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Effect of Leaf Leachates Different Tree Species on Germination and Growth of Various Agricultural Crops

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ABSTRACT

Allelopathic effects of leaf extracts from four different tree species *(Populus deltoides, Eucalyptus hybrid, Anthocephalus cadamba and Terminalia chebula)* were evaluated against germination and growth of different agriculture crops *(Triticum aestivum, Brassica juncea and Lens culinaris)*. In germination bioassay, it was inferred that among the tested crops, wheat recorded the highest germination. In case of total seedling length and dry weight both stimulation and inhibition by extracts was observed when compared with control. The extracts from poplar, *E. hybrid and T. chebula* had a promotory effect on the seedling length of the crops whereas *A. cadamba* proved inhibitory to crops as compared to control. Maximum inhibition in seedling dry weight was observed with *A. cadamba*, whereas least effect was obtained due to *E .hybrid.* Based on the germination, seedling length and dry weight values for seed vigour index was calculated. SVI^1 and SVI^2 was maximum with wheat in the tested crops whereas among the leaf extracts it was maximum in E. hybrid. Based on the laboratory study, it is concluded that extracts from E. hybrid is better than other species and can be recommended as an associated species for large scale agroforestry plantations in future.

Key words:
Allelopathy, poplar, *Eucalyptus hybrid*, wheat, *Brassica juncea*

INTRODUCTION

The tree releases the chemical substances (allelochemicals) in the soil. These allelochemicals inhibit or promote the germination, growth and yield of receiver plants and the phenomena is called as allelopathy. However, according to new definition: Allelopathy refers to any process involving secondary metabolites production by plants, microorganisms, fungi, viruses that influence the growth and development of agricultural and biological systems. Allelochemicals plays a major role in the basic metabolism of the plants and affect numerous physiological and biochemical processes in the plants. Allelopathy in crop production is related to soil sickness, autotoxicity, yield decline, pre-deposition of plants to diseases, reduced nitrification, nutrient uptake and weed interference with crops (Chaturvedi et al. 2012). However, the effects of these chemicals on other plants are concentration dependent and also influences by other compounds present in the extract. The trees are planted in the cultivated fields for fodder, fuel and timber in agroforestry systems. However, farmers losses, perhaps due to wrong selection of tree species with arable crops, which results in negative allelopatic interactions. Hence, an attempt was made to study the effects of trees on field crops growing under their canopy.

MATERIAL AND METHOD

Preparation of aqueous extract

Fresh leaves from several mature trees of *Populus deltoides*, *Eucalyptus hybrid*, *Anthocephalus cadamba* and *Terminalia chebula* were collected from Agroforestry research center. The extracts were prepared by grinding 250 g of fresh senescent leaves with distilled water. Following extraction, the solution was filtered with whatman No. 1 filter paper and kept in refrigerator until required. The leaf extract from each species were prepared at 20% concentration. All extracts were further diluted to 2% concentration and were used for germination bioassay and seedling vigour index of *Triticum aestivum, Brassica juncea* and *Lens culinaris*. Based on this experiment, it was considered that any inhibition observed in germination and seedling vigour of *T. aestivum, B. juncea* and *L. culinaris* would chiefly be due to allelopathic substance present in the extracts.

Germination bioassay

Seeds of the crops were germinated following the procedure of Leather and Einhelling (1986). The germination test was carried out in sterile petridishes (12 cm diameter) lined with filter paper (Whatman No.1).To test the allelopathic effect of tree extracts, the filter paper were moistened with 10 ml of aqueous extracts of different tree species at 2 per cent concentration and distilled water as control. Fifty healthy seeds of each crop were spread out in 2 sheets placed in pertridishes. There were three replicates for each type of extract and recipient species. The petridishes were randomized and incubated at 20^0 C in darkness in biological oxygen demand (BOD). The germination was recorded 48 hrs after the onset of germination, which occurred after three days for each crop and was recorded daily. The experiment was extended over a period of 10 days to allow the last seed germination.

