

Allelopathic Effects of Extracts from Maize Roots and Rice Husks' Residues on the Germination and Growth of *Bidens pilosa* L.

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Abstract

Screen house experiment was conducted to examine the allelopathic effects of the extracts from residues of maize root and rice husk on the germination and growth of *Bidens pilosa* L. The extracts brought about considerable inhibitions in all the growth parameters of the extract-treated seeds examined. The degree of retardation of both extract treated seeds increased with increase in the concentration of the extracts which showed that the inhibition was concentration dependent. The results obtained showed that the degree of retardation appeared to be more pronounced in *B. pilosa* seeds treated with extract from maize roots in growth parameters such as number of leaves at harvest and leaf area, relative growth rates, dry roots and shoot weights were inhibited. Similarly the degree of retardation was more pronounced in rice husk extract-treated seeds in growth parameters such as germination percentage and speed of germination. Statistical analysis ($P < 0.05$) revealed that there were significant differences in germination %, dry shoot weights of *B. pilosa* seeds treated with 40 g and 50 g maize roots extract concentrations when compared to the control experiment while other concentrations showed no significant difference to control experiment. Also, speed of germination, number of leaves at harvest and leaf area of *B. pilosa* seeds treated with extracts from residues of maize roots showed significant differences when compared with the values obtained from the control experiments. However, there were no significant differences in the all the growth parameters with rice husk treated seeds compared to control experiments. Similarly, no significant difference was observed in the relative growth rate of *B. pilosa* seeds treated with maize root extracts compared to control experiments.

Keywords: allelopathy, maize root, rice husk, *Bidens pilosa*, inhibition

1. Introduction

The world population is expanding rapidly and there is need to increase food production to meet the food demand of the growing population of this millennium. The interference of weeds in agricultural fields greatly reduce crop yield thereby hindering the possibility of achieving the desired goal of food for all. The interference of one plant on the other by the release of biomolecules to the environment which affects and influence the growth and development of other plants and microorganisms either positively or negatively are termed allelopathy (Rice, 1984; Quassama, 2003; Khahn et al., 2009).

The biomolecules (allelochemicals) are biosynthesized secondary metabolites in plants such as tannins, flavonoids, alkaloids, terpenoids, coumarins and phenolic substances (Chaves & Escudero, 2006; Khanh et al., 2007). Allelochemicals are present in virtually all plant parts including leaves, stems, roots, rhizomes, flowers, fruits, seeds and pollen grains (Ahmad et al., 2011) from where they are released to the environment through the process of leaching, volatilization, root exudation and decomposition of plant residues (Ben et al., 2001) which are capable of suppressing the growth of other plants. Allelopathic interference is one of the mechanisms for the successful establishment of invasive exotic weeds (Ridenour & Callaway, 2001).

The manifestation of allelochemical in the recipient plant are shown to affect many different cellular processes in target organisms including disruptions of membrane permeability (Galindo et al., 1999), ion uptake, photosynthesis, respiration, crop water uptake are liable to disturbances by allelochemicals (Calera et al., 1995). These are shown in form of inhibited or retarded germination rate, reduced radicle or coleoptile extension, lack of root hairs, swelling of root tip, reduced dry weight accumulation and lower reproductive capacity (Ayeni et al., 1997).

Bidens pilosa L. is one of the major weeds in agricultural farms in South-Western Nigeria and its physiological characteristics made it an invasive plant which competes greatly with crops and reduced their yields. In Nigeria, allelopathic studies reported so far were skewed towards the allelopathic effects of weeds on agricultural crops. These included the studies of Gill et al. (1993) and Tijani- Eniola and Fawusi (1989) on *Chromolaena odorata*, Kayode and Adanlawo (1997) on *Euphorbia heterophylla*, Kayode (2004a and b) on *Aspilia africana* and *Calotropis procera* respectively.

Recently Ayeni et al. (2010) and Ayeni and Kayode (2011) reported the effects of some crops residues on weeds. These crop residues are often left uncared for in the fields after harvest. The aim of this investigation therefore is to examine the allelopathic potentials of residues from maize roots and rice husks on *B. pilosa* a weed widely spread in south western Nigeria.

