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Allelopathic Effect of *Cyperus tuberosus* Seed and Leaf Extract on Seedling Growth of Groundnuts (*Arachis hypogaea*)

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ABSTRACT

The effect of leaf and root extract of *Cyperus tuberosus* on the seedling growth of groundnut (*Arachis hypogaea*) was investigated using six aqueous extracts levels (0, 0.5, 1.5, 2.0 & 3.0 g/cm 3). It was observed that the toxic chemical released by *C. tuberosus* aqueous extract has more effects on groundnuts as significant depression on shoot and root growth was observed. Also shoot growth was more affected than root growth. The results revealed that different concentrations of leaf extracts caused significant inhibitory effect on root and shoot elongation of the receptor crops. Bioassays also indicate that the inhibitory effect was proportional to the concentrations of the extracts and higher concentrations had the stronger inhibitory effect, whereas, the lower concentrations showed stimulatory effect in some cases. This investigation also shows that the leaf extract of *C. tuberosus* have more allelopathy than seed extract. © 2012 Friends Science Publishers

Key Words: Effects; Groundnuts; Allelophatic; Seedling growth; Leaf extract; Seed extract

INTRODUCTION

Weeds species are considered as rich source of secondary metabolites (allelochemicals) and these chemicals modify the environmental system on other plants growing in their vicinity and the phenomenon is known as allelopathy (Nandal *et al*., 1994; Cheema *et al*., 2005). Allelophaty is further defined as the detrimental effect of chemicals or exudates produced by one plant specie on the germination, growth or development of plant specie, sharing the same habitat. Many crops and roots residues have been reported to have allelophatic effect on agricultural plants (Whittaker & Feeny, 1971; Price *et al*., 2008). A lot study has been carried out on the effects of chemicals released by roots, leaves, fruits, and other parts of intact growing plants of one species on the growth of another species (Uga, 2004). Plants may influence the growth of each other by means of exudates, leachets from decomposing residues, and residues incorporated into growing medium. Price *et al.* (2008) demonstrated that the exudates from tropical weeds inhibited the growth of Yam in a manner similar to yield reduction observed when yams are grown in full competition with weeds. Allelophaty is also a biological phenomenon in which on e or more biochemicals produced influences the growth, survival and reproduction of other organism. These biochemicals are known as allelochemicals and can have beneficial (positive allelophaty) or detrimental (negative allelophaty) effect on the target organisms. Willis and Rick (2007) explained that allelochemicals are a subset of secondary metabolites, which are not required for metabolism (i.e., growth, development & reproduction) of the allelophatic organism and the allelochemicals with negative allelophatic effect are an important part of the plant.

The groundnut or peanut (*Arachis hypogaea)* is a species in the legume family (Fabaceae). The cultivated groundnut was probably first domesticated in the valley of Paraguay and Parana rivers in the Chaco region of Paraguay and Bolivia. It is an annual herbaceous plant growing 30- 50 cm tall. The leaves are opposite, pinnate, with four leaflets (two opposite pairs, no terminal leaflet), each leaflet 1-7 cm long and 1-3 cm broad. The flowers are a typical pea flower in shape, 2-4 cm across, yellow with reddish veining. After pollination, the fruit develops into a legume 3-7 cm long, containing 1-4 seeds, which forces its way underground to mature. Ground nuts are known by many local names including earthnuts, peanuts, youber pea, monkey nuts pygmynuts and pignuts (Uga, 2004). They are widely used in Southeast Asian cuisine, particularly in Indonesia, where it is typically made into a spicy sauce. Peanuts originally come to Indonesia from the Philippines, where the legumes come from Mexico in times of colonization. In South Africa, it is used as believed to give males sexual vigor and to be aphrodisiac. Peanuts are used in making candies, cakes, cookies, and other sweets. They are also enjoyed roasted and salted. Peanuts butter is one of the most popular based foods in the USA. It has a variety of industrial end uses such as in paints, varnish, lubricating oil; leather

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dressing, furniture polish, insecticides, and nitroglycerin are made from peanut oil (Abdulkadir *et al*., 2006) Soap is made from saponified oil, and many cosmetics contain peanut oil and its derivatives. The protein portion of the oil is used in the manufacture of some textile fibres. Peanut shells are used in the manufacture of plastics, wallboards, abrasives, fuel, cellulose (used in crayons & papers) and macillage (glue).

