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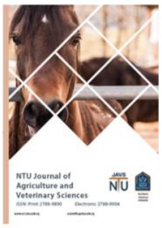

Studying the effect of biological pollination and organic fertilization on some characteristics of yellow maize plants (*Zea mays* L.)

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A B S T R A C T

Sixteen rhizosphere soil samples were collected for several plants from different locations, and phenotype, microscopic, and biochemical tests were conducted on them. In this study, the two most efficient isolates were selected to study the effect of bioinoculation with nitrogen-fixing bacteria, *Azotobacter chroococcum*, and phosphate-dissolving bacteria, *Bacillus subtilis*, in the field experiment and two levels of organic fertilizer on Sheep waste body In two sites, the first in the fields of the College of Agriculture and Forestry with a clay texture, and the second site in the fields for the protection of crops with an alluvial mixed texture, regarding the growth and yield of yellow maize (*Zea mays* L.), the isolates used in the study were grown and preserved at a temperature of 4°C until used in the field. Use two levels of organic fertilizer (0% and 2%) in two locations with different textures (clay and silty Loam). The chemical fertilizers N, P, and K were added to all treatments at one level according to the fertilizer recommendation. Then the seeds were planted after preparing them in the carrier. The study employed a randomized complete block design (RCBD) with three replications in the field, and the Duncan test was used to compare the means. The results of the study showed:

1. The treatment inoculated with a mixture of *A. chroococcum*+ *B. subtilis* and fertilized with sheep waste at the clay texture outperformed all treatments about the characteristics (plant height, biological yield), and gave the highest values, reaching (323.667 cm and 19763.3 tons ha-1) on straight.
2. The treatment inoculated with a mixture of *A. chroococcum* + *B. subtilis* excelled in the clay type, whether fertilized with organic fertilizer or not, as it gave the highest values for the character of the shoots of the plant (905,000 and 902,667 g).
3. The treatment that was not inoculated and was not organically fertilized with the clay texture produced the highest percentage of oil, amounting to 6.331%, while the treatment that was inoculated with a mixture of *A. chroococcum*+ *B. subtilis* fertilized with sheep waste in Silty Loam recorded the lowest percentage of oil, amounting to 4.025%.

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Introduction

Despite the widespread development in modern agricultural methods and the use of advanced irrigation systems in the country, and to limit the excessive use of chemical fertilizers, it was necessary for specialists to invest in biological agricultural techniques to increase crop productivity, by stimulating the speed of germination of seeds and treating them with bio-fertilizers after they have been biologically tested and molecularly diagnosed, which has a positive impact. It increases vegetative growth and yield [1]. Therefore, recent studies have turned to the use of microorganisms, including the genera *Azotobacter* and *Bacillus*, to provide nutrients to plants to reduce the use of chemical fertilizers to a minimum, as well as reduce agricultural production costs. The use of bacterial bio-inoculation, whether single or mixed, has a significant impact on Plant growth [2].

Organic fertilizers play an important role in improving the physical and chemical properties of the soil and increasing biological activity, thus increasing the availability of nutrients necessary for plant growth. When used with bio-fertilizers, organic fertilizers increase the weighted diameter rate and enhance cluster stability while also helping to hold onto nutrients and keep irrigation water from washing them away. Thus improving the physical properties of the soil, On the other hand, bacterial inoculation has an important role in binding the soil particles and increasing their aggregation by adsorbing their cells to the surfaces of the soil particles and holding them. There is also a highly significant effect when treated with a double bio-inoculation consisting of *Azospirillum lipoferum* and Bacillus polymyxa on the weighted diameter ratio as an indicator of the stability of soil aggregates, total porosity, and soil moisture content [3].

Yellow corn, *Zea mays* L., is one of the important economic crops in the world and is ranked third after wheat and rice, in addition to containing carbohydrates, fats, sugar, and fiber. Therefore, determining irrigation systems, both surface and subsurface, is important within the modern systems currently in use, especially in dry and semi-arid areas, such as drip and sprinkler irrigation systems, or the use of nano-irrigation systems due to water scarcity. Iraq is one of the countries most affected and exposed to drought, according to the latest report of the Organization [4], so it had to be addressed by following appropriate irrigation methods for the yellow corn crop while maintaining better crop productivity. The use of irrigation systems is of great importance. On the growth and biological yield of the plant, in addition to its effect on the microorganisms present in the root zone due to the size of the wetness front and water flow, which in turn affects the activity of microorganisms, both aerobic and non-aerobic.

