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Herbicidal Effects of Leachates from Selected Tree species for Weed Control in Maize (*Zea mays.L*) Farm

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The influence of leachates obtained from the leaves of *Eucalyptus camaldulensis; Acacia auriculiforms* and *Gliricidia sepium* on the suppression of weeds in maize farm in Akure was investigated. The weeds in each plot (2m x 2m) of maize received foliar spray of 2 litres of the leachate treatments twice per week during the growing raining season until maize harvest. The total polyphenols in the leachates was 3.80 mg/100g, 3.22mg/100g, and 2.66mg/100g for *Gliricidia, Acacia* and *Eucalyptus* respectively. Weed biomass was consistently higher (P<0.05) in maize plots without leachate treatment for the entire sampling period. Plots that were treated with *Gliricidia* leachate recorded the least (P<0.05) weed biomass and this was consistent for the entire sampling periods ((4WAP, 6 WAP, 8WAP, 12 WAP). Maize height (24.9 cm) and yield (288kg/ha) at harvest (12WAP) was higher (<0.05) in Plots that received foliar spray of *Gliricidia* leachate. Also plots treated with *Eucalyptus* and *Acacia* leachates gave higher (P<0.05) maize height and grain yield relative to control. During the crop cycles, the leachate treatment resulted in selected pressure on weed population s. All the leachate treatments caused the disappearance of some weed species that were apparent at the beginning of the experiment. The results obtained in this study open a promising area for research that offers multiple alternatives to control different agricultural weeds.

Key words: Alkaloids, phenols, application, suppression and diversity

Introduction

The impact of weeds on crop production is enormous. Estimates suggested that weeds are responsible for an overall reduction of more than 10% in yield of major world crops culminating in a huge annual loss of food supplies (Altam and Cambell, 1977). As noted by Roberts (1982), weed infested lettuce may fail to meet the farm marketable requirements. Adejuwon et al (1989) reported that uncontrolled weed growth throughout the crops lifecycle caused 88 – 94% reduction in okra fruit yield compared with completely weed free okra. Singh *et al*., (1981) reported 76.5% in okra seed yield in unweeded plots relative to weed – free plots. The problem of weed in relation to crop is not limited to a direct reduction in yield but can also adversely affect crop quality (IITA, 1990). Several weed control methods are applicable to tropical agriculture. They include cultural, biological, chemical and integrated weed control measures (A kobundie, 1987).

Hoeing seemed generally less costly than other weed control methods; however, weed scientists have placed the greatest emphasis on the risk associated with this traditional method which is mainly damage to crop root system. Aside, higher labour demand of traditional weed control can potentially impair the expansion of crop production. The use of synthetic herbicides is potentially one of the most labour – saving innovation for weed control and had been found to reduce labour equipment 20 – folds in crop production (Diaz *et al*., 1974). However, aside from the rising cost of synthetic herbicides, Parker (1972) have noted the risks associated with synthetic herbicides utilization in subsistence agriculture to include crop damage from in proper application in the short term and development of resistant weed species in the long term and the risks of environmental pollution. To avoid such problems as rising costs of herbicides and possible environmental hazards, there is need for integrated weed control with measures justified not only from an economic but also ecological point of view. Previous reports have indicated inhibitory effects of natural substances from some plant species on the growth of other plants. In a study by Duhan and Lakshinarayana (1995), the growth of *Gymapopis, Fetragonoloba* and *Peninisetum* growing at distance of 1-2 and 7.5m from tree of *Acacia nilotica* was inhibited. Similarly, Jadhar and Gayanar (1992) observed that the percentage of germination of plumule and radicle length of rice and cowpea, were decreased with increasing concentration of *Acacia auriculiformis* leaf leachates. Also Kamal *et al*., (1997) reported that leaf extracts of *Acacia auriculiformis* and *Acacia nilotica* were highly toxic for growing wheat. Several chemical compounds which include alkaloids, flavonoids phenolic acids, tannins and terpenoids which occurs naturally in these tree species have been identified and implicated for phytotoxic effects on other plant species (Einhellig, 2002). Thus some tree species with allelopathic properties can potentially be used to control weeds. Hence, the application of allelopathic compounds before, along or after synthetic herbicides could increase the overall effect on weed control, thereby reducing application rates of synthetic herbicides.

