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Amelioration of Allelopathic Effect of *Lantana camara* L. on Germination, Seedling Growth and Chlorophyll Contents of *Sorghum bicolor* (L.) Conrad Moench Using Vermicompost

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ABSTRACT

In this study, aqueous leaf extract of *Lantana camara* L. was tested for allelopathic activity in *Sorghum bicolor*. The aqueous leaf extract of *Lantana camara* L. was tested at 0, 20, 40, 60, 80 and 100% concentrations with and without vermicompost amendment. The results reveal that aqueous leaf extract of *Lantana camara* L. negatively affects the germination (%), germination index (GI), fresh and dry weight, shoot and root length and chlorophyll content of sorghum seedlings. It is concluded from the study that the aqueous leaf extract of *Lantana camara* L. is negatively allelopathic to sorghum. However, the vermicompost treatment showed improved germination, seedling growth and chlorophyll contents and the vermicompost can be used for crop growth enhancement.

Introduction

Allelopathy is an important phenomenon involved in plant-plant interaction in the ecosystems (Rice, 1984). To elicit allelopathic activity in nature, plants release chemical compounds into their near environment in least three different ways: exudation, leaching and volatilization (Tukey, 1969). Phytotoxins and allelochemicals are released from either the above-ground (leaf, stem, bark, twigs, flower, pollen, seed, etc.) or under-ground

(root, rhizome, tuber, etc.) parts of plants. The production of allelochemicals is an intrinsic determinant of the plant allelopathic effect. Plant roots play a vital role in allelopathy, because allelochemicals produced and exuded as root exudates are involved in the suppression of weed growth near the plant (Wu et al., 2000, 2001). *Lantana camara* L. also known as big-sage (Malaysia), wild-sage, red-sage, white-sage (Caribbean) and tickberry (South Africa), is a species of flowering plant within the verbena

family, Verbenaceae, which is native to the American tropics (Floridata, 2007). *Lantana camara*, a beautiful plant often planted in gardens, has spread from its native Central and South America to around 50 different countries, where it has become an invasive species. It spread from the Americas into the rest of the world when it was brought back to Europe by Dutch explorers and cultivated widely, soon spreading into Asia and Oceania, where it established itself as a notorious weed (Ghisalberti, 2000). *Lantana camara* will often out-compete other more desirable species, leading to a reduction in biodiversity. It can also cause problems if it invades agricultural areas as a result of its toxicity to livestock as well as its ability to form dense thickets which if left unchecked can greatly reduce the productivity of farm land (Kohli, 2006).

The allelopathic effect of *Lantana camara* is well known and it has been studied widely with different crop plants and weeds under laboratory and field experiments. Allelopathic effect of *Lantana camara* has been studied in Chinese cabbage, chilli, chickpea, milkweedvine (*Morrenia odorata*), morning glory (*Ipomoea tricolor*), cluster bean (*Cyamopsis tetragonoloba*) and forest communities by the researchers world-wide (Sahid and Sugau, 1993; Gentle and Duggin, 1997; Achhireddy and Singh, 1984; Casado, 1995; Oudhia, 2000; Karthikeyan et al., 2014). The method of employing earthworms in the degradation of organic matter present in the waste in to useful vermicompost is called as vermicomposting. Vermicomposting, also known as worm composting, is simply the way earthworms transform decaying organic matter into worm castings. It is all-together a natural system in which the earthworms play their major roles in degrading the organic portion of the waste. The use of earthworm in organic waste management is called as vermicomposting or vermistabilization (Edwards et al., 1988).

The earthworms are used for commercial production of vermicompost from various organic waste materials and the valuable vermicompost has been used for the cultivation of crop plants

(Karmegam and Daniel, 2009; Kale and Kamegam, 2010; Prakash and Karmegam, 2010; Jayakumar et al., 2011; Paul et al., 2011). Ample research data are available on the allelopathic effect of different parts of *Lantana camara* and the effectiveness of vermicompost on plant growth and yield. However, ameliorative effect of vermicompost on allelopathic potential of *Lantana camara* is scanty. Hence in the present study has been formulated to find out the effect of vermicompost in reducing the allelopathic effect of *Lantana camara* aqueous leaf extracts on germination, seedling growth and chlorophyll contents of *Sorghum bicolor* (L.) Conrad Moench.

