

Allelopathic Potential Of *Tithonia Diversifolia* (Hemsl.) A. Gray On Vegetative Performance Of Cowpea And Maize

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Abstract: Some plants influence the seed germination and growth of other plants by means of producing toxic chemicals, i.e. allelochemicals or allelopathins. This study examines the susceptibility of Maize (*Zea mays*) and Cowpea (*Vigna unguiculata*) to allelopathic effects of *Tithonia diversifolia*. Fresh shoot aqueous extract (FSE) of *T. diversifolia* was prepared at a concentration of 12.5%, 25% and 50% and used to wet polybags planted with cowpea and maize seeds arranged in Completely Randomized Design and replicated three times. Results obtained from the study show that number of leaves, leaf area development, plant height and stem girth progressively increased at 2, 3, 4 and 5 weeks after planting (WAP) thus indicating that FSE of *T. diversifolia* exhibit stimulatory effects on the vegetative growth of cowpea and maize.

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Introduction

Allelopathy is the ability of plant to inhibit the germination of other plants through the production of allelochemicals which may be present in any parts of the plants, i.e. leaves, roots, fruits, stems, rhizomes and seeds, from where they are released to the soil through volatilization, root exudation, leaching and decomposition of plant residues (Rice, 1984) and could affect (either positively or negatively) germination and growth of other species (Gross and Parthier, 1994; Seligler, 1996). The various negative effects of allelopathy studied on plants include germination inhibition (Djurdjevic et al 2004), plumule and radicle length retardation (Tobe et al 2000), seedlings growth retardation (Bhatt and Todorica), and poor seedlings survival (Smith, 1990). Allelopathic compounds may regulate plant growth and developmental processes involving photosynthesis, respiration, transpiration, biochemical metabolism, as well as protein and nucleic acid synthesis (Chou, 2006). Their action may, theoretically, be stimulatory, neutral, or inhibitory depending on their concentrations and sensitivity of the receiving target plant or plant organ (Rice, 1979). In addition to inhibiting effect on growth and development, nutrient uptake is also impaired.

The importance of allelopathy in biological control of weeds and crop productivity has been highly recognized and various methods have been suggested to know the allelopathic effect (Fujii et al 2004; Taiwo and Makinde, 2005; Terzi, 2008). A

number of weed and crop species have been reported to possess allelopathic effects on the growth of other plant species (Rice, 1984). Chemicals with allelopathic potential are present in many plants and organs, including leaves, flowers, rhizomes, fruits, buds and seeds (Inderjit, 1996; Ashrafi et al., 2007), under selected environmental conditions, the active form may be released which in turn, cause the allelopathic effects (Alam et al 2001).

The need to reduce harmful environmental effects from the overuse of herbicides has encouraged the development of weed management systems which are dependent on ecological manipulations rather than agrochemicals (Liebman and Ohno, 1997; Zoheir et al., 2008; Zoheir et al., 2009). The wild Mexican Sunflower (*Tithonia diversifolia* (Hemsl.) A. Gray) is an impressive member of the family, Asteraceae, and it is a perennial native of Mexico and Central America. *T. diversifolia* is a shrub that has dominated almost all fallowed land in Southwestern Nigeria (Ademiluyi, 2012). This plant has been reported to have some beneficial effects on the growth of some plants (Ademiluyi and Omotoso, 2008; Jama et al., 2000) and have negative effect on the growth stage of some other plants (Otusanya et al 2007). Extracts of *Tithonia* also have medicinal value for treatment of hepatitis and control of amoebic dysentery (Jama et al., 2000).

Tithonia is known to contain allelochemicals which may inhibit germination and growth of some plants as demonstrated by Otusanya et al. (2007).

Tithonia diversifolia has both stimulatory and phytotoxic plant inhibitory attributes (Tongma *et al.*, 1998). Hence, the present study was carried out to determine the allelopathic effect of different concentration of *T. diversifolia* extract on seedling growth of maize and cowpea under laboratory conditions.

