Print : ISSN 0970-7662

Journal of Tree Sciences
online available at www.ists.in

Volume 30 No.1&2 June & December, 2011

Allelopathic Effect of Important Agroforestry Tree Species of Western Himalaya on Field Crops

R. Kaushal[1],K.S. Verma[2], P. Panwar[3] and O.P. Chaturvedi[1]

[1]Central Soil and Water Conservation Reserach & Training Institute, Dehradun;[2]Department of Silviculture and Agroforestry; Dr. Y.S. Parmar University of Horticulture & Forestry, Nauni-173 230 (H.P.); [3]Central Soil and Water Conservation Reserach & Training Institute, Research Centre Chandigarh.
Email: kaushalrajesh1@rediffmail.com

Key words:

Bean, chickpea, inhibition, leachates, maize, plumule, promotory, radicle, soybean, wheat.

ABSTRACT

Aqueous leachates of *Grewia optiva, Morus alba, Toona ciliata* and *Populus deltoides* leaves were evaluated for allelopathic effects on germination and growth of five field crops viz. chickpea (*Cicer arietinum*), wheat (*Triticum aestivum*), maize (*Zea mays*), bean (*Phaseolus vulgaris*) and soybean (*Glycine max*). The test crops were treated with 1, 2, 3, 4 and 5% leachates of tree leaves. Aqueous leachates of different tree species were found to reduce the germination of chickpea, wheat, bean and soybean at all the concentrations. In maize, however, germination was enhanced by 5 % when applied with aqueous leachate of *T.ciliata* and *P. deltoides*. Aqueous leachates of *M. albaat* lower concentration were found to stimulate the growth parameter of maize and soybean. Seedling growth parameters were found to reduce drastically at higher concentrations of aqueous leaf leachates. The maximum reduction was observed when field crops were applied with aqueous leachates of *P. deltoides*.

INTRODUCTION

In agroforestry, litter from the tree releases chemical substances (allelochemicals) in the soil, on coming in contact with rainwater, dew and mist in aqueous form as leachates. These leachates play a major role in the basic metabolism of the plants and affect numerous physiological and biochemical processes in the plants (Narwal 1994; Rice 1984). These leachates inhibit or promote the germination, growth and yield of receiver plants and this phenomenon is called allelopathy. In crop production, allelopathy is related to soil sickness, autotoxicity, yield decline, pre-disposition of plants to diseases, reduced nitrification, nutrient uptake and weed interference with crops. The effect of allelochemicals however, is dependent principally upon the concentration as well as in combination, in which one or more of the substances are released into the environment (Putnam and Tang 1986). The present study was undertaken to determine allelopathic effect of important agroforestry tree species of western Himalaya on major field crops.

MATERIALS AND METHODS

The pot culture study was carried out in the experimental laboratory of the Department of Silviculture and Agroforestry, Dr. Y.S. Parmar University of Horticulture & Forestry, Nauni-Solan,

(H.P.) India. Mature leaves of *Grewia optiva*, *Morus alba*, *Toona ciliata* and *Populus deltoides* were collected from the trees in the farmers fields. 200 g leaves of each tree species were soaked in 1000 ml water for 24 hours. The leachates thus obtained were filtered through Whatman No 1 filter paper and stored in refrigerator until required. These leachates were further diluted to 1, 2, 3, 4 and 5 per cent of the original leachate concentration with tap water. The effect of the leachates on seed germination and seedling growth were tested by placing 20 seeds of each crops viz., chickpea (*Cicer arietinum*) and wheat (*Triticum aestivum*), maize (*Zea mays*), bean (*Phaseolus vulgaris*) and soybean (*Glycine max*) in plastic pots. Pots were filled with soil collected from below the tree canopy of the respective trees. Soil in the pots was moisten by adding leachates before sowing the seeds. Control was also set up where tap water was added in place of leachates. Moisture in the pots was maintained by adding leachates/water when required. Germination was recorded after 24 hours interval upto 7 days till no more seed germinated. After germination of seeds, only 5 seedlings were retained per pot for recording growth parameters. Root and shoot length were measured 30 days after sowing of the seeds. Plants were uprooted after 30 days of sowing and kept for drying in oven at $65\pm2^{\circ}$C till constant weight was attained. The experiment was conducted in Complete Randomized Design (CRD) and the data was analysed statistically.

