EFFECT OF BIOFERTILIZER,VERMICOMPOST AND PHOSPHATE FERTILIZER ON GROWTH AND YIELD OF CAULIFLOWER*(Brassica oleraceae Var.botrytis)*

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ABSTRACT

A field experiment was carried out at Agricultural Researchs and the Experiments Station in Wasit province during 2019-2020 season. This study was aimed to investigate the effect of three factors, the first being biofertilizer at three levels (without addition , a combination of *Bacillus megaterium* + *Glomus mosseae* and complet combination of *G. mosseae, Azotobacter chroococcum, B. megaterium and Azospirillum brasilense)*. the second factor was three levels of vermicompost (without,3,6 Mg ha^{-1}).The third factor included three levels of triple superphosphate (0, 40 and 80%) of the fertilizer recommendation. The treatment were distributed in a factorial experiment according to a randomized complete block design. Results showed that the bilateral interaction between the biofertilizer added in an integrated form and vermicompost at the level of 6 Mg ha^{-1} had a significant effect on all studied properties, while the triple interaction between the biofertilization treatments added as an integrated combination with 6 Mg h^{-1} of vermicompost and 80% of the mineral fertilizer recommendation showed the highest averages for the studied traits (flower disc weight, disc weight with leaves, pink disc diameter, total yield, nitrogen and phosphorous content of fruits), which reached 2.524 kg, 4.353 kg, 35.10 cm, 75.71 Mg ha^{-1}, 4.237%, 0.727% respectively in comparison to the control treatment that gave the lowest averages in all the above traits, which amounted to (1.081 kg, 1.624 kg, 25.10 cm, 32.43 Mg ha^{-1}, 1.893%, 0.210%) on the sequence.

Key words: earthworms, meneral fertilizer, vegtables plant ,bacteria.
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مجلة العلوم الزراعية العراقية -2023 :54(2):505-515 **السلماوي وعبد الرضا**

تأثير السماد الحيوي، الفيرميكمبوست والسماد الفوسفاتي في نمو وحاصل القرنابيط

نور الهدى جواد كاظم السلماوي **حسن علي عبد الرضا**
الباحثة **استاذ**

المستخلص

نفذت تجربة حقلية في محطة الابحاث والتجارب الزراعية / محافظة واسط في الموسم الزراعي 2019 –2020 بهدف دراسة تاثير ثلاثة عوامل الاول هو السماد الحيوي بثلاث مستويات (بدون اضافة وتوليفة مكونة *Glomus mosseae + Bacillus megaterium* وتوليفة كاملة مكونة من، *G.mosseae*، *Azotobacter chroococcum* و*B. megaterium* و*Azospirillum brasilense*).العامل الثاني هو ثلاثة مستويات من الفيرميكمبوست (بدون اضافة و3 و6 ميكاغرام هـ$^{-1}$) والعامل الثالث هو سماد سوبر فوسفات ثلاثي وبثلاثة مستويات (0 و40 و80%) من التوصية السمادية. وزعت المعاملات في تجربة عاملية وفق تصميم القطاعات العشوائية الكاملة. اثر التداخل الثنائي بين السماد الحيوي المضاف بشكل توليفة متكاملة و6 ميكاغرام هـ$^{-1}$ من الفيرميكمبوست معنويا في جميع الصفات المدروسة، في حين اظهر التداخل الثلاثي لمعاملات التسميد الحيوي المضاف بشكل توليفة متكاملة مع 6 ميكاغرام هـ$^{-1}$ من الفيرميكمبوست و80% من التوصية السمادية المعدنية اعلى المتوسطات لصفات (وزن القرص الزهري، وزن القرص مع الاوراق، قطر القرص الزهري، الحاصل الكلي، محتوى الثمار من النتروجين والفسفور) والتي بلغت 2.524 كغم، 4.353 كغم، 35.10 سم، 75.71 ميكاغرام هـ$^{-1}$، 4.237%، 0.727%) على التتابع بالمقارنة مع معاملة عدم الاضافة التي اعطت اقل المتوسطات في جميع الصفات اعلاه والتي بلغت (1.081 كغم،1.624 كغم، 25.10 سم، 32.43 ميكاغرام هـ$^{-1}$، 1.893%، 0.210%) على التتابع.

