African Journal of Biotechnology Vol. 4 (4), pp. 355-360, April 2005
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2005 Academic Journals

Full Length Research Paper

Influence of water extract of Mexican sunflower (*Tithonia diversifolia*) on growth of cowpea (*Vigna unguiculata*)

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Accepted 21 January 2005

Laboratory analysis of the water extract of *Tithonia diversifolia* shoot and root on infra-red spectrometer to determine the phytotoxic potential and greenhouse experiments to evaluate its phytotoxic effect and growth promoting attribute on cowpea (*Vigna unguiculata* L.) were carried out. *T. diversifolia* contained some compounds having functional groups such as alcohols, olefins, six-membered ring lactams, ester, aromatic compound which can also be found in sesquiterpene lactones, an allelochemical implicated in phytotoxicity. The extract promoted seedling and plant growth. *Bacillus* and *Streptococcus* spp. earlier isolated from the root rhizosphere of *T. diversifolia* caused some changes in the spectra of the component compounds in the extract. The plant extract promoted growth of cowpea.

Key words: *Tithonia diversifolia*, sesquiterpene lactones, Infra-red spectrometry; *Vigna unguiculata*, phytotoxicity.

INTRODUCTION

Mexican sunflower, *Tithonia diversifolia*, is a common weed shrub found growing in many parts of the world. In southwestern Nigeria, the weed had predominantly suppressed many common weeds including *Chromolaena odorata*, and some other grassy weeds. The aggressive nature of its growth has been observed to suppress cultivated crops resulting in crop failures. It also inhibits the germination of other weed seeds. Tongma et al. (1998) reported the presence of this weed in many countries in Asia and found them to have become dominant in some regions where it is present. The high growth rate of Mexican sunflower and its allelopathic attributes (Baruah et al., 1979; Dutta et al., 1993; Schuster et al., 1992) could have influenced the domination of the weed shrub over other crops in a competitive environment. Mexican sunflower contains sesquiterpene lactones (taginin A, a naturally occurring bioflavonoid, taginin C ($C_{11}H_{16}O_5$) and the flavonoid hispudin.

Green manure from Mexican Sunflower is rich in nitrogen (N) and phosphorus (P) and the fertilizer value are better than those from Calliandra green manure and *Imperata cylindrica* (Jayawardra et al., 2000; Mango, 1998; NoOrdwijk et al., 1997). Mexican sunflower possesses both fertilizer attribute as well as phytotoxic growth inhibitors. The activities of soil microbial flora and other soil factors have been suggested to influence the productivity, bioavailability and action of some allelochemicals including sesquiterpenes (Inderjit, 1996). The following experiments were carried out to study the interaction of some soil microorganisms and Mexican sunflower extracts as a phytotoxicant and growth stimulator on cowpea from germination to maturity. The results could expand the utilization of the crop as a hormonal extracts in organic agriculture.

MATERIALS AND METHOD

Warm water (55°C) extract of root and shoot were obtained separately and divided into 3 portions each. One portion of 500 ml was further subdivided into 5 lots and inoculated with 10% broth

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culture of *Bacillus* sp. and second portion with the combination of *Bacillus* sp. I, *Bacillus* sp. II, and *Streptococcus* sp. The third portion of the extract was left as the control. The three bacteria used were isolated from the root rhizosphere of Mexican sunflower, characterized (Buchanan and Gibbons, 1974) and preserved on nutrient agar in the laboratory. The inoculated extract was allowed to stay for 24 h on a gyrotatory shaker. The samples were later prepared and scanned on ZnSe Prism of Infrared Spectrometer to determine the infrared spectra.

One greenhouse study were conducted to assess the influence of the water extract of Mexican sunflower on germination and growth of cowpea (*Vigna unguiculata*) - Ife Brown.

Table 1. Pre-cropping soil physico-chemical analysis.

Parameter	Values
Sand %	76.6
Silt %	22.6
Clay %	0.8
% N	0.2
% C	2.14
Ca (meg. 100^{-1})	4.73
Mg ,,	3.15
K ,,	0.82
Na ,,	0.16
H^+ ,,	0.09
CEC	8.95
Base (%)	99.0
Av.P ($mgKg^{-1}$)	16.5
pH	6.4

The first experiment consisted of 7 treatments of prepared samples of shoot and root extracts inoculated with microorganisms. 50 ml of the extracts were applied to the soil at planting as follows:

1. *Bacillus* sp. + Water extract of the shoot of Mexican sunflower
2. *Bacillus* sp. + Water extract of the root of Mexican sunflower
3. Water extract of the shoot of Mexican sunflower alone
4. Water extract of the root of Mexican sunflower alone
5. Three microorganisms + Water extract of the shoot of Mexican sunflower
6. Three microorganisms + Water extract of the root of Mexican sunflower
7. Sterilized water.