RESULTS AND DISCUSSION

Aqueous leachates of different tree species were found to reduce the germination of chickpea, wheat, bean and soybean at all the concentrations (Fig. 1). In maize, however, germination was enhanced by 5 % when applied with aqueous leachate of *T. ciliata* and *P. deltoides*. Amongst the test crops, maximum inhibition was observed in bean when treated with 5 % aqueous leachate of *T. ciliata*. Results further revealed that inhibitory effect on germination of all test crops increased with increase in aqueous leachate concentration (Fig. 1).

Aqueous leachate concentration of different tree species were found to reduce the shoot length of chickpea (Table 1). Dry weight of chickpea was stimulated when supplied with 1 % aqueous leachate concentration of *M. alba* and *T. ciliata*. However, all other concentration of different the tree species inhibited the dry weight of chickpea. In wheat, stimulatory influence of leachate of *M. alba* was observed atlower concentration (1 and 2 %) was observed on shoot and root length (Table 2). Dry weight of wheat, at 1 % concentration of *M. alba* was same as that of control. Dry matter of wheat however, was stimulated when supplied with aqueous leachate of *T. ciliata* at 1 % concentration.

Seedling growth parameters in maize (Table 3) showed stimulatory effect when supplied with, aqueous leachates of *M. alba* (1 and 2 %) and *G. optiva* (1 %).Contrarily, all other aqueous leachates treatments were found to reduce the growth parameters of maize. In bean, aqueous leachates of all the four tree species reduced the seedling growth parameters except at 1 % concentration of *T. ciliata* which was found to stimulate the dry matter of bean (Table 4). Further, it was observed that *P. deltoides* had most depressing effect on dry matter of bean. In soybean, shoot and root length were stimulated when supplied with aqueous leachates at lower concentration (1%) of *G. optiva*, *M. alba* and *T. ciliata* (Table 5). *P. deltoides* aqueous leachates at all the concentrations however, had inhibitory effect on all the growth parameters of soybean.

The results indicated selective germination response of test crops to the different tree leachates thus indicating that the allelopathic effects were selective and species dependent. Allelochemicals affects cell division, cell elongation and metabolic process thereby inhibiting normal growth (Moreled and Novitsy 1987). Reduction in germination of soybean with aqueous extract of *Grewia* was also reported by Melkania (1984) and Bhatt et al. (1993). *P. deltoides* overall showed inhibitory effect on all the growth parameters of test crops. Negative impact of *P. deltoides* on field crop can be attributed to the phytotoxic and phenolics inhibitory compounds present in its leaf and soil below its canopy (Singh et al. 1998; Singh et al. 2001). Inhibition in germination and growth of wheat and chickpea due to *P. deltoides* extract was also

Table 1: Effect of aqueous extract on growth and dry matter of chickpea

Treatment	Shoot length (cm)				Root length (cm)				Dry weight/ plant (g)			
	Grewia	*Morus*	*Toona*	*Populus*	*Grewia*	*Morus*	*Toona*	*Populus*	*Grewia*	*Morus*	*Toona*	*Populus*
1%	9.82	9.59	10.15	8.94	5.50	5.58	5.80	4.97	0.57	0.70	0.75	0.47
2%	8.52	8.96	9.51	7.71	4.80	5.21	5.43	4.29	0.47	0.58	0.65	0.39
3%	7.22	7.67	8.17	6.48	4.08	4.46	4.67	3.60	0.43	0.57	0.61	0.36
4%	6.30	6.74	7.22	5.61	3.56	3.92	4.13	3.12	0.33	0.45	0.52	0.26
5%	5.19	5.63	6.08	4.55	2.93	3.28	3.47	2.53	0.27	0.40	0.47	0.19
Control	10.37	10.37	10.37	10.37	5.86	5.86	5.86	5.86	0.63	0.63	0.63	0.63
SE	0.54	0.45	0.47	0.51	0.30	0.26	0.27	0.28	0.07	0.06	0.07	0.06
$CD_{0.05}$	1.13	0.94	0.98	1.06	0.63	0.55	0.56	0.59	0.14	0.13	0.14	0.13

Table 2: Effect of aqueous extract on germination, growth and dry matter of wheat

