Allelopathic Effect of Root Extract of *Prosopis juliflora* (Mesquite) on Seed Germination and Seedling Growth of Native Dry Forest Plant Species

AGCS Jayasinghe and GAD Perera
Department of Botany, Facility if Science, University of Peradeniya, Peradeniya, Sri Lanka

Abstract

Prosopis juliflora is an alien exotic plant in many arid and semi-arid areas in the tropics such as Saudai Arabia, India and Sri Lanka. This species was introduced to Hambanthota district in the Southern Province of Sri Lanka in early 1950s to improve saline soils in the area. *P. juliflora* produces water soluble alleloapathic chemicals in their leaves, roots, pods and flowers such as L-tryptophan, syringin and laricriesinol. This study was conducted to determine effects of allelopathic compounds present in *P. juliflora* on seed germination and initial seedling growth of *Bauhinia racemosa* (Maila), *Cassia occidentalis* (pinithora), *Drypetis sepiaria* (weera), *Dichrostachya cinerea* (andara), *Flueggea leucopyrus* (katupila) and *Salvodora persica* (mallithan) by keeping seeds in concentration series of root extract of *P. juliflora* in five replicates. The effect on seed germination and initial seedling growth were evaluated by measuring percentage seed germination and root and shoot lengths. Percentage seed germination of *B. racemosa, C. occidentalis, D. sepiaria D. cinerea* and *F. leucopyrus* were significantly ($p<0.05$) reduced in the aqueous root extract. However, the seed germination was delayed only in *C. occidentalis*. Both root and shoot growth of all selected plant species were significantly ($p<0.05$) reduced by the root extract with an exception of *F. leucopyrus* in which the shoot growth was not significantly ($p>0.05$) affected. These results confirm the presence of allelopathic compounds in root extracts of *P. juliflora*, and these allelopathic compounds may adversely affect on seed germination and initial seedling growth of some native dry forest plant species. However, there may be a variation in the sensitivity to allelopathic compounds among native dry forest plant species.

Key words: Alien exotic plant, Concentration series, Alleloapathic chemicals

Introduction

Prosopis juliflora (Family Leguminosae) is a native tree to Central and South America but grows as an aggressive alien exotic plant in many arid and semi-arid regions of the world (Pasiecznik et al. 2001).This species was introduced to the Hambanthota district in Southern Province of Sri Lanka in early 1950s to improve saline soils and as a form of ground cover (Bambaradeniya et al. 2002). It has been reported that the species produce water soluble alleloapathic chemicals such as L-tryptophan, Syringin and Laricriesinol (Nakano et al. 2003). Allelopathic compounds present in roots may exert a greater pressure on native plants. Therefore, this study attempts to reveal the impacts of added root extracts of *P. juliflora* on seed germination and initial seedling growth of native dry forest plant species.

Materials and Methods

The root samples and dry dehiscent fruits such as *B. racemosa, C. occidentalis, D. sepiaria, D. cinerea, F. leucopyrus,* and *S. persica* were collected from Bundala National Park (BNP) in Hambanthota District, Sri Lanka and seeds were cleaned manually. Viability of selected seed samples were detected by using 0.1% Triphenyl Tetrazolium Chloride (Lakon, 1949).

Cleaned fine roots of *P. jiliflora* were crushed separately in a blender (for five minutes and 50 g of crushed plant materials were weighted separately and shaken with 100 ml of distilled water and kept overnight. After 24 hours, mixture was homogenized using a magnetic homogenizer and filtered with whatman No. 42 filter papers. Filtrate was used to prepare a concentration series (2%, 5%, and 10%) of aqueous extracts and stored under 5°C in a refrigerator.

