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BIOHERBICIDAL ACTIVITY OF SOME WINTER WEEDS AGAINST SOME CROPS

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ABSTRACT

The study aims at investigating the allelopathic effects of twelve weed species including Anagallis arvensis, Plantago lanceolata, Medicago polymorpha, Ammi visnaga, Phragmites australis, Silybum marianum, Emex spinosa, Malcolmia africana, Calendula arvensis, Rumex crispus, Fumaria indica and Cirsium arvense on seed germination, seed inhibition, seed germination time, seed germination index and seed vigor index of the test crops (wheat, maize and sunflower). A laboratory experiment was laid out in a completely randomized design in March 2010 in the Department of Weed Science, The University of Agriculture, Peshawar, Pakistan. Rumex crispus inhibited the seed germination up to 80% and 70% in both wheat and sunflower, respectively while the seed of maize showed high tolerance against all extracts except Fumaria indica extract that inhibited the maize seed germination up to 40%. In the present study, sunflower proved more susceptible to all extracts and maize was more tolerant to the phytotoxicity of all the weeds.

Key words: Allelopathy, bioherbicide, crops, germination, seedling vigor index, weeds.

INTRODUCTION

Allelopathy has broadly defined as the direct or indirect stimulatory or inhibitory influence of one plant on other plant through the production of chemical compounds (allelochemicals) that escape into the environment. It is derived from the two Greek words "allelo" and "pathy" which means the reciprocal effects between two organisms especially plants (Rice, 1984; Lawrence *et al*., 1991). Allelochemicals are released by different plant parts (viz. flower, stem, root exudation, residue decomposition, volatilization and other processes) in both natural and agricultural systems (Ferguson and Rathinasabapathi, 2003). Allelopathic plants interfere with neighboring plants by releasing water soluble chemicals into the soil that inhibit seed germination, plant growth and nutrients uptake (Batish *et al*., 2007; Abhilasha *et al*., 2008). It has been reported that majority of the weed species have inhibitory allelopathic effects on crops but some weed species also showed stimulatory effects on seed germination, growth and yield of crops (Narwal, 2004). Weed crop competition exist for moisture, nutrients, space and light and thus

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adversely affect crop yields (Kadioglue *et al.,* 2005). Various parts of same weed have different allelopathic effects on germination and growth of crop (Aziz *et al.,* 2008).

In Pakistan, weeds pose a serious problem in crop production. This includes lack of education and financial resources because the smaller farmers cannot afford the cost of weed management practices for crop improvement. Weeds growing among crop plants adversely affect yield and quality of the harvest and increase production costs, resulting in high economic losses (Alam, 1991). In sub-continent, wheat, maize and sunflower are main crops grown due to climatic suitability and due to their direct consumption for nutritional purpose as wheat and maize are major staple food while, sunflower are grown for oil purpose. Researchers of the region are mainly focusing on all the possible yield reducing factors in the studied crops. Among the various yield reducing factors in crops the one most important factor is their seed germination failure. This failure is mainly assigned with accumulation of weeds extract/debris (allelochemicals) present in soil that leaches in soil through ploughing or rain water. This study was carried out to investigate the phytotoxicity of different weed extracts on seed germination and relative parameters of different crops.

MATERIALS AND METHODS

Experimental site and design

The experiment was carried out at Weed Science Laboratory, The University of Agriculture Peshawar, Pakistan during March 2010. The experimental design used was the Completely Randomized Design and each treatment having three replications. The wheat variety (Atta Habib), the maize variety (Azam) and the sunflower were used as study crops.

