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Effect of biofertilizers and organic fertilization on the growth and yield of cherry tomato plant

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Abstract

A field experiment was conducted at the demonstration farm in the Al-Mahnawiya area, Al-Sadda district, Babil Governorate, to evaluate the effects of bio- and organic fertilization on the growth and yield of tomato plants. Bio-fertilization with mycorrhizal fungi (A1) significantly increased several parameters, including the number of leaves (19.94 leaves plant^{-1}), cluster weight (91.59 g), yield per plant (2783 g), total soluble solids (TSS, 9.31%), acidity (3.93%), and vitamin C content (22.18 mg 100 g^{-1} fresh weight). Bacillus spp. treatment (A2) recorded the highest plant height (184.71 cm), number of clusters (8.89 plant^{-1}), and number of fruits (121.1 plant^{-1}). Among organic fertilization treatments, palm frond residues (B4) resulted in the highest plant height (182.59 cm), number of clusters (8.96 plant^{-1}), fruit number (116.6 plant^{-1}), acidity (3.83%), and vitamin C content (17.54 mg 100 g^{-1}). Poultry waste (B2) also improved plant growth, particularly leaf number (19.34 plant^{-1}) and cluster weight (90.96 g). The combined treatment A1B2 exhibited superior performance across multiple traits, while A1B4 and A2B4 further enhanced vitamin C content and cluster formation, respectively. These results indicate the potential benefits of integrating bio- and organic fertilizers in tomato cultivation.

Keywords: cherry tomato, bio fertilizer, organic, tomato yield, Iraq, tomato growth

INTRODUCTION:

The Solanceae family contains many important vegetable crops, and among the most important are tomatoes, including cherry tomatoes (*Solanum lycopersicum* var. cerasiforme), which are considered a variety of small-sized tomatoes. Cherry tomatoes are important for their nutritional content, as they contain vitamins A, B, and C. Their consumption is beneficial for human health due to the presence of phytochemicals such as lycopene, beta-carotene, folic acid, fructose, and many essential nutrients like phosphorus, potassium, magnesium, and calcium (Filgueira ‹2013).

Cherry tomatoes are an important source of antioxidants, such as polyphenols and carotenoids (Kouser et.al. 2022), which help prevent cancer and cardiovascular diseases caused by oxidative stress (Reuters et. al. 2010). Their size ranges from a pea to a golf ball, and their size is important to many consumers. Smaller fruits, measuring 1.25 - 1.87 cm^3, are used in salads and eaten whole, preferred over larger varieties that require cutting before consumption. Cutting the fruits reduces the vitamin C content, which is prone to oxidation, while uncut fruits retain the same amount of this vitamin without oxidation, increasing the chance of direct benefit without loss. Additionally, their fruits do not suffer from blossom-end rot (Riboldi, et. al. 2020). This encourages its cultivation in the central, southern, and desert regions of Iraq.

Cherry tomatoes are characterized by high productivity and quality, and they enjoy excellent consumer acceptance due to their high sweetness and distinctive taste, which many prefer over regular tomatoes (Mahmood et. al, 2021).

The importance of eco-friendly biofertilizers has increased to improve the performance of plant crops within sustainable agriculture systems. Many factors may have an impact on time needed until flowering (Ullah et.al., 2025) Mycorrhizal fungi shorten the vegetative growth period of tomato plants, leading to early flowering and fruit ripening (Chialva et al., 2016). Additionally, there are studies confirming that the interaction of tomato plants with AMF increases the quality of nutritional elements by enhancing the content of citric acid, carotenoids, certain amino acids, and the antioxidant capacity of the fruits (Miranda et al., 2015) & (Di Fossalunga et al., 2012).

Organic fertilizer is a product of plant, animal, or industrial-agricultural origin that, when added to the soil, improves soil fertility and increases crop productivity and product quality (Tarni et al., 2013).

Studies on tomato plants have confirmed that antioxidants, flavonoids, sugars, and vitamin C are higher in fruits grown using organic farming methods compared to those grown conventionally (Chassy et al., 2006) (Mitchell et al., 2007) (Vallverdú-Queralt et al., 2012).

