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# ALLELOPATHIC POTENTIAL OF MINT WEED (*Hyptis suaveolens* Poit.) ON GERMINATION BEHAVIOUR OF SOME OKRA (*Abelmoschus esculentus* (L.) MOENCH VARIETIES

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## ABSTRACT

The allelopathic effect of water extract of fresh shoot of Mintweed (*Hyptis suaveolens* Poit.) at varying concentrations on germination of some okra varieties under laboratory condition was investigated in 2012. The treatments were a 3 x 5 factorial combination of okra varieties (LD 88-1, JOKOSO, NHAe47–4) and extract concentration (distilled water as control, 0%; 25% w/v, 50% w/v, 75% w/v and 100% w/v), arranged in a completely randomized design with five replications. In this study, total germination ($G_T$), speed of accumulated germination (SAG) and coefficient of rate of germination (CRG) were measured. Among the varieties, extract of fresh shoot of *H. suaveolens* had similar inhibitory effect on LD 88–1 and NHAe 47–4 compared with JOKOSO. The extract concentration at 25% and beyond with LD 88-1 and NHAe 47–4, 50% and beyond with JOKOSO inhibited the seed germination of these varieties. JOKOSO tolerated the allelochemicals of the extract at 25% concentration and promoted similar superior seed germination with the control (0%). $G_T$ and SAG were more sensitive to show allelopathic effect of extract of fresh shoot of *H. suaveolens*, than CRG on okra seeds.

Keywords: Allelopathy, fresh shoot, water extract, germination, *Hyptis suaveolens*, varieties, concentration, okra

## INTRODUCTION

The mint weed (*Hyptis suaveolens*) is an annual of the family *Lamiaceae* (Chatiyanon *et al.*, 2012). It is a common weed of cropped and non-cropped areas that can heavily infest such an area and as well displace the native flora as a result of its ruderal, rigid and aggressive nature (Raizada, 2006). Furthermore, its population expansion can be so fast such that it may prove to be a potent invader. The plant is known to contain several chemical compounds such as phenol, tannin, saponin, alkaloid and steroid among others (Kapoor, 2012) which are a variety of secondary plant products known as allelochemicals (Fateh *et al.*, 2012).

Toxic allelochemicals may inhibit or retard germination rate, reduce root or radicle and shoot or coleoptiles extension, cause lack of root hairs, swelling or necrosis of root tips, bring about curling of root axis, increase number of seminal roots, cause discolouration, reduce dry weight accumulation as well as lower reproductive capacity in plants (Oyerinde *et al.*, 2009). In addition, a wide range of allelopathic effect on crop growth has been attributed to the phytotoxic decomposition of products released from the leaves, stem, fruits, seeds and roots of such plants (Fateh *et al.*, 2012). This weed has been reported to possess inhibition potential on seed germination and seedling growth of crops and weed species (Chatiyanon *et al.*, 2012). All parts of the

weed including leaf, stem, fruit and root have allelopathic effects on crop seed germination and growth through the release of water soluble compounds (Fateh *et al.*, 2012). However, information on the allelopathic potential of *H. suaveolens* weed on okra seed germination and germination behaviour is lacking. Therefore the present study was carried out to determine the effect of water extract of fresh shoot of *H. suaveolens* on seed germination of okra at varied concentration.

## MATERIALS AND METHODS

The experiment was carried out in the Department of Crop Production Laboratory, Federal University of Technology, Minna, Nigeria.

### Preparation of water extract of the weed

Fresh healthy plants of *H. suaveolens* were collected at vegetative stage from the natural environment infested with the weed at the Federal University of Technology, Minna, Nigeria. The roots were separated from the shoot and then washed gently with tap water for few seconds to avoid leaching losses of water soluble allelochemicals. This was followed by quick rinsing in distilled water and drying with clean absorbent paper as described by Kapoor (2012).

The shoot was chopped into lengths of 0.5–3.0 cm, and ground with a pestle and mortar. The following samples: 25, 50, 75 and 100 g of each part of the ground plant materials were weighed and put in 1 L volumetric container and filled up to 1000 ml with distilled water and placed on a shaker set for 24 h continuous shaking at room temperature. Thereafter, each of the solutions containing 25, 50, 75 and 100 g *H. suaveolens* ground material were collected by sieving through three layers of cheese cloth to remove debris, and the filtrate were re-filtered through filter paper and designated as 25%, 50%, 75% and 100% water extract respectively. Distilled water (as 0%) was included as the control. Thymol ($C_{10}H_{14}O$) was added to each extract as a preserving agent at 1% /L.

