EFFECT OF VERMICOMPOST AND BIOFERTILIZATION ON THE AVAILABILITY OF SOME SOIL NUTRIENTS, GROWTH AND YIELD OF SQUASH (*Cucurbita pepo* L.)

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ABSTRACT

A field experiment was carried out to evaluate the effect of four application methods of vermicompost tea (without application, ground application, foliar spray, combination of - ground application + foliar spray) , four types of biofertilization (without application, *Stenotrophomonas maltophilia*, *Bacillus megaterium*, the combination consisting of *S. maltophilia* + *B. megagaterium*), and two levels (0, 50%) of the fertilizer recommendation in the availability of some soil nutrients and on the growth and yield of squash using as randomized complete block design with three replications. The results showed that the triple interaction of the combination of application vermicompost tea with the combination of biofertilizer and 50% of mineral fertilizer was effect significantly and gave the highest values for some vegetative growth parameters. Which included the dry weight of the vegetative part, the length and weight of the root, and total yield which amounted 196.35 g plant^{-1}, 65.33 cm, 60.31 g plant^{-1}, 45.14 Mgha^{-1}, respectively. the available of nitrogen, phosphorous and potassium in soil at the end of the experiment, which amounted 60.56, 38.20 and 191.38 mg kg^{-1}soil in comparison with the treatment without addition, which gave the lowest rates.

Key word: organic fertilizer tea, biofertilizer, climate action, sustainability, recycling.
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تأثير السماد الدودي والحيوي في جاهزية بعض مغذيات التربة وفي نمو وحاصل قرع الكوسة (*Cucurbita pepo* L.)

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المستخلص

نفذت تجربة حقلية لتقييم تأثير أربعة طرائق لأضافة شاي السماد الدودي (بدون أضافة، الأضافة الأرضية، الرش الورقي ، الاضافة المزدوجة لكلا الطريقتين) ، و أربعة أنواع للتسميد الحيوي (بدون أضافة ، لقاح بكتريا *Stenotrophomonas maltophilia*، لقاح بكتريا *Bacillus megaterium*، التوليفة المكونة من *B.megaterium* + *S.maltophilia*) ، و مستويين (0، 50)% من التوصية السمادية في جاهزية بعض مغذيات التربة و في نمو وحاصل قرع الكوسة بأستعمال تصميم القطاعات العشوائية الكاملة وبثلاثة مكررات . أشارت النتائج تفوق التداخل الثلاثي للأضافة المزدوجة لشاي السماد الدودي مع توليفة السماد الحيوي و50% من السماد المعدني معنوياً أذ أعطت أعلى القيم للوزن الجاف للمجموع الخضري و طول ووزن المجموع الجذري والحاصل الكلي و سجلت قيماً بلغت 196.35غم نبات$^{-1}$، 65.33 سم ، 60.31 غم نبات$^{-1}$ و45.14 ميكاغرام هـ$^{-1}$ على التتابع ومحتوى التربة من النتروجين والفسفور والبوتاسيوم الجاهز في نهاية التجربة والتي سجلت 60.56 و 38.20 و 191.38 ملغم كغم$^{-1}$ تربة بالقياس مع معاملة بدون أضافة التي أعطت أقل المعدلات .

الكلمات المفتاحية: شاي السماد العضوي، السماد الحيوي، العمل المناخي، استدامة، تدوير.
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INTRODUCTION

