INTERNATIONAL JOURNAL OF ADVANCES IN PHARMACY, BIOLOGY AND CHEMISTRY

Research Article

Allelopathic Potential of *Chrozophora rottleri (geis.) A.juss.* On germination and growth of some rice (*oryza sativa* l.) Cultivars

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ABSTRACT

An experiment was conducted to evaluate the allelopathic potential of aqueous extract (A.E.) of *Chrozophora rottleri* (Geis) A.Juss. on changes of seed germination, seedling growth and chlorophyll contents in three rice (*Oryza sativa* L.) cultivars viz. ADT-36, BPT and IR-20. The seeds of rice cultivars were exposed to various concentrations of (0, 5, 10, 15, 20 and 25%) shoot, root and whole plant A.E. of *C. rottleri* to analyse the impact of weed extracts on the growth of rice cultivars. Results showed that the increasing concentrations of shoot, root and whole plant A.E. of *C.rottleri* had significant effects by increasing, reductions on germination percentage, root and shoot length, their fresh and dry biomass and total chlorophyll contents. Among the parts of the weed tested, the whole plant extracts had maximum inhibitory effects on the rice cultivars followed by its roots and shoots. Further, the germination and growth was suffered more in rice cultivar ADT-36 by the weed extracts than BPT and IR-20..

Keywords: Allelopathy, Chlorophyll, *Chrozophora rottleri*, Germination, *Oryza sativa* L.

INTRODUCTION

Allelopathy is an important mechanism of plant interference by the addition of plant-produced phytotoxins to the plant environment. Many of the phytotoxic substances suspected of causing germination and growth inhibition have been identified from plant tissues and soil (Whittaker & Fenny, 1971).

Allelopathy is derived from two Greek words 'Allelon' means each other and 'pathos' means to suffer i.e., the injurious effects of one upon another. However Molisch (1937) coined this term which refers to all biochemical interactions (Stimulatory and inventory) among plants, including microorganisms. It represents the plant against-plant aspect of the broader field of chemical ecology. The term Allelopathy generally refers to the detrimental effects of higher plants of one species (the donor) on the germination, growth or development of plants of another species (the recipient) Rice (1984).

The term allelochemicals include, (a) plant biochemicals that exert their physiological/toxicological action an plant (allelopathy, auto toxicity or phytotoxicity), (b) plant biochemical that exert their physiological/toxicological action on micro-organisms and (c) microbial biochemicals that exert their physiological/ toxicological action on plants. Plants produce a large variety of secondary metabolites like phenols, tannins, terperiods, alkaloids, polyactylene, fatty acids, steroids, which have an allelopathic effect on the growth and development of the same plant or neighboring plants. Plant parts which are known to contain allelochemicals are Roots and rhizomes, Stem, Flowers/inflorescence and pollen, Fruits and seeds.

In crops field, weeds and crops mutually infer of each other, which may reduce the growth of one or both species. Rice is a staple food crops and accounts for 30-40% of cropped area. Weeds are major constraints in rice growing areas worldwide but weeds continuously created problems in the growth and yield of paddy. If the weeds not controlled, it reduces the rice yield by 30% – 50%. Although various herbicides are applied to control weeds, but recent research aim is to decrease the use of herbicides, due to their adverse effects including environmental contamination and development of herbicides resistance in weeds that threatens the sustainability of agriculture. Apart from herbicides resistance crops varieties;

allelopathy is the one of the best alternative way for sustainable agricultural management.

Allelopathy can be the most effective form of interference during the juvenile stages of the susceptible plants and allelopathic interactions play a major role in the determining the distributions of plants in nature and yield of different crops(Fisher, 1980).Hence in the present investigation an attempt has been made to determine the allelopathic potential of a weed *Chrozophora rottleri* (Geis) A.Juss. on three cultivars of rice (*Oryza sativa* L.). Root, Shoot and whole plant parts of the weed *C.rottleri* were employed to evaluate their allelopathic potential on the germination and growth responses of three cultivars of rice (*Oryza sativa* L.) *i.e.*, ADT-36, BPT-5204 and IR-20.