A study showed that a higher yield of 15.66% was obtained when using organic fertilizers compared to chemical fertilizers, which increased the tomato yield by 28.9%, making it the highest yielding. All applications showed an increase in carbon dioxide production in the soil; the highest carbon dioxide production was recorded during the late harvest period and after fertilizer application, which increased tomato yield and improved the biological properties of the soil (Murat & Rıdvan, 2022).

Another study showed that the use of organic fertilizers achieved the highest yield and mineral content in the fruits with a dose of 35 ml for the tomato plant. With these doses, the weights of the tomato fruits increased by 137% compared to the control treatment (Aruna et al., 2022).

MATERIALS AND METHODS

A field experiment was conducted during the 2024–2025 agricultural season in the Mahnawea area, Al-Sadda district, located 20 km east of Al-Hilla city, Babil Governorate, Iraq. The study aimed to evaluate the effects of biofertilizers and organic fertilizers on the growth and yield of cherry tomato (Solanum lycopersicum var. cerasiforme). The experimental field was prepared by removing residues of the previous crop, followed by soil pasteurization, plowing, leveling, and ridge formation.

The land was divided into three ridges, each 1 m wide and 1.5 m long. Each ridge contained 15 experimental units. Spacing between ridges was 1 m, and 70 cm between experimental units to avoid treatment interference, with 50 cm between plants. A drip irrigation system was installed prior to planting.

Seeds were sown in polystyrene trays filled with a peat moss–perlite mixture on 14 September 2024. After 35 days, seedlings were transplanted into a greenhouse on 18 October 2024. The experiment was arranged in a factorial design (3 × 5) using a Randomized Complete Block Design (RCBD) with split-plots and three replications. Biofertilizer treatments (main plots) were:

- A0: Control (no biofertilizer)
- A1: Mycorrhizal fungi (5 g $plant^{-1}$)
- A2: *Bacillus* spp. (10 g $plant^{-1}$)

Biofertilizers were supplied by the Agricultural Research Department, Biotechnology Center, Ministry of Science and Technology, and applied at transplanting.

Organic fertilizer treatments (sub-plots) included:

- B0: Control (no organic fertilizer)
- B1: Vermicompost
- B2: Poultry waste

- B3: Mushroom waste
- B4: Palm frond waste

All organic fertilizers were applied at a rate of 10 t ha^{-1} before transplanting.

Data was statistically analyzed using Genstat v.12. Treatment means were compared using the Least Significant Difference (LSD) test at the 0.05 probability level (Al-Rawi & Abdulaziz, 2000).

RESULTS AND DISCUSSION:

The results in Table (3) indicated that the addition of biofertilizers significantly affected the growth, yield, and quality traits of the plants. The treatment with mycorrhizal fungi excelled in the number of leaves, recording the highest value with an average of 19.940 leaves per plant. Plant-1, the highest average cluster weight was 91.59 grams, the highest average yield per plant was 2783 grams, the highest average TSS percentage was 9.312%, the highest average acidity percentage was 3.926%, and the highest average vitamin C was 22.18 mg per 100 grams fresh weight. 100 g^{-1} fresh weight, while the control treatment recorded the lowest average for the above traits, which was 14.973 leaves. Plant-1, 63.59 g, 420.3 g, 6.820%, 1.537%, 10.35 mg. 100 g^{-1} fresh weight, respectively.

The treatment with Bacillus spp. (A2) significantly enhanced several growth and yield traits. It recorded the highest average plant height (184.71 cm), number of clusters per plant (8.893 clusters $plant^{-1}$), and number of fruits (121.1 fruits $plant^{-1}$). In contrast, the control (A0) recorded the lowest values for these traits: 163.35 cm in plant height, 6.873 clusters $plant^{-1}$, and 71.2 fruits $plant^{-1}$.

Organic fertilization also had a significant effect on vegetative growth, yield, and quality traits. The treatment with palm frond residues (B4) resulted in the highest plant height (182.59 cm), number of clusters per plant (8.956 clusters $plant^{-1}$), number of fruits (116.6 fruits $plant^{-1}$), acidity (3.826%), and vitamin C content (17.54 mg 100 g^{-1} fresh weight). In comparison, the control treatment (B0) recorded lower values: 168.01 cm in plant height, 7.144 clusters $plant^{-1}$, 83.1 fruits $plant^{-1}$, acidity of 2.047%, and vitamin C content of 15.04 mg 100 g^{-1}.

