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Impact of organic, biological and mineral fertilizations on the mineral content of potato sprouts and tubers planted in gypsum soils

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Abstract: The study was carried out during the 2021 spring planting season at the Fallujah palm station belonging to the Department of Horticulture, the Ministry of Agriculture, in gypsum soil to study the Impact of organic Fertilization and inoculation with P.sudomonas bacteria, *Trichoderma harzanium* and Mineral fertilization on the growth and yield of potatoes of Burren variety, Experiment included three factors. The addition of fertilization recommendation by 100% (M100) led to a significant increase in the content of major nutrients (N, P, K) in the vegetative part, which amounted to 1.35, 0.25 and 1.42 percent, respectively, and in the tubers which amounted to 1.22, 0.21 and 1.28%, respectively. And the starch in the tubers reached 12.89 g. plant-1, while adding half of the Fertilization recommendation (M50) gave the lowest rates for the traits mentioned earlier. The double and triple interactions gave significant results in growth characteristics, yield and mineral content.

Key words: Potatoes, Organic fertilization, Bio-fertilizations, Mineral fertilization, yield.

Introduction

The potatoes (*Solanum tuberosum L.*), which belong to the Solanaceae family, are the third food Yield after wheat and rice. It is also the most critical type of yield because it contains a quantity of protein, starch, and vitamins[4]. Adding organic matter to soil increases the activity of soil biology, as microorganisms decompose these wastes in the process of mineralizing the organic matter consisting of carbonic acid, which increases the readiness of the elements and reduces the degree of soil interaction, and organic matter may accumulate in the soil (SOM) as a result of the decomposition of waste The plant material that is added to the field soil from the residues of agricultural Yields, and organic materials can be added that are secretions from tree leaves, root secretions and the remains of decomposing soil organisms[2].

Bio-fertilizations are one of the modern agricultural applications, as they contain many microorganisms and have an essential role in the production of growth regulators in addition to improving the physical and mineral properties of the soil, which increases the Impactiveness of bio-fertilizations by adding them with organic Fertilizations and this leads to an increase in yield production[3]. The presence of organic and Bio-fertilizations and the addition of organic matter in the soil increases the activity of microorganisms on the earth. Bacteria that stimulate plant growth (PGPR) are essential for many agricultural Yields[20] as different types of (PGPR) eliminate many plant diseases. It facilitates plant growth directly or indirectly, as well as the decomposition of organic matter[16].

Pseudomonas bacteria secrete plant hormones that encourage plant growth, such as auxins, including IAA (Indol acetic acid) and cytokinin. They also secrete the Enzyme (ACC-deaminase) that inhibits the presence of ethylene[5]. *Trichoderma harzanium* fungus is a valuable living throw fungus that is used in biocontrol on a large scale. Experiments in many countries have also shown that Trichoderma mushrooms have a substantial impact in the agricultural field, especially increasing the readiness of nutrients such as nitrogen, phosphorus and potassium through its excretion of some enzymes and its high ability to degrade existing organic substances or soil additives, as well as its high ability to give the plant breadwinner resistance against pathogens[5,13,18] found that the addition of mushrooms *Trichoderma spp*. It gave the highest level of nitrogen and phosphorus at each level of organic matter, and the addition of mushrooms gave the highest values to the weights of dry matter of the tomato plant.

Showed[22] when adding organic matter (sheep, poultry and horse manures) in interaction with bio-fertilization (*Azotobactre chroococcum*, *Pseudomonas florecienis* (that the organic matter contributed either alone or in interaction with growth-stimulating bacteria in increasing the growth and production of potato plants.

The macronutrients in general and the macronutrients in particular are among the factors that affect the yield of the plant due to their importance in the formation of the vegetative, root and yield Among the most important of these macronutrients are N, P, K These nutrients come from mineral Fertilizations that are added to the soil[11,12] found in their study conducted to find out the impact of the interaction between organic and mineral fertilization and for two seasons on the growth and yield of potatoes when adding urea fertilization at four levels (0, 50%, 75%, 100%) of the Fertilization recommendation approved in his study[24]. Results of the spring season showed that the 100% treatment outperformed the concentration of nitrogen and potassium in the lea-

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ves as it reached 2.07% and 3.65% respectively, compared to the comparison treatment which gave the lowest rates for the aforementioned traits[25] found in his study, which was conducted to find out the impact of the level of mineral and organic Fertilizations added to the soil on the characteristics of the Mineral content, to the presence of superiority in the aspects of the study when adding nitrogen Fertilization with an amount of 240 kg N H^{-1}, compared to the comparison treatment, which gave the content of leaves at the maturity stage of Nitrogen, Phosphorous and Potassium were 4.77, 0.45 and 4.67%, respectively, compared to the comparison treatment, which gave the lowest average for the aforementioned traits.