Corresponding author: *jayasinghecs@gmail.com*

Seeds of *Bauhinia racemosa* (Maila), *Cassia occidentalis* (pinithora), *Drypetis sepiaria* (weera), *Dichrostachya cinerea* (andara), *Flueggea leucopyrus* (katupila) and *Salvodora persica* (mallithan) were soaked in distilled water and different concentrations (2%, 5% and 10%) of root extract of *P. juliflora* for 48 hours. After that seeds were placed in sterilized plastic petri dishes (14.4 cm in diameter) on tissue papers wetted with distilled water and the relevant concentration of the root extract (25 ml). Finally, petri dishes were placed in sterilized growth chambers (40 cm in width, 37 cm in height and 47.5 cm in length Styrofoam box) and condition of the chambers were maintained between 25 -30°C, 70% humidity and 12 hour dark and 12 hour light conditions (Siddiqui *et al.*, 2009). During the experimental period, number of seeds germinated was counted and after 50% of seed germination, length of roots and shoots were measured using a wetted string.

The corrected germination rate index (CGRI) and the germination inhibition percentage (GI) were calculated using fallowing formulae (Saxena *et al.*, 1996) and data were analyzed by performing one-way ANOVA.

$$\text{Germination Rate Index} = \frac{\text{Summation of daily germination percentage}}{\text{Total no. of days of germination}} \times 100$$

$$\text{Corrected Germination Rate Index} = \frac{\text{Germination Rate Index}}{\text{Final germination \%}} \times 100\%$$

$$\text{Percentage Inhibition} = \frac{\text{FG in aquouse extract}}{\text{FG in distilled water}} 100 \times 100\%$$

Results and Discussion

Viability of seeds of all species was high. However, seed germination percentage of the selected plant species showed a significant variation among species ($P<0.001$) (Table 1).

Water soluble chemicals like Tannins, Flavonoids, Steroids, Phenolic compounds, waxes and alkaloids can act as allopathic compounds (Rice, 1974). Significantly low seed germination was observed in *B. racemosa, C. occidentalis, D. cinerea* and *D. sepiaria* in the presence of the root extract of *P. juliflora* and this may be due to the presence of allelopathic compounds in the root extracts of *P. juliflora*. However, the germination of some other species such as *S. persica* and *F. leucopyrus* was not affected. Similarly the time taken for germination increased in some species such as *C. occidentalis* and *D. cinerea* due to the root extract of *P. juliflora*. These evidences imply that the allelopathic compounds produced by *P. juliflora* can delay and reduce seed germination of some native dry forest plant species. However, the osmotic potential of the root extract is low and that might affect seed germination of native dry forest species to a certain extent.

Both shoot and root growth of all selected plant species was significantly ($p<0.05$) reduced by the root extract of *P. juliflora* except *F. leucopyrus* in which showed reduction of root growth. Allelopathic compounds dissolved in water is taken up by plant roots, these contact with the root before reaching shoot parts and these may be the reason for high suppression of root growth than that of shoot growth of selected plant species.

F. leucopyrus is a pioneer plant species which can tolerate harsh environmental conditions like severe drought conditions, allelopathy, etc. Therefore allelopathic compound present in root extracts of *P. juliflora* does not affect much despite that the root growth of the species is slightly reduced. So this suggest that allelopathic chemicals produced by *P. juliflora* do not negatively affect all plant species equally and there is a variation in sensitivity to allelopathic compounds among native dry forest species. Therefore, studied species can be categorized into two groups depending on their responses to allelopathic compounds of *P. juliflora*. They include highly sensitive plants and moderately sensitive plants. *C. occidentalis* is an example for a highly sensitive plant. It is an annual plant and seeds germinate during the rainy seasons and avoid dry periods when allelopathic chemicals are accumulated in the soil. The water soluble allelopathic compounds may have been washed away and the plants were much affected. The other species can be categorized as moderately sensitive plants. These are perennial

Table 1: Final percentage seed germination, GI percentage, CGRI and seedling performance of dry forest plant species in different concentrations of the root extract.