The poultry waste treatment (B2) recorded the highest average number of leaves (19.344 leaves $plant^{-1}$), cluster weight (90.96 g), yield per plant (761.6 g), and total soluble solids (TSS, 8.608%). Conversely, the control treatment yielded lower averages: 16.789 leaves $plant^{-1}$, 73.33 g cluster weight, and 7.287% TSS.

Regarding the interaction between biofertilizer and organic fertilizer treatments, A1B2 recorded the highest plant height (195.86 cm), number of leaves (21.500 leaves $plant^{-1}$), cluster weight (103.07 g), number of fruits (138.5 fruits $plant^{-1}$), yield per plant (952.9 g), TSS (10.220%), and acidity (5.017%). In comparison, the corresponding control treatment recorded values of 150.08 cm plant height, 13.533 leaves $plant^{-1}$, 45.17 g cluster weight, 45.8 fruits $plant^{-1}$, yield per plant of 234.0 g, TSS of 5.247%, and acidity of 0.830%.

The treatment A1B4 achieved the highest vitamin C content (23.63 mg 100 g^{-1} fresh weight), while the control recorded the lowest (8.83 mg 100 g^{-1}). Moreover, the A2B4 treatment produced the highest number of clusters per plant (9.800 clusters $plant^{-1}$), compared to the control (5.533 clusters $plant^{-1}$).

DISCUSSION:

The observed improvements in vegetative growth, yield, and fruit quality traits of cherry tomato plants treated with mycorrhizal fungi can be attributed to enhanced nutrient uptake efficiency and improved hormonal balance within the plant. Mycorrhizal fungi are known to produce growth-promoting hormones such as indole acetic acid (IAA), cytokinins, and gibberellins, which stimulate plant development through rhizosphere secretion and symbiotic transfer to plant tissues. These mechanisms not only enhance growth and yield but also support plant tolerance to abiotic stresses by promoting antioxidant activity, increasing water uptake, and enhancing disease resistance. The effectiveness of mycorrhizae in promoting plant performance has been documented in several studies (Nirmalnath, 2010; Baum et.al, 2015; Al-Hadidi et al., 2021).

The treatment with Bacillus spp. (A2) resulted in significant improvements in fruit number and other quality parameters. This can be explained by the plant growth-promoting capabilities of *Bacillus subtilis*, which is known for its ability to mineralize organic phosphate, solubilize inorganic phosphate, and produce IAA at concentrations up to 6.48 µg ml^{-1}. These characteristics contribute to improved root development and nutrient absorption, which align with the findings of Hanif et al. (2015).

Organic fertilizer treatments also significantly influenced plant growth and quality. Palm frond residue (B4) was particularly effective, likely due to its contribution to enhancing soil fertility through the decomposition of organic matter, which releases essential macro- and micronutrients (Jeki, 2021; Manea, 2017). The increase in vitamin C content under palm frond treatment suggests improved metabolic activity in the plant as a response to enriched soil conditions.

The application of poultry waste (B2) also resulted in notable enhancements, including increased leaf number, cluster weight, and TSS content. This can be attributed to improved soil physical structure and the stimulation of beneficial microbial populations. Poultry manure is rich in essential plant nutrients—containing approximately 65.5% nitrogen, 83.5% potassium, and 68.5% phosphorus—as well as secondary and micronutrients such as calcium, magnesium, iron, manganese, and zinc (Hamidu et al., 2024). These nutrients play a crucial role in both vegetative and reproductive growth phases.

Conclusion:

Based on the findings, the combined application of mycorrhizal fungi and poultry waste (A1B2) resulted in the highest yield and superior fruit quality traits. Additionally, the combination of Bacillus bacteria and palm frond residues (A2B4) led to significant improvement in quantitative yield parameters, while the treatment with mycorrhizal fungi and palm frond residues (A1B4) showed the greatest enhancement in quality-related traits of the fruits

Data availability statement:

Raw data were generated at University of Babylon. Derived data supporting the findings of this study are available from the corresponding author [E.F.O..] on request.

No potential conflict of interest was reported by the author(s).