Groundnuts are rich in nutrients, providing over 30 essential nutrients. Peanuts are good source of niacin, folates, fiber, magnesium, vitamin E, manganese and phosphorus. They are also naturally free of trans-fats and sodium, and contain about 25% protein (a higher proportion than in any true nut). While peanuts are considered to be high in fats, they primarily contain good fats known as unsaturated fats. Peanuts contain 11.5 g unsaturated fats and 2 g of saturated fats. In fact, peanuts have been linked to well enough to their heart-healthy benefits. In 2003, the National Agency of Food and Drug Administration and Control (NAFDAC) released a health claim recognizing peanuts as in helping maintain one's cholesterol. Some brand of peanut are fortified with omega-3 fatty acid in the form of flaxseedoic to balance the ratio of omega-3 – omega - 6 fatty acid. Peanuts are good sources of niacin and thus contribute to brain health and blood flow (Food Retrieved, 2007). Many factors have been known to affect its germination, seedling growth and development. These factors include among others pest, diseases, weeds and allelophatic effects of other plants. *Cyperus tuberosus* is hoxion weeds that is common and prevalent in the agricultural fields of Adamawa state and affect the yield of groundnuts, thereby bringing economic loss to farmers. This research work is designed to determine the allelophatic effect of seed and leaf extract of *Cyperus tuberosus* on seedling growth of groundnut.

MATERIALS AND METHODS

The study was conducted in the microbiology laboratory unit of the science laboratory technology Department of Federal Polytechnic, Mubi. Mubi is the headquarters of Mubi-Northlocal Government which is located on Latitude 10o15'N and Longitude 13o16' E at an altitude of 696 m above sea level. The major ethnic groups include Fulani, Gude, and Fali and the minority groups are Marghi and Kilba. The climate is characterized by alternating dry and wet season. The rains last from April to October with a mean annual rainfall from 700 to 1050 mm (Udo, 1970; Adebayo, 2004).

The fresh samples of the weed plant (*Cyperus tuberosus)* were collected from agricultural fields in Federal Polytechnic Mubi. Both leaves and roots of *Cyperus tuberosus* were collected and the seeds were removed from the roots of the plant and washed several times with running tap water, then rinse with distilled water. The leaves were dried in the oven at 80^{o}C for 24 h and the dried samples were then ground to powder form and also the seeds were dried under the sun for two days and into powder form.

Preparation of extract: The plant (sample) was collected and the seeds were separated from the leaves and then washed with tap water, followed by several washings with distilled water. The leaves and seeds were placed into the hot air oven at 80^{o}C for 24 h for drying and sterilization. This was then transferred into a sterilized mortar and using a sterilized pestle, it was pounded into a fine powder each (leaves & seed powders). These were sieved through a 8.0 mm size wire mesh net screen and the larger particles were removed. The fine particles were weighed into 50, 100, 150 and 300 g by using a weighing scale. Each of them was then dissolved into 100 cm 3 of distilled water to make up the various concentrations and left for 24 h. The concentration were the filtered by using funnel and muslin cloth into various conical flasks. The concentration of 0.5, 1.0, 1.5, 2.0 and 3.0 g/cm 3 were obtained after filtration, and then used for germination and seedling growth tests. The powder was reconstituted at various in nairds to keep the seeds moist in the Petri dishes until the development of the first two leaves.

