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Article

Effect Boi-fertilizer, Humic acid and Sea Algae Extract on growth and yield of Sudn agrass (Sorghum sudanense L.)

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Abstract: A field experiment was conducted during the spring agricultural season of 2021 in two locations, the first in the village of Al-Tilga (10 km northwest of Mosul) and the second in the village of Al-Shuhada (35 km west of Mosul). The experiment was applied according to a randomized complete block design (R.C.B.D) with a split plot system. Where the levels of bio-fertilizer occupied the main plots and the levels of humic acid and seaweed extract (Alggren-Twin) secondary plots and in three replications and the two factors of the study were as follows: The first factor was biofertilizer (Bactofed) at two levels of zero and 750 ml / 1000 L of water / ha. The second factor is four levels of two levels of seaweed extract with the trade name (Algaren Twin): 3 and 6 ml /L of water. The third and fourth levels are 8 and 16 kg / ha of humic acid. The results of the study were as follows: The addition of bio-fertilizer caused a significant increase in plant height, the yield of fresh and dry forage, number of dahlias per plant, the weight of panicles grains, and grain yield of individual and total plants in both locations. Also, the addition of seaweed extract and humic acid increased in most of the studied traits, to achieve the highest average for most traits and in both locations at the level of humic acid 16 kg/ha.

Keywords: Boi-fertilizer; Humic acid; Sea Algae; Sudn agrass; Sorghum sudanense L.

1. Introduction

Sudangrass (Sorghum sudanese)belongs to the Poaceae family and is mainly used as feed for livestock. It is one of the summer grass crops and can be used as an alternative to the yellow corn crop in areas that suffer from a shortage of irrigation water because the yellow corn crop requires a large amount of water in order to achieve the maximum yield, where the water shortage in dry areas and semi-dry crops reduce the use of this crop as a summer feed crop [1].Therefore, it can be replaced with other summer feed crops such as black weed, which is characterized by its low water needs and drought tolerance better than yellow corn. In addition, it is a branched plant that gives a number of weeds. Recently, researchers resorted to using alternative fertilizers for mineral fertilizers to reduce the economic cost and pollution and increase production. The most important of these fertilizers is the bio-bacterial fertilizers, which have replaced the use of mineral fertilizers to reduce the economic cost and reduce the pollution average while increasing production in quantity and quality [2] and found poor and popular. The yield of maize at the level of 6 L/ ha of biofertilizer exceeded the yield of the levels zero, 2 and 4 L / ha, as well as from the alternative fertilizers for mineral fertilizers, organic fertilizers, including humic acid. Which is added to the soil or sprayed on the plant leads to an increase in the absorption of nutrients by the plant, as it acts as a medium for transferring nutrients from the soil to the plant, especially in case it is exposed to drought. for the roots. [3] obtained the highest yield of corn at a concentration of 2.5 ml / liter of humic acid, exelled on the yield of zero concentration 1.5 and 2 ml / L. There is also another type of fertilizer alternative to mineral fertilizers, seaweed extract, which is used to improve vegetative growth and it contains nutrients N, P, K, Ca, Mg, S, vitamins, amino acids, polysaccharides and plant growth hormones (cytokinins, auxins, and gibberellins) [4], and because the use of mineral fertilizers, especially nitrogen, has preparations when added to the soil in the case of cultivation of crops belonging to the genus Sorghum.

