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Efficiency of Cucumber Production by Using Plant Compost, Chicken Manure and Mycorrhizal Fungi

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Abstract: The effectiveness of applying different rates (100, 50, and 33.5%) of plant compost, chicken manure (as organic fertilizers), and Arbuscular mycorrhizal (AM) fungi (as biofertilizer) alone or in combination to sandy soil on the growth and quality parameters of cucumber was evaluated through field experiments conducted in two summer seasons, 2023 and 2024, respectively. A control treatment with only the recommended dose of chemical fertilizers was included. The obtained results showed that the treatment containing 33.5% plant compost and 33.5% chicken manure, in combination with mycorrhizal fungi, had the most significant effects on both growth and quality parameters of the cucumber, compared to the control. The least significant impact on both growth and quality parameters of cucumber was observed with the control treatment (containing only chemical fertilizer). The study recommends using organic fertilizers with biofertilizers instead of chemical fertilizers to produce high-quality cucumbers while also saving the environment from pollution.

1 Introduction

Cucumber (*Cucumis sativus*, L.) is an important vegetable crop because it is rich in nutrients, flavonoids, amino acids, vitamins, and carbohydrates, while being low in calories and high in fiber. These nutrients help reduce swelling and skin irritation (Ejaz and Bahadur 2024). Cucumber is typically grown during the summer, and for years, farmers have relied on increasing the use of inorganic fertilizers to boost yield, which can quickly lead to soil desertification. In traditional agriculture, chemical fertilizers are commonly used to increase crop production; however, they can negatively affect crop quality and the soil's physicochemical and microbial properties. Excessive use of chemical fertilizers also poses environmental risks. The application of bio-organic fertilizers can improve soil physicochemical and biological parameters such as soil aggregation, water retention, increased biological and microbial activity in the rhizosphere, higher cation and anion exchange capacity, porosity, and overall soil fertility (Benaffari et al 2022, Beyk-Khorimizi et al 2023). Conversely, adding bio-organic fertilizers can promote beneficial soil microorganisms and improve crop quality by providing macro- and micronutrients, stimulating plant growth, boosting immunity, and increasing both crop yield and quality (Khan et al 2017, Rasool et al 2023, Limbongan 2023). Additionally, bio-organic fertilization can enhance ecological conditions and support environmental preservation. The benefits of bio-organic fertilization include restoring, maintaining, and improving the physical, chemical, and biological functions of soil, which positively impact crop production

(Abou El-Goud 2020, Abou El-Goud et al 2021, Ayito et al 2023, Limbongan 2023, Nadoda et al 2023, Ejaz and Bahadur 2024, Radwan and Sultan 2024).

Plant compost contains many beneficial microbes (e.g., bacteria, fungi, protozoa, actinomycetes, and mycorrhiza), plant hormones, and growth regulators. It can be used to increase crop yield and quality, and is less expensive compared to chemicals, leading to an increase in pesticide-free crop production. Additionally, it can improve soil organic matter, enhance the permeability of heavy soils, and thereby reduce runoff and erosion. It also helps retain water, improve soil drainage, and act as a mild herbicide. Furthermore, it boosts the population of beneficial microbes, which may suppress specific plant diseases such as Pythium and Fusarium, as well as nematodes (Abou El-Goud 2020, Abou El-Goud et al 2021, Benaffari et al 2022, Rasool et al 2023).

Chicken manure contains bioactive compounds that enhance the ability to suppress parasitic nematodes and various soil-borne diseases (Khan et al 2017, Solaiman et al 2020, Rasool et al 2023, Vallejos-Torres et al 2023). It also helps improve soil fertility and increase overall crop yield. Furthermore, it is not only effective and affordable but also essential for maintaining optimal chemical, physical, and microbial conditions in the soil, which in turn promotes better vegetative growth and higher productivity in crops (Abou El-Goud et al 2021, Shaik and Singh 2022, Tong et al 2023).

Mycorrhiza, in general, is an important beneficial fungus to add, especially to poor-nutrient sandy soil. It can enhance the surface area for N, P, and K absorption by fungal hyphae from depletion zones, producing organic acids to lower soil pH and facilitate the release of elements from organic and mineral complexes. These elements are then translocated into the root surface cortex cells by hyphal tips (Benaffari et al 2022). Moreover, mycorrhizal fungi can enhance the plant's immune system and promote increased plant growth, total yield, and quality. Soil mycorrhiza is also a crucial component that enriches soil elements and maintains soil health sustainably. Additionally, they can elevate plant growth regulators and provide defense against various soil-borne diseases. Arbuscular mycorrhizal (AM) fungi are capable of enhancing regulation, enzymatic activities, and the rate of photosynthesis, as well as supporting bioremediation, thus serving as eco-facilitators in sustainable agriculture both for production and environmental protection (Ejaz and Bahadur 2024).

