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Allelopathic effects of *Tectona grandis* L. and *Mikania micrantha* L. on germination of *Zea mays* L. and *Oryza sativa* L. under laboratory condition

Rebecca Lalmuanpuii* and U. K. Sahoo

Department of Forestry, Mizoram University, Aizawl 796004, India

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ABSTRACT

The effects of aqueous leaf extracts of *Tectona grandis* L. and *Mikania micrantha* L. on germination and growth of *Zea mays* L. (maize) and *Oryza sativa* L. (paddy) were investigated during 2009-2010. The extracts suppressed the germination of paddy to an extent of 10-30% under high extract concentration and 40-50% suppression in maize under similar concentration. The growth of root and shoot of both the test crops also got suppressed under high extract concentration. Similar was also the case with *M. micrantha* where germination of paddy was suppressed to an extent of 10-35% and 45-65% suppression in maize under high extract concentrations. There is a slight decrease in 10% concentration in case of both the test crops. As the concentration increased from 30-100% the aqueous leaf extract of *M. micrantha* has detrimental effect on the root and shoot growth of both the test crops.

Key words: Allelopathy; aqueous leaf extracts; germination; root and shoot length; biomass.

INTRODUCTION

The influence of trees and weeds on their surrounding plants, *i.e.* crops, vegetables, bushes, grasses and fruit bearing trees has important implications in agro-forestry as these govern and direct the planning of suitable agro-forestry systems. Under the traditional agro-forestry system in Mizoram, *Tectona grandis* L. (Lamiaceae/Verenaceae) is one of the major multipurpose trees grown under which various crops are raised. *Mikania micrantha* L. (Asteraceae) is a very common invasive weed species which adversely affect the growth and yield of farm crops. Many researchers reveal that tree crops release some phytotoxins into the soil, which suppress the germination and growth of crops. Allelopathic influences of certain tree crops have been reported by various workers,[1-5] and some information on the allelopathic effects of tree crops on the germination and growth of food crops has been documented.[6] Various studies have shown inhibitory effects of phytotoxins

Corresponding author: Rebecca Lalmuanpuii
Phone: +91-9612319368
E-mail: beckylmpuii@gmail.com

from weeds on crops.[7,8] However, the crop-weed interactions in agro-forestry systems of Mizoram are totally lacking.

In view of this, allelopathic effects of trees and weeds on crops call for assessment as they can act from stimulants to suppressants. Allelopathy is the direct influence of chemicals released from one living plant on the control, development and growth of another plant. Although toxic metabolites are distributed in all plant tissues, the barks and leaves are the most potent sources of allelochemicals.[3,9] The present investigation seeks to assess the effects of extract of *T. grandis* and *M. micrantha* on germination, shoot and root length, biomass of two test crops *viz*. *Zea mays* L. (Poaceae) and *Oryza sativa* L. (Poaceae) under laboratory condition.

MATERIALS AND METHODS

The experiment was conducted in the laboratory of Forestry Department, Mizoram University, Aizawl (92°38' to 92°42' E longitude and 23°42' to 23°46' N latitudes, altitude 950 m above sea level), Mizoram in north east India. Grains of maize (*Z. mays* variety -sticky maize, local variety) and paddy (*O. sativa* variety-IR-64) were obtained from Krishi Vigyan Kendra (Farm Science Centre), Kolasib, Mizoram. The grains were surface sterilized with 1% sodium hypochloride for 20 minutes and then rinsed with distilled water for several times. Fresh leaves of *T. grandis* and *M. micrantha* were collected at random from the plantation site near the main gate of Mizoram University, Aizawl. The leaves were shade - dried and then ground using mortar and pestle in order to pass through 2 mm mesh sieve. The powdered leaves were then soaked with distilled water for 24 h. and made into extract by filtering it using Whatman No.1 filter paper. From the leachates, five different concentrations (10%, 30%, 60%, 90% and 100 %) were prepared. Four replicates per treatment and twenty grain seeds per replicate were incubated on Whatman No.1 filter paper in petri-plates using the respective leachate concentrations and laid in completely randomized design under laboratory condition. The Whatman No.1 filter paper was constantly moistened once daily using the respective leachate concentrations and distilled water as control during the experimental period. The petri-plates were kept at room temperature under 12 h. of natural light each day and monitored daily. Seeds were considered as germinated upon the emergence of radicle. The first germination was observed after two days while the final germination was obtained before twelve days of sowing.

