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# SCREENING THE ALLELOPATHIC POTENTIAL OF VARIOUS WEEDS

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## ABSTRACT

*Allelopathy is now recognized as an interesting aspect of biological science and is gaining popularity worldwide. To investigate the allelopathic potential of weeds, an experiment was undertaken at the Department of Weed Science, Khyber Pakhtunkhwa Agricultural University Peshawar, Pakistan during September 2010. Water extracts of Poa annua, Imperata cylindrica, Cirsium arvense, Datura alba and Phragmites australis were tested for their allelopathic effects against Zea mays, Avena fatua, Convolvulus arvensis, Ammi visnaga, Rumex crispus and Asphodelus tenuifolius. Experiment was conducted in a completely randomized design with three replications. Data were recorded on germination, shoot weight and shoot length of the tested species. Differential response was recorded for different weeds extracts. Maize seeds produced maximum (100%) germination and consequently maximum shoot length and weight, while the weeds germination and other parameter were significantly reduced by the weeds extracts. Phragmites totally inhibited the weeds seeds germination. A. tenuifolius seeds were totally inhibited by the all the weeds extract. These results showed that allelopathic chemicals should be adapted on large scale for better management of weeds suppression in the field.*

**Keywords:** Allelopathy, weeds, maize, bioherbicides.

## INTRODUCTION

The term allelopathy is gaining popularity among the scientific community and is considered as an important aspect of biological sciences mainly due to its wide scope and unlimited opportunities that it provides. Many diverse problems that have direct or indirect adverse effects on human health have been reported due to extensive use of synthetic chemicals in agriculture. Thus the extensive use of pesticides has diverted the research trends and now agriculturists are of the opinion that many plants provide opportunities that could be potential herbicides in future.

Research on allelopathy in Pakistan was initiated during early seventies. Many studies have confirmed that chemicals with allelopathic potential are present in leaves, stems, flowers, roots, seeds and buds. Several researchers have reported the suppression of weed by the crops under field conditions. The superior weed

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suppressing genotypes have been reported in cucumber, oat, rice, sunflower, soybean, sorghum, pearl millet and *Brassica campestris* (Ata and Jamil, 2001). These allelochemicals offer great potential to be used as pesticides because they are free from problems associated with the present pesticides. Therefore, allelochemicals are considered as an important area of current research domain for the development of new herbicides. These could be used for weed control directly or their chemistry could be used to develop new herbicides. The water extracts of many crops e.g. sorghum, sunflower, *B. campestris*, *Eucalyptus camaldulensis* and tobacco etc, contain a number of allelochemicals which are more effective and economical in controlling the weeds of many crops. In mature sorghum plants, nine water soluble allelochemicals have been identified which are phytotoxic to the growth of certain weeds. Several reports address the importance of allelopathic effect of various trees. *Eucaluptus camaldulensis*, *Prosopis juliflora*, and *Acacia nilotica*, significantly affected seed germination and seedling growth of several crops and/or weed species (Dhawan and Gupta, 1996). Allelochemicals can be released either through leaching, decomposition of plant residues, volatilization, or root exudation (Chou, 1999).

In agriculture, the inhibitory effect of weed species on germination and growth of crops has been attributed to phytotoxic chemicals released from the leaf litter and roots. Rice (1974) observed that many species of weeds produce toxins that are inhibitory to other weeds and often to themselves. *Lantana camara*, one of the world's 10 worst weeds was introduced in the Indian subcontinent during the early part of the nineteenth century (Bansal, 1998). This obnoxious weed poses a serious problem to flora and fauna because of its toxic substance and it contains certain allelopathic compounds (Jain *et al.,* 1989). In a field study *Dicranopteris linearis* strongly reduced the weed density in its vicinity. *Ageratum conyzoides a*nd *E. colona,* the most sensitive weed species, were not found in the *D. linearis* infested area (Tet-Vun and Ismail, 2006). Khan *et al.,* (2009) claimed that many plants release allelochemicals that are dangerous for the crops and environment.

Keeping in view the importance of allelopathic potential of several crop and weed species, the experiment was conducted under the laboratory conditions with the objectives to investigate allelopathic status of different weeds on crop seed germination and to quantify the response of crop and weed seeds to different weed extracts.

