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Effect Of Organic Fertilizer Levels And Types Of Biofertilizer On The Two Varieties Of Okra (Abelmoschus Esculentus L.) Traits Cultivated In Greenhouses

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Abstract

The experiment was conducted during the agricultural season 2020-2021, under unheated greenhouse conditions, at the Agricultural Research Station of the Department of Horticulture and Landscape Design Agriculture and Marshlands College, Thi-Qar University, to determine the effect of levels of organic and biological fertilizers on the growth and yield of two okra cultivars (Al-Hussainawi and Petra). The experiment was carried out with three factors, The first factor (class); includes two varieties of okra (Al-Hussainawi A and Petra B). The second factor; was sheep manure with four levels O_0 without addition, O_1 (2.5 kg experimental unit), O_2 (5 kg experimental unit) and O_3 (7.5 kg experimental unit). The third factor; was a mixture of biofertilizer with four levels of O_0 without any addition, A (Azo.) (Azotobacter chroococcum): at a concentration of 1.1×10^9, B (Pseu.): (Pseudomonas flourescens) at a concentration of 3.6×10^9, and C (Azo.+Pse.): (Azotobacter chroococcum + Pseudomonas flourescens) at a concentration of 4.7×10^9. The means were compared according to L.S.D Least Significant Difference test at 0.05. The results showed that the Husseinawi okra cultivar was superior to the Petra okra cultivar in the content of nitrogen, phosphorous and potassium in leaves, the yield of one plant and the total yield (2.791%, 0.420%, 2.299%, 348.21 g plant^{-1}, 2.214 kg m^2). As for the organic fertilizer, the treatment O_3 (7.5 kg experimental unit) of the Husseinawi cultivar was superior in the leaves content of nitrogen, phosphorous and potassium, the yield of one plant and the total yield (3.047%, 0.503%, 2.967%, 380.93 g plant^{-1}, 2.445 kg m^2). Biofertilizer, the treatment C (Azo.+Pse.) was superior in the average leaf content of nitrogen, phosphorous, potassium, yield per plant and total yield (3.007 %, 0.479 %, 2.770 %, 372.17 g plant^{-1}, 2.404 kg m^2). As for the effect of the bilateral interaction between okra cultivars and biofertilizer types, treatment A C (Azo.+Pse.) outperformed the leaves content rates of nitrogen, phosphorous, potassium, yield of one plant and total yield (3.201%, 0.493 %, 2.835 %, 378.67 g plant^{-1}, 2.430 kg m^2). The bilateral interaction between organic and biological fertilizers. The treatment O3C (Azo.+Pse.) showed outperformed in the leaves content of nitrogen, phosphorous and potassium, the yield of one plant and the total yield (3.302%, 0.551%, 3.440%, 403.27 g plant^{-1}, 2.588 kg m^2). The triple interactions showed a significant effect on most of the studied traits.

Keywords: organic fertilizer, biofertilizer, okra, Abelmoschus esculentus L.

Introduction

Okra (Abelmoschus esculentus L.) is one of the important summer vegetable crops in Iraq, which grows in all agricultural areas belonging to the family of Malvaceae (Boras et al., 2011). Okra was called by other names such as Ladies Finers, Bamya, Gumbo, Okura, Kacang Bendi and others. The nomenclature relative to the countries in which they are located (Sathish et al., 2013). Okra was grown in areas of Iraq for the purpose of obtaining its fresh green fruits. Provides humans with proteins, vitamins (K, E, C, B, A), carbohydrates and minerals (Abd EI-Kader et al., 2010).

Specialists sought to increase the agricultural area in vegetable crops and to devise new varieties and hybrids with good fruit and vegetable qualities and high productivity. The introduction of hybrids is considered one of the cheapest methods of breeding and genetic improvement in countries, especially developing countries, to obtain good genetic results and to select genetic structures through the Scientific Research Center and to know the most appropriate to the environmental conditions (Al-Shammari and Saud, 2014).