The nutrient composition of the soil is listed on Table 1. Prior to treatment application, the soil was dried and sieved into 5 kg pots. The treatments were replicated five times. Four cowpea seeds were sown and later thinned to two per pot. Observation commenced at 3 days after sowing (DAS). Time of germination was recorded starting from 2 weeks after planting (WAP). Height measurements were taken and recorded until 6 WAP when the plants were harvested, and the shoot and root weights were also determined. The growth rate was calculated as follows:

$$\frac{\text{[Height at 6 WAP]} - \text{[Height at 2 WAP]}}{\text{[Number of weeks the growth lasted]}}$$

Statistical Analysis

Data generated were analyzed statistically and the treatment means compared using Duncan Multiple Range Test (Steel and Torie, 1980).

RESULTS AND DISCUSSION

In Figures 1 and 2, the possible presence of compounds containing alcohol, olefines, some six-membered ring lactams, esters, aromatic compound (1,4-dissubstituted two hydrogen atoms) were suspected. In Figures 3-6, the presence of amine, imines, ammonium and amide N-H were strongly suspected along with the compounds earlier identified in spectra 1 and 2. Figures 1 and 2 show the spectra of plant extracts not inoculated with any microorganisms. This suggests that the microorganisms were able to modify the configuration of the original compounds. It was also possible that their activities might have led to the formation of new compounds. Further research works are required to identify the exact compounds involved in this transformation. Generally, the suspected transformation did not lead to any significant changes in the growth rate, dry matter of shoot and root of the plant even though, uninoculated shoot extract consistently gave the highest growth parameters (Table 2). However, in most of the parameters assessed, the control plant was consistently overgrown by the plants that received water extract of *T. diversifolia* regardless of whether they were inoculated or not. This indicates that the microbial inoculants had no significant impact on the growth promoting attribute of the extract.

As shown in these results, inoculation of the extract with extraneous microorganisms may not be a rational option than relying on soil indigenous microflora. Generally, however, the extracts impacted positively on the growth of cowpea when compared with the control (Table 2). This is so if the high fertility status of the soil used (Table 1) is considered.

The above observations were not consistent with the observations of Baruah et al. (1994). The authors had earlier observed inhibition of some crops by *T. diversifolia*. According to their report, inhibition of growth by Mexican sunflower is normally attributed to flavanoid ($C_{15}H_{12}O_3$), sesquiterpenes lactones ($C_{10}H_{18}O_5$), hispudin ($C_{12}H_{18}O_{11}$),tagitinin A ($C_{11}H_{16}O_{15}$), tagitinin C ($C_{11}H_{16}O_5$). These compounds are susceptible to microbial attack in soils.

The allelopathic activity of Mexican sunflower is suspected to be most effective when plant is alive and fresh. The chemicals are continually being secreted and act against seeds of other invading weeds or any other