In the world, especially in developing countries, arable land has decreased significantly as a result of agricultural land degradation and global climate change with the increases in the population and the high demand for food products (37), which traditional threatens food and national security and human survival (28), The methods used in agriculture to enhance plant growth and production is highly dependent on the use of mineral fertilizers, Because of its great importance in food production in the world and its availability for rapid absorption by plants, which leads to faster growth and more efficiently however, the increase in production costs, harmful effects due to the excessive and unbalanced use of these fertilizers caused harmful effects on the environment, pollution of the groundwater and soil deterioration of its fertility, reduced biodiversity and increasing greenhouse gas emissions and Thus, the effect on human health (36). Therefore more attention is needed to encourage the use of organic fertilizers to prevent environmental degradation while improving crop growth (5), one of the environmentally friendly methods is the use of organic fertilizers such as vermicompost and its extract tea, which are classified as high quality in addition to being less expensive and contributing to reduce the use of chemical fertilizers and this will improve crop production with high efficiency (7, 8), Vermicompost tea which is made from fermenting Solid vermicompost in water, is rich in nutrients and also contains high quality humus and plant growth hormones , enzymes and substances capable of protecting plants from pests and diseases (18). It plays a major role in improving the biological, physical and chemical properties of soil, Vermicompost tea is of great importance in improving the biological properties of the soil due to its contribution to encouraging the growth and reproduction of beneficial soil bacteria , fungi and actinomycetes, it also has a vital role in the biotic and abiotic interactions that occur in the rhizosphere region of the plant Which positively affects the various biochemical and physiological processes that occur inside the plant, thus increasing production (38). The vermicompost tea is usually added to the soil or foliar application on the plant (31). In addition to organic fertilizers, bio-fertilizers reduces the amount of mineral fertilizers, Biofertilizers alone or their combined use with organic fertilizers can have positive effects on nutrients availability and organic matter transformation (4, 6). It was found that *Stenotrophomonas maltophilia* bacteria that used in biofertilization supplies nitrogen to plants by free nitrogen fixation, In addition, It promotes plant growth by secreting phytohormones and antibiotics (2) while, with *Bacillus megaterium*, it dissolves phosphate compounds by secreting some organic acids and enzymes and thus increasing its availability in the soil and improving soil fertility and Stimulating the absorption of nutrients to increase production (11). The use of organic and bio fertilizers reduces soil pollution resulting from the continuous use of mineral fertilizers and improves the quality of the crop at the same time . squash is one of the most important vegetable crops which belongs to the genus Cucurbita and to the family Cucurbitaceae whose cultivation is scattered all over the world, It is grown for its nutritional importance, as it contains nutrients, vitamins, and others plant compounds that have many health benefits including heart health and improving digestion and strengthening eyesight, It also plays a positive role in human health as a result of Its anti-oxidant, anti-bacterial, anti-fungal, anti-inflammatory and anti-cancer activity (33), In Iraq, there are large areas of agricultural land qualified for the cultivation of this crop, However, in Iraq, its cultivation is very limited. This study aimed to evaluate the effect of application methods of vermicompost tea and biofertilization with *Stenotrophomonas maltophilia* which was isolated in this study for the first time in Iraq and *Bacillus megaterium* with 50% of the mineral fertilizer recommendation and their interactions on availability of some soil nutrients, the growth and yield of squash .

MATERIALS AND METHODS

A field experiment was carried out at the Agricultural Research Station E of the College of Agricultural Engineering Sciences/ University of Baghdad/Al-Jadiriyah for the spring season 2021Soil samples were

