Allelopathic Effect of (*Sorghum bicolor L.)* on Radish (*Raphanus sativus L.)* Growth Characters

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ABSTRACT---- ***A pot experiment was carried out to study the effect of sorghum residue on germination and some growth characters of radish. The experiment comprised of four treatments where the soil was incorporated with sorghum residue powder at 2, 2.5, 3 and 3.5%(w/w) for treatments T_2, T_3, T_4 and T_5, respectively, the control was free of sorghum residue. Results indicated that an increase was observed at low concentration of sorghum residue in germination, growth characters, but a decrease was detected in chlorophyll content and some elements (Na,Ca, K, P,) content in radish incorporated with sorghum residue.***

Keywords---- Allelopathy, chemical constituents, chlorophyll, germination, radish, yield

1. INTRODUCTION

The plants growing together interact with each other through direct or indirect allelopathic effects on growth of each other through releasing compounds known as allelochemicals [1, 2]. Allelochemicals released from plants affect other plants mainly at their germination and seedling growth stages [3]. Harmful effects of decomposing weeds residue on emergence and growth of crops have also been documented [4, 5].

Information relating to allelopathic action of the plant leachates and decomposition products of some crops on succeeding radish crop is not available. The present work was carried out to study the effect of *Sorghum bicolor* L. on the germination and some physiological characters of radish (*Raphanus sativus* L.).

2. MATERIALS AND METHODS

Plant material:

The sorghum plants were collected from the farm of the Faculty of Agriculture, University of Khartoum. The plants were uprooted at maturity then washed thoroughly with distilled water and dried at room temperature (25^{o}C) for 96 hours. The plants then were chopped and ground into fine powder with mortar.

The soil used in the experiment was collected from the field where radish was cultivated.

Pot experiment:

A pot experiment was set up in plastic pots (27 × 18cm) and arranged in a completely randomized design with three replications. The experiment was conducted to study the allelopathic effect of sorghum on radish germination and some growth characters. Five treatments were used; the first treatment was the control, where the infested soil with weeds frees of sorghum residue. In the second, third, fourth and fifth treatments the soil was incorporated with 20, 25, 30 and 35 g for sorghum residue, representing 2, 2.5, 3 and 3.5% (w/w residue/soil) respectively. Ten seeds of radish plant were sown in each pot, then thinned to two homogenous radish seedlings. The plants were irrigated daily with tap water. During the experiment some growth parameters of radish were recorded including, plant height, number of leaves, and leaf area. The shoot and root fresh and dry weight were taken at the end of the experiment. Parts of radish shoot were used to determine Na, Ca, K, and P percentage.

The data of the experiment were subjected to analysis of variance (ANOVA) according to [6].

3. RESULTS AND DISCUSSION

Table (1) showed a small increase in germination percentage of radish but these differences were not significant. The increase in germination reached 2.90 at T_3 (2.5% w/w),, then a decrease was observed at higher concentrations of sorghum residue. Similar results reported by [7] who reported that stimulation in pea growth parameters was noticed by increasing the rate of the incorporated the leaf residue of *Acacia nilotica* from 0.25 to 0.5% (w/w), but a gradual suppression at 1.5 to 2% (w/w). In this respect [8] reported that crops containing allelochemicals in smaller amounts usually promote

growth of other plants. On the other hand, [9] found that sunhemp ground dried residues inhibit germination of various vegetables and cover crops.

The shoot length of radish showed an increase from 16.86 at control to 21.55cm at T_2 (2%, w/w) and 24.87cm at T_3 (2.5%, w/w) then a decrease was observed at T_4 (3%, w/w) and T_5 (3.5%, w/w). These results were supported by the results of [10] who observed the inhibitory allelopathic effect of soil incorporated residues of *Hordeum spontaneum* on seedling length and dry weight of *Triticum aestivum*. In this connection [11] found that the seedling length and weight of *Oryza sativa* was suppressed by residues of *Cyperus irria* in soil. Regarding the number of leaves and leaf area (Table 1), they increase from control up to treatment T_3 (2.5%, w/w), then a decrease was observed at T_4 (3%) and $T_5$3.5% (w/w).

Table (1): Allelopathic effect of sorghum residue powder on germination, shoot length, number of leaves and leaf area of sunflower.

