

## Allelopathic Potential of *Lantana camara* (L.) and *Parthenium hysterophorus* (L.) Weeds on Germination and Growth Behaviour of *Thespesia populnea* (L.)

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### Abstract

A Pot-culture experiment under green house condition was conducted to study the allelopathic effect of *Lantana camara* (L.) and *Parthenium hysterophorus* (L.) weeds on germination and growth behaviour of *Thespesia populnea* (L.) tree species. The experiment was laid out in Randomized Complete Block Design (RCBD) and replicated thrice. Combination of two invasive weed species viz., *Lantana camara* and *Parthenium hysterophorus*) and four concentration levels of aqueous extract viz., 10, 20, 30 and 40% were assigned as main treatments with application of normal water as control. The results revealed that, application of whole plant aqueous extract of *Parthenium hysterophorus* at higher (40%) concentration significantly recorded lower seed germination percentage (26.7), germination value (3.0), germination index (0.14), germination relative index (5.7) in *Thespesia* species than at lower concentration of *Parthenium hysterophorus* and *Lantana camara* weed species. Whereas, number of days required for the germination of *Thespesia* seed was maximum (9.05 days) in application of aqueous extract of *Parthenium hysterophorus* at 40% concentration. *Thespesia* seedlings growth and growth behaviour were also significantly inhibited by the whole plant aqueous extract of *Parthenium* weed at higher concentration, which reduced shoot length (12.6cm), root length (9.2cm), dry weight (12.6 mg plant<sup>-1</sup>), dry weight based vigour index (338) and chlorophyll content (15.7 µmol chlorophyll m<sup>-2</sup>) at 60 days after sowing

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### Introduction

Allelopathy is an important strategy that increases the competitive ability of a species by releasing a chemical compound that inhibits the germination and growth, or increases the mortality of the individuals of another species. Weeds are considered as rich source of secondary metabolites, and these chemicals modify the environmental system on other plants growing in their vicinity (Hossain and Alam, 2010). Many weeds, specifically invasive weed species pose an important biological constraint to crop productivity in agricultural ecosystem and tree productivity in natural forest ecosystems (Sharma and Raghubanshi, 2006).

Invasion of native plant communities by exotic species has been among the most intractable ecological problems of recent years. It is a global scale problem experienced by the natural ecosystems especially forest ecosystems and is considered as the second largest threat to the global biodiversity (Netsere and Mendesil, 2011). The invasion of exotic species affects the native flora and reduces the regeneration ability of other species by decreasing germination, reducing early growth rates and selectively increasing mortality of other plant species in forest ecosystems through their allelopathy and

competitive interference. *Lantana camara* L. and *Parthenium hysterophorus* L. weeds are American in origin and have spread to the other regions of world including India, threatens ecological biodiversity in forest ecosystems by their huge proliferation in any place at any time thus it exerts negative effects on ecology and environment in natural ecosystems (Kohli *et al.*, 2006).

Both species considered as noxious weeds in the world and aggressively growing in forest, agriculture and waste lands. These weeds possess the ability to suppress other plants through the release of allelochemicals from living plants or decomposing plant materials into the environment, which allows these weeds to compete more effectively with crop or tree or pasture species. Although the study of allelopathy in agricultural and horticultural system has long history, allelopathy research in forest ecosystems is recent. With this background, the present experiment was undertaken with the objective of evolving the allelopathic potential of *Lantana camara* and *Parthenium hysterophorus* weeds on germination and growth behaviour of *Thespesia populnea* tree species.

