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Herbicidal effects of 6-trees leaves and stems extracts on *Avena fatua* L. weed in wheat crop

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ABSTRACT

In Petri plate bioassays, we determined the allelopathic herbicidal effects of leaf and stem extracts (5, 10, 15 %) of *Acacia nilotica* L., *Albizia lebbeck* L., *Dalbergia sissoo* L., *Mangifera indica* L., *Melia azedarach* L. and *Ziziphus mauritiana* L. on seeds germination and seedlings growth of *Avena fatua* L. and wheat (*Triticum aestivum* L.). At higher concentrations (10 % and 15 %) of trees leaf water extract, increased wheat germination but decreased that of wild oats. The lower concentrations of *M. mangifera, M. azedarach* and *D. sisso* leaves stimulated the radicle length. All concentrations of *M. azedarach* extracts stimulated the radicle length of wheat. However, leaf and stem extracts of all Donor trees increased the plumule length of wheat.

Key words: *Acacia nilotica*, *Albizia lebbeck*, allelopathy, aqueous extracts, *Avena fatua*, *Dalbergia sissoo*, *Mangifera indica*, *Melia azedarach*, *Triticum aestivum*, *Ziziphus mauritiana*, weed control, wheat, wild oat.

INTRODUCTION

The wild oat (*Avena fatua* L., Poaceae family) is noxious weed specie causing drastic reduction in wheat (*Triticum aestivum* L.) crop yield. The weed causes significant losses to farmers, mostly due to increased costs of tillage and other agricultural activities. Grain production and quality are reduced. This weed grew alongside wheat a major crop (9). Wild oat is a prominent weed in wheat crop in more than 50 countries (12). It has irregular germination, is closely related to wheat, has a high degree of phenotypic diversity, is very reproductive, and the seeds persist for a long period in the soil, making it a very competitive with wheat crop (14). In Pakistan, it is most troublesome wheat weed (6). Weeds when compete with crop for longer length of time reduce crop yields (5). Various techniques for weed management have been used in the past (17). The availability of herbicides has led to a dependence on herbicidal weed management, without investigating the weed elimination threshold level and time. Farmers prefer to use herbicides to manage weeds (13). Herbicides impacts the land, humans, animals and environment, surface and groundwater, natural flora and fauna, and aquatic life (10,18). There should be substitutes for chemical herbicides, plants release chemical that influence adjoining plant, a concept recognized since 370 B.C. Allelopathy is a donor-receiver phenomenon, in which one plant releases chemicals that affect the growth of another (7). Molisch (1937) coined the word ‘Allelopathy’ to explain both harmful and beneficial biochemical interactions between all kinds of crops, as well as microorganisms (11). Allelopathy is a weed-control method that is environmentally friendly, also decreases herbicide use (4).

Who discovered that sorghum mulch greatly decreased the density and dry biomass of *Cyperus rotundus,* one of the worst weeds in the world. Aqueous extracts of *Crisium arvense* and A*geratum conyzoides* inhibits the germination and early seedling development of several wheat weeds (1). This study aimed (i). to determine the effects of allelopathic

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trees beneficial to the germination and seedling growth of wheat crops but harmful to growth of *Avena fatua* and (ii). To select trees with allelopathic herbicidal potential to control wild oats.

Figure 1. Selected allelopathic plant species observed in their natural field condions

MATERIAL AND METHODS

The experiment was done from November 2022 to March 2023 at Allelopathy Laboratory, Botany Department, Hazara University Mansehra, Khyber Pakhtunkhwa, Pakistan (Latitude and Longitude: 29.5419^0 N, 70.3837^0 E, mean height above sea level: 116 m, Annual rainfall: 193 mm, maximum and minimum temp 42 ^{0}C and 21 ^{0}C).

Collection of Plant Material

The leaves and stems of donor allelopathic trees *Acacia nilotica* L., *Albizia lebbeck* L., *Mangifera indica* L., *Ziziphus mauritiana* L., *Melia azedarach* L., and *Dalbergia sissoo* L. wild oat variety seeds were collected from fields of Jampur village (Tehsil Jampur Mouza Muhammadpur Dewan, Punjab).

