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Allelopathic Effects of Aqueous Extracts from Residues of *Sorghum bicolor* Stem and Maize Inflorescence on the Germination and Growth of *Euphorbia heterophylla* L.

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Abstract

The allelopathic effects of powdered extracts from residues of sorghum stem and maize inflorescence on the germination and growth of *Euphorbia heterophylla* L were examined. The extracts brought about considerable inhibitions to all growth parameters of the extract-treated seeds. The degree of inhibition increased with the concentration of the extracts showing that the inhibition was concentration dependent. In *E. heterophylla* seeds treated with maize inflorescence, the degree of inhibition appeared to be more pronounced on the coefficient of velocity (COV), number of leaves at harvest and relative growth rates. Also in sorghum stem extract treated seeds, the degree of inhibition was more pronounced on the germination percentage, leaf area, dry root and shoot weights. Statistical analysis, at 5% significant level, revealed that there were significant differences in germination percentage, COV, leaf area and relative growth rates of *E. heterophylla* seedlings from seeds treated with powdered extracts from residues of sorghum stem when compared to the results obtained in the control experiments. Similarly, significant differences were observed in the number of leaves, leaf areas and the relative growth rate of *E. heterophylla* seedlings derived from seeds treated with extracts from maize inflorescence when compared to the control. However, there were no significant differences in the germination percentage and COV of maize inflorescence extract-treated seeds as well as the number of leaves at harvest in the sorghum stems extract-treated seeds compared to control experiments**.**

Keywords: allelopathy, *Sorghum bicolor* stem, maize inflorescence, *Euphorbia heterophylla*

1. Introduction

Weed infestation has been known to cause considerable reductions in crop yields thereby hindering sustainable agriculture. The menace of the weeds had forced farmers to use synthetic herbicides which have detrimental effects on the environment. Also the synthetic herbicides are expensive and are not readily available for farmers' use. Recent efforts are being intensified on finding alternative strategies for weed management. Such efforts include the use of allelochemicals which are believed to be much safer. Allelochemicals are found in different organs and tissues of plants from where they are released to the soil through the process of leaching, volatilization, root exudation and decomposition of plant residues (Rice, 1984; Ben et al., 2001). The allelochemicals caused allelopathic effects which could either be inhibitory or stimulatory.

Previous studies conducted in Nigeria had concentrated on the inhibitory allelopathic effects of weeds on agricultural crops. These included the earlier work of Ogbe, Gill and Isherhein (1994) on *Chromolaena odorata,* Kayode (1998) on *Euphorbia heterophylla* and Kayode (2004) on *Aspillia africana*. There has been little or no study conducted on the inhibitory allelopathic potentials of crop residues in the country until recently when Ayeni, Kayode and Tedela (2010) and Ayeni and Kayode (2011) reported the allelopathic effects of some crop residues on the germination and seedling growth of *Bidens pilosa* and *Chromoleana odorata* respectively.

The present study was aimed at examining the alleopathic effects of the powdered extracts derived from the residues of maize inflorescence and sorghum stems on *Euphorbia heterophylla* L., a major weed in agricultural farms in South-western Nigeria (Akobundu & Agyaka, 1987; Tijani-Eniola & Fawusi, 1989; Adelusi, Odufeko, & Makinde, 2006).

2. Methodology

This study was conducted in the greenhouse of the Department of Plant Science, Ekiti State University, Ado-Ekiti, Nigeria, between May and July 2010. Top soil, to the depth of 10cm depth, was evacuated from regenerated vegetation on the University campus. The soil was sterilized at 100 ºC by one hour to destroy unwanted and buried seeds. *Sorghum bicolor* stem and maize inflorescence residues were obtained from the experimental farm of the Department and used for the experiment. The residues were air- dried for three weeks after which they were chopped into pieces with knife, pounded with pestle and mortar and later blended into powdery form.

Portions of 10 g, 20 g, 30 g, 40 g and 50 g each were measured out from the powders of the *Sorghum bicolor* stem and maize inflorescence residues, and were each mixed thoroughly with 5600 g of sterilized soil in planting pots. Each treatment was replicated five times in Completely Randomized Design. Five seeds of *E. heterophylla* obtained from University campus were planted in each of the planting pots and was moistened daily with equal amount of distilled water (200 mL) at 7.00 GMT.

The seeds were considered germinated upon plumule emergence and they were evaluated for seven days until no further emergence was observed. The speed of germination known as Coefficient of Velocity (COV) was calculated according to Kayode (2000) as:

$$COV = \frac{A_1 + A_2 + A_3 \ldots\ldots A_n T_n \times 100}{A_1 T_1 + A_2 T_2 + A_3 T_3 + A_n T_n \times 1}$$

Where:

A = number of seedling that emerge at a particular number of days,

T = number of days involved.

