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Full Length Research

Allelopathic Potential of Niger (*Guizotia abyssinica* L.) on *Parthenium hysterophorus* Seed Germination and Seedling Growth

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To determine the allelopathic effect of *Guizotia abyssinica* on *Parthenium hysterophorus*, a laboratory experiment was under taken in Weed Science Research Unit of Plant Protection Research Center, Ambo, Ethiopia. Leaf, root, and stem extracts with 15, 30, 45, 60 and 75 percent levels of concentrations were used for the experiment. Control check was treated similarly with distilled water. The experiment was arranged factorially in a complete randomized design. The results indicate that stem and root aqua's extracts significantly affect germination percentage, root length, shoot fresh and dry weight, and root fresh weight of *Parthenium hysterophorus* (p<0.05). Thus, the allelopathic effect of *Guizotia abyssinica* on *Parthenium hysterophorus* is concentrated in stem and root of the plant. However, leaf parts extract have less inhibitory effect. Increase in the level of concentration extract significantly reduced all germination and growth parameters of *Parthenium hysterophorus*. Higher concentrations (≥ 60%) have maximum deleterious effect on *P. hysterophorus* seed germination and growth parameters.

Keywords: *Allelopathy, germination, Guizotia abyssinica, Parthenium, seedling growth.*

INTRODUCTION

Niger *(Guizotia abyssinica* L.*)* is an oil crop largely grown in the highlands of Ethiopian, and it constitutes about 50% of Ethiopian and 3% of Indian oilseed production (Eneyew, 2013). Niger cultivation and consumption are deeply rooted within the Ethiopian culture and the country's local population highly values the crop. It remains the most popular oil crop for local consumption although it was recently overtaken by sesame with slight margins in terms of production volume in the country (CSA, 2014). Niger is grown mainly from 1,600 to 2,200 m.a.s.l in Ethiopia, but can be cultivated at altitudes as low as 1,200 m.a.s.l and as high as 2,700 m.a.s.l (Getinet and Sharma, 1996). In Ethiopia among oil crops, Niger covers 2.30 % (about 285,303.47 hectares) of the grain crop area and 0.88% (about 2,202,111.90 quintals), of the grain production (CSA, 2014). It is the major source of edible oil that holds significant promise for improving rural livelihoods. In addition, to its oil, Niger offers an important source of seed proteins, carbohydrates, vitamins and fiber that significantly contribute to the human dietary intake (Thatte and Lakshmi, 2012). Niger is also recognized as an effective green manure cover crop (Bulcha, 2007).

Parthenium weed is one of the most aggressive invasive species that can cause irreversible environmental and socio-economic impact from species to ecosystem levels (Tamado, 2002). In addition, it has competitive and allelopathic effect on different crops, it poses health hazard to humans and animals (Kololgi et al*.,* 1997). In Ethiopia, *Parthenium* weed has been reported as relentlessly spreading throughout the agricultural lands, forests, orchards, poorly managed arable crop lands and rangelands, and almost throughout the country it became a serious weed (Tefera, 2002; and Tamado, 2002).

Weed management with strong interfering smoother crops and plants are recommended as element of integrated

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Parthenium weed management (Tamado, 2002). Allelopathic plants may widely be used in sustainable agriculture for their potential role in herb/weed and insect pest management (Tefera, 2002). Allelochemicals derived from many crops such as sunflower (*Helianthus annus*) and castor bean (*Ricinus communis*) prevent some broad and narrow leaf weeds growth (Seyyedi et al., 2013). In Ethiopia, farmers often reported that *G. abyssinica* has suppressing effect on herbaceous weeds and serves as a good precursor for cereals. Inclusion of *G. abyssinica* in the rotation practice of weed prone areas can be considered as one mechanism of weed management.

