Bangladesh J. Bot. **46**(1): 323-328, 2017 (March) Supplementary

# COMPARATIVE PHYTOTOXIC EFFECTS OF AERIAL AND ROOT AQUEOUS EXTRACTS OF *SIDA CORDIFOLIA* L. ON GERMINATION AND SEEDLING VIGOUR PERFORMANCE OF LETTUCE, TOMATO AND CARROT

**H AHMED*, AS JURAIMI[1], MSA HAMDANI[1], YM RAFII[1], F ASLANI[1] AND D OMAR[2]**

*Department of Biological Science, Usmanu Danfodiyo Univercity, Pmb 2346, Sokoto, Nigeria*

*Keywords*: Allelopathy, Phytochemicals, Malvaceae, Extract, *Sida cordifolia*

**Abstract**

A comparative study was conducted to see the effect of *Sida cordifolia* L. aerial and root extracts on seed germination and seedling vigour performance of *Lacttuca sativa* (Lettuce), *Lycopersicon esculentum* (Tomato) and *Daucus carota* (Carrot). Four treatments were prepared 50, 25, 10 and 0 g/l (control). The result showed a significant decrease in germination and growth in all the treatments and regardless of concentrations lettuce was observed to be more susceptible in all extracts**.** Leaf extract exhibited the highest phytotoxicity followed by root while shoot extract produced the least effect**.** Inhibition index showed decrease in growth appeared to be concentration dependent. Liquid chromatography mass spectrum analysis of leaf and root extracts revealed presence of aliphatic acids notably stearic and palmitic which may act as inhibitory agents.

## Introduction

Plant extracts are essential pool utilized for their medicinal and pharmaceutical importance and their secondary metabolites represent a large reservoir of structural moieties which work together thereby exhibiting a wide range of biological activity (Sharmila *et al.* 2007). Chemical interaction between plant species may hinder or promote growth through interference. It is a regular practice for control of weeds and could represent a good approach to reduce the use of pesticides (Nunes *et al.* 2015). Many of plant species have been reported to exhibit allelopathic activity (Khan *et al*. 2009) which inhibited germination (Haq *et al.* 2010). Plants compete for nutrients and important resources and these interactions are thereby involved in chemical signaling such as allelopathy. The use of plants with strong allelopathic properties has continued to show promising result. Allelochemicals are usually released by plant into the environment mainly via leachate or root exudates. Generally, plant residue contains a wide range of chemical compounds such as alkaloids, flavonoids, phenolics, coumarins, terpenoids etc. and many of these compounds are known to enhance the growth of certain plants while inhibit other (Visioli *et al.* 2011). Recently much attention has been focused to allelopathic effect of plants as a mean of biological control of weeds (Sahid and Yusoff 2014).

*Sida cordifolia* L. belongs to the family Malvaceae is an annual herb plant native to India, Australia, west and east Africa. It is extensively used in ethno-botany, medicinal and antimicrobial activity (Sivapalan 2015). Study regarding its potential application as bioherbicide is lacking, this study aimed at evaluating the effect of aerial and root aqueous extracts of *S. cordifolia* on germination and early seedling growth of the *Lactuca sativa* (lettuce), *Lycopersicon esculentum* (tomato) and *Daucus carota* (carrot).

*Author for correspondence: <binahmad2003@gmail.com>. [1]Department of Crop Science, Faculty of Agriculture, Universiti Putra Malaysia, UPM Serdang, 43400, Selangor, Malaysia. [2]Department of Plant Protection, Faculty of Ariculture, Universiti Putra Malaysia, UPM Serdang, 43400, Selangor, Malaysia.