Materials and methods

The plant species selected for the present study, *Lantana camara* L. was based on the literature available on its allelopathic effect. The leaves of *Lantana camara* L. was collected from the plants growing in the foot-hills of Yercaud, Salem district, Tamil Nadu. The collected leaves were used for the preparation of aqueous leaf extracts. The fresh leaves were macerated with known quantity of distilled water, filtered through Whatman No. 1 filter paper and made into concentrations, 0% (control, distilled water), 20, 40, 60, 80 and 100%. The seeds of *Sorghum bicolor* and were selected for the present study and the seeds were procured from Arunai Agro-marketing Private Limited, Salem and stored in air-tight containers till use.

The seeds of *Sorghum bicolor* were individually soaked in 2% mercuric chloride solution and then immersed in distilled water for 24 hrs. The plastic cups (germination test container) of uniform size were used for seed germination tests. Red soil and sand (1:1, volume/volume) were mixed thoroughly and 60g of this mixture was taken in plastic cups to test the allelopathic activity of *Lantana camara* on sorghum and maize. The aqueous extract concentrations (15 ml each) of 0, 20, 40, 60, 80 and 100% were and added to respective treatments, separately for each concentration. The seeds were sown in five replicates of ten seeds each.

The vermicompost for the present study was procured from the local market. The plastic cups were filled with Red soil:sand:vermicompost (1:1:1, volume/volume) were mixed thoroughly and 60g of this mixture was taken in plastic cups to test the ameliorative effect of vermicompost on allelopathic activity of *Lantana camara* aqueous leaf extracts with sorghum and maize. The aqueous extract concentrations (15 ml each) of 0, 20, 40, 60, 80 and 100% were added to respective treatments, separately for each concentration. The plastic cups were watered and the seeds were sown in three replicates of ten seeds each. All the treatment sets were kept in an environmentally controlled room and observed for germination every day up to seven days. After seven days, the seedlings were carefully removed from the culture container and gently washed to remove adhering soil. The root length, shoot length, fresh weight and dry weight of the seedlings were measured and recorded.

The germination percentage of rice cultivars in all treatments were calculated as per the method described in UAF (2010).

$$\text{Germination (\%)} = \frac{\text{No. of germinated seeds}}{\text{Total no. of seeds tested}} \times 100$$

The germination index for each rice cultivar was determined using the following formula (AOSA, 1983).

$$\text{Germination Index (GI)} = \sum \left(\frac{GT}{Tt} \right)$$

$$\text{Or } \left[\frac{\text{No. of germinated seed}}{\text{Days of final or last count}} \right] + \dots + \left[\frac{\text{No. of germinated seed}}{\text{Days of final or last count}} \right]$$

The analysis of total chlorophyll content of sorghum seedlings was carried out according to the method described by Arnon (1949). One gram of fresh leaves were blended and then extracted with 10ml of 80% acetone and left for 15 minutes for thorough extraction. The liquid portion was decanted into another test tube and centrifuged at

2500 rpm for 3 minutes. The supernatant was then collected and the absorbance was taken at 670 nm and 690 nm using Systronics Spectrophotometer and the chlorophyll contents were calculated and expressed as µg/g.

Results and discussion

The percentage germination of *Sorghum bicolor* (L.) Conrad Moench showed variation with respect to the concentration of aqueous leaf extracts of *Lantana camara* L. (Table 1). The seeds of sorghum without extract treatment showed maximum germination percentage of 98.66 and 99.10 in soil and vermicompost media respectively. The germination percentage decreased with the increase of aqueous leaf extract of *Lantana camara*. The soil without vermicompost showed drastic decrease of seed germination of sorghum from 0% (control) to 100% extract concentration.

The percentage germination of 84.00, 78.66, 72.66, 63.00 and 51.66 was recorded in soil media respectively for 20, 40, 60, 80 and 100% aqueous leaf extract of *Lantana camara*. The soil with vermicompost treatment also showed decrease of germination of sorghum. However, the germination percentage in vermicompost treatment was higher than that of the treatment without vermicompost (Table 1). The percentage germination of 96.66, 95.00, 85.00, 91.66, and 81.66 was recorded in vermicompost treatment respectively for 20, 40, 60, 80 and 100% aqueous leaf extract of *Lantana camara*. The same trend was observed in germination index of sorghum (Fig. 1)

Table 1. Germination percentage of *Sorghum bicolor* (L.) Conrad Moench in aqueous leaf extract of *Lantana camara* L. (values are mean of five replicates).