The study aimed to know the impact of organic, Bio and Mineral Fertilizations, with the interaction between them on characteristics of Mineral content of the shoots and tubers of potato plants.

Materials and methods

The study was carried out during the 2021 spring planting season at the Fallujah palm station belonging to the Department of Horticulture, the Ministry of Agriculture, on gypsum soil to study the impact of organic matter and bio-fertilization with *P.Seudomonas florecienis* bacteria, *Trichoderma harzanium* and mineral Fertilization on vegetative growth characteristics, Mineral content and yield traits. RCBD randomized complete blocks with three replications. The area required to carry out the experiment was determined, and the process of preparing the soil for cultivation was carried out by performing orthogonal plowing, smoothing and leveling operations. Soil samples were taken from a depth of 0.3-0 m from different sites of the field. They were mixed well, dried aerobically, smoothed and passed through a sieve with holes 2 mm in diameter, from which samples were taken to conduct some physical and mineral analyses and the results of which are presented in table (1). A field was divided into three sectors, and each sector was divided into 15 experimental units, and each experimental unit was into three lines (each 2.50 m long and the distance between line and the other 0.75 m) left a distance of (1 m) between the experimental units and (2 m) between the sectors.

Study factors

The first factor: Organic Fertilization

We are adding two levels of fermented organic fertilization: (1) without adding C0 organic Fertilization (2) Adding organic Fertilization C1.

The second factor:

Bio-fertilization(1) comparison and symbolized with the symbol (B0)

(2) adding the bacterial vaccine Pseudomonas and symbolized by the symbol (B1)

(3) Adding the Trichoderma fungal vaccine and symbolizing it with the symbol (B2)

(4) Adding the bacterial vaccine Pseudomonas and the Trichoderma fungal vaccine and symbolizing it with the symbol (B3).

The third factor: Mineral fertilization:-

(1) Add half of the Fertilization recommendation (120 kg N, 60 kg P and 200 kg. K h^{-1}), and its symbol is M50

(2) Add 3/4 of the quantity at a rate of 75% (180 kg N, 90 kg P and 300 kg . K h^{-1}) from the Fertilization recommendation and its symbol is M75

(3) Add the total amount of fertilization: (240 kg. N, 120 kg. P and 400 kg .K h^{-1}), and its symbol is M100.

Knowing that the recommended Fertilization recommendation is 250 kg N.h^{-1} and 50 kg N.h^{-1} and potassium is 400 kg, depending on the source[7].

Property	Unit		Value
PH	-		**7.30**
E.C	ds m^{-1}		**4.2**
N	Mg.kg-1		**62.0**
P			**16.2**
K			**149.0**
O.M	g.kg^{-1}		**1.2**
C.E.C			**36.18**
	Ca++	20.95	
	Na+	6.25	
	K+	1.6	
	Mg++	10.75	
	$Co^{=}_3$	Nil	
	HCO-3	1.15	
	CL^-	10.50	
Bulk density	g/cm		**1.10**
Microbial density	Cfu.10^5 g^{-1}soil		**2.21**
Gypsum	g.kg^{-1}. soil		**330**
Clay	g.kg^{-1}. soil		**10**
Silt	g.kg^{-1}. soil		**860**
Sand	g.kg^{-1}. soil		**130**
Calcium carbonate	g.kg^{-1}. soil		**44**
Texture Class	-		**Lomay Sand**

Table 1. Some Mineral and physical properties of field soil before planting.

