The African Journal of Plant Science and Biotechnology ©2010 Global Science Books

Preliminary Evaluation of *Tithonia diversifolia* (Helms.) A. Gray for Allelopathic Effects on Some Selected Crops under Laboratory and Screenhouse Conditions

O. Samuel Olabode • G. Olulakin Adesina* • S. Adelani Babarinde • E. Olabimpe Abioye

Department of Agronomy, Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso, Nigeria

Corresponding author: * lakinsina@yahoo.com

ABSTRACT

Tithonia diversifolia (Helms.) A Gray leaf extract was evaluated for its allelopathic activity against maize (*Zea mays*), soybean (*Glycine max*) and okra (*Abelmoschus esculentus*) seeds at 38 ± 2°C and 69-75% relative humidity in the laboratory. Screenhouse studies were also carried out on the same crops. The concentrations tested in the laboratory experiment were 100, 50, 20 and 0% of the extract. Maize seed germination was not significantly ($P < 0.05$) affected by *T. diversifolia* extract across the concentrations tested. At 100% concentration, *T. diversifolia* extract significantly lowered soybean germination. There were significant differences in the germination of okra seeds but without a trend. The highest germination percentage (88%) occurred at 100% concentration while the least (80%) occurred at 50% concentration and the control. The screenhouse treatments were: (a) sterilized soil + water, (b) natural soil + extract, (c) natural soil + water and (d) soil under *Tithonia* canopy + water. The result from the sceenhouse experiment showed that except for the number of leaves of okra, soil under *Tithonia* canopy + ordinary water did not show any conspicuous negative effect on the tested parameters when compared with the control.

Keywords: allelopathy, germination, growth parameters, wild sunflower

INTRODUCTION

Allelopathy in agriculture has received great attention among scientists in recent times. Current research is focused on the effect of weeds on crops, crops on weeds and crop on crops. Some research works (Ilori *et al*. 2007; Otusanya *et al*. 2007) confirm the possibility of using allelochemicals as growth regulators and natural herbicides to promote sustainable agriculture.

Tithonia diversifolia (Helms) A. Gray (Mexican sunflower, also known as tree marigold) is a perennial and member of the sunflower family, Asteraceae. African farmers have many uses for the plant, the most popular being as an organic fertilizer for vegetable crops in either compost or tea form (Jayawaedena *et al*. 2000). Its insecticidal properties have also been examined by different authors (Adedire and Akinneye 2004; Babarinde *et al*. 2008). A close look at the plantation of the weed shows that it only sparingly allows other weeds to grow underneath its canopy (Taiwo and Makinde 2005). This has been attributed to the close nature of the canopy. Another member of the same family with *T. diversifolia*, *Chromoleana odorata*, has been observed to be allelopathic against tested crops like Chinese cabbage, chilli and rape (Sahid and Sugau 1993), and soybean (Taiwo and Makinde 2005). Tongma *et al*. (1988) had reported that incorporation of its dried leaves into soil inhibited the growth of rice seedlings. With a recent spreading of *T. diversifolia* weed in Nigeria, there is a need to ascertain whether or not the plant has allelopathic potential against common arable crops among subsistent farmers.

Commonly cited effects of allelopathy include reduced seed germination and seedling growth. Allelopathic inhibition is complex and can involve the interaction of different classes of chemicals like phenolic compounds, flavonoids, terpenoids, alkaloids, steroid carbohydrates, and amino acids, with mixtures of different compounds sometimes having greater allelopathic effects than an individual compound alone (Adedire and Akinneye 2004; Ilori *et al*. 2007).

Allelopathic chemicals can also persist in soil, affect both neighbouring plants as well as those planted in succession (Tanveer *et al*. 2010) Although derived from plants, allelochemicals may be more bio-degradable than synthetic herbicides but may also have undesirable effects on non-target species, necessitating ecological studies before widespread use. The objective of this work, therefore, is to determine the allelopathic effect of *T. diversifolia* on germination and growth parameters of soybean, maize and okra seeds. These crops were among the most common arables planted by resource- poor farmers in Africa, hence the reason for their selection for this study.