Experimental set up: Abovementioned five concentrations of *Cyperus tuberosus* water extracts of both leaves and seeds were prepared by dissolving 50, 100, 150, 200 and 300 g each in 100 cm 3 of distilled water. Sixty four petri dishes were used with five seeds of each of both groundnut and beans seeds, and the Petri dishes contained sterilized cotton wool. In order to have good germination, while four Petri dishes were used as control (two were distilled water & two were tap water). The leaves and seeds extracts were used in moistening the cotton wool that contained the seeds of both groundnut and beans, in the Petri dishes. The treatment of each water level were replicated three times and arranged randomly. The germination and seedling growth of each replicate was recorded in a notebook on daily basis. The experiment was terminated after 13 days. The germinated seed were counted, while the shoots and roots length were measured. The results were expressed in terms of the average of the three replicates.

Statistical analysis: The data obtained from the experiment were analyzed statistically by subjecting them to analysis of variance (ANOVA) of Gomez and Gomez (1984) using SAS system for windows (SAS, V8, 2000). Significant differences among means were separated using Least Significant Difference (LSD) procedure (Little & Hills, 1986).

RESULTS

Allelophatic effect of *C. tuberosus* extract on the seedling growth of groundnut: The result of the allelophatic effect of *C. tuberosus* seed extract on the seedling shoot length growth of Groundnut during the 2010 growing season is presented in Table I. The seedling shoot length growth began on the 4th day of the experiment with treatment concentration of 0.5 g/cm 3, which recorded a significant

($P>0.05$) difference with the control treatment. The mean seedling shoot length growth measured 0.51 cm. There was also a commenced seedling shoot length growth between the 5th and 7th days for the treatment 1.0, 1.5 and 2.0 g/cm 3. However, there was no commencement of seedling shoot length growth in aqueous concentration 3.0 g/cm 3 throughout the experimental period (Figs. 1–3). There was also significant difference ($P<0.05$) for all the treatments between the 8th to the 13th day of the experiment. The lowest mean seedling shoot length growth during the growth was 0.40 cm on the 5th day of the experiment on aqueous concentration of 1.0 g/cm 3, while the highest mean seedling shoot length growth was recorded on the 13th day measuring 5.44 cm on aqueous concentration of 0.5 g/cm 3, and 7.10 cm on the control treatment on the same days.

Table II presents the allelophatic effects of *C. tuberosus* leaf extract on the seedling shoot length growth of Groundnuts during the 2010 growing season. On the 1st day, there was no significant ($P>0.05$) seedling shoot length growth in all the treatments. Furthermore, in the 2nd, 3rd and 4th days of the experiments, there was no significant ($P>0.05$) seedling shoot length growth in all the treatments. Similarly, the aqueous concentration of 3.0 g/cm 3 of leaf extract did not show any significant ($P>0.05$) seedling growth from the 1st day of the experiment to its 13th day. However, there was a significant difference ($P<0.05$) between aqueous concentrations of 0.5 g/cm 3 (0.31 cm) and the control (0.90 cm) on the 5th day. Similarly, there was a significant ($P<0.05$) difference between treatments from the 7th to the 13th day for all the treatments. The highest mean seedling shoot length growth was on aqueous concentration of 0.5 g/cm 3, which measured 5.61 cm on the 13th day. The allelophatic effect of *C. tuberosus* seed extract on the root length growth of groundnuts seedling during the 2010 season is also presented in Table III. There was almost near uniform root length growth in the 1st day of the experiment, but the root length growth differed slightly ($P>0.05$) for aqueous concentration of 2.0 g/cm 3 and 3.0 g/cm 3 as compared to the 0.5 g/cm 3, and in the 2nd day of the experiment. Treatments 1.0 and 1.5 g/cm 3 did not significantly ($P>0.05$) differ from each other on the the 2nd day. There was also a significant ($P<0.05$) variation in root length growth between the treatments from the 4th to 13th days of the experiment. The highest mean seedling root length growth was on treatment 0.5 g/cm 3, which was 3.93 cm as against the 4.40 cm recorded in the control treatment. The least mean root length growth was on all the treatments in the 1st day, which was also measured as 0.03 cm.

