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Research Article

ALLELOPATHIC POTENTIAL OF SORGHUM (*Sorghum bicolor* L.) ON SUNFLOWER (*Helianthus annus* 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 sunflower. The experiment was set as a completely randomized design (CRD) with three replications and four treatments. The treatments T2, T3, T4 and T5, the soil was incorporated with sorghum residue powder at (2%, w/w), (2.5%, w/w), (3%, w/w) and (3.5%, w/w) respectively. The control was free from sorghum residue. The results indicated an increase in germination, growth parameters and some elements content at low concentration 2% and 2.5% (w/w), however higher concentration of the residue exhibited an inhibition in the germination and growth parameters.

INTRODUCTION

Weeds have been a persistent problem for agriculture systems because they cause economic losses by reduction in crop yield, and increase cost of crop production [1]. The concerns about negative effects of herbicide use, such as environmental contamination, development of herbicide resistant weeds and human health problems, make it necessary to the diversify of other weed management options [2].

Allelopathy refers to the beneficial or harmful effect of one plant on another plant, both crop and weed species release biochemical known as allelochemicals; from plant parts by leaching, root exudation, volatilization, residue decomposition and other processes in natural and agricultural systems. 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 has been documented [4, 5].

In Sudan grain sorghum is cultivated in a wide area and thus the sunflower cultivated area was increased. Information related to allelopathic action of sorghum residue on succeeding crops is not available; such knowledge may act as a precaution for Sudanese farmers to avoid any deleterious action of some crops present in preceding crop.

This work was conducted to study the allelopathic effect of sorghum residue incorporation in soil on sunflower germination and some growth parameters.

MATERIALS AND METHODS

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 air dried at room temperature (25°C) for 96 hours. The plants then were chopped and ground into powder with mortar.

Soil Materials

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

Pot Experiment

A pot experiment was set up in plastic pots (27 x 28 cm) arranged in completely randomized design with three replicates. The experiment was conducted to determine the allelopathic effect of *Sorghum bicolor* L. on the germination and growth characters of the sunflower. Four treatments were used in addition to the control which is free from sorghum residue. The treatments T_2, T_4 and T_5 the soil was incorporated with 20 ,25, 30 , 35 g , of powdered sorghum residue representing 2.0, 2.5, 3.0 and 3.5% (w/w residue/soil)

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respectively. Ten seeds of sunflower plant were sown in each pot, then thinned to two homogenous seedlings. The plants were irrigated daily with tap water. During the experiment some growth characters of sunflower were recorded at 50 days after sowing. The parameters measured included, shoot length, number of leaves and leaf area. The shoot and root fresh and dry weight were taken at the end of the experiment. Parts of sunflower shoot were used to determine the chlorophyll a and b and some elements (Na, P, K, Ca,) percentages. The results of the experiment were statistically analyzed using analysis of variance (ANOVA) according to [6].

RESULTS AND DISCUSSION

The germination percentage of sunflower exhibited a significant difference between the treatments and control (Table 1). The highest germination percentage (8.00%) was observed at treatment T_3 (2.5%, w/w) and the lowest 4.00% was attained by the control. The additive effect of germination percentage was observed when (2.0% w/w) sorghum residue was used. This increment gradually decreased as the concentration of sorghum residue increased. Similar results were reported by [7] who found a stimulation in pea growth parameters by increasing the rate of the incorporated *Acacia nilotica* leaf residue from 0.25 to 0.5% (w/w), but 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 sunnhemp ground dried residues inhibit germination of various vegetables and cover crops.

The shoot length of sunflower (Table 1) showed an increase from control to treatment T_2 2% (w/w) and treatment T_3 2.5% (w/w), then the shoot length decreased at concentration, 3% (w/w) and 3.5% (w/w) of sorghum residue. Similar results were reported by [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 seedling length and weight of *Oryza sativa* was suppressed by residues of *Cyperus irria* in soil. The root length showed a similar trend as shoot length. A gradual increase in root length was observed from control to treatment T_4 3% (w/w), then a decrease was observed at treatment T_5 3% (w/w). These results were supported by the findings of [7] who found stimulation in pea growth parameters by increasing the rate of incorporated *Acacia nilotica* leaf residue. The increase in shoot and root length and then the decrease at high concentration, can be explained by that, sorghum residue powder in low concentration act as a growth promoter, but in higher concentration (3%) and (3.5%, w/w) act as an inhibitor.

