Range Mgmt. & Agroforestry 31 (1) : 27-30, 2010
ISSN 0971-2070

Allelopathic effect of *Phyllanthus emblica* on germination and growth of field crop

Bhupendra Singh, Sunil Bhatt and Pooja Uniyal
Department of Forestry, Post Box- 59, H.N.B. Garhwal University, Srinagar (Garhwal)-246 174, Uttarakhand, India,
Corresponding author e-mail : butola_bs@yahoo.com
Received : 30th January, 2009 Accepted :20th January, 2010

Abstract

In the present study the leachates leaf, bark and fruit pulp of *Phyllanthus emblica* were used for observing their allelopathic effects on germination and growth of *Eleusine coracana*, *Phaseolus mungo*, *Setaria italica* and *Amaranthus caudatus*. The higher concentration (10.0%) of leaf leachate showed maximum (100.0%) reduction in germination and growth of *A. caudatus*. Lower concentration (2 %) of bark leachates inhibited maximum (47.00%) germination of *S. italica.* Bark leachate (2%) stimulated 15.55 & 37.04% radicle and plumule growth of *S. italica* and *A. caudatus*, respectively. Fruit pulp of *P. emblica* was more toxic for *A. caudatus* and drastically inhibited the germination and growth. Leaf leachate of *P. emblica* were more toxic for germination and growth of all the test crops.

Key words: *Amaranthus caudatus, Eleusine coracana*, Germination and growth, *Phaseolus mungo*, *Setaria italica, Phyllanthus emblica*

Introduction

Allelopathy as a natural phenomenon in plantï plant interaction plays an important role in ecological activity of a system. Rice (1984) defined the allelopathy phenomenon as process by which plants release chemical compounds in their environment, to keep themselves with a competitive advantage (Kong *et al*., 2004). Trees commonly reared in home gardens are rich sources of secondary metabolites. Some of them may act as allelochemicals in the systems. The accumulation of tree part *i.e.* leaf, small twigs, bark and fruits on soil in agroforestry systems have deleterious effects on the germination and growth of crops (Rice, 1984).

Phyllanthus emblica L. (V. Anwla or Aonla) is a deciduous tree of the family Euphorbeaceae, a native of India and widely growing in woodlands and bund of agricultural field of Garhwal Himalaya (Gaur, 1999). Aonla is a potential cash-generating tree and has multiple uses in the mountain farms as well as houses. However, looking at high contents of secondary metabolites in different plant parts present study was carried out to investigate the allelopathic behaviour of Aonla on field crops of Garhwal Himalaya.

Materials and Methods

The plant parts *i.e.* leaf, bark and fruits pulp of *P. emblica* used in the experiments were collected from naturally growing trees in agricultural fields. The fresh plant parts were cleaned with tap water to remove soil and dirt and dried in shade under laboratory conditions. The dried plant material were chopped into small pieces with sharp knife and further dried in oven at 50^{0}C for 48 h and grind with electrical grinder.

Bioassay

For investigation, the seeds of different test crops *i.e. Eleusine coracana*, *Phaseolus mungo*, *Setaria italica* and *Amaranthus caudatus* (local variety) were collected and allelopathic activities of different concentration of *P. emblica* (leaf, bark and fruit pulp) were studied. 2g, 5g and 10g powder of leaf, bark and fruit pulp of *P. emblica* each were added to 100 ml distilled water, properly mixed and left for 48 hours at room temperature (25±2^{0}C). to make, 2%, 5% and 10% w/v aqueous leachates for each component separately. The resulting lechate were filtered through three layers of Whatman no.1 filter paper and stored in conical flasks. The effect of leachate on seed germination, seed growth after 7days were tested by placing 100 seeds (five replications of 20 seeds each) of each test crop in petri dishes (9 cm dia. meter) containing two layers of Whatman no.1 filter paper saturated with particular extract at 25^{0}C prefixed in seed germinator. A separate control series was set up using distilled water. Moisture in the petri dishes was maintained by adding about one ml of extract or distilled water was added daily. The number of seeds germinated were counted daily upto 7 days because after this, radicle in petri dishes normally start shriveling at their tips and any further reading could introduce errors to the data. The data of germination, radicle and plumule growth were statistically analyzed using Duncanõs multiple range tests which were computed on the basis of ANOVA (Minitab software, 2003 vs13.2).