**Materials and Methods**

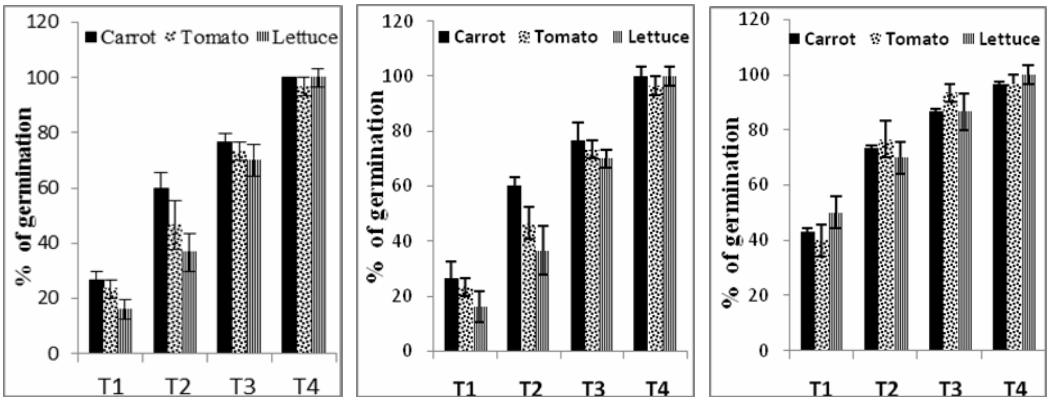
Fresh foliage, shoot and roots of *Sida cordifolia* were collected at flowering stage between February and March, 2015 at Ladang 10 Faculty of Agriculture, Universiti Putra Malaysia ($2^{o}$, 58', 65' N and latitude $101^{o}$, 42', 46' E and 52 m above sea level). The plant materials were shade-dried and pulverized to fine powder. Fifty g ($T_1$), 25 g ($T_2$) and 10 g ($T_3$) and 0 g ($T_4$) powder from each part of the plant was soaked in 1000 ml distilled water and shaken for 48 hrs using orbital shaker at room temperature then filtered through 1 mm sieve, and later passed through Whatman filter paper. Distilled water served as control. Lettuce, tomato and carrot seeds were obtained from Green Eagle Seed, Malaysia. These plants are commonly used species in the bioassay (Aslani *et al.* 2014) due to their sensitivity to phytotoxins and uniform germination potential. Seeds were sterilized with 1% sodium hypochloride for 5 min then rinsed severally with distilled water. Ten seeds were placed onto Petri dish on a double layer Whatman filter paper and 5 ml of different concentrations were added and placed in a growth chamber at $30^{o}$C/$25^{o}$C, 70% humidity and 12 hrs photoperiod day/night. Distilled water was used for the control. Treatments were arranged in CRD with six replicates. Data were collected on germination, radicle and shoot lengths at 5 days after sowing, 50 g powder of leaves were soaked in 1000 ml of 70% aqueous methanol into a conical flask and then wrapped with paraffin and shaken in an orbital shaker at $25^{o}$C for 48 hrs (Aslani *et al*. 2013). Twenty mg crude powder was diluted into 20 ml 100% methanol (HPLC grade) and filtered with 0.2 µm nylon membrane prior to injection. The sample was analyzed on Acquity UPLC C18 100 mm × 2.1 mm × 1.7 µm at $30^{o}$C eluted with a 60 min 5-95% acetonitrile and Isopropanol at a flow rate of 0.3 ml/min. Water Single Quadrapule Detector (SQD) at $150^{o}$C at 3.9 kv capillary voltage and 3v extractor.

Germinability was determined upon protrusion of the radicle by more than one millimeter while smaller size lengths in shoot and root were measured. All parameters were statistically analyzed using ANOVA and means were separated by least significant difference (LSD) using SAS software 9.4 version.

**Results and Discussion**

The result of The present experimentation indicated that leaf, root and shoot leachates of *Sida cordifolia* contain germination and growth inhibitors that are proficient to reduce growth of lettuce, tomato and carrot. Lettuce seeds treated with leaf aqueous extract had significantly decreased ($p < 0.05$) germination ranged from 100, 70, 36.6 to 16% in $T_4/T_3/ T_2// T_1$ treatments, followed by tomato 96.6 to 23.3%, then carrot 100 to 26.6% (Fig. 1a).