الكلمات المفتاحية: ديدان الارض، السماد المعدني، نباتات الخضر، بكتريا.
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INTRODUCTION

The most prominent challenge in the world today due to the increase in the world population is poverty and starvation. Therefore, food security threatens the sovereignty of the independence of many countries, which encouraged many of these countries to develop plans and strategies to confrontation this challenge for the purpose of providing food. The ultimate goal has become to achieve sustainable agriculture with higher productivity per unit area, represented by the clean farming method to maintain soil health and increase production. The excessive use of mineral fertilizers, especially with vegetable crops, and the short duration of production and cultivation for more than one season, exacerbated the harmful effects of fertilizers (20). This encouraged the use of modern technologies to reduce damages, such as the use of biofertilizers, which is one of the safer technologies and has promising success in reducing the negative effects and risks of mineral fertilizers, as well as its contribution to reducing production costs and improving soil properties. The microorganisms used in biofertilization, some of them supply nitrogen through symbiotic and free fixation of gaseous nitrogen, such as Rhizobium, Azotobacter and Azospirllum, and others dissolve phosphate compounds in the soil, such as the fungus Vescular Arbuscular Mycorrhizae (VAM). Increasing its availability and absorption by the plant and some others prepares potassium (18). On the other hand, organic fertilizers have received great attention in recent years due to their integration with mineral and biological fertilizers through improving soil properties and increasing the nutrients availability of plants. Vermicompost is one of the organic fertilizers that has received researchers attention in recent years because of its good advantages and role in increasing plant productivity, improving soil properties and creating a safe and healthy ecosystem for food production (3,4). It supports the public health, environment, increases the soil content of organic matter and gives the desired taste to the parts that are eaten from the plants treated with (17). Cauliflower, (*Brassica oleracear var. botrytis*),is one of the most important vegetable plants belonging to the cruciferae family (22). It is an important food for human health and is rich in the necessary elements in the fruits. These elements are important in preventing some diseases such as prostate and breast cancer, and there is a treatment for diabetes (11). It protects against cancer, especially bladder cancer, due to its content of glutathione, one of the antioxidant compounds (15). In addition to being of high nutritional value and a high content of important medicinal materials and enzymes such as Aisoziamease, which is necessary in the digestive process (1). The current study was aimed to evaluate the role of different combinations of bio-fertilizer and organic fertilizer (vermicompost) under different levels of triple phosphate fertilizer to the growth and yield of cauliflower.

MATERIALS and METHODS

A field experiment was carried out during 2019-2020 at the Agricultural Researchs and Experiments Station of the Wasit Provence Agriculture Directorate / Horticultural Development Station project in silty clay soil.

Field Preparing

The soil was plowed, smoothed and leveled samples were taken from the field soil to estimate some of the physical and chemical properties of the field soil and table 1shows this, then the rows were worked and the field was divided into experimental units with an area of 6 m^2 (length 2 m and width 3 m). Each experimental unit in each block included three furrows, the distance between one furrow and another was 60 cm, the distance between one plant and another was 40 cm to include 18 plants per experimental unit under drip irrigation. Vermicompost was added according to the treatments at three levels V0 (without), V1=3, V2=6 Mg ha^{-1}). Biofertilizer was added at three types (B0(without), B1= include; *Bacillus megaterium + Glomus mosseae* and B2 include; *Azotobacter chroococcum + Azospirillum brasilense + Bacillus megaterium + Glomus mosseae*).triple Phosphate fertilizer included three levels (S0(without), S1=40% and S2=80% of the mineral fertilizer recommendation) (2). Biofertilizer were prepared from the aforementioned bacterial isolates in broth medium, then the roots of cauliflower seedlings were immersed in these media for 15 minutes by moistening with20%

