Allelopathic Effect of Aqueous Extracts of *Lantana camara* L. on the Germination of Seeds and Growth of Seedlings of *Amaranthus cruentus* L.

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Abstract
Lantana camara (LC), a pantropic invasive weed, is fast becoming endemic in the lowland rainforest of Nigeria. It may interfere with other plants and inhibit crop performance by competition or allelopathy. This study aimed at determining the allelopathic and bioherbicidal potentials of its aqueous extracts. The effects of varying concentrations (0, 12.5, 25, 50 and 100%) of aqueous extracts of shoot and root of LC on germination of seeds and growth of seedlings of Amaranthuscruentus (AC) were determined in Ecology Laboratory and Screen house of Department of Crop Protection and Environmental Biology, University of Ibadan. Two (2) ml of each concentration was administered per petri dish containing 50 seeds of AC and 200 ml was administered per pot of seedling of AC, in completely randomized design with three replications. Germination (%), number of leaves (NLV), plant height (PH, cm/plant) and shoot dry weight (SDW, g/plant) were determined. The data were analysed by ANOVA, and significant means separated using Least Significant Difference (LSD) at 5% level of probability. The extracts significantly ($P<0.05$) reduced seed germination and seedling growth in AC. The mean germination was highest in control (91.0%) and least in S100 (26%). For NLV, PH and SDW were 22.00, 52.43 and 3.23,respectively. Similarly, at S100 16.00, 37.10 and 3.10 values were observed for NLV,PH and SDW, while at R100, the values obtained were 13.00, 37.10 and 1.98 respectively. The aqueous extracts of Lantana camara inhibited germination and growth of Amaranthuscruentus, suggesting its potential as abioherbicide.
Keywords: Invasive weed, Lantana camara, Bioherbicide, Aqueous extracts

INTRODUCTION

Lantana camara (big sage) belongs to the family Verbenaceae that is native to the American tropics (Moyhill, 2003). It has its spread from its native central and South America to about 50 different countries where it became an invasive species (Day, 2003). *Lantana camara* will often out-compete other more desirable species leading to reduction in biodiversity. It is toxic to livestock and its dense thickets can reduce farmland productivity.

Alleopathy encompass all types of chemical interactions among plants and microorganisms. Many organic compounds (allelochemicals) released from plants and microbes are known to affect the growth or aspects of functions of the receiving species (Stamp, 2003). Alleochemicals are important features characterizing the interrelationships among organisms. Allelopathy is tightly coupled with competition for resources and stress from disease, extreme temperatures and herbicides. These stresses often increase the production of allelochemicals and accentuate their actions. A number of secondary metabolites, phenolics, phenylalkanoic acids, hydroxanic acids, fattyacids, terpenes and glycosides were identified in extracts of *Lantana camara* (Rimando and Duke, 2003). These compounds are common in plants and some of them have a growth inhibitory activity against several plant species including weeds. Rice (1984) outlined the following factors which affect the amount of allelochemicals produced, and these are radiation, mineral deficiencies, water stress, temperature, allelopathic agents, age of plant organs, genetics, pathogens and predators.

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Lantana camara is an example of invasive weed species that interfere with native plants through allelopathy (Craig *et al*., 2011). Allelopathy may help in weed management (Zimdahl, 1987) through suppression of weed seed germination and seedling emergence by potential allelopathic species, suppression of weed growth through enhancing allelopathic potential of crops particularly in monoculture and use of plant residues and allelopathic crops in rotation and in intercropping systems.

Little is understood about the mechanism of spread of *Lantana camara*, therefore the study aimed at investigating the allelopathic potential of the water extracts of the root and shoot of *Lantana camara* on the germination of seeds and growth of *Amaranthuscruentus*.

MATERIALS AND METHODS

Experimental sites

The petri dish experiment was carried out in the Ecology laboratory while the pot experiment was done at the screen house of the department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan (Latitude 7°27.047[l] Longitude 3° 58.832[l], elevation of 214m above sea level (asl). Ibadan is in the low land rainforest-savanna transition ecological zone in the south western, Nigeria (Awodoyin*et al.*, 2007).