2. Materials and Methods

A screen house experiment was conducted in the Department of Plant Science, Ekiti State University. Ado – Ekiti, Nigeria to examine the effects of maize root and rice husk of *B. pilosa*. Top soil to the depth of 10cm depth was evacuated from regenerated vegetation on the University campus. The soil was sterilized at a constant temperature of 80°C for one hour to destroy the existence of unwanted and buried seeds in the soil. Maize root residues were obtained from the experimental farm of the department. Rice husks were obtained from a rice mill at Igbemo-Ekiti, a town situated at about 15 Km from the University campus. The residues were air-dried for three weeks, 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 maize root and rice husk residues (powder) and were mixed thoroughly with 5600 g of sterilized soil in planting pots. Each treatment was replicated five times in Completely Randomized Design. Five seeds of *B. pilosa* obtained from University campus were planted in each of the planting pots and was moistened daily with equal amount of distilled water at 7.00GMT.

The seeds were considered germinated upon plumule emergence and they were counted 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:

$$COV = \frac{A_1 + A_2 + A_3 + \dots + A_n}{A_1T_1 + A_2T_2 + A_3T_3 + \dots + A_nT_n} \times 100$$

Where:

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

T = number of days involved.

At three weeks after planting, the *B. pilosa* plants were thinned to one plant per pot leaving the most vigorous and healthier plant and the weekly height measurements were recorded for eight weeks. At the end of the eighth week, the parameters such as number of leaves at harvest, longest leaf, fresh and dry root and shoot weights were recorded. The growth parameters determined were:

(1) Leaf area 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

(2) Relative Growth Rate (RGR) according to Hoffmann and Porter (2002), Kayode and Tedela (2005) as

$$RGR = \frac{\ln H_2 - \ln H_1}{T_2 - T_1}$$

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

The plants were carefully uprooted and washed thoroughly before it was later separated into roots and shoots. The fresh weights of the roots and shoots were weighed using Electronic Top Loading Digital balance; G & G model JJ 300Y. China. They were properly tagged kept in the Laboratory of the Department of Plant Science, Ekiti State University, Ado-Ekiti, Nigeria for three weeks to obtain the dry weights. The means from the parameters were subjected to one – way analysis of variance (ANOVA, $P < 0.05$) using Statistical Package for Social Sciences (SPSS) version 15 (2009) computer software.

3. Results

The effects of powdered extracts from residues of maize root and rice husk on the germination percentage of *B. pilosa* were shown in Table 1. The table revealed that both extracts decreased the germination of *B. pilosa*. The rate of decrease increased with the increase in the concentration of the extracts. Results from maize root extracts revealed that the germination percentage was 88% in the control, those of 10, 20, 30, 40 and 50 g extract concentrations were 84%, 80%, 80%, 24% and 20% respectively. In rice husk treated seeds, germination % was 76% in the control experiment, those of 10, 20, 30, 40, and 50 g extract concentrations were 64%, 64%, 60%, 56% and 52% respectively. Statistical analysis (ANOVA, $P < 0.05$) revealed that only the treatments in the 40 and 50g maize root extract concentrations were significantly different from those of the control experiment. In the rice husk treated seeds, no significant difference was observed in the germination percentage of the extract treated seeds when compared to the control experiment.

Table 1. Allelopathic effects of maize root and rice husk on the germination % of *Bidens pilosa*

Treatments (g)	Maize root	Rice husk
0	88.00a	76.00a
10	84.00a	64.00a
20	80.00a	64.00a
30	80.00a	60.00a
40	24.00b	56.00a
50	20.00b	52.00a

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

The effects of extracts on the speed of germination of *B. pilosa* were shown in Table 2. The results revealed that the speed of germination of *B. pilosa* seeds reduced with increase in the concentration of both extracts. The reduced speed of germination was more pronounced in maize root extracts and the degree of retardation was concentration dependent. Results from *B. pilosa* treated with extract from maize root showed that while the speed of germination in the control was 41.11 those of 10, 20, 30, 40 and 50 g extract concentrations were 19.64, 17.87, 17.71, 17.69 and 7.45 respectively. In rice husk treated seeds, the speed of germination in the control was 20.36, those of 10, 20, 40 and 50 g extract concentrations were 19.63, 19.60, 19.46, 19.34 and 19.18 respectively. Statistical analyses (ANOVA, $P < 0.05$) revealed that there were significant differences in the speed of germination of *B. pilosa* seeds treated with maize root extracts while compared to control experiments. No significant difference was observed in rice husk treated seeds compared to control experiment.