Results and Discussion

Germination

The effect of *P. emblica* leaf, bark and fruit pulp leachates were studied on germination of test crops (Table 1). Leaf leachate (2%) showed maximum (36.36 & 46.76%) reduction in germination of *E. coracana* and *P. mungo*. However, germination of *S. italica* was significantly inhibited by 2 and 10% leaf leachate. While, leaf leachates (10.0%) showed maximum (100.0%) reduction in germination of *A. caudatus* as compared to control. The higher (10%) concentration of bark leachates completely inhibited the germination of *E. coracana*, while the two other concentrations stimulate the germination of *E. coracana*. The germination of *A. caudatus* was significantly inhibited by all the concentration but no significant difference was found between different concentrations. Bark leachate (2%) caused maximum (47.00 %) reduction in germination of *S. italica.* On the other hand it was interesting to see that 2% bark extract stimulated (33.33%) germination in *A. caudatus* as compared to control. Fruits pulp of *P. emblica* was more toxic and completely checked germination of *A. caudatus.*

Radicle and plumule growth

Table 2 depicts the data of allelopathic effects of *P. emblica* on seedling growth after 7 days germination of test crops. The leaf leachates significantly (P<0.05) inhibited the radicle and plumule growth of all the test crops. However no significant difference was found between different concentrations of leaf leachates. Leaf leachate (10%) of *P. emblica* exhibited maximum (100.0%) reduction in radicle and plumule growth of *A. caudatus*. Bark leachate (10%) caused maximum (86.56%) reduction in radicle growth of *A. caudatus* and 2 % bark leachate reduced maximum (83.85%) plumule growth of *P. mungo*, while 2 % bark leachate effected maximum (15.55 & 37.04%) stimulation in radicle and plumule growth of *S. italica* and *A. caudatus*, respectively. Fruit pulp leachates of different concentration were more toxic and it completely checked radicle and plumule growth of test crops.

Table 1. Effects of *P. emblica* on seed germination percentage of different test crops

Leachetes contration (%)		*E. coracana* Germination (%)	*P. mungo* Germination (%)	*Setaria italica* Germination (%)	*Amaranthus caudatus* Germination (%)
	Control	82.50±2.89ᵃ	85.0±7.07 ᵃ	50.0±14.14 ᵃ	67.50±3.54 ᵃ
	2	52.50±6.45 ᵇ	45.25±3.54 ᵇ	13±0.00 ᵇ	12.50±10.61 ᵇ
Leaf		(36.36)	(46.76)	(74.00)	(81.48)
	5	70.0±14.72 ᵃ	70.0±4.24 ᵃᶜ	37.0±14.14 ᵃ	5.0±0.00 ᵇ
		(15.15)	(17.65)	(26.00)	(92.59)
	10	80.75±2.50 ᵃ	56.50±23.3 ᵇᶜ	13±0.00 ᵇ	0.00 ᵇ
		(2.12)	(33.53)	(74.00)	(100.00)
	Control	82.50±2.89ᵃ	85.0±7.07 ᵃ	50.0±14.14 ᵃ	67.50±3.54 ᵇ
	2	86.25±4.79 ᵃ	70.0±14.14 ᵇ	26.50±19.09ᶜ	90.0±14.14 ᵃ
Bark		(-4.55)	(17.65)	(47.00)	(-33.33)
	5	90.0±7.07 ᵇ	73.50±19.09 ᵇ	30.0±24.0 ᵇ	72.50±10.61 ᵇ
		(-9.09)	(13.53)	(40.00)	(-7.41)
	10	82.50±9.57 ᵃ	73.50±9.19 ᵇ	40.0±9.90 ᵃ ᵇ	75.0±21.21 ᵇ
		(0.00)	(13.53)	(20.00)	(11.11)
	Control	82.50±2.89ᵃ	85.0±7.07 ᵃ	50.0±14.14 ᵃ	67.50±3.54 ᵃ
	2	0.00 ᵇ	16.67±4.72 ᵇ	26.50±9.19 ᵃ	0.00 ᵇ
Fruit pulp		(100.0)	(80.39)	(47.00)	(100.00)
	5	18.75±10.31 ᵇ	16.67±4.72 ᵇ	16.84±14.38 ᵇ	0.00 ᵇ
		(77.27)	(80.39)	(66.32)	(100.00)
	10	30.0±21.61 ᵇ	13.33±0.00 ᵇ	0.00 ᵇ	0.00 ᵇ
		(63.64)	(84.32)	(100.00)	(100.00)