randomly taken before planting from different locations of the experiment field from the surface layer of the field with a depth of (0-30) cm, Then a composite sample was taken for analysis of some soil biological, chemical and physical properties as stated in (24) (Table 1). The soil of the field was prepared by plowing, smoothing and leveling, after which the experiment land was divided into three sectors, and each sector was divided into 34 experimental units. Cultivation was carried out on meadows, where the area of meadow was 6 m^2 and the distance between one and the another is 50 cm, with three meadows for each experimental unit. The distance between one plant and another was 40 cm, with 18 plants at the each experimental unit. The experiment included studying the effect of three factors with three replications. The first factor included four application methods of vermicompost tea (without application F_0, ground application F_1, foliar spray F_2, combination of -ground application + foliar spray F_3), the second factor included the application of four types of biofertilizer (without application B_0 , application of *Stenotrophomonas maltophilia* B_1, application of *Bacillus megaterium* B_2, application of a combination of *S. maltophilia* + *B. megaterium* B_3) and the third factor included the application of mineral fertilizer at two levels (0% M_0, 50% M_1) of the approved fertilizer recommendation for squash (Bulletin of the Iraqi Ministry of Agriculture). With the use of two other control treatments for the fertilizer recommendation, they are 100% according to the different source of phosphate mineral fertilizer, one of which was phosphate rock (M_2) and the other was triple superphosphate (TSP). Vermicompost tea was added in both methods at a concentration of 100 ml L^{-1} and in three stages (15 days after planting, flowering and during fruiting). The roots of squash seedlings were soaked with 20% gum arabian then the roots of the seedlings were dipped in the liquid bacterial inoculum of the two bacterial isolates above . The mineral fertilizer was added in two batches, the first during planting and the second at the beginning of the flower formation stage except the phosphate fertilizer added before planting. The concentration of available nitrogen, phosphorous and potassium in the soil at the end of the growing season was estimated according to the method (24). The growth parameters and yield of squash were studied for five randomly selected plants from each experimental unit, which included wet and dry weight of the shoot, root length and dry weight and length and diameter of the fruit and inner diameter of the fruit ,the yield of a single plant and the total yield . The nitrogen and potassium concentrations in squash fruits were estimated according to the method described in (13) and phosphorous according to the method (22).

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

No	Properties		Amount	Unit
1	pH (1:1)		7.57	
2	EC(1:1)		2.71	dSm^{-1}
3	CEC		19.08	Cmol kg^{-1} soil
4	SOM		9.66	
5	Carbonate minerals		265	g kg^{-1}soil
6	Gypsum		2.76	
7	Cations	Ca^{2+}	9.20	
		Mg^{2+}	5.41	
		Na^{+}	2.88	
		K^{+}	0.21	mmol L^{-1}
8	anions	Cl^{-}	12.10	
		$SO_4^{=}$	6.89	
		HCO_3^{-}	4.60	
		CO_3^{2-}	Nil	
		N	20.10	mg kg^{-1} soil
9	Available Elements	P	8.50	
		K	120.10	
	Bulk density		1.30	Mgm^{-3}
10	Sand		397	
	Silt		331	g.kg^{-1}soil
	Clay		272	
11	Texture	Loam		
12	Total bacteria	20×10^6		CFU g^{-1} dry soil
13	Total Fungi	9×10^3		

RESULTS AND DISCUSSION

Effect of application methods of vermicompost tea and bio-mineral fertilization on some vegetative growth parameter of squash: The results in table (2) show that there were significant differences for the triple interaction between the averages of the treatments of the application methods of vermicompost tea and bio- mineral fertilization for some vegetative growth parameters, the interaction treatment of the combination application methods of vermicompost tea + the combination of biofertilizer + 50% mineral fertilizer $F_3B_3M_1$ outperformed all other interaction treatments. In terms of wet and dry weight, length and dry weight of the root, and achieve the highest rate of wet and dry weight of the shoot, which reached 2.14 kg plant^{-1} and 196.35 g plant^{-1}, respectively, and the root length was 65.33 cm and 60.31 g plant^{-1}, This was followed by the $F_1B_3M_1$, $F_3B_1M_1$ and $F_0B_3M_1$ interference treatment compared to the control treatment (without addition) $F_0B_0M_0$, which gave the lowest values for the previous characteristics, which amounted to (0.24 kg plant^{-1}, 78.26 g plant^{-1}, 28.21 cm, 12.45 g plant^{-1}) respectively.