Weed management practice in most developing countries include use of synthetic herbicides which are not environmentally friendly, expensive, and not easily available for farmers. Therefore, alternative strategies are required for better weed management at the small holder farmers level. Such alternative strategy includes the use of allelochemicals which are believed to be much safer. Allelochemicals are found in different organs and tissues of plants from where they are released to the soil through the process of leaching, volatilization, root exudation and decomposition of plant residues (Ben et al., 2001). Allelopathic plants compete with other plants, by producing different secondary metabolic components such as alkaloids and glycosides and introducing them to the soil rhizosphere of plants (Jarchow and Cook, 2009). The inclusion of allelopathic plants in crop rotations may have the potential to aid weed control, but identification of the nature and magnitude of allelopathic effects of both traditional and novel break crops is required if opportunities for improved weed control in organic systems are to be fully exploited (Robson et al., 2001). Hence, farmers traditionally used Niger plant as weed smothering crop by involving in the rotation scheme of other crops. This could be due to its vigorous growth and/or allelopathic effect on weed plants. However, there is no information as which crop part and level of extract concentration have major allelopathy effect on parthenium weed. Thus, the purpose of this research was to evaluate the allelopathic effect of Niger plant parts on seed germination and seedling growth of *P. hysterophorus* weed under in vivo condition.

MATERIAL AND METHODS

A laboratory experiment was conducted to evaluate the effect *G. abyssinica* plant parts and their concentration on *P.hysterophorus* at Weed Science Research Unit, Plant Protection Research Center, Ambo, Ethiopia. Fresh local *G. abyssinica* plant leaf, stem and root at vegetative growth stage were collected from Ambo Plant Protection Research surrounding farmer's field. The root mud was washed with tap water and risen with deionized water. The growing fresh tissues of leaf, stem and root parts were crushed and grinded with pestle and mortal separately **(**Kowthar et al., 2011**),** eighty gram of each grind plant material was mixed in distilled water at 1g/ml ratio, soaked and blended with blender (Oudhia et al., 1999). The mixtures were extracted using 100 x 100rpm centrifuge for twenty minutes. The filtered extracts was poured into 250 ml volumetric flasks, well covered by aluminum foil and preserved in refrigerator set to -5^{0}C. Ten percent filtered extracts was taken from 70ml stock solution for each plant parts. Five different concentrations 15, 30, 45, 60 and 75% were prepared for each plant parts. Ten sound seeds of *P.hysterophorus* were sown on a filter paper in a 12cm diameter sterilized Petri dish. The filter paper was moistened with (10ml) aqueous extract of leaf, stem and root extract of *G. abyssinica* plant with the respective concentration in 48hrs. Control check was treated similarly with distilled water. The treatments were arranged using Complete Randomized Design with three replications. The Petri dishes with treatments were incubated at 25ºC for 15 days. Data on germination% and germination rate was recorded within day interval until the final as described by Ellis and Roberts (1981). Seedling length and fresh weight were taken directly by using ruler and sensitive balance, respectively after the seedling root and shoot separated by scissor. The data on dry weight was recorded after root and shoot dried by oven dry for 48hr at 70 ^{0}C, and the collected data were analyzed and tested using SAS version 9.

RESULT AND DISCUSSION

Germination percentage and rate

The analysis of variance showed that aqueous extracts of *G. abyssinica* root, stem and leaf significantly ($p<0.05$) affect the germination percentage of *Parthenium* seeds (Table-1). Maximum seed germination (62.2%) was achieved for the leaf and the minimum (51.667%) was found for the stem extract of *G. abyssinica*. This indicated that stem extract of *G. abyssinica* was having relatively more inhibitory effect on germination percentage than corresponding leaf extract. There was no significant inhibitory difference among *G. abyssinica* plant part (root, stem and leaf) aqueous extracts on the germination rate of *Parthenium* ($p<0.05$). In general, all plant parts affect equally the germination rate of the *Parthenium* seed. In line with these results, Modupe and Joshua (2013), announced that among extracts obtained from different sorghum plant parts, stem comprise maximum effects in preventative property on *Euphorbia heterophylla* weed seeds germination.