This study aimed to achieve a system containing mixtures of organic (plant compost and chicken manure) and biofertilizers (Mycorrhizal Fungi) to produce high-quality Cucumber. At the same time, it is necessary to avoid environmental pollution caused by chemical fertilizers.

2 Materials and Methods

2.1 Characterization of field experiments

Two open-field experiments were conducted at the Faculty of Agriculture (Saba Basha) farm, University of Alexandria in Egypt, for two summer growing seasons: on March 13th and 17th, 2023, and 2024, respectively. The soil in each of the two fields was sampled before cultivation in 2023 and at the end of harvest in 2024. Some of their physico-chemical properties were determined using the Method of Keeney and Nelson (1982). Data are presented in (**Tables 1 and 2**).

2.2 Characterization of biofertilizers & the organic fertilization

Samples of plant compost and chicken manure were collected before being applied to soil and analyzed according to the methods of Lowther (1980) and Keeney and Nelson (1982). The results from the plant compost and chicken manure samples are as follows: Total O.M.% were 18.2 and 17.5; O.C.% 9.1 and 9.9; C/N ratio 2.8 and 1.9; pH (1:10) 7.5 and 7.7; E.C. (1:10 water extract) 5.2 and 5.7 dS/m; total amounts of N 3.2 and 5.3; P 1.8 and 2.3; and K 1.9 and 2.3%, respectively. Mycorrhizal species were obtained from the Agricultural Research Center in El Doky, Giza, Egypt.

2.3 Field work and layout

Bio-organic system was sown with cucumber during the two summer growing seasons. In two open-field experiments, eight treatments were arranged in a randomized complete block design with three replications. Applied treatments were as follows:
T_1 = Arbuscular mycorrhizal fungi (AMF) inoculum (rate of 3g/ hole),
T_2 = $R_{100\,\%}$ Plant compost (rate of 7 tons/ fed.),
T_3 = $R_{100\,\%}$ Chicken manure (rate of 3.5 tons/ fed.),
T_4 = $R_{50\,\%}$ Plant compost + $R_{50\,\%}$ Chicken manure,
T_5 = $R_{50\%}$ Plant compost + AMF,
T_6 = $R_{50\%}$ Chicken manure + AMF,
T7 = R33.5% plant compost + R33.5% chicken manure with mycorrhizal fungi, and T8 = the control (the recommended doses of inorganic nitrogen, phosphorus, and potassium fertilizers) were applied to the control

plots as follows: ammonium nitrate (N = 33.5%) at a rate of 250 kg/fed., mono calcium phosphate ($P2O5$ = 15.5%) at a rate of 200 kg/fed., potassium sulfate ($K2O$ = 48%) at a rate of 150 kg/fed., and AM fungi were used as an inoculant in the two open field experiments.

At planting, two seeds were sown in each hole and irrigated using a drip irrigation system for a sufficient time. Irrigation was applied three times a week. The total area of the plot was 4.0 m (length) × 0.7 m (width) = 2.8 m²; the distance between plants was 35 cm within the row, with nine plants per plot. Both plant compost and chicken manure were applied to the soil surface (0-25 cm) before planting and mixed into the soil during plowing three weeks prior to sowing. Weeds were controlled manually by uprooting. Neem oil extract (Ashok) was used as an organic pesticide, applied as foliar spray on green leaves at a rate of three cm per liter; it was applied every 10 days from 30 days after sowing until harvest (on July 5th and 10th, 2023 and 2024, respectively), to enhance plant resistance against insects. Additionally, cucumber plants were covered with a net for protection. Five plants were randomly selected from each plot (the experimental unit) to measure growth, yield, and quality characteristics.

2.4 The studied plant parameters

The studied parameters of the cucumber plant include growth, yield, and quality.

Growth parameters include plant height, number of leaves per plant, shoot dry weight, leaf area index, and total chlorophyll in green leaves. All of these were measured and recorded at the end of each of the two seasons. The studied yield parameters include fruit length, fruit width, fruit weight, average number of fruits per plant, and total yields. In addition, the quality parameters include the contents of N, P, and K in leaves and fruits.

