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Allopathic effect of (*Tagetes erecta* L.) and (*Sorghum halepense*) on Growth and Productivity of *Phaseolus vulgaris* L.

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ABSTRACT

The study was carried out to evaluation of effect of the shoot and root residues of (*Tageteserecta* L.) and (*Sorghum halepense*) on the growth and Productivity of green beans. The results showed that there was a difference between the stimulation and inhibition of the root and vegetative residues of the (*Tagetes erecta* L.) and (*Sorghum halepense*). The laboratory results showed that the aqueous extractof the root and shoot of the (*Tagetes erecta* L.) plant were superior in germination rate, germination speed, length of the root and the length of the shoot of green bean seeds. The results were better for the root part, where the concentration was recorded at 10%, the highest germination rate 100%, the germination speed 1. Also the results showed that the green bean seeds were treated with the aqueous extractof the root and Shoot parts of the ((*Sorghum halepense*)) plant significantly reductions on the same parameters were studied. In the field experiment, the root residues of the (*Tageteserecta* L.) plant showed 16 g / kg soil significantly higher than the Shoot residues in the studied traits (number of root nodes, plant height (cm), leaf area (dm^2), dry weight of vegetative (g), Number of secondary branches, diameter of stem (mm), concentration of chlorophyll in leaves (mg/g), dry weight of root (g), date of flowering (day), total number of flowers, nodes ratio and first harvesting time.

Key words : *Allopathic, Aqueous extract, (Tagete serecta L.), (Sorghum halepense)*

Introduction

Green beans (*Phaseolus vulgaris* L.) are one important legume plant that belong to Leguminosae, and have high nutritional and medicinal properties. They are a major and inexpensive source of protein with 12% of dry weight in the legume (Hanafy *et al*., 2010). Furthermore, it is also rich in carbohydrates, vitamins and fiber, and has an important role in building the human body, reduce the level of cholesterol in the blood, reduce constipation and reduce the risk of colon cancer. Moreover, it contains some minerals such as iron twice the amount compared to spinach, as well as magnesium, calcium, phosphorus, potassium, copper, zinc, vitamins, flavonoids and carotenoids. Allelopathy is an important mechanism of action occurring among plants as a result of the addition of chemical allelopathic substances to the environment.Allelopathic compounds were found in plant tissues and released in appropriate conditions in sufficient quantities to affect neighboring plants (Rice, 1984). These allelopathic chemicals may be phytotoxins or autotoxins that affect the same secreted plants or affect other plants nearby or followed by agriculture (Al-Juheishy, 2005). Several studies have been shown that these released compounds are with a phenolic nature (*Minkel and Kirby*, 1984). Mirry (2013) observed that

Increasing the aqueous extracts of maize to 100% decreased the plant content of soluble carbohydrate, chlorophyll a, chlorophyll b, protein in wheat, and broad bean. In the same way Hafidh and Redah (2010) found that allelopathic secretions of rice had a significant inhibitory effect on the seed germination rate of wheat varieties includingMaxiback and Saberpic, as well as effect on the length of radicle and plumule, and dry weight for both. Additionally, it was found that using of sunflower plant residues at concentrations of 3 and 6 g/kg soil reduced the percentage of wheat and barley germination (Lahmod *et al*., 2014). Moreover, Zewain *et al*., 2012. revealed that the soil treatment with rice residues has an inhibitory effect on the growth via reducing the height of the plant,number of leaves, number of branches and dry weight of the root and shootsystem..In addition, it was found that there was a significant reduction in chlorophyll content in soybean plants treated with aqueous extracts of velvet leaves (Cotton and Einhelling, 1980), and also in rice seedlings that treated with three phenolic compounds (Yang *et al*., 2002). Through a comprehensive review of the number of researches carried out in the field of allelopathy, we note the multiplication of these studies several times and then to continue by scientists in physiology, plant, soil, weeds and natural products chemistry.

The continued emergence of additional information on the mechanisms of influence of allelopathic compounds in terms of selectivity, excretion, continuity, and genetic regulatory mechanisms poses a continuing challenge for botanists todevelop modern strategies that enhance the protection of biodiversity (Macias *et al.,* 2002). Based on the above, this study was designed to detect the allopathic effect of *Tageteserecta* and *Sorghum halepense*plants on the germination, and some growth indicators of green beans plant (*Phaseolus vulgaris* L.).