Similar decrease in germination was also significantly high in lettuce treated with root aqueous extract at $T_1$ and $T_2$ with 30 and 53.3% (Fig. 1b) compared to tomato (36.6 and 60%) and carrot (40 and 56.6%). Though all the crops recorded high germination value with shoot aqueous extract but lettuce at $T_1$ exhibited the highest germination of 50% (Fig. 1c) while at $T_2$ and $T_3$ tomato appeared less affected (70 and 86.6%) followed by carrot (73.3 and 86.6%). Germination and growth inhibition are substantial parameters used in bioassay studies (Ziebrahimi *et al.* 2007). The findings of this study was supported by Aslani *et al*. (2014, 2015) who reported application of both *Tinospora tuberculata* leaf and stem extracts significantly reduced percentage of germination of lettuce, cucumber, carrot, tomato, rice and weedy rice with increase in extract concentration as compared to control. The aqueous extract of *Parthanium hysterosphorus* leaf and flower seriously inhibited seed germination and seedling growth of lettuce (Mulatu *et al.* 2005).




(a) (b) (c)

Fig. 1. Impact of *Sida cordifolia* (a) leaf, (b) root and (c) shoot aqueous extract on seed germination of carrot, tomato and lettuce.

Shoot length in carrot treated with leaf extract showed greater reduction 0.63 cm at $T_1$ followed by lettuce 0.66 cm then tomato 2.03 cm. Lettuce shoots significantly ($p < 0.05$) indicated low growth with the root extract at $T_1$, $T_2$ and $T_3$ (2.01, 3.33 and 3.86 cm) as compared to the control (5.43 cm), similar trends were also observed in carrot and tomato (Table 1). Shoot extract appeared to induce more decreased in carrot shoot length among the crops while in lettuce no difference was observed among the treatments except with the control. Similarly, Guang *et al.* (2009) reported root exudate of hot pepper had strong allelopathic effect on lettuce and lettuce radicle length was found to be more sensitive to the allelochemicals than watermelon root growth (Hao *et al.* 2007). Generally, lettuce appeared more sensitive and susceptible to different extracts. Similar findings were reported by Santos *et al.* (2015). Root length appeared minimum in lettuce treated with leaf extract with significant reduction at highest concentration followed by carrot then tomato. All the treatments are significantly different at 5% (Table 1). Minimum radicle elongation with shoot extract was observed in the lettuce followed by carrot then tomato. Carrot radicle length was decreased by application of the root extract at different treatment levels ranged from 4.02 to 1.60 cm at $T_3$ and $T_1$ with the control having 4.25 cm. Significant difference was observed between the treatments across the crop species (Table 1).

Reduction in root growth was severe perhaps due to its direct contact with the extract. During the study it was observed that the root tips swelled, darken and seized to advance upon contact with the leachate concentrations thereby suggesting induced phytotoxicity. Visible effect of allelopathy includes decrease in germination, shoot and root inhibition, discoloration, swelling of root tips, necrosis and lower reproductive capacity (Niakan and Saberi 2009). Generally the extract had demoted shoot and root length as the concentrations increased. Growth reduction across the extracts on the species followed the order: leaf extract > shoot extract > root extract.

Phytochemical analysis of leaf and root of *Sida* revealed presence of aliphatic acids (stearic and palmitic) (Fig. 2). Stearic and palmitic acids are important allelochemicals that caused significant inhibition in growth of rice seedling (Tsuzuku *et al.* 1987) and exert cytotoxic effect on the plasma membrane and alter membrane permeability (Wu *et al.* 2006). The aerial part of *Sida* is famous to constitute malvic, fatty acids and many cytotoxic alkaloids compounds (Nagashayana *et al.* 2000). Present findings indicated the existence of aliphatic fatty acids allelochemicals in the extracts and revealed *S. cordifolia* aptitude towards allelopathic inhibition. Reduction in root growth was severe perhaps due to its direct contact with the extract. During the study, it was

