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THE INTERFERING EFFECT OF BIO- AND ORGANIC FERTILIZERS UNDER TWO LEVELS OF WATER STRESS ON SOME PHYSICAL AND FERTILITY PROPERTIES OF THE SOIL AND THE GROWTH AND YIELD OF SORGHUM

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ABSTRACT

In the spring season of 2023, a field experiment was carried out in a private field located in the al-Dura/Hor Rajab area. The purpose of the experiment was to evaluate the effects of various levels of bio-fertilizer (mycorrhiza and azospirillium bacteria) and the addition of organic fertilizer AgriM40 on the growth and yield of sorghum in saline soil. The experiment also examined the influence of two levels of water stress on the sorghum plants. The soil used in the experiment was a saline soil. The experimental design for the study site was the Split Split-Block arrangement with a randomized complete block design (RCBD). The study involved three factors: the primary factor was irrigation breaks, with two levels 5 and 10 days, the secondary factor was a bio-fertilizer consisting of a mixture of mycorrhiza fungus and azospirillium bacteria, with two levels without addition. The sub-secondary factor was organic fertilizer (Agri M40) with three levels (20, 40, and 80L ha^{-1}). The findings demonstrated the improved performance of the I5 irrigation separator treatment in terms of nitrogen concentration in the soil and grain yield, with values of 21.088 mg kg^{-1} soil and 6969.83 mg h^{-1}, respectively. The biofertilizer B1 treatment outperformed in terms grain yield, with values 6563.17 mg h^{-1}, respectively. Similarly, the organic fertilizer treatment 80Lha^{-1} surpassed in grain yield, with values of 6551.00 mg h^{-1}, respectively. The simultaneous application of the bio-fertilizer and irrigation had a notable impact on the level of available potassium in the soil and the crop yield, resulting in a concentration of 8.040 mg kg^{-1} soil and a yield of 171.80 mg h^{-1}. Regarding the simultaneous use of organic fertilizer and irrigation, there were notable disparities observed, respectively. In terms of the triple overlap, the coefficients I10B1C3, I10B1C2, and I5B1C3 exhibited considerable variations in the bulk density and concentration K of soil and grain yield. The values were 1.433 mg m^{-3}, 130.030 mg kg^{-1} soil, and 7664.00 mg h^{-1}.

Keywords: Biofertilizer, Organic fertilizer, Physical properties, Sorghum plant.

[*]This article is taken from the first researcher's master's thesis.

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التأثير المتداخل للسماد الحيوي والعضوي تحت مستويين من الإجهاد المائي في بعض الخصائص الفيزيائية والخصوبية للتربة ونمو وحاصل الذرة البيضاء

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الخلاصة

أجريت تجربة حقلية بزراعة الذرة البيضاء في الموسم الربيعي لسنة 2023 في احد الحقول الخاصة ضمن منطقة الدورة/ هور رجب لتقييم أضافة مستويات مختلفة من السماد الحيوي(المايكورايزا وبكتريا الازوسبيرلم) وأضافة السماد العضوي (AgriM40) تحت مستويين من الاجهاد المائي وتداخلهما في نمو وحاصل الذرة البيضاء في تربة ملحية. نفذت تجربة عاملية وفق ترتيب القطاعات المنشقة (The Split Split-Block Design) وبتصميم القطاعات العشوائية الكاملة (RCBD) تضمنت ثلاث عوامل، العامل الرئيسي فواصل الري وبمستويين (10،5 ايام) والعامل الثانوي هو السماد الحيوي الذي يضم خليط من (فطر المايكورايزا وبكتريا أزوسبيريليوم) وبمستويين بدون أضافة والعامل تحت الثانوية هو السماد العضوي (Agri M40) بثلاث مستويات(20، 40، 80) لتر هكتار$^{-1}$ وبثلاثة مكررات.. أظهرت النتائج تفوق معاملة فاصلة الري I5 في تركيز النتروجين الجاهز في التربة وحاصل الحبوب وأعطت 21.088 ملغم كغم$^{-1}$ تربة و6969.83 ميكاغرام ساعة$^{-1}$. أما معاملة السماد الحيوي B1 تفوقت في حاصل الحبوب إذ أعطت 6563.17 ميكاغرام ساعة$^{-1}$ وتفوقت معاملة السماد العضويC3 في الصفة حاصل الحبوب إذ أعطت 6551.00 ميكاغرام ساعة$^{-1}$. أظهر التداخل الثنائي السماد الحيوي وفاصلة الري تأثير معنوياً في تركيز البوتاسيوم الجاهز في التربة وحاصل الحبوب إذ اعطت 8.040 ملغم كغم$^{-1}$ تربة و 171.80 ميكاغرام ساعة$^{-1}$ وأما التداخل الثنائي للسماد العضوي وفاصلة الري حققت فروق معنوية في N,P,K للتربة. أما التداخل الثلاثي حققت المعاملات I5B1C3 I10B1C2, I10B1C3, فروق معنوي في الكثافة الظاهرية وتركيز K للتربة وحاصل الحبوب وكانت نسبة 1.433 ميكاغرام م$^{-3}$ و130.030 ملغم كغم$^{-1}$ تربة و 7664.00 ميكاغرام ساعة$^{-1}$.