MATERIALS AND METHODS

The preparation of aqueous weed extracts and germination studies were followed by the methods of Padhy *et al.*, (2000) and Bhatt & Chouhan (2000). The root, shoot and whole plant of *C.rottleri* were washed thoroughly and cut in to small pieces. Each of the chopped 250g samples was ground in a mixi using distilled water. Aqueous extracts thus obtained were filtered through muslin cloth and the volume was made up-to 2.5 lr with distilled water. From this stock solution 25, 20, 15, 10, 5, and 2% solutions were prepared by adding distilled water. The extracts were stored in a deep freezer until they were used. Distilled water used as a control. The root, shoot and whole plant extracts of *C.rottleri* were prepared freshly every three days upto 12th day of bioassay germination study. Earthern pots were used for the germination of rice seeds. Three kilogram of normal garden soil used as a medium for the bioassay experiments. The seeds of three cultivars of rice were steeped in water to determine their viability those that floated were discarded. The viable seeds were sterilized for two minutes in 0.2% mercuric chloride ($HgCl_2$) solution. The seeds were then thoroughly washed with tap water and the seeds were sown to the normal garden soil in earthern pot.

Each pot was irrigated uniformly by different concentrations of weed extracts and the distilled water was used as control. Each experiment was carried out with five replicates.The extracts/water were irrigated to the pots in alternative days upto 12th day from the day of seed sown. Germination percentage was recorded on 3th day while, root and shoot length, fresh and dry weight and total Chlorophyll contents (Arnon, 1949) were recorded on 12 days after seed sown. The obtained mean values from five replicates were analyzed statistically (ANOVA followed by Tuke's multiple range test (TMRT)) to find out the significance ($P < 0.05$ Level, Zar, 1984)of the treatments on the crop.

RESULTS AND DISCUSSION

The results on the germination of the seeds of three cultivars of rice (ADT-36, BPT and IR-20) under the root, shoot and whole plant extract treatments of *Chrozophora rottleri* are given in Table-1. The seeds of rice cultivars started germinating on the third day and the maximum percentage of germination was observed on day 5th after soaking both in the control and in treatments. Aqueous extracts of root, shoot and whole plant of *C. rottleri* caused a significant inhibition on the germination of test crops over control. The intensity of inhibition differed depending upon the organ. Among the weed parts, the shoot extract caused a minimum inhibition of germination and the intensity of inhibition increased in the order from root to whole plant. As the concentration of the extract increased, the degree of inhibition on germination was increased over control. Since, 2% A.E did not show any significant stimulatory or inhibitory effects on test plant's germination, it was not used for further testing. Among the rice cultivars tested, ADT-36 Exhibited maximum inhibition and IR-20 showed lesser inhibition on germination percentage but in BPT positioned in between the two cultivars. Similar inhibition of seed germination by root, shoot and whole parts of weed extract was observed by different workers. The study of Bendall (1975) showed that the root extract of Canada thistle inhibited the germination on *Trifolium subterraneum* seed by 87%. The inhibitory effect of *Ipomea carnea* spp. *Fistulosa, Cyperus rotundus, Cynodon dactylon, Echinochloa colonum, Portulaca oleracea* and *Lagasca mollis*, on sorghum, wheat, kidney bean, rice, onion, radish and knol knoll (Jadhav *et al*., 1997; Challa and Ravindra, 1998), which are clearly supports the present findings. The inhibitory effect of stem extracts of *Polygonum orientalle* on the germination of mustard, lettuce, rice and pea (Datta and Chatterjee, 1978 and 1980); *Amaranthus retroflexus, Asclepias syriaea, Chrysanthemum vulgare* and *Datura stramonium* on cabbage, carrot, eggplant, pepper, sunflower and soybean (Qasem, 1995; Beres and Kazinczi, 2000), Whole plant extract of *Trianthema portulacastrum* inhibited the seed germination on soybean (Umarani and Selvaraj, 1996) which favors the present findings. But on the contrary Saxena and Varshney (1995) and Pope *et al*. (1985) noticed that *Cyperus rotundus* stimulated the seed germination in Pea and chickpea. The inhibitory effects of *C.rottleri* on rice cultivars may be due to the presence of higher amounts of growth inhibitory substances in the weed extracts that were released during extraction.