Source of seeds

Seeds of *Amaranthuscruentus* were obtained from the Institute of Agriculture Research and Training (IAR&T) Moor plantation Ibadan, Nigeria. The fresh shoots and roots of *Lantana camara* were collected from the crop garden of the department of Crop Protection and Environmental Biology and the Practical Year Training Program of the Faculty of Agriculture, University of Ibadan.*Lantana camara* plant parts was partitioned into shoots and roots and dried at 40°C.

Soil analysis

The soil sample was collected with a soil auger from the department of Crop Protection and Environmental Biology crop garden and the routine analysis was done at the Department of Agronomy, University of Ibadan. The soil chemical analysis was done according to laboratory standard.

Preparation of aqueous extracts from dry shoot and root of *Lantana camara*

The extraction procedure was carried out according to the method of Ahn and Chung 2000. The shoots and roots of *Lantana camara* were cut into chips, ground with a grinding machine and soaked in 1L of distilled water for 12 hours and filtered through cheese cloth and whatman No 1 filter paper (9cm diameter). The final filtrates obtained from each plant part were considered as the stock solution. Other concentrations of the aqueous (50%,25% and 12.5%) were obtained using serial dilution with distilled water (equal v/v). The extract was stored in the refrigerator at 20°C to prevent putrefaction and degradation of the allelochemicals that may be present in them.

Seeds of *Amaranthuscruentus*were sterilized separately in 5% sodium hypochlorite for 90 seconds to prevent fungal infection after which they were rinsed for five minutes in water. The seeds were randomly selected and washed thoroughly in distilled water. Twenty seven petri dishes were sterilized using 5% sodium hypochlorite, rinsed and lined with whatman No 1 filter paper. The treatments were 12.5% shoot extract (SE), 25%SE, 50%SE, 100%SE, 12.5% root extract (RE), 25%RE, 50%RE, 100%RE.

Fifty seeds of the test crop were placed in each petri dish. The design was CRD with 3 replicates. The filter paper in each petri dish was replenished with 2 ml appropriate treatments daily to prevent drying out. The

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petri dishes were incubated at room temperature (27°C) for a period of 7 days while the number of seeds that germinated in each petri dish was counted and recorded.

Top soil was collected from the crop garden of the department of Crop Protection and Environmental Biology, University of Ibadan and filled into 30 bags. Each bag has a dimension of 13 x 11 cm and was perforated at the base each containing 4 kg soil.

Sterilized seeds of *Amaranthuscruentus* were sown and supplied with 200 mls of water daily for 2 weeks before transplanting at 2 seedlings per bag. Two hundred (200 mls) of the treatment were applied from three weeks.

The growth parameters taken were plant height using meter rule, number of leaves by visual counting and (Otusanya, 2007) dry weights of plant parts using top loading mettler balance (1210). The plants in the pots were lifted out and lowered into buckets filled with water to gently loosen the soil so that the roots can be fully recovered as much as possible.

Data analysis

The treatments were statistically compared using Analysis of Variance (ANOVA) following SAS (2000). Means were compared and separated using Least Significant Difference (LSD) at 5 % probability.

RESULTS

The result of the chemical analysis of the soil (Table 1) showed that the soil was neutral (pH 7.1) with low organic matter content (31.5%) and low nitrogen (2.15%). From the U.S.D.A. textural triangle, the soil was sandy loam.

Effect of varying concentrations of aqueous extracts of dry shoot and root of *Lantana camara* on the germination of *A.cruentus* seeds

The result showed that as the concentration of root and shoot extracts increased, the germination of the seeds as expressed in percentages decreased in the first trial, also control (94.00± 1.15%) was significantly ($p< 0.05$) higher than all the treatments while R12.5 (76.00± 1.15%) was also significantly ($p< 0.05\%$) higher than the treatments R50 (54.00± 1.15%) and R100 (36.00± 1.15%) (Table 2). There were no significant differences between treatment S50 (26.00± 3.05% and S100 (22.00± 1.15%) (Table 2). The same trend was observed during the second trial.