الكلمات المفتاحية : سماد حيوي، سماد عضوي، صفات فيزيائية ، نبات الذرة البيضاء.

INTRODUCTION

Sorghum has a notable tolerance towards diverse climatic circumstances, suboptimal soil fertility, limited water availability, and the salinity of irrigation water; consequently, it possesses the capacity to thrive in a broad spectrum of soil types and under a variety of climatic influences. It is important to acknowledge that a particular crop has the potential to yield higher than barley, yellow corn, and rice under water-deficient settings due to several factors **(Griebel *et al*., 2019; Alhag *et al*., 2021; Abood *et al*., 2021; Al-Aradi & Nimer, 2022).** By the year 2050, a significant challenge faced by researchers in the agricultural sector is the task of providing sustenance for a global population of 9 billion individuals, this challenge is particularly pronounced in arid and semi-arid regions of the world, where the effects of climate change, such as rising temperatures and reduced rainfall, exacerbate the difficulties, the availability of arable land has rapidly declined due to various factors including soil degradation, desertification, salinity, and drought. Notably, the salinity of agricultural land globally is causing a daily reduction in production on a scale of 2,000 hectares. This reduction ranges from (10%) to (25%) and hampers the growth of salt-sensitive crops. In some cases, the severity of salinity is so extreme that it contributes to the process of desertification. In Iraq, for instance, salinity-related issues have led to the deterioration of approximately (70%) of the total irrigated land. In the regions of central and southern Iraq, a significant proportion of production, specifically 30%, experienced full loss. The use of saline water for agricultural purposes is a prominent factor contributing to soil salinization in Iraq. To address these challenges, it is imperative to undertake the rehabilitation and conversion of degraded lands from environmental liabilities into productive and economically viable assets, this approach will contribute to resolving the pressing issue of escalating food demand, exploring alternative water sources such as saltwater and treated wastewater for irrigation purposes, and cultivating crops that exhibit tolerance to salinity **(Hussain, 2019; Elsahookie *et al*.,2021).** Water stress is a prominent factor contributing to the occurrence of significant food shortages on a global scale, resulting in substantial reductions in agricultural crop yields, the unfavorable impact of this phenomenon on chemical, biological, and physiological systems has implications for productivity, the plant experiences water stress due to either restricted water availability at the roots or high rates of transpiration, This phenomenon occurs throughout a time of growth or at a certain stage of development **(Garcia *et al*., 2020).** Biofertilizers play a significant role in sustaining soil fertility over an extended duration. This is due to their capacity to serve as a renewable source of essential nutrients required by plants for optimal growth. Microorganisms facilitate the conversion of elements existing in the soil in an unprepared or complex state into soluble forms that can be readily absorbed by plants **(Fasusi *et al*., 2021).** The use of mycorrhiza facilitates the augmentation of plant development and production by facilitating the efficient assimilation of nutrients and the regulation of soil pH, A research investigation was undertaken to ascertain the etiology of root rot disease in a particular plant, as well as to elucidate the factors contributing to nutrient deficit in the soil when mycorrhiza and plant growth-stimulating bacteria were employed **(Almamori & Abdul- Ratha, 2020).** The study findings indicated a rise in nutrient availability, enhanced plant development, and decreased incidence of root rot disease due to the actions of mycorrhizal fungi and plant growth-promoting bacteria **(Lill *et al*., 2020).** The user's text is already academic and does not need to be rewritten. The biofertilizers have been classed based on the specific nutrients they supply, which can be derived from either plant or soil sources, one example of a nitrogen biofertilizer is the bacterial inoculum, and the findings indicated that the introduction of Azospirillum bacteria to sorghum plants had a little impact on their overall development. The plant's dry weight, height, elemental composition, nitrogen-phosphorus-potassium (NPK) protein rate, and grain yield exhibited no significant differences compared to the control treatment, the application of organic fertilizers to the soil results in the gradual release of nutrients, particularly nitrogen and phosphorus. This slow release aligns with the duration of plant growth, thereby enhancing the likelihood of nutrient absorption by both the soil and plant biology **(Awadalla *et al*.,2020; Tamimi & Hadi, 2022; Salih *et al*., 2022; Hassan *et al*., 2023).** Studying the effect of adding different levels of a type of organic fertilizer on some fertility and physical characteristics of saline soil planted with yield of sorghum.