Table 2. The effect of different study factors on some indicators of vegetative and root growth of squash

Treatment	Parameters			
	The wet weight of the vegetative shoot (kg plant^{-1})	dry weight of the vegetative shoot (g plant^{-1})	root length (cm)	Root dry weight g plant^{-1}
$F_0B_0M_0$	0.24	78.26	28.21	12.45
$F_0B_0M_1$	0.40	81.25	38.51	16.24
$F_0B_1M_0$	0.98	120.01	47.67	23.70
$F_0B_2M_0$	0.63	105.52	35.10	19.04
$F_0B_3M_0$	1.06	124.16	50.10	36.11
$F_1B_0M_0$	0.69	92.54	40.69	22.45
$F_1B_1M_0$	1.13	156.34	57.31	40.21
$F_1B_2M_0$	1.02	153.00	52.43	37.04
$F_1B_3M_0$	1.25	161.31	60.14	42.91
$F_2B_0M_0$	0.47	87.22	33.90	15.78
$F_2B_1M_0$	0.98	134.67	40.00	34.12
$F_2B_2M_0$	0.83	116.90	38.22	31.03
$F_2B_3M_0$	1.14	147.66	57.31	40.13
$F_3B_0M_0$	1.03	97.35	59.10	32.52
$F_3B_1M_0$	1.25	171.10	58.86	42.51
$F_3B_2M_0$	1.10	136.47	45.31	39.01
$F_3B_3M_0$	1.67	191.13	62.10	48.21
$F_0B_1M_1$	1.53	171.33	59.42	42.00
$F_0B_2M_1$	0.99	136.00	44.61	40.16
$F_0B_3M_1$	1.74	189.99	61.88	45.31
$F_1B_0M_1$	1.11	147.00	54.31	37.13
$F_1B_1M_1$	1.64	188.15	60.13	55.91
$F_1B_2M_1$	1.21	149.62	52.21	43.55
$F_1B_3M_1$	1.91	190.70	62.01	58.91
$F_2B_0M_1$	0.92	129.31	48.20	33.21
$F_2B_1M_1$	1.22	176.66	56.22	52.10
$F_2B_2M_1$	1.24	146.67	45.31	40.88
$F_2B_3M_1$	1.75	182.51	60.24	57.00
$F_3B_0M_1$	1.43	159.72	55.31	38.03
$F_3B_1M_1$	1.49	190.61	63.08	58.01
$F_3B_2M_1$	1.32	173.36	55.31	46.31
$F_3B_3M_1$	2.14	196.35	65.33	60.31
LSD F*B*M	0.1853	14.02	2.902	2.951
M_2	0.588	92.05	46.21	24.77
TSP	1.228	116.21	53.44	36.87

It is shows from table (2) the significant effect of the application methods of vermicompost tea on some vegetative growth parameters of squash, This could be attributed to its positive effect because it contains humic acids that act as a mediator in the respiration process, which positively reflects on the activity of enzymes and hormones that cause an increase in photosynthesis products, which leads to an increase in the activity of the cell division process and an increase in its size, that may causes the formation of new parts which leads to an increase in the dry weight of the vegetative and root part (10), in addition to

containing amino acids that contribute to the formation of the chlorophyll molecule in the leaves in addition to increasing the levels of plant hormones because it contains auxins, cytokinins and salicylic acid responsible for activating the cambium within higher plants and increases From the activity of cell division of meristematic cells in a large and rapid way, which develops the vegetative system these results came in agreement with the result of (23). The increase that occurred as a result of adding bio-fertilizer, may due to the role of both *S. maltophilia* and *B. megaterium* bacteria with different mechanisms to dissolve phosphorous from its insoluble compounds and liberate potassium from its minerals and increasing the availability of micronutrients in the soil necessary for plant growth and development in addition to the role of *S. maltophilia* in fixing atmospheric nitrogen and releasing siderophores responsible for the formation of the chlorophyll molecule, the secretion of plant hormones and some growth regulators responsible for the division and elongation of cells that contribute to the growth, development and increase of the root system and the surface area of the absorption zone, which in turn increases the rate of absorption of water and nutrients .These results are agreement with the result of (32), As for the added mineral fertilizer, it increases the availability of N, P and K in the soil and the uptake of nutrients in the leaves and to the important role of nitrogen in the process of cell division and increase its elongation and growth which is reflected in raising the efficiency of the roots in the absorption of more nutrients and to the role of phosphorus in increasing the growth of the root system and the number of its branches, which accelerates the absorption of water and nutrients, as well as its participation in energy formation and acceleration of growth In addition to the role of potassium in maintaining cell swelling pressure and contributing to improving cell growth and elongation, these results agree with (30).