The drip irrigation system, whether surface or subsurface, is one of the approved systems in the world that economically achieves efficient use of water, especially when adding bio-fertilizers and in the presence of organic fertilizers, which in turn improves the properties of the soil and the readiness of the fertilizer for the plant and does not inhibit it in the soil, thus increasing crop productivity [5]. The study aims to examine the effect of Azotobacter and Bacillus genus as bio-fertilizers and organic fertilizer for the two study sites on some characteristics of the yellow corn plant, (*Zea mays* L.).

Materials and working methods

Sample collction

Samples of surface soil at a depth of 10 cm were collected from areas surrounding plant roots in various regions, such as the Rashidiya area of the Mosul District, the College of Agriculture and Forestry / University of Mosul, the College of Agriculture / University of Tikrit, the Nineveh Agriculture Department's plant protection fields, and the fields of different plants (16). As indicated in Table (1), every sample was packed in nylon bags and sent to the laboratory during the time frame spanning from 2-3 to 5-4, 2022.

Table 1. shows the areas and plants from which samples were taken to conduct isolation

Transactions	Location	Type of cultivation	Isolation source
Z_1	College of Agriculture and Forestry University of Mosul	Inside plastic houses	Potatoes
Z_2			Bean
Z_3			Okra
Z_4			Apium
Z_5			Cucumber
Z_6			Cucurbita
Z_7	Fields of the College of Agriculture Tikrit University	College fields	Red clover
Z_8			Wild clover
Z_9			Zea mays
Z_{10}	Agricultural Protection Directorate	Agricultural protection fields	Onion
Z_{11}			Garlic
Z_{12}		The project field is inside greenhouses	Lettuce
Z_{13}			Holland beans
Z_{14}	Errachidia area	Area fields	Chard
Z_{15}			Onion
Z_{16}			Local beans

Bacteria isolation

A series of six dilutions (10^{-1} - 10^{-6}) were performed on all samples in sterile 10 ml test tubes containing 9 ml of sterile distilled water [6]. After numbering the tubes, they were placed in a water bath at 100 °C. 80°C for one hour to eliminate the vegetative cells and the survival of the spore cells to isolate *Bacillus* bacteria, while the tubes were not treated in the water bath during the isolation of *Azotobacter* bacteria. Transfer 1 ml of the last three dilutions to each sample and culture it on the special nutrient medium for the growth of *Azotobacter* bacteria and the special nutrient medium for the growth of *Bacillus* bacteria, and incubated at a temperature of 28ºC for a period of 3-4 days. Two types of bacterial genera were selected after Purification and preservation in the solid slanting medium at 3°C. Temperature: 4ºC until used in agriculture.

Method of taking samples from the field

Surface samples of soil were taken at a depth of 10 cm to conduct some physical, chemical, and biological tests, as shown in Table (2).

Characteristics of the study soil:

Some physical, chemical, and soil biochemical analyses were carried out in the soil according to the methods described by [7] and [8].

Table 2. shows some physical and chemical characteristics of the study soil.

Trait		Unit	Value	
			fields College of Agriculture and Forestry	Plant protection fields
Soil Texture			Clay	Silty Loam
pH			7.4	7.8
Ec		dS^{-1}	0.8	1.20
O.M		%	2.23	2.04
Bulk density		$\mu g\ m^{-1}$	1.5	1.8
CEC		C mol Kg $Soil^{-1}$	17.5	16.1
Ca^{+2}		Mlm L^{-1}	4.3	4.0
Mg^{+2}			2.4	2.1
Na^{+}			2.1	2.6
Cl^{-}			0.38	0.44
SO^{-2}			4.6	4.1
HCO_3^{-}			4.0	3.2
Content of finished items	N	mg Kg^{-1}	18	17
	P		9	7.7
	K		327	218
Total Bacteria		CFU	2.7×10^{5}	$10^{5}\times2.3$

Experiment implementation:

On March 25, 2023, a field experiment was carried out to investigate the effects of inoculation with soil-isolated Bacillus subtilus and *Azotobacter chroococcum* bacteria. The first field was the Agricultural Research Center of the College of Agriculture and Forestry, and the second field was the crop protection fields of the Nineveh Agriculture Directorate, which is located near the Tigris River. To influence the growth and yield of yellow corn plants, the rhizosphere of a few field crops was chosen: Egyptian clover was chosen from the soil of the fields of the College of Agriculture/Tikrit University, and okra was chosen from the soil of the fields of the College of Agriculture and Forestry/University of Mosul.

