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EFFECT OF ENDOTROPHIC MYCORRHIZA AND CHEMICAL (NPK) AND BIO-FERTILIZER ON THE GROWTH AND YIELD OF EGGPLANT (*SOLANUM MELONGENA* L.)

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ABSTRACT

The experiment was conducted in the vegetable field, Department of Horticulture and Gardening Engineering, College of Agriculture and Forestry, University of Mosul during the 2019 agricultural season, to study the effect of three factors: First: Three levels of chemical fertilizer NPK 150, 300, 450 kg.ha^{-1} in addition to the control treatment (Without chemical fertilizer), the second: spraying plants with dry bread yeast emulsion 5 g. / L without spraying yeast, and the third: adding Mycorrhiza and without adding Mycorrhiza for eggplant plants of the Tonkobri cultivars. The eggplant seeds were cultivated on 2/27/2019 in the nursery, and then the seedlings were transferred to the sustainable field on 5/6/2019. The experiment was conducted in the split-plot system twice in the randomized complete block design (RCBD). After analyzing the data, the results were as follows: The treatment of adding the Mycorrhiza fungus and spraying the yeast 5 g.L^{-1} with chemical fertilization of 300 kg. ha^{-1} gave a significant increase in plant height, number of branches, leaf area, number of fruits, average fruit weight, Single plant yield and total yield of the plant.

***Keywords*:** Biofertilizer, chemical fertilizer, mycorrhiza, eggplant.

Introduction

Eggplant (*Solanum melongena* L.) is a crop of the Solanaceae family of important economic importance and is native to India and China (Matlab *et al*., 1989). Eggplant is grown in Iraq as a summer crop in open fields and gives fruits in summer and autumn, Each 100g of fresh eggplant fruits contains 92.7g water, 1.4g protein, 4g carbohydrates, 0.3g fat, 1.3g fiber, 24 calories, 124 international units of vitamin A, 0.4 mg vitamin B, 0.11 mg vitamin B, 34 mg vitamins and B, 12 mg vitamins, 18 mg oxalic acid and also contain mineral salts. Such as potassium 2 mg, phosphorus 47 mg, magnesium 15 mg, calcium 18 mg, iron 0.38 mg, zinc 0.22 mg, sodium 3 mg, sulfur 44 mg, and copper 0.12 mg (Gopalan, 2007). The total area cultivated with this crop in Iraq in 2018 was about 6426 hectares, with a productivity of 104,402 tons (Central Statistical Organization, 2019). Mycorrhiza is part of the biofertilizer production technology, which is considered a very cheap, environmentally and human health food source for plants, when compared to mineral fertilizers (Parial *et al*., 2014). In addition, this relationship increases the efficiency of chemical fertilizers in nutrient-poor soils such as Iraqi soils (Al-Kartani *et al*., 2011), increases plant resistance to diseases and many environmental factors such as freezing and salinity (Chen *et al*., 2014) and enhances its growth by increasing the absorption of plant nutrients, especially phosphorous. And trace elements such as zinc, copper and magnesium (Al-Taie, 2016). In a study conducted by Al-Shaibani (2005) on tomato plant, where the plants inoculated with Mycorrhiza significantly excelled the trait of average fruit, early plant yield and total plant yield. Saleh (2006) found that the plants vaccinated with Mycorrhiza fungus were excelled in the trait of plant length, number of branches, number of leaves, leaf area and dry weight of the Vegetative total compared to non-vaccinated plants, with an increase of 7%, 54.6%, 116.84%, 100% and 60.7% for the traits. respectively at the level of 50% of the fertilizer recommendation, and phosphate fertilization with vaccinated with mycorrhiza helped accelerate the growth average, as the percentage of flowering plants reached 100% after 60 days at the level of 50% of the fertilizer recommendation with TSP, while the increase in flowering plants did not amount to the comparison and vaccinated treatments. In a study by Saba'a *et al*. (2013) on two cultivars of the tomato plant, where vaccination with Mycorrhiza fungus led to a significant increase in most of the study indicators compared with the unvaccinated treatments, where the best results were obtained in this study, especially in the triple interaction treatments between the cultivars Burke and the coverage with slices. Black polyethene and inoculation with Mycorrhiza fungus, It excelled in the early yield and reached 13.59 tons. ha^{-1}, an increase of 338%, the highest total yield was 19.93 tons.ha^{-1}, an increase of 229%, and the highest yield for plants was 2.24 kg, an increase of 265%. Where, the interaction treatment of superquin cultivar, black polyethene coverage and biofertilization with Mycorrhiza fungus excelled the number of fruits 23.1 fruit. Plant^{-1}, an increase of 200%. In a study conducted by Al-Jamal (2015), vaccinating soil with Mycorrhiza fungi caused an increase in stem length, root length, dry weight, fresh weight, number of leaves, and root weight of eggplant plants, compared to plants grown in soils not vaccinated with