Effect of application methods of vermicompost tea and bio-mineral fertilization on some indicators of squash yield: The results of the statistical analysis of table (3) indicate significant differences for the triple interaction between the averages of the treatments of the application methods of vermicompost tea and the bio-mineral fertilization for some indicators of the components of the squash yield. The interaction treatment of the combination application method of vermicompost tea + the combination of biofertilizer + 50% mineral fertilizer $F_3B_3M_1$ outperformed all other interaction treatments in all indicators of the squash yield components and achieve the highest average of fruit length, fruit diameter, inner fruit diameter, single plant yield and total yield and gave a values of (21.48 cm, 48.98 mm, 38.98 mm, 1.508 kg plant^{-1}, 45.140 Mg ha^{-1}) respectively, followed by the interference treatment $F_1B_3M_1$ for the length and diameter of the fruit and $F_3B_1M_1$ in addition to the previous two treatments for the inner diameter of the fruit as for the yield of one plant and the total yield, the treatments $F_1B_3M_1$, $F_1B_3M_0$, $F_0B_3M_1$, $F_3B_1M_1$ and $F_2B_3M_1$ followed without significant difference compared to the control treatment (without addition) $F_0B_0M_0$, which gave the lowest values for the traits for the yield indicators, which amounted to (13.52 cm, 30.08 mm, 18.08 mm, 0.378 kg of plant^{-1},11.350 Mg ha^{-1}) respectively. The results of table (3) show the significant effect of the application methods of vermicompost tea on the indicators of yield and total yield. This increase may be attributed to the fact that vermicompost tea, and in both ways, provided the plant with the nutrients that enter the photosynthesis process and the process of protoplasmic building, respiration and plant hormones, which mainly contributed to improving the nutritional and physiological state of the plant which reflected positively on the yield indicators in addition to its contribution to increasing the effectiveness of the nitrate reductase enzyme as a result, plant protein production is increased (20) and then increasing the number of female flowers as it stimulates the formation of flowers as it regulates the level of hormones in the plant thus, , increasing the number of female flowers and the rate of knots, and thus increasing the yield of squash. As for the effect of bio fertilization, this is due to the role of *S. maltophilia* and *B. megaterium* bacteria in providing important nutrients to the plant

Table 3. The effect of the various study factors on some indicators of the squash yield components

