Allelopathic Effects of Sweet Basil 
(Ocimumbasilicum L.) on Seed Germination and Seedling Growth of some Poaceous Crops

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**Abstract**— Laboratory and greenhouse experiments were carried out at the Faculty of Agricultural Sciences, University of Gezira, Sudan in season 2014/15 to study the allelopathic effects of aboveground parts of sweet basil (Ocimumbasilicum L.) on seed germination and seedling growth of some poaceous crops. Laboratory experiments were conducted to study the allelopathic effects of aqueous extract of aboveground parts of sweet basil on seed germination of sorghum (Sorghum bicolor [L.] Moench), millet (Pennisetumglaucum [L.]R. Br.), maize (Zea mays L.) and wheat (Triticum vulgare L.). Six concentrations (0, 20, 40, 60, 80 and 100%) of the aqueous extract of the aboveground parts of sweet basil were prepared from the stock solution (50 g/l). Treatments, for each crop, were arranged in completely randomized design with four replicates. The seeds were examined for germination at three days after initial germination. Greenhouse experiments were conducted to study the allelopathic effects of powder of aboveground parts of sweet basil on seedling growth of the same poaceous crops. The powder of aboveground parts was incorporated into the soil at rate of 0, 1, 2, 3, 4 and 5% on w/w bases in pots. Treatments, for each crop, were arranged in completely randomized design with four replicates. The experiments were terminated at 30 days after sowing and the plant height, number of leaves and root length of crop seedlings were measured as well as plant fresh and dry weight. Data were collected and subjected to analysis of variance procedure. Means were separated for significance using Duncan’s Multiple Range Test at p ≤ 0.05. The results showed that the aqueous extract of aboveground parts of sweet basil significantly reduced seed germination of the tested poaceous crops and there was direct negative relationship between concentration seed germination. Also, the results showed that incorporating powder of aboveground parts into the soil significantly decreased plant height and root length of crop seedlings as well as seedling fresh and dry weight. In addition, the reduction in seedling growth was increased as the powder increased in the soil. Based on results supported by different studies, it was concluded that sweet basil has allelopathic effects on seed germination and seedling growth of the poaceous crops.

**Keywords**— Allelopathic; Allelochemicals; Sweet Basil; Ocimum; Poeaeae; sorghum; millet; maize; wheat.

**I. INTRODUCTION**

The genus *Ocimum*, Lamiaceae, collectively called basil, is comprises more than 30 species of herbs and shrubs from the tropical and subtropical regions of Asia, Africa, and Central and South America, but the main center of diversity appears to be Africa (Paton, 1992). It is a source of essential oils and aroma compounds (Simon et al., 1984, 1990), a culinary herb, and an attractive, fragrant ornamental (Morales et al., 1993; Morales and Simon, 1996). The seeds contain edible oils and a drying oil similar to linseed (Angers et al., 1996). Extracts of the plant are used in traditional medicines, and have been shown to contain biologically active constituents that are insecticidal, nematicidal, fungistatic, or antimicrobial (Simonet et al., 1990; Albuquerque, 1996).

The *Ocimum* plants have been investigated as potential allelopathic plants (Baličević et al., 2015). Allelopathy refers to direct or indirect negative effects of one plant on another through the release of chemical compounds into the environment (Delabays et al., 2004). These biochemicals are known as allelochemicals (Singh and Chaundhary, 2011). Allelochemicals are released from plant parts by means of leaching, root exudation, volatilization, residue decomposition and other processes in both natural and agricultural systems (Chou, 1990). The allelochemicals can reduce cell division or auxin that induces the growth of shoot and roots (Gholamiet al., 2011). Allelochemicals such as phenolic compounds inhibit root and shoot length (Hussain and Reigosa, 2011). Growth inhibition caused by
these allelochemicals may probably be due to its interference with the plant growth processes (Gholami et al., 2011). Allelochemicals released to the environment can either inhibit shoot and/or root growth, nutrient uptake, or may attack a naturally occurring symbiotic relationship thereby destroying the plant's source of a nutrient.

