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Allelopathic Effects of Leaf Extract of *Populus deltoides* on Germination and Seedling Growth of Important Vegetable Crops

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ABSTRACT

A laboratory experiment carried out to investigate the allelopathic effects of leaf extract of *Populus deltoides* on seed germination and seedling growth of pea, lentil, cow pea, chilies, Knol-khol and broad beans revealed stimulatory and inhibitory effects on germination, shoot and root length, number of secondary roots and vigour index. In peas 10% leaf leachate concentration had a stimulatory effect on germination and length of roots, while as 20% had stimulatory effect on length of shoot, number of secondary roots and vigour index. In lentil 30% leaf leachate concentration recorded stimulatory effect on germination, while as 10% leaf leachate concentration had a stimulatory effect on length of shoot, length of root, number of secondary roots and vigour index. In case of cowpea 0% (control) recorded maximum germination (100%) and 10% leaf leachate concentration had a stimulatory effect on similar parameters studied. In case of chilies stimulatory effect was observed in seed germination upto 30% leaf leachate concentration. Length of shoot was stimulated upto 10%, while as length of root, number of secondary roots was observed maximum in control. Vigour index was recorded maximum in 10% leaf leachate concentration. In case of knol-khol, stimulatory effect was observed in germination and length of shoot upto 20% leaf leachate concentration whereas, length of root and number of secondary roots was observed maximum in control and thereafter an antagonistic effect appeared. Vigour index was stimulated upto 10% leaf leachate concentration and thereafter a fall was observed. In broad beans, control recorded maximum values of studied parameters, indicating the clear cut allelopathic effect of leaf leachate of *P. deltiodes*

Keywords:

Allelopathy, broadbeans cowpea, chilli, knol khol leaf leachate, pea , lentil, *Populus deltoides*

INTRODUCTION

Agroforestry intentionally combines woody perennials with agriculture or pasture crops in a variety of spatial and temporal arrangements, thus the choice of species and combination may dramatically influence the productivity and ultimate success of agroforestry systems. The challenge in plant interference work is identifying which of these various factors cause the associated plant response. Allelochemicals originating in foliage leachates, root products or mulches of crops or woody plants may result in reduced productivity

or death of companion plants eg. Walnut (*Juglans spp*) is widely known for its allelopathic interference with field crops and conifers (Rietveld 1982 and Bajalan et al. 2013). Cultivation of conventional crops like wheat, maize, lentil, cash crops like mustard, sugarcane, soyabean and fodder crops like sorghum, lucerne, berseem as intercrops with *P. deltoides* is being practiced and is widely accepted among the farmers of North India including Kashmir. Planting of *P. deltoides* has made important contribution towards rural economy viz. most important raw material for fruit packaging industry (fruit box), employment generation, availability of fuelwood through pruning and serves as windbreaks and other intangible benefits.

Poplars being most important agroforestry species of temperate areas face many challenges from its growing environment during their life cycle, these challenges are biotic (insects, fungi, bacteria and viruses) as well as abiotic stresses like light, temperature stress and global warming stresses like elevated CO_2 and Ozone. Poplars like other trees have defense against these biotic and abiotic challenges and one of them is the production of low molecular weight metabolites called secondary metabolites like compounds derived from Shikimate-phenylpropanoid pathway, terpenoids and fatty acid derivatives (Chen et al. 2009), these compounds are responsible for allelopathic interference of associated crops in agroforestry systems. The present investigation was thus undertaken to determine the effects of aqueous extracts of *P. deltoides* Marsh. leaves on germination and seedling growth of important vegetable crops of the Kashmir region.

MATERIALS AND METHODS

A laboratory experiment was conducted at Faculty of Forestry, SKUAST-K Shalimar. Fresh leaves of *P. deltoides* were collected and washed in running water, thereafter the leaves were dried in shade and subsequently oven dried at 50^0 C for 48 hours. Aqueous leaf extract was prepared by crushing the dried leaves, then soaked in distilled water (pH -7.0) at room temperature for 48 hours and mechanically stirred for one hour and then filtered. 80 g of dried leaves were soaked in 800 ml. of distilled water for preparing 100% concentration of stock solution.