Treatment	Shoot length (cm)				Root length (cm)				Dry weight/ plant (g)			
	Grewia	*Morus*	*Toona*	*Populus*	*Grewia*	*Morus*	*Toona*	*Populus*	*Grewia*	*Morus*	*Toona*	*Populus*
1%	13.44	14.78	12.94	12.99	4.20	5.28	4.79	4.33	0.47	0.53	0.58	0.42
2%	13.00	14.33	12.50	12.55	4.06	5.12	4.63	4.18	0.37	0.41	0.49	0.34
3%	11.78	13.11	11.28	11.33	3.68	4.68	4.18	3.78	0.33	0.37	0.45	0.30
4%	8.78	10.11	8.28	8.33	2.74	3.61	3.07	2.78	0.28	0.33	0.39	0.25
5%	7.56	8.89	7.06	7.11	2.36	3.18	2.61	2.37	0.23	0.28	0.34	0.20
Control	13.33	13.33	13.33	13.33	4.76	4.76	4.76	4.76	0.53	0.53	0.53	0.53
SE	0.52	0.52	0.50	0.58	0.17	0.19	0.19	0.18	0.05	0.05	0.06	0.05
$CD_{0.05}$	1.10	1.09	1.02	1.15	0.34	0.39	0.40	0.36	0.11	0.11	0.12	0.11

reported by Melkania (1984) and Kausha let al.(2003). Tomaszcnski and Thimanin (1966) also reported reduced growth of field crops due to excess phytotoxins by *Eucalyptus* leachates which inhibited Gibberlin and IAA, induced growth. Reduction in the growth of soybean (Bhardwaj 1993; Bhatt and Todaria 1990), wheat (Kaur and Roa 1998) and bean (Puri and Khara 1991) was also observed due to different leaf leachate concentrations.

The more inhibitory effect by *Populus* may also be attributed to the hightanin content in the former (Lohan et al. 1980) which can suppress nitrifying bacteria (Rice and Pancholy 1973) and affects the growth and germination of field crops.

Table 3: Effect of aqueous extract on germination, growth and dry matter of maize

Treatment	Shoot length (cm)				Root length (cm)				Dry weight/ plant (g)			
	Grewia	*Morus*	*Toona*	*Populus*	*Grewia*	*Morus*	*Toona*	*Populus*	*Grewia*	*Morus*	*Toona*	*Populus*
1%	40.33	44.33	38.83	38.98	13.91	14.54	12.14	11.81	1.57	1.80	1.74	1.27
2%	39.00	43.00	37.50	37.65	13.45	14.10	11.72	11.41	1.47	1.63	1.59	1.19
3%	35.33	39.33	33.83	33.98	12.18	12.90	10.57	10.30	1.27	1.40	1.44	1.05
4%	26.33	30.33	24.83	24.98	9.08	9.95	7.76	7.57	0.87	1.13	1.05	0.65
5%	22.67	26.67	21.17	21.32	7.82	8.74	6.62	6.46	0.64	0.93	0.82	0.44
Control	40.00	40.00	40.00	40.00	13.67	13.67	13.67	13.67	1.77	1.77	1.77	1.77
SE	1.57	1.56	1.47	1.51	0.59	0.56	0.54	0.53	0.09	0.12	0.09	0.09
$CD_{0.05}$	3.29	3.28	3.08	3.17	1.23	1.18	1.14	1.11	0.18	0.24	0.19	0.19

Table 4: Effect of aqueous extract on germination, growth and dry matter of bean

Treatment	Shoot length (cm)				Root length (cm)				Dry weight/ plant (g)			
	Grewia	*Morus*	*Toona*	*Populus*	*Grewia*	*Morus*	*Toona*	*Populus*	*Grewia*	*Morus*	*Toona*	*Populus*
1%	17.67	17.27	17.77	16.99	8.83	8.01	8.46	7.29	0.70	0.68	0.90	0.40
2%	15.33	16.13	16.63	14.65	7.67	7.50	7.92	6.29	0.53	0.60	0.73	0.30
3%	13.00	13.80	14.30	12.32	6.50	6.42	6.81	5.23	0.40	0.55	0.60	0.27
4%	11.33	12.13	12.63	10.65	5.67	5.64	6.02	4.57	0.27	0.42	0.47	0.16
5%	9.33	10.13	10.63	8.65	4.67	4.71	5.06	3.71	0.20	0.35	0.40	0.16
Control	18.67	18.67	18.67	18.67	9.33	9.33	9.33	9.33	0.76	0.76	0.76	0.76
SE	0.96	0.81	0.83	0.96	0.48	0.38	0.40	0.42	0.07	0.06	0.07	0.07
$CD_{0.05}$	2.02	1.70	1.74	2.03	1.01	0.80	0.83	0.88	0.15	0.12	0.14	0.15

Shrivastava *et al.* (1981) and Shrivastava and Gupta (1983) also observed that tanins present in *Adina cardifolia* were responsible for lower germination and growth of soybean.