The Bacterial inoculum was multiplied by taking a weight of 15 g of the nutritional medium (Nutrient Broth) dissolved in a liter of distilled water. The pH of the solution was adjusted to 7.5 -7, then sterilized by the autoclave, the solution was cooled, and the liquid culture was prepared by taking a smear of Pseudomonas bacteria by means of a loop, the lube was inserted into the container flask. The nutrient solution must be carefully designed to prevent other organisms from entering the food environment and contaminating it. This process was carried out inside a Hood device sterilized by alcohol; after the culture process was carried out, the bacterial culture was placed in the incubator at a temperature of 28 °C for Pseudomonas bacteria for 72 hours until signs of growth appeared if Discoloration and turbidity appeared in the solution. The density of Pseudomonas inoculum was 2.3×108 CFU.

After preparing the bacterial inoculum from Pseudomonas bacteria, the bacterial inoculum was added. The tubers were contaminated with the liquid nutritional medium prepared in advance in the laboratory by adding 10% gum arabic and immersing the tubers in the nutrient medium for half an hour to ensure cell adhesion to the tubers. After placing the vaccine, the tubers were directly covered with soil to avoid the impact of sunlight and drought on the vaccine; the Agricultural Research Department prepared local isolates of the bio-vaccine. Ministry of Science and Technology[15].

Sheep residues were added to the soil after they were obtained from the place near the implementation site. The search was done in a pit of dimensions (2 x 3 x 0.5) m.

Characteristics of Mineral content of the shoots and potato tubers

Determination of some elements in leaves and tubers: The fourth leaf was taken from the developing top of the main stem of five plants randomly from the middle line for each experimental unit in the maturity stage according to (Sanderson and White 1983), it was washed with distilled water to remove dirt and dust, and dried in an electric oven containing a vacuum on Temperature is 70 degrees Celsius until the weight is stable[26] then it is Crush and sieved.

Percentage of total nitrogen:- The percentage of total nitrogen was estimated after adding a base acid of NaOH at a ratio of 10 molary by evaporation and distillation method by Micro Kieldahl device after titration with 0.04 standard hydrochloric acid[14].

Percentage of phosphorous:- Percentage of phosphorous was estimated using ammonium molybdate by taking 5 ml of the digested sample, adding to it 10 ml of ammonium molybdate solution, then leaving the samples for 10 minutes, after which the resulting blue intensity was measured by spectrophotometer at a wavelength (620 nm)[28].

Percentage of potassium:- The percentage of potassium is estimated by means of a flame photometer, according to the method used by (19).

Percentage of starch in Tubers-: The percentage of starch (%) in tubers was calculated according to the equation shown in[1] as follows: Starch percentage = 17.55 + 0.89 (% dry matter - 24.18).

Results

Nitrogen content of leaves (%)

The results of table (2, 3) show that the addition of organic fertilization significantly impacted the nitrogen percentage in the leaves and tubers, as the treatment O1 gave the highest nitrogen content in the leaves and tubers, which amounted to 1.38%, and 1.26% respectively. In contrast, the comparison treatment O0 showed the lowest percentage, which amounted to 1.13% and 0.99%, respectively.

While the results of the same tables indicated the significant Impacts as a result of adding bio-fertilization in the nitrogen content of leaves and tubers, as treatment B3 achieved the highest percentage of 1.57% and 1.45% sequentially, then followed by a significant difference between treatment B2 by giving it a rate of 1.33%, 1.20% sequentially, which It differed from treatment B1, which provided a percentage of 1.19% and 1.05%, while treatment B0 achieved the lowest rate of 0.93% and 0.79%, respectively.

Results of table (2, 3) also show the moral Impacts as a result of adding mineral Fertilization, as the M100 treatment recorded the highest percentage of 1.35% and 1.22% sequentially, then followed by a significant difference by the M75 therapy by giving it 1.25%, 1.13% sequentially, while the M50 treatment achieved the lowest percentage. They reached 1.16% and 1.02%, respectively. It was found that the interaction of organic and biological Fertilizations achieved a significant increase in the rate of nitrogen in leaves and tubers, as the treatment O1B3 gave the highest percentage of 1.70% and 1.57%, respectively. In comparison, the treatment O0B0 gave the lowest percentage of 0.84% and 0.67%, respectively.