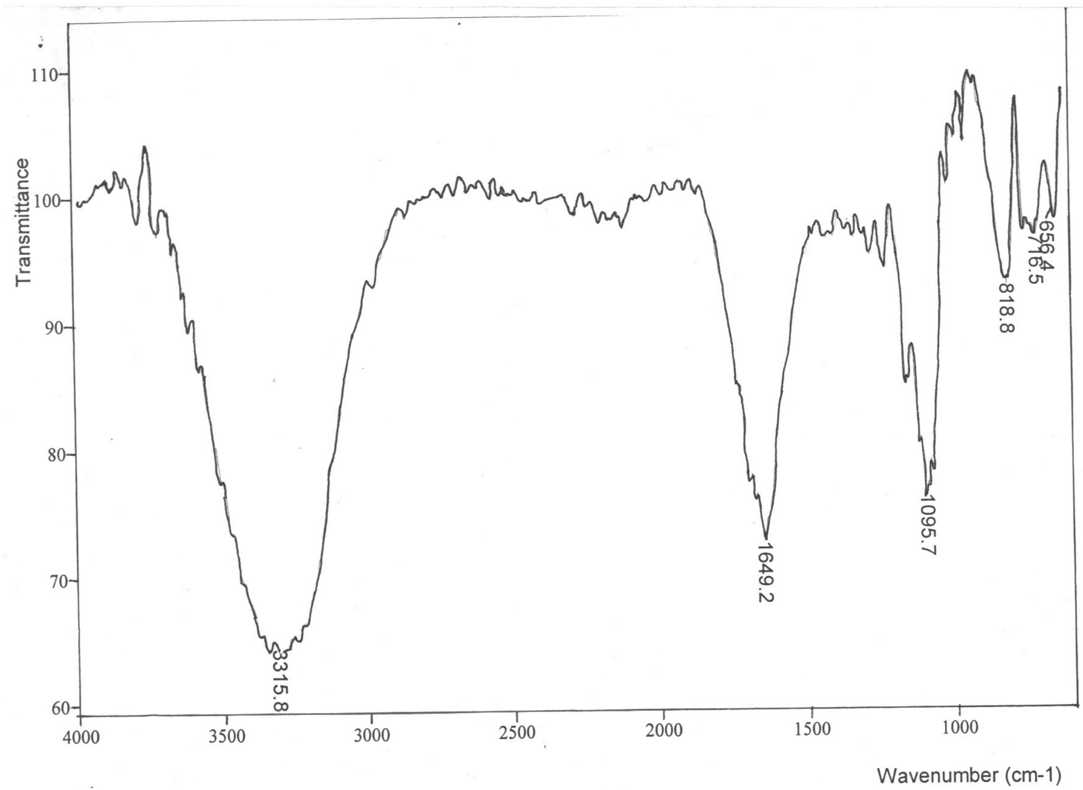

Figure 1. Infra-red spectra of bacillus sp.- inoculated water extract of *T. diversifolia* root.

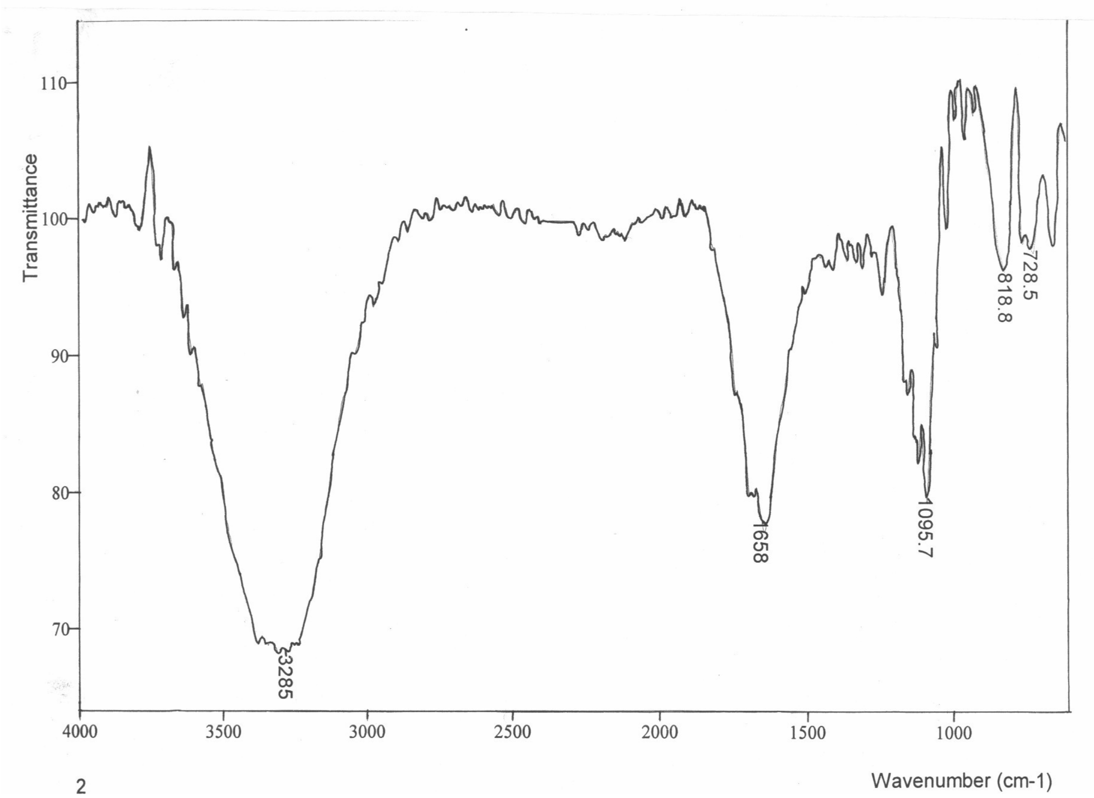

Figure 2. Infra-red spectrum of the water extract of *bacillus* spp. inoculated shoot of *T. diversifoli*a shoot.