Treatments	Germination (%)	Shoot length (cm)	Number of leaves	Leaf area (cm^2)
T_1 (Control)	2.33	16.86	6.75	72.90
T_2 (2% w/w)	2.66	21.55	8.20	127.30
T_3 (2.5% w/w)	2.90	24.87	9.20	139.03
T_4 (3% w/w)	2.66	24.66	8.10	122.00
T_5 (3.5% w/w)	2.60	19.00	7.30	67.16
LSD	1.68	4.10	1.84	28.27

Table (2) indicated an increase in shoot fresh and dry weight of radish. The increase from control 48.80 g, to 89.60 g and from 8.70 to 16.80 g at T_2 2% (w/w), for shoot fresh and dry weight of radish respectively. The highest increment in shoot fresh and dry weight was attained at treatment T_3 2.5% (w/w) 97.00 and 18.10 for fresh and dry weight respectively. A decrease was observed at higher concentration of sorghum residue at T_4 3% and T_5 3.5% (w/w). Similar results were reported by [12] who found that the shoot fresh and dry weight of *Triticum aestivum* was significantly affected by soil in corporation of *Cassia angustifolia*. Also [13] found that the dry weight of barley and wheat seedlings was reduced by the walnut allelochemical juglone. The bulb length, diameter and weight have similar trend as shoot fresh and dry weight. The bulb length increase from control up to T_2 2% and T_3 2.5% (w/w), then decreased at T_4 3% and T_5 3.5% (w/w). The bulb diameter increased from 0.52 at control to 0.97 and 1.16 at T_2 and T_3 respectively, then decreased to 0.95 and 0.67 at T_4 3% and T_5 3.5% (w/w) respectively. The highest increase in bulb weight was observed at T_3 2.5% (w/w) and the lowest weight was observed at control. Similar results were reported by [14] who found an increased in shoot growth parameters of corn when using lower level of Eucalyptus residue.

The suppression in fresh and dry weight of radish may be attributed to the decrease in shoot length and bulb length of seedlings which was induced by the allelochemicals found in sorghum residue. These phyto-chemicals may decrease the water and nutrient absorption through roots and consequently affect plant processes such as photosynthesis, respiration and the whole plant growth.

The chlorophyll content (a, b) decreased significantly as the concentra-tion of sorghum residue increase (Table 2). Similar results were reported by [15] who reported that the total chlorophyll content and consequently the soluble sugar content of maize and kidney bean were reduced due the application of Eucalyptus leaf leachates. The results of this study were supported by the finding of [14] who reported that a reduction was observed in chlorophyll content of corn treated with *Eucalyptus rostrata* leaf residue. The reduction in chlorophyll content may be due to the allelochemicals which induce inhibition of chlorophyll biosynthesis, the stimulation of chlorophyll degrading substances or both [16].

Table (2): Allopathic effect of sorghum residue on shoot fresh and dry weight, bulb length, bulb diameter, bulb weight and chlorophyll content of radish.

Treatments	Shoot fresh weight (g)	Shoot dry weight (g)	Bulb length (cm)	Bulb diameter (cm)	Bulb weight (g)	Chlorophyll	
						(a)	(b)
T_1 (Control)	48.80	8.70	9.50	0.52	4.20	14.79	4.83
T_2 (2% w/w)	89.60	16.80	12.75	0.97	12.60	13.79	4.80
T_3 (2.5% w/w)	97.00	18.10	13.50	1.16	19.20	12.96	4.68
T_4 (3% w/w)	64.96	10.05	10.10	0.95	12.40	11.34	4.31
T_5 (3.5% w/w)	54.20	7.00	10.00	0.67	7.40	9.62	4.31
LSD	37.97	9.26	2.91	0.59	9.16	0.00	0.00

Table (3) showed a decrease in Na and P as the concentration increased. Some investigators reported similar results as concerning phosphorus [17, 18]. However the calcium content increased at T_2, 2% (w/w) then decreased at other concentration of sorghum residue. As concerning potassium, an increase was observed at T_2 2% (w/w) followed by a decrease at T_3, T_4 and T_5. The reduction in these elements may be attributed to the interference of allelochemical with uptake and assimilation of these elements.

Table (3): Allelopathic effect of sorghum residue on some elements of radish plant.

Treatments	Na (%)	Ca (%)	K (%)	P (%)
T_1 (Control)	1.36	2.62	7.49	2.73
T_2 (2% w/w)	1.14	4.56	8.94	2.35
T_3 (2.5% w/w)	0.96	2.66	7.00	2.03
T_4 (3% w/w)	0.97	2.64	8.45	2.35
T_5 (3.5% w/w)	1.01	2.36	7.36	2.31
LSD	0.15	0.14	0.38	0.16

4. CONCLUSION

The results of this study showed that sorghum residue in low concentration can promote the growth of radish, but in higher concentration inhibit the growth. Fields studies are necessary to evaluate the allelopathic effect of sorghum residue in crop rotation and preceding crops.