Baličević et al. (2015) demonstrated that aromatic plants show allelopathic effect toward germination, root and shoot length and fresh weight of weeds, both inhibitory and stimulatory. The allelopathic effect depended on donor and target species. Dikić (2005) reported inhibitory effect of caraway, dill, basil and coriander on germination of hoary cress (Lepidium draba L.). Dhima et al. (2009) found that water extracts of aboveground mass of basil, coriander and oregano reduced germination and growth of barnyardgrass (Echinochloa crus-galli [L.] PB.), while in field experiments reduced plant number of different weed species when incorporated as green manure.

Understanding well the mechanism of allelopathic interactions between aromatic plants and crops will enable to come up with proper and effective management of the agricultural ecosystem. Considering the economic importance of paeoeaceous crops, these studies were carried out to investigate the allelopathic effects of sweet basil (Ocimum basilicum L.), on seed germination and seedling growth of some paeoeaceous crops, particularly sorghum (Sorghum bicolor [L.] Moench), millet (Pennisetum glaucum [L.] R. Br.), maize (Zea mays L.) and wheat (Triticum vulgare L.).

II. MATERIALS AND METHODS

2.1. Experimental site

A series of experiment was carried out at Faculty of Agricultural Sciences (FAS), University of Gezira (UoGF), Sudan, comprised germination test and pot experiments. The germination test was conducted in the biology laboratory having an average temperature range of 25 - 30°C and the relative humidity ranging from 60 to 70%. The pot experiment was conducted in a greenhouse of horticulture nursery under field conditions. The experimental site was located at Latitude 14° 24' N, Longitude 33° 29' E and 407m asl. The climate of the region is semi-desert with a mean annual precipitation of 100-250 mm/year, with the rainy season extended from June to October and the dry season from March to June. The mean annual evapotranspiration is 2400 mm/year. The mean annual minimum and maximum temperatures are 12°C in January and 42°C in May, respectively. The soil of the area is characterized by heavy clay soil (clay 60%), with pH 8-8.5, low organic matter and nitrogen, adequate potassium and low available phosphorous (Elbasher, 2016).

2.2. Materials collection

Mature plants of sweet basil plants were collected from Experimental Farm of the FAS in season 2014/15. The plants were transferred to the biology laboratory of the FAS. The aboveground parts of plants were collected and then washed with sterilized distill water, air dried on bench for 15 days at room temperature in a dark room to avoid the direct sun light that might cause undesired reactions. The dried aboveground parts were then crushed into powder and kept in brown bottles till used. Certified commercial seeds of sorghum (cv. Tabat), millet (cv. Baladi), maize (cv. Hudeiba I) and wheat (cv. Imam), that have a germination percentage of 95-100% and purity of 100%, were obtained from the central market of Wed Medani city, Gezira state, Sudan. The seeds were surface sterilized by sodium hypochlorite, (NaOCl) 1% (v/v), solution, for 3 min continuously agitated to reduce fungal infection. Subsequently the seeds were washed with sterilized distill water for several times and stored at room temperature till used.