Mycorrhiza. Attia (2019) asserted that the treatment of microcrystalline achieved significantly excelled in leaf area (281.9 cm2 plant^{-1}), number of leaves (75.5 leaves), nodule percentage for flowers (74.85%), chlorophyll content (0.0456 mg) fresh and dry weight of vegetative growth (165.7, 510), dry weight (15.74 g) and early yield (0.997 kg.plant^{-1}) and total yield 3.523 kg.plant^{-1} of eggplant plant. Biofertilizers play an important role in plant growth, as many of them are characterized by their ability to stabilize atmospheric nitrogen and excrete a number of compounds such as Auxins, gibberellins, cytokinins, and antibiotics for fungi and bacteria that cause diseases, and also contribute to the maintenance of soil fertility and the improvement of the growth and productivity of agricultural crops (Forlain *et al*., 1995). Omar (2003) observed when tomato plants were sprayed with dry yeast bread at concentrations 0, 2, 4, 6, 8 and 10g. L^{-1}, the spray is concentrated at 8 g.L^{-1} led to a significant increase in plant height, number of branches of the plant, percentage of dry matter in the vegetative growth, number of fruits per plant, average fruit weight and yield per plant. Hussain (2017) observed when using the biostimulator Bacteria Max at a concentration of 20 g.L^{-1} and by the method of ground addition, the Barcelona cultivar eggplant plants cause a significant increase in plant height, number of branches per plant, number of leaves per plant, chlorophyll leaf content, leaf area of the plant, percentage of the dry matter in leaves, early fruit yield and percentage of N, P, K in leaves compared with control treatment. Chemical fertilizers are synthetic chemicals that improve plant nutrition in addition to improving the quality of yield (Ali, 2012), and lead to an increase in production to about 50%, provided that it is balanced when added, including the macro elements (NPK), which are important in the continued growth of the plant. Especially in the stage of vegetative growth, flowering and contract (Al-Shahat, 2007). Akanbi *et al*. (2010) found that fertilizing eggplant plants with chemical fertilizer NPK at levels (0, 200, 300 and 400 kg. ha^{-1}) after 5, 6 and 7 weeks of seedlings caused a significant increase in plant height, number of fruits, and fruit yield at 300 kg level. ha^{-1}. Suge *et al*. (2011) noted that increasing NPK fertilization from 50% to 100% recommended increased the average of vegetative growth of eggplant represented by plant height and fresh weight of the vegetative growth, as well as increasing the length and diameter of the fruit and the total yield of eggplant fruits. Ekwu *et al*. (2012) obtained their addition of the chemical fertilizer NPK (10–10–20) and at levels of (0, 75 and 150) kg. ha^{-1} of eggplant plants in Nigeria showed a significant increase in plant height (49.88 cm) with an addition of 150 kg. ha^{-1} and in the number of leaves. plant^{-1} (170.33) and the number of branches (12.96) when adding 75 kg of NPK chemical fertilizer. Abolusoro *et al*. (2013) in Nigeria found that the addition of NPK (15-15-15) chemical fertilizer at an average of 200 kg. ha^{-1} to Ethiopian eggplant plants led to a significant increase in plant height (43.67 cm) after 12 weeks of cultivation.

Materials and Methods

The research was conducted in the vegetable field of the Department of Horticulture and Gardening Engineering, College of Agriculture and Forestry, the University of Mosul in the spring agricultural season 2019. The land was plowed perpendicular tillage and smoothed and a random sample was taken from the field soil from the soil surface at a depth of 30 cm to perform some chemical and physical analyzes shown in the table (1).

Table 1 : Physical and chemical properties of the experimental soil.

Texture class	Clay %	Silt %	Sand %	Exchangeable K (mg.kg^{-1})	Available P (mg.kg^{-1})	Total N (mg.kg^{-1})	Organic matter%	EC (ds.m^{-1})	pH
Sandy loam	108	280	612	101.0	9.6	42.0	0.69	1.0	7.7

The field was divided into replicate and experiment units, 16 experiment units in each replicate, and then the furrow was made and added the NPK 15-15-15 compound fertilizer and mixed with the soil and according to the treatments, each experiment unit included 3 furrow, the length of the furrow is 2 m, the distance between one furrow and another 0.90 m , The area of the experiment unit was 5.40 m^2.

Eggplant seedlings of Elton Kobry cultivars were cultivated in the nursery on 2/27/2019 and the seedlings were transferred to the permanent field on 5/6/2019 and seedlings were cultivated at a distance of 0.4 m, the number of plants in the experiment unit reached 12 plants, the drip irrigation system was followed,

The experiment was conducted with the split-plot system twice in the Randomized complete block design (RCBD), and with three replicates, the NPK was placed in the main plot and the dry yeast extract spray concentrations in the sub-plot, and the mycorrhiza fungus was added in subplot, and the following factors were studied:

First factor 1: Four levels of NPK (15-15-15):

Zero (compared to no fertilization), 150 kg. ha^{-1}, 300 kg. ha^{-1}, 450 kg. ha^{-1}.

These quantities were added in one batch after preparing the soil.

The second factor: spraying the vegetative with dry yeast emulsion at a concentration of 5g.L^{-1} without spraying the yeast (spraying with water only).

Dried yeast emulsion was sprayed in three batches:

The first batch one month after transplanting, the second batch one month after the first, and the third batch a month after the second batch, using a diffuser until complete wetness.