## MATERIALS AND METHODS

Laboratory based experiment was conducted in the Weed Science Laboratory, Department of Weed Science, Khyber Pakhtunkhwa Agricultural University Peshawar during summer 2010 to assess the allelopathic potential of (*Poa annua, Imperata cylindrica, Cirsium arvense, Datura alba* and *Phragmites australis*). Whole plants of these weeds were collected at flowering stage from Peshawar in 2009. Leaves were detached and the fresh green leaves of the above mentioned weeds were washed with tap water and then kept in paper bags for shade drying. After shade drying the leaves were then grinded with the help of grinder. The grinded material was then soaked in tap water for 24 hrs at room temperature (25±5 $^0$C). The concentrations of each species were 100 g $L^{-1}$ i.e. powder of each weed species was soaked at the rate of 100 g $L^{-1}$ of water. Control (tap water) was also included for comparison. The experiment was laid out in completely randomized design (CRD) and repeated once. Weed seeds were collected during spring 2009 and stored at room temperature. While maize seeds were collected from Agricultural Research Farm, Kyyber Pakhtunkhwa Agricultural University Peshawar. Ten seeds of each species i.e. maize (Azam variety), *Avena fatua, Convolvulus arvensis, Ammi visnaga, Rumex crispus* and *Asphodelus tenuifolius* were placed in petri-dishes (lining with Wattman paper 1) in the bottom. Weed extracts were applied to petri-dishes individually soon after placing the seeds in each petri-dish. There were five extracts viz., *Poa annua, Imperata cylindrica, Cirsium arvense, Datura alba* and *Phragmites australis* and control and were tested against seed germination, shoot weight and seedling length of six plants species viz., maize (Azam variety), *Avena fatua, Convolvulus arvensis, Ammi visnaga, Rumex crispus* and *Asphodelus tenuifolius* Different extracts were applied to the petri-dishes when needed. Data on germination percentage was recorded three weeks after application of extracts and seedling weight and seedling length were also recorded three weeks after initiation of the experiment. Number of individual species that showed plumule of 2mm was considered as germinated and then average was calculated. To record the seedling length of the plants, all the seedlings of each species in each Petri-dish were measured from root to the tip of the terminal leaf and then the average was computed. Similarly, weight of all the seedlings was recorded and average was calculated.

**Statistical analysis**

Data analysis of the above experiment was conducted using Analysis of Variance (ANOVA) using Statistical software and the significance was tested using the Least Significant Differences (LSD) at P=0.05 (Steel and Torrie, 1980).

## RESULTS AND DISCUSSION

**Germination**

Analysis of variance of the data showed that different species showed different response to weed extracts had significantly affected the seed germination of the studied weeds (Table-1). The data depicted that among the weeds maximum (87.78%) germination was recorded for maize followed by *Avena fatua* (12.22%). While minimum germination percentage (3.33) was observed for *A. tenuifolius*. Thus maize showed great tolerance to the weeds extracts as compared to the other weed species tested. Among the extract concentration, maximum germination (42.22%) was observed in the control while all the weeds extracts produced statistically similar results. The interaction of different concentrations and weed and crop seed germination showed that highest germination (100%) was observed for maize under control and *I. cylindrica* treated treatments. *P. australis* showed strong allelopathetic effects by inhibiting the seed germination of all the tested weed species. *A. tenuifolius* proved the most sensitive as germination failure was observed in all the extracts used in the instant study. Some weeds extracts inhibited the seed germination of other weeds seeds (De-Moral and Muller, 1970). The above findings are further supported by the findings of Noor and Khan (1994) who reported a high reduction in *Zea mays* seed germination by *A. samana* fresh root extracts. Khan *et al.* (2004) reported that *P. australis* has a strong allelopathic effects on the seed germination. Extracts of many weeds have the potential to inhibit the germination of other weeds (Khan *et al.,* 2005). Thus the presence of these weed species in agricultural lands can greatly affect the seed germination of crops and other weeds. However, the incorporation of these weeds in the soil might be proved effective to inhibit the seeds of weeds but how to avoid these allelochemicals not to affect the seed germination of the crop is a question that needs to be addressed on scientific backgrounds.

**Seedling weight (mg plant$^{-1}$)**

Statistical analysis of the data revealed that different weeds extract had significant effect on the seedling weight of the studied weeds (Table-2). Similarly means of the species presented in Table-1 depicted that maximum seedling weight (68.61 mg plant$^{-1}$) was recorded for maize while all the weeds produced statistically similar seedling weight. Thus maize was the most tolerant species in respect of germination and shoot weight probably due to inherent genetic makeup. Among the various weed extracts maximum seedling weight (20.56 mg plant$^{-1}$) was recorded in control treatment followed by *C. arvense* while minimum seedling weight (13.39 mg plant$^{-1}$) was produced by *D. alba.* The rest of the extracts produced statistically similar results. These results are supported by the findings of Helgeson and Konzak (1950) who reported that aqueous extracts of *C. arvensis* and *C. arvense* inhibited the germination of seeds and growth of seedlings of many crops. The presence of allelochemicals have been explored many times and many scientists are of the view that allelopathins are present in various parts of the plants and can greatly affect the receiver plants in many ways. However, Allelochemicals are synthesized in plants as secondary metabolites and located in certain specialized organs of donor plants (Kobayashi, 2004). Decreasing biomass of weeds due to application of allelopathins is an indicator of success of such studies. Although herbicides are cheaper and effective as compared to allelochemicals, but still it seems that allelopathins could be successfully used for weed control in developing countries by small farmers.