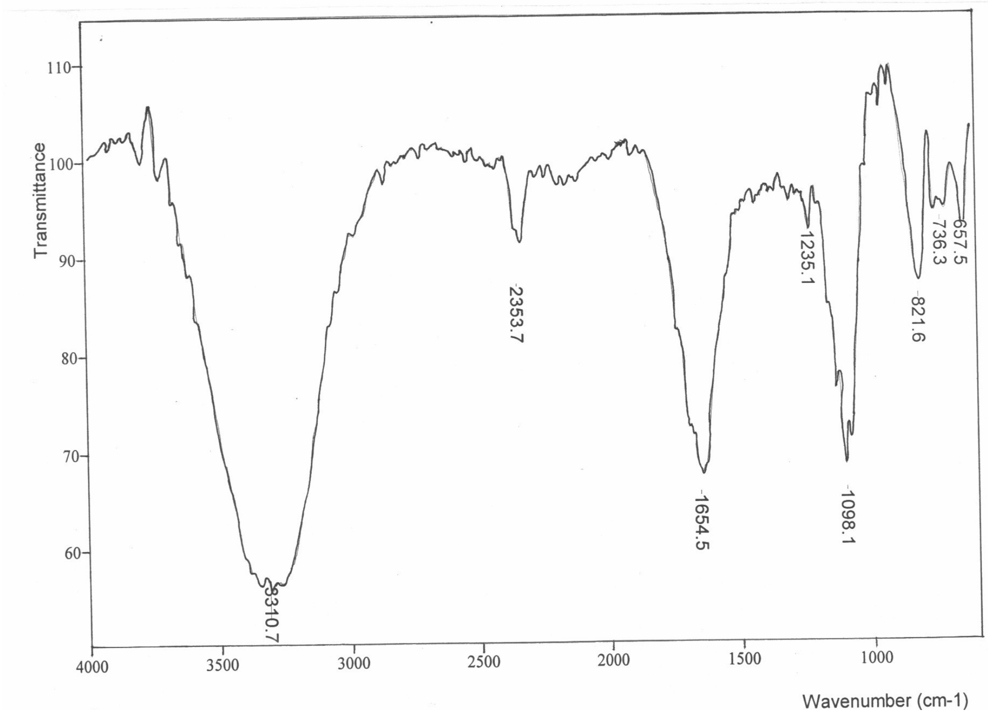

Figure 3. Infra-red spectrum uninoculated water extract of the shoot of *T. diversifolia.*

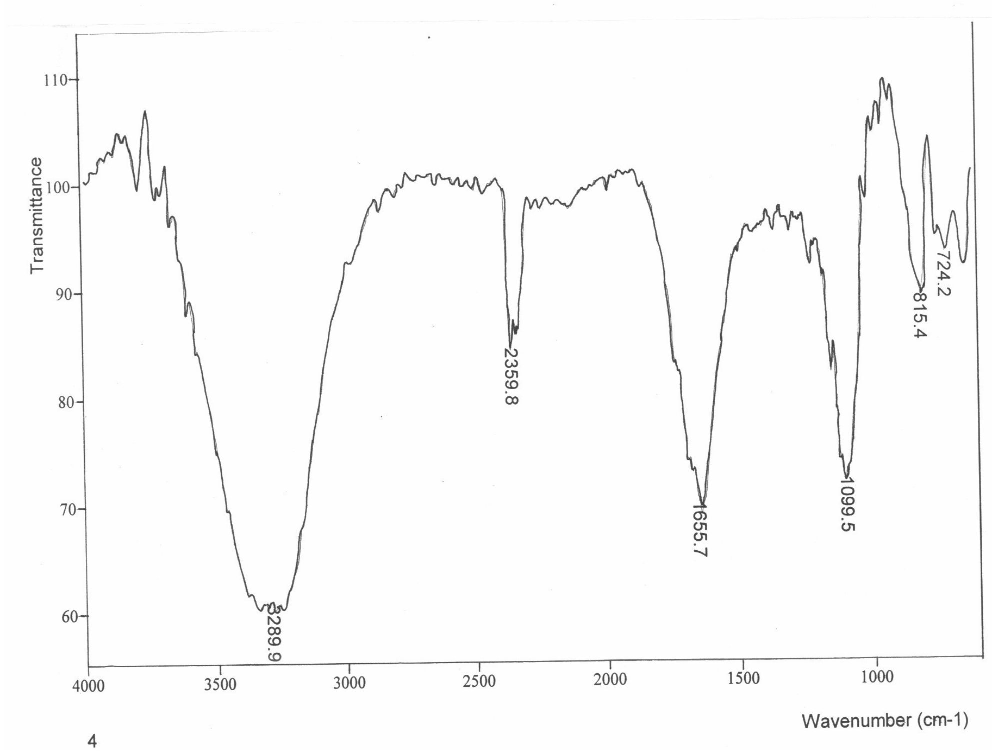

Figure 4. Infra-red spectrum of uninoculated water extract of root of *T. diversifolia*.