The number of leaves and the leaf area (Table 1) have similar trend as shoot and root length. The number of leaves and leaf area increase from control up to treatment T3 2.5% (w/w), then decrease at treatment T4 (3% w/w) and treatment T_5 (3.5%, w/w).As shown in Table (2) the shoot fresh weight of sunflower increased from control (6.81) up to (12.60) at treatment T_3 (2.5%, w/w) then decreased to (12.21) 11.70 at T_4 (3%, w/w) and T_5 (3.5%, w/w) respectively. The shoot dry weight increased from 2.30 to 3.67 then decreased at T_4(3%) and T_5(3.5%).In this respect, [12] reported that the shoot fresh and dry weight of *Triticum aestivum* was significantly affected by soil incorporation of *Cassia angustifolia*. [13] found that the dry weight of barley and wheat seedlings was reduced by the walnut allelochemical juglone. The root fresh and dry weight increased from control up to treatment T_3 (2.5%, w/w), then decreased at treatment T_4 (3%, w/w) and T_5 (3.5%, w/w). The decreases in root fresh and dry weight were also reported by [12]. Similar results were reported by [14] who found an increase in shoot growth parameters of corn when using lower level of Eucalyptus residue.

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

Treatments	Germination (%)	Shoot length (cm)	Root length (cm)	Number of leaves	Leaf area (cm^2)
T_1 (Control)	4.00	33.56	6.00	33.50	15.80
T_2 (2% w/w)	6.64	43.85	7.00	43.83	33.40
T_3 (2.5% w/w)	8.00	44.30	8.67	44.80	35.48
T_4 (3% w/w)	6.64	41.80	9.87	41.30	33.30
T_5 (3.5% w/w)	5.20	36.60	9.40	38.70	30.00
LSD	0.01	7.70	2.39	6.86	8.76

Table 2 Allopathic effect of sorghum residue powder on shoot fresh weight, shoot dry weight, root fresh weight and root dry weight, and chlorophyll content of sunflower

Treatments	Shoot fresh weight (g)	Shoot dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Chlorophy ll (a)	Chlorop hyll (b)
T_1 (Control)	6.81	2.30	0.97	0.62	22.07	6.80
T_2 (2% w/w)	11.67	3.56	1.60	0.72	14.90	4.28
T_3 (2.5% w/w)	12.60	3.67	2.40	0.78	15.75	5.44
T_4 (3% w/w)	12.21	2.91	1.99	0.72	17.81	5.96
T_5 (3.5% w/w)	11.70	2.40	1.66	0.70	17.24	5.50
LSD	5.95	1.63	0.00	0.53	0.008	0.18

The suppression in fresh and dry weight of sunflower may be attributed to the decreased in root and shoot length of seedlings which was induced by the allelochemicals found in sorghum residue. The phytochemicals which was released by the sorghum residue may decrease the water and nutrient absorption through roots and consequently affect plant processes such as photosynthesis and respiration and the whole growth.

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

Table (3) showed an increase in sodium (Na) and calcium (Ca) content in treatments compared with control. On contrast, the data expressed a decrease in phosphorus P content in the treatments compared with control. These results are in agreement with the findings of [17], who found that the dibutylphthalate inhibits the absorption of P by tomato roots. Similar results were reported by [18] who found that higher levels of Eucalyptus allelochemicals (1 and 2%) reduced the amount of phosphorus fraction, possibly due to their interference with uptake and assimilation,

Table 3 Allelopathic effect of sorghum residue powder on some elements of sunflower

Treatments	Na (mg/kg)	P (mg/kg)	K	Ca (mg/kg)
T_1 (Control)	439	426	18700	28800
T_2 (2% w/w)	1239	390	66100	14400
T_3 (2.5% w/w)	679	424	88500	15800
T_4 (3% w/w)	859	414	65400	14400
T_5 (3.5% w/w)	1979	422	93500	10.00
LSD	1.81	1.81	2.78	0.33

CONCLUSION

The results of this study showed that sorghum residue in low concentration can promote the growth of sunflower, but higher concentration inhibits the growth. Field studies are needed to evaluate the allelopathic role of sorghum residue in rotation and the preceding crops.

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