Sl. No.	Concentration of extract (%)	Germination (%)	
		Control	Vermicompost
1	0	98.66	99.10
2	20	84.00	96.66
3	40	78.66	95.00
4	60	72.66	85.00
5	80	63.00	91.66
6	100	51.66	81.66

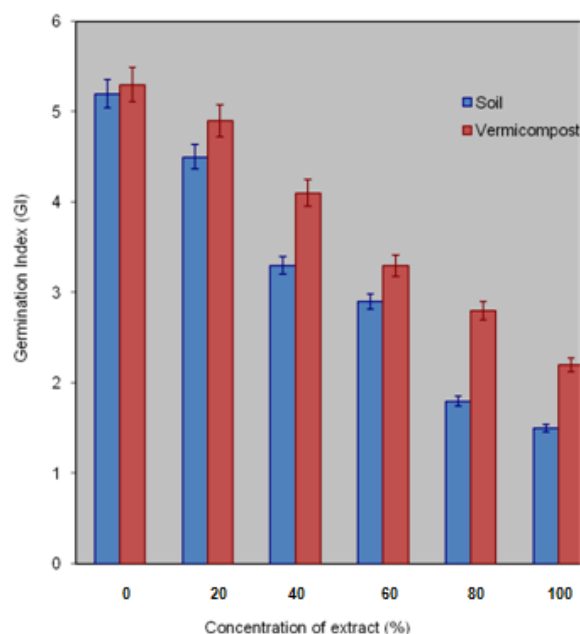


Fig. 1: Germination index of *Sorghum bicolor* (L.) Conrad Moench in aqueous leaf extract of *Lantana camara* L. (values are mean of five replicates).

As a measure of seedling growth, fresh weight, dry weight, root length and shoot length were recorded for aqueous leaf extract *Lantana camara* (Tables 2-3). All the growth parameters of rice seedling

growth were found to decrease towards higher concentration. In soil media without vermicompost the fresh weight of the seedlings were 8.31 g in 0% extract then decreased towards higher concentration and 100% aqueous leaf extract of *Lantana camara* showed 5.37 g (Table 2) and the same has been observed for dry weight. In vermicompost treatment, the fresh weight of the seedlings were 10.39 g in 20% extract then decreased towards higher concentration and 100% aqueous leaf extract of *Lantana camara* showed 7.33 g (Table 2) and the same has been observed for dry weight. However, these results were higher in vermicompost than in soil without vermicompost. Similar results were observed for seedling length also. The chlorophyll contents of the seedlings raised with and without vermicompost are shown in Table 4 and Table 5. The total chlorophyll content was 22.9, 21.4, 17.5, 16.5, 13.1 and 11.1 $\mu\text{g/g}$ respectively in 0, 20, 40, 60, 80 and 100% aqueous leaf extract of *Lantana camara* applied in soil without vermicompost (Table 4). The total chlorophyll content was 30.4, 28.5, 28.3, 27.7, 22.8 and 22.8 $\mu\text{g/g}$ respectively in 0, 20, 40, 60, 80 and 100% aqueous leaf extract of *Lantana camara* applied in soil without vermicompost (Table 5).

Table 2. Seedling weight of *Sorghum bicolor* (L.) Conrad Moench in aqueous leaf extract of *Lantana camara* L. with and without vermicompost (values are Mean of seedlings recovered from five replicates).