Tested Plant species	Concentration (w/w)	FG (%)	GI %	CGRI	Root length (mm)	Shoot length (mm)
B. racemosa	Control	100.00 ^{a}	0.00^{a}	90.77 ^{a}	24.83^{a}±0.68	18.55^{a}± 1.36
	2%	78.00 ^{b}	-22.00^{b}	88.37 ^{a}	15.96^{b}± 1.00	17.66^{bc}±0.76
	5%	47.00 ^{c}	-53.00^{c}	90.10 ^{a}	14.50^{b}± 1.32	15.92^{cd}±0.95
	10%	44.00 ^{c}	-56.00^{c}	86.54 ^{a}	13.66^{bc}±1.30	15.37^{d}±0.86
C. occidentalis	Control	100.00 ^{a}	0.00^{a}	99.77 ^{a}	18.46^{a}±1.18	21.09^{a}± 1.45
	2%	100.00 ^{a}	0.00^{a}	100.00 ^{a}	13.29^{b}± 0.73	16.34^{b}±0.93
	5%	99.00^{ab}	-1.00^{ab}	98.85 ^{ab}	10.90^{c}±0.70	13.35^{c}± 0.78
	10%	95.00 ^{b}	-5.00^{b}	96.46 ^{b}	9.40^{c}± 0.79	11.17^{d}±0.69
D. cinerea	Control	88.00^{a}	0.00^{a}	79.98^{a}	21.42^{a}±1.25	29.71^{a}± 1.33
	2%	82.85^{a}	-5.85^{a}	77.07^{ab}	20.45^{a}±1.39	25.09^{b}±1.09
	5%	77.42^{ab}	-14.45^{b}	72.68^{bc}	20.25^{a}±1.09	25.38^{b}±1.11
	10%	78.00^{ab}	-11.36^{b}	69.84^{c}	11.5^{b}±1.24	20.13^{c}± 1.52
D. sepiaria	Control	79.00 ^{a}	0.00^{a}	74.44 ^{a}	32.24^{a}±2.58	17.61^{a}± 0.47
	2%	36.00 ^{b}	-54.00^{b}	75.33 ^{a}	25.58^{b}± 2.84	10.93^{b}±0.58
	5%	29.00 ^{b}	-63.29^{b}	73.46 ^{a}	26.54^{b}± 2.05	9.31b^{c}±1.67
	10%	23.00 ^{b}	-70.88^{b}	72.44 ^{a}	20.34^{b}± 3.75	8.08^{c}±1.10
F. leucopyrus	Control	55.00 ^{a}	0.00^{a}	70.86 ^{a}	14.86^{a}±1.24	11.79^{a}± 1.46
	2%	55.00 ^{a}	0.00^{a}	74.75 ^{a}	14.02^{ab}±1.34	11.83^{a}± 0.93
	5%	55.00 ^{a}	0.00^{a}	66.53 ^{a}	14.11^{ab}±1.41	11.90^{a}± 0.57
	10%	53.00^{ab}	-3.63^{a}	75.13 ^{a}	11.90^{b}± 1.00	11.74^{a}± 0.45
S. persica	Control	98.00 ^{a}	0.00^{a}	90.49 ^{a}	18.36^{a}±1.60	15.37^{a}± 0.84
	2%	98.00 ^{a}	0.00^{a}	90.41 ^{a}	6.39^{b}±0.61	12.05^{b}±0.53
	5%	98.00 ^{a}	0.00^{a}	93.79 ^{a}	6.24^{b}±0.63	11.90^{b}±0.57
	10%	95.00 ^{a}	-3.06^{a}	91.86 ^{a}	6.26^{b}±0.47	11.74^{b}±0.45

species and sometimes, mature individuals of these species can be seen growing in association with *P. juliflora* but seedlings of these species are also not found in *P. juliflora* invaded sites. However, the effect of allelopathic chemicals accumulated in the soil on germination and initial seedling growth is worth studying further

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