Materials and Methods

The experiment was carried out in the screen house at the Research farm of Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria (Latitude 7° 11' 43" N, Longitude 5° 33' 57" E). The fresh shoot of *T. diversifolia* were collected within the Polytechnic community, 250g of the shoot was weighed using electronic balance and cut into small chips of about 4cm and finely grounded with mortar and pestle. The grounded plant material was soaked in a plastic bucket containing 150ml distilled water for 12 hrs and thereafter filtered using muslin cloth. By dilution with distilled water 12.5, 25 and 50% concentration of the extract were prepared. One hundred and twenty (120) polythene bags were filled with unsterilized top soil collected from the Polytechnic Teaching and Research Farm, arranged in Complete Randomized Design (CRD) and replicated thrice with four (4) treatments i.e. T1 = Seeds of receptor plants grown in distilled water only (control), T2 = Seeds of receptor plants grown in fresh shoot extracts of 12.5 % concentration, T3 = Seeds of receptor plants grown in shoot extract of 25 % concentrations, T4 = Seeds of receptor plants grown in shoot extract of 50 % concentration.

The seeds of cowpea (Ife brown) and maize (Oba super) varieties used in this research were obtained from Ondo State Agricultural Development Project (ADP), Akure. Two seeds of each crop were sown per polythene bag and later thinned to one stand per polythene bag a week after germination. The polythene bags were irrigated with the aqueous extract a day before planting and on weekly basis after germination to facilitate seedlings establishment.

Data were collected on the following growth parameters: leaf area, number of leaves, plant height and stem girth 2 weeks after planting (WAP). The data were subjected to analysis of variance (ANOVA). Significant means were separated using Duncan's Multiple Range Test (DMRT) (Mukhtar, 2003).

Results

Figures 1-4 show the effect of *T. diversifolia* on the vegetative growth of cowpea and maize plants at 2 – 5 weeks after planting (WAP). The soil treated with 50% of *T. diversifolia* extract produced the highest number of leaves, which was significantly different ($P < 0.05$) from those treated with 12.5% of *T. diversifolia* extract and control polybags. The control

experiment however recorded the least number of leaves.

Leaf area evaluation showed that all the treatments recorded identical figures for cowpea plants leaf area production. While the control treatment recorded the least leaf area production, all the data obtained were not significantly different from each other when compared. Similar trends were equally observed for maize plants.

Plants treated with 50% and 25% of *T. diversifolia* extracts recorded the tallest plants, while the shortest was recorded in the control bags. Plant height was not significantly different between the 50% and 50% *T. diversifolia* applied soils but significantly different compared to control. Stem girths observed in the 50% and 25% *T. diversifolia* applied soils were not significantly different but showed unsteady increased in the stem girth development of both crops.

Discussion

Allelopathy is an interference mechanism, in which live or dead plant materials release chemical substances, by leaching, root exudation, volatilization, residue decomposition and other processes in both natural and agricultural systems (Seghatoleslami *et al.* 2012) which inhibit or stimulate the associated plant growth (Harper, 1977; May and Ash, 1990). Allelopathy, may also play an eminent role in the intraspecific and interspecific competition and may determine the type of interspecific association. The plant may exhibit inhibitory or rarely stimulatory effect on the germination and growth of other plants in the immediate vicinity. Inhibitory or stimulatory effect of weeds on growth of crops depends upon the concentration of allelochemicals, which inhibit the growth of some crops at certain concentrations, may stimulate the growth of same or different crops at lower concentrations (Narwal, 2004). The chemicals involved in allelopathic interactions are present in virtually all plant parts including leaves, stems, fruits, roots, rhizomes, buds and seeds (Qin *et al.*, 2006; Rudrappa *et al.*, 2007).

The main goal of this study was to examine inhibitory nature of interference of aqueous leaf extract of *T. diversifolia* on cowpea and maize growth, but results obtained show stimulatory effects. The aqueous extracts of *T. diversifolia* generally stimulated growth of cowpea seedlings in agreement with the results reported by Neelamegam, (2011) where the leaf extract of *Ixora coccinea* showed more stimulatory (negative allelopathic) effect on seed germination and most of the seedling growth parameters of paddy. This stimulation in growth suggests that the functional allelochemicals in *T. diversifolia* were broken down and transformed into plant nutrients. The green leaf biomass of *T.*

diversifolia is known to be rich in nutrients, averaging about 3.5% N, 0.37%P and 4.1%K (Jama *et al.*, 1998; Taiwo and Makinde, 2005). Sangakkara *et al.* (2003) reported in their investigation that *T. diversifolia* is a potential green manure and organic fertilizers for vegetable crops.