The third factor: adding the Mycorrhiza fungi to the seedling during the transplantation process, with an amount of 1 gm for one time, without adding Mycorrhiza.

After 15 days from the third spray of dry bread yeast extract, the following data were recorded

1- Plant height (cm). 2- The number of branches of the plant. 3-Number of leaves per plant. 4- The leaf area (cm^2. Plant^{-1}) 5- The percentage of dry matter in the leaves. 6- Number of fruits per plant. 7- Average weight of the fruit (g).

8- Yield of one plant (kg). 9-Early yield of fruits (tons. ha^{-1}). 10- Total fruit yield (tons. ha^{-1}).

The analysis was done using an electronic computer according to the SAS program (2001) and the averages were compared using the Duncan polynomial test at a level of 0.05 (Al-Rawi and Khalaf Allah, 2000).

Results and Discussion

Vegetative growth traits: The results in Table (2) indicate that the treatment with Mycorrhiza fungus gave the highest values in plant height, number of branches of the plant, number of leaves per plant, leaf area of the plant, and percentage of dry matter in leaves compared to treatment without Mycorrhiza e that gave the lowest values in the same traits mentioned. In spraying the dry bread yeast emulsion, the significantly excelled of the spraying with a concentration of 5 g.1 litre is observed in plant height, number of branches of a plant, number of leaves per plant, leaf area, and percentage of dry matter in the leaves compared to treatment without spraying yeast. In chemical fertilization NPK, it is noticed that the treatment of 450 kg. ha^{-1} gave the highest values in plant height, number of branches per plant, number of leaves per plant, leaf area of plants, and percentage of dry matter in leaves and it was significantly excelled in compared with other treatments, and it did not differ significantly with fertilization treatment 300 Kg. ha^{-1} in plant height and leaf area of the plant.

The results in Table (3) indicate that the treatment of the Mycorrhiza fungus and the spraying with a yeast emulsion of 5 $g.L^{-1}$ caused an increase in the plant height, the number of branches of the plant, the number of leaves per plant, the leaf area of the plant, the percentage of dry matter in the leaves and significant differences with all treatments except for the two treatments of fungus Mycorrhiza with spraying with water only, without Mycorrhiza, with 5 $g.L^{-1}$ of bread yeast emulsion per number of leaves. In the interaction between Mycorrhiza fungus and NPK fertilization, it is noticed that the treatment of Mycorrhiza fungus and NPK fertilization of 450 kg. ha^{-1} caused an increase in plant height and dry matter percentage in the leaves and the treatment of Mycorrhiza fungus and NPK fertilization of 300 kg. ha^{-1}in the leaf area of the plant, without Mycorrhiza with chemical fertilization NPK 450 kg. ha^{-1}in number of branches and number of leaves per plant. The interaction between spraying with yeast emulsion 5 $g.L^{-1}$ and fertilizing NPK 450 kg. ha^{-1} caused an increase in plant height, number of branches of the plant, leaf area, dry matter percentage in leaves, and significant differences with all treatments except for the spray treatment of 5 $g.L^{-1}$ bread yeast with NPK fertilization 300 kg. ha^{-1} in plant height, number of branches per plant and leaf area of the plant. It is also noted that the treatment of spraying with water only with chemical fertilization NPK 450 kg. ha^{-1} in the number of leaves per plant.

The results in Table (4) indicate that the treatment of Mycorrhiza with spraying with 5 g. L^{-1} yeast emulsion with fertilization NPK 450 $kg.ha^{-1}$ caused an increase in plant height and dry matter percentage in the leaves and treatment of Mycorrhiza with spraying with 5 g. L^{-1} yeast emulsion Bread with NPK fertilization of 300 $kg.ha^{-1}$ and it was significantly excelled in the number of branches of the plant, leaf area of the plant, and treatment of Mycorrhiza with water spraying with NPK fertilization of 450 $kg.ha^{-1}$ was significantly higher in the number of leaves per plant. The results in Table (5) indicate that the treatment with Mycorrhiza gave the highest values in the average fruit weight, single plant yield and total fruit yield compared to treatment without Mycorrhiza and no significant difference was observed between the two treatments in the number of fruits per plant and early fruit yield.

The yield traits:

The results in Table (5) indicate that the addition of Mycorrhiza caused a significant increase in the average fruit weight, the yield of one plant and the total fruit yield, and no significant difference was observed between the addition of Mycorrhiza without addition in the number of fruits per plant and the early yield of the fruits. L^{-1} gave the highest values in the number of fruits per plant, average fruit weight, yield per plant, total fruit yield, as measured by treatment without yeast spraying. In chemical fertilization NPK, it is noticed that the treatment of 450 kg. ha^{-1} gave the highest values in the number of fruits per plant and the average fruit weight and fertilization of 300 kg. ha^{-1} gave the highest values in the yield of one plant and the early and total yield of fruits.