Table IV presents the results of the allelophatic effects of *C. tuberosus* leaf extract on the root length growth of groundnut seedling during the 2010 season. This result revealed that the response of the groundnut seedling to the aqueous extract was more severe in the concentration of 3.0 g/cm 3. There was no significant ($P<0.05$) difference in respect of root length for all the treatment in the 1st day of the experiments. The 2nd and 3rd day noticed significant

Fig. 1: Germination of groundnuts at the initial setup using seed extract

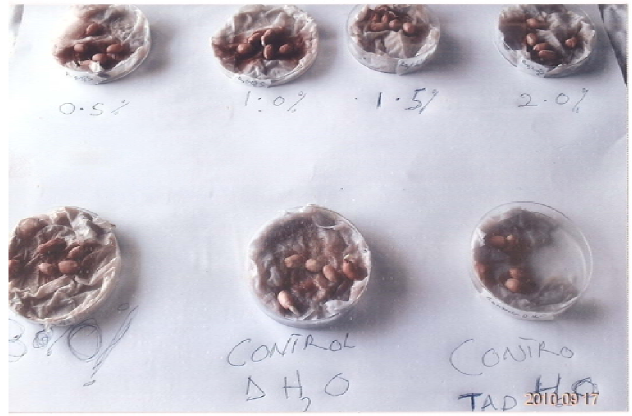


Fig. 2: Germination of groundnuts after six days using seed extract

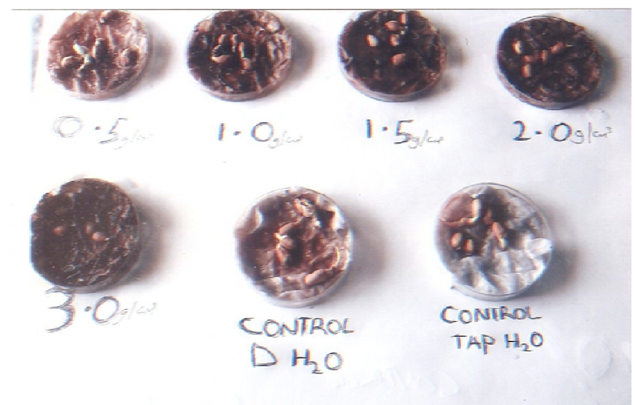
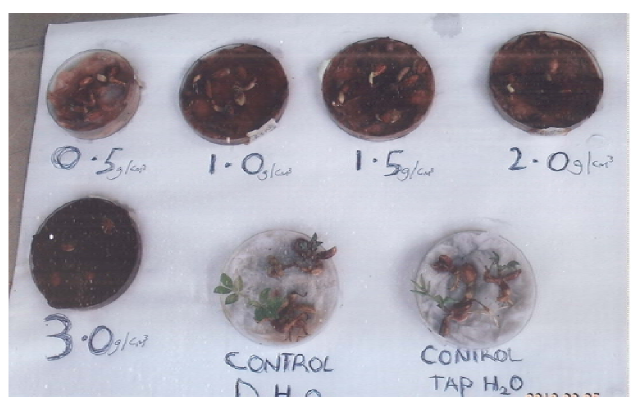


Fig. 3: Germination of groundnuts after 13 days using seed extract



($P<0.05$) changes in root length especially on aqueous concentration of 1.0 and 1.5 g/cm 3. There was also significant ($P<0.05$) variation in the root length growth in all the treatments from 4th to 13th day of the experiment. The steady increase in root length for aqueous extract concentration of 0.5 and 1.0 g/cm 3 revealed a better growth

Table I: Effect of *Cyperus tuberosus* Seed extract on the seedling growth of groundnuts (shoot length)