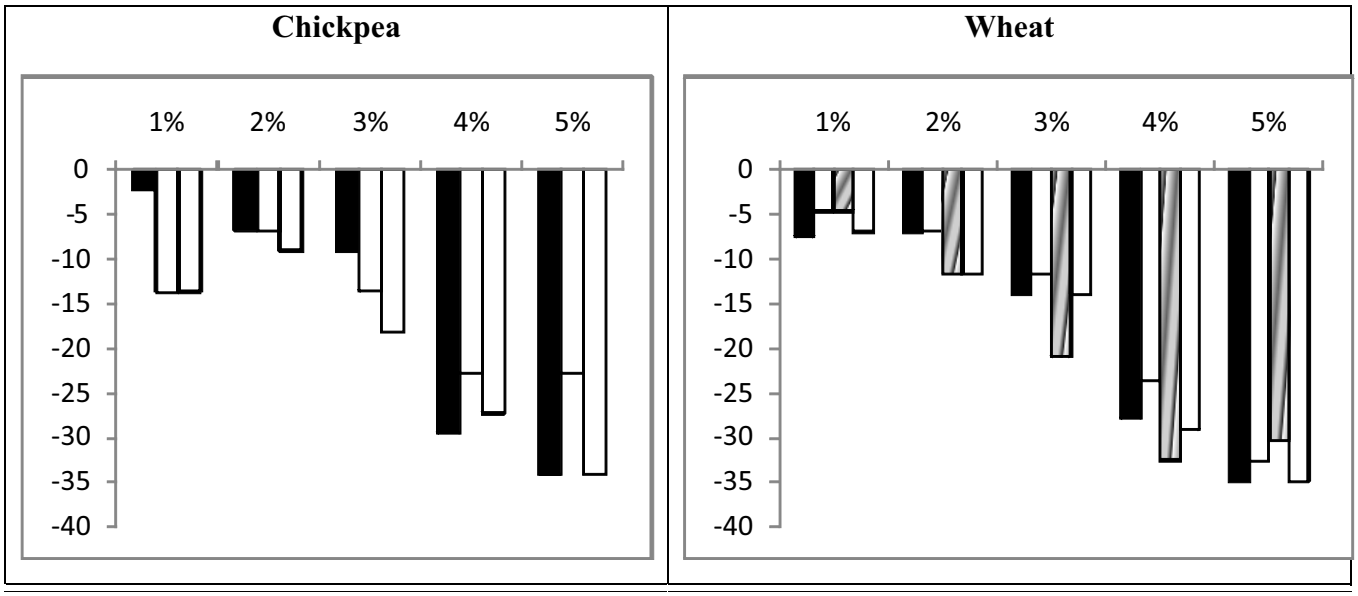
Kaushal *et al.* (2006) also reported inhibitory effect of *M. alba* and *T. ciliata*leachates on different field crops.Enhancing or promotory effect of *M. alba* and *G. optiva*leachates on growth of field crops at lower concentration (1 and / or 2% leachate) can be attributed to the interactions of chemical substances present in leachates with those present in seeds, which in turn might have brought down concentration of inhibitory substances. Aqueous leachates of *M. alba* were reported to stimulate the radical and plumule growth of chickpea in petri dishes. Stimulatory

Table 5: Effect of aqueous extract on germination, growth and dry matter of soybean

Treatment	Shoot length (cm)				Root length (cm)				Dry weight/ plant (g)			
	Grewia	*Morus*	*Toona*	*Populus*	*Grewia*	*Morus*	*Toona*	*Populus*	*Grewia*	*Morus*	*Toona*	*Populus*
1%	26.67	28.67	26.83	25.00	15.69	17.06	15.51	14.20	1.03	1.17	1.27	0.86
2%	22.00	25.00	22.67	20.43	12.94	14.88	13.10	11.61	0.86	1.07	1.17	0.70
3%	20.00	22.33	20.67	18.00	11.76	13.29	11.95	10.23	0.73	0.93	1.03	0.56
4%	16.00	19.00	17.50	15.33	9.41	11.31	10.12	8.71	0.53	0.80	0.80	0.36
5%	13.67	17.33	15.17	12.00	8.04	10.32	8.77	6.82	0.39	0.58	0.67	0.20
Control	26.00	26.00	26.00	26.00	15.00	15.00	15.00	15.00	1.06	1.06	1.06	1.06
SE	1.32	1.06	1.56	1.10	0.77	0.63	0.90	0.63	0.07	0.09	0.07	0.07
$CD_{0.05}$	2.78	2.22	3.28	2.32	1.62	1.33	1.90	1.33	0.15	0.18	0.15	0.15

Shrivastava *et al.* (1981) and Shrivastava and Gupta (1983) also observed that tanins present in *Adina cardifolia* were responsible for lower germination and growth of soybean.