Leaf area index and total chlorophyll in green leaves were measured as described by Rhoads and Bloodworth (1964). All plant samples, including leaves and fruits, were cleaned with water and dried in an oven at 65°C for 72 hours until their dry weight was constant. Dry weights were then recorded. Early yields were calculated by summing the fruit weights from the first two harvests. Total yields were collected from the first cut on May 5, 2023, and May 9, 2024. Subsequent harvests occurred on July 5th and 10th in 2023 and 2024, totaling 14 harvests. The number of fruits per plant, fruit length, diameter, and average fruit weight were all measured. Mineral contents in plant parts (leaves and fruits) were also analyzed. Dry leaf and fruit samples were finely ground, and wet digestion was performed using a mixture of H_2SO_4 and H_2O_2, as described in Lowther (1980). The total macro-element contents, such as nitrogen, phosphorus, and potassium in the fruits and leaves, were determined using methods outlined in Chapman and Pratt (1961) and AOAC (2023).

2.5 Statistical analysis

All results were subjected to statistical analysis using the SAS program, and the means of all treatments were compared using Duncan's Multiple Range test at a 5% level of probability (SAS 2006).

3 Results and Discussion

To study the influence of various organic treatments on cucumber production and quality, it was necessary to examine each parameter separately.

3.1 The growth parameters

The vegetative characteristics of *Cucumis sativus*, L., include plant height, number of leaves per plant, total chlorophyll content in green leaves, Leaf Area Index (LAI), and shoot dry weight. Data in **Table 3** clearly show the influence of applying plant compost and chicken manure at different rates (100%, 50%, and 33.5%) as well as AM fungi alone or in combination on the growth parameters of cucumber. All studied treatments have significant effects on all growth parameters, but to varying degrees compared to the control treatment (chemical fertilization only). They can be ordered as follows:

$$T7 > T4 > T6 > T5 > T3 > T2 > T1 > T8.$$

As such, the highest average values were recorded for T7, while the lowest were for T8. Therefore, the average values across two seasons for both T7 and T8 were calculated as shown in **Table 3**. The highest significant values for T7 were 204.4 cm, 110.6 leaves per plant, 62.1, 1.49 cm², and 400.8 g per plant, respectively. Conversely, the lowest significant values for T8 (control) were 99 cm, 53 leaves per plant, 32.2, 0.57 cm², and 192 g per plant, in the same order. These results may be attributed to the ability of plant compost, chicken manure, and AM fungi to improve the physicochemical and biological properties of the soil, as well as their adequate supply of macro- and micro-nutrients, which enhances nutrient uptake by root hairs, leading to improved growth parameters. Similar trends have

Table 1. Physical and chemical properties of the experimental soil before sowing in the first season, 2023

Particle distribution		**Available Macronutrients (mg kg^{-1})**	
Sand	91.3%	**N**	110.0
Silt	3.2%	**K**	309.2
Clay	5.5%	**P**	26.3
Texture class	Sand		
Soil properties **pH (1:1)**	8.3	**Ca^{2+}**	1.8
EC (dS m^{-1}) (1:1)	0.44	**Mg^{2+}**	2.44
Total $CaCO_3$	27%	**Na^{+}**	1.6
OM	0.34%	**Soluble Anions (meq/ L) HCO_3^-**	5.67
		Cl^-	1.33
		SO_4^{-2}	0.23

Table 2. Physical and chemical properties of the experimental soil collected from all treatments at the end of the second summer growing season, 2024

Mechanical Analysis	**Soil properties**							
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**
Sand (%)	74.4	78.22	68.14	78.12	76.10	72	76.12	76.8
Silt (%)	11.6	11.7	10.09	11.3	11	17	12.5	12.5
Clay (%)	14	10.1	21.77	10.58	12.90	11	11.38	9.7
Textural class	**Sandy loam**	**Sandy loam**	**Sandy loam**	**Sandy loam**	**Sandy loam**	**Sandy loam**	**Sandy loam**	**Sandy loam**
pH (1:2)	8.9	8.5	8.6	8.4	8.5	8.1	8.2	8.4
EC (1:2) ds/ m	0.27	0.34	0.30	0.30	0.20	0.34	0.34	0.44
O.M (%)	0.41	0.40	0.68	0.44	0.91	0.57	1.3	0.53
O.C (%)	0.24	0.30	0.44	0.33	0.63	0.35	0.66	0.46
C/ N ratio	29.44	25.47	42.78	22.85	29.10	28.30	43.11	37.25
CaCO3 (%)	32.2	15.6	17.4	15.7	25.7	22.6	26.9	11.8
	Available Nutrients (mg kg^{-1})							
N	94.6	93.64	103.00	98.30	155.31	114.51	125.41	77.21
p	20.22	39.8	23.4	38.3	33.6	17.2	25.7	20.2
k	620	670	685	680	595	635	647	660