The results in Table (6) indicate the interaction between the Mycorrhiza fungus and the spraying of yeast extract at a concentration of 5 $g.L^{-1}$ caused an increase in the number of fruits per plant, the average weight of the fruit, the yield of one plant and the total fruit yield. In the interaction between Mycorrhiza fungus and NPK fertilization of 300 kg. ha^{-1} caused an increase in the number of fruits per plant, average fruit weight, single plant yield and early and total fruit yield. In the interaction between spraying with yeast at a concentration of 5 $g.L^{-1}$ and fertilizing NPK 300 kg. ha^{-1} caused an increase in the number of fruits per plant, the yield of one plant and the total yield, and the treatment of spraying with yeast at a concentration of 5 $g.L^{-1}$ and the NPK fertilization of 450 kg. ha^{-1} gave the highest A value in the average fruit weight, and no significant differences were observed between the parameters of this interaction in the early yield of fruits.

The results in Table (7), the interaction between the studied factors, indicate that the mycorrhiza treatment fungus and the spraying with yeast emulsion 5 g. L^{-1} and the NPK fertilization of 300 kg. ha^{-1} caused an increase in the number of fruits of the plant, the average weight of the fruit, the yield of one plant and the early and total yield of fruits. 34.57 $fruits.plant^{-1}$, 183.51 g and 5.36 kg. $Plant^{-1}$ and 33.936 tons. ha^{-1} and 48.990 tons. ha^{-1}, respectively.

The excelled of the Mycorrhiza fungus in the traits of vegetative growth (Table 2) may be due to the fact that Mycorrhiza increases phosphorous uptake from the soil, which is located far from the root zone and as a result of the spread of fungus hyphae that increase the surface area for absorption and explore the largest number of soil particles that are difficult for the capillaries Root access to it compared to others treated with Mycorrhiza fungus, Mycorrhiza works by secreting the phosphatase enzyme, which works to dissolve phosphate ions and make them dissolved in the soil solution and available for absorption by the roots of the plant, in addition to the presence of this element in the soil, The phosphorus component is immobile and prone to holding and fixing in soil particles, so it cannot be used well in plants other than treated with mycorrhiza l fungus due to the inability of the roots to reach it (Marschner, 1995), Mycorrhiza play an important role in increasing the

absorption of macro elements such as nitrogen, potassium and trace elements such as iron, zinc and manganese due to the increase in the area of absorption, and these elements have a clear effect on increasing the growth indicators, which is reflected in the increase in the formation of energy compounds ATP and the consequent increase in the growth of the root hairs as well as the increase of their area this reflected positively in increased absorption of other nutrients and thus increased plant growth (Ali *et al*., 2015).This is consistent with what was found by Seven *et al.* (2013) on the tomato plant, and Atiyah (2019) on the eggplant plant. The increase in the yield and its components as a result of the addition of Mycorrhiza may be due to the fact that bio-fertilizers, including symbiotic, such as Mycorrhiza, increase the production systems of inoculated plants, especially in soils poor in nutrients, better than fertile soils, as a result of what fungus add to the root area and their efficiency in absorbing and transferring elements from solution, Soil is estimated to triple the uninfected roots, as the fungus Hypha reach farther distances from the rhizosphere (Sanders and Tinker, 1973). The increase in the yield components when adding Mycorrhiza may be due to the fact that the treatment with the Mycorrhiza fungus caused a significant increase in the vegetative growth traits represented in plant height, number of branches of the plant, number of leaves per plant, leaf area and percentage of dry matter in the leaves (Table 2), which was reflected in an increase in the components of The yield (Table 5). These results are consistent with what Al-Shaibani (2005) and Saleh (2006) reported on the tomato plant. The reason for the increase in vegetative growth with the use of chemical fertilizer NPK may be due to the availability of the necessary nutrients in the chemical fertilizer N, P and K added to the soil close to the root zone, its transfer to the vegetative system and its exploitation in the biological and physiological processes inside the plant such as carbon assimilation, respiration and the processes involved in the synthesis of acids Nuclear necessary in the division of cells and new tissues that help the growth of different parts in the plant (Patil *et al*., 2008) where the nitrogen component has an important role in encouraging the process of cell division and elongation of cells (Sharaqi *et al*. 1985) and then increasing the plant height, which has a positive effect on increasing number of leaves and leaf area in the plant (Kadhim *et al.*, 2011). Also, phosphorus has an important role in plant growth as it contributes to the formation of energy-rich compounds that the plant needs to form other compounds such as phospholipids, carbohydrates and enzyme paradoxes that contribute to activating the vital activities of the plant, which leads to an increase in vegetative growth as the increase in plant height may be due to the role the significant role played by this element in plant growth (Abu Dahi *et al*., 1988). Potassium also has an important role in the photosynthesis process by activating the enzymes associated with the process of energy transfer and building (ATP) the main energy carrier inside the plant (Humbel and Raske, 1971), and also accelerates the transfer of all manufactured materials to storage sites, in addition to its important role. It is effective in cell division and elongation (Fawzy *et al*., 2007), thus increasing vegetative growth, as the increase in nitrogen and potassium content in the plant has an effect on improving vegetative growth traits (plant height, number of leaves and leaf area)

This is consistent with what (Suge *et al*., 2011; Ekwu *et al*., 2012 and Abolusoro *et al*., 2013) found on eggplant plant. The increase in the yield components may be due to the increase in the vegetative growth indicators represented by plant height, the number of leaves, leaf area and percentage of dry matter, Table (2) which was positively reflected in the increase in the yield indicators.