Three weeks after planting, the *E. heterophylla* seedlings (five seedlings) were thinned to one seedling per pot leaving the most vigorous and healthier seedling in each pot. Weekly height measurements were recorded for each seedling for eight weeks. The average height of the five replicates were determined for each treatment and recorded. At the end of the eighth week, the seedlings were carefully uprooted and washed thoroughly. The number of leaves at harvest, lengths of longest leaf, fresh and dry root and shoot weights were recorded.

Also, the leaf area (A) was determined according to Kayode and Otoide (2007) as;

$$A = L \times B \times 0.75 \times 2$$

Where:

A = Area of the leaf, L= Length of the leaf, B= Breath of the leaf and 0.75= a constant

The Relative Growth Rate (RGR) was determined, according to Kayode and Tedela (2005) as

$RGR = \ln H2 - \ln H1 / T_2 - T_1$

Where: H_2 = final height of the plant, H_1 = initial height of the plant, T_2 = Final time and T_1 = initial time.

The data obtained were subjected to one – way analysis of variance (ANOVA, P=0.05) using SPSS version 15(2009) computer software.

3. Results

The effects of the powdered extracts from residues of *Sorghum bicolor* stem and maize inflorescence on the germination percentage of *E. heterophylla* were shown in Table 1. The results revealed that both extracts decreased the germination of *E. heterophylla* and the rate of the decrease increased with increasingconcentration of the extracts.

Statistical analysis(ANOVA, P= 0.05) revealed that results obtained in the 50g *Sorghum bicolor* stem extract concentration were significantly different from those obtained in the control experiment while other treatments showed no significant difference to control experiment. In maize inflorescence treated seeds, there was no significant difference in the germination percentage of the extract treated seeds when compared to the control experiment.

Table 1. Allelopathic effects of *Sorghum bicolor* stem and maize inflorescence on the germination % of *Euphorbia heterophylla*

Treatments (species) /g	*Sorghum bicolour* stem	Maize inflorescence
0	96.00a	100.00a
10	96.00a	96.00a
20	88.00a	84.00a
30	72.00ab	84.00a
40	68.00ab	76.00a
50	60.00b	76.00a

Means followed by the same letter within column are not significantly different at P=0.05.

The effects of extracts from residues of *Sorghum bicolor* stem and maize inflorescence on the COV of *E. heterophylla* were shown in Table 2. The results revealed that the COV of *E. heterophylla* seeds decreases with increasing concentrations of both extracts. The reductions were more pronounced in maize inflorescence extracts-treated seeds and the degree of inhibition was concentration dependent. Statistical analyses (ANOVA, p= 0.05) revealed that there were no significant differences in the COV of both extracts-treated seeds when compared to those of the control experiments except that of the 50 g *Sorghum bicolor* stem extracts treated seeds that showed significant difference to the control experiment.

Table 2. Allelopathic effects of *Sorghum bicolor* stem and maize inflorescence on the speed of germination of *Euphorbia heterophylla*

Treatments (species) /g	*Sorghum bicolour* stem	Maize inflorescence
0	19.44a	17.58a
10	19.33ab	17.19a
20	19.12ab	17.07a
30	18.79ab	17.07a
40	18.73ab	16.91a
50	18.23b	15.61a

Means followed by the same letter within column are not significantly different at P=0.05.

The effects of extracts from residues from *Sorghum bicolor* stem and maize inflorescence on the number of *E. heterophylla* leaves at harvest were shown in Table 3. The extracts caused reduction in the number of leaves. The leaf number decreases with increasing concentration of the extracts. Statistical analyses revealed that there were no significant differences in the number of leaves of *E. heterophylla* treated with *Sorghum bicolor* stem when compared to the control experiment but in the maize inflorescence extract treated seeds, significant differences were observed when compared to the control.

Table 3. Allelopathic effects of *Sorghum bicolor* stem and maize inflorescence on the number of leaves of *Euphorbia heterophylla*

Treatments (species) /g	*Sorghum bicolour* stem	Maize inflorescence
0	34.80a	40.80a
10	33.80a	25.20b
20	30.00a	20.00b
30	29.40a	18.60b
40	26.40a	18.40b
50	17.00a	17.20b

Means followed by the same letter within column are not significantly different at P=0.05.