## Material and Methods

Pot culture experiment under greenhouse was conducted at nursery site of Forest College and Research Institute, Mettupalayam, Tamil Nadu situated in Southern India at 11°20' N latitude and 76°56' E longitude with an altitude of about 320m above mean sea level. The experiment was laid out in randomized complete block design with treatments comprising of two weed species viz., *Lantana* and *Parthenium* and four concentrations of whole plant aqueous extract viz., 10, 20, 30 and 40%, and normal water as control and replicated thrice. Weeds were collected at flowering stage and chopped into 5-10cm pieces. The extract of 100% concentration was prepared by soaking 1000g chopped plant material in 1000ml distilled water (1:1 weight/volume basis) at room temperature (22-26°C) for 72 hours and ground with mixer grinder. The extract was filtered through muslin cloth and the volume of the filtrate was made to 1000ml with distilled water. The extract was considered as stock solution and a series of solution (10%, 20%, 30% and 40% aqueous extract) were prepared by dilution and stored. Pot culture soil media was prepared with soil, sand and farmyard manure (2:1:1) and was filled in pot for sowing the seeds of *Thespesia* @ 10 seeds per poly bag. *Thespesia* seeds were pre-treated with cold water for 24 hours and dried in shade for half an hour and used for sowing. A 500ml aqueous extract was applied immediately after sowing in each treatment. Thereafter, equal quantity (100ml) of aqueous extract was added to the respective treatment on daily basis to keep the pot mixture soil moist enough to get favourable condition for seed germination and seedlings growth. The experiment was maintained up to 60 days to study the germination and growth behavior of target tree species.

## Results and Discussion

### Germination Parameters

Aqueous extract of *Lantana camara* and *Parthenium hysterophorus* weed exhibited allelopathic effect on germination parameters of *Thespesia populnea*. The result depicted in Table 1, indicated that irrespective of the weed species studied, seed germination percentage, germination value, germination index, germination relative index and mean rate of seed germination of *Thespesia populnea* varied significantly due to the different concentration levels of whole plant aqueous extract. With the increase of concentration levels, all the germination parameters were progressively decreased. Among the weed species and

different concentration levels studied, the lowest seed germination percentage (26.7), germination value (3.0), germination index (0.14), germination relative index (5.7) and the highest mean rate of germination (9.05) were recorded in application of 40% aqueous extract of *Parthenium* weed (T<sub>8</sub>) followed by 40% aqueous extract of *Lantana* (T<sub>8</sub>). The maximum seed germination, germination value, germination index and germination relative index and the minimum rate of germination were found in application of distilled water (T<sub>9</sub>). This was significantly higher than application of 10% aqueous extract of *Parthenium* (T<sub>5</sub>) and was on par with application of 10% aqueous extract of *Lantana* (T<sub>1</sub>). Seed germination is the best indicator of seed viability under stressed condition. The higher inhibitory effect of *Parthenium hysterophorus* weeds on *Thespesia populnea* tree species is due to presence of large amount of allelochemicals, which inhibit the process of seed germination. An indirect association between lower seed germination and allelopathic inhibition may be the consequence of the inhibition of water uptake. The lower seed germination in 40% aqueous extract of *Parthenium* was recorded partly due to the fact that the presence of some allelochemicals in the extracts prevented the growth of seed embryo or caused its death. This experiment result was in conformity with the findings of Kohli *et al.* (2006).

Analysis of variance test (ANOVA) showed significant difference ( $p < 0.005$ ) between application of normal water/control, whole plant aqueous extracts of *Lantana camara* and *Parthenium hysterophorus* weeds at different concentration levels with respect to shoot length, root length, dry weight of the seedlings, vigour index and chlorophyll content of *Thespesia* seedlings. With the increase in concentration levels of aqueous extract of *Lantana* and *Parthenium* from 10% to 40%, the inhibitory effect on seedlings growth and development also increased. Among the levels of whole plant aqueous extract of *Lantana* and *Parthenium* weed, maximum reduction in shoot length (12.6cm), root length (9.2cm), dry weight of the seedlings (12.6 mg plant<sup>-1</sup>), vigour index (338) and chlorophyll content (15.7 μmol m<sup>-2</sup> of leaf) were observed in 40% concentration of *Parthenium hysterophorus* weed extract. This was significantly lower than application of 40% concentration of *Lantana* weed extract and 30%, 20% and 10% concentration of *Lantana* and 20% and 10% concentration of *Lantana* and *Parthenium* weeds extract. All the growth

