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Araştırma Makalesi / Research Article

Herbicidal Evaluation of the Aqueous Extract of *Populus nigra* L. Leaves on Six Weed Species

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ABSTRACT

In a laboratory experiment, the herbicidal potential of poplar leaves was evaluated against six weed species that are *Avena fatua, Phalaris minor, Rumex dentatus, Parthenium hysterophorus, Lepidium sativum* and *Silybum marianum.* Aqueous extract of *Populus nigra* leaves' powder obtained at 10, 15, and 20 g concentrations were used as treatments for testing germination and seedling growth responses of the target weed species. Germination and growth of all six weeds species were reduced with increasing concentration of the leaves. Results suggests the potential role of this plant's extracts in the management of weeds; however, more work is needed to be conducted for identification of the allelochemicals present in poplar plant which exhibit inhibitory activities against seed germination and growth parameters of test plants.

Key Words: *Populus nigra*; weed suppression, herbicidal potential, phenolics, growth regulators

INTRODUCTION

The term allelopathy refers to both detrimental as well beneficial effect of the natural metabolic substances produced by plants upon another (Narwal, 1994). It is the processes by which chemical substances are produced by one plant (or other organism), released to the surrounding vicinity and which then impart either beneficial or harmful effects on other plant (or organism) (Bansal and Bhan, 1993). The interaction between plants (or organisms) is based on the release of biochemical substances called allelochemicals that are generally the secondary metabolic substances produced by plants and other organisms (Levin, 1976).

In modern agriculture, protection of plants against insects and pests and their ample production depend on the input of chemical pesticides and fertilizers. The widespread use of such chemicals generally results in environmental issues which need to be replaced with alternative methods like allelopathy which has spacious potentials in suppressing plants pathogens and in the improvement of soil fertility; thus, can elevate crop production in a sustainable manner (Majeed et al., 2012, 2018).

Weeds occurrence in fields is an impeding factor which negatively affect the production of crops. Although significant progress has been accomplished in weed management research over the years, the extensive use of agrochemicals remains uncontrolled in agriculture for weed suppression and crop production elevation. Keeping in view of the negative consequences of herbicides, the conducted study is an attempt to assess the effect of *Popolus nigra* on the selected test species of wheat and weeds in respect of germination percentage, extension of radicle and plumule length, under different treatments in laboratory bioassay condition compared with control. Confirmation of the herbicidal activity of the aqueous extracts of *P. nigra* could lead to its wider use in weed control programs with a minimum reliance on synthetic weedicides.

MATERIALS AND METHODS

During March 2017, mature leaves were collected from cultivated *Populus nigra* trees. The leaves were cleaned and dried under shady conditions until reached to constant weight, they were grinded to powder, and different concentration of aqueous extracts were obtained by dissolving 10, 15 and 20 g samples separately in 200 ml water. Samples were sufficiently soaked in water (96h) at room temperature, and then filtered.

For seedling bioassay, ten healthy seeds of each of the six weeds species i.e. *Avena fatua, Phalaris minor, Rumex dentatus, Parthenium hysterophorus, Lepidium sativum* and *Silybum marianum* were retained on filter paper which was twice folded in Petri plates (100×15 mm). Petri dishes were kept at an incubator in completely randomized design with three replications. Temperature was set at 25°C while photoperiod was adjusted for 12h light and darkness. Each Petri dish in each treatment was provided with an 8 ml aqueous extracts of different concentration while for control setup, distilled water was used. After 96 h, data for percent germination, radicle and plumule growth were recorded.

Data were statistically analyzed using analysis of variance (ANOVA) separately for each weed species, while the least significant difference (LSD) procedure was employed for determination of the significance level.

RESULTS

Germination Percentage

Populus nigra aqueous extracts significantly suppressed seed germination percentage of all six problematic weeds. Maximum germination percentage was observed at control (72.78%), followed by 10g (48.89%), and 15g (18.89%) concentrations while no germination occurred at 20g concentration. However, varietal response show that maximum germination was observed in *S. marianum* (41.67%), *R. dentatus* (35.83%), *P. minor* (34.17%), *L. sativum* (33.34%), *P. hysterophorus* (33.33%) and *A. fatua* (32.49%). The germination (%) reduction of all the above mentioned six weeds species was concomitant with increase of concentration (Table 1). Interactive effect shows that maximum germination was observed in control level of all weed species.

Table 1. Germination performance of different weeds as influenced by extract concentration

Species	Control	10g	15g
Avena fatua	63.33^{a}	43.33^{b}	23.33^{c}
Phalaris minor	70.00^{b}	46.67^{b}	20.00^{c}
Rumex dentatus	73.33^{b}	50.00^{d}	20.00^{c}
Parthenium hysterophorus	76.67^{b}	43.33^{b}	13.33^{e}
Lepidium sativum	66.67^{a}	50.00^{d}	16.67^{e}
Silybum marianum	86.67^{f}	60.00^{a}	20.00^{c}

LSD value for Concentration= 5.415 at α 5%; values in rows and columns superscripted with different letters indicate significant differences

Radicle Length

Significant variation in response was observed about radicle length of the selected weed species placed in the aqueous extracts of the leaves of *Populus nigra.* According to means (Table 2) maximum radicle length was observed in control (3.04 cm), 10g (0.60 cm), 15g (0.31 cm) and 20g (0). The results also illustrated minimum radicle length reduction in *L. sativum* (1.07 cm), *P. hysterophorus* (1.02 cm), *A. fatua* (0.99 cm), *P. minor* (0.98 cm), *R. dentatus* (0.96 cm) and *S. marianum* (0.20 cm) respectively. Suppressive effects were linearly correlated with extract concentration.