The large population of the world requires an increase in the production of multiple agricultural crops inside greenhouses (glass and plastic) without the season, in addition to open cultivation, the use of organic fertilizers will be an inevitable practice in organic farming to meet the plant's need of nutrients necessary for growth. Organic fertilizers are considered as interventions that increase production and improve the quality of crops by preparing the elements and improving the course of the vital activities of the plant (Verma et al., 2017), as well as the use of biological fertilizers and the activity of microorganisms in the soil, it was a suitable source for providing the necessary elements for the plant as compared to chemical fertilizers (Al-Haddad, 1998).

Recently, many countries have tended to encourage the biological production of plants that are characterized by clean food that is free from the harmful effects of chemical fertilizers (Al-Amri, 2011). The technique of using bio-fertilizers is known as Natural Agriculture or Bio. Farming technology, from advanced technologies through the best use of biological and organic fertilizers, reducing the addition of chemical fertilizers despite their cheapness and abundance compared to chemical fertilizers, in addition to improving the physical and chemical properties of the soil and stimulating the physiological functions of plants, stimulating organic farming as a fertilizer for many horticultural crops, increasing the availability of basic nutrients NPK and microelements and fixing nitrogen in the soil and improving plant growth and production (Al-Jubouri, 2013).

The great importance of adding organic fertilizers and types of biological fertilizers in reducing pollution, reducing economic damage, maintaining public health, increasing plant growth production and creating a clean healthy environment, therefore, the research aimed to use such fertilizers and reduce chemical fertilizers and apply them to the two types of okra in Iraqi soils and greenhouses.

Materials and Methods

The field experiment was conducted during the agricultural season 2020-2021, at an unheated greenhouse, with dimensions of 51 m x 9 m (of 459 m^2 area), College of Agriculture and the Marshes, University of Thi-Qar, Al-Mustafaweya area, to study the effect of organic fertilizer levels and types of biofertilizer, okra plant cultivars on some physical and chemical properties of okra plant inside greenhouses. Random samples were taken before planting from different places of the plastic house soil, with a depth of 0-30 cm, they were mixed well and then their physical and chemical properties were analyzed in the soil laboratory of the College of Agriculture.

Table (1): physical and chemical properties.

Parameters	Unit	Value
Ec	ds m-1	5.08
pH	-----	7.04
Available Nitrogen	ppm	40.00
Available Potassium	ppm	280.00
Available Phosphorus	ppm	22.06
Sand	g kg-1	260.00
Silty	g kg-1	591.00
Clay	g kg-1	149.00
Organic matter	%	0.87
Soil texture	----	Silty loam

Laboratory of the Soil Department at the College of Agriculture, Thi-Qar University.

Two types of local varieties (Al-Hussainawi and Petra) were selected that are desired by the consumer, known for its abundant production due to its large plants and many branches, It was sown directly in the ground after isolating unwanted seeds in terms of shape and size, soak the seeds for 12 hours in lukewarm water before planting, it was planted in a hollow at a depth of 3-4 cm, the distance between a hollow and another was 30 cm on both sides of the plots, the decomposed organic manure obtained from sheep waste from the barns and was added at the beginning of the experiment.

Study factors

The first factor: two varieties of okra
A: Husseinawi class
B: Petra class

The second factor: levels of organic fertilizer
O_0: without adding fertilizer.
O_1: organic fertilizer at a rate of 2.5 kg. experimental unit.
O_2: organic fertilizer at a rate of 5 kg. experimental unit.
O_3: organic fertilizer at a rate of 7.5 kg. experimental unit.

The third factor: types of biological pollination
O: without addition.
A: Pollen with Azotobacter Chroococcum at a concentration of 1.1×10^9.

B: Pollen with Pseudomonas fluorescens at a concentration of 3.6×10^9.
C: Pollen with Azotobacter Chroococcum+ Pseudomonas fluorescens at a concentration of 4.7×10^9.
The number of experimental units in each sector is 32 and the total number is 96 units.