Germination of *P. hysterophorus* seeds were adversely affected by aqueous extracts of *G. abyssinica* (Table-2). However, germination response of *P. hysterophorus* seed varied with the levels of concentration.

Table 1. Effect of Niger (*G. abyssinica* L*)* plant part on germination and growth of *Parthenium hysterophorus*

Plant part	Germination (%)	Germination rate	Root length(cm)	Shoot length (cm)
Leaf	62.222^{a}	0.666^{a}	1.733^{a}	2.908^{a}
Stem	51.667^{b}	0.622^{a}	1.552^{a}	3.258^{a}
Root	59.444^{ab}	0.706^{a}	1.258^{b}	2.548^{a}
SE (m)	14.69	0.15	0.20	0.28
CV (%)	25.42	8.4	9.92	11.35

N.B Similar letter in each column show non–significant difference according to Duncan's Multiple Range Test (DMRT) at 0.05 level of probability.

Table 2. Effect of different aqueous extract concentration of Niger plant on germination and growth of *P. hysterophorus*

Aqua's extract (%)	Germination (%)	Germination rate	Root lengths (cm)	Shoot lengths (cm)
0	81.11^{a}	1.143^{a}	3.36^{a}	6.47^{a}
15	77.78^{ab}	0.821^{b}	2.81^{b}	5.09^{b}
30	65.56^{b}	0.739^{b}	2.04^{c}	3.33^{c}
45	71.11^{ab}	0.724^{b}	0.48^{d}	1.49^{d}
60	41.11^{c}	0.438^{c}	0.33^{de}	0.81^{e}
75	10.00^{d}	0.121^{d}	0.07^{e}	0.23^{f}
SE(m)	14.69	0.15	0.20	0.28
CV(%)	25.42	8.4	9.92	11.35

N.B. Similar letter in each column show non–significant difference according to Duncan's Multiple Range Test (DMRT) at 0.05 level of probability

All extracts negatively affect the germination of *P. hysterophorus,* when compared with the control. Niger aqua's extract with 60 and 75% inhibited the germination of *P. hysterophorus* seed by 59% and 90%, respectively. There was no significant difference among 15, 30, and 45% treatments on germination rate; nevertheless increase ≥ 60% in concentration of aqua extract significantly affected growth parameters. The decrease in germination rate may be due to the slowdown of living processes of the plants caused by the loss of seeds respiration resulted by chemicals (Rezaee et al., 2008; Gella et al., 2013). Mohammadi and Rajaie (2009) also reported the decreased in germination rate with increases allelochemicals. Reduction in seed germination under allelochemical could be due to the reduction or delay in reserve mobilization under allelopathy stress conditions (Gniazowska and Bagatek, 2005).

Root and shoot lengths

The root, stem, and leaf aqueous extracts of *G. abyssinica* significantly affect root length of *Parthenium* seedlings. The maximum seedlings root length was observed on leaf and stem extracts, while the minimum *Parthenium* seedlings root length (1.25cm) on the root extracts (Table-1). There is no significant difference (p<0.05) on the inhibitory effect of *G. abyssinica* plant parts (root, stem and leaf) aqueous extracts on shoot length of *Parthenium* (Table-1).

Aqueous extracts of all the three plant parts exhibited phytotoxic activity against seedling growth of the noxious weed. The susceptibility of *Parthenium* to different levels of extracts could be due to inherent differences in various biochemicals involved in the process. Gholami et al., (2011) found that allelochemicals inhibits plant root growth through generation of reactive oxygen species induced oxidative damage. These observations showed that *G. abyssinica* root may possess higher inhibitory effect on the root growth of *Parthenium* because root is the first plant part that contact allelochemicals from the solution.