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6. REFERENCES

[1] Kumar, Lakiang, J.J. and Gopich, B. (2006). Phytotoxic effects of agro-forestry free crops on germination and radicle growth of some food crops Myzoram, Lyonia, 11(2): 83-89.

[2] Batish, D.K., Singh, H.P., Kohli, R.K. and Kaur, S. (2008). Euclyptus essential oil as natural pesticides. Forest Ecology and Management, 256(12): 21662,174.

[3] Oyerinde, R.O., Otusanya, O.O. and Akpr, O.B. (2009). Allelopathic effect of *Tithonia diversifolia* on germination, growth and chlorophyll content of maize (*Zea mays* L.). Sci. Res. Essay 4(12): 1553-1558.

[4] Singh, H., Batish, D.R., Kaur, s, Arora, K. and Kohli, RK. (2006). Pineae inhibit growth and induces oxidative stress in roots. Ann. Bot., 98: 1261-1269.

[5] Samad, M.A., Rahman, M.M., Mossain, A.K.M.M, Rahman, M.S. andRahman, S.M. (2008). Allelopathic effects of five selected weed species on seed germination and seedling growth of corn. J. Soil Naur, 2(2): 13-18.

[6] Gomez, A.K. and Gomez, A.A. (1984). Statistical procedures for agricultural research. John Willey and Sons, inc. Canada.

[7] Abu El-Soud, W.H. (2001). Allelopathic potential of *Acacia nilotica* tree leaves on the metabolic changes of pea (*Pisum sativum*). M.Sc. thesis, Faculty of Science, Cairo, University of Egypt.

[8] Cheema, Z.A. (1988). Weed control in wheat through sorghum allelo-chemicals, Ph.D. Thesis, Agronomy Department, University of Agriculture, Faisalabad, Pakistan.

[9] Skinner, E.M., Draz-Perez, J.C., Phatak, S.C, Schmberg, H.A. and Vencil, W. (2012). Allelopathic effect of sunnhemp (*Crotalaria juncea* L.) on germination of vegetables and weeds. Hort. Science, 47(1): 138-142.

[10] Hamidi, R., Mazaheri, D., Rahimian, H., Alizadeh, H.M., Ghadiriand, H and Zeinals, H. (2008). Phytotoxicity effects of soil amended residues of wild barley (*Hordeum spontaneum* Koch) on growth and yield of wheat (*Triticum aestivum* L.). Desert, 13(1): 1-7.

[11] Ismail, B.S. and Siddique, M.A.B. (2011). The inhibitory effect of grass hopper cyperus (*Cyperus iria* L.) on the seedling growth of five Malaysian rice varieties. Trop. Life Sci. Res., 22(1): 81-89.

[12] Hussain, S., Siddique, S.U., Khalid, S., Jamal, A., Qayyum, A. and Ahmed, Z. (2007). Allelopathic potential of senna (*Cassia angustifolia* Vahl.) on germination and seedling characters of some major cereal crops and their associated grassy weeds. Pak J. Bot., 39(4): 1145-1153.

[13] Terzi, I. and Kocacaliskan, I. (2010). The effect of giberellic acid and kinetin on overcoming the effects of juglone stress on seed germination and seedling growth. Turk. J. Bot., 34: 67-72.

[14] Hegab, M.M., Gabr, M.A, Al Wakeel, SA.M. and Hamed, B.A. (2016). Allelopathic potential of *Eucalyptus rostrata* leaf residue on some metabolic activities of Zea mays L, University Journal of Plant Science, 4(2): 11-21.

[15] El Khawas, S.A. and Shehata, M.M. (2005). The allelopathic potentialities of *Acacia nilotica* and *Eucalyptus rostrat* on monocot (*Zea mays* L.) and Dicot (*Phaseolus vulgaris* L.) plants, Biotechnology 4(1): 23-34.

[16] Yang, C.M., Lee, C.N. and Chouc, H. (2007). Effects of three allelopathic phenolics on chlorophyll accumulation of rice seedling by inhibition of supply orientation. Bot. Bull. Acad. Sinica, 43: 299-304.

[17] Baziramakenga, R., Leroux, GD. And Simard, R.R. (1995). Effects of benzoic and cinnamic acids on membrane permeability of soy bean roots. J. Chem. Ecol., 21: 1271-1285.

[18] Geng, G.D., Zhang, S.Q and Cheng, Z.H. (2009). Effects of different allelochemicals on mineral elements absorption of tomato root. China Veget., 4: 48-51.