Effect of varying concentrations of aqueous extracts of dry shoot and root of *Lantana camara* on number of leaves, plant heightand dry weights of *A.cruentus*

Plant height of both the dry shoot and dry root extract of the control seedlings of *A. cruentus* remained the highest in the experiment and was significantly different from their respective treatment.

The result also showed that as the concentration of shoot extract increased, the number of leaves reduced except for 5 and 6 WAS that increased and decreased respectively while as concentration of root extract increased, the number of leaves increased at 3 and 4WAS(Table 3). There was a reduction in the plant height while as the concentration of root extracts increased, plant height increased (Table 4). There was no significant difference among the treatments at the shoot extract concentration. As the concentrations of shoot extract increased:, shoot and dry weight increased while the concentrations of root extract increased, shoot and dry weight decreased(Table 5).

DISCUSSIONS

Studies that have been carried out on the colonizing plants of the Verbenaceae family, and it has been suggested that these plants could compete effectively and

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supress other plants in the same habitat as a result of their allelopathic activity or potential (Reigosa and Gonzalez, 2006). The extract from the dry shoot and dry root of *Lantana camara* had slight inhibitory effect on the germination of seeds of *Amaranthuscruentus.* Hussein *et al*,(2011) also showed that aqueous extracts of all plant parts of *Lantanacamara* have strong allelopathic effect on maize and finger millet.

Basically, the potential of the chemical compounds present in both the root and shoot of *Lantana camara*must have been responsible for the reduction in the germinated seeds. Otusanya*et al*. (2007) demonstrated that aqueous extract of root and shoot of *Tithoniadiversifolia* was inhibitory to the germination and growth of *A. cruentus* L.

Desalegn (2014), reported that *Lantana camara* leaf extracts had no significant ($p>0.07$) effect on seed germination of maize, tef and finger millet , but, at 75% extract concentration seed germination of tef was significantly reduced ($p<0.01$) by 13.5%.

The result is in line with that of Ann and Chung (2000), who found that aqueous extract of rice hull inhibited the shoot height of Barnyard grass (*Echinochloacrusgalli*). There was no distinct significant difference observed in the dry weight of *A. cruentus* at 6WAS except for the dry shoot and root extract at R100 when compared to its control. Huber *et al*. (2002) had earlier observed that exogenously applied phenolic acids reduced root and shoot dry weight of soybean. Sami and Jha (2016) reported that allelopathic effect of *Lantana camara* leaf extract on seedling growth of *Ciceraeritinum* indicated that higher concentration (75%) of the leaf extract have inhibitory effect on the seed germination.

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Table 1 Physicochemical properties of Experimental soil

Soil Properties		**Values**
pH		7.10
	Sand	72.00
Particle size (g/kg)	Clay	10.00
	Silt	18.00
	Ca	9.15
	Mg	0.54
Exchangeable bases (cmol/kg)	Na	0.40
	K	0.28
ECEC		12.40
% base sat		99.50
Organic C (g/kg)		3.15
Total N (g/kg)		0.21
Av P (mg/kg)		34.3
Textural class		Sandy loam

Table 2: Effect of varying concentrations of aqueous extract of dry shoot and root of *Lantana camara* on germination of *Amarantuscruentus* seeds at 7 days after sowing (values shown are mean± SE, n=3)

Treatment	% Germination	
	Trial 1	Trial 2
C00	94 ±1.15	88 ±1.15

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S12.5	46±3.46	56±2.42
S25	40±1.15	46±3.46
S50	26±3.05	34±1.15
S100	22±1.15	30±3.05
R12.5	96±1.15	78±2.92
R25	76±1.15	76±1.15
R50	52±1.15	56±1.15
R100	36±1.15	44±1.15
LSD(0.05)	5.40	5.40