Aqueous extracts of *G. abyssinica* concentration significantly affect shoot length growth. The concentration of extract part increases the inhibition of the shoot length (Table 2). The maximum (0.23cm) and minimum (5.09cm) inhibitory effect of *G. abyssinica* in shoot length was observed on 75 and 15%, respectively. The reduction in seedlings roots and shoot lengths (Table 2) may be attributed to the reduced rate of cell division and cell elongation due to the presence of allelochemicals in the aqueous extracts (Gholami et al., 2011). Jefferson and Pennacchio, (2003) concluded that reducing of seedling growth of weeds by allelochemicals in soil are detrimental to their survival since plants that usually germinate at slower rates are smaller.

Root and shoot fresh weights

Root extract highly affected root fresh weight when compare with leaf extract (Table-3). The maximum (0.006g) and minimum (0.004g) root fresh weights were recorded on leaf and root, respectively. Shoot fresh weight

Table 3. Effect of Niger plant parts on fresh and dry weights of *Parthenium hysterophorus*

Plant part	Root fresh weight (g)	Root dry weight (g)	Shoot fresh weight (g)	Shoot dry weight (g)
Leaf	0.006[a]	0.0014 [a]	0.0298 [a]	0.0103[a]
Stem	0.005[ab]	0.0012 [a]	0.0162 [b]	0.0046[b]
Root	0.004[b]	0.0008[a]	0.0158 [b]	0.0053[b]
SE(m)	0.02	0.01	0.05	0.02
CV(%)	1.79	0.90	4.17	2.29

Table 4. Effect of different aqueous extract concentration of Niger plant part on fresh and dry weights of *Parthenium hysterophorus*

Aqua's extract (%)	Root fresh weight (g)	Root dry weight (g)	Shoot fresh weight (g)	Shoot dry weight (g)
0	0.02289[a]	0.00522[a]	0.09133[a]	0.030[a]
15	0.0065[b]	0.00146[b]	0.02964[b]	0.010[b]
30	0.00096[c]	0.00017[c]	0.00223[c]	0.0005[c]
45	0. 00029 [c d]	0.00001[d]	0.00047[c d]	0.0001[c]
60	0.0000[d]	0.0000[d]	0.00003[cd]	0.0000[c]
75	0.0000[d]	0.0000[d]	0.000 0[d]	0.0000[c]
SE(m)	0.02	0.01	0.05	0.02
CV(%)	1.79	0.90	4.17	2.29

N.B. Similar letter in each column show non–significant difference according to Duncan's Multiple Range Test (DMRT) at 0.05 level of probability

was significantly affected by extracts of plant parts (leaf, stem and root). Root extract was comparatively inhibitorier than stem and leaf extracts. The maximum (0.03g) and minimum (0.016g) shoot fresh weight was recorded in leaf and root, respectively (Table-3). Aqua's extract of *G.abyssinica* totally inhibited the root fresh weight of *P. hysterophorus* beyond 45% (Table-4) because the root is first organ of plant deals with allelopathic materials and toxin compounds. The result was also related with other reports; that reduction in growth and survival of plant may be due to inhibition of mitosis in plant (Mohamadi and Rajaie, 2009), alteration of balance in phytohormones (Chou, 1980), changes in permeability of membranes (Gniazowska and Bagatek, 2005), and stimulation or inhibition of respiration (Batish et al., 2001) under allelopathy stress could be the effective parameters. As aqueous concentration of Niger plant increased ≥15% shoot fresh weight decreased significantly (P≤0.05) (Table-4). This could be due to inhibition of protein synthesis and inhibition or alteration of the function of enzymes in the plant (Bertin et al., 2007).