Treatment	Parameters				
	Fruit length (cm)	Fruit diameter mm)(	Fruit inner diameter mm)	yield of one plant (kg plant^{-1})	total yield Mg ha^{-1}
$F_0B_0M_0$	13.52	30.08	18.08	0.378	11.350
$F_0B_0M_1$	14.08	31.01	19.01	0.461	13.820
$F_0B_1M_0$	16.59	36.76	27.76	0.747	22.420
$F_0B_2M_0$	14.06	32.04	21.04	0.467	14.010
$F_0B_3M_0$	17.36	38.35	28.35	0.964	28.930
$F_1B_0M_0$	15.55	34.45	23.12	0.666	19.980
$F_1B_1M_0$	18.87	41.65	33.65	1.264	37.930
$F_1B_2M_0$	18.60	40.01	27.01	1.191	35.730
$F_1B_3M_0$	19.23	42.81	31.81	1.456	43.670
$F_2B_0M_0$	14.21	33.21	21.21	0.426	12.780
$F_2B_1M_0$	15.36	37.14	26.14	1.117	33.520
$F_2B_2M_0$	15.32	37.03	22.03	1.048	31.430
$F_2B_3M_0$	18.05	41.03	29.53	1.268	38.040
$F_3B_0M_0$	17.20	34.87	23.37	0.792	23.760
$F_3B_1M_0$	18.41	40.71	30.05	1.259	37.760
$F_3B_2M_0$	16.35	37.89	25.89	1.124	33.730
$F_3B_3M_0$	19.55	43.24	32.24	1.484	44.520
$F_0B_1M_1$	19.02	42.44	32.44	1.279	38.370
$F_0B_2M_1$	16.25	38.32	28.65	1.124	33.720
$F_0B_3M_1$	18.50	43.32	33.32	1.477	44.310
$F_1B_0M_1$	16.94	34.21	23.21	1.049	31.480
$F_1B_1M_1$	19.00	45.43	34.93	1.436	43.090
$F_1B_2M_1$	17.01	40.22	29.22	1.287	38.610
$F_1B_3M_1$	20.05	48.23	37.23	1.491	44.740
$F_2B_0M_1$	16.27	33.41	20.41	0.902	27.060
$F_2B_1M_1$	18.92	42.21	30.21	1.420	42.600
$F_2B_2M_1$	16.21	40.00	28.00	1.233	36.990
$F_2B_3M_1$	18.66	45.76	31.76	1.478	44.330
$F_3B_0M_1$	17.05	35.88	23.88	1.138	34.140
$F_3B_1M_1$	19.64	46.85	37.35	1.466	43.990
$F_3B_2M_1$	17.30	42.95	30.95	1.298	38.940
$F_3B_3M_1$	21.48	48.98	38.98	1.508	45.140
LSD F*B*M	1.222	1.814	2.009	0.0499	1.497
M_2	16.78	31.77	20.77	0.774	23.220
TSP	16.99	40.21	31.21	1.045	31.350

such as nitrogen, phosphorous and potassium and then increasing its concentration in the plant and fruits, and thus increasing the total yield of the plant, *S. maltophilia* fixes atmospheric nitrogen, dissolves phosphorous compounds and releases potassium from its compounds through the secretion of some organic acids (21) , In addition to the role of *B. megaterium* in dissolving phosphate rock and increasing the availability of phosphorous for its important role in increasing the number of leaves per plant, which leads to an increase in the number of flower buds, and then an increase in the number of fruits per plant, which is positively reflected in the productivity of one plant and the productivity of the unit area (3). The results are agreement with (16). The addition of mineral fertilizer affected the increase in the growth indicators and the yield of squash with the increase in the levels of addition. This increase may be attributed to the increase in the availability of macronutrients in an abundant and ready-to-absorb manner by the squash plant, thus prolonging the period of fruit filling, by delaying aging and increasing the size of the food tissue (the fruit) these results are in agreement with the result of (19).

Effect of application methods of vermicompost tea and bio-mineral fertilization in NPK concentrations in squash fruits: The results in table (4) show significant differences for the triple interaction between the averages of the treatments of the methods of adding vermicompost tea and bio-mineral fertilization on the concentrations of NPK in the fruits of squash, the interaction treatment of the combination application methods of vermicompost tea + the combination of biofertilizer + 50% mineral fertilizer ($F_3B_3M_1$) outperformed all other interaction treatments and gave the highest values of nitrogen, phosphorous and potassium concentrations in fruits that reached

2.90%,0.80% and 2.71% respectively Compared to the control treatment for the full fertilizer recommendation for TSP, M_2 treatment and the comparison treatment (without addition) $F_0B_0M_0$ that gave the lowest values 1.31%,0.2% and 1.24% respectively. The addition of vermicompost tea had a significant effect on increasing the concentrations of nitrogen, phosphorous and potassium in the fruits, this increase may be attributed to its role in increasing the permeability of cell membranes, which improves the absorption of nutrients that enter into vital processes that take place within the plant such as photosynthesis and associated processes, In addition to the nutrients, antibiotics, and amino acids that vermicompost tea contains, nitrogen is mainly included in its composition (27), These results are consistent with that of (14).