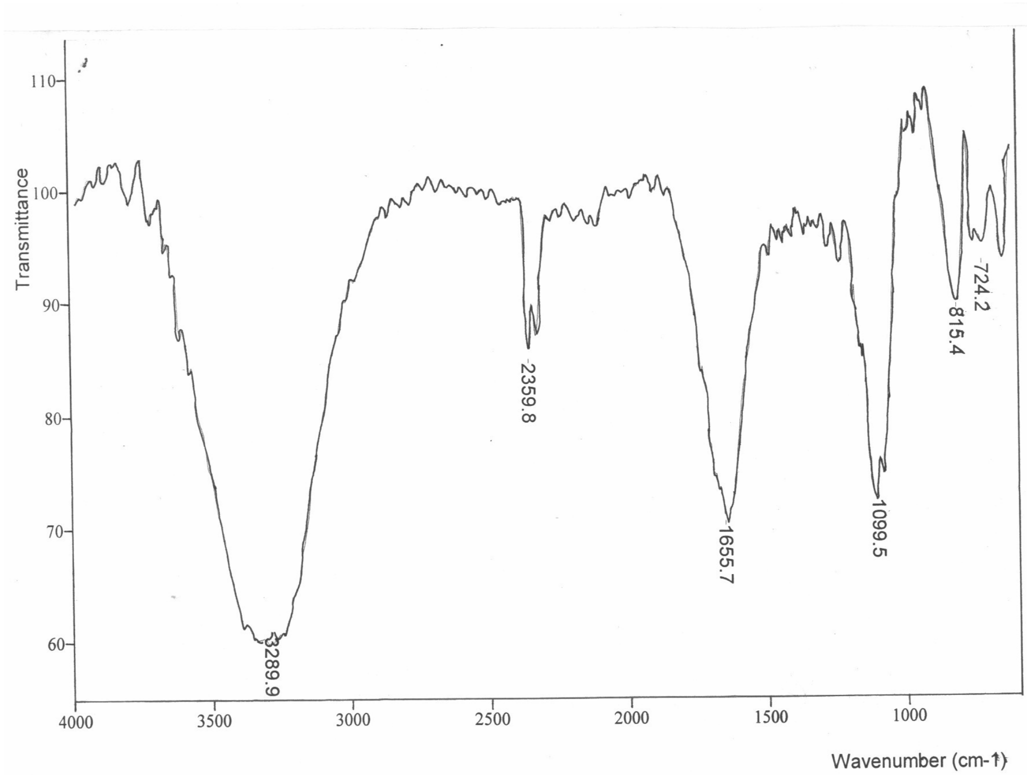

Figure 5. Infra-red spectrum of mixed culture-inoculated water extract of shoot of *T. diversifolia*.

