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ALLELOPATHIC POTENTIAL OF *Tectona grandis* L. ON THE GERMINATION AND SEEDLING GROWTH OF *Vigna mungo* (L.) Hepper

V. Rincy Evangeline[1], E. John Jothi Prakash[1], A. Selvin Samuel[2] and M. Jayakumar[3]

ABSTRACT

The allelopathic impact of Tectona grandis L. on the germination and seedling growth of Vigna mungo (L.) Hepper has been investigated in this experiment. Bioassay studies of the aqueous extracts of the leaves of T. grandis showed that seed germination and seedling growth of V. mungo were inhibited. In addition, the reduction of seed germination was found to be up to 48% at 10% concentration. At this concentration, the epicotyl showed 67.3% reduction in length when compared to the control. Consequently, the hypocotyl demonstrated 64.7% reduction in length. In pot culture experiments, a 4% aqueous extract of the leaves was found to inhibit seed germination and the growth of the seedlings. This concentration of leaf extracts reduced seed germination percentage to the tune of 70%. There was reduction in shoot length to about 33.3% and the root length about 54.3. Higher concentration of aqueous extracts of the leaves prevented seed germination. As for the biomass of V. mungo is concerned, aqueous extracts of the leaves of T. grandis caused a corresponding reduction.

Key words: Allelopathy, bioassay, germination, seedling, *Tectona grandis, Vigna mungo*.

INTRODUCTION

Allelopathy refers to the detrimental and beneficial biochemical interaction among all classes of plants including microorganisms. The term allelopathy, coined by Macias *et al*., (2000), is derived from the Greek ‘allelo’ = each other and ‘pathos’ = to suffer. Thus allelopathy means the injurious effect of one (plant) upon another. Rice (1984) gave the definition of allelopathy as any direct or indirect harmful or beneficial effect by one plant (including microorganisms) on another through the production of chemical compounds that escape into the environment. Allelochemicals produced by a plant escape into the

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[1]Dept. of Botany, Tirunelveli Dakshina Mara Nadar Sangam College, T. Kallikulam-627113, [2]St. John's College, Palayamkottai, Tirunelveli-627007, [3]Dept. of Botany, VHNSN College, Virudhunagar-626001, Tamil Nadu, India. Correspondence email: john.jothiprakash@rediffmail.com

environment and subsequently influence the growth and development of neighboring plants. There is voluminous work on the alleopathic effect of many plants on a variety of economically important plants. Studies on allelopathy in agroforestry systems have also gained momentum in view of the empirical knowledge of negative impact of several forest species on crop plants and other neighboring plant species. In an agroforestry system, there is a combination of crops with forests trees which is found to be greatly beneficial. This methodology increases food production and it provides wood as a by-product. It also enhanced soil preservation, soil protection against erosion, and weed suppression, in some cases. In general, such agroforestry systems have been successful. Usually, the species selection to intercultivate has been made on the basis of the empirical knowledge of farmers. However, the success of the agroforestry system depends upon allelocompatibility of forest and cultivar species (Rizvi *et al.,* 1998).

T. grandis L. a valuable timber tree of Asia has been successfully used as a partner in agroforestry. In the second half of 19^{th} century *Tectona grandis* and maize were inercultivated in Indonesia and other tropical countries in Asia (Wiersum, 1982). Since then, this species has been used successfully in rotation and is combined with agricultural species such as mountain rice (give scientific name of this and all other species when coming first time), cotton, tapioca, chilli and ginger. In India it was found that teak plantations with groundnut and soybean were very successful (Mishra and Prasad, 1980). However, later studies showed that leaves of *T. grandis* had allelopathic effect on several crop plants. Jayakumar *et al.* (1987) demonstrated the allelopathic effects of teak leaves on the germination of peanut and maize. The allelopathic extracts from teak leaves significantly inhibited germination and growth of tomato (*Lycopersicum esculentum),* eggplant (*Solanum melongena*) and *Capsicum annum* (Krishna *et al.,* 2003). *T. grandis* has also shown high allelopathic activity on *Triticum aestivum* (Krishna *et al.,* 2003). Macias *et al.* (2000) reported the phytotoxic activity of aqueous extracts from bark and leaves of *T. grandis* between 1000-125 ppm, on the germination, root and shoot length of *Lepidium sativum* L.*, Lactuca sativa*, *Lycopersicum esculentum*, *Allium cepa* and *T. aestivum* L. Bioassay results showed that bark extract of *T. grandis* had higher phytotoxicity. The most affected parameters were root length of tomato, onion and wheat. Sahoo *et al.* (2007) have reported teak as a potential harmful allelopathic plant to maize and the toxic effect of teak followed the order: leaf litter >crushed seeds >soil root zone. This study had also showed that leaf, bark and seed extracts and soil from the root zone of teak had suppressive effects on germination, radical length and yield of maize. Little is known about the allelopathic effect of *T. grandis* on germination and growth of *V. mungo*, an important legume crop. The present research work describes some of these aspects.