The results on the Root and shoot length of seedlings of rice are given in tables-2 and 3. The inhibitory effect of root, shoot and whole plant extracts of *C. rottleri* on root and shoot growth of

rice seedlings was similar to their inhibitory effect of seed germination. The stem extracts of *Trianthema portulacastrum* inhibited the seedling growth of soybean. (Umarani and Selvaraj, 1996). The aqueous extracts of aerial parts of Prunus amygdalus inhibited the growth of root and shoot length on wheat and finger millet (Pandey *et al.*, 1998). The study of Patil (1994) revealed that the leaf extracts of *Glyricidia maculata* L. inhibited the seedling growth of rice, sorghum, black gram and green gram. The leaf extract of *Faxinus micrantha* L. inhibited the growth of root and shoot length of *Raphanus sativus*, *Eleusine coracana*, *Triticum aestivum* and *Brassica campest*ris (Joshi *et al*., 1996). These studies are in compliance with the present findings. But on the contrary the study of Lovett and Sagar (1978) showed that the aqueous washings of leaves of *Camellina sativa* stimulated the growth of radicles of flax seedlings. Similarly, the study of Tripathi *et al*. (1998) showed that the leaf extracts of *Albizia procera*, *Tectona grandis* and *Acacia nilotica* stimulated root and shoot length in soybean.

The results on the fresh and dry weight of seedlings of rice are given in tables-4 and 5. The root, shoot and whole plant extracts of *C. rottleri* showed significant reduction on fresh and dry weight of the seedlings of three cultivars of rice .The study of Kazinczi *et al*. (1997) revealed that the root residues of *Centaurea cyanus* inhibited the fresh weight of rape as compared to control; *Rumex obtusefolius* and *Asclepias* on corn (Beres and Kazinczi, 2000). But on the other hand the root leachate of donor soybean with significantly increased the dry matter of receiver soybean (Ramamurthy and Shivashankar, 1995).

The results on the total chlorophyll contents of rice seedlings are given in table-6. Aqueous shoot and root extracts of *Parthenium hysterophorus* on mulberry (Singhal *et al*., 1996). bamboo on groundnut (Eyini *et al*., 1981). Leaf residue of *Parthenium* on *Najas graminea* (Pandey, 1997) aqueous leaf leachates of *Euclyptus globulus* on *Costus speciosus* and finger millet (Konar and Kushari, 1995; Padhy *et al*., 2000), the leaf and leaf litter extracts of *Quercus glauca* and *Q. lauotrichophora* on wheat, mustard and lentil (Bhatt and Chauhan, 2000); *Hyptis suaveolens* on *Parthenium*.. But on the contrary the leaf and rhizome extracts of *Dendrocalamus strictus* caused a significant increase in chlorophyll (a and b) content on soybean (Tripathi *et al*., 1998).These studies strongly support the present findings.

CONCLUSION

The present investigation clearly shows the weed *C.rottleri* had adverse allelopathic effects on the germination and growth of rice seedlings and it can be recommended that the weed *C.rottleri* completely must be eradicate from the fields to get better germination, growth for the preparation of seedling beds.

Table 1: Germination Percentage of rice seeds exposed to root, shoot and whole plant extracts of *Chorzophora rottleri*

Extract Concentrations (%)	Root Extracts			Shoot Extracts			Whole plant Extracts		
	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20
Control	100a -	100a -	100a -	100a -	100a -	100a -	100a -	100a -	100a -
2%	98a (-2)	98a (-2)	98a (-2)	100a (-)	100a (-)	100a (-)	97a (-3)	98a (-2)	98a (-1)
5%	85b (-15)	87b (-13)	91b (-9)	88b (-12)	89b (-11)	93b (-7)	82b (-18)	87b (-13)	89b (-11)
10%	73c (-27)	75c (-25)	83c (-17)	79c (-21)	82b (-18)	84c (-16)	70c (-30)	76c (-24)	78c (-22)
15%	61d (-39)	64d (-36)	72d (-28)	64d (-36)	67c (-33)	75d (-25)	58d (-42)	61d (-39)	68d (-32)
20%	55e (-45)	59e (-41)	64e (-36)	57e (-43)	61c (-39)	69d (-31)	52d (-48)	53e (-47)	62e (-38)
25%	43f (-57)	46f (-54)	58f (-42)	49f (-51)	48d (-52)	62de (-38)	41e (-59)	43f (-57)	55f (-45)