**Table 1. Shoot and radicle length of lettuce, tomato and carrot treated with difference aqueous concentrations of root leaf, root and shoot extract of *S. cordifolia.***

| Treatment | Leaf extract | | Root extract | | Shoot extract | |
|---|---|---|---|---|---|---|
| | Shoot length (cm) | Radicle length (cm) | Shoot length (cm) | Radicle length (cm) | Shoot length (cm) | Radicle length (cm) |
| Carrot | | | | | | |
| T1 | 0.63 ± 0.35c | 0.50 ± 0.11c | 2.53 ± 0.29c | 1.60 ± 0.22b | 2.05 ± 0.22c | 1.83 ± 0.20c |
| T2 | 3.00 ± 0.32b | 2.36 ± 0.27b | 3.93 ± 0.35b | 3.73 ±0.44a | 3.50 ± 0.28b | 2.66 ± 0.17b |
| T3 | 3.95 ± 0.36a | 3.05 ± 0.23b | 4.05 ± 0.24b | 4.02 ± 0.79a | 3.66 ± 0.31b | 3.13 ± 0.36b |
| T4 | 4.46 ± 0.16a | 4.25 ±0.42a | 4.46 ± 0.16a | 4.25 ±0.42a | 4.46 ± 0.16a | 4.25 ± 0.42a |
| Tomato | | | | | | |
| T1 | 2.03 ± 0.36b | 2.00 ± 0.20d | 2.81 ± 0.28d | 2.46 ± 0.21c | 2.48 ± 0.11c | 2.50 ± 0.55b |
| T2 | 5.06 ± 0.48a | 4.25 ± 0.50c | 4.13 ± 0.58c | 3.70 ± 0.25c | 5.68 ± 0.64b | 5.41 ± 0.62a |
| T3 | 5.71 ± 0.39a | 6.96 ± 0.49b | 5.28 ±0.37ba | 5.28 ± 0.37b | 6.40 ± 0.53a | 7.85 ± 0.50a |
| T4 | 6.66 ± 1.08a | 9.4 ± 0 .80a | 6.66 ± 1.08a | 9.40 ± 0 .80a | 6.66 ± 1.08a | 9.40 ± 0 .80a |
| Lettuce | | | | | | |
| T1 | 0.66 ± 0.42c | 0.08 ± 0.05c | 2.01 ± 0.27c | 1.85 ± 0.24c | 2.83 ± 0.36b | 1.63 ± 0.40c |
| T2 | 2.83 ± 0.49b | 3.30 ± 0.50b | 3.33 ± 0.25b | 3.91 ± 0.58b | 3.00 ± 0.18b | 4.06 ± 0.49a |
| T3 | 3.86 ± 0.25b | 5.28 ± 0.48ab | 3.68 ± 0.29b | 5.21 ± 0.28ab | 3.36 ± 0.23b | 5.11 ± 0.86a |
| T4 | 5.43 ± 0.45a | 6.33 ± 1.31a | 5.43 ± 0.45a | 6.33 ± 1.31a | 5.43 ± 0.45a | 6.33 ± 1.31a |

Values are expressed as mean ± S.E. Mean with the same letter in the column are not significant at 5%.