of gum Arabic. Phosphate fertilizer was added by making an incision at the bottom of the plant at a distance of 5 cm and in two does; the first was during planting stage, and the second at the beginning of the flowering discs (14). The planting was on 15/10/2019 and harvested on 27/2/2020. At the end of the experiment, the growth indicators and yield (plant height (cm), flower disc weight (kg plant^{-1}), flower disc diameter (cm) and biological yield (pink discs with leaves, kg plant^{-1}) were recorded from six plants randomly selected from each experimental unit. The nitrogen concentration in the fruits was estimated using the micro keldhal device and phosphorous using the spectrophotometer (16).

Table 1. Some chemical, physical and fertility properties of the study soil before planting

Soil properties	Value	Unite
$Ec_{1:1}$	3.1	(ds m^{-1})
$pH_{1:1}$	7.36	
$CaCO_3$	280.21	g kg^{-1}
O.M	8.5	g kg^{-1}
Available N	25.5	mg kg^{-1}
Available P	10.5	mg kg^{-1}
Available K	122	mg kg^{-1}
Total bacteria	25.5×10^{7}	(C.F.U g-1 Soil)
SAND	124	g kg^{-1}
SILT	440	g kg^{-1}
CLAY	436	g kg^{-1}
Texture	Silty Clay	

RESULTS and DISCUSSION

Plant height (cm)

The results in Table 2 show that there are significant differences as a result to add bio-fertilizer as integrated combination when it is added alone or companion with organic fertilizer (vermicompost) or mineral fertilizer in the form of a binary or triple interaction. The biofertilizer added alone gave the highest plant height of 54.44 cm While the addition of the organic fertilizer alone recorded an average height of 52.30 cm, while the addition of 80% from recommendation of mineral fertilizer alone resulted in a lower height compared with bio or organic fertilizer (52.27 cm). The results of the interaction between integrated combination of biofertilizer and 6 Mg ha^{-1} of vermicompost showed significant differences compared with non-addition, which gave the highest height (55.69 cm). Also, there were significant differences for the interaction between bio-fertilizer and mineral fertilizer, which recorded the highest plant height of 55.40 cm plant^{-1} when adding bio-fertilizer as combination with 3 Mg ha^{-1} of vermicompost, while there were no significant differences for the interaction between organic fertilizer and mineral fertilizer . On the other hand, there were significant differences for the triple interaction among the biofertilizer added as an integrated combination with 6 Mg ha^{-1} of organic fertilizer and 40% of the recommendation of fertilizer, as it gave the highest plant height of 58.33 cm compared to the control treatment that did not received any fertilizer that gave The minimum value of plant height 40.55 cm

Table 2. Effect of adding biofertilizer, vermicompost and mineral fertilizer on Plant height (cm)

BioFertilizer (B)	Vermicompost (V)	Phosphorous Fertilizer (S) S0	S1	S2	(V* B)
	V0	40.55	45.35	45.17	43.69
B0	V1	48.53	48.93	53.75	50.41
	V2	46.50	50.50	50.90	49.30
	V0	51.00	51.07	53.00	51.69
B1	V1	51.33	51.37	52.70	51.80
	V2	51.07	52.07	52.57	51.90
	V0	52.73	53.13	54.75	53.54
B2	V1	53.70	54.73	53.80	54.08
	V2	55.00	58.33	53.75	55.69
$LSD_{0.05}$			3.09		1.78
average (S)		50.05	51.72	52.27	
$LSD_{0.05}$			1.03		
			(B*S)		average (B)
B0		45.19	48.26	49.94	47.80
B1		51.13	51.50	52.76	51.80
B2		53.81	55.40	54.10	54.44
$LSD_{0.05}$			1.78		1.03
			(V*S)		average (V)
V0		48.09	49.85	50.98	49.64
V1		51.19	51.68	53.42	52.09
V2		50.86	53.63	52.41	52.30
$LSD_{0.05}$			N.S		1.03