2.3. Laboratory experiments

These experiments were conducted in the biology laboratory to study the allelopathic effects of aqueous extract of aboveground parts of sweet basilon seed germination of sorghum, millet, maize and wheat. Fifty grams of the powder of aboveground parts of sweet basil were placed in a conical flask, sterilized distill water was added to give a volume of 1000 ml and then the flasks were shaken for 24 hours at room temperature (27±3°C) by an orbital shaker (160 rpm). The extracts were drained through double layers of cheese cloth and then through 2 layers of Whatman No-2 filter paper to remove solid material. The filtrate was centrifuged at 3000 rpm for 20 min. The supernatant was collected and filtered through a 0.22 µm membrane filter paper. The stock solution was stored at 4°C until further use. Six concentrations (0, 20, 40, 60, 80 and 100%) of the aqueous extract were prepared from the stock solution. Seeds of sorghum, millet, maize and wheat (100 seeds each) were put on Glass Fiber Filter Paper (GFFP) (Whatman GF/C) placed in a glass Petri-dish (GPD), 9 cm internal diameter (i.d). Each GPD moistened with 20 ml of aqueous extract of aboveground parts of sweet basil, sealed with Parafilm, covered with black polyethylene bag and incubated at 30°C in the dark. The treatments, of each crop, were arranged in completely randomized design with four replicates. The seeds were examined for germination at three days after initial germination for three days.
2.4. Greenhouse experiments

These experiments were conducted at the greenhouse of horticulture nursery to study the allelopathic effects of powder of aboveground parts of sweet basil on seedlings growth of sorghum, millet, maize and wheat. Plastic pots, 10 cm i.d. and 18 cm high with drainage holes at the bottom, were filled with Gezira soil and river silt that at the ratio 1:1, oven dried at 120°C for 48 h and screened to pass a 2-mm sieve. The powder of aboveground parts of sweet basil was incorporated into the soil at rate of 0, 1, 2, 3, 4 and 5% on w/w bases. Five seedsof each crop were sownin pots. The pots were kept weed free, irrigated and then seedlings were thinned to 3 plants per pot, 7 days after emergence. Treatments, for each crop, were arranged in completely randomized design with four replicates. At 30 days after sowing the experiments were terminated and plant height (cm), number of leaves and root length (cm) of crop seedlings were measured as well as seedlings fresh and dry weight (g).

2.5. Statistical analysis

Data were collected and subjected to analysis of variance procedure. Means were separated for significance using Duncan’s Multiple Range Test at p ≤ 0.05. The statistical analysis was done using the Statistical Analysis System software v.9.0 (SAS, 2004).

III. RESULTS

3.1. Laboratory experiments

The results of laboratory experiments showed that the aqueous extract of aboveground parts of sweet basil significantly (P ≤ 0.05) reduced seed germination of the tested poaceous crops compared to the controls (Table 1). The reduction in seed germination increased with concentration of aqueous extract of aboveground parts. The highest seed germination was observed in the corresponding controls. However, the highest concentration (100%) displayed lowest seed germination which was 71.5, 74.3, 58.3 and 67.3% in sorghum, millet, maize and wheat, respectively. Maize seeds were highly affected by the aqueous extract of aboveground parts of sweet basil in comparison to other tested crops.

3.2. Greenhouse experiments

The results of the greenhouse experiments showed that incorporated powder of aboveground parts of sweet basil into the soil significantly (P ≤ 0.05) decreased seedling growth attributes of tested poaceous crops in comparison to the controls (Table 2, 4, 5 and 6).

3.2.1. Effects on plant height

At 30 days after sowing, the highest plant crop seedlings were observed in the control treatments (Table 2). The plant height of sorghum, millet, maize and wheat in the control treatments were 37.5, 30.3, 43.5 and 24.3 cm, respectively. However, increasing the concentration of powder of aboveground parts of sweet basil into the soil exhibited lowest plant height in all tested crops. The powder of aboveground parts of sweet basil when incorporated into the soil at rate of 1 to 5% decreased the plant height of poaceous crops in comparison to control treatments (Table 2). Moreover, the reduction in the plant height was increased as powder of aboveground parts increased in the soil. The greatest reduction in plant height was observed when powder of aboveground parts was incorporated into the soil at the rate of 5%. At high concentration of powder of aboveground parts, the plant heights were significantly (P ≤ 0.05) decreased to 31.3 cm in sorghum, 15.0 cm in millet, 35.8 cm maize and 10.8 cm in wheat seedlings.