Allelochemicals contained in *T. diversifolia* extracts stimulated growth in plant height, leaf area, number of leaves and stem girth of cowpea seedlings. This result is similar to findings of Bano *et al.* (2012), Musyimi, (2012) and Tongma *et al.* (1997) who reported the stimulatory effect of neem leaf extracts and *T. diversifolia* shoot extracts on root growth of Wild oat seedlings and the growth of *Cleome gynandra* and paddy respectively. Also Oyerinde *et al.* (2009) investigated the allelopathic effect of *T. diversifolia* on maize and they found out that the stimulatory functions of *T. diversifolia* significantly enhanced the growth parameters (shoot height, fresh weight, dry weight and leaf area) of older plants. The results are also in agreement with the findings of Nassir *et al.* (2005) on the stimulatory effect of *Stevia rebaudiana* on lettuce and cucumber. Increase in leaf area and number of leaves per plant can result to higher photosynthetic capacity of a plant and ultimately promote growth. Results from this study confirm the findings of Taiwo and Makinde (2005) who equally reported on similar stimulatory effects when *Vigna unguiculata* was treated with extract from *Tithonia sp.*

Addition of *T. diversifolia* extract had significant stimulatory effects on various parameters studied in

the experiment. It could be suggested that the allelopathic or phytotoxic compounds are known to be mainly phenolic acids (Glass, 1984). The results in this research also confirm observation made by Tian (1992) who reported that, the phytotoxic effect was not harmful to maize and cowpea under field condition as the phytotoxic compounds can be degraded faster in the field than in the laboratory which resulted in a significant increase in maize and cowpea yield. The findings of this study are also similar to that of Obando (1987) who reported no allelopathic effect of *Gliricidia* mulch on maize and beans. Tian (1992) also reported that, the biologically inhibitive role of polyphenols does not persist under humid tropical field conditions, due to leaching and decomposition of polyphenols. This report is consistent with this study because, this research was carried out in a humid tropical condition therefore, the allelochemicals may have leached out and degraded from the soil.

Conclusion

The results from the study indicated that *T. diversifolia* exhibited stimulatory effects on the vegetative growth of cowpea and maize plants and beneficial functions of the allelochemicals in *T. diversifolia* shoot extract. Therefore, *T. diversifolia* can be employed to achieve an increase in the germination and seedling growth of cowpea and in turn increase its productivity. Further study is recommended to identify the exact allelochemicals in the plant which promote crop growth.