Table 4.The effect of the study factors on the NPK(%) concentration of squash fruits

Treatment	Parameters N%	P%	K%
$F_0B_0M_0$	1.31	0.20	1.24
$F_0B_0M_1$	1.35	0.23	2.00
$F_0B_1M_0$	2.15	0.45	1.36
$F_0B_2M_0$	1.45	0.32	2.11
$F_0B_3M_0$	2.25	0.50	1.42
$F_1B_0M_0$	1.45	0.38	2.38
$F_1B_1M_0$	2.48	0.60	1.51
$F_1B_2M_0$	1.62	0.42	2.45
$F_1B_3M_0$	2.58	0.71	1.31
$F_2B_0M_0$	1.37	0.30	2.29
$F_2B_1M_0$	2.42	0.50	1.38
$F_2B_2M_0$	1.47	0.36	2.30
$F_2B_3M_0$	2.33	0.60	1.63
$F_3B_0M_0$	1.70	0.43	2.44
$F_3B_1M_0$	2.57	0.61	1.57
$F_3B_2M_0$	1.81	0.45	2.51
$F_3B_3M_0$	2.61	0.74	2.00
$F_0B_1M_1$	2.97	0.54	2.34
$F_0B_2M_1$	1.52	0.39	1.46
$F_0B_3M_1$	2.47	0.62	2.42
$F_1B_0M_1$	1.95	0.43	1.75
$F_1B_1M_1$	2.65	0.67	2.47
$F_1B_2M_1$	2.00	0.48	1.87
$F_1B_3M_1$	2.75	0.78	2.68
$F_2B_0M_1$	1.52	0.38	1.40
$F_2B_1M_1$	2.62	0.58	2.40
$F_2B_2M_1$	1.75	0.43	1.58
$F_2B_3M_1$	2.70	0.67	2.53
$F_3B_0M_1$	2.21	0.50	2.08
$F_3B_1M_1$	2.68	0.72	2.50
$F_3B_2M_1$	2.25	0.51	1.92
$F_3B_3M_1$	2.90	0.80	2.71
LSD F*B*M	0.046	0.037	0.036
M_2	1.68	0.28	1.60
TSP	1.72	0.40	1.62

The bio-fertilizer gave a significant effect in increasing the concentrations of, nutrients, and this may due to the direct effect of *S. maltophilia* in fixing nitrogen in the soil and continuous manner throughout the growth period of squash and then increasing its concentration in the plant and transferring the surplus from it to the fruits (26), and to the role of both phosphate-dissolving bacteria that work on dissolving and preparing phosphorous from solubilizing insoluble phosphate compounds and dissolving phosphate rock and from the mineralization of organic phosphorous in the soil and it appears through its efficiency in the production of organic acids and the secretion of the phosphatase and phytase enzyme that leads to an increase in the uptake of it in the plant (12) and these results came in agreement with the result of (34). The results showed a clear effect of adding mineral fertilizer on the concentrations of nitrogen, phosphorous and potassium in fruits with an increase in the levels of addition compared to the control treatment. It may be attributed to the fact that nitrogen, phosphorous and potassium are ready for absorption by the plant as a result of adding suitable amount of mineral fertilizers for plant growth and increase their concentrations in the soil, which is reflected positively on the amount absorbed by the plant, the results of the study agree with several other researchers (5, 9, 15).

Effect of application methods of vermicompost tea and bio-mineral fertilization in the availability of NPK in soil (mg kg^{-1} soil): The results of table 5 show significant differences for the triple interaction Between the averages of the coefficients of the application methods of vermicompost tea and the bio-mineral fertilization In the available concentrations of nitrogen, phosphorous and potassium in the soil at the end of the field experiment, as the treatment of the triple interaction of the combination of application methods of vermicompost tea with the combination of biofertilizer with 50% of the mineral fertilizer ($F_3B_3M_1$) outperformed significantly by giving the highest values for available NPK in the soil that reached to 60.56, 38.20 and 191.38 mg kg^{-1} soil, respectively Compared to the control treatment for the full fertilizer recommendation for TSP, M_2 and the comparison treatment (without addition)