Study parameters:
1. Percentage of nitrogen (%).
2. The percentage of phosphorous (%).
3. Percentage of potassium (%).
4. The yield of one plant (g $plant^{-1}$).
5.Total yield (kg m^2).

Results and discussion

1. The nitrogen content of the leaves:

Table (2) shows that the okra class had a significant effect on the nitrogen content of the leaves, as the A-Husseinawi class outperformed, by 2.791%, the Petra okra B class, 2.529 %, with an increase of 10.359%, due to a variation in the genetic factors of the class, the effect of these traits on the variation in response between these varieties to this trait (Sudra et al., 2010). The same table showed that adding different levels of organic fertilizer had a significant effect on the nitrogen content of the leaves at levels 2.5, 5 and 7.5 kg experimental unit, the rates of A class (Al-Husseinawi) reached. 2.663, 2.936 and 3.047%, respectively. B class (Petra) reached. 2.438 , 2.557 and 2.923 % , compared to the treatment of no addition of 2.518 and 2.199 % for both types, respectively. The quantity increased by increasing the level of addition of it, significant differences occurred between the treatments for the role of organic matter in improving the physical and chemical properties of soil, the organic fertilizer contains nitrogen, and thus increases its absorption by the plant (Al-Shaibani, 2005; Abdel-Mawgoud et al., 2007; Al-Khalaf, 2009).

The same table showed that the addition of bio-fertilizer had a significant effect in increasing the nitrogen content of the leaves, as the treatment of the mixture C (Azo.+Pse.) outperformed it, amounting to 3.007%, with an increase of 30.11% compared to the comparison treatment, which amounted to 2.311%, the reason for this is due to the role of added bacteria in the growth of the root system of a plant, as well as the production of phytohormones, which is reflected in the promotion, absorption and transfer of nitrogen within the plant. This is consistent with what was found (Cleyet-Marel et al., 2001).

The table also showed that the binary interaction between the cultivars and the organic fertilizers had a significant effect, as the treatment O_3 of the class A gave the highest values, amounting to 3.047%, whereas, the plants of the treatment O_0 of class B gave the lowest values, which amounted to 2.199%.

The same table also shows that the bilateral interaction between cultivars and biofertilizers has a significant effect, as the treatment A C (Azo.+Pse.) gave the highest values, amounting to 3.201%, BO_0 treated plants gave the lowest values of 2.195%.

The same table showed the bilateral interaction between organic and biological fertilizers has a significant effect as the treatment plants O_3C (Azo.+Pse.) gave the highest values amounting to 3.302%, while the control plants gave the lowest values amounting to 1.892 %.
As for the triple interaction between the experimental factors, it was significant, as the overlapping treatment $A*O_3*C$(Azo.+Pse.) excelled in reaching the highest values, which amounted to 3.350%, while the plants of the treatment $B*O_0*O_0$ gave the lowest values (1.827%).

Table (2): Effect of organic fertilizer levels and types of biofertilizer and their interactions for the two okra cultivars on the nitrogen content of leaves (%).

Class	Organic (kg. experimental unit)	Bacterial					Interaction between C*O	Mean (Class)
		O_0	A(Azo.)	B(Pse.)	C(Azo.+Pse.)			
A	O_0	1.957	2.663	2.530	2.920		2.518	2.791
	O_1(2.5)	2.290	2.430	2.730	3.200		2.663	
	O_2(5)	2.630	2.850	2.930	3.333		2.936	
	O_3(7.5)	2.830	2.930	3.077	3.350		3.047	
B	O_0	1.827	2.230	2.287	2.453		2.199	2.529
	O_1(2.5)	2.053	2.430	2.550	2.717		2.438	
	O_2(5)	2.240	2.563	2.593	2.830		2.557	
	O_3(7.5)	2.660	2.750	3.030	3.253		2.923	
Bacterial mean		2.311	2.606	2.716	3.007			
$L.S.D_{0.05}$		O	C	B	C*O	C*B	O*B	C*O*B
		0.0522	0.0739	0.0739	0.1045	0.1045	0.1477	0.2089