The objectives of the present study were to investigate the presence and concentration of water – soluble allelochemicals (phenolics; alkaloids) in selected tree species, determine the effect of leachates from selected tree species on the diversity and biomass of weed species in maize farm and to evaluate the growth and yield of maize in plots under different leachate weed control with a view to establish or otherwise the potential of leachates from the selected tree species for weed control.

Materials and Methods

Experimental Site

The field experiment was conducted at the Teaching and Research Farm of the Federal University of Technology, Akure in 2008. Akure is located on latitude 7^0 17' N and longitude 5^0 10' E, an altitude of 350 m above sea level and mean annual temperature of about 27^0C. The mean annual rainfall is 1500 mm with a bimodal rainfall pattern. Relative humidity ranges between 68% and 86% during the rainy season and less than 50% during the harmattan dry period. The soil is classified as ferruginous tropical soil on crystalline rock of basement complex and belongs to Egbeda series (Smyth and Montgomery, 1962)

Data Collection

Ten trees each of *Acacia auriculiformis*, *Gliricidia sepium* and *Eucalyptus camaldulensis* were randomly selected from where foliage was collected. The foliage collected from ten trees of each species was mixed together and re-sampled to obtain three replicate samples from the composite samples. The leaf samples were sundried and thereafter, 1000 grams of each of the foliage sample was soaked in plastic buckets containing 10 litres of water for 48 hours to obtain the leachates.

Phenolic compounds (polyphenol) and alkaloids have been reported as water soluble allelochemicals that occurs in some tree species. Hence the leachate obtained were analysed for the presence and concentration of polyphenol and alkaloids.

Total polyphenol (as tannic acid equivalent) in the leachate was determined using Folin-coicalteu reagent as described by Makkar and Goodchild (1996). The alkaloid concentration in the leachate was determined by Harbon method.

A land area measuring 12 m x 9 m was demarcated and cleared of existing vegetation. The land area was thereafter divided into 12 plots of 2 m x 2 m each separated by 1m Each plot was planted with maize during the early planting season at an espacement of 90 cm x 30 cm (between and within rows). At two weeks after maize germination, the 12 (2 m x 2 m) plots were randomly distributed to three leachate treatment and a control (without leachate treatement) at three replicate per treatment. Each plot received foliar spray of 2 litres of leachates twice per week. During each spray period, caution was taken to ensure that the maize plants were not affected by the foliar spray. The foliar spray continued until maize maturity. The design of experiment was a completely randomized design at three replicate per treatment. At 2 weeks interval after the start of leachate application, the weeds in each plot were harvested and identified by their species. Thereafter the weed species harvested per plot was oven-dried to constant weight to obtain the biomass. Also at 2 weeks interval, maize height was measured during growth. At maturity, the maize plants on each plot were harvested and yield per plot was evaluated in kg/ha.

Statistical analysis of data

The data collected were subjected to one way analysis variance (ANOVA) for completely randomized design (CRD) using SPSS statistical package.

Results and Discussion

As shown in Table 1, Phenols and alkaloid were present as water soluble allelochemicals in the leachates obtained from the foliage of *Gliricidia sepium,Acacia auriculiformis* and *Eucalyptus camaldulensis.* The total polyphenol present in the leachate obtained from *Gliricidia sepium* was significantly ($P<0.05$) higher (3.80 mg/100g) than in both *Acacia auriculiformis* (3.22mg/100g) and *Eucalyptus camaldulensis* (2.66mg/100g). The total polyphenol in the leachate of *Eucalyptus* sp was significantly (P<0.05) lower than in *Acacia auriculiformis* (Table 1). However, the alkaloid concentration in the leachate obtained from the foliage of *Eucalyptus camaldulensis* (1.22mg/100g) was significantly higher (P<0.05) than in *Acacia auriculiformis* (1.09mg/100g) while *Gliricidia Sepium* leachate contained the least concentration of alkaloid (1.02mg/100g).

As shown in table 2, the weed biomass was significantly higher (P<0.05) in the control plots (without leachate treatment) than in any of the leachate treated plots at 4WAP, 6WAP, 8WAP, 10WAP and 12WAP (Table 2). Accordingly, the weed biomass in plots treated with *Gliricidia* leachate was significantly lower than weed biomass in *Acacia* and *Eucalyptus* leachate treated plots for the entire sampling periods (Table 2). However, the weed biomass in plots treated with *Acacia* and *Eucalyptus* leachates were not significantly different (P<0.05) at all the sampling periods (Table 2). Conversely, at all the sampling times (4WAP, 6WAP, 8WAP, 10WAP, 12WAP), the maize plant height was significantly lower (P<0.05) in plots without leachate treatment (control) than in all the plots that received leachate treatments (Table 3). Similarly, the maize plant height in plots treated with *Gliricidia* leachate was significantly higher (P<0.05) than those in plots treated with *Eucalyptus* and *Acacia* leachates for all the sampling periods (Table 3). Furthermore, throughout the period of sampling, the maize plant height was not significantly different (P<0.05) in plots treated with *Eucalyptus* and *Acacia* leachates.