Table 2 : Effect of mycorrhiza fungi and bread yeast and NPK fertilizer on vegetative growth.

Treatments	Plant height (cm)	Branches number per plant	Leaves number per plant	Leaf area ($cm^2.plant^{-1}$)	Leaf dry matter%
Effect of Mycorrhiza					
Without mycorrhiza	62.10 b	7.75 b	80.46 b	2907.5 b	23.85 b
Mycorrhiza	73.02 a	8.46 a	86.54 a	4721.2 a	26.14 a
Effect of bread yeast					
Water spray	64.53 b	7.30 b	76.92 b	3153.2 b	22.52 b
5 $g.l^{-1}$	70.59 a	8.91a	90.08 a	4475.5a	27.47a
Effect of NPK ($kg.ha^{-1}$)					
0	61.77 c	6.87 c	66.96 d	2715.9 b	23.05 b
150	65.75 bc	7.87 b	75.08 c	3141.7 b	23.70 b
300	69.60 ab	8.81 b	82.27 b	4555.9 a	24.13 b
450	73.11 a	9.49 a	109.69 a	4843.9 a	29.09 a

The average with same letter for each factor is nonsignificant according to Duncan's multiple range tests under level 0.05.

Table 3 **:** Effect of Interaction of mycorrhiza fungi, dry bread yeast and NPK fertilizer on vegetative growth

Treatments		Plant height (cm)	Branches number per plant	Leaves number per plant	Leaf area ($cm^2.plant^{-1}$)	Leaf dry matter%
		Interaction between mycorrhiza fungi×dry bread yeast				
Mycorrhiza	5 $g.l^{-1}$	79.84 a	9.44 a	89.94 a	5256.8 a	28.30 a
	Water spray	66.20 b	7.47 c	83.13 a	4185.6 b	23.98 b
Without mycorrhiza	5 $g.l^{-1}$	61.34 c	8.37 b	90.22 a	3694.1 b	26.63 c
	Water spray	62.85 c	7.12 c	70.70 b	2120.9 c	21.06 d

		Interaction between mycorrhiza fungi×NPK(kg.ha^{-1})				
Mycorrhiza	0	69.31 b	7.12 cd	73.25 c	3038.4 b	23.67 cd
	150	65.75 bc	8.66 b	78.28 bc	3770.7 b	25.33 bc
	300	77.27 a	8.83 b	85.88 b	6112.6 a	23.65 cd
	450	79.75 a	9.23 ab	108.75 a	5963.1 a	31.91 a
Without mycorrhiza	0	54.23 d	6.62 d	60.68 d	2393.3 b	22.44 d
	150	65.75 bc	7.08 cd	71.89 c	2512.8 b	22.07 d
	300	61.94 c	7.54 c	78.66 bc	2999.2 b	24.61 bc
	450	66.47 bc	9.75 a	110.63 a	3724.6 b	26.27 b
		Interaction between Bread Yeast ×NPK(kg.ha^{-1})				
5 g.l^{-1}	0	66.53 cd	7.75 d	73.18 d	3462.2 bc	26.28 b
	150	68.14 bc	8.58 c	87.21 c	3662.4 bc	25.80 b
	300	73.10 a	9.37 ab	96.91 bc	5305.7 a	25.27 b
	450	74.58 a	9.93 a	103.03 b	5471.6 a	32.51 a
Water spray	0	57.01 e	6.00 f	60.75 e	1969.6 d	19.83 d
	150	63.35 d	7.16 de	62.95 e	2621.1 cd	21.60 cd
	300	66.10 cd	7.00 e	67.63 de	3806.1 b	22.98 c
	450	71.64 ab	9.04 bc	116.35 a	4216.1 b	25.67 b

The average with same letter for each factor is nonsignificant according to Duncan's multiple range tests under level 0.05.

Table 4 : Effect of the triple interaction between Mycorrhiza, Bread Yeast and NPK fertilizer on vegetative growth:

Treatments			**Plant height (cm)**	**Branches number per plant**	**Leaves number per plant**	**Leaf area (cm^2.plant^{-1})**	**leaf dry matter%**
Mycorrhiza	**Bread Yeast**	**NPK (kg.ha^{-1})**					
Mycorrhiza	5 g.l^{-1}	0	73.76 b	7.00 d	72.83 de	3482.27 c-f	26.10 c-f
		150	71.83 bc	10.08 a	85.07 cd	4487.62 b-e	27.41 bcd
		300	88.62 a	10.58 a	108.25 b	7053.60 a	24.20 d-g
		450	85.13 a	10.13 a	93.63 c	6003.87 ab	35.50 a
	Water spray	0	64.86 e	7.25 cd	73.67 de	2594.61 fg	21.24 ghi
		150	59.66 ef	7.25 cd	71.50 de	3053.82 efg	23.26 e-h
		300	65.91 cd	7.08 d	63.52 ef	5171.52 bc	23.10 e-h
		450	74.36 b	8.33 b	123.87 a	5922.40 ab	28.33 bc
Without mycorrhiza	5 g.l^{-1}	0	59.29 ef	8.50 b	73.53 de	3442.07 def	26.47 b-e
		150	64.45 e	7.08 d	89.37 c	2837.10 efg	24.20 d-g
		300	57.58 f	8.17 bc	85.58 cd	3557.72 c-f	26.35 b-f
		450	64.03 ef	9.75 a	112.43 ab	4939.40bcd	29.53 b
	Water spray	0	49.16 g	4.75 e	47.83 g	1344.50 g	18.43 i
		150	67.04 cd	7.08 d	54.42 fg	2188.43 fg	19.94 hi
		300	66.29 cd	6.92 d	71.75 de	2440.71 fg	22.87 fgh
		450	68.91 bcd	9.75 a	108.83 b	2509.87 fg	23.02 e-h