MATERIALS AND METHODS

The field experiment was conducted in the spring of 2023 at a designated area inside the al-Dura/Hor Rajab region, situated approximately 20 km distant at coordinates 122.40'40°44 south and 597.08'18°33 east, following the design of the segmented sectors. The symbol (I5, I10) represents the interruption of irrigation for duration of five and ten days, which serves as a common feature influencing both the Split Split-Block Design and the design of entirely random sectors (RCBD). The composition of the biofertilizer, consisting of a combination of mycorrhiza fungus and azospirillium bacteria at aconcentration of (320g) per plate, also resulted in modifications to the design of the randomized complete block design (RCBD). The symbols C1, C2, and C3 are used to denote the three distinct volumes of organic fertilizer (Agri M40) applied on agricultural plots of five, ten, and twenty liters, respectively. The total number of experimental units in the study was 36, with each unit having an area of (2x2) square meters. Subsequently, the seeds of Sorghum bicolor L. with white pigmentation were planted. In the context of a research class, the user's text is insufficient to determine the specific topic or purpose of the research. During the spring season on February 4, 2023, the distribution of seeds took place at Jur, with a spacing of 25 cm between Jur and another location. The lines of seeds were spaced 50 cm apart, and a plant density of 80,000 plants per hectare was maintained. Additionally, At a nitrogen (N) application rate of 320 kg ha^{-1}, urea fertilizer with a nitrogen content of 46% the fertilizer was applied in three separate batches phosphorus was applied. When planting, a single application of 200 kg P_2O_5 h^{-1} was made using triple superphosphate (TSP) in the form of fertilizer, which contains 46% P_2O_5. Also used. Potassium (K) was applied at a rate of 200 kg ha^{-1} (K_2O). The potassium fertilizer was applied in two separate batches. The first batch was applied during planting using potassium sulfate (K_2SO_4) with a potassium oxide content of 50%. The second batch was applied one month after planting. The cultivation of sorghum should adhere to the prescribed guidelines for nitrogen, phosphorus, and potassium fertilizer application **(Ali *et al*., 2014).** The experimental conditions, consisting of the application of biofertilizer containing mycorrhiza and azoosperilium bacteria, were included before to the planting phase. In each iteration of the experiment, both biofertilizer and bacteria were introduced into the slab and thoroughly incorporated into the top layer at a specified depth of 5-10 cm. A quantity of 10 grams was introduced on each iteration. Incorporate the use of organic fertilizer, specifically AgriM40, into the agricultural practice. The chemical properties of L ha^{-1} were watered at three different levels (5, 10, & 20). The field received irrigation from a branch canal that sources its water from the nearby Hor Rajab river basin. The experiment was carried out until it reached its ultimate stage of maturity and was harvested on February 8, 2023. Soil samples were collected from the field prior to planting on December 3, 2023. These samples were obtained at a depth of (0-30cm) in order to assess their chemical and physical characteristics. The results of this analysis are presented in (Table 1). Following the completion of the harvesting process, a soil sample was collected from each experimental unit. Subsequently, the collected samples were subjected to a drying procedure. Once dried, the samples were mechanically processed using pneumatic milling techniques and subsequently filtered through a sieve with a whole width measuring (2 mm). The soil samples were subjected to essential studies, whereby bulk density and NPK nutrients in the plant and the grain yield were quantified. The bulk density was estimated using the incoming paraffin wax method, **(Black, 1965)** and the nitrogen concentration in the leaves was determined using a microkaldal device. A sample weighing 0.2 g was subjected to digestion by adding 3.5 g of concentrated sulfuric acid and 1.5 g of concentrated perchloric acid, followed by distillation as described in method **(Page *et al*., 1982).** The phosphorus concentration was estimated using ammonium molybdate and ascorbic acid. The light intensity was measured using a spectrophotometer as outlined in method. Lastly, the potassium concentration was estimated using a flame photometer as described in method. **(Haynes, 1980).**