At the time of maize harvest, maize grain yield (227.4kg/ha) was significantly lower (P<0.05) in plots without leachate treatment (control) than the leachate treated plots. However, plots that were treated with leachates from *Gliricidia* and *Eucalyptus* gave significantly higher (P<0.05) maize grain yield which were 288.5kg/ha and 284.4/ha respectively than in plots treated with *Acacia* leachate (232.8kg/ha). (Table 4).

At 12WAP, the weed species in plots without leachate treatment (control) were more than in plots that received leachate treatments (Table 5). There were eight different species represented by the families *poaceae* (5 spieces), *Lamiaceac* (2 species), *Malvaceac* (1 species) and *Cyperaceae* (1 species). At this same sampling time (12WAP), three species namely *Kyllinga Pumilla*; *Solanum nigrum* and *Trianthema potulacastrum* were present in plots that received *Eucalyptus* leachate treatment (Table 6). In the same sampling period, four species (*Andropogon*, *tectorum*, *Sida acuta*, *solanum nigrum*, *cleome nitidesperma*) were harvested in plots treated with leachates obtained from *Acacia auriculiformis* (Table 7). In plots treated with *Gliricidia sepium* leachates, only two species namely, *Boerhavia coccinea* and *Acatho spermum hispidum* were harvested.

As indicated by the results of this study, *phenols* and *alkaloids* were present as water soluble *allelochemicals* in the leachates obtained from the foliage of the test species. These findings agree with the report of Seigler (1996) who earlier noted that chemicals with *allelopathic* activity are present in many plants and various organs, including leaves and fruits. According to the author, the components are released to the environment by means of volatilization, leaching, decomposition of residues and root exudation. As observed in the present study however, the concentration of water soluble allelochemicals (alkaloids and phenols) in the leaves of plants varies among species.

In this study, plots without leachate treatment (control) recorded lower maize height growth and grain yield than those that received foliar spray of leachates obtained from the test species to control weeds. The findings implied that the economic losses that could results from the effects of weeds on crop yield could be enormous. The present findings corroborate the earlier report by Adejuwon et al (1989) who noted that uncontrolled weed growth throughout the crops life cycle caused 88-94% reduction in okra fruit yield compared with completely weed free okra. Similarly, Iremiren (1987), showed that unrestricted weed growth in okra farm caused 73-88% pod yield reduction. Oriade et al (1989) reported losses in quality of maize crop expressed in form of reduced sugar and carbohydrate content. The losses in crop yield and quality due to weed problems could be ascribed to severe competition between the weeds and planted crop for both above-ground (space, light, co_2) and below-ground (water, nutrients, soil air) growth resources. Other reasons could be due to root–root (crop-weed) competition and probable release of toxic substances from some of the weed species to the soil environment that can be allelopathic to the crop. This assertion supports the earlier claim by Blumetal (1999) who indicated that a large number of weed species possess allelopathic properties which have growth inhibiting effect in crops.

During the crop cycles, the leachate treatments resulted in selective pressure on weed populations. All the leachate treatments resulted to the disappearance of some weed species that were apparent at the beginning of the experiment. For example, *Anoxopus compressus*; *Chromolaena odorata*; *paspalum scrobiculatum* and *phyllanthus amary* which were harvested in plots treated with *Eucalyptus* leachate at 4WAP have completely disappeared at 12WAP (Table 6). Similarly *Talinum triangulae*; *sida acuta*; *chromolaena odorata* and *Anoxopus compressus* which were apparent in plots treated with *Gliricidia* leachate at 4WAP have completely disappeared at 12WAP (Table 8). These findings agree with the earlier report by Florentine and Fox (2003) who noted the role of allelopathy in suppressing the growth of weed plants. As equally observed in this present study, several studies (Yelu et al, 1999); Reigosa et al 2000; Sahar and Shehata 2005) reported *allelopathic* influence of leachates from *Eucalyptus* and *Acacia auriculiformis* which resulted to inhibitory on the germination and growth of crops such as wheat, cowpea and groundnut which are annual crops.