Flower disc weight (Kg plant^{-1})

It is noted from the results in Table 3 that there are positive differences between the fertilizer treatments added alone in the curd weight, but the interaction between bio-fertilizer and vermicompost gave the highest curd weight among the rest of the interactions, which were not significant, with an average of 2.401 kg plant^{-1}. The results of the triple interaction among bio, organic and mineral fertilizers showed significant differences in the weight of the curd, as it reached the highest weight of 2.524 kg plant^{-1} when treating biofertilizer as complete combination with 6 Mg ha^{-1} vermicompost and 80% of the phosphate fertilizer recommendation, which outperformed the treatment of no addition of bio, organic and mineral fertilizers and gave the lowest mean weight of 1.081 kg plant-1 .

Flower disc diameter(cm plant^{-1})

The results showed in Table 4. that the single addition of bio, organic or mineral fertilizers had a significant effect on the flower disc diameter, as the highest diameter obtained when adding biofertilizer as a complete combination that gave 31.62 cm, while the addition 6 Mg ha^{-1} of vermicompost gave the highest diameter of 31.20 cm. On the other hand, adding 80% of the phosphate fertilizer recommended gave the highest diameter that reached 30.49 cm, the triple interactions recorded significant differences in this indicator when adding biofertilizer as an integrated combination with 6 Mg ha^{-1} vermicompost and 80% of phosphate fertilizer recommendation, as it gave the highest diameter (35.10 cm) and did not differ significantly from the results recorded by the same treatment, The combination with vermicompost when adding 40% from the recommendation of mineral fertilizer, as it resulted in the highest diameter of 34.68 cm compared with the control treatment, which gave the lowest diameter of 25.10 cm.

Biological yield (Kg plant^{-1})

The results in Table 5. Refer to significant differences for adding bio, organic or mineral fertilizers alone on the biological yield. The treatment of adding biofertilizer in a complete combination gave the highest biological yield, which amounted to 3.202 kg plant^{-1}, while it was the highest average biological yield as a result of adding organic fertilizer alone (6 Mg ha^{-1}) reached 3.126 kg plant^{-1}. On the other hand, the phosphate fertilizer added at the level of 80% of the recommendation also had a significant effect on the biological yield and gave 3.083 kg plant^{-1}. The results of the statistical analysis of the triple interaction of the biological, organic and mineral fertilizers

showed that there were significant differences treatments of the biological yield, as the interaction treatments among the biofertilizer as complete combination with 6 Mg ha^{-1} of vermicompost and 80% of the recommended fertilizer for phosphate, gave the highest average of biological yield 4.353 $Plant^{-1}$ kg.

Table3. Effect of adding biofertilizer, vermicompost and mineral fertilizer on Flower disc weight (Kg $plant^{-1}$)

BioFertilizer (B)	Vermicompost (V)	Phosphorous Fertilizer (S)			(V* B)
		S0	S1	S2	
	V0	1.081	1.209	1.259	1.183
B0	V1	1.214	1.576	1.868	1.553
	V2	1.605	1.617	1.952	1.725
	V0	1.690	2.057	2.121	1.956
B1	V1	1.762	1.786	1.781	1.776
	V2	1.817	1.890	2.104	1.937
	V0	1.724	1.923	2.019	1.889
B2	V1	2.089	2.150	2.162	2.134
	V2	2.319	2.360	2.524	2.401
$LSD_{0.05}$			0.443		0.256
Average (S)		1.700	1.841	1.976	
$LSD_{0.05}$			0.148		
			(B*S)		Average(B)
B0		1.300	1.467	1.693	1.487
B1		1.756	1.911	2.002	1.890
B2		2.044	2.144	2.235	2.141
$LSD_{0.05}$			N.S		0.148
			(V*S)		Average(V)
V0		1.498	1.730	1.799	1.676
V1		1.688	1.837	1.937	1.821
V2		1.914	1.956	2.193	2.021
$LSD_{0.05}$			N.S		0.148