The average with same letter for each factor is nonsignificant according to Duncan's multiple range test under level 0.05.

Table 5 : Effect of mycorrhiza fungi and bread yeast and NPK fertilizer on Yield

Treatments	**number of fruits per plant**	**Average fruit weight (g)**	**Yield per plant (kg. Plant^{-1})**	**Early yield (t.ha^{-1})**	**total yield (t.ha^{-1})**
Effect of Mycorrhiza					
Without mycorrhiza	24.69 a	132.55 b	3.17 b	23.504 a	88.225 b
Mycorrhiza	26.83 a	150.49 a	4.06 a	26.769 a	113.042 a
Effect of bread yeast					
Water spray	24.43 b	134.19 b	3.31 b	24.100 a	92.116 b
5 g.l^{-1}	27.09 a	148.85 a	3.92 a	26.173 a	109.151 a
Effect of NPK (kg.ha^{-1})					
0	23.37 c	123.2 b	3.02 c	22.14 b	84.069 c
150	24.93 bc	131.51 b	3.54 b	22.35 b	98.515 b
300	26.76 ab	152.76 a	4.13 a	29.39 a	114.761 a
450	27.99 a	158.61 a	3.78 b	26.65 ab	105.189 b

The average with same letter for each factor is nonsignificant according to Duncan's multiple range tests under level 0.05.

Table 6 : Effect of interaction between mycorrhiza fungi and bread yeast and NPK fertilizer on yield:

Treatments		number of fruits per plant	Average fruit weight (g)	Yield per plant (kg.Plant^{-1})	Early yield (t.ha $^{-1}$)	total yield (t.ha^{-1})
		Interaction between mycorrhiza fungi×bread yeast				
Mycorrhiza	5 g.l^{-1}	28.46 a	157.42 a	4.62 a	27.700 a	128.55 a
	Water spray	25.2 ab	143.56 b	3.51 b	25.838 a	97.534 b
Without mycorrhiza	5 g.l^{-1}	25.72 ab	140.27 b	3.23 c	24.647 a	89.751 c
	Water spray	23.67 b	124.83 c	3.12 c	22.362 a	86.698 c
		Interaction between mycorrhiza fungi×NPK(kg.ha^{-1})				
Mycorrhiza	0	25.76 ab	130.66 de	3.68 c	24.665 ab	102.397 c
	150	24.57 ab	143.41 bc	3.92 b	23.415 ab	109.105 b
	300	28.87 a	165.09 a	4.57 a	33.545 a	126.962 a
	450	28.12 a	162.81 a	4.09 b	25.451 ab	113.703 b
Without mycorrhiza	0	20.98 b	115.73 d	2.36 e	19.615 b	65.74 e
	150	25.29 ab	119.61 de	3.16 d	21.303 ab	87.925 d
	300	24.66 ab	140.44 bc	3.69 c	25.242 ab	102.559 c
	450	27.85 a	154.41 ab	3.48 c	27.858 ab	96.675 c
		Interaction between Bread Yeast ×NPK(kg.ha^{-1})				
5 g.l^{-1}	0	24.98 ab	130.46 cd	3.35 d	23.592 a	93.138 d
	150	26.39 ab	134 c	3.98 b	22.891 a	110.684 b
	300	28.83 a	165.09 a	4.54 a	29.124 a	126.157 a
	450	28.16 a	165.84 a	3.83 bc	29.087 a	106.624 bc
Water spray	0	21.76 b	115.94 d	2.7 f	20.688 a	74.999 f
	150	23.47 ab	129.02 cd	3.1 e	21.827 a	86.346 e
	300	24.7 ab	140.44 bc	3.72 c	29.664 a	103.365 c
	450	27.81 a	151.38 ab	3.73 c	24.222 a	103.754 c

The average with same letter for each factor is nonsignificant according to Duncan's multiple range test under level 0.05.