### Seed germination bioassay

Empty and undeveloped seeds of each okra variety were removed by floating in tap water prior to seed germination test. The seeds were then surface sterilized with potassium permanganate at 0.5% for 5 min and then thoroughly washed with distilled water and dried between two clean paper towels. Twenty seeds were placed in sterilized plastic Petri-dishes lined with filter paper, covered with a fitting lid and placed in the dark at 26 ± 2°C, and 6 ml of each water extract was used to soak the seeds. The seeds in the control were soaked with 6 ml of distilled water. Germination count was taken every-day for a period of 7 days in each replication.

### Treatments and experimental design

The treatments were a 3 x 5 factorial combination of three okra varieties (LD 88-1, JOKOSO and NHAe 47- 4) and five concentration levels (0%, 25%, 50%, 75% and 100%) of *H. suaveolens* fresh shoot water extracts; arranged in a complete randomized design (CRD) with five replications.

### Data collection and statistical analysis

The data collected were seed germination percentage, considered when the radicle extended through the seed coat. Germination indices; total germination ($G_T$), speed of accumulated germination (SAG) and coefficient of rate of germination (CRG) were used to test the allelopathic effect of water extracts of *H. suaveolens* shoots as described by Allaie *et al.* (2006) as follows:

germination (GT) = $\frac{N_T \times 100}{N}$

the proportion of germinated seeds at treatment for the last time of measurement. N is the number of seeds used in the bioassay.

accumulated germination (SAG) =

$\frac{N_1}{1} + \frac{N_2}{2} + \frac{N_3}{3} \ldots + \frac{N_n}{n}$

where $N_1, N_2, N_3, \ldots N_n$ is the cumulative number of seeds which germinated on time 1, 2, 3, .....N following set up of the experiment

of the rate of germination (CRG)

$\frac{N_1 + N_2 + N_3 + \ldots + N_0) \times 100}{T_1 + (N_2 \times T_2) + (N_3 \times T_3) + \ldots + (N_n \times T_n)}$

$N_1$ is the number of germinated seeds on time $T_1$, $N_2$ is the number of germinated seeds on time $T_2$ and $N_n$ is the number of germinated seeds on time $T_n$

The data obtained were subjected to analysis of variance, and means were separated by using Student Newman-Keuls (SNK) test at 5% probability level. Percent germination data obtained were subjected to arcsin transformation before statistical analysis.

## RESULTS AND DISCUSSION

The allelopathic effect of fresh shoot extract of *H. suaveolens* on seed germination of some okra seeds at various concentrations at different time periods in days had a *significant influence (P<0.05)* among variety and concentration levels (Table 1). In respect of variety, LD 88–1 and NHAe 47–4 were adversely affected by the extract of *H. suaveolens*, while the extract had a marginal depressing effect on JOKOSO, respectively. In this case, JOKOSO recorded the highest germination and LD 88–1 the least which was similar to NHAe 47–4. The present investigation demonstrated that fresh shoot water extract of *H. suaveolens* inhibited the seed germination of LD 88–1, JOKOSO and NHAe 47–4 okra varieties commonly grown in Nigeria. This result was similar to the research on *H. suaveolens* leaf water/ methanol extracts that inhibited seed germination of *Pennisetum setosum* (Chatiyanon *et al.*, 2012).

Table 1: Seed germination of some okra varieties as affected by fresh shoot extract of *Hyptis suaveolens* at varied concentration