Material and Methods

Two experiments were carried out to detect the allelopathic potential of *Tageteserecta* L. and *Sorghum halepense* on the growth and productivity of the green bean crop (*Phaseolus vulgaris* L.). The first experiment was conducted in the laboratories at College of Basic Education/ Al-Mustansiriya University, while the second experiment was concoctedin the plastic house of the Agricultural Research Department/the Ministry of Science and Technology. Seeds were obtained from local markets in Baghdad. *Tageteserecta* L. residue was collected from the botanical garden at the Ministry of Agriculture, while *Sorghum halepense*residue collected from one of the fields in Al-Twaitha. The shoot and root system were cleaned separately to get rid of dust and suspended materials, then cut and dried in the sun for three days, and after that the drying was done also in the electric oven at 70 °C degrees for 48 hours and left until the weight is established. Subsequently, the residue is ground by electric grinder for fine powder which was then kept in clean bag in the refrigerator until use.

Laboratory experiment

The aqueous extract of shoot and root system residue of *Tageteserecta* L. and *Sorghum halepense*was prepared by placing 40 g of powder in a 500 mL glass jar containing 200 mL of water. The mixture placed on the rotor using magnetic stirrer for 2 hours. Then the mixture left for 24 hours under laboratory conditions. The mixture was filtered using the gauze to get rid of the large suspended materials, and then re-filter using filter paper. The concentrations of 20, 15, 10 and 5% were prepared by dilution method from the stock solution. Glass plates of 9 cm diameter were used to grow green bean seeds with 10 seeds per dish on a filter paper for each concentration of the extract. The distilled water used as a control group. The dishes were closed and left under laboratory conditions, and a concentration solution was added daily or as needed until the end of the experiment. The germination percentage, germination speed, radicle length and plumule length were calculated after 10 days of culturing according the following equation:-

% Germination = Number of germinating seeds/ total number of plant × 100 (Saied, 1984).

The speed of seed germination/day was calculated according the following equation:-

Number of germinating seeds in the first counting/number of days + number of germinating seeds in the second counting/number of days + number of germinating seeds in the third counting/number of days (Saied, 1984).

Field experiment

A mixture of t hree kilograms of loam soil was used for agriculture in pots with a diameter of 15 cm. The

residues of shoot and root system were added with 4, 8, 16 and 24 g/kg of in addition to control group (no residues added). Then, the pots were watered and covered with polyethylene to preserve their moisture and left for 10 days to give sufficient opportunity to decompose the residues. Green bean seeds were planted at 5 seeds per pot and reduced to 2 seeds after germination. The experiments were performed by CRD design and the statistical analysis was performed using the GenStat 101 program, and the averages were compared using Duncan multi-range test at a probability level of 0.05. At the end of the experiment, several parameters were measured including the number of root nodes, plant height (cm), leaf area (dm^2), dry weight of shoot system (g/plant), number of secondary branches, stem diameter (mm), chlorophyll concentration in leaves ($mg.g^{-1}$), dry weight of root system (g), flowering date (day) and total number of flowers as Plant height (cm), Number of branches. The leave area was calculated according to the following equation: The leave area = Length * Width * 0.95

Results and Discussion

The laboratory experiment

The results as shown in Table 1 that the effect of using aqueous extracts of *Tageteserecta* L. and *Sorghum halepense* in the laboratory experiment was varied between stimulation and inhibition. The results showed the superiority of aqueous extracts of the root and shoot system, these extracts significantly stimulated the germination rate, germination speed and radicle and plumule length at all used concentrations compared to control group. The aqueous extracts of root system at 10% concentration have more potential in comparison to shoot system; it was recorded (100%,1, 4.16 mm^2 and 4.5 mm) respectively compared to the comparison treatment that recorded (50%, 0.5, 2.75 and 2.63 mm^2) respectively. Furthermore, the results also showed that the aqueous extracts of shoot system of *Tageteserecta* significantly exceeded the control group (not treated) for the same studied characteristics in the laboratory experiment. However, the results showed that the

Table 1. The Allelopathic effect of the root and shoot extracts of *Tageteserecta* and *Sorghum halepance*on the germination characteristics in Green beans (*Phaseolus vulgaris* L.)