Table 2. Allelopathic effects of maize root and rice husk on the speed of germination of *Bidens pilosa*

Treatments (g)	Maize root	Rice husk
0	41.11a	20.36a
10	19.64b	19.63a
20	17.87b	19.60a
30	17.71b	19.46a
40	17.69b	19.34a
50	7.45c	19.18a

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

The effects of extracts from residues from maize root and rice husk on the number of *B. pilosa* leaves at harvest were shown in Table 3. The results also revealed that the extracts resulted in the reduction of *B. pilosa* leaf number. The leaf number decreased with increase in the concentration of the extracts. The reduction was more pronounced in maize root treated seeds. The results from maize root treated seeds showed that the mean leaf number in the control experiment was 44.00, while those of 10, 20, 30, 40 and 50 g concentrations were 36.20, 28.20, 20.00, 2.80

and 1.60 respectively. Also the leaf number of *B. pilosa* treated with residues of rice husk was 93.40 in the control, those of 10, 20, 20, 30, 40 and 50 g concentrations were 90.60, 80.00, 73.40, 61.60 and 58.80 respectively. Statistical analyses revealed that there were significant differences in the number of leaves of *B. pilosa* from seeds treated with extracts from maize root when compared to the control experiment. In rice husk extract treated seeds; there were no significant differences in the number of leaves of seedlings from the extract treated seeds when compared to the control experiment.

Table 3. Allelopathic effects of maize root and rice husk on the number of leaves of *Bidens pilosa*

Treatments (g)	Maize root	Rice husk
0	44.00a	93.40a
10	36.20ab	90.60a
20	28.20bc	80.00a
30	20.00c	73.40a
40	2.80d	61.60a
50	1.60d	58.80a

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

The effects of extracts on the leaf area of *B. pilosa* were shown in Table 4. The results revealed that both residues (extracts) treatments have inhibitory effects on the leaf area of *B. pilosa*. The leaf area of the treated seeds was retarded with the proportion of the retardation increasing with increase in the concentration of the extracts. The retardation was more pronounced in the seedlings from the maize root extracts treated seeds. This tends to suggest the effects were concentration dependent. The results from maize root extract treated seeds revealed that while the leaf area of *B. pilosa* in the control experiment was 92.23 cm², those of 10, 20, 30, 40 and 50 g concentrations were 90.77 cm², 83.03 cm², 42.08 cm², 22.79 cm², and 6.30 cm² respectively. Similarly in rice husk treated seeds, the leaf area of *B. pilosa* in the control was 163.27 cm², those of 10, 20, 30, 40 and 50 g concentrations were 159.83 cm², 146.59 cm², 132.62 cm², 124.94 cm² and 110.70 cm². Statistical analysis revealed that results obtained from the 40 and 50 g maize root extract concentrations were significantly different from those of the control experiment. No significant difference was observed in the rice husk treated seeds compared to control experiments.