Weeds collection

Mature plants of twelve commonly found weed species: *Anagallis arvensis, Plantago lanceolata, Medicago polymorpha, Ammi visnaga, Phragmites australis, Silybum marianum, Emex spinosa, Malcolmia africana, Calendula arvensis, Rumex crispus, Fumaria indica, Cirsium arvense* were collected from the New Developmental Farm, The University of Agriculture Peshawar, Pakistan in March 2010. These whole plant samples were collected by cutting them using a manual cutter at soil level. All the plants were gently washed of dust and attached debris using tap water. The samples were put in paper bags and oven dried (65^{o}C for 72 hours). All the plant samples were ground into powder with a grinder and kept in paper bags under room temperature. After grinding an aqueous extract solution were made from each sample with a ratio of 4:60 (4 g sample and 60 ml distil water) and kept for 24h at room temperature.

Experimental detail

Ten seeds of each wheat, maize and sunflower were put separately in petri dishes of 9cm diameter containing three layers of Whatman No.1 filter paper. Three mL of the prepared extract was applied to each petri dish while tape water was applied to the petri dishes containing the control treatment. The experiment was run at 32^{o}C temperature.The experiment was regularly visited and the extracts were added when needed.

Parameters recorded

The seed germination data were recorded on daily basis for a week. After seven days of the experiment, the following parameter were calculated by using the formulae,

Mean Germination Time (MGT) and Germination Index (GI) both were calculated by using the formulae of Ellis and Roberts (1981) and Kendrick and Frankland (1969).

$$MGT = \sum Dn/\sum n$$

Where n= number of seeds germinated on day D (where D is the number of days since the sowing of seeds)

GI = total seed germination percent/time (in hours) taken for 50% seed germination

The seedlings vigor index (SVI) was calculated using the formula of Abdul-Baki and Anderson (1973).

SVI = percent seed germination X shoot length (cm)

The seed inhibition percentage was calculated using the formula of Hong *et al*. (2003) as under:

Inhibition (%) = (1-(sample extracts/control) x 100.

$$\text{Seed germination (\%)} = \frac{\text{Number of seed germinated}}{\text{Total number of seed}} \times 100$$

RESULTS AND DISCUSSION

Seed germination and inhibition (%)

The results depicated that different weed extracts significantly affect seeds germination of the tested crop species. The data in Table-1 showed that maximum percent germination of wheat was recordedunder the aqueous extract of *Plantago lanceolata* L. (90%) as compared to control (100%). The percent germination of wheat was highly suppressed under aqueous extract of *Rumex crispus* L. (20%*)* and *Phragmites australis* (cav.) Trin. (30%). The germination of maize was 100% under the aqueous extract of *Plantago lanceolata*L. and 90% each in *Anagallis arvensis* L., *Medicago polymorpha* L., *Phragmites australis* (Cav.) Trin. and *Silybum marianum* (L.) Gaertn. assigned treatments while 100% seed germination was recorded under the untreated check (Table-2). Aqueous extract of *Fumaria indica* (Hausskn.) Pugsley*.* highly suppressed the maize germination (60%). Similarly in case of sun flower the untreated seeds (control)

germinated comparatively quickly and 100 % followed by *Medicago polymorpha* L. (70%) and *Plantago lanceolata* L. (60%) assigned treatments (Table-3). The lowest germination was observed under the aqueous extract of *Rumex crispus* and *Cirsium arvense* (30%) each (Table-3).

The percent inhibition is the reciprocal of percent germination i.e. the treatments having high percent germination will have low percent inhibition percent and vice versa. The overall germination data showed that *Plantagolanceolata* and *Medicago polymorpha* aqueous extracts having low phytotoxicity against all the tested crop seeds while *Rumex crispus* and *Fumari aindica* were highly toxic. The germination inhibition may be due to the release of phytotoxins (allelochemicals) from the decaying materials that remain active and stable for considerable duration in soil (Burhan and Shaukat, 1999). Allelochemicals are synthesized in certain specialized organs of donor plants as secondary metabolites (Kobayashi, 2004). Leaching from different parts of various weeds significantly influenced the germination, radical and plumule extension of field crops (Singh *et al*., 1989). The present results are also in agreement with findings of Kadioglue *et al*. (2005). Shaukat and Siddiqui (2001) reported that inhibitory compounds present in the soil cause marked reduction or stop growth of plant.