Steps to implement the field experiment:

The land was plowed and prepared for cultivation using a triple disc plow, then the process of leveling and smoothing was carried out using the ripper and it was divided into panels. The area of each panel is 4 x 5 m^2, and each panel contains 4 lines. A distance of 75 cm was left between one line and another and between one panel and another, and the distance between one hole and another was 50 cm. A drip irrigation system was configured for each study site. After that, the soil was sterilized with formaldehyde and covered with nylon in the two study sites.

Planting seeds

The two sites were planted for the spring agricultural season / 2023 with yellow corn seeds of the *Zea mays* L. variety. Sound seeds of similar sizes were selected, inoculated with the bacterial isolates used in the study, and planted at fixed depths of 10 cm at a rate of 3 seeds per hole. The seedlings were thinned out after a week of drip irrigation on the plates. From germination to one plant per seedling. Organic fertilizers were added in the form of poultry waste to all treatments at a rate of 2 tons ha^{-1}. Mineral fertilizers were also added to all treatments as an encouraging boost before planting. Nitrogen fertilizer at a rate of 40 kg N ha^{-1} was added using urea fertilizer at 46% N as a source of nitrogen, and phosphate fertilizer at a rate of 40 kg P ha^{-1}. Using triple super phosphate fertilizer 21% P as a source of phosphorus and potassium at a rate of 40 kg K h^{-1} using potassium sulphate fertilizer 43% K as a source of potassium, before planting.

Plant specimens were taken from the field 90 days after germination to conduct measurements and analyzes of some plant characteristics. The experiment was implemented according to a randomized complete block design (R.C.B.D.). Each treatment was repeated 3 times, resulting in 48 experimental units.

Studied plant characteristics

Plant height (cm^{-1} plant):

Plant height was estimated for all treatments and replicates using a measuring tape after flowering was completed, starting from the soil surface to the top of the leaf base (flag leaf), [9].

Weight of stalks per plant (gm - 1 plant)

From each experimental unit, ten plant samples were obtained, and the shoots were harvested. Each plant's weight in shoots was determined, and each plant's specific extraction rate was then determined.

Biological yield (kg ha^{-1}):

Biological yield was calculated by the weight of total dry matter (grains + plant residues) per unit area [10].

Oil percentage:

The oil percentage was calculated according to what was stated in [11]. He took 2 grams of seeds, placed them in (filter paper), tied them with a tight thread, and placed them in the oven for half an hour at a temperature of 75°C. He took their weight, then placed them in the Saxolite device in the tube, and put petroleum ether, with a boiling point of 60-80°C, in the Saxolite beaker and placed it. On a water bath, the petroleum ether was placed at the boiling point, and the petroleum ether was heated, the process of distillation took place and the seeds were washed from the oil. Samples were taken after washing them well with petroleum, dried air, then placed for an hour in the oven at a temperature of 75°C. After drying, they were weighed and the percentage of fixed oil was calculated from the following law:

$$\text{Percentage of fixed oil \%} = \frac{\text{Sample weight before washing} - \text{Sample weight after washing}}{\text{Weight of seed sample}} \times 100$$