been observed by many authors with other crops, including Abou El-Goud (2020), Abou El-Goud et al (2021), Vallejos-Torres et al (2023), Ejaz and Bahadur (2024), and Radwan and Sultan (2024).

3.2 The yield parameters

The yield parameters of cucumber include fruit length, fruit width, fruit weight, mean number of fruits per plant, and total yields. The results shown in Table 4 indicate that significant increases are primarily due to the application of AM fungi alone. Although these increases were significant, their values were lower than those in other treatments (except the control). Once again, the highest significant values were achieved with treatment T7 (i.e., the mixture containing 33.3% plant compost R, 33.3% chicken manure, and AM fungi). The average values obtained were 2471.3 g per plant, 20.5 cm, 4.85 cm, 220.7 g, 11.2 fruits per plant, and 30.3 tons per fed., respectively, based on two summer seasons. In contrast, the lowest significant values were recorded for T8 (control with inorganic fertilizers), with corresponding values of 573.6 g per plant, 9.6 cm, 2.3 cm, 108.9 g, 5.3 fruits per plant, and 6.3 tons per fed., as averages over both summer seasons. The results of all treatments can be arranged in the following order:

T7 > T6 > T5 > T4 > T3 > T2 > T1 > T8.

Table 3. Growth parameters of cucumber plant as affected by application of plant compost, chicken manure, and AM fungi at two summer growing seasons, 2023 and 2024

T	Plant height (cm)		No.of leaves/ plant		Total chlorophyll in leaves		Leave area index (cm^2)		Shoot dry weight (g/ plant)	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season
T1	104.1 g	114.5 g	56.1 g	61.7 g	32.8 g	36.1 g	0.67 e	0.75 e	201.7 g	225.9 g
T2	115.6 f	127.2 f	62.3 f	68.5 f	36.9 f	40.6 f	0.77de	0.87 de	224.2 f	251.1 f
T3	128.2 e	140.9 e	69.9 e	78.4 e	40.5 e	44.6 e	0.87cd	0.98 cd	249.0 e	278.9 e
T4	176.2b	193.8 b	95.0 b	106.4 b	53.7 b	59.0 b	1.3 a	1.51 a	341.4 b	382.3 b
T5	143.4 d	157.7 d	77.3 d	86.6 d	44.9 d	49.5 d	0. 97 c	1.09 c	276.8 d	309.9 d
T6	158.7 c	174.6 c	86.0 c	96.4 c	50.1 c	55.1 c	1.1 b	1.28 b	306.9 c	343.7 c
T7	194.6 a	214.1 a	104.3 a	116.8 a	59.1 a	65.1 a	1.4 a	1.58 a	378.1 a	423.5 a
Mean	204.4		110.6		62.1		1.49		400.8	
T8	94.3 h	103.8 h	50.0 h	56.0 h	30.6 h	33.7 h	0.53 f	0. 60 f	181.2 h	202.9 h
Mean	99.1		53.0		32.2		0.57		195.6	
L.S.D.0.05	0.92	1.01	0.77	0.86	0.85	0.93	0.10	0.11	0.97	1.08

T1= AM inoculation, T2 = plant compost $R_{100\%}$, T3 = chicken manure $R_{100\%}$, T4 = plant compost R $_{50\%}$ + chicken, manure $R_{50\%}$, T5 = plant compost, R $_{50\%}$ + AM inoculation, T6 = chicken manure $R_{50\%}$ + AM inoculation, T7 = plant compost R $_{33.3\%}$ + chicken manure R $_{33.3\%}$ + AM inoculation and T8 = Chemical N, P and K fertilizers, R $_{100\%}$ (Control).
Values in the same column with different letters are significantly different ($p \leq 0.05$)

Table 4. Fruits yield parameters of cucumber plant as affected by application of plant Compost, chicken manure and AM fungi at two growing seasons, 2023 and 2024