Table 4. Allelopathic effects of maize root and rice husk on the leaf area of *Bidens pilosa*

Treatments (g)	Maize root	Rice husk
0	92.23a	163.27a
10	90.77a	159.83a
20	83.03a	146.59a
30	42.08ab	132.62a
40	22.79b	124.94a
50	6.30b	110.70a

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

The effects of extracts on the Relative Growth Rate (RGR) of *B. pilosa* were shown in Table 5. The RGR of *B. pilosa* in both extracts decreased with increase in the concentration of the extracts showing that degree of retardation were concentration dependent. For example, the RGR of *B. pilosa* treated with maize root had 0.42 cm in the control experiment, those of 10, 20, 30, 40 and 50 g concentrations were 0.42 cm, 0.42 cm, 0.35 cm, 0.30 cm and 0.28 cm respectively. Similarly, the RGR of *B. pilosa* treated with rice husk residues was 0.49 cm in the control, those of 10, 20, 30, 40, and 50 g concentrations were 0.49 cm, 0.47 cm, 0.45 cm, 0.44 cm and 0.41 cm respectively. Statistical analyses revealed that there were no significant in the RGR of *B. pilosa* seedlings from seeds treated with both extracts when compared to control experiments.

Table 5. Allelopathic effects of maize root and rice husk on the Relative Growth Rate (RGR) of *Bidens pilosa*

Treatments (g)	Maize root	Rice husk
0	0.42a	0.49a
10	0.42a	0.47a
20	0.42a	0.47a
30	0.35a	0.45a
40	0.30a	0.44a
50	0.28a	0.41a

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

The effects of the extracts on the biomass of *B. pilosa* were shown in Table 6. The results obtained on the dry root and shoot weights of *B. pilosa* in both residues were similar. Decreased root and shoot weights were obtained. The values decreased as the concentration of the extracts increases. In maize root treated seeds, the dry root weight of *B. pilosa* in the control experiment was 1.00 g, which decreased to 0.22 g in 50 g concentration. Similarly, the dry shoot weights decreased from 2.82 g in the control to 0.14 g in 50 g concentration. Also, in rice husk treated seeds, the dry root weight of *B. pilosa* decreased from 0.82 g in the control to 0.46 g in the 50 g extract concentration. Similarly, the dry shoot weight decreased from 7.30 g in the control to 6.00 g in the 50 g concentration. Statistical analyses revealed that the values obtained in the 40 and 50 g extract concentrations of both the root and shoot weights of maize root treated seeds were significantly different from the control experiments. However, no significant difference was observed in both root and shoot weights of rice husk treated seeds when compared to the control experiments.

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

Treatments (g)	Maize root		Rice husk	
	R	S	R	S
0	1.00a	2.82a	0.82a	7.30a
10	0.80a	2.64a	0.76a	6.68a
20	0.72a	2.06a	0.64a	6.42a
30	0.22a	2.02a	0.62a	6.06a
40	0.06a	0.20b	0.60a	6.00a
50	0.22c	0.14b	0.46a	6.00a

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

4. Discussion

It was observed that the extract from the maize root demonstrated more inhibitory effects on most of the growth parameters such as number of leaves and leaf area, relative growth rate, root and shoot weights as well as the relative growth rate of *B. pilosa* examined in this study. This tends to suggest the suitability of the extract from the maize root residues as bio herbicides in the control of weeds.

Previous assertion by Salam et al. (2009) suggested that extracts from rice husk contain growth inhibitory substances that limit the root and shoot growth elongation of *E. grucigalli*. Also, Oyun (2006) reported that the root and shoot lengths and seedling index of maize were decreased with increasing concentration of *Gliricidia sepium*. The number of leaves and leaf areas in seedling of the extract treated seeds decreased with increase in the concentration of the extracts. This corroborated the work of Yarnia 2009 that the number of leaves and leaf areas of extract treated seeds decreased with increase in the concentration of the extracts. This tends to suggest that the physiological activities of the extract treated weeds decreased as the concentration of the extract increases. The allelochemicals produced from the crop residues might be responsible for the inhibitory effects observed in this

study. Previous study by Sanchez-Moreiras et al. (2004) had revealed that maize inflorescence contained hydroxamic acid. Also, Einhellig and Souza (1992) revealed that maize root exudates are mostly saponin that is extremely phytotoxic while Chou and Lin (1976) asserted that rice husks contained chemicals such as P-hydroxyl benzoic acid, syringic acid, vallinic, ferrulic, acetic-o-hydroxyl Phenyl acetic, propionic and butyric acids. All these chemical compounds (allelochemicals) might be responsible for the inhibition of *B. pilosa* shown in this study.

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