The percentage of nitrogen also increased significantly as a result of the interaction of organic and Mineral Fertilizations, especially the treatment O1M100, which gave the highest percentage of nitrogen amounted to 1.47% and 1.34%, respectively, while the treatment O0M50 gave the lowest percentage of 1.05% and 0.89% respectively. The bilateral interaction between bio-fertilization and mineral fertilization significantly increased the percentage of nitrogen, as the treatment B3M100 achieved the highest percentage of 1.70% and 1.57%, respectively. In comparison, the treatment B0M50 gave the lowest percentage of 0.74% and 0.58%, respectively.

As for the triple interaction between organic,bio-fertilization and Mineral Fertilizations, the results of table (2, 3) showed significant Impacts due to the tripartite interaction of the research treatments, as the treatment O1B3M100 achieved the highest percentage of 1.77%, 1.64% respectively, while the treatment O0B1M50 performed the lowest percentage of 0.71%, 0.45 % sequentially.

Phosphorous content of leaves and tubers (%)

The results of Table (4, 5) indicated that the phosphorous content of leaves and tubers was significantly affected by the addition of organic Fertilizations, as treatment O1 gave the highest content of 0.26% and 0.22%, respectively, while treatment O0 gave the lowest phosphorous content of 0.19% and 0.15% respectively. It was also shown from the results of the same table that the phosphorous content of leaves and tubers increased as a result of the addition of bio-fertilization, as treatment B3 gave the highest concentration of 0.34% and 0.29% sequentially, followed by a significant difference by treatment B2 with a percentage of 0.27%, 0.23% respectively. In comparison, treatment B0 gave The lowest concentration, 0.12% and 0.08%, respectively.

It was found that the treatment with Mineral fertilization achieved a significant increase in the phosphorous content of leaves and tubers, as the M100 treatment gave the highest concentration of 0.25%, and 0.21% sequentially, then followed by a significant difference by the treatment M75 with a percentage of 0.22%, 0.18% sequentially, while the M50 treatment gave the lowest concentration 0.20%, 0.16% sequentially. The bilateral interaction between organic and biological fertilization had a significant impact in increasing the phosphorous content of leaves and tubers, as the O1B3 treatment showed the highest percentage of 0.39% and 0.34%, respectively, compared to the comparison treatment, which showed the lowest percentage of 0.10% and 0.07%, respectively.

As for the bilateral interaction between organic and mineral fertilization, the results of table (4, 5) showed that it caused a significant increase in the phosphorous content of the leaves, as the treatment O0M100 gave the highest percentage of 0.29% and 0.25%, respectively, while the treatment O0M50 gave the lowest percentage of 0.16%, 0.13% sequentially.

We also note from the results of table (4, 5) that the second interaction between biological and mineral fertilization has made a significant difference, as treatment B3M100 gave the highest percentage of 0.36%, 0.31%, respectively, while treatment B0M50 gave the least significant difference in phosphorous content of leaves and tubers, which amounted to 0.10%. 0.07% sequentially.

(O) Organic Fertilization	(B) Bio- Fertilization	(M) Mineral Fertilization			B × O
		M_{50}	M_{75}	B_{100}	
O_0	B_0	0.71	0.83	0.98	0.84
	B_1	1.04	1.06	1.14	1.08
	B_2	1.14	1.14	1.17	1.15
	B_3	1.30	1.42	1.62	1.45
O_1	B_0	0.77	1.10	1.16	1.01
	B_1	1.24	1.28	1.36	1.30
	B_2	1.46	1.49	1.58	1.51
	B_3	1.62	1.69	1.77	1.70
Impact of Organic Fertilization (O)					
M × O	O_0	1.05	1.11	1.23	1.13
	O_1	1.27	1.39	1.47	1.38
Impact of Bio- Fertilization (B)					
M × B	B_0	0.74	0.97	1.07	0.93
	B_1	1.14	1.17	1.25	1.19
	B_2	1.30	1.32	1.37	1.33
	B_3	1.46	1.56	1.70	1.57
Impact of Mineral fertilization(M)		1.16	1.25	1.35	

L . S . D 5 %						
O	B	M	B × O	M × O	M × B	O × M × B
0.07	0.10	0.09	0.14	0.12	0.17	0.25

Table 2. Impact of organic,bio-fertilization and Mineral Fertilizations on the nitrogen content of leaves of potato plant (%).