Table 7 : Effect of the triple interaction between mycorrhiza and Bread Yeast and NPK fertilizer on yield:

Treatments			Number of fruits per plant	Average fruit weight (g)	Yield per plant (kg. Plant^{-1})	Early yield (t.ha $^{-1}$)	total yield (t.ha $^{-1}$)
Mycorrhiza	Bread Yeast	NPK (kg.ha^{-1})					
mycorrhiza	5 g.l^{-1}	0	26.64 b	140.77 de	4.13 c	27.332 ab	114.971 c
		150	24.74 bc	146.86 cd	4.76 b	23.149 ab	132.425 b
		300	34.57 a	183.51 a	5.36 a	33.936 a	148.99 a
		450	27.90 ab	158.54 bcd	4.24 c	26.381 ab	117.814 c
	Water spray	0	24.88 bc	120.55 ef	3.23 fg	21.997 ab	89.823 fg
		150	24.39 bc	139.97 de	3.08 g	23.681 ab	85.786 g
		300	23.17 bc	146.66 cd	3.77 ed	33.155 ab	104.934 de
		450	28.34 ab	167.07 abc	3.94 cd	24.52 ab	109.592 cd
Without mycorrhiza	5 g.l^{-1}	0	23.32 bc	120.14 ef	2.56 h	19.852 ab	71.305 h
		150	28.05 ab	121.14 ef	3.20 fg	22.633 ab	88.944 gf
		300	23.08 bc	146.66 cd	3.72 de	24.312 ab	103.323 ed
		450	28.42 ab	173.14 ab	3.43 efg	31.792 ab	95.434 efg
	Water spray	0	18.63 c	111.32 f	2.16 i	19.378 b	60.175 i
		150	22.53 bc	118.08 ef	3.12 g	19.973 ab	86.907 g
		300	26.22 bc	134.22 def	3.66 ed	26.173 ab	101.795 ed
		450	27.27 ab	135.68 de	3.52 fe	23.923 ab	97.916 e

The average with same letter for each factor is nonsignificant according to Duncan's multiple range test under level 0.05.

Conclusions

The treatment with mycorrhiza, yeast spraying and chemical fertilization NPK 300 kg. Ha^{-1} gave the highest values in most of the studied traits (plant height, number of branches of the plant, leaf area of the plant, chlorophyll content in leaves, number of fruits per plant, average fruit weight, yield per plant, Total fruit yield).

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References

Abolusoro, S.; Abolusoro, P.; Mathew, F. O.; and Izuogu, N. B. (2013). Effects of organic and in organic manures on the growth attributes of root-knot nematode (*Meloidogyne incognita*) infected Ethiopian eggplant (*Solanum aethiopicum*). Academia Journal of Agricultural Research, 1(6): 83-87.

Abu Dahi, Y.M. and Al-Yunis, M.A. (1988). Handbook of Plant Nutrition. House of Books for Printing and Publishing, University of Mosul, Ministry of Higher Education and Scientific Research, Iraq.

Akanbi, W.; Olaniran, O.A.; Tairu, F.M.; Akinfasoye, J.A.; Ojo, M.A. and Adeyeye, A. (2010). Response of *Solanum melongena* to NPK fertilizer and age of transplant in the *Guniea savana* zone of ecological area of south western nigeria (Vol. 4). Libyan Agriculture: Research center Journal International**.**

Ali, B.Z. and Thamer, A.S.M. (2015). Efficiency of dendritic mycorrhizae (AM) in stimulating non-enzymatic antioxidants in tomato roots infected with Fusarium oxysporum f.sp.lycopersici. Journal of the College of Basic Education. 21(90): 345-364.

Ali, N.S. (2012). Fertilizer technologies and their uses. University of Baghdad: Ministry of Higher Education and Scientific Induction.

Al-jamal, I.M. (2015). Evaluation the Effect of Local Endomycorrhizal Fungi on Growth of *Solanum melongena* and *Capsicum annuum* Plants in Gaza Strip. The Islamic University – Gaza.

Al-Kartani, Abdul-Karim Oraibi Sebaa and Salah al-Din Hammadi Midi al-Taie (2011). The effect of biological fertilization with Mycorrhizae fungus (*Glomus mosseae*), organic fertilization with Humic acid and chemical fertilization on some growth characteristics of maize plants grown in gypsum soil. The Fifth Scientific Conference of the Faculty of Agriculture, Tikrit University, April 26-27.

Alrawi, K.M. and Abdulaziz, M.K.A. (2000). Design and Analysis of Agricultural Experiments (2nd ed.). Dar Al-Kutub Foundation for Printing and Publishing, University of Mosul, Republic of Iraq.

Al-Shahat, M.R. (2007). Bio-fertilizers and organic farmings are food and a clean environment. Cairo: Faculty of Agriculture, Ain Shams University, House of Arab Thought.

Al-Shaibani, J. and Abdul-Kadhim, K. (2005). The effect of chemical and biological (mycobacterial) fertilization on tomato plant growth and yield. PhD thesis. faculty of Agriculture. Baghdad University.

Al-Taie, H.A. (2016). The effect of adding *Glomus mosseae* fungus vaccine and spraying Gujarat extract on the growth and production of four hybrids of cucumber. *Cucumis sativus* L. Master Thesis - Department of Plant Production - College of Agriculture - University of Muthanna.

Al-Taie, H.a. (2016). The effect of adding *Glomus mosseae* fungus vaccine and spraying Gujarat extract on the growth and production of four hybrids of cucumber. *Cucumis sativus* L. Master Thesis - Department of Plant Production - College of Agriculture - University of Muthanna.