3.2.2. Effects on number of leaves

At 30 days after sowing, the results showed that incorporated powder of aboveground parts of sweet basil into the soil at rate of 1, 2, 3, 4 and 5% negatively affected the leaves number of seedlings of all tested crops compared to the control treatments (Table 3). The highest leaves numbers of crop seedlings were obtained in the control treatments. The leaves number of sorghum, millet, maize and wheat in the control treatments were 6.8, 7.5, 7.0 and 6.0, respectively (Table 3). Incorporating powder of aboveground parts of sweet basil into soil at the rate of 3% or more significantly (P ≤ 0.05) reduced leaves number of seedlings of millet in comparison to the control treatments. While, significant reduction in leaves number of seedlings of maize and wheat were obtained as powder of aboveground parts incorporated into soil at the rate of 5%. However, sorghum seeds were not significantly affected by incorporated powder of aboveground parts of sweet basil into the soil at rate of 1 to 5% in comparison to other tested crops.

3.2.3. Effects on root length

Incorporation of powder of aboveground parts of sweet basil into the soil significantly (P ≤ 0.05) reduced root length of seedlings of all tested poaceous crops (Table 4). The reduction in root lengths was increased with concentration of powder of aboveground parts in the soil. At 30 days after sowing, the longest root lengths of crop seedlings were observed in the control treatments and amounted to 21.0, 25.8, 20.3 and 15.8 cm in sorghum, millet, maize and wheat, respectively. The root length was decreased to
studied the allelopathic effect of basil (Ocimum basilicum) on germination and early growth of weeds under laboratory conditions and found that basil reduced germination of hoary cress from 13.8 to 27%. These effects of basil powder were possibly due to the release of allelochemicals after decaying (Chou and Patrick, 1976).

This study indicated that incorporating powder of aboveground parts of sweet basil into the soil at rate of 1, 2, 3, 4 and 5% (w/w) significantly decreased plant height, number of leaves per seedling, root length of crop seedlings as well as plant fresh and dry weight. In addition, the reduction in seedling growth was increased as seed powder increased in the soil. These results are in lined with the findings reported by Đikić (2005) and Dhima et al. (2009). The study pertains to the exploration of the phytotoxic (allelopathic) potential of aqueous extracts derived from leaf, root and seeds of Ocimum on some commercially important agricultural crops like wheat, gram lentil, mustard, barley, okra and pea, in terms of seed germination, root and shoot elongation. The inhibitory effect was exhibited by all the extracts with maximum in leaf followed by root and seed extract (Vermel, 2012). Bakićević et al. (2015) reported that the extracts from dry plant biomass of basil in higher concentration completely (10%) inhibited germination and weed seedling growth of scentless mayweed (Tripleurospermum inodorum[L.] C.H. Schultz). On average, the extracts from dry plant biomass had higher inhibitory effect. Reduction in weed seed emergence and growth was recorded when dry plant residues in rates of 10 and 20 g/kg were incorporated in the soil.

Moreover, the aqueous leaf extract of Basil (Ocimum sanctum L.) plants was prepared in different concentrations and was tested on some legumes like Green gram (Phaseolus radiatus[L]Wilczek), Cow pea (Phaseolus vulgaris(L) Walp), Pigeon pea (Cajanus cajan(L).), Chickpea (Cicer arietinum L.), Black gram (Phaseolus mungo(L.) Heeper) and Moth bean (Phaseolus acutifoliusJacq.). Some concentrations were also used to see the effect on Dichanthium annulatumL., Chloris barbata L., Acalypha indica L. and Amaranthus spinosus L. The study was conducted at laboratory condition to see the effect of extracts on seed germination and seedling growth. The objective of the study was to find out suitable concentration which inhibits weed germination but not of legume crops. The study showed that Basil had differential effects on each legume at different concentration. Based on results supported by different studies, it was concluded that sweet basil has allelopathic
affects on seed germination and seedling growth of the tested poaceous crops (Purohit and Pandya, 2013).