(O) Organic Fertilization	(B) Bio- Fertilization	(M) Mineral Fertilization			B × O
		M_{50}	M_{75}	B_{100}	
O_0	B_0	0.45	0.70	0.85	0.67
	B_1	0.90	0.93	0.98	0.94
	B_2	0.99	1.00	1.03	1.01
	B_3	1.20	1.30	1.50	1.33
O_1	B_0	0.70	0.98	1.03	0.90
	B_1	1.11	1.15	1.25	1.17
	B_2	1.33	1.40	1.45	1.39
	B_3	1.50	1.56	1.64	1.57
Impact of Organic Fertilization (O)					
M × O	O_0	0.89	0.98	1.09	0.99
	O_1	1.16	1.27	1.34	1.26
Impact of Bio- Fertilization (B)					
M × B	B_0	0.58	0.84	0.94	0.79
	B_1	1.01	1.04	1.12	1.05
	B_2	1.16	1.20	1.24	1.20
	B_3	1.35	1.43	1.57	1.45
Impact of Mineral fertilization(M)		1.02	1.13	1.22	

L . S . D 5 %						
O	B	M	B × O	M × O	M × B	O × M × B
0.07	0.10	0.09	0.14	0.12	0.18	0.25

Table 3. Impact of organic , bio-fertilization and Mineral Fertilizations on the nitrogen content of tubers (%).

As for the triple interaction, the results shown in Tables (4, 5) indicate that the research treatments have significantly increased the phosphorous content of leaves and tubers, as the O1B3M100 treatment achieved the highest percentage of 0.42%, and 0.36%, respectively. In comparison, the O0B0M50 interaction treatment achieved the lowest percentage of 0.08%, 0.05% sequentially.

Potassium content of leaves and tubers (%)

The results shown in table (6, 7) show that the addition of organic fertilization significantly increased the potassium content of leaves and tubers, as the O1 treatment achieved the highest concentration of 1.45% and 1.32%, respectively. In comparison, the comparison treatment O0 gave the lowest potassium content of 1.19%, 1.08 % sequentially.

We note from the results of table (15) the significant differences as a result of adding bio-fertilization, where treatment B3 gave the highest concentration of potassium, as it reached 1.69%, 1.50%, respectively. Treatment B2 followed by giving it the percentage of 1.43%, 1.28%, while treatment B0 gave the lowest percentage The potassium content of leaves and tubers was 0.94% and 0.93%, respectively.

It was also found that the addition of Mineral Fertilization has achieved a moral increase in the content of leaves and tubers of potassium, with the M100 transaction achieving the highest ratio of 1.42%, 1.28% sequentially, followed by the M75 transaction by giving it a ratio of 1.33%, 1.20% sequentially. In contrast, the M50 transaction gave the lowest ratio to the content of papers and tubers.

Binary overlap between organic and bio-fertilization had a moral Impact, giving the O1B3 transaction the highest ratio of 1.78%, 1.61% sequentially, while the trade gave the lowest proportion O0B0 the content of leaves and tubers of potassium 0.87%, 0.89% sequentially. The results of the same table also indicate the moral impact of adding organic and metallic compost, giving the O1M100 transaction the highest ratio of 1.55%, and 1.39% sequentially, while the O0M50 transaction gave the lowest rate of 1.07%, 0.99% sequentially.

As for the bilateral interaction between bio and Mineral fertilization, Table (6 , 7) showed a positive Impact in increasing the potassium content of leaves and tubers. The B3M100 treatment achieved the highest percentage of 1.83% and 1.64%, while the O0M50 treatment gave the lowest percentage of 0.80%, and 0.87. % sequentially.

As for the triple interaction of the research treatments, results shown in table (6 , 7) showed that the tripartite interaction achieved a significant increase in potassium content of leaves and tubers, as the treatment O1B3M100 gave the highest percentage amounting to 1.90%, 1.71% respectively. In contrast, the treatment O0B0M50 showed the lowest percentage. They reached 0.74% and 0.82%, respectively.