Studied plant traits

Plant height

Yellow corn (*Zea mays* L.) growth and yield are affected by bacterial inoculation and organic fertilization of two distinct tissues, and Table 3 shows the effects of these interactions in terms of plant height (cm). The findings indicated that while treatment inoculated with *A. chroococcum* + *B. subtilis* was superior to inoculated treatments, inoculation with the bacteria *Azotobacter chroococcum*, *Bacillus subtilis*, and *Azotobacter chroococcum* + *Bacillus subtilis* resulted in a significant increase in plant height, with percentages of increase reaching (19.00%, 13.25%, and 22.04%), respectively, compared to the uninoculated treatment. The ability of bio- fertilizers to supply nutrients, particularly nitrogen that is ready for plant absorption and allows the plant to produce a large number of meristematic cells, is the cause. The reason may be due to the role of organic fertilizers in supplying the soil with nitrogen, N, and phosphorus, P, and thus the plant absorbs them, which encourages vegetative growth and increases plant height [12]. These results are consistent with the findings of [13]. As for the soil texture, no significant differences were observed in the clay texture compared to the Silty Loam texture.

This is because the percentage of sand sediments in the two textures is similar, while the percentage of clay sediments in the first texture and silt in the second texture is higher. This causes the soil to retain moisture content, which aids in plant growth and elevates the clay texture soil to a higher height of 293.916 cm compared to This rise is the result of the combined effects of inoculation with a mixture of bacteria and fertilization with sheep dung, with a Silty Loam texture reaching 291,750 cm. The organic fertilizer contributed to providing the necessary nutrients in the soil, which led to the activity of microorganisms and their secretion of enzymes to provide the soil with the elements nitrogen and phosphorus, which helped the plant absorb them, and a clear effect appeared in the quality of Plant height compared to the single effect of the bacteria, whether A. chroococcum alone or B. subtilis alone. As for the effect of soil texture and bacterial inoculation on the character of plant height, a greater height was observed in Silty Loam, as its average height reached 316.333 cm. The explanation could be that the presence of elements like temperature and humidity in the clay-textured soil allowed bacteria to become more active, which helped prepare The nutrients in the soil are taken up by the plant and have a major impact on the plant's height. Table (3) also showed, when studying the effect between organic fertilization with sheep manure and the texture type of the cultivated plants, a convergence in the average height for both the clay textures and nitrogen and phosphorus, and the high rate of their absorption by the plant contributed to the increase in the weight of the Silty Loam, as the average height reached 300,250 cm and 300,916 cm, respectively, compared to the non-organically fertilized treatment. The reason may be due to the role of microorganisms in preparing the nutrients represented by As for the interaction between inoculation and organic fertilization of two different tissues, the results showed that inoculation with a mixture of *A. chroococcum* + *B. subtilis* bacteria and fertilization with sheep waste was better and had higher plant yields compared to *A. chroococcum* alone or *B. subtilis* bacteria alone. The reason may be due to the combined effect of the mixture of bacteria in supplying the soil with nutrients, especially nitrogen and phosphorus. In the presence of sheep manure fertilizer, there was a very slight superiority of the clay texture over Silty Loam.

Weigh the stalks per plant

Table (4) shows the effect of bacterial inoculation and organic fertilization of two different tissues and their interaction on the average weight of shoots per plant, gm^{-1} plant. The results showed that all bacterial inoculation treatments had a significant effect compared to the non-inoculated treatment, as the percentage of increase reached (17.43%, 51.84% and 66.41% respectively, and the inoculation agent with a mixture of bacteria outperformed all treatments. The reason may be due the highest value. The value reached 753.667 gm plant^{-1} compared to all treatments. shoots in the plant. This is consistent with the findings of [14]. As for the effect of organic fertilization with sheep waste, the results showed the superiority of the fertilized treatment and gave the highest value of 611.333 gm plant^{-1} over the non-fertilized treatment, which amounted to 495.999 gm plant^{-1}, while the effect of the clay texture on the weight of the shoots was higher, reaching 706.249 gm plant^{-1} compared to Silty Loam treatment, which amounted to 401.083 gm plant^{-1}. Between inoculation with bacteria and organic fertilization, the inoculation agent is with a mixture of *A. chroococcum* + *B subtilis* bacteria. and fertilized with sheep waste gave the highest value, reaching 707,000 gm plant^{-1} compared to all treatments. The results also showed that inoculation with bacteria and soil texture type outweighed the factor of inoculation with *A. chroococcum* + *B. subtilis* bacteria for the clay texture, which gave the highest value, reaching 903.833 gm plant^{-1} compared to all treatments, while the effect of organic fertilization with sheep waste for the clay texture had a significant effect and gave the highest value. The value reached 753.667 gm plant^{-1} compared to all treatments.