Class	O	A	B	C
A	2.427	2.718	2.817	3.201
B	2.195	2.493	2.615	2.813
Organic	**O**	**A**	**B**	**C**
O_0	1.892	2.447	2.408	2.687
O_1	2.172	2.430	2.640	2.958
O_2	2.435	2.707	2.762	3.082
O_3	2.745	2.840	3.053	3.302

2. The phosphorous content of the leaves (%):

Table (3) show that there are significant differences between the cultivated varieties in the content of phosphorous in leaves, the Husseinawi okra class A significantly outperformed the Petra okra class B, with an average of 0.420 and 0.356 %, respectively, with an increase of 17.97 %, due to the structural genetic characteristics of the class that made it absorb the largest amount of elements and thus increase its growth (Abu Dahi and Younis, 1988).

The same table showed that adding different levels of organic fertilizer had a significant effect on the phosphorous content of leaves at levels 2.5, 5, 7.5 kg experimental unit, as the rates of class A Al-Husseinawi. 0.432, 0.458 and 0.503%, respectively, class B rates reached Petra. 0.319, 0.399 and 0.479 %, compared to the comparison treatment 0.288 and 0.230% for both cultivars as the phosphorous content of the leaves increased with the increase in the level of addition. The reason for this is due to the effect of the organic fertilizer added in the processing of phosphorous, when analyzed, it releases CO_2, which produces carbonic acid when melting, works to dissolve the precipitated phosphate compounds, thus liberating phosphorus (Al-Arqwazi, 2000; Mohamed, 2002; Herencia et al., 2006). In addition, the organic fertilizer added with peat moss improves the physical and chemical properties of the soil, and the preparation of the soil with phosphorous (Dumitru et al., 1996).

The same table showed the effect of adding bio-fertilizer, which led to significant differences, where the treatment of the mixture outperformed the nitrogen fixing bacteria and the phosphorous solvent bacteria, which amounted to 0.479 % compared to the comparison treatment 0.275%. The reason for this is due to the increased absorption of phosphorous by the roots due to the phosphorous-dissolving microorganisms, which increases the density and absorption of the root system. It also supplies the plant with its needs of water and other nutrients (Tisdale, 1997; Al Mandalawi, 2002). Phosphorous-dissolving bacteria contribute to increasing the ability of the plant to increase the presence of phosphorus (Al-Karaki and Raddad, 1997). Govedarica et al. (1994) noted that Azotobacter bacteria secrete growth regulators such as indole, gibberellin, phenol, which encourages vegetative and root growth from which it becomes able to absorb nutrients. These results are consistent with what was reached (Mohandes, 1987; Bashir, 2004), it shows that the joint addition of nitrogen-fixing bacteria and phosphorous solvents increases the concentration of phosphorous.

The table also showed that the binary interaction between the cultivars and the organic fertilizers had a significant effect, as the treatment O_3 of the class A gave the highest values, which amounted to 0.503%. The O_0 plants of the B class gave the lowest values of 0.230%.

The same table also shows that the bilateral interaction between cultivars and biofertilizers has a significant effect, as the treatment AC(Azo.+Pse.) gave the highest values, amounting to 0.493 %, whereas, the plants treated with BO_0 gave the lowest values, which amounted to 0.247 %.

The same table showed the binary interaction between organic and biofertilizers, which has a significant effect, the treatment plants O_3C(Azo.+Pse.) gave the highest values, which reached 0.551%. The comparison plants gave the lowest values of 0.166 %.

As for the triple interaction between the experimental factors, it was significant, as the overlapping treatment A*O_3*C(Azo.+Pse.) excelled in reaching the highest values, which amounted to 0.553 percent, while the plants of the treatment B*O_0*O_0 gave the lowest values, which amounted to 0.123%.

Table (3): Effect of organic fertilizer levels and types of biofertilizer and their interactions for two okra plant cultivars on the phosphorous content of leaves (%).