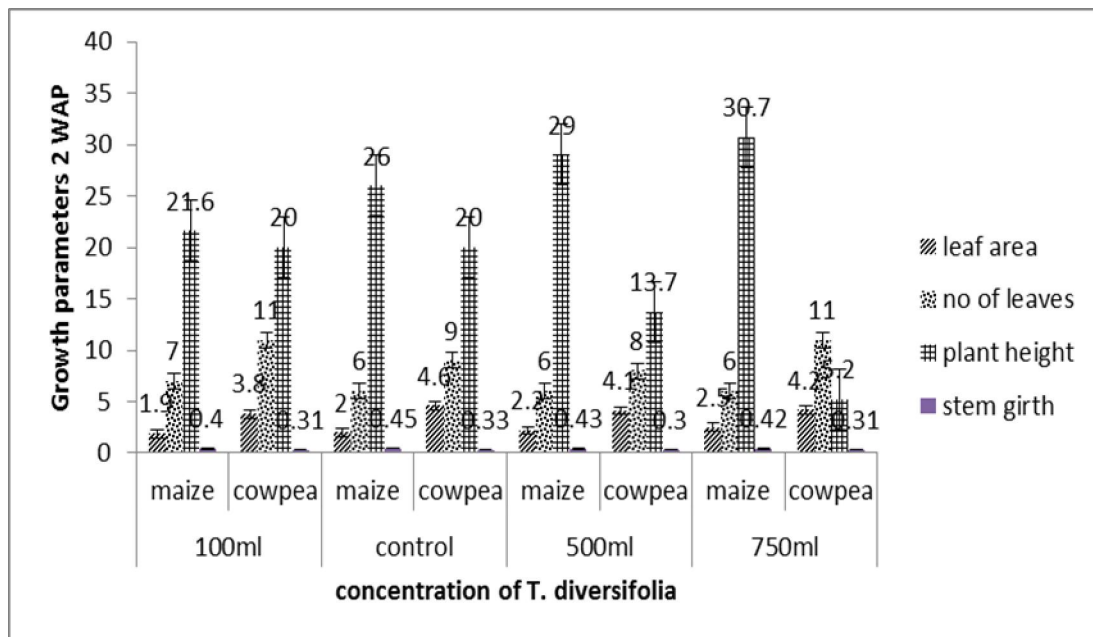


Fig. 1: Effects of *T. diversifolia* on cowpea and maize vegetative growth 2 WAP

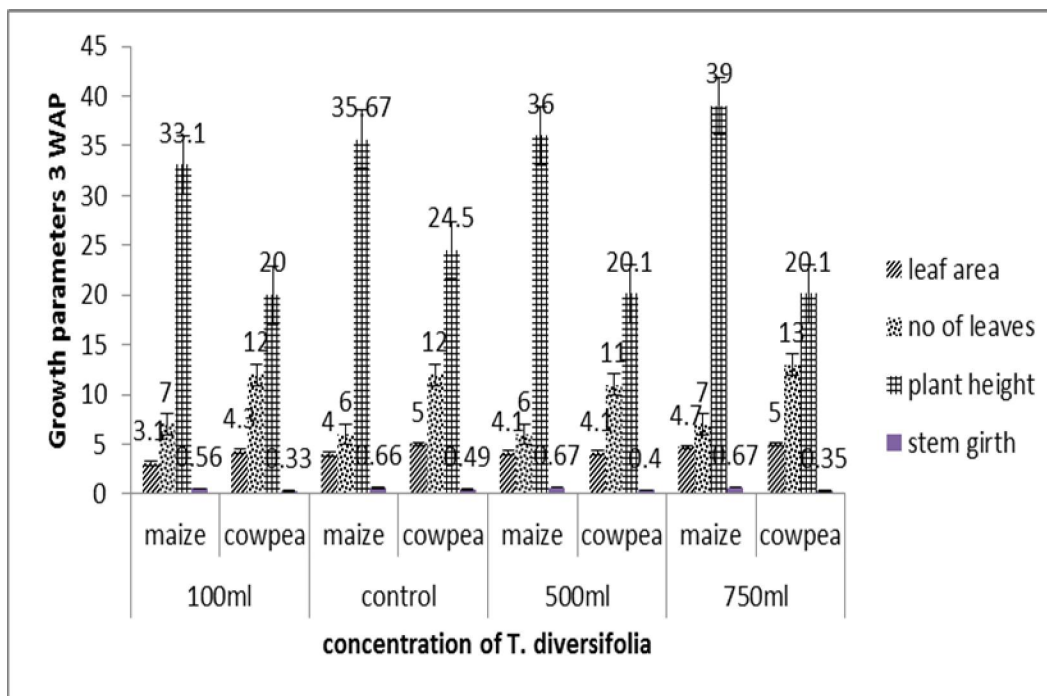


Fig. 2: Effects of *T. diversifolia* on cowpea and maize vegetative growth 3 WAP

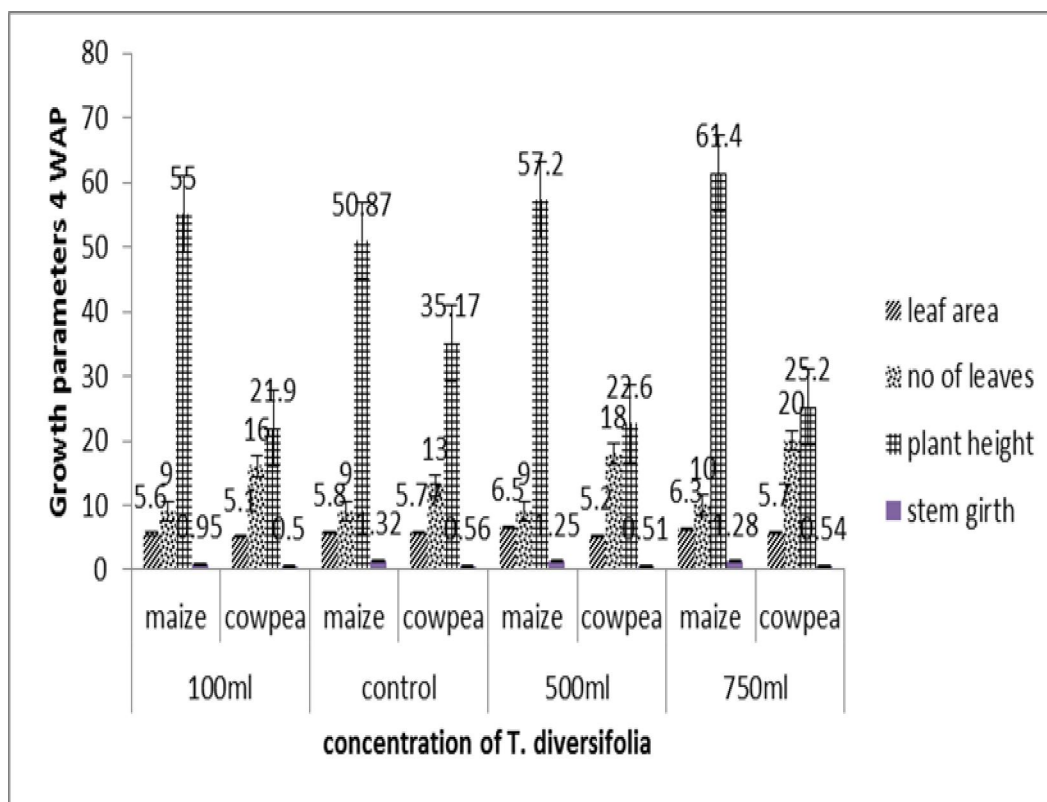


Fig. 3: Effects of *T. diversifolia* on cowpea and maize vegetative growth 4 WAP

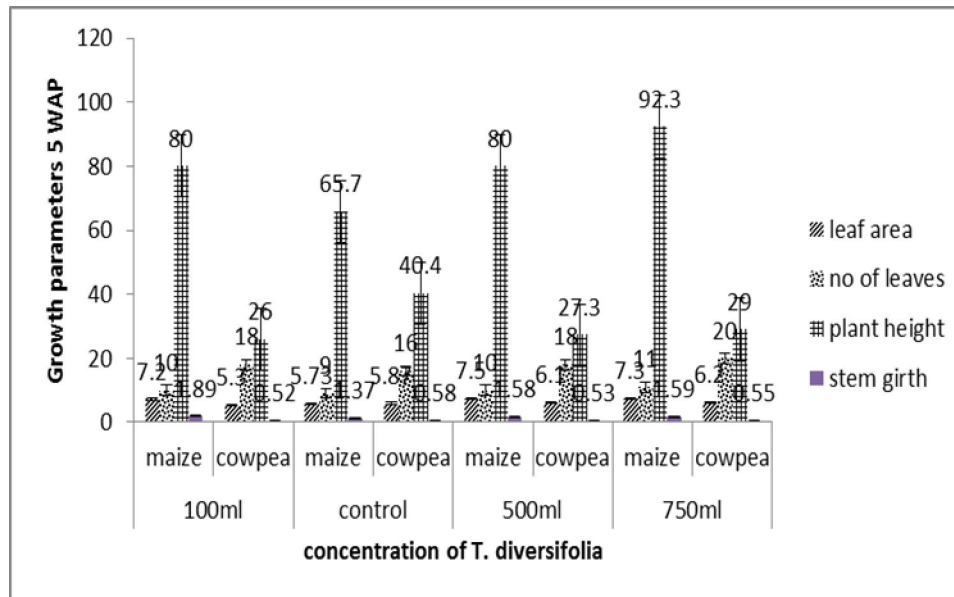


Fig. 4: Effects of *T. diversifolia* on cowpea and maize vegetative growth 5 WAP

References

- Ademiluyi, B. O. (2012). Effect of *Tithonia diversifolia* (Hemsl) A. Gray on the Growth and Yield of Okra (*Abelmoschus esculentus*) Journal of Agricultural Science and Technology B 2 (2012) 219-222.
- Ademiluyi, B. O. and Omotoso, S. O. (2008) Comparative evaluation of *Tithonia diversifolia* and NPK fertilizer for soil improvement in maize (*Zea mays*) production in Ado Ekiti, Southwestern Nigerian. Research Journal of Agronomy 2 (1) 8-11.
- Alam, S. M., Ala, S. A., Azmi, A. R., Khan, M. A. and Ansari, R. (2001). Allelopathy and its in Agriculture. Online Journal of Biological Sciences, 1(15):308-315.