MATERIALS AND METHODS

Laboratory experiment

The laboratory experiment was carried out in the Department of Agronomy Laboratory, Ladoke Akintola University of Technology (LAUTECH) Ogbomoso. A Nigerian variety of maize (ACR 9931 DMR SRY) was used, the variety of soybean seed used was TGX 1448-2E and the variety of okra seed used was Sologo. Soybean and maize seeds were obtained from the International Institute of Tropical Agriculture (IITA), while okra seed was obtained from the National Institute for Horticultural Research (NIHORT), both located in Ibadan, Nigeria.

T. diversifolia leaves were obtained from the premises of LAUTECH, Ogbomoso and were sun dried for 4 days till the leaves were crisp. It was then powdered and sieved using a domestic sieve. Leaf powder (160 g) was added to 4 l of water (corresponding to 40 g/l, w/v) and was mixed thoroughly to form a stock solution. The mixture was stored under laboratory conditions (38 ± 2°C and 69-75% relative humidity) for 18 h and later sieved using muslin cloth. The resultant supernatant was stored in a cool dry place in the laboratory under similar conditions until use.

Four concentrations of extract were made as follows: a) 100%

Received: 25 December, 2009. Accepted: 19 March, 2010.

Research Note

= 5 ml extract + 0 ml of water; b) 50% = 2.5 ml extract + 2.5 ml of water; c) 20% = 1 ml extract + 5 ml of water; d) 0% = 0 ml extract + 5 ml of water.

Ten seeds of each crop variety were planted in 9 cm diameter Petri dishes lined with Whatman No 1 filter paper. The Petri dishes were arranged on laboratory tables in a randomised complete block design with the concentrations being the treatment and the crop type being the block. There were 6 replicates in all making a total of 72 (4 treatments, 3 blocks, 6 replicates). Each of the Petri dishes was irrigated with the corresponding concentration. Irrigation was repeated every other day. Data on germination was taken 7 days after planting. Germination was accessed by emergence of radicle and plumule.

Screenhouse experiment

The screenhouse experiment was carried out in the screenhouse, Teaching and Research Farms, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. The seeds used were the same as those used for the laboratory experiment. The concentrations were the same as those used for the laboratory experiment but in larger volumes to cater for the bigger soil weight. The soils used were sterilized soil, natural soil and soil obtained from under the canopy of *T. diversifolia* on a plot of land that had been under fallow for 3 years. Soil was sterilized by hot steam at > 100°C for 24 h.

The treatments were: (a) sterilized soil + extract, (b) natural soil + extract, (c) natural soil + ordinary water (which was the control), and (d) soil under *Tithonia* + ordinary water. Corresponding soil (50 g) were filled into each polythene bag. There were three bags per crop treatment in 3 replicates such that there were 108 bags in all.

Three seeds of each crop varieties were planted in the polythene bags on the same day. Germination data was assessed one week after planting (WAP), plant height was measured 2 WAP and number of leaves were counted 4 WAP. Data were analyzed using the relevant analysis of variance and means were compared using Duncan's Multiple Range Test (DMRT) at the 5% probability level (Steel and Torie 1980).

RESULTS

The allelopathic effect of *T. diversifolia* on the germination of selected crops is presented in **Table 1**. Maize seed germination was not significantly (P < 0.05) affected by *T. diversifolia* extract across the concentrations tested. At 100% concentration, *T. diversifolia* extract significantly lowered soybean germination. However, at all other concentrations lower than 100%, there was no significant difference in the seed germination of soybean. The effect of *T. diversifolia* extract on seed germination of okra was not definite. There were significant differences in the germination of the seeds but without a trend. The highest germination percentage (88%) occurred at 100% concentration while the least (80%) occurred at 50% concentration and the control.