Treatment	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13
0.0	0.00a	0.00a	0.00a	0.70a	0.90a	2.60a	3.00a	3.33a	4.10a	4.33a	4.90a	5.40a	7.10a
0.5	0.00a	0.00a	0.00a	0.51b	0.80a	1.95b	2.05b	2.26b	3.42b	4.30a	4.71a	5.15ab	5.44b
1.0	0.00a	0.00a	0.00a	0.00c	0.40b	0.74c	1.31c	1.50cd	2.31c	3.19b	4.24b	4.82b	5.15b
1.5	0.00a	0.00a	0.00a	0.00c	0.41b	0.50d	0.91cd	1.71bc	1.90d	2.35c	2.74c	2.90c	3.58c
2.0	0.00a	0.00a	0.00a	0.00c	0.00c	0.00e	0.54de	0.97d	1.06e	1.27d	1.57d	1.76d	2.47d
3.0	0.00a	0.00a	0.00a	0.00c	0.00c	0.00e	0.00e	0.00e	0.00f	0.00e	0.00e	0.00e	0.00e
Lsd	0.00	0.00	0.00	0.90	0.09	0.08	0.71	0.57	0.30	0.25	0.26	0.34	0.45

Table II: Effect of *Cyperus tuberosus* leaf extracts on the seedling growth of groundnuts (shoot length)

Treatment	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13
0.0	0.00a	0.00a	0.00a	0.20a	0.90a	2.66a	3.10a	3.53a	3.86a	4.20a	5.00a	5.33a	7.00a
0.5	0.00a	0.00a	0.00a	0.06b	0.31b	0.70b	0.90c	1.64c	1.92c	3.21c	4.31b	4.72b	5.61b
1.0	0.00a	0.00a	0.00a	0.00b	0.31b	0.62b	1.42b	2.31b	3.21b	3.71b	4.17b	4.57b	4.92c
1.5	0.00a	0.00a	0.00a	0.00b	0.00c	0.00c	0.00e	0.43d	0.94d	1.29d	2.04c	2.55c	3.34d
2.0	0.00a	0.00a	0.00a	0.00b	0.00c	0.00c	0.33d	0.40d	0.50de	0.90e	1.32d	2.15d	2.81d
3.0	0.00a	0.00a	0.00a	0.00b	0.00c	0.00c	0.00e	0.00e	0.00e	0.00e	0.00e	0.00e	0.00e
Lsd	0.00	0.00	0.00	0.12	0.10	0.22	0.18	0.10	0.58	0.32	0.19	0.32	0.66

Table III: Effect of *Cyperus tuberosus* seed extract on the seedling growth of groundnuts (root length)

Treatment	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13
0.0	0.20a	0.46a	0.70a	0.90b	1.80a	2.50a	2.46a	2.70a	2.80b	3.30a	3.80a	3.90a	4.40a
0.5	0.06b	0.34b	0.48b	0.97b	1.33b	1.56b	1.56d	1.97d	2.33d	2.70d	3.13c	3.43b	3.93b
1.0	0.03b	0.23c	0.56b	0.98b	1.24c	1.37d	1.74c	2.10c	2.97a	3.02c	3.14c	3.33c	3.51c
1.5	0.03b	0.20c	0.52b	1.08a	1.22c	1.47c	1.53d	1.62e	2.13e	2.35e	2.46d	2.72d	3.27d
2.0	0.03b	0.03d	0.36c	0.57c	0.73d	0.82e	1.92b	2.20b	2.47c	3.14b	3.23b	3.47b	3.59c
3.0	0.03b	0.03d	0.07d	0.20d	0.36e	0.56f	0.78e	0.96f	1.39f	1.53f	1.64e	1.71e	1.82e
Lsd	0.05	0.07	0.09	0.08	0.06	0.06	0.03	0.09	0.06	0.09	0.06	0.06	0.18

Table IV: Effect of *Cyperus tuberosus* leaf extract on the seedling growth of groundnuts (root length)