Lab Bioassay

The experimental Treatments consisted of 4 factors (i). Donor tree species: 6 (*Acacia nilotica* L., *Albizia lebbeck* L., *Mangifera indica* L., *Ziziphus mauritiana* L., *Melia azedarach* L., and *Dalbergia sissoo),* (ii) Recipient plants: 2 (Wheat, Wild oat), (iii). Extracts (Leaves, stem) and (iv). Extract Concentrations: 3 (5,10, 15 %). The treatments were replicated thrice in a completely randomized design. The collected leaves and stems were dried in shade and powdered separately. The dried and powdered stems and leaves were soaked overnight at room temperature in Distilled water and diluted in tap water to prepare 5 %, 10 %, and 15 % concentrations. These were filtered through Whatman #1 filter paper, and the filtrate was concentrated to 100 ml. Each concentration was stored in a separate bottle.

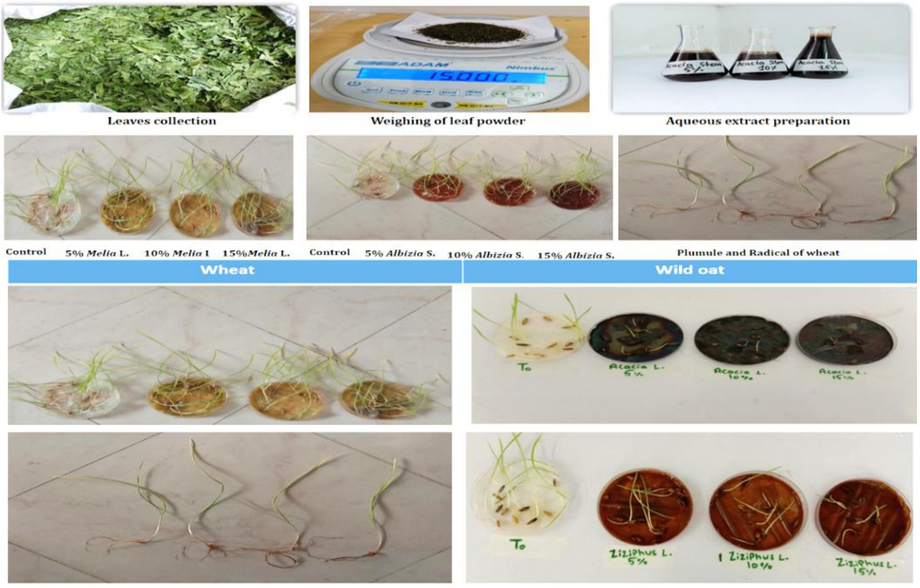

Figure 1. Pictorial view of material and method and lab experiment

Seven seeds of wheat and wild oat were sown in Petri dishes (9 cm dia), lined with 2-layers of filter paper. Each petri dish received 10 ml extract or distilled water (Control) (6). All Petri plates were kept in the Incubator for 72 h at 25 ^{0}C. The Germination, radical, and plumule lengths were recorded after 7- days.

Statistical Analysis

One-way ANOVA (Computer Statistics 8.1) was used to statistically analyze the data. The least significant difference (LSD) test was performed to compare the mean values of the treatments at the 0.05 percent probability level. (16).

RESULTS

Water extract of the leaves of allelopathic plant considerably stimulated he wheat radical length. Some allelopathic trees' aqueous extracts considerably (P <0.0001) influenced the germination of wheat. Both the lower extract concentrations (5 % and 10 %) and the higher ones (15 %) significantly increased the radical and plumule length. With the increase in extract concentration, the radical length increased. The allelochemical in the leaf aqueous extract significantly promoted the development of plumule and radicals of wheat. The extracts from the *Melia Azedarach* increased the radical and plumule length of wheat at all concentrations. After the *Melia Azedarach*, the *Dalbergia Sissoo* extracts increased the germination of wheat at different doses, followed by all selected trees (Figure 2). The *Avena fatua* radical length was reduced at 5, 10, and 15 % concentrations of *Melia azedarach* and was followed by other selected plants (Figure 4). All concentrations of aqueous extract of *Dalbergia Sissoo* and *Mangifera Indica* drastically reduced the germination, plumule and radical length of wild oat than wheat.