Results from the screenhouse experiment showed that there was no significant difference in maize seed germination from soil under *T. diversifolia*'s canopy watered with ordinary water and the control (natural soil + ordinary water). Least percentage germination (50%) occurred on sterilized soil treated with *T. diversifolia* extract and was significantly less than percentage germination (64.3%) from the natural soil treated with *T. diversifolia* extract. However, the control gave significantly better percentage germination (83.3%).

Table 1 Allelopathic effect of *Tithonia diversifolia* extract on the seed germination of selected crops in the laboratory.

Dosage of extract	Crops		
	Maize	Okra	Soybean
100%	70 a	88 a	50 b
50%	73 a	80 c	55 a
20%	72 a	85 b	53 a
0%	70 a	80 c	53 a

Means followed by similar letters of the alphabet within a column are not significantly different (P= 0.05) by DMRT.
Data are percentage seed germination on the 5th day after planting

The treatment did not have any significant effect on the germination of soybean as there was no significant difference between the treated and control plots. Maize and okra plants were taller in natural soil treated with *T. diversifolia* extract (treatment b) and soil from under *T. diversifolia* canopy (treatment d), which were better than the control. Shortest plants were observed in sterilized soil treated with *T. diversifolia* extra. For soybean, the result followed the same trend as for germination. The effect of *T. diversifolia* extract on the number of leaves per plant followed the same trend as for plant height (**Table 2**). In general, except for the number of leaves of okra, soil under *Tithonia* canopy + ordinary water did not show any conspicuous negative effect on the parameters when compared with the control.

DISCUSSION

The lower percentage germination of soybean seeds as observed from this experiment confirmed the finding of Taiwo and Makinde (2005), who observed reduction in cowpea seed germination treated with *Chromolaea odorata* extract. These results are also similar to the findings of Channappagoudar *et al.* (2005). They reported that extracts of *Cyperus rotundus* and *Commelina benghalensis* had an inhibitory effect on the germination, seedling length, and seedling vigor index of wheat, sorghum, green gram, and soybean. The lower seed germination which occurred in maize and okra when planted on sterilized soil treated with *T. diversifolia* extract than those of the control and the soil from under *T. diversifolia* canopy can be attributable to the possible allelopathic effect of *T. diversifolia*; since there were no microbes in the sterilized soil to digest the extracts. Better growth was observed under natural soil treated with extract and on the soil from under the *T. diversifolia* canopy. It may be due to better soil nutrients in the experimented soil. *T. diversifolia* has been reported to supply nitrogen (N) to soil and this may be the reason why the plants did better even than the control. Green manure from *T. diversifolia* is rich in N and phosphorus (P) and the fertilizer value is better than that from *Calliandra* green manure and *Imperata cylindrica* (Jayawaedena *et al.* 2000). 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 and Dakshini 1996). Putman (1988) stated that if allelopathic chemicals are present in sufficiently low concentrations, they may stimulate instead of inhibit growth. Otusanya *et al.* (2008) reported that the aqueous extract of the fresh shoot of *T.*

Table 2 Allelopathic effect of *Tithonia diversifolia* on the germination and growth parameters of selected crops in the greenhouse.

	Germination			Plant height (cm)			No. of leaves		
	Maize	Okra	Soybean	Maize	Okra	Soybean	Maize	Okra	Soybean
Sterilized Soil + Extract	50.0 c	67.7 c	97.6 a	7.1 a	16.6 c	18.9 a	3.3 c	5.8 a	6.7 b
Natural + Extract	64.3 b	72.1 c	93.6 a	13.6 a	19.3 a	19.2 a	4.4 b	3.7 c	6.8 b
Soil under *Tithonia* + Ordinary water	87.7 a	99.4 a	93.1 a	13.1 a	19.1 a	18.8 a	5.0 a	3.8 c	8.0 a
Natural Soil + Ordinary water (Controlled)	88.3 a	77.8 b	96.1 a	11.9 b	18.4 b	18.7 a	4.5 b	4.8 b	6.8 b

Means followed by similar letters of the alphabet within a column are not significantly different (P= 0.05) by DMRT.

diversifolia did not affect the germination of *Lycopersicon esculentum* seeds but significantly retarded germination of *Capsicum annum.*They therefore concluded that the allelochemicals in *T. diversifolia* are capable of performing a dual role: inhibitory to germination and chlorophyll *b* accumulation; but their mode of actions differs depending on the associated plant species.