Class	Organic (kg. experimental unit)	Bacterial O_0	Bacterial A(Azo.)	Bacterial B(Pse.)	Bacterial C(Azo.+Pse.)	Interaction between C*O	Mean (Class)
A	O_0	0.209	0.236	0.313	0.395	0.288	0.420
	O_1(2.5)	0.290	0.431	0.499	0.511	0.432	
	O_2(5)	0.319	0.485	0.516	0.514	0.458	
	O_3(7.5)	0.396	0.522	0.543	0.553	0.503	
B	O_0	0.123	0.213	0.252	0.332	0.230	0.356
	O_1(2.5)	0.199	0.273	0.323	0.481	0.319	
	O_2(5)	0.283	0.343	0.473	0.498	0.399	
	O_3(7.5)	0.386	0.451	0.531	0.550	0.479	
Bacterial mean		0.275	0.369	0.431	0.479		

$L.S.D_{0.05}$	O	C	B	C*O	C*B	O*B	C*O*B
	0.0053	0.0037	0.0053	0.0075	0.0075	0.0106	0.0150

Class	O	A	B	C
A	0.304	0.418	0.467	0.493
B	0.247	0.320	0.394	0.465

Organic	O	A	B	C
O_0	0.166	0.224	0.282	0.363
O_1	0.244	0.352	0.411	0.496
O_2	0.301	0.414	0.494	0.506
O_3	0.391	0.486	0.537	0.551

3. Potassium content of leaves (%):

Table (4) showed a significant increase in the potassium content of the leaves, the Husseinawi cultivar significantly outperformed the Petra cultivar, reaching 2.299 and 2.148% for both varieties, with an increase of 7.03%. The reason for this is due to the nature of the resulting genetic differences between the varieties and the impact of their response to this trait (Aktas et al., 2009).

The same table showed that adding different levels of organic fertilizer had a significant effect on the potassium content of leaves at levels 2.5, 5 and 7.5 kg experimental unit. The rates of class A Husseinawi were 2,143, 2,405, and 2.967%, respectively. The rates of class B Petra reached 1.992 , 2.326 and 2.785 % , compared to the measurement treatment 1.680 and 1.490 % , respectively , and the quantity increased by increasing the level of addition. The reason for this increase is due to the role of organic fertilizer in improving the physical and chemical properties of soil (Summer, 2000; Havlin et al., 2005), because it increases the availability of nutrients in the soil, which provides suitable conditions for plant growth, as well as increases the cation exchange capacity, which liberates potassium and increases its readiness and prevents it from fixing, as well as the decomposition of organic matter to form organic acids that release potassium (Cooper and Chunhuna, 1998; Salman, 2000; Bakayok et al., 2009).

The same table also showed that the addition of different levels of biofertilizers led to a significant increase in the potassium content of the leaves for treatments (A, B, C) amounting to 2.072, 2.385 and 2.770%, compared with the control treatment, which amounted to 1.667%, for the role of biofertilizer in increasing the level of nitrogen and phosphorous in plants because it fixes nitrogen and dissolves phosphorus (Govedarica et al., 1993; Hoflich et al., 1994; Balkhi, 2005). Improving the growth quality of the plant through the secretion of growth regulators such as auxins, gibberellins, and cytokines that encourage the plant to absorb nutrients (Bashir, 2004; Al-Shaibani, 2005). Thus, it increases potassium uptake. The table also shows that the bilateral interaction between cultivars and organic fertilizers has a significant effect, as the treatment O_3 of class A gave the highest values of 2.967%, while the plants of the O_0 treatment of class B gave the lowest values of 1.490%.

The same table also shows that the bilateral interaction between cultivars and biofertilizers has a significant effect, as the treatment A C(Azo.+Pse.) gave the highest values of 2.835 %, while the plants of the BO_0 treatment gave the lowest values of 1.735 %.

The same table showed the bilateral interaction between organic and biofertilizers, which had a significant effect, as the treatment plants O_3C(Azo.+Pse.) gave the highest values of 3.440%, while the control plants gave the lowest values of 1.210%.

