



P-ISSN: 2349-8528
 E-ISSN: 2321-4902
 IJCS 2017; 5(3): 785-787
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 Received: 22-03-2017
 Accepted: 23-04-2017

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Effect of allelochemicals present in *Populus deltoides* leaf extract on wheat (*Triticum aestivum*) in poplar based agroforestry system

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Abstract

The study was designed to explore the allelopathic effect of *Populus deltoides* leaf extract on *Triticum aestivum* under laboratory condition during 2015-2016 in the department of Silviculture and Agroforestry, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan 173230. The allelopathic influence of aqueous extracts of *Populus deltoides* leaves have determined on the germination, radical and plumule length of cereal crops. The experiment was laid out at completely randomized design with four replicates. In laboratory studies, wheat grown in the field was screened for allelopathic effect of poplar leaf extracts by using four extract concentrations of 5 (T₁), 20 (T₂), 40 per cent (T₃) and control (T₄). Inhibition effect of leaf extract on germination and growth parameters (radicle and plumule length) increased with increase in concentration of leaf extract. The maximum inhibition in germination percent (75.85%), radicle length (2.75 cm) and plumule length (1.48 cm) was reported in treatment T₃, where 40% concentration of poplar leaf extract was given

Keywords: Allelopathy, wheat, germination, radicle, plumule, allelochemicals, agroforestry

Introduction

Trees release some phytochemicals in the soil which adversely affect the germination and yield of understory crops (Harborne 1977) [5]. Allelopathic interactions in tree crop associations in agroforestry greatly influence the crop production. Chemicals with inhibitory activity are present in many plants and their many organs, including leaves, flowers, fruits and buds (Ashrafi *et al.*, 2007) [11]. A number of trees negatively affect performance of understory crops through release of allelochemicals. These include *Leucaena leucocephala*, *Populus deltoides*, *Eucalyptus* and *Acacia* species (Ralhan *et al.*, 1992 and Singh *et al.*, 1999) [9, 12].

Poplar which is multipurpose fast growing valuable timber species has emerged as one of the most suitable tree species for agrisilviculture system. Poplar based agroforestry systems are economically viable and sustainable than many other crop rotations prevalent in North India (Singh and Sharma, 2006) [10]. A lot of tree-crop combinations are practised by the farmers in poplar based agroforestry system. Poplar provides remarkable production of biomass on a short rotation basis and recycles soil nutrients periodically by adding leaf litter through its leaf shed in winter season.

Cereal grains are grown in greater quantities and provide more food energy worldwide than any other type of crop, they are therefore staple crops. In their natural form, they are a rich source of vitamins, minerals, carbohydrates, fats, oils and protein. In some developing nations, grain in the form of rice, wheat, millet or maize constitutes a majority of daily sustenance. In developed nations, cereal consumption is moderate and varied but still substantial. Wheat during the winter season is most widely cultivated crop in the interspaces of poplar.

Although agroforestry system has a potential to increase yield, it has to compete with food crops. Leaf extracts are a potent source of allelochemicals and toxic effects of these are species specific (Bhatt *et al.*, 1993; Todaria *et al.*, 2005) [3, 13]. Therefore, detailed studies on the effect of tree allelochemicals on seed germination, growth and metabolism of crop plants needs to be conducted prior to recommending any tree species for agroforestry programme. Despite the increase in research on allelopathy in agroforestry systems from the last two decades, little work has been carried out to test the allelopathic effect of poplar on performance of wheat under mid-hill subhumid conditions of Himachal Pradesh, which need further investigations. Therefore, in the present study emphasis is given to test the allelopathic effect on germination and growth attributes of cereal crop wheat.