Table4. Effect of adding biofertilizer, vermicompost and mineral fertilizer on flower disc diameter (cm $plant^{-1}$)

Biofertilizer (B)	Vermicompost (V)	Phosphorous Fertilizer (S)			(V*B)
		S0	S1	S2	
	V0	25.10	25.57	26.93	25.87
B0	V1	27.20	27.53	27.57	27.43
	V2	27.87	28.00	31.10	28.99
	V0	28.20	28.33	29.07	28.53
B1	V1	28.70	29.10	30.25	29.35
	V2	30.70	31.05	31.00	30.92
	V0	28.13	29.53	32.13	29.93
B2	V1	31.17	31.27	31.30	31.24
	V2	31.30	34.68	35.10	33.69
$LSD_{0.05}$			3.65		N.S
average S		28.71	29.45	30.49	
$LSD_{0.05}$			1.22		
			(B*S)		Average (B)
B0		26.72	27.03	28.53	27.43
B1		29.20	29.49	30.11	29.60
B2		30.20	31.83	32.84	31.62
$LSD_{0.05}$			N.S		1.22
			(V*S)		Average (V)
V0		27.14	27.81	29.38	28.11
V1		29.02	29.30	29.71	29.34
V2		29.96	31.24	32.40	31.20
$LSD_{0.05}$			N.S		1.22

Table5. Effect of adding biofertilizer, vermicompost and mineral fertilizer on Biological yield (Kg plant^{-1})

Biofertilizer (B)	Vermicompost (V)	Phosphorous Fertilizer (S)			(V* B)
		S0	S1	S2	
	V0	1.624	2.317	2.538	2.160
B0	V1	2.042	2.495	2.674	2.404
	V2	2.559	2.584	3.025	2.723
	V0	2.461	2.727	2.718	2.635
B1	V1	2.765	2.995	3.004	2.921
	V2	2.968	2.980	3.105	3.018
	V0	2.518	3.088	3.217	2.941
B2	V1	2.882	3.087	3.113	3.027
	V2	3.093	3.463	4.353	3.636
$LSD_{0.05}$			0.568		N.S
Average(S)		2.546	2.860	3.083	
$LSD_{0.05}$			0.189		
			(B*S)		Average (B)
B0		2.075	2.466	2.745	2.429
B1		2.731	2.901	2.942	2.858
B2		2.831	3.213	3.561	3.202
$LSD_{0.05}$			N.S		0.189
			(V*S)		Average (V)
V0		2.201	2.711	2.824	2.579
V1		2.563	2.859	2.930	2.784
V2		2.874	3.009	3.494	3.126
$LSD_{0.05}$			N.S		0.189

Total yield (Mg ha^{-1})

The results in Table 6. shown there was a significant effect among the biofertilization treatments on the total yield of cauliflower, as the biofertilization treatment was superior in a complete combination and gave the highest average of the total yield to 64.23Mg h^{-1}.The results of vermicompost treatments showed also the superiority of the treatment of adding 6 Mg ha^{-1} Vermicompost that gave the highest yield (60.62 Mg ha^{-1}). Also, significant differences were found among the mineral fertilization treatments in the total yield of cauliflower, which appeared that phosphate fertilizer at a rate of 80% gave the highest yield (59.29 Mg ha^{-1}). The interaction between bio-fertilizer and vermicompost showed significant differences in the total yield. Bio-fertilizer as a complete combination with 6 Mg ha^{-1} of organic fertilizer superiority on the without bio-organic fertilizer treatment, which amounted to 72.03 and 35.49 Mg ha^{-1}. On the other hand, the results of the interaction between biofertilizer treatments with mineral fertilizer or with organic fertilizer did not show any significant differences in the total yield compared with the control treatment. The interaction treatments among bio-fertilizer, organic fertilizer and mineral fertilizer showed significant differences, which gave the bio-fertilization treatment as a complete combination of bacteria and fungi that dissolved phosphate,with nitrogen fixation bacteria and vermicompost (6 Mg ha^{-1}) and 80% of phosphate mineral fertilizer recommendation the highest total yield of cauliflower was 75.71 Mg ha^{-1} compared with no addition of any types of fertilization, which gave the lowest mean of total yield (32.43 Mg ha^{-1}).