Concentration of extract (%)	Control (without vermicompost)		Vermicompost treatment	
	Fresh weight (g/seedling)	Dry weight (g/seedling)	Fresh weight (g/seedling)	Dry weight (g/seedling)
0	8.31	3.84	13.10	7.33
20	8.03	3.23	10.39	4.46
40	7.54	3.02	8.99	4.65
60	6.48	2.96	9.45	4.40
80	6.11	2.77	8.94	3.52
100	5.37	2.53	7.33	4.4

Allelopathy is one of the expressed phenomena of chemical interaction exhibiting widespread significance in natural eco-systems (Dayan et al., 2000; Parvez et al., 2003). In nature, the released allelochemicals function on other plants, weeds or micro-organisms in inhibitory or excitatory ways. The chemical compounds are believed to act additively or synergistically for the allelopathic expression (Rice, 1984). In the present study, an

attempt has been made to study the effect of aqueous leaf extracts of *Lantana camara* L. The current study clearly indicated that the aqueous leaf extract of *Lantana camara* L. at concentrations higher than 20% is able to negatively affect the sorghum invariably in both the treatments with slight variations. The allelopathic effect of leaf extract of *Lantana camara* L. is clearly observed in germination percentage, germination index,

seedling growth and chlorophyll contents of the seedlings. Parvez et al. (2004) reported that the bark and seed of tamarind tree is exhibiting strong allelopathic potentiality and these two materials display differential allelopathic effects (inhibitory

or excitatory) in the species tested, it is evident that certain biologically active chemical compounds are either additively or synergistically involved in the plant-specific expression, particularly in the seed.

Table 3. Seedling length of *Sorghum bicolor* (L.) Conrad Moench in aqueous leaf extract of *Lantana camara* L. with and without vermicompost (values are Mean of seedlings recovered from five replicates).

Concentration of extract (%)	Control (without vermicompost)		Vermicompost treatment	
	Shoot length (cm /seedling)	Root length (cm/seedling)	Shoot length (cm /seedling)	Root length (cm/seedling)
0	8.75	6.56	9.04	10.01
20	8.74	6.22	8.54	7.92
40	7.33	5.92	7.50	7.71
60	5.17	4.45	6.47	7.53
80	4.75	4.05	6.24	6.12
100	3.48	4.60	5.68	6.90

Table 4. Chlorophyll content of *Sorghum bicolor* (L.) Conrad Moench in aqueous leaf extract of *Lantana camara* L. without vermicompost.

Concentration of extract (%)	Chlorophyll a (µg/g)	Chlorophyll b (µg/g)	Total chlorophyll (µg/g)
0	11.1	11.8	22.9
20	10.9	10.5	21.4
40	8.0	9.5	17.5
60	8.0	8.5	16.5
80	6.0	7.1	13.1
100	6.0	5.1	11.1

Table 5. Chlorophyll contents of *Sorghum bicolor* (L.) Conrad Moench in aqueous leaf extract of *Lantana camara* L. with vermicompost.

Concentration of extract (%)	Chlorophyll a (µg/g)	Chlorophyll b (µg/g)	Total chlorophyll (µg/g)
0	12.2	18.2	30.4
20	11.5	17.0	28.5
40	11.0	17.3	28.3
60	10.8	16.5	27.7
80	10.2	12.6	22.8
100	9.6	13.2	22.8

There are ample evidences available on the improved growth of plants in vermicompost application. Karmegam and Daniel (2008) showed that the growth and yield of *Lablab purpureus* (L.) Sweet. had increased with the application of vermicompost than chemical fertilizers. Pontillas et al. (2009) while studying the effect of vermicompost on the growth and yield of rice as well as on the return on capital reported that the

application of vermicompost alone and the combination of inorganic fertilizer and vermicompost resulted to no significant differences in the height in comparison with inorganic fertilizer at 60 DAT both in 1st and 2nd trial. It was at harvest that rice applied with inorganic produced a significantly tallest plants among the treatments in 1st trial. Further their study implies that vermicompost can be a substitute to pure inorganic

fertilizer application. The study by Sinha et al. (2010) showed that earthworms and vermicompost can promote growth from 50 to 100% over conventional compost and 30 to 40% over chemical fertilizers besides protecting the soil and the agro-ecosystem while producing 'nutritive and tasty food' at a much economical cost (at least 50-75% less) as compared to the costly chemical fertilizers. These studies clearly support the improved seed germination, germination index, seedling growth and chlorophyll contents of *Sorghum bicolor* in *Lantana camara* aqueous leaf extract treatments with vermicompost.

Conflict of interest statement

Authors declare that they have no conflict of interest.

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