Starch in tubers

Table 8 shows the impact of fertilization on the proportion of growing up in potato plant tubers since the addition of organic fertilization has given a slight increase in the proportion of growing up to tubers compared to the level of non-additivity, where the balance of growing up in tubers is 12.82%. A moral difference has been observed in biomedicine treatment by bacteria and fungi. The addition of Trichoderma fungi with pseudomonas bacteria gave the ideal

(O) Organic Fertilization	(B) Bio- Fertilization	(M) Mineral Fertilization				B × O
		M_{50}		M_{75}	B_{100}	
O_0	B_0	0.08		0.09	0.11	0.10
	B_1	0.13		0.15	0.18	0.15
	B_2	0.19		0.22	0.27	0.23
	B_3	0.25		0.30	0.31	0.28
O_1	B_0	0.12		0.13	0.15	0.13
	B_1	0.18		0.22	0.25	0.22
	B_2	0.28		0.31	0.34	0.31
	B_3	0.37		0.37	0.42	0.39
Impact of Organic Fertilization (O)						
M × O	O_0	0.16		0.19	0.22	0.19
	O_1	0.24		0.26	0.29	0.26
Impact of Bio- Fertilization (B)						
M × B	B_0	0.10		0.11	0.13	0.12
	B_1	0.16		0.18	0.21	0.18
	B_2	0.24		0.27	0.31	0.27
	B_3	0.31		0.33	0.36	0.34
Impact of Mineral fertilization(M)		0.20		0.22	0.25	
L . S . D 5 %						
O	B	M	B × O	M × O	M × B	O × M × B
0.01	0.02	0.02	0.02	0.02	0.03	0.04

Table 4. Impact of organic, bio-fertilization and mineral fertilizations on the phosphorous content of leaves of potato plant (%).

(O) Organic Fertilization	(B) Bio- Fertilization	(M) Mineral Fertilization			B × O
		M50	M75	B100	
O_0	B_0	0.05	0.07	0.08	0.07
	B_1	0.09	0.11	0.13	0.11
	B_2	0.15	0.18	0.22	0.18
	B_3	0.20	0.24	0.26	0.23
O_1	B_0	0.08	0.10	0.12	0.10
	B_1	0.15	0.18	0.21	0.18
	B_2	0.25	0.28	0.31	0.28
	B_3	0.33	0.32	0.36	0.34
Impact of Organic Fertilization (O)					
M × O	O_0	0.13	0.15	0.17	0.15
	O_1	0.20	0.22	0.25	0.22
Impact of Bio- Fertilization (B)					
M × B	B_0	0.07	0.08	0.10	0.08
	B_1	0.12	0.15	0.17	0.15
	B_2	0.20	0.23	0.27	0.23
	B_3	0.27	0.28	0.31	0.29
Impact of Mineral fertilization(M)		0.16	0.18	0.21	

L .S .D 5 %						
O	B	M	B × O	M × O	M × B	O × M × B
0.01	0.02	0.01	0.02	0.02	0.03	0.01

Table 5. Impact of organic, bio-fertilization and mineral fertilizations on the phosphorous content of tubers (%).

ratio for the highest average of 14.85% tuberculosis-formed growing up compared to the comparison treatment that offered the lowest starch rate of 9.23%.

As for the Impact of Mineral Fertilization, the same table results indicate moral differences, as the M100 transaction gave the highest potassium concentration at 12.89%. In comparison, the M50 transaction showed the lowest concentration at 11.44%.

As for the bilateral overlap between organic composting and bio-fertilization, it recorded a moral difference where the O1B3 transaction excelled and gave the highest rate of 15.96%, while the non-additionality transaction gave O0B0 8.81%

One of the results mentioned in the table shows us that there are moral differences in the treatment of organic Fertilization and Mineral fertilization in the percentage of origin found in tubers, giving the O1M100 transaction the highest rate of 13.65%. In comparison, the O0M50 transaction gave the lowest percentage of 10.95%.

The bilateral overlap between bio-fertilization and Mineral Fertilization has had a moral Impact on increasing the proportion of starch material in tubers, giving the B3M100 the best result of 16.01%, compared to the comparison treatment B0M50, which gave the lowest result of 8.46%. Concerning the triple overlap of the study's factors, the table results indicated a moral increase in the percentage of starchy substances in potato tubers, giving B3O1M100 the highest percentage of 17.30% compared to the comparison treatment B0O0M50 which showed the lowest rate of 8.30 %.