MATERIALS AND METHODS

Tectona grandis L. (*T. grandis*) belongs to the family Verbenaceae is a large, deciduous tree reaching over 30 m height in favorable conditions. Its crown is open with many small branches. Bark is brown, distinctly fibrous with shallow, longitudinal fissures. The root system is superficial, often no deeper than 50 cm, but roots may extend laterally up to 15 m from the stem. The very large, 4-sided leaves are shed for 3-4 months during the latter half of the dry season, leaving the branchlets bare. Shiny above, hairy below, vein network clear, about 30 x 20 cm but young leaves up to 1 m long. Fruit is a drupe with 4 chambers; round, hard and woody, enclosed in an inflated, bladder-like covering; pale green at first, then brown at maturity. Each fruit may contain 0 to 4 seeds. *T. grandis* grows in deciduous forests of Asia, from India to Indonesia. It is cultivated in the tropical regions of Asia for its valuable wood, which is used in the construction of ships, trains, and buildings and in furniture-making. Mature fresh leaves of *T. grandis* were collected from the campus of Tirunelveli Dakshina Mara Nadar Sangam College, T. Kallikulam, Tamil Nadu, India. Seed of *Vigna mungo* L. (*V. mungo*) were purchased from the local market.

Preparation of leaf extract

Fresh leaves of *T. grandis* were washed thoroughly, cut into small pieces, shade dried for four days, powdered (40 mesh) and used for bioassay and pot culture studies. Ten gram of leaf powder was dissolved separately in 100 mL of distilled water in a beaker and kept for 24 h at room temperature with occasional swirling. The solution was filtered through Whatman No 1 filter paper and the volume was made up to 100 mL with distilled water to get 2, 4, 6, 8, and 10% concentrations. Bioassay studies were performed. Ten seed were placed on Whatman No.1 filter paper in Petri plates (9mm x 9mm). Petri plates were moistened (2 mL/plate) of leaf extract/distilled water (control) and incubated in dark (28°C). Germination (%), plumule and radical length were measured after three days. For pot-culture experiments, the seeds of *V. mungo* were sown in plastic trays (14mm x 10mm) in soil of a mixture of silt, humus and sand in the ratio of 1:1:2. The treatment was started after the 3rd leaf emerged. All the experimental plants were grown in field conditions and also in growth chambers. The seedlings were irrigated with different concentrations of aqueous extracts of the leaves of *T. grandis.* Seedlings were watered with different concentrations of extracts of the leaves of *T. grandis* (50 mL/tray) on alternate days. Control plants were irrigated with water.

After the treatment period of 10 days, germination percentage, plumule length, radicle length, shoot length, root length and biomass of the shoot and root were determined.

RESULTS AND DISCUSSION

Germination inhibition

The bioassay studies showed that the leaf extract of the *T. grandis* significantly reduced germination of *V. mungo* over the control and the magnitude of reduction differed depending upon the crop and the concentration of the extracts employed. The 2% aqueous leaf extract slightly inhibited germination while the extracts of higher concentrations (6-10%) caused a clear inhibition of different intensities over the control.