2. Materials and methods

A field experiment was conducted during the spring agricultural season of 2021 in two locations, the first in the village of Al-Thilga (10 km northwest of Mosul) and the second in the village of Al-Shuhada (35 km west of Mosul).Where the levels of bio-fertilizer occupied the main plots and the levels of humic acid and seaweed extract (Alggren-Twin) secondary plots and three replicates.The factors of the study were as follows: The first factor was the bio-fertilizer (Bactofid) at two levels of zero and 750 ml / 1000 liters of water / Dunam, which contains the following bacteria: Azospirillium, Azotobacter, pseudomonas fluorescens, Trichoderrna viride, Bacillus spp, and Lactobacilli.It was added to the plants after 10 days of planting with irrigation water (according to the manufacturer's recommendations) and the second factor is four levels, two levels of seaweed extract with the trade name (Algaren Twin), a brown seaweed called (Ecklonia maxima). It is a product from the Italian company Green Hayes (GREEN HAS) and it contains 2.3% organic nitrogen, 16.1% organic carbon, 32.2% organic matter: (3 and 6 ml/liter of water). The two levels were sprayed on plants after 21 days of planting (until full wetness), In the dorsal sprinkler, and the third and fourth levels, 8 and 16 kg / ha, are humic acid, as each level of humic acid was added to its experimental units by dissolving it with water in an amount sufficient to distribute it on the soil homogeneously .It was added in two batches, the first during cultivation and the second after 20 days of cultivation, and was added by dissolving each level of humic acid in 500 ml of water. After tillage and smoothing the soil, it was divided into three replicates: each replicate contained (8) experiment units. Each experimental unit contained six rows of length 5 m, the distance between one row and another was 50 cm, between one and another 10 cm, and between one and the other 1 m, and between one and another 50 cm, and the plant density was 200 thousand plants/ha. The planting was conducted on 1/5/2021 with Haymax, a Spanish cultivar produced by Vito company. All operations of servicing the crop were conducted, such as thinning, fertilization, weeds, and insect control, according to the recommendations in force. The studied traits: (10) plants were randomly taken from the middle rows of each treatment and replicates at the stage of full flowering. The following traits were studied: Plant height (cm)

Number of leaves/plant, dry feed yield (tons/ha): A length of (1 m) was cut from the two middle rows after leaving half (m) from the beginning of the row for each treatment. The leaves were separated from the stems for each of them to calculate the percentage of leaves and the dry feed yield. The samples were dried pneumatically and at room temperature, then the samples were dried by an electric oven at a temperature of 70 °C for 72 hours (until the weight is stable).Then the dry yield was estimated (after collecting the yield of leaves and stems) by means of an electronic scale, then according to the average dry weight of one plant after dividing the total dry weight by the number of plants in one row and multiplying by the number of plants per hectare to get the total dry matter yield (tons/ha). The percentage of leaves was calculated according to the following equation: According to the equation:

$$\text{Leaves\%}=\frac{\boldsymbol{Dry\ yield\ of\ leaves\ ton/ha}}{\boldsymbol{Total\ total\ dry\ yield\ ton/ha}}\times 100 \quad (1)$$

Number of panicle/plant Ten plants were taken randomly from the midlines at full maturity and from them, the number of panicle/plant was calculated. Weight of panicle(gm): The panicles of ten plants were taken randomly and were weighed separately and according to the average weight of the grains in one panicle, the weight of the grains was calculated. Per plant from multiplying the number of panicles per plant by the weight of panicle grains.The average grain yield was calculated by harvesting ten plants and the total grain yield was extracted by multiplying the grain weight/plant by the plant density (200,000 thousand plants/ha).

Table 1. Some physical and chemical properties of the soil of the two location

components	Al-Thilga	Al-Shuhada	units
sand%	774	750	**$g.kg^{-1}$**
Clay%	393	497	**$g.kg^{-1}$**
silt%	530	427	**$g.kg^{-1}$**
	silty clay loam	Silty Clay	
pH	7.5	7.1	
EC . electrical conductivity	1.88	2.4	**$Ds.m^{-1}$**
availability potassium	382.0	256.7	**$mg.kg^{-1}$**
availability phosphorous	4.0	3.5	**$mg.kg^{-1}$**
availability nitrogen	54.0	89.0	**$g.kg^{-1}$**
Organic matter	**1.90**	**2.06**	**$g.kg^{-1}$**