- Ashrafi, Z., Mashhadi, H. R. and Sadeghi, S. (2007). Allelopathic effects of Barley (*Hordeum vulgare*) on germination and growth of wild varley (*Hordeum spontaneum*). Pakistan Journal of Weed Science Research, 13(1-2): 99-112.
- Bano S, Ullah MA, Khaliq A, Abbasi KH, Khanum S. 2012. Effect of aqueous extract of sun – dried neem (*azadirachta indica a*) leaves on wheat and wheat weeds (wild oat and dumbi sitti) in Vitro. International Research Journal of Plant Science 3(4), 69-73.
- Bhatt, B. P. and Todorica, N. P. (1990). Studies on the allelopathic effects of some agro-forestry tree crops of Garhwal Himalaya, Agro. Forestry System, 12: 252-255.
- Chou, C. H. 2006. Introduction to Allelopathy. In: M. J. Reigosa, N. Pedrol and L. Gonzalez (eds). *Allelopathy: A Physiological Process with Ecological Implications*. Springer. The Netherlands. P 1 – 9.
- Djordjevic, L., Dinic, A., Pavlovic, P., Mitrovic, M., Karadzic, M. and Tesevic, V. (2004). Allelopathic potentials of *Allium ursinum* L., Biochemical systematic and Ecology 32 (6): 533-544.
- Fujii, Y., Shibuya, T., Nakalani, K., Itam, T., Hiradate, S and Parvez, M.M. (2004). Assessment method for allelopathic effect from leaf litter leachates. 4: 19-23.