Table-1. Bioassay of aqueous leaf extract of *T. grandis* on seed germination (germ.), shoot length and root length of *V. mungo.*

Concentration (%)	Germ. (%)	Shoot length (cm)	Root length (cm)
Control	100	4.6 ± 0.1	10.5 ± 0.1
2	81 ± 2.0 (-19)*	4.5 ± 0.1 (-2.1)	9.3 ± 0.1 (-11.4)
4	76 ± 1.5 (-24)	2.5 ± 0.0 (-45.6)	7.6 ± 0.1 (-27.6)
6	70 ± 1.0 (-30)	2.0 ± 0.0 (-56.5)	5.3 ± 0.0 (-49.5)
8	61 ± 0.9 (-39)	2.0 ± 0.0 (-56.5)	4.5 ± 0.0 (-57.1)
10	52 ± 0.8 (-48)	1.5 ± 0.0 (-67.3)	3.7 ± 0.0 (-64.7)

*The numbers in parenthesis indicate the percentage deviation from the control.

The leaf extracts showed more inhibition of the length of plumule than that of the radical. A similar pattern of decrease in plumule length was observed in the seedlings. There was a low level of decrease in plumule and radicle length in 2% to 4% leaf extracts, but 6% to 10% showed a higher level of reduction in plumule and radicle length (Table-1). In pot culture experiments leaf extracts of *T. grandis* showed inhibitory effect on shoot and root length, fresh and dry weight of the tested plant.

Table-2. Pot culture of *V. mungo* with leaf extract of *T. grandis.* Figures in parenthesis indicate the percentage deviation from the control.

Concentration (%)	Germ. (%)	Shoot length (cm)	Root length (cm)
Control	100	48 ± 0.7	21.9 ± 0.3
2	56 ± 0.3 (-44)	40 ± 0.5 (-16.6)	18 ± 0.2 (-17.8)
4	30 ± 0.3 (-70)	32 ± 0.5 (-33.3)	10 ± 0.1 (-54.3)
6	0[A]	0	0
8	0	0	0
10	0	0	0

[A] Germination completely inhibited.

Shoot and root growth

Together with root: shoot ratio high specific root length has also been reported to be a characteristic of plants growing in infertile environments or being exposed to some environmental stress (Omezine and Skhiri-Harzallah, 2011). The aqueous extracts of leaf of *T. grandis* significantly reduced root and shoot growth of *V. mungo* than the control and the magnitude of reduction different depending upon the crop, while the concentration of the extracts had no inhibitory effect on the growth of root and shoot. While the extracts of other concentration caused decreased in inhibition of different intensities the concentration of the extracts decreased from 6-10% (Table-2).

Fresh weight

Leaf extracts at lower (2%) concentration did not reduce fresh weight while the increasing concentrations decreased it over the control and a complete inhibition was recorded with 6-10% extract concentration (Table-3).

Table-3. Effect of aqueous leaf extract of *T. grandis* on fresh weight of *V. mungo.*

Concentration (%)	Dry weight (mg/plant)	Change (%)
Control	3.62 ± 0.3	-
2	1.54 ± 0.1	-57.4
4	1.87 ± 0.2	-48.3
6	0[A]	0
8	0	0
10	0	0

[A] Germination completely inhibited.

Dry weight

Two percent of leaf extracts had no inhibitory effect on the dry weight, while the extracts of other concentrations caused a decrease in dry weight. As the concentrations of the extracts increased from 2% to 4% the dry weight of the seedlings also decreased, and a maximum inhibition was caused by 6% to 10% extracts (Table-4). Reports by Eyini *et al*. (1996) revealed that the leaf extracts of *Tephrosia purpurea, Albizzia amara* and *Delonix regia* caused a decrease in the biomass of maize.

Table-4. Effect of aqueous leaf extract of *T. grandis* on dry weight (mg/plant) of *V. mungo.*

Concentration (%)	Dry weight (mg/plant)	Change (%)
Control	0.37 ± 1.8	-
2	0.27 ± 1.8	-27.0
4	0.21 ± 1.8	-43.2
6	0[A]	0
8	0	0
10	0	0

[A] Germination totally inhibited.

CONCLUSION

Present investigation demonstrated harmful allelopathic effects of *T. grandis* on *V. mungo* seed germination, seedling growth, shoot and root length and biomass. The allelopathic effect had increased with increasing the concentrations of the leaf extract.

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