As for the triple interaction between pollination, organic fertilization, and the tissue, the pollination agent was superior to the mixture of *A. chroococcum* + *B. subtilis*, whether yellow corn plant with good vegetative characteristics has good production. These results were consistent with the findings of [15].

Table 3. The effect of inoculation with bacteria, organic fertilization, and tissue, and their interaction on the characteristic of plant height (cm) on the growth and yield of yellow corn (*Zea mays* L.).

texture	Organic fertilization	Pollination: Non Pollination	Pollination: *Azotobacter chroococcum*	Pollination: *Bacillus s ubtilis*	Pollination: *Azotobacter chroococcum* + *Bacillus subtilis*	Interaction between tissue and organic fertilization	Texture effect	Effect of organic fertilization
Texture 1 Clay	O_0	252.000 f	302.333 bc	287.000 d	309.000 b	287.583 b		
	O_1	270.333 e	306.667 a	300.333 bc	323.667 a	300.250 a		
Texture 2 silty loam	O_0	242.000 g	299.000 bc	283.667 d	305.667 a	282.583 c		
	O_1	267.000 e	319.333 a	297.000 c	320.333 a	300.916 a		
Interaction between tissue and pollination	Texture 1 Clay	261.167 c	304.500 a	293.667 b	316.333 a		293.916 a	
	Texture 2 silty loam	254.500 c	309.167 a	290.333 b	313.000 a		291.750 a	
Interaction between fertilization and pollination	O_0	247.000 f	300.667 bc	285.333 d	307.333 b			285.083 b
	O_1	268.667 e	313.000 a	298.666 c	322.000 a			300.583 a
Pollination effect		257.833 c	306.833 a	292.000 b	314.667 a			

Table 4. The effect of inoculum with bacteria, organic fertilization, tissue, and their interaction on the weight of shoots per plant, gm plant^{-1}, on the growth and yield of yellow corn (*Zea mays* L.).

Texture	Organic fertilization	Pollination: Non Pollination	Pollination: *Azotobacter chroococcum*	Pollination: *Bacillus subtilis*	Pollination: *Azotobacter chroococcum* + *Bacillus subtilis*	Interaction between tissue and organic fertilization	Texture effect	Effect of organic fertilization
Texture 1 Clay	O_0	443.000 i	604.333 g	683.000 c	905.000 a	658.833 b		
	O_1	665.333 e	670.667 d	776.000 b	902.667 a	753.667 a		
Texture 2 silty loam	O_0	162.667 n	301.333 m	435.667 j	433.000 j	333.166 d		
	O_1	382.667 k	365.667 l	616.333 f	511.333 h	469.000 c		
Interaction between tissue and pollination	Texture 1 Clay	554.166 c	637.500 c	729.500 b	903.833 a		706.249 a	
	Texture 2 silty loam	272.667 f	333.500 h	526.000 d	472.167 e		401.083 b	
Interaction between fertilization and pollination	O_0	302.833 h	452.833 g	559.333 c	669.000 b			495.999 b
	O_1	524.000 e	518.167 f	696.166 d	707.000 a			611.333 a
Pollination effect		413.416 c	485.500 d	627.750 b	688.000 a			

Biological quotient

Table (5) shows the effect of bacterial inoculum, organic fertilization, and tissue type on the biological yield (ton ha^{-1}). The treatment inoculated with a mixture of *A. chroococcum* + *B. subtilis* bacteria was superior to the inoculation agent alone, as its value reached 18.06817 tons ha^{-1}. The results were consistent with the weight of dry shoots and the weight of total grains. The results showed that there were significant differences in the treatments inoculated with bacteria, whether it was *A. chroococcum*, *B. subtilis*, or *A. chroococcum* + *B. subtilis*. The percentage of increase was (19.2%, 18.72%, and 53.44%) respectively compared to the control treatment. The results showed that organic fertilization with sheep waste was superior to the non-fertilized treatment, as its value reached 14.79100 tons ha^{-1}. It was observed that there was a significant effect in the treatment of the clay texture, as its value amounted to 15.24658 tons ha^{-1} compared to Silty