Table (1): Some physical and chemical properties of soil before planting.

<table>
<tr><th colspan="2">Trids</th><th>Value</th><th>Unit</th></tr>
<tr><td colspan="2">Electrical conductivity EC 1:1</td><td>43.5</td><td>dsm-1</td></tr>
<tr><td colspan="2">PH The degree of soil reactivity 1:1</td><td>7.23</td><td>—</td></tr>
<tr><td colspan="2">Organic matter</td><td>0.38</td><td rowspan="3">gm kg-1 soil</td></tr>
<tr><td colspan="2">Carbonate minerals</td><td>230.00</td></tr>
<tr><td colspan="2">Gypsum</td><td>28</td></tr>
<tr><td colspan="2">CEC</td><td>22</td><td>Cmol + kg-1 soil</td></tr>
<tr><td rowspan="8">* Dissolved ions</td><td>Sodium</td><td>9.80</td><td rowspan="7">mmol L-1</td></tr>
<tr><td>Calcium</td><td>20</td></tr>
<tr><td>Magnesium</td><td>14</td></tr>
<tr><td>Potassium</td><td>1.2</td></tr>
<tr><td>Bicarbonate</td><td>1.95</td></tr>
<tr><td>Chloride</td><td>32.13</td></tr>
<tr><td>Sulfates</td><td>10.6</td></tr>
<tr><td>Carbonates</td><td>Nil(0.1)</td><td></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td rowspan="4">Ready-made feeders</td><td>Nitrogen</td><td>16.0</td><td rowspan="4">mg kg-1 soil</td></tr>
<tr><td>Phosphorus</td><td>6.21</td></tr>
<tr><td>Potassium</td><td>112.01</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">Bulk density</td><td>1.52</td><td rowspan="2">Mg m-3</td></tr>
<tr><td colspan="2">particle density</td><td>2.65</td></tr>
<tr><td colspan="2">Porosity</td><td>43</td><td>%</td></tr>
<tr><td colspan="2">Humidity at field capacity</td><td>0.416</td><td rowspan="3">cm-3 cm-3</td></tr>
<tr><td colspan="2">Humidity at the point of permanent wilting</td><td>0.261</td></tr>
<tr><td colspan="2">Ready-made water</td><td>0.155</td></tr>
<tr><td rowspan="3">Soil particles</td><td>Sand</td><td>112</td><td rowspan="3">gm kg-1 soil</td></tr>
<tr><td>Slit</td><td>400</td></tr>
<tr><td>Clay</td><td>488</td></tr>
<tr><td colspan="2">Soil texture</td><td colspan="2">Silty clay loam</td></tr>
<tr><td>Biology preparation</td><td>Total bacteria</td><td>26×107</td><td>gm-1 soil Cfu</td></tr>
</table>

RESULTS AND DISCUSSION

Bulk density

The results of the statistical analysis (Table 2) showed that there were no significant differences in the bulk density in the sorghum of the irrigation interval. The results (Table 2) showed that there were no significant differences for the treatment of biofertilizer in bulk density. The effect of adding organic fertilizer did not achieve any significant differences in the bulk density of Sorghum. As for the bilateral overlap between the biofertilizer level and the irrigation interval, it did not achieve significant differences in the bulk density of Sorghum. The results in Table (2) also showed that there were no significant differences in the bulk density of Sorghum for the bilateral overlap between the level of organic fertilizer and the irrigation interval.

Table (2): The impact of different quantities of organic and bio-fertilizers frequency of irrigation, on bulk density (mg m^{-3}).