Means for a seed germination of test crop same letter within a row indicate no significant statistical difference between treatments (p < 0.05).

Value in parentheses indicate percentage reduction from control.

Table 2 : Effect of *P. emblica* on seedling growth (7 days) attributes of different test crops

Leachates		*Eleusine coracana*		*Phaseolus mungo*		*Setaria italica*		*Amaranthus caudatus*	
contraction %		Radicle	Plumule	Radicle	Plumule	Radicle	Plumule	Radicle	Plumule
	Control	4.67±0.40^{a}	2.69±0.03^{a}	6.25±0.75^{a}	13.19±2.36^{a}	2.7±1.08^{a}	2.6±0.95^{a}	4.54±0.48^{a}	3.78±0.03^{a}
Leaf	2	1.25±0.23^{b}	1.95±0.01^{b}	3.62±1.36^{b}	3.98±3.99^{b}	1.12±1.11^{b}	1.38±0.18^{b}	2.03±0.11^{b}	2.48±0.11^{ab}
		(73.23)	(27.50)	(47.84)	(69.82)	(58.51)	(46.92)	(55.29)	(34.39)
	5	0.58±.52^{b}	1.70±0.07^{b}	1.90±0.03^{b}	1.39±1.51^{b}	0.40±0.21^{b}	1.30±0.57^{b}	1.1±0.05^{b}	1.4±0.08^{b}
		(87.58)	(36.80)	(69.6)	(89.46)	(85.18)	(50)	(75.77)	(62.96)
	10	0.28±0.04^{b}	1.41^{b}	3.39±2.87^{b}	2.80±0.48^{b}	.58±0.11^{b}	1.33±0.18^{b}	0.00^{b}	0.00^{b}
		(94.00)	(47.58)	(45.76)	(78.77)	(78.51)	(48.8)	(100)	(100)
	Control	4.67±0.40^{a}	2.69±0.03^{a}	6.25±0.75^{a}	13.19±2.36^{a}	2.7±1.08^{a}	2.6±0.95^{b}	4.54±0.48^{a}	3.78±0.03^{b}
Bark	2	3.94±0.9^{ab}	2.69±0.13^{a}	3.09±2.05^{a}	2.13±1.36^{c}	3.12±0.23^{a}	2.31±0.22^{b}	5.14±0.25^{a}	5.18±0.45^{a}
		(15.63)	(0)	(50.56)	(83.85)	(+15.55)	(11.15)	(+13.22)	(+37.04)
	5	3.29±0.26^{b}	2.51±0.12^{ab}	6.26±0.25$^{a(-}$	8.12±2.63^{ab}	2.17±0.24^{a}	3.27±0.69^{a}	3.95±0.98^{a}	4.84±0.14^{a}
		(29.55)	(6.69)	(160)	(38.43)	(19.62)	(+25.76)	(13.00)	(+28.04)
	10	2.79±0.21^{b}	2.22±0.11^{b}	11.69±5.78^{b}	7.63±1.00^{b}	3.01±0.16^{a}	2.53±0.04^{b}	0.61±0.07^{b}	4.68±0.96^{a}
		(40.25)	(17.47)	(-87.04)	(42.15)	(+11.48)	(2.69)	(86.56)	(+23.81)
	Control	4.67±0.40^{a}	2.69±0.03^{a}	6.25±0.75^{a}	13.19±2.36^{a}	2.7±1.08^{a}	2.6±0.95^{a}	4.54±0.48^{a}	3.78±0.03^{a}
Fruit pulp	2	0.00^{b}	0.00^{b}	1.03±.11^{b}	4.76±1.71^{b}	0.17±0.01^{b}	0.58±0.25^{b}	0.00^{b}	0.00^{b}
		(100)	(100)	(83.52)	(63.91)	(93.7)	(77.69)	(100)	(100)
	5	0.32±0.16^{b}	1.20±0.36^{b}	2.14±0.62^{b}	1.19±1.47^{b}	0.22±0.12^{b}	0.18±0.16^{b}	0.00^{b}	0.00^{b}
		(93.14)	(55.39)	(65.76)	(90.97)	(91.85)	(93.08)	(100)	(100)
	10	1.14±0.46^{b}	1.36±0.15^{b}	1.08±.11^{b}	0.58±.46^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}
		(75.58)	(49.44)	(82.72)	(95.60)	(100)	(100)	(100)	(100)