Loam, whose value was 13.27083 tons ha^{-1}. It was noted that the best results were achieved when combining bacterial inoculation using a mixture of *A. chroococcum* + *B. subtilis* bacteria with organic fertilized with sheep waste or not, in the clay tissue, as its value reached 905,000 and 902,667 gm plant^{-1}, respectively, compared to all treatments, while it did not There was no significant difference in the organic fertilization treatment. These results were consistent with the vegetative characteristics of the plant mentioned previously. The best treatments are from a vegetative standpoint and their characteristics, which confirms that the fertilization with sheep waste, as this treatment significantly exceeded all other treatments, reaching a value of 18.5757 tons ha^{-1}. While the same table shows the effect between bacterial inoculation, organic fertilization, and tissue type on the biological yield, the factor inoculated with a mixture of *A. chroococcum* + *B. subtilis* bacteria and fertilized with sheep waste in the clay fabric outperformed the rest of the treatments, as its value reached 19.7633 tons ha^{-1}.

In light of the previous results, it is clear that the reason for the increase may be due to the efficiency of bacteria in stimulating the growth of the root group by increasing the absorption of water and nutrients and producing growth regulators. Inoculation with a mixture of bacteria has a positive effect on increasing plant growth through their secretions that prepare nutrients for the plant to absorb. These results are in agreement with [16], [17] and [13], who indicated that fertilizing yellow maize seeds with bio-fertilizer increased crop growth and grain yield, which was reflected positively in increasing biological yield.

Table 5. The effect of inoculum with bacteria, organic fertilization, and tissue on the biological yield (ton ha^{-1}) on the growth and yield of yellow corn (*Zea mays* L.)

texture	Organic fertilization	Pollination: Non Pollination	*Azotobacter chroococcum*	*Bacillus subtilis*	*Azotobacter chroococcum* + *Bacillus subtilis*	Interaction between tissue and organic fertilization	Texture effect	Effect of organic fertilization
Texture 1 Clay	O_0	11.4240 j	12.010 i	16.7253 d	19.1240 b	14.82133 b		
	O_1	13.0760 g	16.3240 e	13.5240f	19.7633 a	15.67183 a		
Texture 2 silty loam	O_0	10.6307 k	11.8113 i	12.0867 i	15.9973 e	12.63150 d		
	O_1	11.9700 i	12.6980 h	13.5847 f	17.3880 c	13.91017 c		
Interaction between tissue and pollination	Texture 1 Clay	12.2500 f	14.1680 d	15.1247 c	19.4437 a		15.24658 a	
	Texture 2 silty loam	11.3003 g	12.2547 f	12.8357 e	16.6927 b		13.27083 b	
Interaction between fertilization and pollination	O_0	11.0273 g	11.9117 f	14.4060 c	17.5607 b			13.72642 b
	O_1	12.5230 e	14.5110 c	13.5543 d	18.5757 a			14.79100 a
Pollination effect		11.77517 d	13.21133 c	13.98017 b	18.06817 a			

Oil ratio (%)

The results shown in Table (6) indicate that the main effect of the bio-pollination agents differed significantly in their effect on the oil percentage (%) from that on the grain yield. It was found that the rates of the oil percentage were inversely related to the protein percentage and grain yield, as increasing the yield led to The percentage of oil was reduced, as the lowest percentage in all inoculated treatments, which were *A. chroococcum*, *B. subtilis*, and *A. chroococcum* + *B. subtilis*, was (5.035%, 4.784%, and 4.834%), respectively, the highest percentage reached (5.939%) when treated without biological inoculation. The reason for the decrease in the oil percentage may be due to the role of Bacillus bacteria, which has a lesser effect than *Azotobacter* bacteria in increasing the readiness of phosphorus, which is the main component of the oil. These results are consistent with the findings of [18], who showed that increasing the readiness of nutrients, especially the phosphorus element, was reflected in a significant way. Positive on the oil percentage in the yellow corn crop, As for the effect of organic fertilization, the results showed that the lowest percentage was in the treatment fertilized with sheep waste, reaching 4.601%. While the highest percentage was in the non-fertilized treatment and amounted to 5.695%. The reason for the decrease in the percentage of oil may be due to the nutrients contained in the organic fertilizer, especially nitrogen, most of which is converted into protein, which leads to a decrease in the percentage of oil in the grains. The results also demonstrated that there was a considerable variation in the percentage of oil produced by the different soil textures. The percentage of oil produced by treating the clay texture was the lowest at 5.077%, while the percentage produced by treating the silty loam texture was the highest at 4.601%. It was noted that bacterial inoculation and organic fertilization had a significant effect on oil percentages, and the highest percentage was when treated without bacterial inoculation and organic fertilization, as the percentage reached 6.218%, and the lowest percentage reached 4.085% when treated with mixed inoculation *A. chroococcum* + *B. subtilis* and fertilization with sheep waste. The results showed that the inoculum treatments and soil texture type gave the lowest percentage of oil when the inoculation agent used a mixture of *A. chroococcum* + *B. subtilis* bacteria and Silty Loam.