Material and methods

The experiment was conducted in the laboratory of department of Silviculture and agroforestry, Dr Y S Parmar university of Horticulture and Forestry Nauni Solan, HP. In laboratory studies, wheat variety grown in the field was screened for allelopathic effect of poplar leaf extracts by using four extract concentrations of 5 (T₁), 20 (T₂), 40 per cent (T₃) and control (T₄) where water was used. The treatments were replicated four times in a completely randomized block design. The aqueous leaf extracts of senescent dried leaf samples of poplar were prepared by soaking 5, 20 and 40 per cent by weight in distilled water for 48 hrs. Aqueous extract thus obtained was filtered through Whatman No.1 filter paper. Fifteen seeds were evenly placed in petridishes lined with double layer of filter paper. The seeds were moistened with 10 ml of the respective extract on first day and 5 ml on subsequent days as and when required. Germination and growth parameters (radicle and plumule

length) were recorded on the seventh day after sowing. Germination was determined by counting the number of germinated seeds. Radicle and plumule length of the germinated seed were measured using a ruler.

Result and Discussion

Germination

The allelopathic effect of *Populus deltoides* on the germination and growth parameters of wheat are shown in Table 1. Wheat germination was significantly affected by poplar leaf extract. It was obvious that aqueous leaf extract of *Populus deltoides* inhibited germination of wheat crop. The maximum germination (96.66%) was shown in control where no extract was given. The percentage seed germination was decreased with increase in concentration of leaf extract and reported minimum germination (75.85%) in treatment T₃ where 40% concentration of extract was given.

Table 1: Effect of allelochemicals present in aqueous extract of *Populus deltoides* leaves on germination and growth parameters of cereal crops

Treatments	Growth parameters		
	Germination (%)	Radicle length (cm)	Plumula length (cm)
T ₁ (5% conc)	93.30 (9.66)	3.85	2.68
T ₂ (20% conc)	87.43 (9.44)	3.40	2.05
T ₃ (40% conc)	75.85 (8.92)	2.60	1.48
T ₄ (control)	96.66 (9.87)	4.38	3.33
Lsd	0.10	0.44	0.56

* Value in parenthesis indicate transformed values for seed germination (%)

The present findings corroborate the earlier report by Basotra *et al.* (2005) [2] who reported an inhibitory effect of leachate from leaf and root/tubers of some medicinal plants on the germination and growth of food crops in Garhwal Himalaya. Further, Bora *et al.* (1999) [4] found that, the inhibitory effect of leaf extracts of *Acacia auriculiformis* on germination of some agricultural crops was proportional to the concentration of the extract. Also, as noted by Jadhar and Gayanar (1992) [6] the percentage of germination, plumule and radicle length of rice and cowpea, were decreased with increasing concentration of *Acacia auriculiformis* leaf leachates.

Radicle and plumule length

The radicle and plumule length of wheat crop were measured and compared with those of control. Both radicle and plumule growth got inhibited by leaf leachate treatments (Table 1). Inhibition effect of leaf extract on growth parameters increased with increase in concentration of leaf extract. Maximum radicle (4.38 cm) and plumule length (3.33 cm) was observed in control i.e. treatment T₄. Whereas, minimum radicle (2.60 cm) and plumule length (1.48 cm) was observed in treatment T₃, where 40% concentrated poplar leaf extract was given. Negi *et al.* (2007) [8] also reported that leaf extract of *Ougeinia oojainensis* are equally toxic to the germination and plumule and radicle growth of *Brassica campestris*, *Hordeum vulgare*, and *Triticum aestivum*. Similarly, Khan *et al.* (2016) [7] also reported that plumule length and radical length of *Z. mays* were inhibited by the bark extract of *Populus nigra*. Further, Singh *et al.* (2009) [11] also confirmed that agroforestry trees *Ficus subincisa*, *Bauhinia purpurea* and *Toona hexandra* had allelopathic effect on germination and growth of wheat crop. The effects of leachates on wheat crop was concentration dependent.

Conclusion

Allelopathy is inhibitory effect of one plant on another plant through the release of some chemicals. The study provides the evidence that *Poplar deltoides* has allelopathic potential on wheat crop. Germination and growth performance of wheat crop revealed that rate of germination, radicle and plumule length were suppressed by presence of allelochemicals. Again, inhibitory effects on germination and growth parameters of wheat crop are affected by leaf extract concentration. Based on these results it can be concluded that allelopathy is a concentration dependent phenomenon, as the concentration of the poplar leaf extracts increases, its detrimental effects also increases on receptor plant.

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