Root and shoot dry weights

The root dry weight accumulation of *P. hysterophorus* was equally affected by all plant parts (leaf, stem and root) (Table-3). Shoot dry weight of *Parthenium* weed was significantly affected by plant parts of *G. abyssinica.* The root and stem of *G. abyssinica* showed maximum inhibitory effect in shoot dry weight than the leaf (Table-3). The ANOVA result showed that shoot dry weight of *Parthenium* weed seedling was significantly affected with aqueous extracts of *G.abyssinica* (Table 4). As the concentration increases from 15 to 30% inhibitory effect increased significantly. Increase in *G. abyssinica* concentration beyond 15% caused total failure of shoot development. Yarnia et al., (2009) also reported that 5 to 20% leaf extract of sorghum reduced plant height, leaf area, shoot and root dry weighs of *Amaranths retroflexus*. Besides, Dadkhah (2012) reported that application of Ephedra major aquatic extracts (15 to 45%) decreased leaf area, plant height, shoot and root weights, and chlorophyll content of *Cirsium arvence* and the reduction was concentration-specific. In addition, aqueous extract concentration of *G. abyssinica* reduced root dry weight accumulation in *P. hysterophorus* seedling. A significant reduction was observed with increase in aqua's extract of *G. abyssinica* beyond 30% which caused complete failure of germination, thus no dry matter production (Table-4).

CONCLUSION AND RECOMMENDATION

Niger plants poses threat on seed germination percentage and rate, seedlings root, and shoot lengths of *P. hysterophorus*. Aqua's extracts of *G. abyssinica* inhibited *Parthenium* weed seed germination and seedlings growth and plant biomass. Germination, shoot and root lengths, fresh and dry weights of *P. hysterophorus* plant were adversely affected by aqueous extracts ≥15% concentration, and all plant parts have unequal effect on the *Parthenium* weed. Aqueous extracts concentrations ≥ 60% are more effective for the management of *Parthenium*. Thus, *G. abyssinica* has a great potential to be used as bio-herbicide in *Parthenium* weed control. However, Verification of this study under field conditions, and identification of the allelochemicals in *G. abyssinica* should be done in the future work.

REFERENCE

Batish DR, Singh HP, Kohli RK, Kaur S (2001). Crop allelopathy and its role in ecological agriculture. *J.* Crop*. Prod.,* 4 (2): 121-161.

Ben HM, Hebit G, Kremer RJ, Quassama O (2001). Allelopathic effects of barley extracts on germination and seedlings growth of bread and durum wheat. *Agrono.*, 21: 65-71.

Bertin C, Leslie TW, Georg HJ, Thomas O (2007). Grass roots chemistry: meta-tyrosine, an herbicidal non-protein amino acid. *Proc Natl. Acad. Sci.* 104 (43): 16964-16969.

Bulcha W (2007). *Guizotia abyssinica* (L.f.) Cass. Record from PROTA4U. van der Vossen, H.A.M. & Mkamilo, G.S. (Editors). PROTA (Plant Resources of Tropical Africa / Resources végétales de l'Afrique tropicale), Wageningen, Netherlands.

Central Statistical Agency (CSA) (2014). Report on area and production of major crops, agricultural sample survey 2013/2014. Statistical Bulletin, Addis Ababa.

Chou HC (1980). Allelopathic researches in the subtropical vegetation in Taiwan. *Comp. Physiol. Ecol.,* 5: 222-234.

Dadkhah A (2012). Allelopathic effect of Ephedra major on growth and photosynthesis of *Cirsium arvense* weed. *Int. J. Agric.,* 2(4): 416-419.

Ellis RA, Roberts EH (1981). The quantification of ageing and survival in orthodox seeds. *Seed Sci.Technol.,* 9:373- 409.

Eneyew T (2013). Evaluation of Ethiopian Nigerseed (*Guizotia Abyssinica Cass)* Production, Seed Storage and Virgin Oil Expression. Landwirtschaftlich-Gärtnerische Fakultät der Humboldt-Universität zu Berlin. Pp. 1-16.

Gella D, Habtamu A, Takele N (2013).Allelopathic effect of aqueous extracts of major weed species plant parts on germination and growth of wheat. *J. Agri. and Crop Res.,* 1(3): 30-35.

Getinet A, Sharma SM (1996). Niger (*Guizotia abyssinica* L.) Promoting the conservation and use of underutilized and neglected crops. Vol. 5. Institute of Plant Genetics and Crop Plant Research, Gatersleben/ International Plant Genetic Resources Institute, Rome.