The number of germination from each petriplates were counted till the twelve days and length of shoot and root, fresh weight of shoot and root were taken with the help of Digital Electronic Weighing Machine (Model-AND GP-300). After taking the fresh weight of shoot and root, they were oven dried at 120^0C for 1 h. The materials were taken out and dried weight of shoot and root were taken. For statistical analysis, seedling growth was assessed by harvesting four individuals per treatment and different growth parameters including fresh and dry weights after 12 days were determined which were then compared with the Control.

RESULTS AND DISCUSSION

The extract of *T. grandis* suppressed seed germination of *O. sativa* under high concentration by 10-30% (Table I), however no effect was observed under low concentrations (T_1&T_2). The average root and shoot length remained almost similar under control and under low extract concentrations (T_1,T_2,T_3). However, under high concentrations significant reduction was observed. The value of reduction was almost 11 times at T_5, followed by 7 times at T_4 concentration (Fig. 1).

It is obvious that the fresh weight and dried weight of root and shoot were significantly ($P<0.01$) decreased under high concentration of *T. grandis* where the weight of fresh

Table 1. Effect of aqueous leaf extract of *T. grandis* on seed germination, shoot and root extension, fresh and dry weight of shoot and root of *O. sativa*.

Treatment	Mean germination (%)	Root length (cm)	Shoot length (cm)	Biomass			
				Fresh wt. of		Dry wt. of	
				root (gm)	shoot (gm)	root (gm)	shoot (gm)
Control	100±0.0	16.7±0.3	13.5±0.12	0.013±0.11	0.039±0.11	0.005±0.02	0.008±0.01
T_1	100±0.0	13.6±0.32	10.37±0.27	0.011±0.22	0.029±0.21	0.003±0.08	0.006±0.09
T_2	100±0.0	9.03±0.04	10.6±0.05	0.010±0.05	0.032±0.22	0.002±0.06	0.006±0.06
T_3	90±0.01	6.8±0.05	8.0±0.12	0.006±0.08	0.021±0.01	0.002±0.09	0.004±0.01
T_4	80±0.03	2.5±0.03	5.75±0.22	0.005±0.22	0.019±0.23	0.001±0.12	0.004±0.05
T_5	72±0.05	1.5±0.10	3.6±0.11	0.004±0.23	0.014±0.12	0.000±0.00	0.001± 0.07
CD at 5%	8.01	4.4	2.52	0.01	0.02	0.01	0.02

T_1=10%, T_2=30%, T_3=60%, T_4=90%, T_5=100% leaf extract concentrations.

and dried root and shoot were almost similar under low concentration and control.

The rate of germination of *Z. mays* under extract of *T. grandis* was severely inhibited as compared to control (Table 2). Apparently, under high concentration of *T. grandis*, when the root and shoot length were measured and compared with control, growth of root and shoot from all the treatments was drastically decreased as increased in the concentration of the extract and magnitude of suppression was highest in T_5 concentration (Fig. 2).

The rate of germination of *O. sativa* under low concentration (T_1) and control were almost similar while reduction was observed as increased in concentration. As the concentration increased from 30% to 100% the extract of *M. micrantha* has detrimental effect on the root growth (Fig. 3).

Similar was the response of *Zea mays* to the extract of *M. micrantha*. There was a slight decrease in shoot and root length under 10% concentration (Table IV). However, the length of root and shoot, fresh and dry weight of root and shoot of *Z. mays* decreased with increase in leaf extract (Fig. 4).

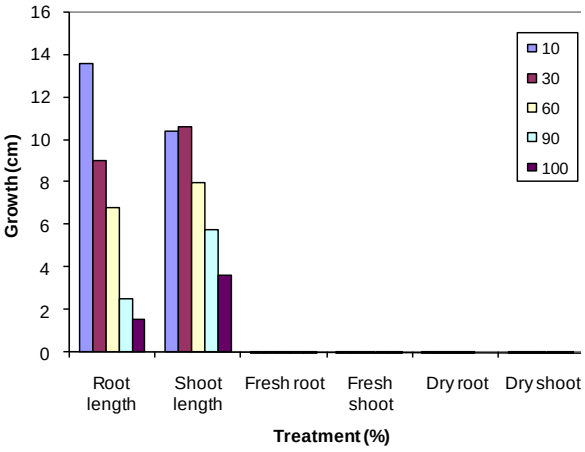

Figure 1. Percent increase in growth of *Oryza sativa* over control as affected by leaf extract of *T. grandis*.