Treatments consisted of 5 concentrations of leaf extract of *P. deltoides* (10, 20, 30, 40 and 50 %) along with control and six crops viz; pea (*Pisum sativum* L.), Lentil (*Lens esculenta* Moench), cow pea *(Vigna unguiculata* L. Walp.), Chilies *(Capsicum annum* L.*)*, Knol- khol *(Brassica oleracea var. gongylodes Pasq.)* and Broad beans *(Vicia faba* L.*)* Thirty seeds of each test crop were placed separately in pre-sterilised petridishes with two fold filter paper at the bottom. The experiment was laid in completely randomized design with three replications and each crop was studied separately. 10 ml each of control and five concentrations of leaf leachate were added in each petridish on first day and 5 ml. later on as and when required. The petridishes were placed in an incubator at a temperature of 25 $\pm 1^0$C. Germination, root length, shoot length and number of secondary roots of five randomly selected seedlings from each treatment in all the three experiments were recorded after 10 days of the start of experiment. Vigour index was worked out by multiplying germination percent with total seedling length (Bhattacharya et.al.1991).

RESULTS AND DISCUSSION

The effect of aqueous leaf extract of *P. deltoides* on germination and seedling growth of various vegetable crop is given and discussed as under:

Pea

In pea, the differences within various parameters studied were found to be significant. Increase in leaf leachate concentration had an inhibitory effect on all the parameters of pea. Maximum germination percentage of 98.33 was recorded at 10% leaf leachate concentration and thereafter the trend declined (Table 1). Similar observations in finger millet with leaf leachate of *Eucalyptus globules* are also reported (Padhay et al. 1992). Maximum shoot length of 9.03 cm was observed in 20% leaf leachate concentration and it was significantly different from all other concentrations. Similarly maximum root length of 9.56 cm. was recorded in 10% leaf leachate concentration. Maximum number of secondary

roots (24.26) was recorded in 20% leaf leachate concentration and it was significantly better than all other concentrations. Vigour index was recorded to be maximum (1612.66) in 20% leaf leachate concentration. This is in agreement with the findings with Poplar trees on agriculture crops (Shoup and Witcomb 1981; Kaushal et al. 2003; Khan et al. 2006; Kaushal et al. 2006).

Lentil

In lentil, maximum germination (91.66%) was recorded at 30% leaf leachate concentration (Table 1). There was a decrease in germination beyond 30% leaf leachate concentration. Sahoo et al (2010) also observed reduction in germination of lady finger, chilli, maize, soybean and paddy at higher concentration of aqueous leaf extract of *Mangifera indica*. Maximum shoot length (7.06cm) recorded at 10% leaf leachate concentration was significantly better than 0, 30, 40 and 50% leaf leachate concentration . Root length was observed to be maximum (7.27cm) at 20% leaf leachate concentration and was significantly better than 40 and 50% but at par with 0, 20 and 30% leaf leachate concentration. The number of roots recorded maximum (3.40) in 10% leaf leachate concentration was significantly better than all other concentrations. Vigour index was also recorded maximum (1241.1) at 10% leaf leachate concentration and was at par with 20 and 30% but significantly different from 0, 40 and 50% leaf leachate concentration. Thus increase in the leaf leachate concentration had an inhibitory effect on all the parameters studied. Similar inhibitory effects in poplar were recorded as a result of increased concentration of secondary metabolites (Joshi and Prakash 1992; Singh et al. 2001) and on *Jatropha curcus* (Cramonaz 2013).

