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Allelopathic Effects of Sunflower (*Helianthus annuus* L.) On Germination and Seedling Growth of Wheat (*Triticum aestivum* L.)

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Abstract: The allelopathic influence of water extracts of sunflower on wheat's germination and seedlings growth have been evaluated. It was observed that sunflower water extracts at a concentration of 25, 50, 75 and 100% showed inhibitory effect on wheat germination and the effect differed significantly in all the treatments. The growth of wheat seedlings was found significant in terms of root and shoot lengths and non-significant for fresh and dry weights in comparison to the control. Chemical composition of wheat seedlings influenced by four sunflower water extracts indicated a significant change in the starch contents in all the treatments in comparison to the control. A similar trend was also found in the protein and phosphorus contents. Potassium contents of wheat seedlings were decrease gradually except at 75% concentration. Whereas ash contents increased in 25 and 75% concentration and decreased in 50% and 100% concentrations suggesting the stimulatory and inhibitory potencies of sunflower water extracts at different concentrations. It is concluded that the degree of inhibition was dependent upon the concentration of the extract. The chemical parameters like starch, protein, phosphorus, potassium and ash were also reduced confirming the influence of water extracts of sunflower at various concentrations.

Key words: Sunflower, wheat, allelopathic effects

Introduction

Allelopathic chemicals are secondary plant metabolites that have role in plant-plant, plant-soil, plant disease, plant-insect and plant predator interactions that may be beneficial or detrimental to the plant (Tang *et al.*, 1989). The interaction of woody perennial and agricultural crops when sown as mixed or inter or in rotation results in inhibition or stimulation of the growth of the crops. This process involves the release of chemicals into the ecosystem. These chemicals have harmful effects on the crop in the ecosystem resulting in the reduction and delaying of germination, mortality of seedlings and reduction in growth and yield (Rice, 1984; McWhorter, 1984). Sunflower (*Helianthus annuus* L.) is a high quality vegetable oil crop which is not strictly season bound and can be grown twice a year in Pakistan. Being a potent allelopathic in nature, its effects on subsequent crop and weeds have been reported (Leather, 1983; Mehboob, 1999). Wheat (*Triticum aestivum* L.) is a very important economical crop of Pakistan with a very low yield per hectare. The lower yield per hectare may be due to poor germination and residual effects of neighboring allelopathic plants like sunflower, mungbean and sorghum. Seed germination is the basic parameter which determines the final stand of plant and reflects the response of species to their immediate environment (Rice, 1984; Waller *et al.*, 1993; Duke, 1985).

The purpose of the present investigation is to evaluate the allelopathic potential of sunflower on wheat seedlings and their quality parameters when grown under laboratory conditions.

Materials and Methods

Mature plants of HYSUN 33 sunflower variety were obtained from experimental fields of University of Agriculture, Faisalabad. They were dried for 30 days and ground and stored at room temperature. Healthy seeds of Inqalab-91 wheat variety were obtained from Institute of Wheat Research, Faisalabad in 1999.

Preparation of Sunflower Water Extracts: The ground plant material was dissolved in distilled water in the ratio of 1:20 and kept for 24 hours. The filtrate was designated as stock solution of 100% concentration. From this stock solution other concentrations of 25, 50 and 75% were made by diluting it with distilled water and the control contained only distilled water (Hussain and Gadoon, 1981).

Wheat Germination and Seedlings Growth: Ten seeds of Inqalab-91 wheat variety were grown in petri dishes of 9 cm diameter replicated four times in completely randomized design. Whatman No. 42 filter paper was used as medium of germination. In total, 4 cm^3 of solution was applied, half (2 cm^3) of which was used as moisture for filter paper receiving seeds in the dishes and remaining half was applied to the covering filter paper. The control treatment received 4 cm^3 of distilled water in the same fashion. Both control and treated petri dishes were kept moist by applying distilled water whenever needed. The dishes were kept at $25 \pm 3^{\circ}C$ for seed germination in the laboratory and germination counts were recorded daily for a period of eleven days. Root and shoot lengths in cm and fresh and dry weights in g were also recorded (Hussain and Gadoon, 1981).

Seedling Quality: Quality parameters like starch, protein, K, P and ash were determined following A.O.A.C. methods (AOAC, 1994).

Statistical Analysis: Completely randomized design (CRD) was used to analyze the data and compared the concentration ratios. Regression effect of germination on time was studied by fitting regression lines (Steel and Torrie, 1992).