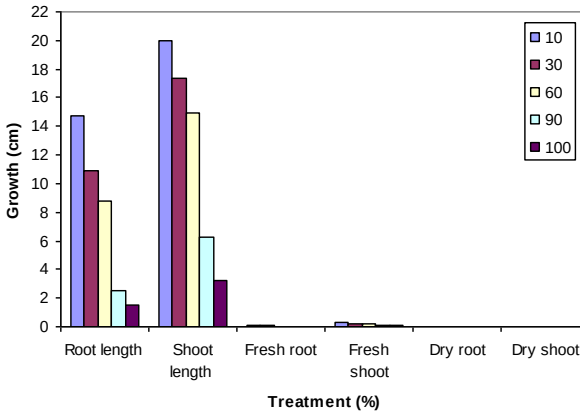

Figure 2. Percent increase in growth of *Zea mays* over control as affected by leaf extract of *T. grandis*.

Table 2. Effect of aqueous leaf extract of *Tectona grandis* on seed germination, shoot and root extension, fresh and dry weight of shoot and root of *Zea mays*.

Treatment	Mean germination (%)	Root length (cm)	Shoot length (cm)	Biomass			
				Fresh wt. of		Dry wt. of	
				root (gm)	shoot (gm)	root (gm)	shoot (gm)
Control	75±0.23	22.05±02	21.73±0.03	0.103±0.11	0.307±0.09	0.015±0.04	0.031±0.01
T_1	30±0.12	14.7±0.01	20.0±0.08	0.078±0.21	0.305±0.07	0.012±0.01	0.030±0.03
T_2	30±0.22	10.9±0.03	17.4±0.11	0.072±0.19	0.249±0.08	0.009±0.03	0.030±0.04
T_3	30±011	8.8±0.11	14.9±0.23	0.047±0.23	0.161±0.11	0.007±0.02	0.022±0.12
T_4	25±0.09	7.2±0.23	6.3±0.24	0.034±012	0.082±0.05	0.005±0.04	0.012±0.21
T_5	16±0.12	1.2±0.17	3.2±0.02	0.014±0.09	0.058±0.02	0.003±0.01	0.009±0.09
CD at 5%	9.23	6.01	3.12	0.03	0.04	0.003	0.005

Table 3. Effect of aqueous leaf extract of *M. micrantha* on seed germination, root and shoot extension, fresh and dried weight of root and shoot of *O. sativa*.

Treatment	Mean germination (%)	Root length (cm)	Shoot length (cm)	Biomass			
				Fresh wt. of		Dry wt. of	
				root (gm)	shoot (gm)	root (gm)	shoot (gm)
Control	100±0.02	16.7± 0.01	13.5±0.06	0.013±0.1	0.039±0.06	0.005±0.07	0.007±0.01
T1	100±0.03	13.6± 0.07	10.6±0.02	0.011±0.03	0.037±0.01	0.004±0.02	0.005±0.02
T2	90±0.11	9.5±0.09	9.8±0.01	0.009±0.01	0.032±0.03	0.001±0.01	0.004±0.03
T3	90±0.03	4.6±0.03	6.3±0.04	0.008±0.02	0.030±0.02	0.001±0.02	0.003±0.02
T4	90±0.04	1.8±0.11	3.8±0.03	0.002±0.01	0.017±0.01	0.001±0.03	0.001±0.03
T5	85±0.02	0.65± 0.04	2.8±0.04	0.002±0.02	0.013±0.02	0.00±0.03	0.000±0.01
CD at 5%	5.02	3.12	3.51	0.12	0.16	0.002	0.001

Table 4. Effect of aqueous leaf extract of *M. micrantha* on seed germination, root and shoot extension, fresh and dried weight of root and shoot of *Z. mays.*

Treatment	Mean germination (%)	Root length (cm)	Shoot length (cm)	Biomass			
				Fresh wt. of		Dry wt. of	
				root (gm)	shoot (gm)	root (gm)	shoot (gm)
Control	75±0.12	22.05±0.03	21.73±0.03	0.103±0.02	0.307±0.02	0.015±0.03	0.031±0.03
T1	30±0.013	18.45±0.02	20.3± 0.01	0.046±0.01	0.37± 0.04	0.011±0.01	0.030±0.02
T2	30±0.01	14.2±0.01	17.8± 0.02	0.039±0.03	0.25± 0.02	0.007±0.03	0.009±0.01
T3	20±0.02	10.7±0.03	13.7± 0.04	0.019±0.01	0.098±0.03	0.007±0.04	0.007±0.04
T4	15±0.03	7.25±0.01	9.95± 0.05	0.012±0.02	0.05± 0.01	0.005±0.03	0.005±0.05
T5	13±0.01	3.0±0.03	6.3± 0.07	0.009±0.03	0.03± 0.03	0.00±0.02	0.002±0.04
CD at 5%	2.03	3.48	4.02	0.004	0.03	0.003	0.004