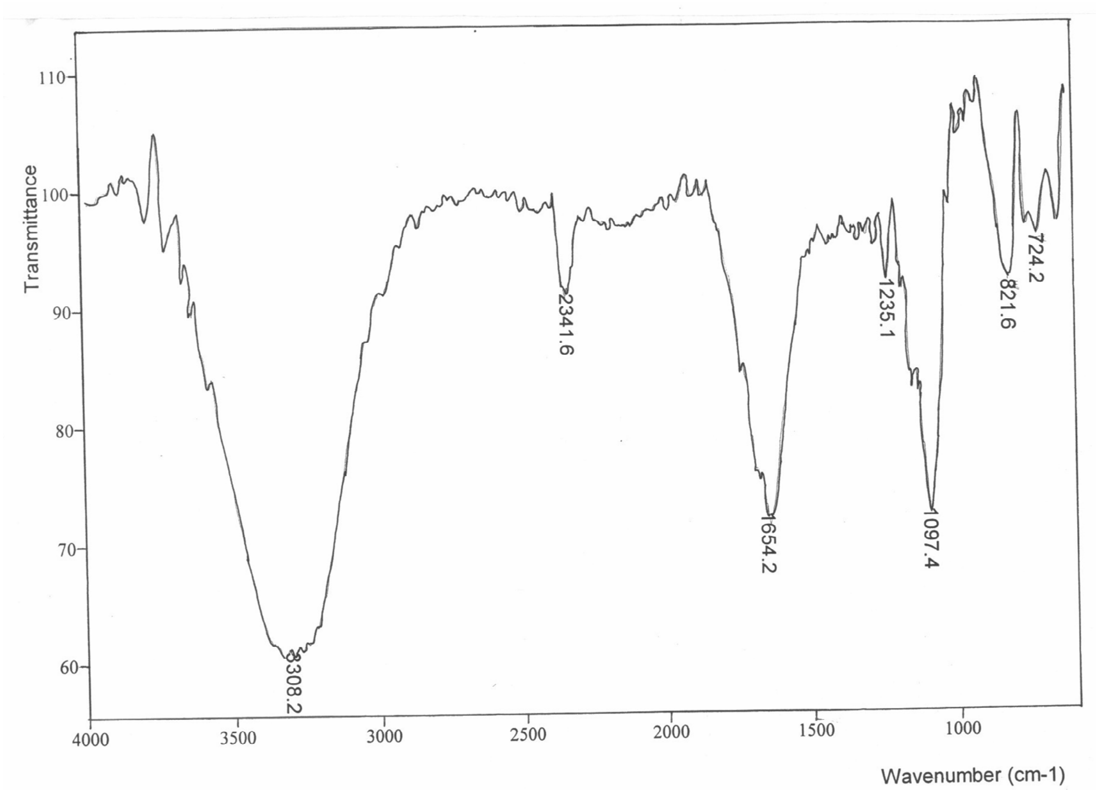

Figure 6. Infra-red spectrum of mixed culture - inoculated water extract of root of *T. diversifolia*.

Table 2. Height measurements of Cowpea plant fertilized by the water extract of *T. diversifolia* inoculated with Bacillus sp. and a mixed culture of *Bacillus* and *Streptococcus* spp.

Treatments	Height (cm)					DM shoot	DM root	Growth rate/wk
	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP			
Bacillus sp.+Water extract of shoot	29.8[a]	37.6[a]	42.6[a]	46.6[bc]	71.6[ab]	3.9[a]	1.5[a]	10.5[ab]
Bacillus sp.+ Water extract of root	28.4[a]	35.6[a]	42.6[a]	49.8a[b]	79.0[a]	4.2[a]	2.1[a]	12.7[a]
Un-inoculated water extract of shoot	27.2[ab]	36.2[a]	43.0[a]	52.4[a]	84.4[a]	5.2[a]	2.3[a]	14.3[a]
Un-inoculated water extract of root	29.2[a]	37.2[a]	43.0[a]	47.4[b]	78.0[ab]	4.8[a]	2.2[a]	12.2[ab]
Mixed culture-inoculated water extract of shoot	29.0[a]	37.0[a]	42.4[a]	47.0[bc]	74.0[ab]	3.9[a]	2.0[a]	11.3[ab]
Mixed culture-inoculated water extract of root	29.2[a]	37.8[a]	41.6[a]	47.0[bc]	70.4[ab]	3.7[a]	1.9[a]	10.3[ab]
Control	24.8[b]	32.8[b]	36.8[b]	43.0[c]	63.8[b]	2.0[b]	0.9[b]	9.8[b]
CV (%)	9.0	9.2	6.7	7.9	13.74	15.2	11.7	14.2

All figures in the column followed by the same letter are not significantly different (p=0.5).

seeds in its vicinity. Observation that the weed has growth promoting attribute could be explained by the presence of some growth promoting compounds isolated by Baruah et al. (1994). These compounds might have acted as growth promoters or involved in modifying the soil chemical and/or biological factors in favour of the test crop. These compounds are suspected to be available when the plant has been harvested. In the experiment reported, harvested plant was used and this might have contributed to the positive impact of the weed. Further analysis of water and other chemical extract of the plant is required to properly isolate and classify the active ingredients for its growth promoting attribute.

ACKNOWLEDGEMENTS

The authors express their sincere appreciation to the management and staff of ROTAS Soilab services for the Infra-Red Spectrometry analysis. We also thank Mrs. Folake Owosibo, and Mrs. Bose Akorede for their assistance in the laboratory. We also appreciate the approval given for the publication of this manuscript by the management of the Institute.

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