T	Average, Fruit yield (g/plant)		Fruit, length cm		Fruit width cm		Fruit, weight g		Average number of fruits / plant		Total Fruit, yield (tons/ fed.)	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season
T1	647.5 cd	794.4 g	10.8 g	11.9 g	2.7 g	3 g	113.6 g	126.1 g	5.7 g	6.3 g	7.7 g	8.6 g
T2	797.5 cd	948.7 f	11.7 f	13.0 f	2.9 f	3.2 f	125.1 f	138.8 f	6.1 f	6.8 f	8.7 f	9.8 f
T3	973.3 bcd	1202.0 e	12.9 e	14.4 e	3.0 e	3.4 e	139.0 e	153.3 e	7 e	7.8 e	11.1 e	12.4 e
T4	1119.3 bc	2203 b	17.7 b	19.9 b	4.4 b	4.9 b	190.2 b	211.2 b	9.4 b	10.4 b	20.5 b	22.9 b
T5	1215.3 bc	1503.3 d	14.5 d	16.1 d	3.4 d	3.8 d	153.9 d	170.8 d	7.9 d	8.8 d	13.9 d	15.6 d
T6	1469.3 b	1815 c	15.8 c	17.6 c	3.7 c	4.1 c	171.5 c	190.4 c	8.6 c	9.5 c	16.8 c	18.8 c
T7	2210.3 a	2732.3 a	19.4 a	21.6 a	4.6 a	5.1 a	209.2 a	232.2 a	10.6 a	11.7 a	33.9 a	26.6 a
Mean	2471.3		20.5		4.85		220.7		11.2		30.3	
T8	505.5 d	641.7 h	9.1 h	10.1 h	2.2 h	2.4 h	103.2 h	114.6 h	5.0 h	5.6 h	5.9 h	6.6 h
Mean	573.6		9.6		2.3		108.9		5.3		6.3	
L.S.D.0.05	35.2	63.2	0.66	0.74	0.13	0.14	1.34	1.49	0.28	0.31	0.37	0.41

T1= AM inoculation, T2 = plant compost $R_{100\%}$, T3 = chicken manure $R_{100\%}$, T4 = plant compost R $_{50\%}$ + chicken, manure $R_{50\%}$, T5 = plant compost, R $_{50\%}$ + AM inoculation, T6 = chicken manure $R_{50\%}$ + AM inoculation, T7 = plant compost R $_{33.3\%}$ + chicken manure R $_{33.3\%}$ + AM inoculation and T8 = Chemical N, P and K fertilizers, R $_{100\%}$ (Control).
Values in the same column with different letters are significantly different ($p \leq 0.05$)

Table 5. Quality parameters of cucumber expressed as mineral contents in leaves and fruits affected by application of plant compost, Chicken manure and AM fungi at two growing seasons, 2023 and 2024

T	In Leaves						In Fruits					
	N uptake, (mg/kg)		P uptake, (mg/kg)		K uptake, (mg/kg)		N %		P %		K %	
	F.S	S.S	F.S	S.S	F.S	S.S	F.S	S.S	F.S	S.S	F.S	S.S
T1	0.41 ef	0.4 ef	0.61 d	0.60 d	3.6 f	3.7 f	0.91 e	0.92 e	0.8 b	0.9 b	16.2 cd	16.4 cd
T2	0.55 de	0.55 de	0.36 e	0.37 e	10.6 c	10.6 c	1.5 c	1.60 c	0.7 b	0.8 b	16.4 cd	16.7 cd
T3	0.86 c	0.86 c	0.50 de	0.51 de	7.4 e	7.5 e	1.3 d	1.33 d	0.8 b	0.9 b	17.3 bc	17.2 bc
T4	1.1 b	1.1 b	0.68 cd	0.70 cd	8.7 d	8.8 d	2.8 b	2.9 b	0.9 b	0.8 b	16.8 c	16.7 c
T5	0.73 cd	0.73 cd	0.86 bc	0.89 bc	8.3 d	8.4 d	1.6 c	1.7 c	0.8 b	0.9 b	17.8 b	17.9 b
T6	0.76 c	0.78 c	0.94 b	0.94 b	12.5 b	12.5 b	1.5 c	1.6 c	0.6 c	0.5 c	15.5 d	15.6 d
T7	1.99 a	1.9 a	1.7 a	1.75 a	16.5 a	16.9 a	3.2 a	3.3 a	3.5 a	3.2 a	20.3 a	20.7 a
Mean	**1.95**		**1.73**		**16.7**		**3.25**		**3.35**		**20.5**	
T8	0.34 f	0.35 f	0.14 f	0.24 f	1.1 g	1.4 g	0.17 f	0.29 f	0.3 d	0.1 d	10.1 e	9.7 e
Mean	**0.34**		**0.19**		**1.25**		**0.23**		**0.2**		**9.9**	
LSD.0.05	0.21	0.30	0.17	0.19	0.68	0.73	0.20	0.23	0.22	0.19	1.03	0.98