Irrigation (I) comma	(B) Bio-fertilizer	(C) Organic fertilizer			B*I
		C1	**C2**	**C3**	
5 days	B0	1.263	1.247	1.480	1.330
	B1	1.357	1.360	1.277	1.331
10 days	B0	1.387	1.373	1.227	1.329
	B1	1.330	1.423	1.433	1.396
LSD $_{I*B*C}$		0.083			N.S
I		I*C			I Average
5 days		1.310	1.303	1.378	1.331
10 days		1.358	1.398	1.330	1.362
LSD $_{I*C}$		N.S			N.S
B		B*C			B Average
B0		1.325	1.310	1.353	1.329
B1		1.343	1.392	1.355	1.363
LSD $_{B*C}$		N.S			N.S
Average C		1.334	1.351	1.354	
LSD $_C$		N.S			

As for the bilateral overlap between the bio- and organic fertilizer levels, there were no significant differences in the bulk density of Sorghum. The results of the statistical analysis in Table (2) showed that the effect of the triple overlap between the level of the irrigation interval and bio and organic fertilizer achieved significant differences in the bulk density of sorghum, as treatment I5B0C3 gave the highest value of 1.480 mg m^{-3} with an increase of 20.62% compared to treatment I10B0C3, which gave a minimum value of 1.227 mg m^{-3}.

Available nitrogen

The results of the statistical analysis in (Table 3) showed the effect of the irrigation interval on the concentration of ready nitrogen in the soil, as the I5 treatment surpassed and gave the highest percentage of 21.088 mg kg^{-1} soil and a decrease of 13.92% compared to the I10 treatment, which gave 18.510 mg kg^{-1} soil. The reason for this may be due to the fact that in the case of five-day irrigation, water is more available in the soil, which leads to an increase in the readiness of nitrogen in the soil and its absorption by the plant. These results took the same direction as indicated by **(Shamsullah *et al*.,2023).** The results of (Table 3) showed that there were no significant differences for biofertilizer in the concentration of ready nitrogen in the soil. The results of Table (3) also showed that there were no significant differences for the addition of organic fertilizer in the concentration of ready nitrogen in the soil.

Table (3): The influence of organic and biogenic fertilizer levels and irrigation intervals on the readiness of nitrogen in the soil (mg kg^{-1} soil).

Irrigation (I) comma	**(B) Bio-fertilizer**	**(C) Organic fertilizer**			**B*I**
		C1	**C2**	**C3**	
5 days	B0	17.000	21.030	17.400	18.477
	B1	16.330	19.400	19.900	18.543
10 days	B0	24.070	19.000	20.930	21.333
	B1	19.670	21.330	21.530	20.843
LSD_{I*B*C}		N.S			N.S
I		I*C			I Average
5 days		16.665	20.215	18.650	21.088
10 days		21.870	20.165	21.230	18.510
LSD_{I*C}		1.490^{**}			1.801^{*}
B		B*C			B Average
B0		20.535	20.015	19.165	19.905
B1		18.000	20.365	20.715	19.963
LSD_{B*C}		1.137^{**}			N.S
Average C		19.268	20.190	19.940	
LSD_{C}		**N.S**			

The level of the irrigation interval and biofertilizer did not make a big difference in the amount of ready nitrogen in the soil. There are big differences in the amount of ready nitrogen in the soil when the level of organic fertilizer and the time between irrigation overlap in both directions. Treatment I surpassed I10C1, which gave the highest percentage of 21.870 mg kg^{-1} soil and an increase of 31.23% when compared with treatment I5C1, which gave 16.665 mg kg^{-1} soil. The bilateral overlap between the levels of organic and biofertilizer had a significant effect on the concentration of ready nitrogen in the soil for sorghum plants, as the B1C3 treatment surpassed B1C3 and gave the highest value of 20.715 mg kg^{-1} soil, a decrease of 15.08% compared to the B1C1 treatment, which gave 18.000 mg kg^{-1} soil. The results of Table (3) showed that no significant differences were achieved for the triple overlap between the levels of organic and biofertilizer and the irrigation interval in the concentration of ready nitrogen in the soil.