The inhibitory effect of the leachates from the test species on weed biomass and weed population observed in this study may have resulted from the morphological reduction exerted due to the allelopathic potential of the tree species which is accompanied by reduction in biochemical parameters of the weeds. This action may lead to reduction in total chlorophyll content of the weed plants and consequently reduction of the soluble sugar.

The results obtained in this study open a promising area of research that offers multiple alternatives to control different agricultural weeds. The use of leachate from tree legumes for weed management in agro systems show a more ecological way to obtain sustainable agriculture without a negative impact to the environment and biodiversity that commercial herbicides sometimes cause.

Table 1: Phenol and alkaloid concentrations of leachate from the foliage of selected tree species

Tree Species	Phenol (Mg/100g)	Alkaloid (Mg/100g)
Gliricidia sepium	3.80[a]	1.02[a]
Acacia auriculiformis	3.22[b]	1.09[b]
Eucalyptus camaldulensis	2.66[c]	1.22[c]

Means followed by dissimilar superscript in column are significantly different (P<0.05)

Table2: Effect of Leachate treatment from foliage of selected tree species on weed biomass (g/m2) in maize farm

Tree species	Sampling time				
	4WAP	6WAP	8WAP	10WAP	12WAP
Control	136.1	92.7[a]	98.3[a]	70.7[a]	67.7[a]
Acacia	94.0[b]	12.0[b]	9.6[b]	6.5[b]	5.4[b]
Eucalyptus	105.8[b]	6.0[b]	8.5[b]	8.1[b]	6.2[b]
Gliricidia	35.3[c]	1.0[c]	0.9[c]	0.7[c]	0.8[c]

WAP = Weeks after planting.

Means with dissimilar superscripts in column are significantly different ($P<0.05$)

Table 3: Maize plant height (cm) in a farm subjected to weed control by leachate treatments from the foliage of selected tree species

Tree species	Sampling time				
	4WAP	6WAP	8WAP	10WAP	12WAP
Control	57.2[a]	65.6[a]	134.1[a]	176.4[a]	206.9[a]
Eucalyptus	75.9[b]	87.8[b]	173.2[b]	226.7[b]	241.8[b]
Acacia	71.9[b]	84.1[b]	183.5[b]	210.2[b]	231.5[c]
Gliricidia	84.0[b]	104.7[c]	203.4[c]	228.1[c]	241.8[b]

WAP =Weeks after planting

Means with dissimilar superscripts in column are significantly different ($P<0.05$).

Table 4: Yield of maize (Kg/ha) in a farm subjected to weed control by leachate treatments from the foliage of selected tree species.

Tree species	Grain yield Kg/ha
Control	224.4[a]
Acacia	232.8[a]
Eucalyptus	284.4[b]
Gliricidia	288.5 [b]

Means with dissimilar superscripts in column are significantly different ($P<0.05$).

Table5: Diversity of weed species in control plots without weed control treatment at 12 WAP in a maize farm.

Weed species	Family
Panicum maximum	*Poaceae*
Anoxopus compressu	*Poaceae*
Sclerocarpus aftrcanum	*Lamiaceae*
Cynodon dactylon	*Poaceae*
Sida acuta	*Malvaceae*
Kyllinga pumilla	*Cyperaceao*
Platostoma africaum	*Laminaceae*
Paspalum scrobiculatim	*Poaceae*

Table 6 Diversity of weed species in plots treated with leachate from *Eucalyptus camaldulensis* at 12WAP in a maize farm.

Weed species	Family
Kyllinga pumilla	*Cyperaceae*
Solanum nigrum	*Solanaceae*
Trianthema potulacastrum	*Aizoaceae*

Table7: Diversity of weed species in plots treated with leachate from *Acacia auriculiformis* at 12WAP in a maize farm.

Weed species	Family
Adropogon lectorum	*Poaceae*
Sida acuta	*Malvaceae*
Solabyn nigrdum	*Solanaceae*
Cleome rutidosperma	*Cleinaceae*

Table 8: Diversity of weed species in plots treated with leachate from *Gliricidia spium* at 12WAP in a maize farm.

Weed species	Family
Boerhaevia coccinea	*Poaceae*
Acanthospermum hispidum	*Asteraeae*

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