Plant part	Concentration	Germination rate %	Germination speed (day)	Radicle length mm^2	Plumule length mm
			Tageteserecta		
Root system	0%	50f	0.5	2.75d	2.63c
	5%	60e	0.6d	3.33c	3.66b
	10%	100a	1a	4.16a	4.5a
	15%	75b	0.75b	3.67b	3.33b
	20%	75b	0.75b	3.87b	3.83b
Shoot system	0%	50f	0.5e	1.25f	2.02
	5%	55e	0.5e	1.83f	2.33c
	10%	65d	0.75b	3.66c	2.16d
	15%	70c	0.6d	2.17e	3.25b
	20%	65d	0.65c	3.25c	3.33b
			Sorghum halepense		
Root system	0%	100a	1a	11.33a	11.66a
	5%	90c	0.95a	10.66b	10.33b
	10%	85d	0.85	10.0b	9.76c
	15%	80e	0.80b	9.83b	9.11c
	20%	80e	0.80b	9.16b	9.0c
Shoot system	0%	95b	0.95a	9.83b	10.66b
	5%	90c	0.90a	8.66c	8.83d
	10%	85d	0.85a	7.65d	8.00d
	15%	80e	0.85a	6.83e	7.85e
	20%	80e	0.85a	6.33e	7.65e

Data with similar characters have no significant differences between them at the probability level of 0.05 and according to the Dunkin multi-range test.

aqueous extracts of root and shoot extracts of *Sorghum halepense* were significantly decreased the studied characteristics at all concentrations; the decreasing in the germination features was in line with the increased concentration compared to the comparison treatment, although the aqueous extracts of the shoot system had a lower reduction of germination features above.

The field experiment

As shown in Table 2, the data showed the superiority of the root and shoot system residues of *Tageteserecta* in all the studied traits including the number of root nodes, plant height (cm), leaf area (dm^2) and dry weight of the shoot system (g/plant). In addition, the root system residues significantly increased in the above criteria, where the level of 16 g/kg of soil was higher than the other levels in comparison to control group. Furthermore, the residues of the shoot system of *Tageteserecta* at all concentration significantly was effective as compared to control group that recorded lower levels in both root and shoot system in the similar studied characteristics. While the root and shoot system residues of *Sorghum halepense* significantly decreased the studies characteristics, it was recorded at level 24 g/kg of soil the lower values for both root and shoot system as compared to control group.

The results in Table 3 found that the root and shoot system residues of *Tageteserecta* significantly increased the levels of all studies parameters including the number of secondary branches, stem diameter (mm), chlorophyll concentration in the leaves (mg/g) and the dry weight of the root system in comparison to control group. The level of 16 g/kg of soil recorded the higher results as compared to other levels. These findings confirmed that the residue of the root and shoot system have a significantly increased the similar studied characteristics as compared to control group that recorded the lower values. The root and shoot system residues of *Sorghum halepense* significantly decreased the studied parameters, and the level of 24 g/kg of soil for both root and shoot system compared to control group.

Table 2. The Allelopathic effect of the root and shoot system extracts of *Tageteserecta* and *Sorghum halepense*on som growth parameter of Green beans (*Phaseolus vulgaris* L.).

Plant part	Concentration	Number of root nodes	Plant high (cm)	Leaf area (dm^2)	dry weight of shoot system (g/plant)
			Tageteserecta		
Root system	0	14.34f	34.65j	13.3e	13.15j
	4 g/kg	17.15c	37.78e	15.53b	15.25c
	8 g/kg	18.45b	39.67c	15.76b	14.85d
	16 g/kg	20.55a	42.56a	17.65a	18.55a
	24 g/kg	18.56b	40.65b	17.25a	16.75b
Shoot system	0	14.65f	33.67j	11.34e	10.30j
	4 g/kg	15.34e	35.66f	13.45d	12.25f
	8 g/kg	16.87d	37.96e	13.35d	13.65e
	16 g/kg	18.45b	40.23b	15.25b	14.15d
	24 g/kg	16.65d	38.56d	14.86c	14.55d
			Sorghum halepense		
Root system	0	14.56a	32.65a	12.85a	12.25a
	4 g/kg	12.34b	30.45b	11.54b	11.00b
	8 g/kg	11.76c	29.56c	11.65b	10.25c
	16 g/kg	10.25d	29.25c	10.65c	9.35d
	24 g/kg	9.54e	28.56d	10.5c	9.15d
Shoot system	0	12.35b	30.45b	11.50b	11.50b
	4 g/kg	14.56c	29.67c	11.25b	11.25b
	8 g/kg	9.65e	27.60d	10.35c	10.35c
	16 g/kg	8.45f	27d	10.25c	10.25c
	24 g/kg	8.65f	26.15d	9.25d	9.25d