Available phosphorus

The results of Table (4) showed that there were no significant differences in the irrigation interval in the concentration of ready phosphorus in the soil. The results of Table (4) also showed that there were no significant differences in the treatment of biofertilizer in the concentration of ready phosphorus in the soil after harvesting. The results of the same table showed that there were no significant differences for the addition of organic fertilizer in the concentration of ready phosphorus in the soil. The bilateral overlap between the level of the irrigation interval and the vital fertilizer did not achieve significant differences. As for the effect of bilateral interference between the level of organic fertilizer and the irrigation interval, significant differences were observed in treatment I5C3, which gave the highest value of 5.314 mg kg^{-1} soil and a decrease of 14.03% compared to treatment I10C1, which gave 4.660 mg kg^{-1} soil.

Table (4): The influence of organic and biogenic fertilizer levels and irrigation interval on the readiness of phosphorus in the soil (mg kg^{-1} soil).

Irrigation (I) comma	(B) Bio-fertilizer	(C) Organic fertilizer			B*I
		C1	C2	C3	
5 days	B0	5.080	5.177	5.190	5.149
	B1	4.827	5.093	5.437	5.119
10 days	B0	4.420	5.660	4.623	4.901
	B1	4.900	4.923	5.283	5.035
LSD $_{I*B*C}$		N.S			N.S
I		I*C			I Average
5 days		4.954	5.135	5.314	5.134
10 days		4.660	5.292	4.953	4.968
LSD $_{I*C}$		0.474**			N.S
B		B*C			B Average
B0		4.750	5.419	4.907	5.025
B1		4.864	5.008	5.360	5.077
LSD $_{B*C}$		0.289**			N.S
Average C		4.807	5.213	5.133	
LSD $_{C}$		N.S			

As for the bilateral overlap between the bio- and organic fertilizer levels, significant differences were observed in the B0C2 treatment, which gave 5.419 mg kg^{-1} soil, with a decrease of 14.08% compared to the B0C1 treatment, which gave 4.750 mg kg^{-1} soil. The results in (Table 4) showed that there were no significant differences in the triple overlap between the levels of organic and bio fertilizer and the time between irrigations.

Available potassium

The results of the statistical analysis in (Table 5) showed that there were no significant differences for the irrigation interval in the concentration of ready potassium in the soil. The results of (Table 5) showed that the effect of biofertilizer did not achieve significant differences in the concentration of ready-made potassium in the soil. The results of Table (5) showed that there were no significant differences in the treatment of organic fertilizer in the concentration of ready potassium in the soil.

Table (5): The influence of organic and biogenic fertilizer levels and irrigation interval on the readiness of potassium in the soil (mg kg^{-1} soil).

Irrigation (I) comma	(B) Bio-fertilizer	(C) Organic fertilizer			B*I
		C1	C2	C3	
5 days	B0	126.370	123.830	121.470	123.890
	B1	114.900	109.670	126.130	116.900
10 days	B0	123.330	121.230	114.070	119.543
	B1	116.570	130.030	119.270	121.957
LSD $_{I*B*C}$		8.364*			8.040**
I		I*C			I Average
5 days		120.635	116.750	123.800	120.395
10 days		119.950	125.630	116.670	120.750
LSD $_{I*C}$		6.036*			N.S
B		B*C			B Average
B0		124.850	122.530	117.770	121.717
B1		115.735	119.850	122.700	119.428
LSD $_{B*C}$		5.914**			N.S
Average C		120.293	121.190	120.235	
LSD $_{C}$		N.S			

The bilateral overlap between the level of irrigation separator and biofertilizer had a significant impact on this trait, as a significant difference was found in treatment I5B0, which gave 123,890 mg kg^{-1} soil, with a decrease of 5.97% compared to treatment I5B1, which gave 116,900 mg kg^{-1} soil. As for the bilateral overlap between the level of organic fertilizer and the irrigation interval, there were differences. Treatment I10C2 gave a value of 125.630 mg kg^{-1} soil, with a decrease of 7.60% compared to treatment I5C2, which gave 116.750 mg kg^{-1} soil. The bilateral overlap between the levels of bio- and organic fertilizer achieved significant differences, as treatment gave the B0C1 highest value of 124.850 mg kg^{-1} soil with a decrease of 7.87% compared to treatment B1C1, which gave 115.735 mg kg^{-1} soil. As shown in Table (5), there are significant differences in the three-way overlap between the levels of organic and biological fertilizer and the irrigation interval, as the I10B1C2 treatment gave the highest value of 130.030 mg kg^{-1} soil 18.56% compared to the I5B1C2 treatment, which gave 109.670 mg kg^{-1} soil.