Table 6. Effect of adding biofertilizer, vermicompost and mineral fertilizer on Total yield (Mg ha^{-1})

Biofertilizer (B)	Vermicompost (V)	Phosphorous Fertilizer (S)			(V* B)
		S0	S1	S2	
B0	V0	32.43	36.27	37.76	35.49
	V1	36.43	47.29	56.04	46.59
	V2	48.15	48.51	58.55	51.74
B1	V0	50.69	61.72	63.62	58.68
	V1	52.85	53.58	53.44	53.29
	V2	54.51	56.70	63.11	58.11
B2	V0	51.72	57.69	60.57	56.66
	V1	62.67	64.50	64.85	64.01
	V2	69.58	70.80	75.71	72.03
$LSD_{0.05}$			13.29		7.67
Average (S)		51.00	55.23	59.29	
$LSD_{0.05}$			4.43		
			(B*S)		Average (B)
B0		39.00	44.02	50.78	44.60
B1		52.68	57.33	60.06	56.69
B2		61.32	64.33	67.04	64.23
$LSD_{0.05}$			N.S		4.43
			(V*S)		Average (V)
V0		44.95	51.89	53.98	50.27
V1		50.65	55.12	58.11	54.63
V2		57.41	58.67	65.79	60.62
$LSD_{0.05}$			N.S		4.43

The positive effect of bio-fertilizer as a combination of phosphorous-dissolving and nitrogen-fixation organisms (Tables 3, 4, 5 and 6) may be attributed to the ability of these organisms to produce many growth regulators such as auxins, gibberellins and cytokines, in addition to preparing the macro and micro nutrients that improve the growth of the vegetative system through increased cells division and elongation, and this reflected plant to height of the plant and increased the vegetative dry weight complex, as a result of a vital role in the early stages of plant growth. These results are consistent with (12) and (8). The significant effect of vermicompost on the overall characteristics, may be due to its role in increasing the numbers and activity of microorganisms in the soil that decompose organic matter and release nutrients (5,10,19). The mineral fertilizer also increases the availability of the plant's macronutrients in the soil solution, and it is easy to absorb them in quantities that are sufficient for its growth and building its tissues. It also has a role in regulating the effectiveness of hormones responsible for biological processes. For example, nitrogen plays a role in the effectiveness of meristem cells and the production of auxin in sufficient quantities so that it is positively reflected on plant growth parameters as is evident increase of plant height, flower disc weight and diameter, biological yield and total yield(7).

Concentration of nitrogen(%)in flower disc after harvest: The results of the statistical analysis in Table 7. Showed the significant effect of the biofertilization treatments on the nitrogen content of fruits, the addition of biofertilizer of as a combination led to an increase in the percentage of nitrogen in the fruits (3.730%), while the control treatment gave the lowest nitrogen percentage of 2.732%. The results also showed a significant effect of vermicompost on nitrogen concentration in fruits, the treatment of adding 6 Mg ha^{-1} of vermicompost outperformed the treatment of no addition, which gave the lowest percentage of 3.599 and 3.103% respectively, on the other hand, the mineral fertilizer also had a significant effect of increasing nitrogen in fruits. Treatment of 80% recommended dose outperformed by giving the highest rate of 3.539%, while the interaction among bio-fertilizer and