Discussion

The main reason for the increase in the characteristics mentioned in tables (2, 3, 4, 5, 6, 7, 8 and 9) may be due to the components of the added organic fertilization containing many nutrients, in addition to the fact that its components are decomposed and thus stimulates the growth of the plant by providing macro and micronutrients Which the plant needs to increase the Mineral content of the potato plant. Organic fertilization improves the physical properties of the soil, as it helps the roots to spread and increase of absorption of elements and water. These two factors contribute to forming a good root system reflected in the nutrient content of the plant and tubers[17].

The reason for the increase in the concentration of nutrients N, P and K in the soil may be due to bio-fertilization contains nitrogen-fixing organisms and phosphate-dissolving organisms.

The role of these organisms in the secretion of organic acids, growth regulators and chelators leads to an increase in the concentration of remaining nutrients in the soil. It may be due to the rise in the surface area of the roots, which increases the absorption capacity of the roots and, thus, the concentration of the remaining elements in the soil. The rest of the nutrients with bio-fertilization was more apparent when added with mineral fertilization because of what the latter provides of ready-made nutrients and easy to lose by volatilization, washing, sedimentation and fixation in the soil. Also, the integrated fertilization between the three vital, mineral and organic Fertilizations has an essential role

(O) Organic Fertilization	(B) Bio- Fertilization	(M) Mineral Fertilization M50	M75	B100	B × O
O_0	B_0	0.74	0.90	0.98	0.87
	B_1	1.03	1.06	1.05	1.05
	B_2	1.07	1.32	1.35	1.24
	B_3	1.43	1.60	1.75	1.59
O_1	B_0	0.85	1.00	1.18	1.01
	B_1	1.32	1.41	1.48	1.40
	B_2	1.58	1.62	1.65	1.62
	B_3	1.69	1.75	1.90	1.78
Impact of Organic Fertilization (O)					
M × O	O_0	1.07	1.22	1.28	1.07
	O_1	1.36	1.45	1.55	1.36
act of Bio- Fertilization (B)					
M × B	B_0	0.80	0.95	1.08	0.80
	B_1	1.18	1.23	1.27	1.18
	B_2	1.32	1.47	1.50	1.32
	B_3	1.56	1.68	1.83	1.56
Impact of Mineral fertilization(M)		1.21	1.33	1.42	

L . S . D 5 %						
O	B	M	B × O	M × O	M × B	O × M × B
0.03	0.04	0.03	0.05	0.05	0.07	0.09

Table 6. Impact of organic, bio-fertilization and Mineral Fertilizations on the potassium content of leaves of potato plant (%).

(O) Organic Fertilization	(B) Bio- Fertilization	(M) Mineral Fertilization M50	M75	B100	B × O
O_0	B_0	0.82	0.89	0.95	0.89
	B_1	0.91	0.93	0.94	0.93
	B_2	0.97	1.15	1.20	1.11
	B_3	1.24	1.40	1.57	1.40
O_1	B_0	0.92	0.93	1.08	0.98
	B_1	1.19	1.25	1.31	1.25
	B_2	1.41	1.46	1.48	1.45
	B_3	1.53	1.58	1.71	1.61
act of Organic Fertilization (O)					
M × O	O_0	0.99	1.09	1.17	0.99
	O_1	1.26	1.31	1.39	1.26
Impact of Bio- Fertilization (B)					
M × B	B_0	0.87	0.91	1.02	0.87
	B_1	1.05	1.09	1.12	1.05
	B_2	1.19	1.31	1.34	1.19
	B_3	1.38	1.49	1.64	1.38
Impact of Mineral fertilization(M)		1.12	1.20	1.28	

L. S . D 5 %						
O	B	M	B × O	M × O	M × B	O × M × B
0.02	0.04	0.03	0.05	0.04	0.06	0.09

Table 7. Impact of organic, bio-fertilization and mineral fertilizations on the potassium content of tubers (%)