Treatment	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13
0.0	0.20a	0.50a	0.70a	0.90a	1.80a	2.50a	2.50a	2.70a	2.80a	3.30ab	3.80a	3.90a	4.30a
0.5	0.00b	0.27b	0.48b	0.81a	1.30b	1.87b	1.98b	2.31ab	2.72b	3.31a	3.31b	3.59b	3.62b
1.0	0.00b	0.17bc	0.44b	0.70b	0.96c	1.08c	1.31c	1.98bc	2.41c	2.70b	3.21c	3.31c	3.51c
1.5	0.00b	0.15bc	0.20c	0.20d	0.41e	0.60e	0.71d	1.24d	1.12e	1.28cd	1.82e	2.22d	2.95d
2.0	0.00b	0.10cd	0.21c	0.59c	0.71d	0.91d	1.31c	1.58cd	1.72d	1.83c	2.05d	2.16d	2.25e
3.0	0.00b	0.00d	0.08c	0.27d	0.31f	0.31f	0.40e	0.41e	0.50f	1.00d	0.53f	0.50e	0.50f
LSD(0.05)	0.07	0.13	0.21	0.10	0.09	0.10	0.08	0.40	0.06	0.59	0.07	0.06	0.07

Means with the same letter are not significantly different

condition and less allelophatic effect on the seedling than the aqueous concentration of 2.0 and 3.0 g/cm 3. The lowest mean root length growth was noted at concentration of 3.0 g/cm 3 measuring 0.08 cm as against least of the control treatment (0.20 cm). The highest mean root length growth was on aqueous concentration of 0.5 g/cm 3 measuring 3.62 cm as against the highest in the control (4.30 cm).

DISCUSSION

The seedling growth of both shoot and root of groundnut significantly decreased with the incorporation of residue in the agar gel medium. The average seedling growth decrease in shoot and root growth at the maximum concentration of the extract (i.e., 2.0 & 3.0 g/cm 3) using both leaf and seed extract. Similar results have been reported by Heisey (1990). The pearl millet and cowpea shoot and root length were reduced a maximum of 64 and 36%, respectively. The degree of retardation also increased with an increase in the concentration of extracts. The groundnut seed was affected more, especially at the high level of concentration of the leaf extract. This shows that soluble toxin that is released from the residue during decomposition affected plants growth. Shoot growths were affected more than roots growth. The leaf extracts of *C. asiatica* affected the shoot length of the crop plants more than the root length. Allelochemical activity of plant is measured by the sensitivity of roots in the bioassay (Heisey, 1990).

The inhibitory effect was progressively increased with the increase of concentration. These growing points, which were in contact with the extract of both leaf and root, were exposed to the possible toxins evolved either through the process of leaching from residue or by the action of micro organism upon decomposition. The growth inhibition cause resulted from allelochemicals from *C. tuberosus* residue to interfere with many processes. Evanari (1949) noted that presence of germination inhibitors is a wide spread phenomenon, while the detrimental effect of chemical exudates from growing plant can be directly related to their environmental product of decay or dead plant tissue are only part of the inert, non living component of the ecosystem. Besides the root inhibition by various crop residues and their combinations, morphological disorders like root twisting and distorting were also observed. This confirms the affect of allelochemicals on root morphology (Jennings & Nelson, 2002). Also many seedlings lost their ability to develop normally as a result of reduced radical elongation and root necrosis. So, it can be concluded that the inhibitory effect of *Lantana* extract dependent very much on their concentration, which was also reported by Daniel (1999).

In conclusion, allelochemicals released by *C. tuberosus* water extract of both leaf and seeds have an inhibiting effect on growth of both shoot and root of groundnut also the toxic chemical has more effect on groundnut seedlings. It is recommended that further research should be carried out to investigate the effect of this weed plant, *C. tuberosus* on the seedling growth of different species of crops.

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