Attia, A.R. (2019). The effect of animal and Mycorrhizae fertilizers on growth and yield of eggplant. *Solanum melongena* L. under protected cultivation. Master Thesis, Al-Muthanna University, College of Agriculture.

Attia, A.R. (2019). The effect of animal and Mycorrhizae fertilizers on growth and yield of eggplant. *Solanum melongena* L. under protected cultivation. Master Thesis, Al-Muthanna University, College of Agriculture.

Central Statistical Organization (2019). Secondary Crops and Vegetable Production - Ministry of Planning, Iraq.

Chen, Q.G.; Zhang, W.J.; Liu, P. and Dong, S.T. (2014). An empirical model changes in the leaf area of maize. Can. J. Plant Sci**.**

Ekwu, L.; Utobo, E. and Nwokwu, G.N. (2012). Effect of NPK fertilizer and weeding regime on the growth and yield of eggplant (*Solanum melongena* L.). INTL Journal of Agriculture and Rural Dev.; 15(2): 1033-1040**.**

Fathy, E.L.; Farid, S. and El-Desouky, S.A. (1996). Effect of some chemical treatments, yeast preparation and royal Jelly on some vegetable crops growing in late summer season to induce their ability towards better thermal tolerance. Agric. Sci.; Mansoura Univ.: J.

Fawzy, Z.F.; El-Nemar, M.A. and Saleh, S.A. (2007). Influence of levels and methods of potassium fertilizer application on growth and yield of eggplant J. of Applied Science Res.

Forlain, G.M.; Branzoni, M.R. and Sarvilli, S. (1995). Root potentiall related properties in plant associated bacteria. Italy: Journal of General breeding**.**

Gopalan, C.R. (2007). Nutritive Value of Indian Foods of brinjal (*Solanum melongena* L.). National Institute of Nutrition**.**

Humbel, G. and Raske, H. (1971). Stomata opening quantitively related to potassium transport. J. plant physiol.

Hussein, M.J. (2017). The effect of biostimulator (*Bacteria mix*) and nutrient solution (Primo) on growth and yield of eggplant. *Solanum melongena* L grown in unheated greenhouses. Kufa Journal of Agricultural Sciences, 9 (4), 61-47.

Kadhim, A.J., Abdullah, A.A. and Al-Shuwaili, M.S. (2011). The effect of nitrogen fertilization and the export process on growth and yield of winter cucumbers (local variety) (Volume 2). Basra Research Journal (Operations).

Marschner, H. (1995). Mineral nutition of Ligher plant Journal of Experimental Botany. (56), 2153 – 2161.

Matlub, A.N.; Sultan, I.A. and Abdoul, K.S. (1989). Vegetable Production (Part 1), second revised edition. Iraq: Dar Al Kutub for Printing and Publishing. University of Al Mosul.

Nagodawithana, W.T. (1991). Yeast technology Universal foods. Corporation Milwaukee.Wisconsin. Published by Van Nostracl veinhold Newyork.

Omar, K.A. (2003). The effect of spraying with dry yeast suspensions on tomato plant growth and productivity. Iraqi Journal of Agricultural Sciences, 4(3): 23-28.

Parial, R.; Mohajan, S.; Hussain, M.; Hashem, M.; Manisha, M. and Islam, A.D. (2014). Isolation of Arbuscular Mycorrhizal Fungi and evaluation its effect on plant growth over chemical fertilizers for better human health. SMU. Med. J.

Patil, B.C.; Hosamani, R.M.; Ajjappalavara, P.S.; Naik, B.C.; Smith, R.P. and Ukkund, C.K. (2008). Effect of foliar application of micronutrients on growth and yield of tomato (*Lycopersicon esculuntum* Mill). Karnataka J. Agric. Sci.

Saba'a, A.K.O.; Othman, K.A.R. and Waheeb, M. (2013). The effect of soil cover and biological fertilization with *Mosseae glomus* on some yield characteristics of two tomato cultivars grown in gypsum soil. Diyala Journal of Agricultural Sciences, 5(1): 73-81.

Saleh, M.M. (2006). The role of Mycorrhizae, triple superphosphate fertilizer and phosphate rock in growth and production of tomato. Lycopersicon esculentum Mill. Master Thesis, Faculty of Agriculture. Baghdad University.

Saleh, M.M. (2006). The role of Mycorrhizae, triple superphosphate fertilizer and phosphate rock in growth and production of tomato. *Lycopersicon esculentum* Mill. Master Thesis, Faculty of Agriculture. Baghdad University.

Sanders, F.E. and Tinker, P.B. (1973). Phosphate flow in to mycorrhizal roots. Pest. Sci.

Sharaqi, M.M. and Abd al-Hadi Khader (1985). Plant Physiology (Translator). Cairo, Egypt: The Arab Publishing Group.

Suge, J.K.; Omunyin, M.E. and Omami, E.N. (2011). Effect of organic and inorganic sources of fertilizer on growth, yield and fruit quality of eggplant (*Solanum melongena* L). Archives of Applied Science Research, 3(6): 470-479.