| Treatment | % Seed germination (time in days) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Variety (V) | | | | | | | |
| LD 88 - 1 | 2.8b | 23.8b | 33.8b | 36.6b | 36.6b | 36.6b | 36.6b |
| JOKOSO | 3.8a | 31.2a | 48.2a | 53.2a | 53.6a | 53.4a | 53.4a |
| NHAe 47 - 4 | 2.0c | 27.0ab | 35.8b | 38.8b | 40.0b | 40.0b | 40.0b |
| SE ± | 0.5 | 1.0 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| Level (L) (%) | | | | | | | |
| 0 | 11.3a | 48.7a | 65.0a | 70.0a | 72.0a | 72.0a | 72.0a |
| 25 | 31.0b | 31.3b | 44.0b | 49.3b | 49.7b | 49.7b | 49.7b |
| 50 | 0.0c | 18.3c | 26.7c | 29.7c | 30.0c | 30.0c | 30.0c |
| 75 | 0.0c | 19.3c | 30.3c | 32.0c | 32.0c | 32.0c | 32.0c |
| 100 | 0.0c | 19.0c | 30.3c | 33.0c | 33.3c | 33.3c | 33.3c |
| Interaction | | | | | | | |
| V x L | * | * | NS | * | * | * | * |

Means with the same letter in a treatment column are not significantly different using Student Newman Keuls (SNK) test at 5 % level of probability

As regards extract concentration, okra seed germination declined with increase in concentration. Similar adverse effect on seed germination was recorded with 50, 75 and 100% concentration compared to 25 and 0% (control). The 0% concentration recorded the highest germination and least by 50%; which was comparable with 75 and 100 % concentrations. It was also evident that germination of okra varieties was significantly reduced by the extract at each concentration compared to the control (0% concentration). However, the lowest extract concentration (25%) provided minimal seed germination inhibition. This finding suggests the presence of inhibitory chemicals in each concentration of the shoot extract of *H. suaveolens*. It had been reported that degree of inhibition of plant extract increases with increase in its concentration, suggesting that effect of extracts depends in the concentration level (Ayeni and Kayode, 2013).

There was significant interaction between variety and concentration levels of fresh shoot water extract of *H. suaveolens* on seed germination of some okra varieties at 1, 2, 4, 5, 6 and 7 d exposure times (Table 2). Highest seed germination percentage was

Table 2: Interaction between variety and concentration level of water extract of fresh shoot of *Hyptis suaveolens* on germination percent of okra

| Treatment | Extract concentration level (%) | | | | |
|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 |
| Variety | | | | | |
| | | | Day 1 | | |
| LD 88 – 1 | 10.0b | 4.0c | 0.0d | 0.0d | 0.0d |
| JOKOSO | 14.0a | 5.0c | 0.0d | 0.0d | 0.0d |
| NHAe 47 – 4 | 10.0b | 0.0d | 0.0d | 0.0d | 0.0d |
| SE ± | | | 1.1 | | |
| | | | Day 2 | | |
| LD 88 – 1 | 42.0c | 21.0e | 17.0ef | 16.0ef | 23.0de |
| JOKOSO | 50.0ab | 46.0bc | 22.0ef | 20.0ef | 18.0ef |
| NHAe 47 – 4 | 54.0a | 27.0d | 20.0ef | 20.0ef | 14.0f |
| SE ± | | | 2.2 | | |
| | | | Day 4 | | |
| LD 88 – 1 | 73.0ab | 38.0ef | 26.0gh | 25.0gh | 21.0h |
| JOKOSO | 75.0a | 68.0b | 47.0d | 40.0e | 36.0ef |
| NHAe 47 – 4 | 62.0c | 42.0de | 32.0fg | 31.0fg | 27.0gh |
| SE ± | | | 2.7 | | |
| | | | Day 5 | | |
| LD 88 – 1 | 73.0a | 38.0cd | 26.0ef | 25.0ef | 21.0f |
| JOKOSO | 75.0a | 69.0ab | 47.0b | 40.0c | 37.0cd |
| NHAe 47 – 4 | 68.0a | 42.0cd | 32.0ef | 31.0f | 27.0fg |
| SE ± | | | 2.6 | | |
| | | | Day 6 | | |
| LD 88 – 1 | 73.0ab | 38.0de | 26.0fg | 25.0fg | 21.0g |
| JOKOSO | 75.0a | 69.0ab | 46.0c | 40.0cd | 37.0de |
| NHAe 47 – 4 | 68.0b | 42.0cd | 32.0ef | 31.0f | 27.0fg |
| SE ± | | | 2.6 | | |
| | | | Day 7 | | |
| LD 88 – 1 | 73.0ab | 38.0de | 26.0gh | 25.0gh | 21.0h |
| JOKOSO | 75.0a | 69.0ab | 46.0c | 40.0cd | 37.0def |
| NHAe 47 – 4 | 68.0ab | 42.0cd | 32.0efg | 31.0fg | 27.0gh |
| SE ± | | | 2.7 | | |