Table 5. The effect of the study factors on the availability of NPK in soil (mg kg^{-1} soil)

Treatment	Parameters N mg kg soil^{-1}	P mg kg soil^{-1}	K mg kg soil^{-1}
$F_0B_0M_0$	10.55	3.65	113.51
$F_0B_0M_1$	19.42	4.01	126.03
$F_0B_1M_0$	27.00	17.20	136.41
$F_0B_2M_0$	15.90	12.51	128.30
$F_0B_3M_0$	31.28	22.44	141.00
$F_1B_0M_0$	20.11	10.30	133.07
$F_1B_1M_0$	33.81	20.14	160.20
$F_1B_2M_0$	24.50	15.00	142.98
$F_1B_3M_0$	44.34	30.50	165.66
$F_2B_0M_0$	13.40	3.87	116.52
$F_2B_1M_0$	29.88	19.31	141.32
$F_2B_2M_0$	18.20	13.41	129.77
$F_2B_3M_0$	35.30	26.44	151.33
$F_3B_0M_0$	24.60	12.01	135.88
$F_3B_1M_0$	35.77	23.19	163.83
$F_3B_2M_0$	26.22	15.42	145.25
$F_3B_3M_0$	45.21	32.15	169.80
$F_0B_1M_1$	33.21	20.10	153.32
$F_0B_2M_1$	21.09	14.24	138.21
$F_0B_3M_1$	41.56	28.05	161.03
$F_1B_0M_1$	25.71	17.60	140.06
$F_1B_1M_1$	45.68	30.00	178.21
$F_1B_2M_1$	31.00	17.00	147.50
$F_1B_3M_1$	57.75	35.21	186.20
$F_2B_0M_1$	21.22	5.72	131.11
$F_2B_1M_1$	37.31	23.22	157.33
$F_2B_2M_1$	28.44	15.31	138.27
$F_2B_3M_1$	41.74	30.10	166.30
$F_3B_0M_1$	28.31	18.22	144.96
$F_3B_1M_1$	46.21	31.21	180.00
$F_3B_2M_1$	32.22	20.31	150.02
$F_3B_3M_1$	60.56	38.20	191.38
LSD F*B*M	2.19	1.285	2.288
M_2	24.33	4.31	135.78
TSP	25.80	15.66	136.40

$F_0B_0M_0$ which gave the lowest values for the concentrations 10.55,3.65 and 113.51 mg kg^{-1} soil, respectively .The application methods of vermicompost tea had a significant effect on increasing available nitrogen, phosphorous and potassium in the soil. The addition of vermicompost tea to the soil led to an increase in nitrogen availability in the soil, this may be due to the fact that the added vermicompost tea is considered as a good source of nutrients , including nitrogen , and it contains atmospheric nitrogen-fixing bacteria, which led to an increase in the concentration of nitrogen available in the soil (17), The increase in phosphorous and potassium available in the soil is also may due to the humic acids in vermicompost tea which contribute to the encapsulation of clay particles as a result of the release of negative ions of carboxyl and hydroxyl groups that interact with calcium and magnesium ions which in turn reduces phosphorous fixation and increases its availability (16), in addition, it contains organic acids that contribute to the release of potassium ions from these minerals into the soil solution, these results agree with (25). The addition of bio-fertilizers had a significant effect on increasing the concentrations of nitrogen, phosphorous and potassium available in the soil, which may be attributed to the role of *Stenotrophomonas maltophilia* in freely fixing atmospheric nitrogen (26) and then increasing the nitrogen concentration in the soil as a result of the activity of the nitrogenase enzyme (1), As for the increase in the values of available phosphorous and potassium concentrations in the soil, it may be attributed to the combined effect of both *S. maltophilia and B. megaterium* bacteria in the process of dissolving phosphate rock and phosphate compounds. (35) and its main role in the oxidation of sulfur and the production of sulfuric acid, which leads to the dissolution of phosphate rock (29).

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