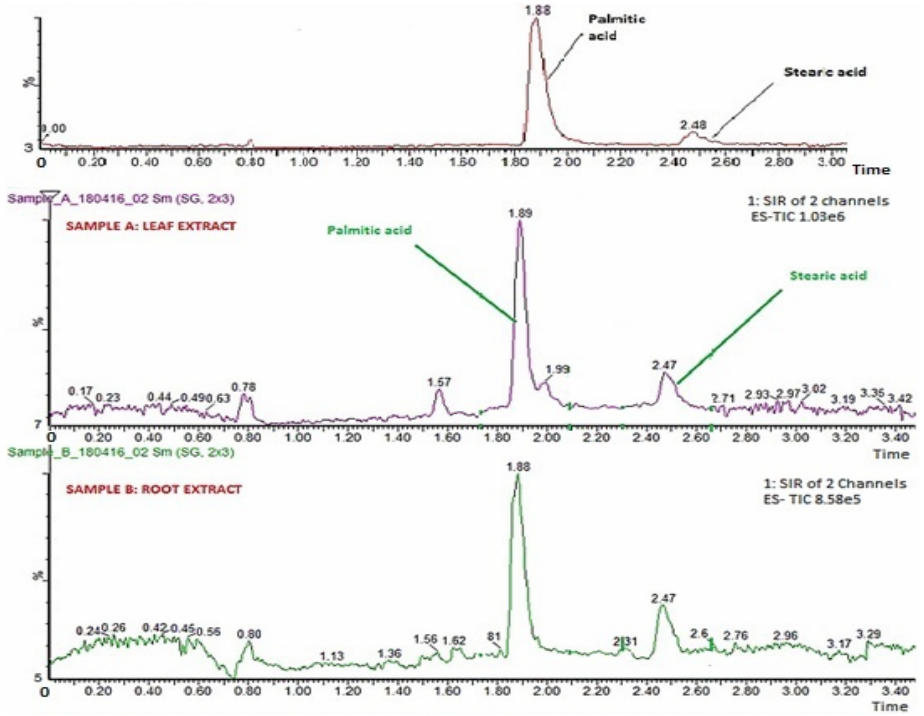



Fig. 2. Chromatogram of major fatty acids compounds detected in the leaf and root extracts of *Sida cordifolia* (top) standards peaks of stearic and palmitic acid, (bottom) leaf and root samples analyzed.

observed that the roots tips swelled, darken and severely seized to advance upon contact with the leachate concentrations thereby suggesting induced phytotoxicity. Visible effect of allelopathy includes decrease in germination, shoot and root inhibition, swelling of root tips and necrosis (Niakan and Saberi 2009). Stearic and palmitic acids are important allelochemicals that caused significant inhibition in growth of rice seedling (Tsuzuku *et al.* 1987).

The observed variability in growth indicated that *Sida* leaf has great phytotoxicity on germination, radicle and shoot growth with inhibition order lettuce > tomato > carrot. LC- MS analysis confirmed the presence of aliphatic acids in *Sida* extract which might be capable of inducing allelopathic effect on the tested crops. The present investigation revealed *S. cordifolia* aptitude towards allelopathy and potential use in natural weed management. Further identification of allelochemicals and mechanism of activity is needed.

**Acknowledgements**

The first author (HA) acknowledges the authority of Malaysian Genome Institute for phytochemical analysis, Mr. Yunus Abdul Wahab of Weed Science Laboratory for his support and University Putra Malaysia for financial support.

**References**

Aslani F, Juraimi AS, Ahmad-Hamdani MS, Alam MA, Hashemi FSG, Dzolkhifli O and Hakim MA 2015. Phytotoxic interference of volatile organic compounds and water extracts of *Tinospora tuberculata* Beumee on growth of rice weeds in rice fields. South African J. Bot. **100**: 132-140.

Aslani F, Juraimi AS, Hamdani MAS, Omar D, Alam MA, Hashemi FSG and Uddin MK 2014. Allelopathic effect of methanol extracts from *Tinospora tuberculata* on selected crops and rice weeds. Acta Agric. Scandinavica, Section B-Soil & Plant Sci. **64**(2): 165-177.

Aslani F, Juraimi AS, Ahmad-Hamdani MS, Dzolkhifli O, Alam MA, Hakim MA and Uddin M K 2013. Allelopathic effects of Batawali (*Tinospora tuberculata*) on germination and seedling growth of plants. Research on Crops **14**(4): 1222-1231.