a,b: Means with the same letter(s) within a set a treatment column and between rows are not significantly different using Student Newman Keuls (SNK) test at 5% level of probability

from JOKOSO with 0% concentration at 1, 4, 6 and 7 d exposure time as well as at 2 d exposure time with NHAe with 0% concentration. Seed of LD 88–1 in conjunction with concentration at 4, 6 and 7 d exposure as well as NHAe 47–4 with 0% concentration, JOKOSO with 25% extract concentration at 5, 6 and 7 d exposure times and JOKOSO with 0% concentration were comparable to the highest. Furthermore, all the okra varieties given 0% water extract concentration as well as JOKOSO with 25% water extract concentration resulted in comparable higher seed germination at 5 d exposure time. In all the varieties tested it was discovered that inhibition of okra seed germination decreased with increase in leachate concentration. The present finding is in agreement with the work of Kapoor

Table 3: Germination indices of some okra varieties as affected by fresh shoot extract of *Hyptis suaveolens* at varied concentration

| Treatment | $G_T$ (%) | SAG | CRG (%) |
|---|---|---|---|
| Variety (V) | | | |
| LD 88 – 1 | 36.6b | 5.4b | 42.6a |
| JOKOSO | 53.6a | 8.9a | 41.9a |
| NHAe 47 – 4 | 40.0b | 5.7b | 43.5a |
| SE ± | 1.2 | 0.5 | 0.6 |
| Level (L) (%) | | | |
| 0 | 72.0a | 12.1a | 45.0a |
| 25 | 49.7b | 8.7b | 42.9ab |
| 50 | 30.0c | 3.8c | 43.6ab |
| 75 | 32.0c | 4.1c | 42.7ab |
| 100 | 33.3c | 4.4c | 39.2b |
| SE ± | 1.5 | 0.6 | 0.8 |
| Interaction | | | |
| V x L | * | * | NS |

Means with the same letter(s) in a treatment column are not significantly different using Student Newman Keuls (SNK) test at 5 % level of probability
NS – not significant
* - Significant at 5 % level probability
$G_T$ - Total germination
SAG - Speed of accumulated germination
CRG – Coefficient of rate of germination

Table 4: Interaction between variety and concentration level of water extract of fresh shoot of *Hyptis suaveolens* on total germination and speed of accumulated germination of okra

| Variety | Extract concentration level (%) | | | | |
|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 |
| | Total germination (GT) | | | | |
| LD 88 – 1 | 73.0a | 38.0b-e | 26.0ef | 25.0ef | 21.0f |
| JOKOSO | 75.0a | 69.0a | 47.0b | 40.0b-d | 37.0b-e |
| NHAe 47 – 4 | 68.0a | 42.0bc | 32.0c-f | 31.0c-f | 27.0d-f |
| SE ± | | | 2.7 | | |
| | Speed of accumulated germination (SAG) | | | | |
| LD 88 – 1 | 11.4a | 6.6b | 3.3bc | 3.1bc | 2.5c |
| JOKOSO | 13.6a | 13.3a | 6.7b | 5.1bc | 4.6bc |
| NHAe 47 – 4 | 11.6a | 4.3bc | 4.2bc | 4.0bc | 3.2bc |
| SE ± | | | 1.0 | | |

Means with the same letter(s) within a set a treatment column and between rows are not significantly different using Student Newman Keuls (SNK) test at 5% level of probability

(2012) who indicated that seed germination and other biochemical components can be decreased with increase in concentration of the leaf extracts.

The germination indices of some okra varieties as affected by *H. suaveolens* fresh shoot extract differed significantly among the varieties and levels of extract concentration (Table 3). The extracts greatly reduced total germination ($G_T$) and speed of accumulated germination (SAG) of LD 88–1 and NHAe 47–4. GT and SAG of JOKOSO was slightly affected by the extract. Furthermore, $G_T$ and SAG were significantly reduced particularly at 50% concentration, which was at par with 75 and 100% concentrations, compared to 0 and 25% concentrations. Coefficient of rate of germination (CRG) was not significantly different among the varieties, except where it was most inhibited at 100%, which was inferior to 0% concentration only. The three indices used to assess the allelopathic effects of mint weed on germination of the okra varieties revealed that $G_T$ and SAG were sensitive enough to conclusively confirm the allelopathic activity of the fresh shoot water extract of *H. suaveolens*. Supporting evidence had been shown by Allaie *et al.* (2006), who reported that multiple indices could be used to adequately reflect the effect of allelochemicals of a plant extract on germination behaviour of some field crops.