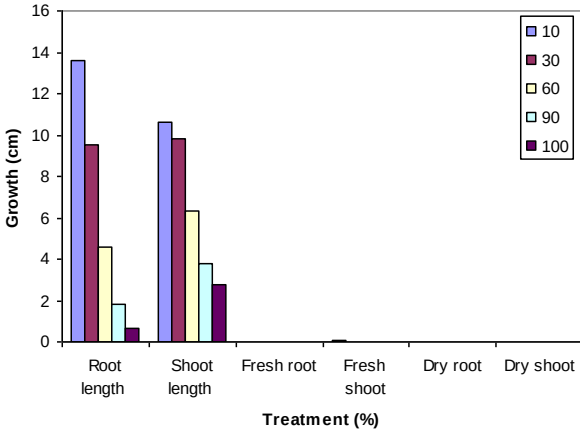

Figure 3. Percent increase in growth of *O. sativa* over control as affected by leaf extract of *M. micrantha*.

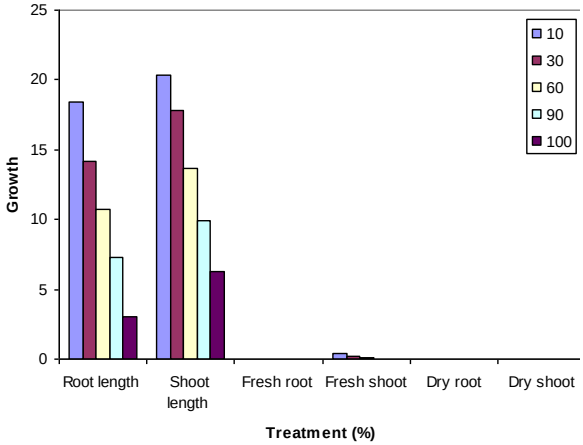

Figure 4. Percent increase in growth of *Z. mays* over control as affected by leaf extract of *M. micrantha*.

In general, the germination percentage of *Z. mays* under *T. grandis* and *M. micrantha* were more inhibited as compared to *O. sativa*. However, for all the test crop under different concentrations, higher concentration level of leachates showed maximum reduction in germination and extention of root and shoot. It was well documented that, release of allelochemicals occurs at the time of germination or at the early developmental stage, as the plants are more susceptible in terms of competition with their neighbouring plants for light, nutrients and water.[10]

In agro-forestry systems of Mizoram, *T. grandis* are extensively grown on farm lands and *M. micrantha* also invading the jhum fallow lands which severely suppresses the agricultural crops. Our findings are in agreement with the observations of many researchers.[1,2,8] Among various weeds, *Eupatorium odoratum* L. (Asteraceae), *M. micrantha*, *Physalis minima* L. (Solonaceae) and *Drymeria cordata* L. (Caryophyllaceae) were found most toxic.[11] Allelopathic effects of weeds on germination and growth were found on legumes and cereal crops of north east Himalayas. It is also reported that legume food crops were most susceptible to toxicity of weeds[12-14] and germination of maize was reduced by the extracts of squash *Cucurbita pepo* L. (Cucurbitaceae) foliage.[15] Other studies have shown strong phytotoxic response of foliage from *Terminalia tomentosa* L. (Combretaceae) on paddy crops.[16]

Phytotoxic responses of foliage of various agro-forestry tree crops on germination and radicle extension of food crops have also been reported.[2,14] Various plant parts such as foliage, bark and leaf litter leachates of *Eucalyptus* spp. (Myrtaceae) were found to have phytotoxic to growing agricultural crops.[9] It is well known that, plant parts contain allelochemicals when they released in soil are known to inhibit or sometimes promote germination, growth, development, distribution and propagation of plant species[17] and our findings on germination of seeds, shoot and root growth do agrees with it as germination of seeds and shoot, root growth were suppressed by the increasing concentration of aqueous leaf extract of *T. grandis* and *M. micrantha* on maize and paddy.

CONCLUSION

The percent of germination and extension of root and shoot of *Z. mays* and *O. sativa* were suppressed both by the extracts of leaf of *T. grandis* and *M. micrantha* in proportion that

was related to the concentration of leaf extracts. It seems that the nature of interference may be due to inhibition of water absorption in germinating seeds of *Z. mays* and *O. sativa*. It was observed that the fresh and dried weight of root and shoot of *Z. mays* showed positive features for allelopathic interference assessment than *O. sativa*.

Though our study is preliminary in nature, there are indications that the magnitude of toxicity increases with the increased in concentration of the extracts which may severely inhibit the germination and growth of farm crops and, therefore, proper management on tree-crop is suggested.

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