As for the triple interaction between the experimental factors, it was significant, as the overlapping treatment A*O_3*C(Azo.+Pse.) excelled in reaching the highest values, which amounted to 3.463%, while the treatment plants B*O_0*O_0 gave the lowest values, amounting to 1.076 %.

Table (4): Effect of organic fertilizer levels and types of biofertilizer and their interactions for the two okra cultivars on potassium content of leaves (%).

Class	Organic (kg. experimental unit)	Bacterial					Interaction between C*O	Mean (Class)
		O_0	A(Azo.)	B(Pse.)	C(Azo.+Pse.)			
A	O_0	1.343	1.500	1.530	2.350		1.680	2.299
	O_1(2.5)	1.586	1.990	2.400	2.596		2.143	
	O_2(5)	1.830	2.330	2.530	2.933		2.405	
	O_3(7.5)	2.183	3.030	3.193	3.463		2.967	
B	O_0	1.076	1.350	1.490	2.043		1.490	2.148
	O_1(2.5)	1.493	1.730	2.250	2.496		1.992	
	O_2(5)	1.796	2.053	2.596	2.860		2.326	
	O_3(7.5)	2.030	2.596	3.096	3.416		2.785	
Bacterial mean		1.667	2.072	2.385	2.770			
$L.S.D_{0.05}$		O	C	B	C*O	C*B	O*B	C*O*B

	0.0308	0.0218	0.0308	0.0436	0.0436	0.0616	0.0872
Class	**O**	**A**	**B**	**C**			
A	1.735	2.212	2.413	2.835			
B	1.599	1.932	2.358	2.704			
Organic	**O**	**A**	**B**	**C**			
O_0	1.210	1.425	1.510	2.196			
O_1	1.540	1.860	2.325	2.546			
O_2	1.813	2.191	2.563	2.896			
O_3	2.106	2.813	3.145	3.440			

4. Yield of one plant (g plant^{-1}).

Table (5) shows the significant improvement of the cultivars, as the plants of class A (Al Husseinawi), which amounted to 348.21 g plant^{-1}, outperformed the plants of class B (Petra), which amounted to 336.34 g plant^{-1}, with an increase of 3.53%. The reason for this is due to the genetic variation between the cultivated varieties due to the prevailing conditions surrounding the area, and to the discrepancy in the strength of vegetative growth between the two varieties.

The same table showed that the addition of different levels of organic fertilizer had a significant effect on the amount of yield per plant at levels 2.5, 5 and 7.5 kg as an experimental unit. The rates of class A (Husseinawi) were 333.45, 364.69 and 380.93 g plant^{-1}, respectively. The rates of Petra B class were 325.83, 350.08 and 363.67 g plant^{-1}, compared with the treatment of no addition 313.77 and 305.76 g plant^{-1} and significant differences were obtained between the treatments. The yield of one plant increased with the increase in the level of addition, and the quantity increased with the increase in the level of addition for the role of organic fertilizers in improving the physical and chemical properties of the soil during aeration, increasing its moisture, and raising the temperature of the soil (Al-Ajil, 1998; Abow El-Magad et al., 2006). It provides suitable conditions for plant growth and the development of the root system, and the provision of nutrients necessary for major and minor growth (Selim et al., 2009), increasing the plant's absorption of elements and thus increasing the nitrogen content in the leaves, which led to an increase in the vegetative growth of the plant, such as the height of the plant, the number of leaves, the diameter of the stem, the leaf area, the content of the leaves from chlorophyll, the increase in the number of flowers and the increase in the number and weight of fruits, thus increasing the yield of a single plant, agreed with what was reached (Al-Shammari, 2015b; Farooq et al., 2015; Al-Ibrahimi, 2011; Al-Zubaidi, 2012).

The same table showed that the addition of bio-fertilizer had a significant effect on increasing the amount of yield per plant, as the mixed vaccine of nitrogen-fixing bacteria and phosphorous solvent C (Azo.+Pse.) outperformed 372.17 g plant^{-1}, the reason for the increase is due to the ability of the added bacteria to produce growth regulators such as gibberellins and IAA, which increases cell division and raises the level of plant metabolism, as well as improving the nutritional status by providing elements such as iron, zinc, copper and phosphorous, which is positively reflected on the yield of the plant (Swain et al., 2007) consistent with what was reached (Bochow et al., 2006).