V. CONCLUSION

- The aqueous extract of the aboveground parts of sweet basil, significantly, reduced seed germination of the poaceous crops: sorghum, millet, maize and wheat.
- Incorporating powder of the aboveground parts of sweet basil into the soil, significantly, decreased plant height, number of leaves and root length of crop seedlings as well as seedlings fresh and dry weight of all tested crops.
- The reduction in seedling growth was increased as seed powder increased in the soil.
- Sweet basil has allelopathic effects on seed germination and seedling growth of the tested poaceous crops.
- More studies related to the effects of sweet basil allelochemicals over cultivated plants and other weed plants are required.

REFERENCES

[1] Albuguerque, U. (1996). Taxonomy and ethnobotany of the genus Ocimum. Federal Univ. Pernambuco.
[2] Angers, P., M.R. Morales, and J.E. Simon. (1996). Fatty acid variation in seed oil among Ocimum species. J. Am. Oil Chem. Soc. 73:393–395.
[3] Baričević, R., Ravlić, M. and Ravlić, I. (2015). Allelopathic Effect of aromatic and medicinal plants on Tripleurospermumidorum (L.) C. H. Herbologia, 15 (2): 2, 41-53.
[4] Chou, C. H. (1990). The role of allelopathy in agroecosystems: Studies from tropical Taiwan. In: Gliessman S. R. (ed) 1990. Agroecology: Researching the ecological basis for sustainable agriculture. Ecological studies 1978. Springer - Verlag. Berlin, 105-121.
[5] Chou, C. H. and Patrick, Z. A. (1976). Identification and phytotoxic activity of compounds produced during decomposition of corn and rye residues in soil. J. Chern. Ecal. 2: 369 387.
[6] Delabays, N., Mermillod G., De Joffrey, J. P. and Bohren, C. (2004). Demonstration, in cultivated fields, of the reality of the phenomenon of Allelopathy. XII. International conference on weed biology, 97-104.
[7] Dhima, K. V., Vasilakoglou, I. B., Gatsis, Th. D., Panou-Philoteou, E. and Eleftherohorinos, I. G. (2009). Effects of aromatic plants incorporated as green manure on weed and maize development. Field Crops Research, 110: 235–241.
[8] Dikić, M. (2005): Allelopathic effect of cogermination of aromatic and medicinal plants and weed seeds. Herbologia, 6 (1): 15-24.
[9] Elbasher, O. A. (2016). Vermination of climate changes using rainfall and temperature as indicators and its impacts on agricultural production in the arid zone of Sudan (1981-210). Ph.D Thesis, University of Gezira, Sudan.
[10] Gholami, B. A.; Faravani, M. and Kashki, M. T. (2011). Allelopathic effects of aqueous extract from Artemisia kopeidaghensis and Saturejahortensia growth and seed germination of weeds. Journal of Applied Environmental and Biological Sciences, 1(9): 283-290.
[11] Hussain, I. M. and Reigosa, M. J. (2011). Allelochemical stress inhibits growth, leaf water relations, PSII photochemistry, non-chemical fluorescence quenching, and heat energy dissipation in three C3 perennial species. Journal of Experimental Botany, 62(13): 4533-4545.
[12] Morales, M. R. and Simon, J. E. (1996). New basil selections with compact inflorescence for the ornamental market. p. 543–546. In: Janick, J. E. (ed.), Progress in new crops. ASHS Press, Alexandria, VA.
[13] Morales, M. R., Charles, D. J. and Simon, J. E. (1993). New aromatic lemon basil germplasm. p. 632–635. In: Janick, J. and Simon, J. E. (eds.), New crops. Wiley, New York.
[14] Paton, A. (1992). A synopsis of Ocimum L. (Labiatae) in Africa. Kew Bul. 47:403–435.
[15] Purohit, Sh. and Pandya, N. (2013). Allelopathic activity of Ocimum sanctum L. And Tephrosiapurpurea(L.) Pers. Leaf extracts on few common legumes and weeds. International Journal of Research in Plant Science, 3(1): 5-9.
[16] Sharmal, S. D. and Singh, M. (2003). Allelopathic Effect of Basil (Ocymumsanctum) Materials on the Germination of Certain Weed Seeds. Indian J. WeedSci. 36 (1 and 2): 99-103.
[17] Simon, J. E., Chadwick, A. F. and Craker, L. E. (1984). Herbs: An indexed bibliography 1971–1980. Archon Books, Hamden. p. 7–9.
[18] Simon, J. E., Quinn, J. and Murray, R.G. (1990). Basil: a source of essential oils. p. 484–489. In: Janick, J. and Simon, J. E. (eds.), Advances in new crops. Timber Press, Portland, OR.
[19] Singh, P. A. and Chaudhary, B. R. (2011). Allelopathic potential of algae weed Pithophoraoedogonia (Mont.) ittrock on the germination and seedling growth of
Oryza sativa L. Botany Research International, 4(2): 36-40.