Results of the experiment showed that *T. diversifolia* exhibited allelopathy against soybean seed germination in the laboratory. The effect on okra was not definite. However, since the crops are rarely grown exclusively with *T. diversifolia* extract and crop performance on natural soils treated with *T. diversifolia* extra and on soil from under *T. diversifolia* canopy was comparable to the control, it is safe to plant these crops (maize, soybean and okra) on *T. diversifolia*-infested field.

REFERENCES

Adedire CO, **Akinneye JO** (2004) Biological activity of tree marigold, *Tithonia diversifolia* on cowpea seed bruchid (*Callosobruchus maculatus*). *Annals of Applied Biology* **144**, 185-189

Babarinde SA, Olabode OS, Akanbi MO, Adeniran OA (2008) Potential of *Tithonia diversifolia* with peremphos methyl in control of *Sitophilus zeamais* (Coleoptera: Curculinaae). *The African Journal of Plant Science and Biotechnology* **2**, 77-80

Channappagoudar BB, Jalager BR, Biradar NR (2005) Allelopathic effect of aqueous extracts of weed species on germination and seedling growth of some crops. *Karnataka Journal of Agricultural Sciences* **18**, 916-920

Ilori OJ, Otusanya OO, Adelusi AA (2007) Phytotoxic effect to *Tithonia diversifolia* on germination and growth of *Oryza sativa. Research Journal of Botany* **2 (1)**, 23-32

Inderjit K, Dakshini MM (1996) Allelopathic potential of *Pluchea lanceolata*: comparative studies of cultivated fields. *Weed Science* **44**, 393-396

Jayawaedena VP, Rajaguru ASB, Gunasena HPM (2000) Nutritive and medicinal values of *Erythria* and *Tithonia* species. *Proceedings of the 11th National Workshop on Multipurpose Trees*, December 2000, Kandy, Sri Lanka, pp 72-77

Otusanya OO, Ilori OJ, Adelusi AA (2007) Allelopathic effect of *Tithonia diversifolia* (Hemls) A. Gray on germination and growth of *Amaranthus cruentus. Research Journal of Environmental Sciences* **1 (6)**, 285-293

Otusanya OO, Ikonoh OW, Ilori OJ (2008) Allelopathic potentials of *Tithonia diversifolia* (Hemsl) A. Gray: Effect on the germination, growth and chlorophyll accumulation of *Capsicum annum* L. and *Lycopersicon esculentum* Mill. *International Journal of Botany* **4**, 471-475

Putman AR (1988) Allelochemical from plants as herbicides. *Weed Technology* **2**, 510-518

Sahid IB, Sugau JB (1993) Allelopathic effect of Lantana (*Lantana camara*) and Siam weed (*Chromolaena odorata*) on selected crops. *Weed Science* **41 (2)**, 303-308

Steel R, Torie J (1980) *Principles and Procedures of Statistics*, McGraw-Hill, New York, pp 107-109

Taiwo LB, Makinde JO (2005) Influence of water extract Mexican sunflower (*Tithonia diversifolia*) on growth of cowpea (*Vigna unguiculata*). *African Journal of Biotechnology* **4**, 355-360

Tongma S, Kobayashi K, Usui K (1998) Allelopathic activity of Mexican sunflower (*Tithonia diversofolia*) in soil. *Weed Science* **46**, 432-437

Tanveer A, Rehman A, Javaid MM, Abbas RM, Sibtain M, Ahmad AUH, Ibin-I-Zamir MS, Kchaudhary KM, Aziz A (2010) Allelopathic potential of *Euphorbia helioscopia* L. against wheat (*Triticum aestivum* L.), chickpea (*Cicer arietinum* L.) and lentil (*Lens culinaris* Medic.). *Turkish Journal of Agriculture and Forestry* **34**, 75-81