Table 4. Allelopathic effects of *Sorghum bicolot* stem and maize inflorescence on the leaf area of *Euphorbia heterophylla*

Treatments (species) /g	*Sorghum bicolour* stem	Maize inflorescence
0	97.29ab	134.94a
10	92.16ab	120.39ab
20	90.07ab	116.94ab
30	86.65ab	104.64ab
40	79.39ab	81.66b
50	49.07c	79.69b

Means followed by the same letter within column are not significantly different at P=0.05.

The effects of the extracts on the leaf area of *E. heterophylla* were shown in Table 4. Both residues (extracts) treatments have inhibitory effects on the leaf area of *E. heterophylla*. The leaf area retardation increased with increasing concentration of the extracts. This tends to suggest that the effects were concentration dependent. Statistical analysis however revealed that there were no significant differences in the leaf areas of the *Sorghum bicolor* stem extract treated seeds when compared to those of the control experiments except that of the 50 g extract concentration. In the maize inflorescence extract-treated seeds, the 40 g and 50 g concentration showed significant difference when compared to the control experiments. No significant differences were observed in the other treatments when compared to the control experiment.

Table 5. Allelopathic effects of *Sorghum bicolot* stem and maize inflorescence on the Relative Groth Rate (RGR) of *Euphorbia heterophylla*

Treatments species /g	*Sorghum bicolour* stem	Maize inflorescence
0	0.41a	0.37a
10	0.41a	0.32b
20	0.40a	0.32b
30	0.39a	0.30bc
40	0.37a	0.29c
50	0.29b	0.27c

Means followed by the same letter within column are not significantly different at P=0.05.

Table 6. Allelopathic effects of crop residues on the Dry Root and Shoot weights of *Euphorbia heterophylla*.

Treatments(species) /g	*Sorghum bicolor* stem		Maize inflorescence	
	R	S	R	S
0	0.98a	3.84a	1.58a	7.98a
10	0.88ab	3.68a	1.04b	6.72ab
20	0.84ab	3.58a	0.99b	5.54bc
30	0.68ab	2.62a	0.79b	4.12cd
40	0.52bc	2.36a	0.69b	2.52d
50	0. 26c	2.00a	0.44b	2.29d

Means followed by the same letter within column are not significantly different at P=0.05.

The effects of the extracts on the Relative Growth Rate (RGR) of *E. heterophylla* were shown in Table 5. The RGR in both extracts decreased with increasing concentration of the extracts thus indicating that the degree of retardation was concentration dependent. Statistical analysis revealed that only 50g concentration of *Sorghum bicolor* stem extract treated seeds showed significant difference in their RGR when compared to that of the control experiment. In maize inflorescence treated seeds, significant differences were observed in the RGR of the treated seeds when compared to control experiment. Other treatments showed no significant difference when

compared to the control experiments.

The effects of *Sorghum bicolor* stem and maize inflorescence residues on the biomass of *E. heterophylla* were shown in Table 6. The results obtained in both residues were similar. Decreased root and shoot weights were obtained. The rate of decrease increased with increasing concentrations of the extracts. Statistical analysis revealed that there were significant differences in the dry root weights of sorghum treated seeds as well as the dry root and shoot weights of maize inflorescence treated seeds when compared to the control. However, no significant difference was observed in the dry shoot weights of sorghum stem treated seeds.

4. Discussion

Our results showed that the extracts from the maize inflorescence exhibit more inhibitory effects on most of the growth parameters examined in this study especially the coefficient of velocity, number of leaves and relative growth rate of *E. heterophylla*. This tends to suggest that the allelochemicals in the maize inflorescence that inhibited the growth of *E. heterophylla* might be useful as bio herbicides in the control of this weed. Previously Yarnia (2009) reported that sorghum extracts decrease the growth of *Amaranthusretroflexus.* Similarly, Salam et al. (2009) reported that extracts from rice husk may contain growth inhibitory substances that inhibit root and shoot growths elongation of *E. grucigalli*. Also, Jose and Gilliespie (1998) reported that jugleone released from black walnut exhibited inhibitory effects on the measured variables that included photosynthesis, transpiration, stomata conductance, leaf and shoot respiration in corn and soybeans.

Moreover North and Paul (2006) identified glucoside and sorgoleone as the active compounds in sorghum. These and two other compounds, Dhurin and sorgolenne, could be associated with allelopathic action of sorghum. Sorgoleone is a long chain hydroxyquinone exuded from growing sorghum roots (Netzyl & Butler, 1986). Similarly, Sanchez–Moreiraset al. (2004) asserted that the maize inflorescence allelopathy could be attributed to hydroxamic acid. All these chemical compounds (allelochemicals) might be responsible for the inhibition of *E. hereophylla* in this study.

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