Kaushal *et al.* (2006) also reported inhibitory effect of *M. alba* and *T. ciliata*leachates on different field crops.Enhancing or promotory effect of *M. alba* and *G. optiva* leachates on growth of field crops at lower concentration (1 and / or 2% leachate) can be attributed to the interactions of chemical substances present in leachates with those present in seeds, which in turn might have brought down concentration of inhibitory substances. Aqueous leachates of *M. alba* were reported to stimulate the radical and plumule growth of chickpea in petri dishes. Stimulatory behaviour was also observed for soybean due to allelopathic interactions of adjacent *Alnus nepalensis* trees (Singh and Kumar 1987).In petridish studies, leachates of *G. optiva* and *P.*



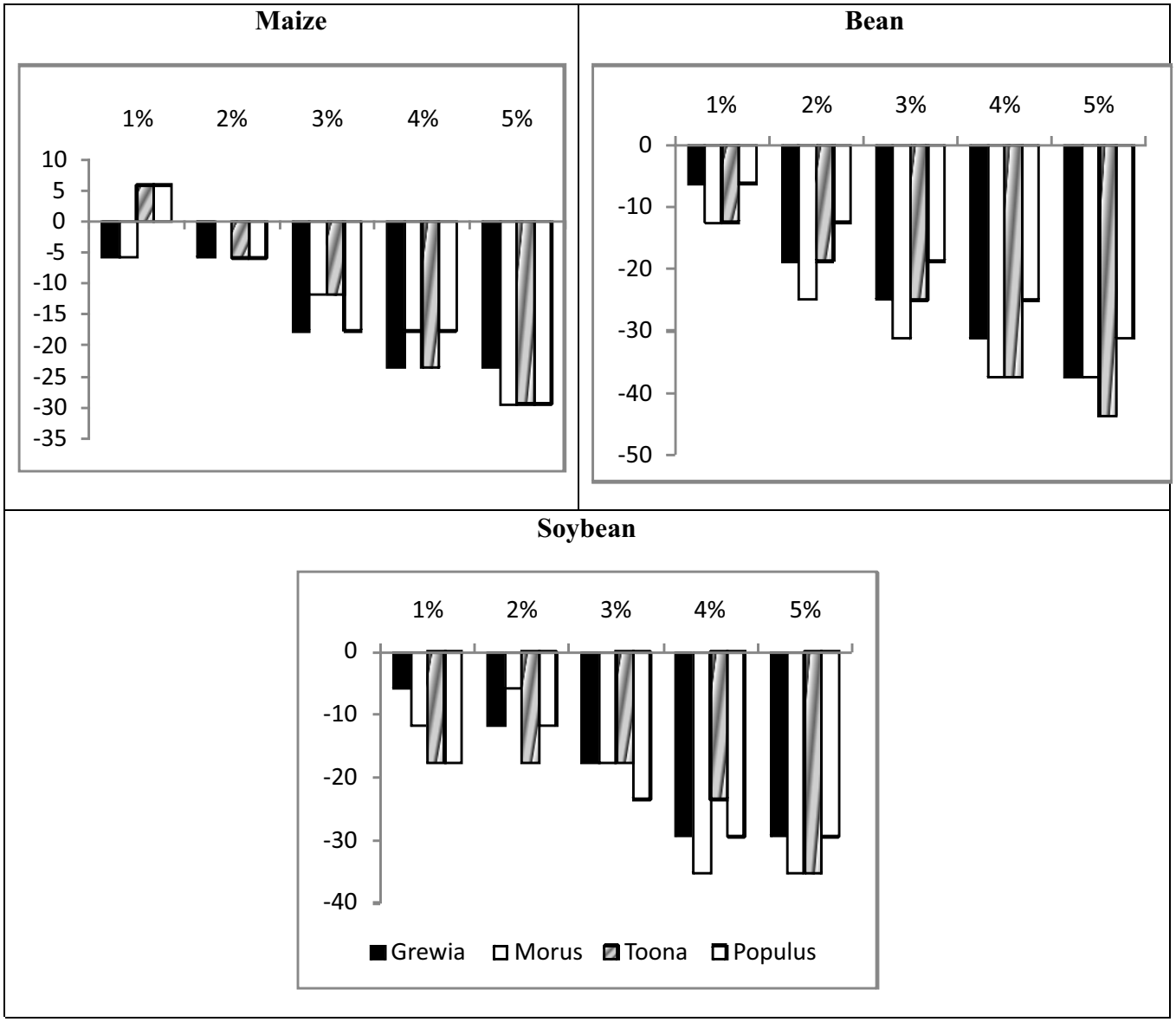


Fig. 1. Effect of aqueous leachates on the germination of various field crops.

deltoides were found to stimulate the germination of maize at lower concentration (Kaushal *et al.* 2003).

REFERENCES

Bhardwaj SD 1993 Effect of leaf leachatee of *Robonia pseudoacacia* on seed germination and growth of some agricultural crops. *Indian Journal of Forestry* **16**:285-286.

Bhatt BP and Todaria NP 1990 Studies on allelopathic effects of some agroforestry tree crops of Garhwal Himalaya. *Agroforestry Systems* **12**:251-255.

Bhatt BP, Chauhan DS and Todaria NP 1993 Phytotoxic effect of tree crops on the germination and radicle extension of some food crops. *Tropical science* **33**(1): 69-73.

Kaur A and Rao PB 1998 Effect of the tree leaf leachates on germination of certain varieties of wheat. *Indian Journal of Environment Science* **2**(1): 29-34.

Kaushal R, Verma KS and Singh KN 2003 Effect of

*Grewia optiva*and *Populus deltoids* leachates on field crops. *Allelopathy Journal.* **11(2)**: 229-234.

Kaushal R, Verma KS and Singh KN 2006 Allelopathic effect of *Morus alba*and*Toona ciliata* on germination and seedling growth of field crops. *Indian Journal of Forestry.* **29 (4)**: 385-388

Lohan OP, Lall D, Pal RN and Negi SS 1980 A note on tanins in tree fodders. *Indian Journal of Animal Science* **50**: 881.