The table also showed that the binary interaction between the cultivars and the organic fertilizers had a significant effect, as the treatment O3 of the class A gave the highest values amounting to 380.93 g plant^{-1}, while the plants of the treatment O_0 of the class B gave the lowest values which amounted to 313.77 g plant^{-1}.
The same table also shows that the bilateral interaction between cultivars and biofertilizers has a significant effect, as treatment A C(Azo.+Pse.) gave the highest values amounted to 378.67 g plant^{-1}, while treatment plants BO_0 gave the lowest values amounted to 305.13 g plant^{-1}.
The same table showed the bilateral interaction between organic and biofertilizers, which had a significant effect, as the treatment plants O_3C(Azo.+Pse.) gave the highest values amounting to 403.27 g plant^{-1}, while the control plants gave the lowest values amounted to 270.41 g plant^{-1}.
As for the triple interaction between the experimental factors, it was significant, as the overlapping treatment A*O_3*C(Azo.+Pse.) excelled in reaching the highest values of 417.44 g plant^{-1}, while the plants of the interaction B*O_0*O_0 gave the lowest values reached 259.50 g plant^{-1}.

Table (5): Effect of organic fertilizer levels and types of biofertilizer and their interactions for the two okra cultivars on the yield of one plant (g plant^{-1}).

Class	Organic (kg. experimental unit)	Bacterial					Interaction between C*O	Mean (Class)
		O_0	A(Azo.)	B(Pse.)	C(Azo.+Pse.)			
A	O_0	281.31	308.64	321.54	343.59		313.77	348.21
	O_1(2.5)	300.67	333.23	342.67	357.23		333.45	
	O_2(5)	351.24	346.35	364.75	396.41		364.69	
	O_3(7.5)	371.02	362.31	372.94	417.44		380.93	
B	O_0	259.50	302.95	314.78	345.79		305.76	336.34
	O_1(2.5)	296.72	323.98	335.04	347.56		325.83	
	O_2(5)	326.27	338.89	354.92	380.24		350.08	
	O_3(7.5)	338.03	359.13	368.45	389.10		363.67	
Bacterial mean		315.60	334.44	346.89	372.17			
$L.S.D_{0.05}$		O	C	B	C*O	C*B	O*B	C*O*B
		3.653	5.166	5.166	7.306	7.306	10.332	14.612
Class		O	A	B	C			
A		326.06	337.63	350.47	378.67			
B		305.13	331.24	343.30	365.67			
Organic		O	A	B	C			
O_0		270.41	305.80	318.16	344.69			
O_1		298.70	328.61	338.86	352.40			
O_2		338.76	342.62	359.83	388.33			
O_3		354.53	360.72	370.69	403.27			

5.Total yield (kg m^{-2}):

Table (6) show that there are significant differences between the cultivated varieties in the characteristic of the total yield, whereas, the Husseinawi plant class A significantly outperformed the Petra plant class B, with an average of 2.214 and 2.166 kg m2 for each, respectively, with an increase of 2.22%, due to the difference in the nature of the genetic factors of the Husseinawi class, which determined the degree of growth and development represented by the increase in plant height, number of leaves and surface area, thus, the effect on increasing the yield of a single plant and the total yield.

The same table showed that adding different levels of organic fertilizer had a significant effect on the amount of the total yield at levels 2.5, 5 and 7.5 kg. experimental unit. The rates of class A Al-Husseinawi reached 2,140, 2.340 and 2.445 kg m^2, respectively, and the rates of class B Petra reached 2,122, 2.247and 2.334 kg m^2, compared with the treatment of no addition of 1.931 and 1.962 kg m2 and significant differences were obtained between the treatments. The total yield increased with the increase in the level of addition and the reason for the increase may be due to the role of the added organic residues in heating the area around the roots, which increases the ability of the root to absorb nutrients and thus encourages vegetative growth, such as increasing the leaf area and increasing the manufactured materials important in the growth and development of the number and weight of the fruit (Al-Ajil and Al-Sahhaf, 1999), in addition to the decomposition of organic matter in the soil, it dissolves some of the elements, this increased its readiness for plants, as well as soil retention of ions in the root zone due to its high surface area (Tisdale et al., 1997; Hartman, 2002).