Growth and vigour studies

Root and shoot length of ten selected seedlings were measured with help of scale after measuring both were dried separately in plant drier at $70+2^0$C for 72 hrs and averaged to recorded seedling length and dry weight. Vigour index was calculated according to method adopted by Baki and Anderson (1973):

SVI_1 = germination (%) x total seedling length

SVI_2 = germination (%) x total seedling dry weight

Statistical analysis

The experiments were done in a factorial randomized block design with three replications. The data collected from the germination and growth studies were subjected to one - way ANOVA followed by separation of means at P 0.05 in the standard programme developed by Department of Mathematics, Statistics and Computer Science of G.B. Pant University.

RESULT AND DISCUSSION

Germination

The data on germination percentage of crop species was found to be maximum in *T. aestivum* (96.0%) followed by *L. culinaris* and *B. juncea*. The aqueous extract from different tree species showed pronounced inhibition on germination of crops (Table 1). However, response of different species was different. Inhibition of seed germination in response to aqueous extract from a number of tree species has also been reported by Siddiqui et al. (2009). The effect of extract depend on plant extracts, *E .hybrid* had stimulatory effect on germination of the crops but *P. deltoides* and *T. chebula* had a inhibitory effect, so that germination of crops was reduced 1 to 2 per cent compared with the control (without plant extract). The selective germination response of test crops to the extracts of different trees indicate variability in the allelopathic potential of tree species. Kaushal et al. (2003) also reported reduction in germination of crops with the aqueous extract of *Grewia optiva* and *Populus deltoides*. Stimulatory effect on germination of O*ryza sativa* by *Alnus nepalensis*, has also been reported by Kumar et al. (2006).

Seedling length

The root and shoot length were differed significantly among the crops but by the tree species only root length was influenced. Among the crops, the highest root and shoot length was recorded with *T. aestivum* while within the tree species it was attained with *T. chebula*. The seedling length varied significantly among crops.

Among the tested crops, the seedling length of *L. culinaris* was affected most strongly, with reduction of shoot and root length. This shows that lentil was the most susceptible crop within the tested crops. Seedling length of germinated seed was also affected in response to the different tree plants. However, the response was different to different tree species exhibiting a differential species-specificity. The extracts from *P. deltoides*, *E. hybrid* and *T. chebula* had a promotory effect on the seedling length of the crops whereas *A. cadamba* proved inhibitory to crops as compared to control. Inhibitory effect of tree on test crops may be attributed to influence of allelochemicals on the cell division and cell elongation. Negative impact of *Grewia oppositifolia, Ficus roxburgii* and *Celtis australis* of seedling growth of wheat has already been reported by Todaria et al. (2005).

Table 1. Germination (%), mean root, shoot and seedling lengths (cm) and dry weights (mg) as influenced by various treatments

Treatments	Germination (%)	Root length (cm/root)	Shoot length (cm/shoot)	Total seedling length (cm/seedling)	Root dry weight (mg/root)	Shoot dry weight (mg/shoot)	Total seedling dry weight (mg/seedling)
Crops (C)							
Mustard	74.7	7.0	3.8	10.8	0.44	2.38	2.82
Wheat	96.0	8.8	5.9	14.7	3.92	4.90	8.82
Lentil	93.1	5.4	4.9	10.3	1.95	2.94	4.89
C D at 5%	3.3	0.8	0.6	0.8	0.22	0.33	0.42
Leaf extracts (L)							
Poplar	86.5	7.7	5.1	12.8	2.06	3.35	5.41
Eucalypt	89.0	7.6	5.1	12.7	2.10	3.75	5.85
Kadam	88.3	5.7	4.6	10.3	2.07	3.31	5.38
Harar	87.3	8.1	5.2	13.3	2.30	3.21	5.51
Control	88.5	6.2	4.6	10.8	2.00	3.42	5.42
C D at 5%	NS	1.1	NS	1.1	NS	NS	NS

Seedling dry weight

The root and shoot dry weight varied significantly among the crops but was not influenced by leaf extracts of different tree species. The maximum and significantly more root and shoot dry weight were in as compared to *B. juncea* and *L. culinaris*. Among the tree extracts, highest dry weight of root was recorded with *T. chebula* abstract while shoot dry weight was with *E .hybrid* extract. Seedling dry weight was affected significantly by the crops but remain unaffected with the application of extracts from different tree species. Among the tested crops, minimum dry weight was recorded by the *B. juncea* whereas, maximum was with *T. aestivum*. The dry weight revealed that the growth of crop was suppressed by the aqueous extract of the tree leaves but with varying degree of susceptibility. Both stimulation and inhibition by extracts was observed when compared with control. There was a slight difference between extracts with respect to seedling biomass, although *E. hybrid* was less inhibitory than others to the crop biomass. The second best treatment was two per cent *T. chebula* extract which did not suppress crop biomass as compared with control.