3. Results

3.1.Biofertilizer effect

The data in Table (2) indicate that all studied traits were significantly affected by the biofertilizer in the two study locations, except for the number of leaves and the percentage of leaves in the location of the Alshuhada, which were not significantly affected by the biofertilizer. The addition of bio-fertilizer caused a significant increase in the plant height trait, and the increasing percentage was 7.33-5.78% compared with the (non-addition) treatment in the two study locations, Al-Shuhada and Al-Thilqa, respectively.The reason for this increase in the height of the plant may be that the biofertilizer is the reason for the increase in the vital activity of the plant and as a result, the length of the internodes increases, and when the length of the internodes increases, the height of the plant will increase [4] These results are in agreement with the result of [4] The results in Table (2) indicate that the traits of the number of leaves and the percentage of leaves were significantly affected by the biofertilization in the Al-Thilqa location only. The biofertilization treatment gave the highest average number of leaves/plant, which amounted to 12.4 leaves/plant, and the highest percentage of leaves reached 58.5%.The reason for the increase in the number of leaves of the plant may be due to the increase in the height of the plant, which was reflected in the increase in the number of internodes, because the greater the number of internodes, the greater the number of leaves, and This result is in line with the result of [5] in his study of wheat.The addition of bio-fertilizer caused a clear and significant increase in the yield of fresh and dry feed in the two study location. In Al-Shuhada' location, the bio-fertilization treatment gave the highest yield of fresh and dry feed, which amounted to 32.5 and 9.8 tons/ha, and on soil and at Al-Tilqa location it amounted to 26.2 and 7.7 tons/ha. .The reason for this increase in the fresh and dry yield may be the ability of bacteria to secrete growth-stimulating substances such as gibberellins, cytokines, auxins and vitamins [5]In addition, bacteria contribute to improving the growth and increasing its density, the root total of its production of some growth regulators, Including auxins, which increase the plant's ability to absorb water and nutrients from the soil solution surrounding the plant roots. (Mrkovack and Milic, 2001) and this result agrees with [6] The data in the table below indicate that there are significant differences between the treatments with and without biofertilizer in the traits of the number of panicles/plant and the weight of panicle grains. The treatments to which biofertilizer was added and gave 2.8 panicles/plant, 7.4 g, 2.8 panicles/plant, and 6.2 g in Al-Shuhada and Al-Thlja location, respectively. The reason for this excelled may be the same reasons mentioned when discussing the dry matter yield. The highest grain yield per individual plant and total grain yield was achieved in the treatments to which biofertilizer was added, and it was at Al-Shuhada location 20.9 g, 4.2 tons / ha, 17.4 g and 3.5 tons / ha, respectively. The reason for this increase achieved when these treatments were added to bio-fertilizer may be excelled of these treatments in grain weight / panicle and the number of panicles.This finding is consistent with what was reached by Al-Hassan (2011) and [4]in their study of the bread wheat.

Table 2. Effect of bio-fertilizer on growth traits and yield of Sudanese feed and grains in the two study location for the spring season 2021.

Treatments	Traits								
	grain yield (tons/ha)	Grain yield / plant	panicles grain weight (gm)	Number of panicles/plant	Dry feed yield (tons/ha)	Fresh feed yield (tons/ha)	% leaves	number of leaves/plant	plant height (cm)
	Al-Shuhada location								
control	2.6 b	12.7 b	6.3 b	2.0 b	8.4 b	28.2 b	58.7 a	13.1 a	164.4 a
Bio fertilizer (750 ml / 1000 L / ha)	4.2 a	20 .9 a	7.4 a	2.8 a	9.8 a	32.5 a	58. 6 a	13.5 a	177.4 b
	Al-Thilga Location								
control	2.1 b	10.4 b	4.9 b	2.1 b	6.6 b	23.2 b	57.4 b	11.3 b	138.5 b
Bio fertilizer (750 ml / 1000 L / ha)	3.5 a	17.4 a	6.2 a	2.8 a	7.7 a	26.2 a	58.5 a	12.4 a	147.0 a