**Table 1:** Allelopathic effect of *Lantana camara* and *Parthenium hysterophorus* weed aqueous extract on germination and growth behaviour of *Thespesia populnea* species

| Treatments                                       | Germination Parameters |                   |                   |                            |                          | Growth Parameters at 60 DAS |                  |                                      |              |  |
|--|------------------------|-------------------|-------------------|----------------------------|--------------------------|-----------------------------|------------------|--------------------------------------|--------------|--|
|  | Total germination (%)  | Germination value | Germination index | Germination relative index | Mean rate of germination | Shoot length (cm)           | Root length (cm) | Dry weight (mg plant <sup>-1</sup> ) | Vigour Index | Chlorophyll content (µmol m <sup>-2</sup> of leaf) |
| T <sub>1</sub> - <i>Lantana</i> extract @ 10%    | 86.7                   | 25.6              | 0.78              | 75.3                       | 1.32                     | 30.7                        | 19.5             | 22.3                                 | 1933         | 39.8   |
| T <sub>2</sub> - <i>Lantana</i> extract @ 20%    | 73.3                   | 19.0              | 0.58              | 54.0                       | 1.91                     | 26.6                        | 17.2             | 20.1                                 | 1473         | 35.2   |
| T <sub>3</sub> - <i>Lantana</i> extract @ 30%    | 56.7                   | 11.8              | 0.40              | 32.3                       | 2.94                     | 22.8                        | 14.3             | 17.8                                 | 1009         | 29.3   |
| T <sub>4</sub> - <i>Lantana</i> extract @ 40%    | 36.7                   | 5.2               | 0.23              | 13.7                       | 5.63                     | 16.6                        | 11.7             | 16.1                                 | 591          | 21.4   |
| T <sub>5</sub> - <i>Parthenium</i> extract @ 10% | 80.0                   | 22.6              | 0.65              | 61.7                       | 1.65                     | 25.5                        | 17.1             | 20.6                                 | 1648         | 38.9   |
| T <sub>6</sub> - <i>Parthenium</i> extract @ 20% | 66.7                   | 16.4              | 0.46              | 35.7                       | 2.43                     | 21.1                        | 14.8             | 18.5                                 | 1234         | 33.3   |
| T <sub>7</sub> - <i>Parthenium</i> extract @ 30% | 43.3                   | 7.3               | 0.29              | 21.7                       | 5.05                     | 17.6                        | 12.4             | 15.7                                 | 680          | 25.8   |
| T <sub>8</sub> - <i>Parthenium</i> extract @ 40% | 26.7                   | 3.0               | 0.14              | 5.7                        | 9.05                     | 12.6                        | 9.2              | 12.6                                 | 336          | 15.7   |
| T <sub>9</sub> - Control/normal water            | 93.3                   | 29.3              | 0.90              | 84.0                       | 1.11                     | 36.4                        | 21.6             | 26.2                                 | 2445         | 43.4   |
| SE.d   | 5.9                    | 2.6               | 0.06              | 5.9                        | 0.82                     | 1.7                         | 0.7              | 1.6                                  | 179          | 1.0  |
| CD(p=0.05)                                       | 12.4                   | 5.4               | 0.12              | 12.4                       | 1.72                     | 3.5                         | 1.4              | 3.4                                  | 377          | 2.0  |

parameters of *Thespesia* in control (normal water) treatment were significantly higher than (P<0.05) application of various concentration levels of whole plant aqueous extract of *Lantana* and *Parthenium* weed. The highest inhibiting effect on growth parameters of *Thespesia* was found in application of 40% aqueous extract of *Parthenium* followed by 40% aqueous extract of *Lantana*. This can be attributed mainly by the release of different kinds of phytotoxic compounds viz., phenolics, sesquiterpenes and lactones from root and vegetative part of *Parthenium* and its accumulation in shoot and root meristem of the plants. These chemicals are capable of suppressing the growth of receptor crops and can have multiple phytotoxic effects

viz., reduction in plant hormone synthesis, inhibition on nutrient and ion absorption. Earlier works have also reported that aqueous leachates of *Parthenium hysterophorus* reduced the growth parameters of the crops (Netsere and Mendesil, 2011; Hossain and Alam, 2010).

To summarize, application of whole plant aqueous extract of *Partheniumhysterophorus* weed at 100% concentration level had strong allelopathic inhibitory effect on germination, seedlings growth, dry matter production and chlorophyll synthesis of *Thespesia populnea*. The sensitivity of *Thespesia* tree species to allelochemicals and extent of germination

inhibition, growth reduction and chlorophyll production varied with invasive weed species and concentration levels of whole plant aqueous extract. Allelopathic potential of *Parthenium hysterophorus* may be an important mechanisms involved in invasive success of this weed in natural ecosystems.

#### References

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