Melkania NP 1984 Influence of leaf leachates of certain wood species on agricultural crops. *Indian. Journal. of Ecology* **11**: 82-86.

Moreled DE and Novitsy WP 1987 Interference by luteolin, quercein and taxifolin with chloroplast-mediated electron transcript and phosphorylation. *Plant and Soil* **98***: 145-150.*

Narwal SS 1994 Allelopathic related problems in crop production, agroforestry and horticulture. Proceedings of the International conference on Allelopathy. **Vol 1**. In :Allelopathy Field Observation and Methodology (Narwal, S.S. and Tauro, P., eds) Scientific Publishers. Jodhpur / India.

Puri S and Khara A 1991 Allelopathic effect of *Eucalyptus tereticornis* on *Phaseolus vulgaris* seedlings. *The International Tree Crop Journal* **6**:287-293

Putnam AR and Tang CS 1986 The Science of Allelopathy. Willey Inter Science, New York, USA.

Rice EL1984 Allelopathy. New York. Academic Press. 422. pp. **2nd ed**.

Rice EL and Pancholy SK 1973 Inhibition of nitrification by climax ecosystem. II. Addition evidence on possible role of tanins. *American Journal of Botany* **60**: 691-702.

Shrivastava SK and Gupta RK 1983 Flavanoids from *Adina cardifolia*Roxb. *Indian Journal of Chemistry* **22B**(10):1064.

Shrivastava SK, Gupta RK and Shrivastava SD1981 A new flavanone from *Adina cardifolia. Indian Journal of Chemistry***20B**(9):833.

Singh HP, Kohli RK and Batish DR 1998 Effect of Poplar (*Populus deltoides*) shelterbelt on the growth and yield of wheat in Punjab, India. *Agroforestry Systems* **40**: 207-213.

Singh HP, Kohli RK and Batish DR 2001 Allelopathic influence of *Populusdeltoides* with some winter season crops. *Agronomie* **21**: 139-146

Singh SK and Kumar S 1987 Allelopathy interaction of *Alnusnepalensis* on seed germination and root shoot length of soybean. *Indian Journal of Agriculture Science* **57**: 371-372.

Tomaszewski M and Thimanin KV1966 Interaction of phenolic acids, metabolic ions and chelating agents on auxin induced growth. *Journal of Plant Physiology* **41**: 1443-1454.