Cow pea

The differences were found to be significant within all the characters except shoot length under study. Maximum germination (100.00%) recorded in control was at par with 10, 20 and 30% but significantly better than 40 and 50% leaf leachate concentration (Table 1). The increase in leaf leachate concentration had an inhibitory effect on the performance of the parameters. Inhibitory effect of leaf leachate of *P. deltoides* on spinach and knol-khol is also reported (Melkania 1984). Maximum shoot length (9.44 cm) was recorded in 10% leaf leachate concentration, however, the differences in shoot length were found to be non-significant. Maximum root length (10.54 cm) recorded in 10% leaf leachate concentration was at par with 0 and 20% but significantly different from 30, 40 and 50% leaf leachate concentration. Maximum number of secondary roots (12.60) and vigor index (1964.50) recorded in 10% leaf leachate concentration was at par with 0% but significantly different from 20, 30, 40 and 50% leaf leachate concentration. There was a gradual decrease in the performance of parameters with the increase in leaf leachate concentration. Similar decrease has been observed on lentil with Morus leaf leachate extract (Mughal 2000).

Chilies

Except for germination significant differences were found in all the parameters studied viz. length of shoot, length of root, number of secondary roots and vigour index (Table 2). Maximum shoot length (4.52cm) was recorded in 10% leaf leachate concentration which was significantly better than all other treatments. Thus 10% leaf leachate concentration had a stimulatory effect on length of shoot. Singh and Verma (1988) reported a stimulatory effect of leaf leachate of *Pinus roxburghii* on seed germination and seedling growth of black gram and horse gram. Maximum root length of 2.48cm recorded in control was significantly better than other treatments. There was an inhibitory effect on length of root with the increase in leaf leachate concentration. Chaturvedi and Jha (1992) reported an inhibitory effect of Leucaena leaf extract on rice radicle growth. Similarly the maximum number of roots (5.33) in control was at par with 10, 20 30, and 40% but significantly different from 50% concentration. Vigour index recorded maximum (522.53) in 10% leaf leachate concentration was at par with 0% (Control) but significantly different from 20, 30, 40 and 50% leaf leachate concentration.

Knol-khol

Differences were found to be significant within all the parameters studied. There was a stimulatory effect in germination up to 20% leaf leachate

Table 1: Effect of aqueous leaf extract of *P. deltoides* on germination and seedling growth of pea, lentil and cow pea.

Crop	Aqueous leaf conc. (%)	Germination (%)	Length of shoot (cm)	Length of root (cm)	Number of secondary roots	Vigour index
Pea	0	90.00(74.99)	5.37	9.35	17.13	1349.66
	10	98.33(85.69)	6.06	9.56	16.40	1536.70
	20	86.66(68.85)	9.03	9.52	24.26	1612.66
	30	91.66(80.00)	4.71	7.16	16.40	1089.83
	40	78.33(62.47)	3.38	7.14	12.93	825.43
	50	70.00(56.84)	2.48	4.60	9.66	499.20
CD at 5%		17.80	2.95	2.58	5.34	551.54
Lentil	0	80.00(63.54)	5.01	6.90	1.53	954.46
	10	86.66(68.66)	7.06	7.27	3.40	1241.13
	20	88.33(70.50)	5.72	6.86	2.00	1112.43
	30	91.66(76.25)	5.41	6.55	1.53	1095.70
	40	90.00(75.69)	4.52	4.88	1.20	849.60
	50	61.66(51.80)	3.55	5.70	1.13	571.86
CD at 5%		15.32	1.63	0.83	0.96	234.13
Cow Pea	0	100.00(90.00)	8.74	8.82	10.60	1757.33
	10	98.33(85.69)	9.44	10.54	12.60	1964.50
	20	98.33(85.69)	7.43	8.09	8.80	1524.36
	30	95.00(79.54)	4.78	6.96	5.80	1112.96
	40	85.00(67.70)	6.24	7.04	6.00	1126.60
	50	75.00(60.07)	7.67	5.70	4.73	994.73
C.D at 5%		11.63	-	2.46	2.75	411.03