Guang-Dong G, Su Qin Z and Zhi Hui C 2009. Allelopathy and allelochemicals of root exudates in hot pepper. Acta Horticulturae Sinica **36**(6): 873-878.

Hao ZP, Wang Q, Christie P and Li XL 2007. Allelopathic potential of watermelon tissues and root exudate. Scientia Horticulture **112**(3): 315-320.

Haq RA, Hussain M, Cheema ZA, Mushtaq MN and Farooq M 2010. Mulberry leaf water extract inhibits Bermudagrass and promotes wheat growth. Weed Bio. and Management **10**: 234-240.

Khan AL, Hussain J, Hamayun M and Shinwari ZK 2009. Inorganic profile and allelopathic effect of endemic *Inula koelzii* from Himalaya. Pak. J. Bot. **41**(5): 2517-2527.

Mulatu W, Gezahegn B, Befkadu B 2005. Allelopathic effects of *Parthanium hysterosphorus* extracts on seed germination and seedling growth of lettuce. Tropical Sci. **45**(4): 159-162.

Nagashayana N, Sankarankutty P, Nampoothir M, Mohan P and Mohanakumar K 2000. Association of L-DOPA with recovery following Ayurveda medication in Parkinson's disease. J. of the Neurological Sci. **176** (2): 124-127.

Niakan M and Saberi K 2009. Effects of eucalyptus allelopathy on growth characters and antioxidant enzymes activity in Phalaris weed. Asian J. of Plant Sci. **8**(6): 440-446.

Nunes PMP, Silva CB, Paula CS, Smolarek FF, Zeviani WM, Chaves SC, Lorini F, Dias JFG, Miguel OG, Zanin SMW and Migue MD 2015. Residues of *Citrus sinensis* (L.) Osbeck as agents that cause a change in antioxidant defense in plants. Brazilian J. of Pharm. Sci. **51**(2): 479-493.

Sahid I and Yusoff N 2014. Allelopathic effects of' *Chromolaena odorata* (L.) King and Robinson and *Mikania micrantha* HBK on three selected weed species. Australian J. Agric. Sci. **8**(7): 1024-1028.

Santos PC d, Santos VHM, Mecina GF, Andrade ARd, Fegueiredo F, Moraes V, Silva R and Márcio G 2015. Phytotoxicity of *Tagetes erecta* L. and *T. patula* L. on plant germination and growth. South African J. of Bot. **100**: 114-121.

Sharmila BG, Kumar G and Rajasekara PM 2007. Cholesterol lowering activity of the aqueous fruit extract of *Trichosanthes dioica* Roxb. in normal and streptozotocin diabetic rats. J. Clin. Diagn. Res. **1**: 561-569.

Sivapalan SR 2015. Phytochemical study on medicinal plant - *Sida cordifolia* Linn. International J. of multi-discplinaryres. and development **2**(1): 216-220.

Tsuzuki E, Yamamoto Y and Shinizu T 1987. Fatty acids in buckwheat are growth inhibitors. Annal. Bot. **60**: 69-70.

Visioli F, Catalina LADL, Andres-Lacueva C, Aviram M, Calhau C, Cassano A and Fogliano V. 2011. Polyphenols and human health: A prospectus. Crit. Rev. in Food Sci. and Nutrition **51**(6): 524-546.

Wu JT, Chiang YR, Huang WY and Jane WN 2006. Cytotoxic effects of free fatty acids on phytoplankton algae and cyanobacteria. Aquatic Toxicology **80**: 338-345.

Zeibrahimi L, Khavari-Nejad RA, Fahimi H and Nejadsatari T 2007. Effects of aqueous *Eucalyptus* extracts on seed germination, seedling growth and activities of peroxidase and polyphenoloxidase in three wheat cultivar seedlings *Triticum aestivum* (L.). Pak. J. Biol. Sci. **10**: 3415-3419.

*(Manuscript received on 8 December, 2016; revised on 24 January, 2017)*