Table 2. Plumule growth response of weeds under allelopathic extracts of poplar leaves

Species	Con	10g	15g
Avena fatua	2.96[a]	0.67[b]	0.33[d]
Phalaris minor	2.93[a]	0.70[b]	0.27[e]
Rumex dentatus	3.00[a]	0.50[c]	0.33[d]
Parthenium hysterophorus	3.17[b]	0.60[b]	0.32[d]
Lepidium sativum	3.13[b]	0.73[b]	0.43[d]
Silybum marianum	3.03[a]	0.40[d]	0.20[e]

LSD value for Concentration= 1.122 at α 5%; values in rows and columns superscripted with different letters indicate significant differences

Plumule Length

Plumule length of all six weeds species was significantly affected by *Populus nigra* leaves extract. Concentration mean display that maximum radicle length was observed in control level (2.55 cm), 10g (0.89), 15g (0.32 cm) and 20g (0). Varietal response illuminated highest reduction in the plumule length of *L. sativum* (0.56cm), *A. fatua* (0.66 cm), *R. dentatus* (0.74cm), *P. minor* (0.82), *P. hysterophorus* (0.91 cm) and *S. marianum* (0.94 cm) Table 3.

Table 3. Radicle growth of weeds as affected of extracts of poplar leaves

Species	Con	10g	15g
Avena fatua	1.78[a]	0.57[c]	0.28[e]
Phalaris minor	2.15[b]	0.88[d]	0.23[e]
Rumex dentatus	2.18[b]	0.51[c]	0.25[e]
Parthenium hysterophorus	2.55[c]	0.75[d]	0.35[e]
Lepidium sativum	1.75[a]	0.37[e]	0.13[f]
Silybum marianum	2.55[c]	0.89[d]	0.32[e]

LSD value for Varieties= 0.2583; Concentration= 0.2109 at α 5%; values in rows and columns superscripted with different letters indicate significant differences

DISCUSSION

The current study was aimed at exploring the allelopathic potential of *P. nigra* leaves extract on germination and seedling growth of the weed species. In literature, no such study on suppression effect of *Populus nigra* leaves extract has been documented. *P. nigra* leaves aqueous extract strongly inhibited germination percentage of *Avena fatua, Phalaris minor, Rumex dentatus, Parthenium hysterophorus, Lepidium sativum* and *Silybum marianum.* It was noted that reduced germination percentage was more evident at high extract concentration. These results agree with previous studies where it was stated that germination and seedling length of *Lactuca sativa* and several other weed species seedlings was significantly reduced by the extracts of *C. papaya* and *L. leucocephala* (Ahmed et al., 2008; Parvin et al., 2011; Wabo et al., 2011).

It was observed that a linear relation was found in suppression effect of *Populus nigra* leaves aqueous extract on weeds species with increase in concentration of extract. Some investigators have proposed that a lower concentration of allelochemicals may have stimulation on growth while higher concentration may cause inhibition in germination and growth of plants (Pelinganga and Mashela, 2012). It is also suggested that plants may possess either growth enhancing or suppressing substances which may accordingly impart healthy or detrimental effects on other pants’ growth and physiology (Yamada et al., 2010). Division of cells and their sizes may significantly decrease due to the influence of allelochemicals (Ortega et al., 1988). In many prior researches, inhibitory responses of plants treated with aqueous extracts were proportional to the extract concentration which was also evident in this study. In earlier studies similar pattern of dose dependency of extracts and plants responses have been observed (Tawaha and Turk, 2003; Dorning and Cipollini, 2006).

The enhanced phytotoxicity with increasing concentration and soaking duration is also noted by various workers (Hussain et al., 2004; Xuan et al., 2004; Chon et al., 2005) thus supports our findings. According to our findings at higher concentration (20g) germination of all tested weed species was completely inhibited by *Populus nigra* aqueous extract. Similar results were obtained by Araniti et al. (2017) (*A. arborescens, C. nepeta and H. hircinum*,) and Akhtar et al. (2014) (*C. sativa*) who reported complete inhibition of lettuce seeds by aqueous extract.

Decrease in radicle length to the applied extracts may explain plants’ susceptibility and inability to modulate internal molecules and to absorb external resources efficiently. Since first contact of the allelochemicals occurs with seedling roots, they are supposed to exhibit more sensitivity to extracts than other plants parts (Wakjira et al., 2005). Abnormalities in radicle emergence and growth due to allelopathic influences may subsequently disturb seedling survival and further growth phenomena. Thus, growth of radicle may be considered as an indicating factor to determine the allelopathic stimulation or retardation on plants. Barkatullah et al. (2010) have revealed water extracts of *Dodonaea viscosa* from leaves, bark, and flowers significantly reduced the plumule and radicle growth of different plants. Nevertheless, they correlated growth suppression in seedling radicle to concentration increase of the extract. Results of this study are strongly supported by observations recorded by Hadi et al. (2014).

CONCLUSIONS

Allelopathy is well known phenomenon which impart negative as well as healthy effects n plants. In this work, we observed negative growth responses from six weeds which were targeted with aqueous extracts of *Populus nigra* leaves. Thus, it is concluded that leaves of the tested plant may contain different active biological compounds which suppresses germination and growth of weed seedlings. Extract concentration of 20 g showed more phytotoxic effects on weeds than lower concentrations. Further research on chemical profiling of this plant can help in the identification of phytochemicals and their possible utilization for weed management as natural weedicides.

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Conflict of interest

There is no conflict of interest

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