Data with similar characters have no significant differences between them at the probability level of 0.05 and according to the Dunkin multi-range test.

As shown in Table 4, the root and shoot system residues caused a significant difference in the flowering date (day), total number of the flowers, nodes rate and the first harvesting date. Although, the residues of the root system significantly increased the studied parameters at the level 16 g/kg of soil than others comparison to control group. Additionally, this study observed that the shoot system residues at all levels significantly elevated the studies parameters as compared to control group that recorded

Table 3. The Allelopathic effect of the root and shoot extracts for *Tageteserecta* and *Sorghum halepense* on some growth parameter of Green beans (*Phaseolus vulgaris* L.).

Plant part	Concentration	number of secondary branches	stem diameter (mm)	chlorophyll concentration (mg/g)	dry weight of root system (g/plant)
			Tageteserecta		
Root system	0	9.25e	7.45d	9.45e	5.45d
	4 g/kg	10.12d	8.25c	10.25b	6.25c
	8 g/kg	11.15c	8.75c	10.75b	6.75c
	16 g/kg	13.55a	10.25a	11.55a	8.55a
	24 g/kg	12.76b	9.55b	11.25a	8.25a
Shoot system	0	9.00e	7.25	8.25d	5.25d
	4 g/kg	9.25e	7.75	8.75d	5.75d
	8 g/kg	10.75d	8.00c	9.00c	6.10c
	16 g/kg	11.25c	8.55c	9. 85c	7. 15b
	24 g/kg	12.35b	8.85c	9.55c	7.25b
			Sorghum halepense		
Root system	0	9.65a	7.15a	8.15a	5.10a
	4 g/kg	9.25a	7.00a	7.75a	5.05a
	8 g/kg	9.10a	6.85b	7.25b	4.95a
	16 g/kg	8.75b	6.50b	7.00b	4.85a
	24 g/kg	8.65b	6.00c	6.75b	4.75a
Shoot system	0	9.15a	7.00a	8.00a	4.85a
	4 g/kg	9.00a	6.85b	7.00b	4.65b
	8 g/kg	8.75b	6.45b	7.15b	4.25b
	16 g/kg	8.50b	6.00c	6.90b	4.10b
	24 g/kg	8.25b	5.85c	6.55c	4.00b

Data with similar characters have no significant differences between them at the probability level of 0.05 and according to the Dunkin multi-range test.

Table 4. The Allelopathic effect of the root and shoot extracts of *Tageteserecta and Sorghum halepense* on in the flowering date (day), total number of the flowers, nodes rate and the first harvesting date in Green beans (*Phaseolus vulgaris* L.).

Plant part	Concentration	Flowering date (day)	Total number of the flowers	Nodes rate	The first harvesting date
Root system	0	40.65e	85.25j	33.65e	62.67f
	4 g/kg	38.75c	90.45f	35.75d	60.65d
	8 g/kg	38.25c	100.25d	37.15b	58.35b
	16 g/kg	37.85b	115.25a	41.25a	56.15a
	24 g/kg	36.25a	110.55b	40.65a	57.45c
Shoot system	0	41.25e	80.56k	32.86e	63.65f
	4 g/kg	40.15d	85.65j	34.45d	61.75e
	8 g/kg	39.55d	97.45e	35.76d	60.14d
	16 g/kg	37.55b	105.75c	37.67b	58.75c
	24 g/kg	37.15b	102.75d	36.65c	59.10d

Data with similar characters have no significant differences between them at the probability level of 0.05 and according to the Dunkin multi-range test.

lower values in the presence of the root and shoot system residues of *Tageteserecta*. The root and shoot system residue of *Sorghum halepense* decreased the above studied characteristics compared to control group.