- Glass, A. D. M. (1976). The allelopathic potential of phenolic acids associated with rhizosphere of *Pteridium aquilinum*. Canadian Journal of Botany, 54: 2440 – 2444.
- Gross, D. and Partheier, B. (1994): Novel natural substances acting in plant growth regulation. Journal of Plant Growth Regulation, 13: 93-114.
- Harper, J. L. (1997) Population Biology of Plants. Academic Press, London, 892p.
- Inderjirt, I. (1996): Plant phenolies in Allelopathy. Botanical Review, 62: 186 – 202.
- Jama B, Palm C, Buresh R, Niang A, Gachengo C, Nziguheba G, Amadala B. (2000). *Tithonia diversifolia* as a green manure for soil fertility improvement in Western Kenya: A review. Agroforestry Systems 49(2): 201-221.
- Liebman, M. and Ohno, T. (1997): Crop rotation and legume residue effects on weed emergence and growth: applications for weed management. In: Hatfield, J. L. et al., 1997. Integrated Weed and Soil Management, Ann Arbor Press, Chelsea, MI, 181-221 Pp.
- May, F. E. and Ash, J. E. (1990) An assessment of the allelopathic potential of Eucalyptus. Australian Journal of Botany, 38:245-254.
- Mukhtar. F. B. (2003): Introduction to Biostatistics. 1st ed. Samrid Publishers, Nigeria Pp 152.