**Seedling Length (cm)**

Analysis of variance of the data revealed that different weed extracts had significant effect on the seedling length of the tested species (Table-3). Means of the species showed that maximum seedling length (6.62 cm) was recorded for maize seedlings while lowest seedling length (0.75cm) was observed for *A. tenuifolius* seedlings. Overall, *P. australis* showed strong allelopathic effects by inhibiting the germination percentage, seedling weight and seedling length of all the species tested except maize. Among the different weed extracts maximum seedling length (6.10 cm) was recorded in control treatment followed by *I. cylindrica* (2.18 cm). However, this value was statistically at par with the rest of the weeds extracts except in *P. australis* which produced minimum value of seedling length (0.91cm). Interaction between extracts and species tested showed that maximum seedling length (9.83 cm) was recorded for *A. fatua* under control treatment followed by maize seedlings (9.59cm) treated with *I. cylindrica* extracts. Many of the weed species that used for testing the allelopathic potential are less explored and needs to be addressed in agro-ecosystem. The instant results showed that presence of allelopathic weeds in the agricultural fields may pose a serious threat to the crop production as these plants will release allelopathins to the soil environment and thus could results in failure of seed germination. On the other hand, these weeds provide opportunity to be used for weed management. In a similar study, Cheema and Khaliq (2000) reported that allelochemicals are effective and could be successfully used in weed management techniques. However, the presence of allelochemicals in plants depend on many factors. Yamamoto (1995) reported that coumarin was contained in all parts of *Anthoxanthum odoratum* with a higher concentration in the leaves, but the concentration varied with the season. Weed science must develop and incorporate additional practices to create integrated management systems that diversify selection pressures and reduce environmental degradation (Buhler *et al.,* 2000).

**Table-1. Effects of weeds extracts on the germination percentage of different weeds and maize seeds.**

| Species | Weeds Extracts | | | | | | Mean |
|---|---|---|---|---|---|---|---|
| | Control | *P. annua* | *Imperata cylindrica* | *Cirsium arvense* | *D. alba* | *P. australis* | |
| **Maize** | 100 | 90 | 100 | 90 | 66.67 | 80 | 87.78 a |
| ***Avena fatua*** | 60 | 6.67 | 3.33 | 0.00 | 3.33 | 0.00 | 12.22 b |
| ***Convolvulus arvensis*** | 20 | 20 | 6.67 | 13.33 | 10 | 0.00 | 11.67 bc |
| ***Ammi visnaga*** | 30 | 0.33 | 0.00 | 0.00 | 0.00 | 0.00 | 5.10 cd |
| ***Rumex crispus*** | 23.33 | 0.00 | 3.33 | 0.00 | 0.00 | 0.00 | 4.44 d |
| ***Asphodelus tenuifolius*** | 20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.33 d |
| **Mean** | 42.22 a | 19.50 b | 18.89 b | 17.22 b | 13.33 b | 13.33 b | |

LSD(0.05) for concentrations = 7.1490

**Table-1. Effects of weeds extracts on seedling weight (mg plant$^{-1}$) of different weeds and maize.**

| Species | Weeds Extracts | | | | | | Mean |
|---|---|---|---|---|---|---|---|
| | Control | *P. annua* | *Imperata cylindrica* | *Cirsium arvense* | *D. alba* | *P. australis* | |
| **Maize** | 16.33 | 64.33 | 87.67 | 87.00 | 70.67 | 85.67 | 68.61 a |
| ***Avena fatua*** | 15.67 | 1.33 | 11.00 | 0.00 | 6.00 | 0.00 | 5.67 b |
| ***Convolvulus arvensis*** | 36.00 | 21.33 | 0.33 | 33.00 | 3.67 | 6.67 | 16.83 b |
| ***Ammi visnaga*** | 7.67 | 1.33 | 0.00 | 0.00 | 0.00 | 0.00 | 1.50 b |
| ***Rumex crispus*** | 35.00 | 0.00 | 0.33 | 0.00 | 0.00 | 0.00 | 5.89 b |
| ***Asphodelus tenuifolius*** | 12.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.11 b |
| **Mean** | 20.56 | 14.72 | 16.56 | 20 | 13.39 | 15.39 | |

LSD(0.05) for concentrations = 15.8

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**Table-1. Effects of weeds extracts on the seedling length (cm plant$^{-1}$) of different weeds and maize.**

| Species | Weeds extracts | | | | | | Mean |
|---|---|---|---|---|---|---|---|
| | Control | *P. annua* | *Imperata cylindrica* | *Cirsium arvense* | *D. alba* | *P. australis* | |
| **Maize** | 7.97 | 5.00 | 9.59 | 6.23 | 5.42 | 5.49 | 6.62 a |
| ***Avena fatua*** | 9.83 | 1.40 | 1.73 | 0.00 | 1.20 | 0.00 | 2.35 b |
| ***Convolvulus arvensis*** | 7.45 | 3.03 | 0.92 | 2.14 | 1.83 | 0.00 | 2.56 b |
| ***Ammi-visnaga*** | 3.54 | 0.77 | 0.00 | 0.00 | 0.00 | 0.00 | 0.72 c |
| ***Rumex crispus*** | 3.23 | 0.00 | 0.87 | 0.00 | 0.00 | 0.00 | 0.68 c |
| ***Asphodelus tenuifolius*** | 4.52 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.75 c |
| **Mean** | 6.10 a | 1.70 bc | 2.18 b | 1.40 bc | 1.40 bc | 0.91 c | |

LSD (0.05) for concentrations = 0.99

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