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Table 1. Physical and chemical properties of the field soil before planting

The property	unit values	Standard
Electrical conductivity EC	3 m/ds	3.4
pH level	---	7.8
Organic matter	g. kg-1	0.56
Ready nitrogen	mg/kg	20
Ready phosphorus	mg. kg-1	8.6
Ready potassium	Milligram. kg-1	152.6
Apparent density	g. cm^3	1.3
Soil texture	Sandy-clay-loamy	

Table 2: Characteristics and Components of Organic Fertilizers Used in the Experiment

Characteristics	Unit	Waste Poultry	Waste Worm	Compost Palm Fronds	Mushroom Bedding
pH	-	6.6	6.8	7.04	7.3
Organic carbon	%	14.9	10.16	43.70	335
Nitrogen	%	2.23	3.498	2.30	25.0
C:N	-	6.7	8.1	19.00	13.4
Phosphorus	%	0.83	1.73	0.650	12.3
Potassium	%	2.35	2.23	2.80	230.5
Calcium	%	1.42		2.93	
Magnesium	%	0.58		0.850	

Table 3: The effect of biofertilizers and organic fertilizers on the growth and yield of cherry tomatoes

Bio fertilizer	plant hieght	number of leaves	Number of clusters per plant	weight of the cluster	Number of fruits	Yield of a single plant	Tss	Acidity level	Vit. C
Comparison	163.35	14.97	6.873	63.59	71.2	420.3	6.82	1.53	10.35
A1	184.50	19.94	8.85	91.59	117.9	783.2	9.31	3.92	22.18
A2	184.71	19.27	8.89	90.85	121.1	778.4	8.31	3.67	16.63
LSD0.05	**1.282**	**0.2164**	**0.5136**	**2.111**	**8.63**	**47.93**	**0.2830**	**0.1356**	**0.948**
Organic fertilization									
Comparison	168.01	16.789	7.144	73.33	83.1	525.9	7.28	2.047	15.04
B1	175.71	17.88	7.98	79.39	98.4	622.2	8.24	2.45	16.34
B2	181.70	19.34	8.55	90.96	115.6	761.6	8.60	3.65	17.22
B3	179.58	17.55	8.38	79.98	103.2	648.1	8.18	3.24	15.79
B4	182.59	18.73	8.95	86.40	116.6	745.3	8.42	3.82	17.54
LSD0.05	**2.458**	**0.2838**	**0.4891**	**2.309**	**7.30**	**36.67**	**0.2671**	**0.1431**	**0.721**
Interference	**A*B**								
A0B0	150.08	13.533	5.533	45.17	45.8	234.0	5.247	0.830	8.83
A0B1	163.16	14.367	6.767	53.83	66.3	338.2	7.387	0.913	10.10
A0B2	163.02	16.267	7.000	75.53	80.3	505.9	7.167	1.877	10.6

									7
A0B3	167.94	14.167	7.333	66.43	76.7	459.1	6.877	2.147	10.10
A0B4	172.57	16.53	7.733	77.00	86.9	564.4	7.423	1.920	12.07
A1B0	174.70	18.46	8.200	84.33	100.0	671.0	9.063	2.563	20.93
A1B1	178.39	20.20	8.533	93.60	111.8	767.0	8.733	3.113	21.50
A1B2	195.86	21.50	9.567	103.07	138.5	952.9	10.220	5.017	23.37
A1B3	186.29	19.96	8.63	85.13	111.7	703.7	9.177	4.117	21.47
A1B4	187.25	19.56	9.33	91.83	127.5	821.4	9.367	4.820	23.63
A2B0	179.27	18.367	7.70	90.50	103.4	672.8	7.550	2.747	15.37
A2B1	185.60	19.10	8.66	90.73	117.1	761.6	8.603	3.32	17.43
A2B2	186.21	20.26	9.10	94.27	128.0	826.0	8.437	4.07	17.63
A2B3	184.52	18.53	9.20	88.37	121.4	781.4	8.490	3.46	15.80
A2B4	187.95	20.10	9.80	90.37	135.5	850.1	8.493	4.73	16.93
LSD0.05	**3.907**	**0.464**	**0.843**	**3.878**	**12.95**	**67.03**	**0.461**	**0.241**	**1.320**