3.2. Effect of seaweed extract and humic acid on growth traits and yield of Sudanese grains

The data presented in Table (3) indicate that all studied traits were significantly affected by the levels of marine algae extract and humic acid in the study location of Al-Shuhada and Al-Tilgha, except for the percentage of leaves in the Al-Tilgha location that were not significantly affected.The

addition of marine algae extract and humic acid caused an increase in plant height, and the highest plant height was 178.9 cm and 147.3 cm at a level of 16 kg/ha of humic acid, which differed significantly with other levels, and the lowest plant height was 167.3 and 139.0 cm at a level of seaweed 3 ml / L which in turn differed significantly with other levels,. The lowest fresh and dry yield at the level of seaweed extract was 3 ml / L of water 29.2 and 8.7 tons / ha at Al Shuhada location 23.5 and 6.9 tons / ha in Al-Tilgha location. The levels of seaweed extract and humic acid differed significantly in the traits of the number of panicle/plant and panicle grain weight , where the highest number of panicle/plant and the highest grain weight were achieved at the level of humic acid 16 kg/ha, 2.8 panicle/plant 7.3 gm at Al-Shuhada location and 2.8 panicle/plant 6.0 g at the Al-Tilgha location and the reason for this increase may be due. The role of humic acid in increasing the availability of some nutrients in the soil and increasing their absorption by the plant as well as its positive effects on the physical properties of the soil and its effect on the growth of the root and vegetative group. This result is consistent with what [11]. The data shown in Table (3) indicate that there are significant differences in the trait of the grain yield of the individual plant and the total grain yield in the two study location .The level of humic acid of 16 kg/ha was excelled on the grain yield of the individual plant and the total grain yield, which differed significantly with all other levels and in both sites. It was at the Al-Shuhada location 20.1 g and 4.1 tons/ha and at Al-Tilgha location 16.7 and 3.3 tons/ha.The lowest grain yield for individual and total plants at the level of marine algae extract was 3 ml per liter of water 15 g and 3.0 tons / ha at Al Shuhada location and at Al-Tilgha location was 11.1 g and 2.3 tons / ha, 16 kg / ha is the excelled of this level over other levels in the number of panicle/ plant and weight of panicle grains. This result is in agreement with the results of [12]

Table 3. The effect of seaweed extract and humic acid on growth trait and yield of Sudanese feed and grains in the two study location for the spring season 2021

Treatments	Traits								
	grain yield (tons/ha)	Grain yield / plant	panicles grain weight (gm)	Number of panicles/plant	Dry feed yield (tons/ha)	Fresh feed yield (tons/ha)	% leaves	number of leaves/plant	plant height (cm)
	Al-Shuhada location								
seaweed extract 3ml/L water	3.0 d	15.0 d	6.6 d	2.2 d	8.7 d	29.2 d	59.3 a	13.1 b	d 167.3
seaweed extract 6ml/L water	3.4 c	17.0 c	6.9 c	2.4 c	9.0 c	30.5 c	59.0 a	13.3 b	169.8 c
Humic acid (8kg/ha)	3.7 b	18.6 b	7.0 b	2.6 b	9.5 b	31.0 b	58.9 a	a 13.9	175.7 b
Humic acid (16kg/ha)	4.1 a	20.8 a	7.3 a	2.8 a	9.9 a	32.9 a	57.5 b	13.2 b	178.5 a
	Al-Thilga Location								
seaweed extract 3ml/L water	2.3 d	11.1 d	5.1 c	2.1 d	6.9 c	23.5 c	57.9 a	11.6 c	139.0 d
seaweed extract 6ml/L water	2.5 c	13.1 c	5.5 b	2.3 c	7.2 b	24.3 b	58.3 a	11.8 b	139.0 c
Humic acid (8kg/ha)	2.9 b	14.7 b	5.6 b	2.6 b	7.1 c	25.1 a	58.0 a	12.0 a	144.3 b
Humic acid (16kg/ha)	3.3 a	16.7 a	6.0 a	2.8 a	7.5 a	25.6 a	57.6 a	12.1 a	147.3 a

3.3. The effect of interaction between bio-fertilizer, seaweed extract and humic acid on growth traits and yield of Sudanese feed and grains.