Means for radicle and plumule growth of test crop same letter within a row indicate no significant statistical difference between treatments ($p < 0.05$).
Value in parentheses indicate percentage reduction from control.

This preliminary bioassay study was conducted to investigate the influence of *P. emblica* on germination and growth of important field crops and the results revealed its significance to introduction in existing agroforestry system of Garhwal Himalaya. Table 1 reveals the inhibitory effect of various leachate concentration of *P. emblica* on germination response of the field crops. Among these, fruit pulp leachate showed greater effect on *A. caudatus* and *E. coracana,* however, *S. italica* was moderately resistance while *P. mongo* was slightly affected under various categories of leachates.

Most published work has revealed that foliage leachates are potent source of toxic metabolites and their toxic effects are species specific (May and Ash, 1990, Bhatt and Todaria 1990, Bhatt *et al*., 1993 Kaletha *et al*., 1996). The results of present investigation when compared to earlier studies show that fruit pulp leachate are most toxic (*P. emblica* fruits contains tannin contents) followed by leaf leachate. Fruits of *P. emblica* are utilized in different pharmaceutical, as well as food industries. The fruit of *P. emblica* was also a valuable source for making myrobalans tans. In contrast Basotra *et al*., (2005) reported inhibitory effect of leaf and root /tubers extracts of some medicinal plants on germination and growth of food crops of Garhwal Himalaya. A large diverse allelochemicals leach out with organic and inorganic compounds such as phenolic acids, terpenoides and alkaloids (Tukey, 1970). Differential inhibitory effects of various parts of the same plant are most likely due to variability in the concentration of phytotoxic compounds in different plant tissues (Rice, 1984; Nishmura *et al*., 1982; May and Ash, 1990).

The stimulatory response of *P. emblica* on germination and growth extension of investigated field crops may be due to the low concentration of phytotoxins which might have acted as growth stimulation to seedlings of test crops. While, reduction in germination and growth under treatments of different concentration of leaf, bark and fruit pulp extracts may be due to the presence of myrobalans tans (Annonymous, 1976). These findings also indicate higher possibilities of radicle and plumule growth inhibition as compared to germination.

The study indicates that the efficacy of treatments is due to various/variable content of phytotoxins. On the basis of above findings fruit pulp and leaf leachates were found toxic to germination and growth of different test crops. On the other hand the test crops *E. coracana* and *P. mungo* were found least toxic as compared to the other two crops. These two crops *i. e. E. coracana* and *P. mungo* could be grown under canopy of *P. emblica*.

Acknowledgement

Authors gratefully acknowledge to Indian Council of Agriculture Research, New Delhi for providing financial assistance and Dinesh Raj for laboratory assistance.

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