Discussion

It is clear from the finding of the current study that the aqueous extracts of *Tagetes erecta* at different concentrations as well as the residues at several levels for both the root and shoot system of achieved the best results in all studied parameters (Table 1-4).

The results have been shown a variation in the effects of *Tagetes erecta* and *Sorghum halepens e*extracts and residues; these effect included inhibition and stimulation depending on the type of plant, concentration, level of the residue and the response of the plant tissue. Interestingly, these results are indicating the presence of water soluble allelopathic compounds, and most of these compounds are phenolic acids (Einhelling, 2002) due to the variation in the chemical nature of allelopathic compounds, and also the potential effect of the extracts and residues of the root and shoot system of *Tagetes erecta* attributes to the metabolism of produced chemical compounds to other compounds with simplest structurewhich may be non-toxic by microorganisms (Rice, 1984).

the results also showed that the effect of aqueous extracts on the plant treated with plant residues decreased the seed germination rate, and the growth of radicle andplumule in most treatments. This is in agreement with the observations of Chou (1999) that found an inhibition in all the growth parameters of rice treated with aqueous extracts of the rice residues.

Additionally, a variation in the response of plant species to the effect of these extracts was observed in all studied traits; this may be due to the difference in the genotype. These results were consistent with the Purvis (1990) study which confirmed there is a variance in the susceptibility of varieties within the same species to tolerate the toxicity of plant wastes or show a different allelopathic effort. Furthermore, these findings are in consistent with the results of Ashrafi *et al*. (2008) which observed that the treatment with the residues of the root and shoot system of sunflower plant to a barley significantly decreased the germination, length and weight of barley in comparison to control group (no residue was added). The results of this study also noticed that there is a significant stimulation by residues of*Tageteserecta*, this may be due to improving the efficiency of the roots for absorption and water tension. The results also showed that the inhibition in the studies growth parameters occurred after treatment withthe residues of root and shoot system of *Sorghum halepense*; it is may due to the quality and concentration of allelopathic compounds produced by this plant, or may be due to the type of added plant part as a residues. The reason for the difference between different plant species is may due to the fact that some compounds that exist in a particular plant play an important role in this difference, because some phenolic acids act in synergistic model with each other, and this synergistic effect leads to a high rate of inhibition compared to the inhibition caused by Each acid alone. Many researchers noted that *Sorghum halepense* released many terpenes and phenols compounds that are soluble in water and released to the growth environment of other plants through the secretions of roots, washing and decomposition, which in turn inhibit the germination and growth (Macias *et al*., 2004). Moreover, this may be due to the fact that the plant residues after decomposition give allelopathic compounds and these compounds transferred to the enviroment depending on the amount, survival duration and biological activity causing the impact on the receiving plant such as stimulation or inhibition in the germination and growth (Ballester, 1972); this is may be attributed to containing *Sorghum halepense* of high concentrations of diorin compound, which hydrolyzes and produces cyanide that prevents seed germination (Sene *et al*., 2001). Interestingly, Al-Obeidi (2003) indicated that the aqueous extract of *Sorghum halepense* caused a decrease in the dry weight of the green beans and maize. Vasilakoglou *et al*. (2005) also found that the effect of *Sorghum halepense* is higher than the bull in inhibiting the chlorophyll content of cotton and maize. This inhibition was due to the presence of P-coumaric acid and phenolic compounds which were found to inhibit the biosynthesis of chlorophyll. Similar results obtained by Saadawi*et al*.(2007) which observed that maize residues caused a decrease in chlorophyll levels in broad bean. Al-Jubouri (2002) study found that the aqueous extracts of a number of annual weeds have an effect on the germination and growth of some crops as well as some otherweeds; the effects of these extracts may be negative or posi-

tive on other plants. Additionally, the effect of allelopathic compounds on the receiving plant may be positive or negative depending on the concentration and type of plant, also these compounds may cause physiological effects in the receiving plant (Reigosa *et al*., 2000). It may also be due to the sensitivity of the plant part, and these compounds may affect one of the growth phases while not affecting another phase (Al-Juhaishi, 2005).

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