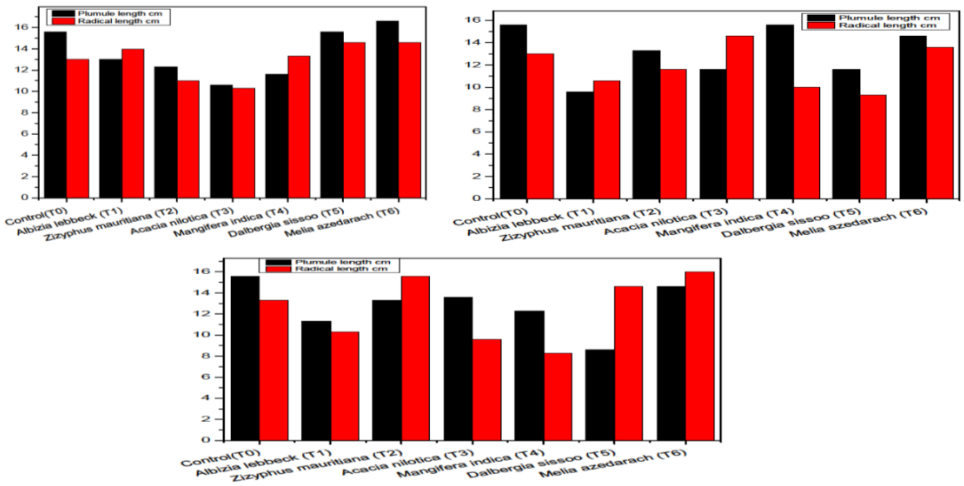

Figure 2. Allelopathic effects of plants leaf aqueous extract on radical and plumule length of wheat

The wheat plumule and radical length were increased by the leaf aqueous extract of 10 % *Melia azedarach* and *Mangifera indica*, followed by the other selected trees. The 15 % aqueous extract of *Melia azedarach* and *Ziziphus mauritiana*, considerably improved wheat germination (Figure 2). The plumule length of *Avena fatua* was reduced by all doses of leaf aqueous extract (5 %, 10 %, and 15 %), but the plumule length of wheat was increased Wheat germination was considerably promoted by all selected trees (p=0.006). The aqueous preparations of allelopathic tree stems also considerably increased wheat plumules length. The results showed that higher concentrations (10 %) of *Mangifera indica* and *Acacia nilotica* stem promoted wheat plumule growth, followed by stems of all chosen trees, the 15 % stem aqueous extract was most beneficial to wheat (Figure 3).

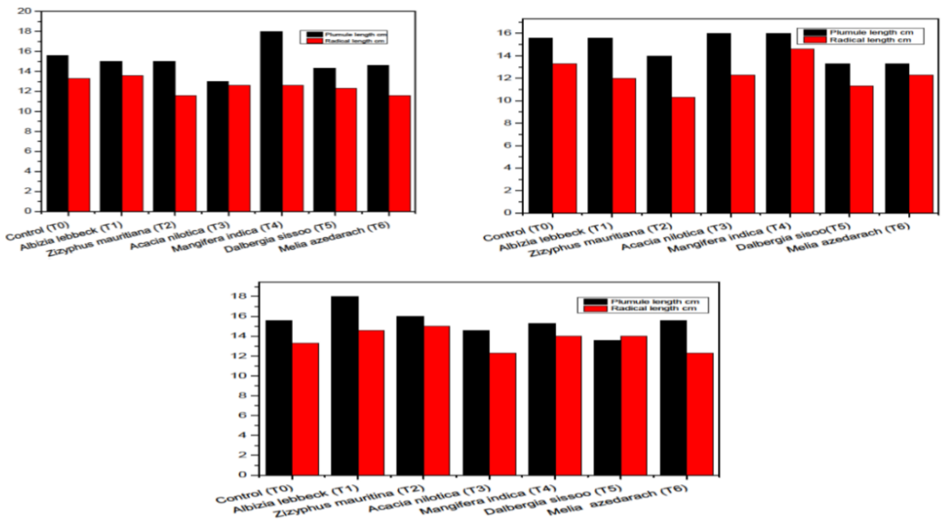

Figure 3. Allelopathic effects of plants stem aqueous extract on radical and plumule length of wheat