Results and Discussion

The germination of Inqalab-91 wheat variety have been influenced by different Hysun-33 sunflower water extracts treatments and reported in Table 1. It can be seen that treatments 25 and 50% Sunflower Water Extract (SWE) showed inhibitory effect but to a lesser extent as compared to control. Seed germination in 75 and 100% SWE treatments showed 5.129 and 7.69% decrease. These findings are in line with the studies reported earlier, which explained that increasing the extract concentration results a corresponding increase in growth inhibition (Darrel, 1995).

Table 1: Seedling phenology of eleven days old wheat effected by sunflower water extract (SWE)

Treatment	Germination (%)	Shoot length (cm)	Root length (cm)	Fresh weight (g)	Dry weight (g)
0%	*97.5 a	7.528 a	5.808 a	1.258 a	0.503 a
25%	95.0 b	7.00 b	5.688 a	1.133 a	0.433 a
50%	95.0 b	6.245 c	5.44 b	1.288 a	0.545 a
75%	92.5 c	6.113 c	5.195 c	1.078 a	0.420 a
100%	90.0 d	6.045 c	4.352 d	0.925 a	0.365 a

*Each value is a mean of four replications. The values showing the same letters are not significant at 5% level.

Table 2: Chemical composition of eleven days old wheat seedlings effected by sunflower water extract (SWE)

Treatment (SWE)	Starch (%)	Protein (%)	Phosphorus (%)	Potassium (%)	Ash (%)
0%	*56.94	9.216	0.94	0.102	1.387
25%	41.88	8.944	0.76	0.042	1.52
50%	36.44	7.008	0.60	0.031	1.28
75%	29.66	4.896	0.64	0.29	1.191
100%	27.866	2.796	0.31	0.012	1.09

The shoot lengths of wheat seedlings as influenced by sunflower water extract (SWE) treatments have also been shown in Table 1. It was observed that reduction in shoot length was 17.04, 18.08 and 19.7% with 5, 75 and 100% SWE concentrations respectively in comparison to the control. 25% SWE treatment exerted inhibitory effect but to a lesser extent than those of the higher concentrations. This gradual decrease in the shoot length was due to allelopathic effects of the extracts and supporting the earlier findings of Tongma *et al.* (1998) who also reported that shoot and root growth of the test plant species decreased when grown with sunflower.

The root length of wheat seedlings have been significantly effected Table 1 by all treatments of SWE. Application of 100% SWE decreased the root length of wheat upto 25.07% as compared to the control. Maximum root length have been found in the control treatment and then there was a gradual reduction and this reduction of root length in wheat can be due to the presence of inhibitory allelochemicals in SWE treatments. Anderson *et al.* (1978) have also observed that extracts of whole sunflower plant significantly inhibited both radical and shoot length growth of wheat and concluded that treatments differed in the degree of inhibition. The data presented in Table 1 revealed a non-significant difference in the fresh and dry weights of wheat seedlings under the influence of SWE treatments in comparison to the control. The protein contents of wheat seedlings grown in 25, 50, 75 and 100% SWE treatments were 8.49, 7.01, 4.896 and 2.98% respectively in comparison to the control Table 2. The decrease in protein contents in four treatments can be due to the activity of allelochemicals and the higher contents of protein found in the control are related to the more germination of the seedlings (Alsaadawi *et al.*, 1985). A similar decreasing trend was found with starch contents as compared to the control. Control treatment showed 50.94% starch contents, whereas they were 41.88, 36.44, 29.66 and 27.80% at 25, 50, 75 and 100% SWE concentrations Table 2. Inhibitory effect on starch contents due to allelochemicals confirm the earlier findings of Pirog (1993).

The chemical analysis of phosphorus contents in wheat seedlings under the influence of SWE treatment has been reported in Table 2 which indicated that quantity of phosphorus contents gradually decreased and were 0.76, 0.60% and 0.31% in 25%, 50 and 100% SWE treatments respectively but increase in 75% SWE treatment in comparison to the control treatment. These findings revealed that allelochemicals present in SWE treatments influenced the amount of phosphorus contents in wheat seedlings (Alsaadawi *et al.*, 1985).

A similar trend of potassium contents of wheat seedlings under the influence of SWE treatments have been reported in Table 2. It can be observed that potassium contents in 75% SWE treatment were more than 100% SWE treatment. The percentage of ash contents were 1.387, 1.52, 1.28, 1.91 and 1.09% in 25, 50, 75 and 100% SWE treatments Table 2. The increase or decrease in the amount of ash contents can be due to the presence of allelochemicals in SWE treatments and also depend on the status of mineral contents and seedlings phenology in general (Pirog, 1993). The results of wheat seedlings phenology and quality revealed that SWE inhibited the germination, root and shoot lengths, fresh and dry weights and also decreased protein, starch, phosphorus, potassium and ash contents of wheat seedlings.

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