T1= AM inoculation, T2 = plant compost $R_{100\%}$, T3 = chicken manure $R_{100\%}$, T4 = plant compost $R_{50\%}$ + chicken manure $R_{50\%}$, T5 = plant compost, $R_{50\%}$ + AM inoculation, T6 = chicken manure $R_{50\%}$ + AM inoculation, T7= plant compost $R_{33.3\%}$ + chicken, manure $R_{33.3\%}$ + AM, inoculation and T8 = Chemical, N, P and K fertilizers, $R_{100\%}$ (Control)
(F.S. = First Season, 2023 and S.S. = Second Season, 2024).
Values in the same column with different letters are significantly different ($p \leq 0.05$)

These results highlighted that combining plant compost (33.5%) and chicken manure (33.5%) with mycorrhizal fungi can enhance various beneficial microbial communities in the plant rhizosphere, which can help prevent soil-borne pathogens, as stated by Abou El-Goud et al (2021) and Ejaz and Bahadur (2024). This may also reflect enhanced plant immunity, including increased levels of regulators, hormones, vitamins, and minerals, as well as improved crop production and quality. Additionally, these treatments might improve the availability of exchangeable water, macro- and micro-nutrients, and nutrient chelation in the soil, leading to better nutrient uptake and improved growth parameters, which could result in higher yields (Abou El-Goud 2020, Abou El-Goud et al 2021, Beyk-Khorimizi et al 2023, Tong et al 2023, Radwan and Sultan 2024).

3.3 The quality parameters

The studied quality parameters include certain chemical components of the leaves and fruit, such as nitrogen, phosphorus, and potassium percentages. Therefore, data in **Table 5** shows the influence of different treatments on the nutrient content in cucumber leaves and fruits. Again, T_7 was superior regarding N, P and K uptake in the leaves, as well as N, P and K contents in the fruits, when compared to the control treatment. The corresponding mean values of both seasons in the leaves are 1.95, 1.73, 16.7 (mg/ kg); 3.25, 3.35, 20.5% in the fruits. Additionally, T8 was the lowest in all previously mentioned elements, whether with the leaves or the fruits. The corresponding mean values for both seasons in the leaves are 0.34, 0.19, 1.25 (mg/kg); 0.23, 0.20, 9.9% in the fruits, in the same order. The results can be arranged, generally, by following:

$$T7 > T6 > T5 > T4 > T3 > T2 > T1 > T8$$

These results are in harmony with those obtained by Abou El-Goud (2020), Abou El-Goud et al (2021), Beyk-Khormizi et al (2023), Ejaz and Bahadur (2024) and Radwan and Sultan (2024), who declared that the addition of plant compost with chicken manure in the presence of mycorrhiza can improve soil organic matter, organic carbon and C/N ratio, which leads to an increase in the macro- and micro-nutrients available, their uptakes and positively reflect in cell elongation, its quick binary divisions in plant cells in addition to the stimulation of photosynthesis, metabolic, flowering, and fruiting processes. The more benefits of mycorrhizal external hyphae of root cells can also absorb and translocate more nutrients, which can lead to an increase in soil volume more than that of non-mycorrhizal plants. Benaffari et al (2022) reported that mycorrhizal fungi play an essential role in enhancing the nutritional status of a plant more than an uninoculated plant grown in poor nutrient soil.

Therefore, the application of plant compost and chicken manure may lead to an increase in humic acid, organic matter, carbon, phosphorus, and nitrogen in the soil compared to inorganic N, P, and K fertilizers; hence, increasing soil fertility, yield growth, and quality.

4 Conclusion

Based on the results, it can be concluded that growing cucumbers in sandy, low-fertility soil requires intensive fertilization. To avoid chemical fertilizers, the study recommends a mixture of 33.5% plant compost and 33.5% chicken manure with mycorrhizal fungus. This combination helps produce high-quality cucumber fruits rich in nutrients when grown in poor, sandy soil, without chemicals, thereby preventing their harmful environmental effects.

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