) and soaked in distilled water (300ml) at 70° C and then placed for 24h in water bath (Behdad-80004) at 60° C. The water extract was obtained by filtering the mixture (herbage and water) through filter paper and then diluted with distilled water to prepare different concentrations according to the treatment (Narwal, 1999). Petri dishes were given a thorough washing with detergent using hot water as precautionary measure against pathogens and pollutants. *Glaucium* water extracts were diluted with distilled water to prepare solutions of different concentrations (v/v): 25, 50, 75 and 100%. For control treatment only distilled water was used. Fifty seeds of *Sinapis arvensis* were put in each petri dish after removing of dormancy. Overall 3 dishes were used in the experiment (3 replications) in completely randomized design. Filter paper (Whatman) was used as medium of germination. Five ml of solution was applied to the dishes and the control treatment received 5 ml of distilled water. The outer filter paper was removed just before the initiation of germination. Both treated and control Petri dishes were kept continuously moist by applying distilled water or extracts, whenever needed. The dishes were kept at seed chamber temperature (20° C±2) for seed germination in the Physiology Laboratory (Iran-khodsaz, I K H- RH). Germination counts were recorded daily for a period of 10 days. Root and shoot length was recorded using a ruler. Fresh and dry weight of shoot and root were measured using a scale (GF-600), after 10 days.

Statistical analysis

The data were analyzed using Analysis of Variance (ANOVA) test. A one-way ANOVA was performed on all results. Probabilities of less than 0.05 were considered statistically significant. Differences between means were determined using Duncan compromise test. The software SPSS (Ver. 17) was used to conduct all the statistical analysis.

Results

Extracts from shoot of *Glaucium*, greatly inhibited Charlock seed germination at all concentrations when compared with the water control. Germination and growth factors of Charlock was significantly ($P \leq 0.005$) reduced by dried shoot extracts of *Glaucium* (Tables 1, 2 and 3). The highest inhibition in seed germination (up to 98.67%) was observed in concentration (100%) while the lowest (up to 44.67%- 81.34%) was recorded in concentration (25%). The extracts not only reduced the seed germination but also shoot and root length and fresh and dry weight of shoot and root (Tables 1-3). Our results showed that allelochemicals in *Glaucium* have significant effect on seed germination percentage and germination index.

Discussion

Shoot aqueous extract of *Glaucium* had a clear reduction effect on the seedling growth characteristics in *Sinapis arvensis*. The results of this study suggest that dried shoot of *Glaucium*

Table 1
Allelopathic effect of *Glaucium oxylobum* water extract on the germination and seedling growth of *Sinapis arvensis*

Parameter	Percentage of Germination	Root Length (mm)	Shoot Length (mm)	FW.Root (mg)	DW.Root (mg)	FW.Shoot (mg)	DW.Shoot (mg)
0%	80a	18.33a	21.66a	48.37a	2.19a	76.57a	5.84a
25%	36.66b	5.66b	16.66b	6.64b	0.28b	27.72b	2.31b
50%	26c	1.66c	3.66c	1.53c	0.06bc	4.43c	0.32c
75%	6.66d	1.33c	0.66c	0.28cd	0c	0d	0c
100%	1.33d	0.5c	0c	0d	0c	0d	0c

Table 2
Allelopathic effect of *Glaucium elegans* water extract on the germination and seedling growth of *Sinapis arvensis*

Parameter	Percentage of Germination	Root Length (mm)	Shoot Length (mm)	FW.Root (mg)	DW.Root (mg)	FW.Shoot (mg)	DW.Shoot (mg)
0%	71.33a	28.33a	18.33a	38.95a	0.31a	32.33a	1.39a
25%	18.66b	1.33b	1.33b	0.48b	0.003b	0.55b	0.029b
50%	12.66b	1.25b	0.66b	0.4b	0b	0.19b	0.008b
75%	11.33b	0.91b	0.33b	0.19b	0b	0.08b	0b
100%	1.33c	0.5b	0b	0b	0b	0b	0b

Table 3
Allelopathic effect of *Glaucium grandiflorum* water extract on the germination and seedling growth of *Sinapis arvensis*

Parameter	Percentage of Germination	Root Length (mm)	Shoot Length (mm)	FW.Root (mg)	DW.Root (mg)	FW.Shoot (mg)	DW.Shoot (mg)
0%	80a	51.66a	45a	52.74a	2.65a	80.57a	10.29a
25%	55.33b	5.66b	11.66b	4.39b	0.2b	14.84b	1.84b
50%	20.66c	4bc	4.66c	1.09c	0.05b	2.75c	0.24c
75%	8.66d	1.66cd	1c	0.18c	0b	0.19d	0c
100%	1.33d	0.5d	0c	0c	0b	0d	0c

contain water-soluble allelochemicals which could inhibit seed germination and seedling growth of Charlock. Similar findings were also reported by Chun-Mei et al. (2008) as they showed that rhizome, stem and leaf of ginger could inhibit seed germination and seedling growth of soybean and chive. Also Yarnia et al. (2009) found sorghum extract treatment decreased height, shoot and root dry weight and biomass of *Amaranthus retroflexus*. Mortality of the seedlings and reduced vigor under laboratory conditions indicated the accumulation of toxic substances (allelopathic potential) of the donor plant is harmful to the growth of seedlings of receptor plants. These findings correlated with the report of Uddin et al. (2007), Khanh et al. (2005), Mubaraki et al. (2009), Siddiqui et al. (2009) and Maharjan et al. (2007). These results suggest that *Glaucium* has a long-term potential to reduce the growth of plants (i.e., allelopathicity). This response could be attributable to a greater contribution of allelochemicals from shoots. The presence of allelochemicals like alkaloids in *Glaucium*, may be the reason for poor germination and other growth factors of *Sinapis arvensis*. Several studies found that alkaloidal compounds or extracts from plants are responsible for many allelopathic effects (Elakovich et al., 1996; Petroski et al., 1990; Wink, 1983). From the present study it was concluded that various applications of *Glaucium* can be successfully used in weed control, especially for *Sinapis arvensis* in farms. It can also be concluded that *Glaucium* water extract at higher and lower concentrations suppressed the germination, root and shoot growth and root and shoot fresh and dry weight of Charlock and this suppression was possibly due to the presence of allelochemicals in *Glaucium* plant. Although it was a preliminary laboratory study, it provided encouraging results and a basis for future research.

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