Seed vigour index$_1$ (SVI_1):

The SVI_1 was affected significantly in response to different crops and leaf extracts (Figure 1). The SVI_1 among the tested plants was drastically reduced in *B. juncea* crop whereas maximum was recorded under *T. aestivum*. *E. hybrid* showed maximum SVI_1 as compared to other tree species. Leaf extract from *E.hybrid, P.deltoides* and *T. chebula* stimulated the SVI_1over the control while extract from *A. cadamba* reduced it. Similar observations as regards the effect of extracts have been made by Walia *et al*. (2002) wherein SVI_1 of tested seedlings was adversely affected by extract from Neem (*A .indica*).According to the data on SVI_1, the leaf extract of the four tree species can be arranged according to increasing allelopathic potential: *E. hybrid* < *P. deltodes* < *T. chebula* < *A. cadamba*.

Seed vigour index$_2$ (SVI_2)

Alike SVI_1 the (SVI_2) varied significantly among the various crops and was also influenced significantly by different leaf extracts (Figure 2). Maximum inhibition in SVI_2 was observed with *T. aestivum*, whereas least effect was obtained on *B. juncea*. The tree extracts from all the tree species showed promotory effect on the seedling dry weight of crops as compared to control.

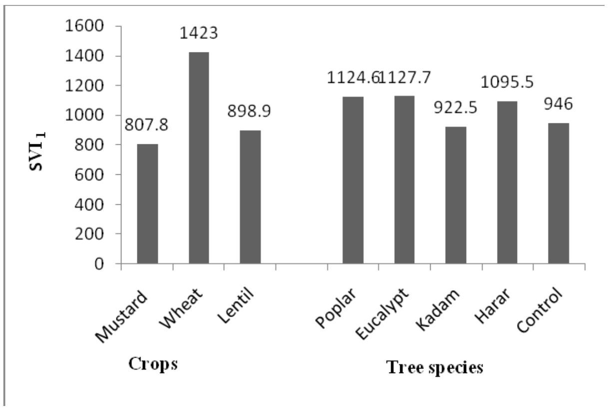

Figure 1. Seed vigour index$_1$ (SVI_1) as influenced by various crops and tree leaf extract

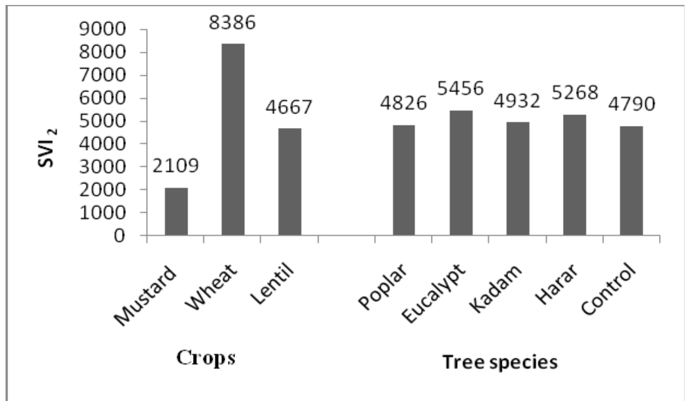

Figure 2. Seed vigour index$_2$ (SVI_2) as influenced by various crops and tree leaf extract

CONCLUSION

T. aestivum was more compatible than *B. juncea* and *L. culinaris* in agroforestry systems under different trees. The inhibitory effect of *A. cadamba* and *T. chebula* on germination and seedling growth of tested plants as mainly due to excess presence of phytotoxincs and allelochemicals.

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