The data in Tables (4 and 5) indicate that all studied traits were significantly affected by the interaction between biofertilizer, seaweed extract and humic acid.The highest plant height, the highest fresh and dry feed yield, the highest number of panicle /plant, and the highest grain weight/panicle were achieved. The highest individual grain/plant weight, the highest total grain yield from the interaction of biofertilizer, and the level of humic acid was 16 kg/ha. The Al-Shuhada location was 186 cm, 36.6 tons/ha, 10.5 tons/ha, 3 panicle /plant, 7.7 g, 22.9 g, 4.6 tons/ha respectively, while the same interaction was recorded in the Al-Thilga Location of 151 cm, 26.8 tons/ha, 8.2 tons/ha, 2.9 panicle /plant, 6.6 g, 19 g, and 3.8 tons/ha. The lowest plant height, the lowest fresh and dry feed yield, the lowest number of panicle /plant, and the lowest grain weight/panicle .The lowest grain yield/plant and the lowest total grain yield from the interaction of the control treatment (without biofertilization) and the level of seaweed extract 3ml/L of water. The averages recorded at Al-Shuhada location were 27.7 tons/ha and 8.2 tons/ha, 1.7 panicle /plant and 5.9 g and 9. 9 g and 2 tons / ha, respectively. The same averages and from the same intervention were recorded in the Al-Thilga Location of 133.3 cm, 21.5 tons/ha, 6.5 tons/ha, 1.5 dahlias/plant, 4.4 g, 6.8 g and 1.4 tons/ha respectively

Table 4. The effect of interaction between bio-fertilizer, seaweed extract and humic acid on growth traits and yield of Sudanese feed and grains at Al-Shuhada location , study for the spring season 2021

bio fertilizer	**Seaweed extract + humic acid**	**Traits**								
		grain yield (tons/ha)	Grain yield / plant	panicles grain weight (gm)	Number of panicles/plant	Dry feed yield (tons/ha)	Fresh feed yield (tons/ha)	% leaves	number of leaves/plant	plant height (cm)
Control	seaweed extract 3ml/L water	3.0 d	15.0 d	6.6 d	2.2 d	8.7 d	29.2 d	59.3 a	13.1 b	d 167.3
	seaweed extract 6ml/L water	3.4 c	17.0 c	6.9 c	2.4 c	9.0 c	30.5 c	59.0 a	13.3 b	169.8 c
	Humic acid (8kg/ha)	3.7 b	18.6 b	7.0 b	2.6 b	9.5 b	31.0 b	58.9 a	a 13.9	175.7 b
	Humic acid (16kg/ha)	4.1 a	20.8 a	7.3 a	2.8 a	9.9 a	32.9 a	57.5 b	13.2 b	178.5 a
Bio fertilizer (750 ml / 1000 L/ ha)	seaweed extract 3ml/L water	2.3 d	11.1 d	5.1 c	2.1 d	6.9 c	23.5 c	57.9 a	11.6 c	139.0 d
	seaweed extract 6ml/L water	2.5 c	13.1 c	5.5 b	2.3 c	7.2 b	24.3 b	58.3 a	11.8 b	139.0 c
	Humic acid (8kg/ha)	2.9 b	14.7 b	5.6 b	2.6 b	7.1 c	25.1 a	58.0 a	12.0 a	144.3 b
	Humic acid (16kg/ha)	3.3 a	16.7 a	6.0 a	2.8 a	7.5 a	25.6 a	57.6 a	12.1 a	147.3 a