The wheat plumule and radical length were considerably enhanced by the stem aqueous extracts of *Albizia lebbeck*, *Ziziphus mauritiana*, and all other selected plants at lower doses (5 %). The wheat plumule and radical length were significantly boosted by the stem aqueous extracts of *Albizia lebbeck* and *Ziziphus mauritiana*, followed by the other chosen trees. The lower concentrations (5 %) of *Mangifera indica* increased the germination, plumule and radical length of wheat.

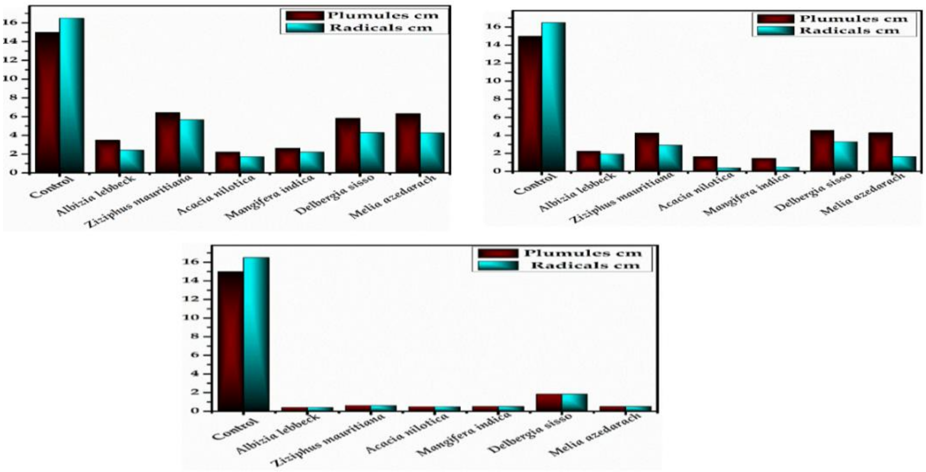

Figure 4. Allelopathic effects of donor trees leaf aqueous extract on radical and plumule length of wild oat

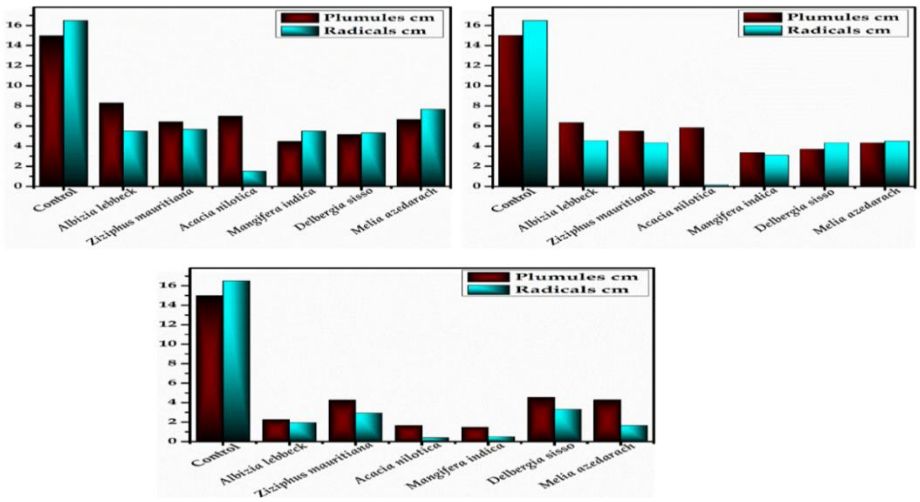

Figure 5. Allelopathic effects of donor trees stem aqueous extract on radical and plumule length of wild oat.