<table>
<tr><th rowspan="2">(O)
Organic Fertilization</th><th rowspan="2">(B)
Bio- Fertilization</th><th colspan="4">(M) Mineral Fertilization</th><th rowspan="2">B × O</th></tr>
<tr><th colspan="2">M50</th><th>M75</th><th>B100</th></tr>
<tr><td rowspan="4">O_0</td><td>B_0</td><td colspan="2">0.82</td><td>0.89</td><td>0.95</td><td>0.89</td></tr>
<tr><td>B_1</td><td colspan="2">0.91</td><td>0.93</td><td>0.94</td><td>0.93</td></tr>
<tr><td>B_2</td><td colspan="2">0.97</td><td>1.15</td><td>1.20</td><td>1.11</td></tr>
<tr><td>B_3</td><td colspan="2">1.24</td><td>1.40</td><td>1.57</td><td>1.40</td></tr>
<tr><td rowspan="4">O_1</td><td>B_0</td><td colspan="2">0.92</td><td>0.93</td><td>1.08</td><td>0.98</td></tr>
<tr><td>B_1</td><td colspan="2">1.19</td><td>1.25</td><td>1.31</td><td>1.25</td></tr>
<tr><td>B_2</td><td colspan="2">1.41</td><td>1.46</td><td>1.48</td><td>1.45</td></tr>
<tr><td>B_3</td><td colspan="2">1.53</td><td>1.58</td><td>1.71</td><td>1.61</td></tr>
<tr><td colspan="7">act of Organic Fertilization (O)</td></tr>
<tr><td rowspan="2">M × O</td><td>O_0</td><td colspan="2">0.99</td><td>1.09</td><td>1.17</td><td>0.99</td></tr>
<tr><td>O_1</td><td colspan="2">1.26</td><td>1.31</td><td>1.39</td><td>1.26</td></tr>
<tr><td colspan="7">Impact of Bio- Fertilization (B)</td></tr>
<tr><td rowspan="4">M × B</td><td>B_0</td><td colspan="2">0.87</td><td>0.91</td><td>1.02</td><td>0.87</td></tr>
<tr><td>B_1</td><td colspan="2">1.05</td><td>1.09</td><td>1.12</td><td>1.05</td></tr>
<tr><td>B_2</td><td colspan="2">1.19</td><td>1.31</td><td>1.34</td><td>1.19</td></tr>
<tr><td>B_3</td><td colspan="2">1.38</td><td>1.49</td><td>1.64</td><td>1.38</td></tr>
<tr><td colspan="2">Impact of Mineral fertilization(M)</td><td colspan="2">1.12</td><td>1.20</td><td>1.28</td><td></td></tr>
<tr><td colspan="7">L. S . D 5 %</td></tr>
<tr><td>O</td><td>B</td><td>M</td><td>B × O</td><td>M × O</td><td>M × B</td><td>O × M × B</td></tr>
<tr><td>0.02</td><td>0.04</td><td>0.03</td><td>0.05</td><td>0.04</td><td>0.06</td><td>0.09</td></tr>
</table>

Table 8. Impact of organic, bio-fertilization and mineral fertilizations on the starch content of tubers (%).

in increasing the concentration of nutrients remaining in the soil[8,10]. The impact of bio-fertilization on the absorbed nitrogen, phosphorous and potassium came from the critical role of bio-fertilization in improving some of the soil's physical, mineral and fertility properties and then improving the absorption of those elements. Nutrients by plants, as the response to bio-fertilization, were clearer when added with Mineral fertilization because of what mineral fertilization provides from nutrients ready for absorption[21].

The increase in the concentration of nutrients in part before the plant may be attributed to converting the unready formula to its ready-to-absorb formula, which is in line with what was mentioned by (9).

That bio-fertilizations are essential in increasing the average concentration of nutrients nitrogen, phosphorous and potassium in plants. The superiority is due to the availability of nutrients in a balanced and integrated manner as a result of adding mineral, organic and biological Fertilizations together. Thus bio-fertilization is distinguished by providing growth stimulants and regulators that increase the growth of the root system, as well as the availability of nitrogen in the soil solution and organic fertilization. Provide a balanced growth medium of nutrients, followed by mineral Fertilization, in which the plant is equipped with the necessary elements.

Conclusions

All of this contributes to improving the plant's content of nutrients, especially nitrogen, to build a good root and vegetative group that can benefit from the elements available in the soil and a vegetable group that performs its vital activities that help increase the concentration of elements in the tubers, and these results are consistent with (27) who showed that the plant yield is of high value from the plant's nitrogen content when integrated fertilization is available, which helps the plant to grow actively, manufacture nutrients and transfer them to the yield

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