Mean germination time

The value of MGTexpresses the rapidity of the germination when lower the value of the mean germination time faster will be the germination. The analysis of the data indicated that the lowest value of MGT for wheat was recorded in control treatment (0.5) while the highest (4) were observed in the treatment under the aqueous extract of *Anagallis arvensis* L. (Table-1). Likewise in maize the MGT value was lower in the control treatment (2.9) whereas the highest value of 4.2 was observed in treatment assigned to the extract of *Phragmites australis* which was statistically at par with *Medicago polymorpha*, *Silybum marianum* and *Emex spinosa* with mean germination time of 4.1, 4 and 4 respectively (Table-2). Like wheat and maize, sunflower also showed the lower value (0.2) of MGT in control treatment while the highest was observed under the aqueous extract of *Anagallis arvensis* (4; Table-3). The present study findings showed strong uniformity with those of Meihua *et al*. (2006). The results are also in line with those of Stavrianakou *et al*. (2004). They reported that different weed extracts possessed the ability to inhibit the germination and GI of lentil and chickpea.

Germination index

The GI is directly correlated with seed germination percentage. Thus greater the value of GI, the greater will be germination percentage. The present findings revealed that different weeds

extracts significantly affect the germination index as compared to control treatments. The results of present experiment revealed that the high value for GI in wheat, maize and sunflower was 4, 4.5 and 4.7 respectively were noticed in control treatments while the lowest values of wheat (0.6) under extract of *Rumex crispus* (Table-1), maize (2.9) under extract of *Malcolmia africana* (Table-2) and sunflower (0.8) under extract of each *Rumex crispus* and *Cirsium arvense* (Table-3). The present results are strongly supported by findings of Khan *et al*., 2005. Similarly Tanveer *et al*. (2008) also stated that minimum germination percentage and germination index of rice was noticed when applied with leaf extracts of *Xanthium strumarium* L. Datta and Bandopadhya, 1981: Tripathi *et al*., 1981 and Angiras*et al*., 1988) also reported that the species *Eupatorium odoratum* (L.) and *E. adenophorum* (Sprengel) showed allelopathic effects in wheat, mustard, chickpea and white clover.

Seed vigor index

Like other parameter the SVI values were also significant in the current investigation. The statistical analysis of the data revealed that high value for SVI in wheat, maize and sunflower was 600, 1347 and 1167 respectively in the control treatments (Table-1-3) while the lowest values were recorded for wheat (39) under extract of *Rumexcrispus* L. (Table-1), Maize (419) under extract of *Cirsiumarvense* (Table-2) and sunflower (0) under extract of each *Ammi visnaga*, *Silybummarianum*, *Malcolmiaafricana* and *Rumex crispus* (Table-3). The present findings corroborate the earlier report by Bora *et al*. (1999) who found that leaf extracts of *Acacia auriculiformis* L. showed inhibitory effect on germination of some agricultural crops. Mubeen *et al*. (2011) reported that a significant minimum seed vigor index (SVI) was observed in rice seeds which were soaked in the leaf extract of *Trianthema portulacastrum* L. Leaf extracts of different weeds inhibit the seed germination, plumule and radical extension of field crops have also been reported earlier by Singh *et al*. (2005).

CONCLUSION

In the light of the coming results, it was concluded that different weeds contain toxic and water soluble compounds (allelochemicals). These compounds are released from different plant parts and dissolved in water under field conditions hence affect the upper fertile rooting zone of the soil and resulting in the seed germination failure as well as seedling growth inhibition in wheat, maize and sunflower. Further studiesare recommended to investigate the physiological changes occurred inside the seeds after exposed to allelochemicals in the test crops and many other useful crops.

Table-1. Effects of weed extracts on seed germination, inhibition, mean seed germination time (MGT), seed germination index (GI) and seed vigor index (SVI) of Wheat.