[20] Verma, S.K., Kumar, S., Pandey, V., Verma, R. K. and Patra, D. D. (2012). Phytotoxic effects of sweet basil (Ocimum basilicum L.) extracts on germination and seedling growth of commercial crop plants. European Journal of Experimental Biology, (6):2310-2316.

**Table 1:** Allelopathic effects of aqueous extract of aboveground parts of sweet basil on seed germination of some poaceous crops

| Concentration extracts (w/v) | Sorghum | Millet | Maize | Wheat |
|-----------------------------|---------|--------|-------|-------|
| 0%                          | 97.3 a  | 98.8 a | 96.5 a | 94.5 a |
| 20%                         | 92.5 b  | 97.8 a | 92.5 a | 91.3 a |
| 40%                         | 89.3bc  | 94.0ab | 81.3 b | 81.3 b |
| 60%                         | 86.3 c  | 89.8bc | 77.5bc | 72.0 c |
| 80%                         | 81.5 d  | 85.0 c | 76.3 c | 63.0 d |
| 100%                        | 71.5 e  | 74.3 d | 58.3 d | 67.3 e |

SE± 1.45 CV% 3.4

* Means in the same column followed by the same letter(s) are not significantly different according to Duncan’s Multiple Range Test (P ≤ 0.05).

**Table 2:** Allelopathic effects of incorporated powder of aboveground parts of sweet basil into soil on plant height of some poaceous crops

| Concentration the powder (w/w) | Sorghum | Millet | Maize | Wheat |
|--------------------------------|---------|--------|-------|-------|
| 0 %                            | 37.5 a  | 30.3 a | 43.5 a | 24.3 a |
| 1 %                            | 37.0 a  | 25.0 b | 39.0 b | 23.8 a |
| 2 %                            | 36.5 a  | 22.0 c | 37.3 b | 22.5 a |
| 3 %                            | 35.8ab  | 21.3 c | 36.8 b | 16.8 b |
| 4 %                            | 33.8 b  | 17.3 d | 36.0 b | 11.8 c |
| 5 %                            | 31.3 c  | 15.0 e | 35.8 b | 10.8 c |

SE± 0.81 CV% 4.5

* Means in the same column followed by the same letter(s) are not significantly different according to Duncan’s Multiple Range Test (P ≤ 0.05).