The same table showed that the addition of biofertilizer had a significant effect on the characteristic of the total yield, the superiority of the mixed inoculum of nitrogen-fixing and phosphorous-dissolving bacteria C (Azo.+Pse.) reached 2.404 kg m^2. The reason for this is that the added biological fertilizers supply the plant with the nutrients necessary for the plant, such as nitrogen, phosphorous, zinc, iron and copper (Gilmore, 1971; Gress et al., 1986; Clark and Zeto, 2000), as azotobacter improves plant growth and yield through the formation of growth-stimulating substances (Bashan et al., 1996; and Papic-Vidakovic, 2000). In addition to its role in preparing food needs, especially nitrogen and phosphorous, this is consistent with (Al-Rubaie, 2018).

The table also showed that the binary interaction between the cultivars and the organic fertilizers had a significant effect, as the treatment O_3 of the class A gave the highest values, amounting to 2.445 kg m^2, while the plants of the treatment O0 of the class A gave the lowest values, amounting to 1.931 kg m^2.

The same table also shows that the bilateral interaction between cultivars and biofertilizers has a significant effect, as the treatment A C(Azo.+Pse.) gave the highest values, amounting to 2.430 kg m^2, while the plants of the BO_0 treatment gave the lowest values, which amounted to 1.958 kg m^2.

The same table showed the bilateral interaction between organic and biofertilizers, which had a significant effect, as the plants treated O_3C(Azo.+Pse.) gave the highest values, amounting to 2.588 kg m^2. Whereas, the comparison plants gave the lowest values of 1.735 kg m^2.

As for the triple interaction between the experimental factors, it was significant, as the interaction treatment A*O_3*C(Azo.+Pse.) excelled in reaching the highest values, which amounted to 2.679 kg m^2, while the plants of the treatment B*O_0*O_0 gave the lowest values, which amounted to 1.665 kg m^2.

Table (6): Effect of organic fertilizer levels and types of biofertilizer and their interactions for the two okra cultivars on the total yield (kg m^2).

Class	Organic (kg. experimental unit)	Bacterial					Interaction between C*O	Mean (Class)
		O_0	A(Azo.)	B(Pse.)	C(Azo.+Pse.)			
A	**O_0**	1.806	1.981	1.731	2.205		1.931	2.214
	O_1(2.5)	1.930	2.139	2.200	2.293		2.140	
	O_2(5)	2.254	2.223	2.341	2.544		2.340	
	O_3(7.5)	2.381	2.326	2.394	2.679		2.445	
B	**O_0**	1.665	1.944	2.021	2.219		1.962	2.166
	O_1(2.5)	1.904	2.079	2.150	2.356		2.122	
	O_2(5)	2.094	2.175	2.278	2.441		2.247	
	O_3(7.5)	2.170	2.305	2.365	2.497		2.334	
Bacterial mean		2.025	2.146	2.185	2.404			
L.S.D$_{0.05}$		**O**	**C**	**B**	**C*O**	**C*B**	**O*B**	**C*O*B**
		0.0676	0.0478	0.0676	0.0956	0.0956	0.1352	0.1912
Class		**O**	**A**	**B**	**C**			
A		2.093	2.167	2.166	2.430			
B		1.958	2.126	2.203	2.378			
Organic		**O**	**A**	**B**	**C**			
O_0		1.735	1.962	1.876	2.212			
O_1		1.917	2.109	2.175	2.324			
O_2		2.174	2.199	2.309	2.492			
O_3		2.275	2.315	2.379	2.588			

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