19. Musyimi, D. M., Kahihu, S. W., Buyela, D. K. and Sikuku, P. A. (2012) Allelopathic effects of Mexican sunflower [*Tithonia diversifolia* (Hemsl) A. Gray] on germination and growth of Spiderplant (*Cleome gynandra* L.). *Journal of Biodeversity and Environmental Sciences*, 2(8): 26-35.
20. Nassir, H., Iqbal, Z., Araya, H., Ominami, H. and Fujii, Y. (2005). Growth promoting attribute of *Stevia rebaudiana*. Paper presented at the Fourth World Congress in Allelopathy. 21st – 26th August 2005.
21. Narwal, S. S. 2004. Allelopathy in crop Production, Scientific Publishers, Jodhapur, India.
22. Neelamegam, R. (2011). Allelopathic effect of *Ixora coccinea* Linn. on Seed germination and early seedling growth of Paddy (*Oryza sativa* L.) *Journal of Phytology*, 3(6), 51-55.
23. Obando, L. (1987). Potential allelopathy of *Gliricidia sepium* on maize, beans and various weeds p. 59 – 60. In D. Withington, N. Glover, and Brewbaker (eds.) *Gliricidia Sepium* (Jacq.) Walp. Management and improvement Honolulu/U.S.A NFTA.
24. Otusanya, O. O., Illori, O. J. and Adelusi A. A. (2007). Allelopathic effect of *Tithonia diversifolia* (Hemsl) A. Gray on germination and growth of *Amaranthus cruentus*. *Research Journal of Environmental Science* 1(6), 285-293.
25. Oyerinde, R. O., Otusanya, O. O. and Akpor, O. B. (2009). Allelopathic effect of *Tithonia diversifolia* on the germination, growth and chlorophyll contents of maize (*Zea mays* L.) *Scientific Research and Essay*, 4 (12), 1553-1558.
26. Qin, B., L.G. Perry, C.D. Broeckling, J.Du, F.R. Stermitz, M.W. Paschke and J.M. Vivanco. 2006. Phytotoxic allelochemicals from roots and root exudates of leafy spurge (*Euphorbia esula* L.). *Plant Signaling and Behavior*, 1: 323-327.
27. Rice, E. L. 1979. Allelopathy – an update. *The Botanical Review* 45:15 – 109.
28. Rice, E.L. (1984). *Allelopathy* 2 Edition, Academic Press, New York, p.422.
29. Rudrappa, T., W. J. Quinn, N. R. Stanley-Wall and H.P. Bais. 2007. A degradation product of the salicylic acid pathway triggers oxidative stress resulting in down-regulation of *Bacillus subtilis* biofilm formation on *Arabidopsis thaliana* roots. *Planta*, 226: 283-297.
30. Sangakkara, U. R., Stamp, P., Suldati, A. and Liedgens, M. (2002). Green manures stimulate root development of maize and mungbean seedlings. *Journal of Agronomy*, 19: 225-237.
31. Seghatoleslami, M. J., Mousavi, G. R. and Akbari, H. (2012) Studying the allelopathic effects of shoot and root water extracts of hoary cress (*cardaria draba* L.) on germination and seedling growth of wheat. *Pakistan Journal of Weed Science Research*, 18: 565-568
32. Smith, A. E. (1990). The potential allelopathic characteristics of bitter sneeze weed (*Helenium amaranum*), *Weed Science*. 37: 665-669.
33. Seligler, D. S. (1996): Chemistry and mechanism of allelopathic interactions. *Agronomy Journal*, 88: 876-885.
34. Taiwo, L. B. Makinde, J. O. (2005). Influence of water extract of Mexican sunflower (*Tithonia diversifolia*) on growth of cowpea (*Vigna unguiculata*). *African Journal of Biotechnology*, 4(4): 355-360.
35. Terzi, I. (2008). Allelopathic effects of Juglone and decomposed walnut leaf juice on muskmelon and cucumber seed germination and seedling growth. *African Journal of Biotechnology*, 7 (12); 1870-1874.
36. Tian G., B. T., and L. Brussard. (1992). Biological effects of plant residues with contrasting chemical compositions under humid tropical conditions – decomposition and nutrient release. *Soil Biology and Biochemistry*, 24: 1051 – 1060.
37. Tobe, K., Li, X. and Omasa, K. (2000) Seed germination and radicle growth of halophyte *Kalidium capsicum* (Chenopodiaceae), *Annals of Botany* 85 (3): 391-396.
38. Tongma, S., Kubayashi, K. and Usui, K. (1998). Allelopathic activity of Mexican Sunflower (*Tithonia diversifolia*) in soil. *Weed Science* 46(4), 432-437.
39. Zoheir, Y. A., Aptin, R., Sedigheh, S., Hassan, M. A. and Mashhadi, H. R. (2008): Study of the allelopathic potential of *Azadiracta indica* (Neem). *Journal of Biological Sciences*, 8(3):57-61.
41. Zoheir, Y. A., Sedigheh, S., Hassan, M. A. Mashhadi, H. R. and Ebrahim, R. M. (2009): Study of bioassay of the allelopathical effect of neem (*Azadiracta indica*) n-hexane, acetone and water soluble extract on six weeds. *International Journal of Biology*, 1(1): 71-77.