*Figures in parenthesis are transformed values

concentration and thereafter it decreased with the increase of leachate concentration (Table 2). Maximum germination (86.66%) recorded at 20% leaf leachate concentration was statistically at par with 0, 10 30 and 40% but significantly different from 50% leaf leachate concentration. Sheikh et al. (1983) reported that leaf extract of Poplar reduced the germination of winter crops. Maximum shoot length (4.27 cm) recorded in 20% leaf leachate concentration was significantly different from 50% but at par with rest of leaf leachate concentrations. Thus a stimulatory effect was observed up to 20% leaf leachate concentration, thereafter an antagonistic effect was observed. Length of root observed maximum (5.72 cm) in control was significantly different from all other treatments. Number of secondary roots recorded maximum (8.26) in control was at par with 10 and 20% but significantly different from 30, 40 and 50% leaf leachate concentrations. Thus there was an

Table 2: Effect of aqueous leaf extract of *P. deltoides* on germination and seedling growth of chilies, knol-khol and broad beans.

Crop	Aqueous leaf conc. (%)	Germination (%)	Length of shoot (cm)	Length of root (cm)	Number of secondary roots	Vigour index
Chilies	0	83.33(65.95)	3.62	2.48	5.33	507.90
	10	83.33(66.63)	4.52	1.75	4.13	522.53
	20	80.00(63.73)	3.14	1.08	5.00	338.93
	30	85.00(67.40)	2.56	1.02	5.06	305.70
	40	83.00(66.25)	2.58	0.72	3.80	276.36
	50	68.33(56.26)	3.12	0.78	2.73	269.96
C.D. at 5%		-	0.61	0.40	1.62	97.85
Knol -khol	0	76.66(61.91)	4.07	5.72	8.26	752.73
	10	83.33(66.25)	3.80	3.03	8.00	570.36
	20	86.66(68.66)	4.27	1.86	7.00	530.83
	30	81.66(64.99)	3.07	1.30	3.13	362.66
	40	80.00(63.54)	3.02	1.20	2.93	336.30
	50	53.33(46.95)	1.58	0.26	2.33	89.13
C.D. at 5%		11.13	1.46	0.99	2.99	176.44
Broad beans	0	53.33(47.57)	5.36	7.69	10.46	656.66
	10	50.00(45.16)	4.94	6.95	8.93	575.76
	20	50.00(45.08)	4.39	5.99	7.46	505.06
	30	46.66(43.05)	3.61	5.00	6.00	404.96
	40	41.66(40.11)	2.78	4.52	3.93	301.43
	50	13.33(21.33)	2.04	1.94	3.00	53.90
C.D. at 5%		-	0.86	1.73	1.69	241.24

*Figures in parenthesis are transformed values

antagonistic effect observed in this case. Maximum vigour index (570.36) recorded in 10% leaf leachate concentration was at par with 0 and 20% but significantly different from 30, 40 and 50% leaf leachate concentration. There was an antagonistic effect beyond 10% leaf leachate concentration. Bisla et al. (1992) reported that higher concentrations of leaf leachate extract of Poplar had an inhibitory effect on vigour index, shoot and root length in lentil, chick pea and wheat.

Broad beans

Except for germination, significant differences were observed in all the parameters studied (germination was recorded to be maximum 53.33% in 0% leaf leachate concentration but it was statistically non significant). Maximum length of shoot (5.36cm) recorded in 0% (control) leaf leachate concentration was at par with 10% but

significantly different from other leaf leachate concentrations (Table 2). Bisla et al. (1992) has reported a similar inhibitory effect on shoot length of lentil, chick pea and wheat with Poplar leaf extract. Maximum length of roots (7.69 cm) was at par with 10 and 20% but significantly different from 30, 40 and 50% leaf leachate concentration. Maximum number of secondary roots (10.46) was at par with 10% but significantly different from other leaf leachate concentrations. Maximum vigour index of 656.66 recorded in control was at par with 10 and 20% but significantly different from 30, 40 and 50% leaf leachate concentrations. Thus, there was an antagonistic effect on all the parameters studied. A similar inhibitory reaction was noticed by Shoup and Witcomb (1981) for poplar trees on agricultural crops, likewise Padhay et al. (1992) also reported similar observations in finger millet with leaf leachate of *Eucalyptus globulus*. According to Rice (1984) chemicals that inhibit the growth of some species at certain concentrations can stimulate the growth of the same or different species at other concentrations.

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