yield Grain

The statistical analysis in (Table 6) showed that the length of time between irrigation had a significant impact on the grain yield. Treatment I5 produced 6969.83 mg h^{-1}, which is 26.91% more than treatment I10, which produced 5491.67 mg h^{-1}. Sequentially, this clearly indicates that the spacing of irrigation periods significantly affects the creation of abnormal conditions, which affect the growth of plants, as well as reflects on the yield and its components. Sequentially, this agrees with many researchers, including. **(Shakeri *et al*., 2017; Ali & Kadhim, 2023).**

Confirmed that the exposure of plants to water stress leads to a delay in the production of leaves in the main stem and delays the emergence of flowers by several days, which in turn leads to a decrease in the size of the heads and grain yield **(Wahed & Al-Azawi, 2023).** (Table 6) shows that the biofertilizer treatment increased the grain yield more than the control treatment. Treatment B1 gave 6563.17 mg h^{-1} 11.27, which is 11.27% more than treatment B0, which gave 5898.33 mg h^{-1}. (Table 6) shows that the use of organic fertilizer had a noticeable impact on grain yield. For example, the treatment at level C3 resulted in 6551.00 mg h^{-1}, which is 9.76% less than the treatment at level C1, which resulted in 5968.00 mg h^{-1}. The reason for the increase in yield when adding organic residues is due to the role of decomposed organic matter in improving physical and fertility qualities and increasing the concentrations of some nutrients such as N ,P, K, who showed an increase in the yield of sorghum when adding various organic residues and that the addition of organic fertilizers to the soil has an effect in the Fertilizers stimulate growth regulators, especially auxins and gibberellins, which play an important role in increasing the percentage of nodes by controlling the movement of nutrients towards flowers and accelerate the growth of the pollen tube, which encourages the fertilization process and the formation of grains, as well as their role in increasing the amount of pollen and eggs formed through their effect on growth and the efficiency of photosynthesis Flowers from foodstuffs to ensure their holding.

Table (6): The effect of organic and biofertilizer levels and irrigation interval on grain yield (mg h^{-1}).

Irrigation (I) comma	(B) Bio-fertilizer	(C) Organic fertilizer			B*I
		C1	C2	C3	
5 days	B0	6496.00	6696.00	6883.00	6692.00
	B1	7035.00	7045.00	7664.00	7248.00
10 days	B0	4736.00	5136.00	5443.00	5105.00
	B1	5605.00	5816.00	6214.00	5878.33
LSD $_{I*B*C}$		195.80**			171.80**
I		I*C			I Average
5 days		6765.50	6870.50	7273.50	6969.83
10 days		5170.50	5476.00	5828.50	5491.67
LSD $_{I*C}$		N.S			93.60**
B		B*C			B Average
B0		5616.00	5916.00	6163.00	5898.33
B1		6320.00	6430.50	6939.00	6563.17
LSD $_{B*C}$		N.S			99.20**
Average C		5968.00	6173.25	6551.00	
LSD $_{C}$		91.50**			

These results are consistent with the findings of **(Ghazi, 2015; Mahmood *et al*., 2020; Kadhim & Hamza, 2021).** Treatment I5B1 achieved significant differences in the effect of bilateral interference between the biofertilizer and the irrigation interval, giving the highest value of 7248.00 mg h^{-1}, which was a 41.98% increase compared to treatment 10B0 value of 5105.00 mg h^{-1}. The effect of bilateral interference between the level of compost and the irrigation interval on the grain yield did not achieve significant differences. The results shown in (Table 6) did not achieve significant differences for the bilateral overlap between the levels of bio- and organic fertilizer in the grain yield. However, the results showed numerically that the transaction B1C3 gave the highest value, amounting to 6939.00 mg h^{-1} when compared with the transaction B0C1, which amounted to 5616.00 mg h^{-1}. The results also showed in (Table 6) that the effect of the triple overlap between the irrigation interval and bio- and organic fertilizer achieved significant differences in the grain yield, as treatment I5B1C3 gave 7664.00 mg h^{-1}, with an increase of 61.82% compared with treatment I10B0C1, which amounted to 4736.00 mg h^{-1}.

CONCLUSION

Adding biofertilizer and organic fertilizer to the soil achieved a significant and positive effect on most of the nutrient availability (NPK) concentrations in the soil, as well as crop growth.

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