Treatments	Seed germination (%)	Inhibition (%)	MGT	GI	SVI
A. arvensis	40 d	60 c	4.0 a	1.0 d	117 d
P. lanceolata	90 b	10 e	1.2 cd	2.5 b	183 b
M. polymorpha	50 c	50 d	2.4 b	1.5 c	198 b
A. visnaga	40 d	60 c	1.3 cd	1.0 d	155 bc
P. australis	30 e	70 b	1.3 cd	0.8 e	117 d
S. marianum	50 c	50 a	1.0 e	1.3 c	175 b
E. spinosa	40 d	60 c	2.0 b	1.0 d	141 bc
M. africana	50 c	50 d	1.4 cd	1.2 c	105 d
C. arvensis	40 d	60 d	1.8 bc	1.0 d	080 e
R. crispus	20 d	80 a	1.0 e	0.6 e	039 f
F. indica	50 b	50 d	0.4 f	1.2 c	118 d
C. arvense	40 e	60 c	2 bc	1.0 d	096 e
Control	100 a	00 f	0.5 f	4.0 a	600 a
LSD (0.05)	38.12	37.94	2.85	3.50	480.4

Table-2. Effects of weed extracts on seed germination, Inhibition, mean germination time (MGT), germination index (GI) and seed vigor index (SVI) of Maize.

Treatments	Seed germination (%)	Inhibition (%)	MGT	GI	SVI
A. arvensis	90 b	10 c	3.7 ab	3.6 bc	987 b
P. lanceolata	100 a	00 d	3.7 ab	4.1 a	847 bc
M. polymorpha	90 b	10 c	4.1 a	3.6 bc	684 cde
A. visnaga	80 c	20 b	4.1 a	3.7 abc	848 bc
P. australis	90 b	10 c	4.2 a	3.8 abc	984 b
S. marianum	90 b	10 c	4.0 a	3.6 bc	1101 ab
E. spinosa	80 c	20 b	4.1 a	3.2 bcd	661 cde
M. africana	80 c	20 b	3.9 ab	2.9 cd	819 bc
C. arvensis	80 c	20 b	3.1 bc	3.5 bc	709 cd
R. crispus	80 c	20 b	3.4 abc	3.5 bc	619 cde
F. indica	60 d	40 a	3.7 ab	2.3 e	604 cde
C. arvense	80 c	20 b	3.1 c	2.9 cd	419 f
Control	100 a	00 d	2.9 cd	4.5 a	1347 a
LSD (0.05)	39.47	23.98	9.13	3.39	580.3

Table-3. Effects of weed extracts on seed germination, inhibition, mean germination time (MGT), germination index (GI) and seed vigor index (SVI) of sunflower.

Treatments	Seed germination (%)	Inhibition (%)	MGT	GI	SVI
A. arvensis	40 e	60 b	4.1 a	1.0 d	60 e
P. lanceolata	60 c	40 d	1.2 cd	1.7 c	558 b
M. polymorpha	70 b	30 e	1.6 cd	2.1 b	567 b
A. visnaga	40e	60 b	2.2 b	1.1 d	0 f
P. australis	50 f	50 c	1.4 cde	1.3 cd	283 c
S. marianum	40 e	60 b	1.5 cde	1.0 d	0 f
E. spinosa	40 e	60 b	1.3 def	1.0 d	351 c
M. africana	40 e	60 b	1.3 def	1.1 d	0 f
C. arvensis	50 d	50 c	1.2 def	1.2 cd	342 c
R. crispus	30 f	70 a	1.7 bc	0.8 i	0 f
F. indica	50 d	50 c	0.8 i	1.5 c	337 c
C. arvense	30 f	70a	1.3 def	0.8 e	195 d
Control	100 a	0 f	0.2 j	4.7 a	1167 a
LSD (0.05)	31.57	31.57	3.17	4.11	1015.3

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