vermicompost treatments significantly affected nitrogen content in fruits, as the bio-fertilization treatment as combination and 6 Mg ha^{-1} of vermicompost outperformed on the treatment of not adding bio or organic fertilizer, it gave the lowest percentage of 3.872 and 2.291%, respectively. The results of the interaction between the biological and mineral fertilization treatments gave a significant differences in the nitrogen content of fruits, as the biofertilization treatment with 80% of the fertilizer recommendation gave the highest percentage of 4.024% compared to the treatment of not adding biological and mineral fertilizers, which gave the lowest percentage of nitrogen in the fruits amounted to 2.400 %. There were significant differences for the interaction between vermicompost and the mineral fertilizer, as the addition of 6 Mg ha^{-1} of vermicompost and 80% of the mineral fertilizer recommendation led to an increase in the nitrogen content of fruits more than the rest of the treatments, while not addition vermicompost and mineral fertilizer led to a decrease of nitrogen content of fruits, less than the rest of the treatments. The results of the statistical analysis of the triple interaction showed that there were significant differences between the treatments of bioorganic and mineral fertilizers, as the treatment of adding biofertilizer as an integrated combination and 6 Mg ha^{-1} of vermicompost with 80% of the mineral recommendation significantly affected the nitrogen content of fruits, which gave the highest percentage reached 4.237% compared with the control treatment, which gave the lowest percentage of 1.893%.

Table7. Effect of adding biofertilizer, vermicompost and mineral fertilizer on Nitrogen percentage (%) in fruits

BioFertilizer (B)	Vermicompost (V)	Phosphorous Fertilizer (S)			(V* B)
		S0	S1	S2	
	V0	1.893	2.483	2.497	2.291
B0	V1	2.517	2.533	2.603	2.551
	V2	2.790	3.570	3.703	3.354
	V0	3.310	3.433	3.527	3.423
B1	V1	3.347	3.600	3.713	3.553
	V2	3.290	3.693	3.730	3.571
	V0	3.380	3.647	3.760	3.596
B2	V1	3.403	3.687	4.077	3.722
	V2	3.480	3.900	4.237	3.872
$LSD_{0.05}$			0.216		0.125
Averages (S)		3.046	3.394	3.539	
$LSD_{0.05}$			0.072		
			(B*S)		Average (B)
B0		2.400	2.862	2.934	2.732
B1		3.316	3.576	3.657	3.516
B2		3.421	3.744	4.024	3.730
$LSD_{0.05}$			0.125		0.072
			(V*S)		Average (V)
V0		2.861	3.188	3.261	3.103
V1		3.089	3.273	3.464	3.276
V2		3.187	3.721	3.890	3.599
$LSD_{0.05}$			0.125		0.072

Concentration of phosphorus (%)in flower disc after harvest: The results of the statistical analysis in Table 8 showed significant differences in the phosphorous content of fruits, as the treatment of adding bio-fertilizer in a combination excelled in obtaining the highest percentage phosphorous content of fruits, which amounted to 0.572% compared to the control treatment, which gave the lowest percentage of 0.302%. It was also found that vermicompost had a significant effect on the phosphorous content of fruits when added at a level of 6 Mg ha^{-1} and it outperformed the non-addition treatment, which amounted to 0.519 and 0.357%, respectively. The addition of mineral fertilizer at a rate of 40 or 80% of the fertilizer recommendation was superior to the non-addition treatment, which amounted to 0.504, 0.467 and 0.367%, respectively. The results of the statistical analysis of the interaction between bio-fertilizer and organic fertilizer showed that there were significant differences in the percentage of the phosphorus concentration characteristic in the fruits, as the addition of bio-fertilizer as a combination with vermicompost at a level of 6 Mg ha^{-1} gave the highest percentage of 0.601%. The interaction between bio-fertilizer and mineral fertilizer showed significant differences in the percentage of phosphorus, as the treatment of adding bio-fertilizer as a complete combination with 80% of the fertilizer recommendation for mineral fertilizer outperformed the treatment of not adding bio-mineral fertilizer, which amounted to 0.669 and 0.234%, respectively, on the other hand, the interaction between vermicompost and mineral fertilization treatments had a significant effect on the phosphorous content of fruits, as the treatment of adding 6 Mg ha^{-1} of vermicompost with 80% of the fertilizer recommendation gave the highest percentage of 0.600% compared to the treatment of no addition.The results of the interaction among the bio, organic and mineral fertilizer treatments showed that there were significant differences, as the treatment of adding bio fertilizer as integrated combination with 6 Mg ha^{-1} of vermicompost and 80% of the recommendation fertilizer significantly excelled in the property of the phosphorous content of fruits and gave the highest percentage, reached 0.727%, while the control treatment gave the lowest percentage (0.210%).