Mean with different alphabets in a column differed significantly
as per Tukey's Multiple Range Test (TMRT) ($P < 0.05$).
Data in parenthesis indicates % of increase or decrease over control

Table 2: Root Length (cm/plant) of rice cultivars exposed to root, shoot and whole plant extracts of *Chorzophora rottleri*

Extract Concentrations (%)	Root Extracts			Shoot Extracts			Whole plant Extracts		
	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20
Control	3.4a	3.9a	4.2a	3.4a	3.9a	4.2a	3.4a	3.9a	4.2a
5%	2.99a (-12)	3.51b (-10)	3.94a (-6)	3.06a (-10)	3.62a (-7)	3.99b (-5)	2.75b (-19)	3.35b (-14)	3.78b (-10)
10%	2.68b (-21)	3.23c (-17)	3.73b (-11)	2.85ab (-16)	3.39b (-13)	3.82b (-9)	2.41c (-29)	3.04c (-22)	3.65b (-14)
15%	2.21c (-35)	2.76d (-29)	3.19c (-24)	2.34c (-31)	2.84c (-27)	3.31c (-21)	2.07d (-39)	2.49d (-36)	2.85c (-32)
20%	1.83d (-46)	2.22e (-41)	2.89d (-31)	2.00d (-41)	2.49d (-36)	3.23c (-23)	1.73e (-49)	2.18e (-44)	2.47d (-41)
25%	1.53e (-55)	1.91f (-49)	2.47e (-41)	1.73e (-49)	2.26e (-42)	2.81d (-33)	1.39f (-59)	1.87f (-52)	2.14e (-49)

Mean with different alphabets in a column differed significantly as per Tukey's Multiple Range Test (TMRT) ($P < 0.05$).
Data in parenthesis indicates % of increase or decrease over control

Table 3: Shoot Length (cm/plant)of rice cultivars exposed to root, shoot and whole plant extracts of *Chorzophora rottleri*

Extract Concentrations (%)	Root Extracts			Shoot Extracts			Whole plant Extracts		
	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20
Control	12.3a	15.8a	20.5a	12.3a	15.8a	20.5a	12.3a	15.8a	20.5a
5%	10.94b (-11)	14.53b (-8)	19.47a (-5)	11.31b (-8)	14.85a (-6)	19.68a (-4)	10.82b (-12)	14.20b (-10)	18.86b (-8)
10%	10.08b (-18)	13.58c (-14)	18.45ab (-10)	10.45c (-15)	14.06ab (-11)	18.86b (-8)	9.34b (-24)	13.11c (-17)	17.42c (-13)
15%	8.48c (-31)	11.69d (-26)	15.99c (-22)	8.85e (-28)	12.32c (-22)	17.01c (-17)	7.74c (-37)	10.74d (-32)	14.55d (-29)
20%	7.13d (-43)	9.63e (-39)	14.35d (-30)	7.50f (-39)	11.06d (-30)	16.19d (-21)	6.64d (-46)	9.00e (-43)	12.09e (-41)
25%	6.39e (-50)	8.84f (-44)	12.09e (-41)	6.51g (-47)	10.27d (-35)	15.58e (-24)	5.65e (-54)	7.74f (-51)	10.86f (-47)

Mean with different alphabets in a column differed significantlyas per Tukey's Multiple Range Test (TMRT) ($P < 0.05$).
Data in parenthesis indicates % of increase or decrease over control

Table 4: Fresh Weight (g/plant) of rice cultivars exposed to root,shoot and whole plant extracts of *Chorzophora rottleri*