The concentration of aqueous extract from allelopathic tree stems reduced the radical and plumule in *Avena fatua* than wheat (Figure 4). Stems extracts of *Melia azedarach, Dalbergia Sissoo,* and *Mangifera Indica* decreased the radical and plumule length of oat followed by other selected trees. All concentrations of aqueous extract of selected tree leaves and stems reduced the growth of wild oats.

Wild oat germination was inhibited by aqueous extracts of leaf and stem of certain trees, but increased the wheat germination. Comparably, the leaf extracts had greater impact on wild oat's than stem extracts. The findings were evident that certain plants emitted chemicals into the environment through their leaves, toxic to wild oats but favorable to wheat. *Mangifera Indica* 5 % leaves and stems extract were inhibitory (29.7 %) on plumule and (9.09 %) on the radical of wild oat. The 10 % extract showed 22.2 % inhibitory effects on plumule and 0.7 % on radical, while 15 % had more inhibitory effects (16 %) on plumule and 4.6 % on radical of wild oat.

DISCUSSION

The *Acacia nilotica*, *Albizia lebbeck*, *Mangifera indica*, *Ziziphus mauritiana*, *Melia azedarach*, and *Dalbergia sissoo,* each had different impact on the germination of wheat and wild oat. Allelopathic plants with the greatest concentration of leaf and stem aqueous extract (15 %) considerably improved the germination, but decreased the growth of wild oats. The germination of wheat was impacted differently by various leaf and stem concentrations of selected plants. Although germination for all treatments began on the same day, the control-like condition persisted till 7 days. *Albizia lebbeck* showed less allelopathic effects, whereas, *Melia azedarach* leaf concentrations of 5 %, 10 %, and 15 % exhibited a significant allelopathic effects, Moh et *al* (8) reported similar results. The germination increased as the extracts concentration rose. *Albizia lebbeck*, *Mangifer Indica* and leaf aqueous extract from *Acacia nilotica* at 5 % concentration inhibited germination. The leaf aqueous extract from *A. nilotica*, *A. lebbek, M. indica, Z. mauritiana, M. azedarach* and *D. sissoo* at 10 % and 15 % considerably inhibited the germination of wild oat. Similar findings were reported by Ayalew and Asfaw (2). The allelopathic tree stems aqueous extract decreased the *Avena fatua* radical length than control. In comparison to 5 % and 10 % concentrations, 15 % concentration of stem aqueous extract significantly reduced the radicals length. *Avena fatua's* plumule length was impacted by the stem aqueous extract of donor plants. Maximum plumule length was seen in control. While the stem aqueous extract of 5 % and 10 % concentrations of did not affect radical length, while 15 % extract had highly significant effects. Aqueous extract from the stem of allelopathic tree substantially decreased the plumule length of *Avena fatua*. The development of plumules was inhibited by higher extract concentration (10 %), with 15 % stem aqueous extract of allelopathic trees were most inhibitory. The lower stem aqueous extract concentrations (5 %) did not affect the plumule length. These results concur with those from Turk and Tawaha (15).

CONCLUSIONS

Allelopathy may be an alternative method for weed control and weed management. Allelopathy is the natural method to control the weeds by planting allelopathic trees near the wheat crop, whose extract have positive effect on wheat crop but negative effect on wild oat. Trees release allelochemicals beneficial for wheat germination but harmful for weeds. At higher concentrations (10 % and 15 %) trees leaf water extract, increased wheat germination but decreased that of wild oats. The lower concentrations of *M. mangifera, M. azedarach,* and *D. sisso* leaves stimulated the radicle length of wheat. All concentrations of *M. azedarach* extracts stimulated the radicle length of wheat, while, leaf and stem extracts of all Donor trees increased the plumule length of wheat.

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration with all authors. All authors finally approved and drafted the manuscript.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. All authors agree to publish it.

DECLARATION

We declare that all authors of this Ms. have made substantial contributions. We did not exclude any author who substantially contributed to this Ms. We have followed our ethical norms established by our respective institutions.

ETHICAL STATEMENT

This is to inform you that in this study, we have not been involved in any animal and human studies.

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