Table 8. Effect of adding biofertilizer, vermicompost and mineral fertilizer on phosphorous percentage (%) in fruits

Biofertilizer (B)	Vermicompost (V)	Phosphorous Fertilizer (S) S0	S1	S2	(V* B)
	V0	0.21	0.267	0.28	0.252
B0	V1	0.243	0.277	0.3	0.273
	V2	0.25	0.447	0.443	0.38
	V0	0.27	0.243	0.297	0.27
B1	V1	0.513	0.543	0.577	0.544
	V2	0.533	0.567	0.63	0.577
	V0	0.417	0.58	0.653	0.55
B2	V1	0.437	0.633	0.627	0.566
	V2	0.433	0.643	0.727	0.601
$LSD_{0.05}$			0.083		0.048
Averages(S)		0.367	0.467	0.504	
$LSD_{0.05}$			0.028		
			(B*S)		Averages(B)
B0		0.234	0.33	0.341	0.302
B1		0.439	0.451	0.501	0.464
B2		0.429	0.619	0.669	0.572
$LSD_{0.05}$			0.048		0.028
			(V*S)		Averages(V)
V0		0.299	0.363	0.41	0.357
V1		0.398	0.484	0.501	0.461
V2		0.406	0.552	0.600	0.519
$LSD_{0.05}$			0.048		0.028

It is noted from Tables 7 and 8 that the addition of biofertilizer as an integrated combination of *Glomus mosseae, Azotobacter chroococcum, Bacillus megaterium and Azospirillum bracelinse* alone, or as companion with vermicompost and phosphate fertilizer, led to a significant increase in the content of phosphorous, nitrogen and these result may be due to the content of the fertilizer combination of bacteria, which stimulate plant growth through the released of some hormones that increase root size and nutrient absorption and have a high ability to fix atmospheric nitrogen freely or associatively by the nitrogenase enzyme, as well as released enzymes that have a role in facilitating or increasing of nutrients availability in soil solution, which take it plants after stimulating the roots by bacteria to absorb it, that increases the percent of nitrogen and other nutrients inside the plant and thus is reflected in the yield and qualitative characteristics of the fruits (6). On the other hand, the reason for the increase in phosphorous may be due to the fact that the fertilizer contains phosphate-dissolving bacteria and stimulates the growth of roots (13). In the case of interaction with phosphate fertilizer, the reason may be due to the presence of mineral elements in the soil and the presence of phosphate-dissolving bacteria in the soil and become available for the plant, and reflected on increase the content in fruits (9). As for the triple interaction among of *Glomus mosseae, Azotobacter chroococcum Bacillus megaterium, Azospirillum brasilense*, vermicompost and mineral fertilizer, may be due to the role of added mineral fertilizer and organic matter that improve soil properties, activate microorganisms, release enzymes and availability of nutrients and reflection on the content of nitrogen and phosphorous in fruits (21).

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