Gholami MF, Barat A, Mohamad TK (2011). Allelopathic effects of aqueous extract from *Artemisia kopetdaghensis* and *Satureja hortensison* growth and seed germination of weeds. *J Appl Environ Biol Sci.,* 1: 283-290.

Gniazowska A, Bogatek R (2005). Allelopathic interactions between plants multi site action of allelochemicals. *Acta Physiol. Plant,* 27: 395-407.

Jarchow ME, Cook BJ (2009). Allelopathy as a mechanism for the invasion of *Typha angustifolia. Plant Ecol.*, 204:113-124.

Jefferson LV, Pennacchio M (2003). Allelopathic effects of foliage extracts from four Chenopodiaceae species on seed germination. *J.* Arid *Env.,* 55: 275-285.

Kololgi PD, SD Kololgi, NP Kololgi (1997). Dermatological hazards of *Parthenium* in human beings. In: Mahadevappa M and VC Patil (eds) pp. 18-19. Proceedings of the first international conference on parthenium management, 6-8 October 1997, University of Agricultural Sciences, Dahrwad, India.

Kowthar, G. El-Rokiek R, Eid A, Lobna ST (2011). Allelopathic effects of croton leaves residue on jasmine trees and associated weeds. *J. Appl. Sci. Res.,* 7(6): 948-954.

Modupe JA, Joshua K (2013). Allelopathic effects of aqueous extracts from residues of *Sorghum bicolor* stem and maize inflorescence on the germination and growth of *Euphorbia heterophylla* L. *J. Plant Studies,* 2(2): 1-6.

Mohamadi N, Rajaie P (2009). Effects of aqueous eucalyptus (*E. camadulensis*) extracts on seed germination, seedling growth and physiological responses of *Phaseolus vulgaris* and *Sorghum bicolor*. *Asian J. Plant Sci.,* 4 (12): 1292-1296.

Oudhia PN, Pandey RS, Thipati (1999). Allelopathic effects of weeds on germination and seedling vigor of hybrid rice. Department of Agronomy, Indra Gandhi Agricultural University (IGAU), Raipur, Madhya Pradish, India.

Rezaee F, Yarnia M, Mirshekari B (2008). Allelopathic effect of extracts of different parts of red-root amaranth, goosefoot and Bermuda grass on germination and growth of rapeseed. *Modern Agric. Knowl. J.* 10:125-131.

Robson MC, Robinson D, Litterick AM, Watson C, Leitch M (2001). Investigations into allelopathic interactions of white lupin (*Lupinus albus*). British Crop Protection Council Conference (Weeds), Brighton,UK. 12-15 November. Vol. 1 and Vol. 2. British Crop Protection Council, Alton, Hampshire, UK.

Seyyedi M, Rezvani MP, Shahriari R, Azad M, Eyshi RE (2013). Allelopathic potential of sunflower and caster bean on germination properties of dodder (*Cuscuta compestris). Afr.* J. *Agric. Res.,* 8(7): 601-607.

Tamado T (2002). Biology and management of parthenium (*Parthenium hysterophorus* L.) in Ethiopia. Doctoral thesis. Swedish University of Agricultural Sciences, Uppsala, pp. 1-27.

Tefera T. (2002). Allelopathic effects of *Parthenium hysterophorus* extracts on seed germination and seedling growth of *Eragrostis tef. J. Agronomy & Crop*

Science, 188: 306—310.

Thatte P, Lakshmi AJ (2012). Nutritional potential, bio-accessibility of minerals and antioxidant properties of Niger (*Guizotia abyssinica*) seed protein. *Int. J.* Food*. Sci.* Tech.*,* 47: 656–663.

Yarnia M, Khorshidi BMB, Farajzadeh MTE (2009). Allelopathic effects of sorghum extracts on *Amaranthus retroflexus* seed germination and growth. *J. Food Agric. and Environ.* 7: 770-774.