**Table 3:** Allelopathic effects of incorporated powder of aboveground parts of sweet basil into soil on number of leaves of some poaceous crops

| Concentration the powder (w/w) | Sorghum | Millet | Maize | Wheat |
|--------------------------------|---------|--------|-------|-------|
| 0 %                            | 6.8 a   | 7.5 a  | 7.0 a | 6.0 a |
| 1 %                            | 6.0 a   | 7.5 a  | 7.0 a | 5.8ab |
| 2 %                            | 6.0 a   | 7.0ab  | 6.3ab | 5.5ab |
| 3 %                            | 5.8 a   | 6.0bc  | 6.3ab | 5.3ab |
| 4 %                            | 5.5 a   | 5.0 c  | 5.5ab | 4.8ab |
| 5 %                            | 5.3 a   | 5.0 c  | 5.0 b | 4.3 b |

SE± 0.46 CV% 15.7

* Means in the same column followed by the same letter(s) are not significantly different according to Duncan’s Multiple Range Test (P ≤ 0.05).
Table 4: Allelopathic effects of incorporated powder of aboveground parts of sweet basil into soil on seedlings root length of some poaceous crops

| Concentration the powder (w/w) | Sorghum | Millet | Maize | Wheat |
|-------------------------------|---------|--------|-------|-------|
| 0 %                           | 21.0 a  | 25.8 a | 20.3 a| 15.8 a|
| 1 %                           | 17.8 b  | 22.5 b | 19.8ab| 15.5 a|
| 2 %                           | 15.8 c  | 18.8 c | 17.8bc| 13.8ab|
| 3 %                           | 14.0 cd | 17.8 cd| 16.8 cd| 12.0bc|
| 4 %                           | 12.8 d  | 17.3 cd| 16.5 cd| 10.5 c|
| 5 %                           | 10.3 e  | 15.5 d | 15.3 d | 7.8 d |
| SE±                           | 0.64    | 0.87   | 0.67  | 0.73  |
| CV%                           | 8.3     | 8.9    | 7.6   | 11.6  |

* Means in the same column followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test (P ≤ 0.05).

Table 5: Allelopathic effects of incorporated powder of aboveground parts of sweet basil into soil on seedlings fresh weight of some poaceous crops

| Concentration the powder (w/w) | Sorghum | Millet | Maize | Wheat |
|-------------------------------|---------|--------|-------|-------|
| 0 %                           | 12.7 a  | 10.4 a | 14.4 a| 8.3 a |
| 1 %                           | 12.1 a  | 10.2 a | 14.3 a| 8.3 a |
| 2 %                           | 10.6 b  | 8.1 b  | 12.3 b| 6.2 b |
| 3 %                           | 8.2 c   | 8.1 b  | 12.3 b| 6.1 b |
| 4 %                           | 7.1 d   | 6.2 c  | 11.3 c| 5.2 c |
| 5 %                           | 6.2 e   | 5.2 d  | 9.3 d | 4.3 d |
| SE±                           | 0.20    | 0.13   | 0.21  | 0.13  |
| CV%                           | 4.1     | 3.2    | 3.4   | 4.0   |

* Means in the same column followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test (P ≤ 0.05).

Table 6: Allelopathic effects of incorporated powder of aboveground parts of sweet basil into soil on seedlings dry weight of some poaceous crops

| Concentration the powder (w/w) | Sorghum | Millet | Maize | Wheat |
|-------------------------------|---------|--------|-------|-------|
| 0 %                           | 3.9 a   | 2.4 a  | 3.2 a | 1.9 a |
| 1 %                           | 3.7 a   | 2.3 a  | 3.2 a | 1.7ab |
| 2 %                           | 3.0 b   | 2.0 b  | 3.1 a | 1.6bc |
| 3 %                           | 1.8 c   | 1.5 c  | 2.7 b | 1.3 cd|
| 4 %                           | 1.4 d   | 1.3 cd | 2.4 c | 1.2 d |
| 5 %                           | 1.1 e   | 1.1 d  | 2.2 c | 0.8 e |
| SE±                           | 0.11    | 0.08   | 0.08  | 0.08  |
| CV%                           | 8.7     | 9.3    | 5.4   | 11.1  |

* Means in the same column followed by the same letter(s) are not significantly different according to Duncan's Multiple Range Test (P ≤ 0.05).