Extract Concentrations (%)	Root Extracts			Shoot Extracts			Whole plant Extracts		
	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20
Control	0.71a	1.23a	1.41a	0.71a	1.23a	1.41a	0.71a	1.23a	1.41a
5%	0.63b (-11)	1.13a (-8)	1.34a (-5)	0.65b (-8)	1.17a (-5)	1.33a (-4)	0.61b (-14)	1.09b (-11)	1.34b (-5)
10%	0.60b (-15)	1.11ab (-9)	1.32ab (-6)	0.62b (-12)	1.13ab (-8)	1.26b (-11)	0.57b (-19)	1.04b (-16)	1.19c (-15)
15%	0.50c (-29)	0.87c (-29)	1.13c (-19)	0.53c (-25)	0.92c (-25)	1.15c (-18)	0.49c (-30)	0.89c (-27)	1.03d (-26)
20%	0.42d (-40)	0.79c (-35)	1.07c (-24)	0.47c (-30)	0.84d (-31)	1.10c (-21)	0.38d (-44)	0.71d (-42)	0.86e (-39)
25%	0.37d (-47)	0.71cd (- 42)	0.90d (-36)	0.42cd (-40)	0.75e (-39)	0.92d (-34)	0.34d (-47)	0.68d (-45)	0.77f (-45)

Mean with different alphabets in a column differed significantly as per Tukey's Multiple Range Test (TMRT) ($P < 0.05$).
Data in parenthesis indicates % of increase or decrease over control

Table 5: Dry weight (g/plant) of rice cultivars exposed to root, shoot and whole plant extracts of *Chorzophora rottleri*

Extract Concentrations (%)	Root Extracts			Shoot Extracts			Whole plant Extracts		
	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20
Control	0.53a	0.70a	0.91a	0.53a	0.70a	0.91a	0.53a	0.70a	0.91a
5%	0.40b (-24)	0.65a (-7)	0.85a (-6)	0.42b (-20)	0.65a (-7)	0.82b (-6)	0.39b (-26)	0.61b (-13)	0.80b (-12)
10%	0.37b (-30)	0.56b (-20)	0.71b (-14))	0.39b (-49)	0.61ab (-24)	0.75c (-18)	0.31b (-41)	0.52c (-25)	0.69c (-24)
15%	0.24c (-54)	0.49b (-30)	0.68b (-28)	0.27c (-32)	0.53c (-26)	0.67d (-22)	0.21c (-60)	0.43d (-38)	0.55d (-39)
20%	0.20c (-62)	0.38c (-45)	0.58c (-36)	0.23c (-56)	0.47c (-32)	0.52e (-29)	0.20c (-62)	0.32e (-54)	0.43e (-52)
25%	0.20c (-62)	0.32c (-54)	0.52c (-39)	0.22cd (-58)	0.37d (-47)	0.59e (-35)	0.19c (-64)	0.28e (-60)	0.38f (-58)

Mean with different alphabets in a column differed significantly as per Tukey's Multiple Range Test (TMRT) ($P < 0.05$).
Data in parenthesis indicates % of increase or decrease over control

Table 6: Total Chl. Content (mg/g.fr.wt.) of rice cultivars exposed to root,shoot and whole plant extracts of *Chorzophora rottleri*

Extract Concentrations (%)	Root Extracts			Shoot Extracts			Whole plant Extracts		
	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20	ADT-36	BPT	IR-20
Control	0.957a	0.974a	1.137a	0.957a	0.974a	1.137a	0.957a	0.974a	1.137a
5%	0.830b (13.3)	0.871b (-10)	0.967b (-14)	0.847b (-11)	0.901a (-7)	0.987b (-13)	0.813b (-15)	0.825b (-15)	0.938b (-17)
10%	0.759b (21)	0.807b (-17)	0.935b (-17)	0.821b (-14)	0.871b (-11)	0.959b (-15)	0.716c (-25)	0.761c (-21)	0.901c (-20)
15%	0.614c (-35)	0.710c (-27)	0.793c (-30)	0.698c (-27)	0.718c (-26)	0.851c (-25)	0.588d (-38)	0.634d (-34)	0.734d (-35)
20%	0.537d (-43)	0.576d (-40)	0.756c (-33)	0.574d (-40)	0.641d (-34)	0.789d (30)	0.482e (-49)	0.544e (-44)	0.616e (-44)
25%	0.440d (-54)	0.507d (-47)	0.601d (-47)	0.525d (-45)	0.591e (-40)	0.706e (-37)	0.381f (-60)	0.422f (-56)	0.541f (-52)

Mean with different alphabets in a column differed significantly as per Tukey's Multiple Range Test (TMRT) ($P < 0.05$).
Data in parenthesis indicates % of increase or decrease over control

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