There was significant interaction between variety by concentration levels of fresh shoot water extract of *H. suaveolens* on $G_T$ and SAG of okra (Table 4). Comparable higher $G_T$ and SAG was obtained with LD 88–1, JOKOSO and NHAe 47–4 at 0 % concentration and JOKOSO in conjunction with 25 % concentration in this study. The study also showed that inhibition of seed germination of the okra varieties was most pronounced in LD 88-1 and NHAe 47–4 compared to the control. In contrast, JOKOSO tolerated the water extract of fresh shoot of *H. suaveolens* up to 25% concentration. In this case, JOKOSO had a marginal germination at 25% concentration similar to the control, indicating its capability to detoxify the allelochemical constituent of *H. suaveolens*. The inhibition of seed germination of JOKOSO at 50–100% concentration, LD 88–1, NHAe 47–4 at 25–100% water extract concentration of fresh shoot of *H. suaveolens* might be attributed to the arrest of protease and ∞ - amylase activity by the phytotoxins contained in the extracts which might have inhibited protein and starch break down that resulted in germination reduction (Kapoor, 2012). Therefore, the implication of the present observation is that *H. suaveolens* can regulate or reduce the population size of LD 88–1 and NHAe 47–4, while JOKOSO can provide a marginal improvement in the germination of okra varieties.

## CONCLUSION

Results of the present study showed that *water extract from fresh shoot of H. suaveolens* had an inhibitory effect on seed germination of LD 88-1 and NHAe 47-4 from 25%, and JOKOSO from 50% extract concentration. JOKOSO marginally tolerated the allelochemicals of *H. suaveolens* at 25%, and had similar superior seed germination with the control (0% concentration). Total germination ($G_T$) and speed of accumulated germination (SAG) were sensitive enough to establish allelopathic effect on okra seeds. It will be difficult to directly apply the results of this study to production situation because the experiment was conducted under laboratory conditions. Therefore, further investigations need to be carried out under glass house and field conditions to verify if the findings of this study will differ due to change in the growth conditions.

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## REFERENCES

Ajilie, R. R., Reshi, Z., Rashad, I. and Wafai, B. A. 2006. Effect of aqueous leaf leachate of *Anthemis cotula* – An alien invasive species on germination behaviour of some field crops. *Journal of Agronomy and Crop Science*, 192: 186 – 191.

Ayeni, M. J. and Kayode, J. 2013. Allelopathic effects of sorghum stem and maize inflorescence residues on the germination and growth of okra (*Abelmoschus esculentus* L.). *Journal of Food, Agriculture and Environment*, 11: 320 – 323.

Chuthyanon, B., Tanee, T., Talubmook, C. and Wongwattana, C. 2012. Effect of *Hyptis suaveolens* Poit. Leaf extracts on seed germination and subsequent seedling growth of *Pennisetum setosum* (Swartz.) L. C. Rich and *Mimosa invisa* Mart. *Agricultural Journal*, 7: 17 – 20.

Fateh, E., Sohrabi, S. S. and Gerami, F. 2012. Evaluation of the allelopathic effect of bindweed (*Convolvulus arvensis* L.) on germination and seedling growth of millet and basil. *Advances in Environmental Biology*, 6: 940 – 950.

Kapoor, R. T. 2012. Phytotoxic potential of fresh leaf leachate and dry leaf extracts of *Hyptis suaveolens* to control *Parthenium hysterophorus* L. *International Conference on Chemical Processes and Environmental Issues*, p. 154 – 158. July 15 – 16, 2012, Singapore.

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: 1553 – 1558.

Raizada, P. 2006. Ecological and vegetative characteristics of a potent invader, *Hyptis suaveolens* Poit. From India. *Lyonia*, 11: 115 – 120.