Where S12.5,S25, S50 and S100 =12.5,25,50 and 100% concentration of aqueous extract of shoot
R12.5, R25 ,R50 and R100 = 12.5,25,50 and 100% concentration of aqueous extract of root

Table 3: Effect of varying concentrations of aqueous extracts of dry shoot and root of *Lantana camara* on number of leaves of *Amaranthuscruentus* (values shown are mean±SE, N=3)

Treatment	3WAS	4WAS	5WAS	6WAS
Control	9.67±1.08	11.67±0.82	19.67±0.82	22.00±0.82
S12.5	9.67±0.82	14.00±0.00	23.00±0.58	19.00±2.65
S25	8.67±1.08	12.00±0.00	19.00±2.45	12.00±2.82
S50	8.00±0.71	12.00±0.71	21.00±1.22	18.00±0.82
S100	11.00±1.87	11.00±0.00	17.00±0.82	16.00±4.14
R12.5	8.00±0.71	13.00±1.22	18.00±0.71	19.00±1.08
R25	9.00±0.41	14.00±0.71	19.00±0.71	19.00±0.82
R50	9.00±0.41	14.00±0.00	18.00±0.41	21.00±3.24
R100	10.00±0.71	14.00±0.41	19.00±0.82	13.00±2.55
LSD(0.05)	1.69	1.94	1.94	5.08

Where S12.5,S25, S50 and S100 =12.5,25,50 and 100% concentration of aqueous extract of shoot
R12.5, R25 ,R50 and R100 = 12.5,25,50 and 100% concentration of aqueous extract of root

Table 4: Effect of varying concentrations of aqueous extracts of dry shoot and root of *Lantana camara* on plant height (cm) of *Amaranthuscruentus* at 3,4,5 and 6WAS(values shown are mean±SE, N=3)

Treatment	3WAS	4WAS	5WAS	6WAS
Control	11.67±0.59	20.40±1.49	36.20±2.13	52.43±4.07
S12.5	11.73±0.94	22.83±1.76	38.20±4.35	49.76±5.83
S25	9.27±0.35	16.80±0.44	29.97±4.10	38.67±5.25
S50	9.17±0.29	17.60±1.42	34.43±0.66	47.33±1.24

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S100	8.45±1.54	14.55±3.09	23.65±8.94	31.15±9.73
LSD(0.05)	1.89	3.54	7.89	10.73
Control	11.67± 0.59	20.40±1.49	36.20±2.13	52.43±4.07
R12.5	11.43±0.59	20.17±0.89	35.53±1.39	47.33±2.68
R25	9.97±2.66	23.07±1.93	36.37±3.03	47.77±4.59
R50	11.03±1.42	21.53±1.94	36.70±2.43	49.10±2.39
R100	10.97±0.94	19.27±1.06	33.93±0.43	37.10±3.18
LSD(0.05)	3.76	3.92	5.36	8.93

Where S12.5,S25, S50 and S100 =12.5,25,50 and 100% concentration of aqueous extract of shoot
R12.5, R25 ,R50 and R100 = 12.5,25,50 and 100% concentration of aqueous extract of root

Table 5: Effect of varying concentrations of aqueous extracts of dry shoot and root of *Lantana camara* on dry weight (mg/g) of *Amaranthuscruentus* after 6WAS(values shown are mean±SE, N=3)

Treatment	Dry shoot	Dry root
C00	3.23±0.76	0.57±0.13
S12.5	2.02±0.35	0.47±0.67
S25	2.51±0.43	0.56±0.02
S50	2.39±1.01	0.45±0.19
S100	3.10±0.37	0.81±0.12
LSD(0.05)	NS	NS
C00	2.95± 0.05	0.96±0.54
R12.5	2.55±0.26	0.57±0.22
R25	1.80±0.17	0.66±0.17
R50	1.46±0.36	0.39±0.60
R100	1.37±0.15	0.34±0.05

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