The percentage was 4.670%, which was lower than the highest percentage of oil found in the treatment without impregnation, which occurred in both clay and Silty Loam textures, reaching 5.945% and 5.934%, respectively. It was also observed that the interaction fertilizer or not, gave the highest values in terms of dry vegetative weight. The treatment inoculated with a

between the type of tissue and organic fertilization produced the lowest percentage of oil, 4.602%, in the treatments involving the fertilization of clay tissue and sheep waste, while the treatment lacking organic fertilization in the clay tissue yielded the highest percentage 5.893%. While there was no significant difference in the treatment fertilized with sheep waste for the clay texture compared to the organically fertilized treatment with Silty Loam texture. The results indicated that bacterial inoculation, organic fertilization, and the soil texture type shown in Table (6) led to a decrease in the percentage of oil when inoculated with a mixture of bacteria and fertilized with sheep waste of an Silty Loam. The lowest value of the oil percentage was 4.025% compared to the uninoculated and non-organically fertilized treatment with Clay texture, which recorded the highest percentage, reaching 6.331%.

Table 6. The effect of inoculum with bacteria, organic fertilization, and tissue, and their interaction on the percentage of oil (%) on the growth and yield of yellow corn (*Zea mays* L.).

texture	Organic fertilization	Pollination: Non Pollination	Pollination: *Azotobacter chroococcum*	Pollination: *Bacillus subtilis*	Pollination: *Azotobacter chroococcum* + *Bacillus subtilis*	Interaction between tissue and organic fertilization	Texture effect	Effect of organic fertilization
Texture 1 Clay	O_0	6.331 a	5.931 c	5.242 i	5.852 d	5.893 a		
	O_1	5.538 g	4.290 m	4.427 k	4.146 n	4.600 cd		
Texture 2 silty loam	O_0	6.105 b	5.684 f	5.102 j	5.315 h	5.551 b		
	O_1	5.785 e	4.235 m	4.366 l	4.025 o	4.602 c		
Interaction between tissue and pollination	Texture 1 Clay	5.934 ab	5.110 b	4.834 d	4.999 cd		5.219 a	
	Texture 2 silty loam	5.945 a	4.960 c	4.734 e	4.670 f		5.077 b	
Interaction between fertilization and pollination	O_0	6.218 a	5.807 b	5.172 d	5.583 e			5.695 a
	O_1	5.661 c	4.262 g	4.396 f	4.085 h			4.601 b
Pollination effect		5.939 a	5.035 b	4.784 d	4.834 c			

Conclusions

The treatment inoculated with a mixture of *A. chroococcum* + *B. subtilis* and fertilized with sheep waste for clay texture outperformed all treatments in most of the plant growth and yield traits, namely (plant height and biological yield), while the treatment inoculated with a mixture of *A. chroococcum* + *B. subtilis* outperformed the cultivar The clay texture, whether fertilized with organic mixture of *A. chroococcum* + *B. subtilis* bacteria and fertilized with sheep manure in the alluvial mixture tissue recorded a lower percentage of oil compared to the uninoculated and non-organically fertilized treatment in the clay texture. There was a significant effect for the organically fertilized treatments compared to the non-fertilized treatments for both sites. The results confirmed that soil texture had a significant effect on the growth and yield of yellow corn, and it was better in soil with a clay texture than in soil with an alluvial mixture texture.

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