Table 5. The effect of interaction between bio-fertilizer, seaweed extract and humic acid on growth traits and yield of Sudanese feed and grains at Al-Tilga study location for the spring season 2021

		Traits

bio fertilizer	**Seaweed extract + humic acid**	grain yield (tons/ha)	Grain yield / plant	panicles grain weight (gm)	Number of panicles/plant	Dry feed yield (tons/ha)	Fresh feed yield (tons/ha)	% leaves	number of leaves/plant	plant height (cm)
Control	seaweed extract 3ml/L water	1.4 f	6.8 g	4.4 g	1.5 g	6.5 f	21.5 e	56.7 c	11.1 e	133.3 f
	seaweed extract 6ml/L water	1.7 e	8.8 f	4.9 f	1.8 f	6.8 e	22.5 d	57.4 c	11.2 e	136.3 e
	Humic acid (8kg/ha)	2.3 d	11.8 e	4.9 f	2.4 e	6.5 f	23.6 d	57.3 c	11.7 d	141.0 d
	Humic acid (16kg/ha)	2.9 c	14.3 d	5.4 e	2.6 d	6.7 e	24.4 c	57.8 bc	11.4 *e*d	143.7 c
Bio fertilizer (750 ml / 1000 L/ ha)	seaweed extract 3ml/L water	2.3 b	15.5 c	5.8 d	2.7 cd	7.3 d	25.4 b	59.1 a	12.0 c	144.7 c
	seaweed extract 6ml/L water	3.5 b	17.5 b	6.2 c	2.8 ab	7.6 c	26.0 ab	58.9 a	12.4 b	146.7 b
	Humic acid (8kg/ha)	3.5 b	17.6 b	6.4 b	2.8 ab	7.8 b	26.6 a	58.7 ab	12.5 b a	147.7 b
	Humic acid (16kg/ha)	3.8 a	19.0 a	6.6 a	2.9 a	8.1 a	26.7 a	57.3 c	12.8 a	151.0 a

4.Discussion

The reason for increasing the average plant height may be due to the physical, chemical and biological benefits that humic acid does when added to the soil, as it improves soil composition and aeration and increases its ability to hold water, thus increasing the plants' tolerance to drought and increases the readiness of the necessary nutrients in the soil and then increasing its absorption by the roots of a plant, which stimulates the metabolic processes of the plant. This results in an increase in the growth of the developing top, elongation and division of plant cells and their construction, and activation of vital activities, and then an increase in plant height [9] The data shown in the table indicate that there are significant differences between the levels of humic acid and seaweed extract in the two study locations in the traits of the number of leaves/plant with the excelled of the levels of humic acid for that trait.This may be due to the positive effect of adding humic acid to the soil, which contributed to improving the properties of the soil and increased the permeability of cell membranes and this result is consistent with the result of [10] The addition of the levels of humic acid and seaweed extract caused a significant difference in the percentage of leaves in the Al-Shuhada location only.As the percentage of leaves of humic acid level of 16 kg/ha differed with the other levels, which did not differ significantly with each other with the highest yield of dry and fresh feed in the two study location, at the level of humic acid 16 kg/ha, it was 32.9 and 9.9 tons/ha in Al-Shuhada location, and 25.6 and 7.5 tons/ha and in Al-Tilgha location ,The reason for the excelled of the yield of fresh and dry feed at this level may be due to their excelled in the traits of the number of leaves and plant height[16].

5. Conclution

Excessive use of the fertilizers used leads to an increase in the concentration of alkaloids and an increase in the concentration of these substances in the feed and leads to health problems for the animal that feeds on them and thus cause the death of the animal if the concentration reaches the lethal concentration, so this research was conducted to get the best combination of the three mentioned fertilizers, which gives the highest production with no health problems for the animals if the animals are fed on the feed of this crop. Furthermore the findings conclude that the interaction

between biofertilizer, seaweed extract and humic acid had a significant effect on most of the studied traits.

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