Response of lettuce plant to mycorrhiza inoculation and spraying with an amino acid compound on vegetative traits and yield indicators

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Abstract:

The experiment was carried out in one of the civil fields in the East of the Canal area in Baghdad city, to study the effect of inoculation with mycorrhiza fungus and spraying with the organic compound Terra-Sorb complex on growth indicators and yield of lettuce plant for the autumn agricultural season 2022. The experiment was conducted using a 3 × 3 factorial design with (Randomize Complete Block Design) with 3 replications, the averages were compared according to LSD test with a probability level of 0.05, The first factor with three levels is without inoculation of the fungus, the inoculation is 5 and 10 gm for each plant, coded (M1, M2, M3), and the second factor is spraying with the organic compound of amino acids in three concentrations (0, 2 and 3) ml. L^{-1} has the symbol (T1, T2, T3).

The results showed a significant and clear superiority of the inoculation treatment with mycorrhiza 5 gm. For each plant with spraying at a concentration of 3 ml. L^{-1} with the organic compound Terra-Sorb complex in each of the characteristics of plant height (cm) and number of leaves (leaf). $Plant^{-1}$ leaves content of chlorophyll mg. gm^{-1}, and the marketing yield $Ton.h^{-1}$ was (37.60, 65.07, 15.08, and 71.86), respectively, while the treatment of overlapping inoculation with mycorrhiza 10 gm was superior. For each plant with spraying at a concentration of 3 ml. L^{-1} in the organic compound Terra-Sorb complex for the content of the leaves of nitrogen and ascorbic acid, which amounted to 5.10% and 14.35 mg. 100 gm $^{-1}$ compared to the control treatment, which gave the lowest values.

Keywords: (organic compound Terra-Sorb, pollination, mycorrhiza fungus, lettuce).

Introduction

Lettuce, *Lactuca sativa L*., is an important winter leafy vegetable. The leaves contain fiber, iron, vitamins A and C, in addition to carotenoids (Pérez *et al* ,2013) Eating the lettuce plant continuously contributes to maintaining levels of human health (Natesh *et al*, 2017) and helps in the health of the digestive system. Lettuce is an important source of folate vitamin B9 (USDA, 2015). Studies have shown that folic acid Contributes to the building and synthesis of protein as well as the synthesis of nucleic acids and the formation of the neural tube in humans (Kołton *et al*,2022).

The use of biological and organic alternatives in modern agriculture has contributed to reducing the risk of cancerous diseases, as it has contributed to reducing the concentration of nitrates and thus reducing the accumulation of nitrosamine compounds (Aboohanah *et al*, 2019). The microorganisms, including mycorrhiza, and through the metabolic activities carried out by these organisms, improve the properties of the soil (Ahmad,2022), which works to increase the readiness of nutrients for the plant (Lee *et al* , 2013), in addition to contributing to improving the structure and texture of the soil and contributing to increasing the acidity of the center From the roots and raise the efficiency and readiness of the nutrients in the soil of the field to accelerate absorption by the plant (Mataroiev, 2002) and through its vital activities contribute to raising the plant's ability to resist plant stresses and diseases through the strength of root growth and thus the plant (Oliveira , *et al* 2019)

Amino acids are included in many components within the plant cell, in addition to that some of them contribute as catalysts in the vital activities of the plant. These compounds also contribute to increasing division and elongation in plant cells (Aseel and Al-jubouri, 2023), as well as contributing to reining in senescence compounds, delaying the processes of chlorophyll demolition, and stimulating photosynthetic enzymes. (Al-Asadi and Al-Khikani, 2019), that inoculation with life-fertilizers such as the mycorrhiza fungus has proven to contribute to increasing antioxidants, antibiotics, and plant resistance to diseases (Al-Ibrahimi, 2015).

The research aimed to test the response of lettuce plant to biological and organic factors to increase growth and yield

MATERIALS AND METHODS

The research was conducted in one of the civil fields in the province of Baghdad city to evaluate the effect of inoculation with mycorrhiza fungus and spraying with the organic compound Terra-Sorb complex on growth indicators and yield of lettuce plant for the autumn agricultural season 2022, as the roots of lettuce seedlings were inoculated before planting with levels of the fungus loaded On petmos in the beds of seedlings, seedlings were planted at a distance of 30 cm between one plant and another, and on both sides of the meadow, the distance between one meadow and another was 75 cm. on the shoots, with three concentrations of the organic compound Terrasorb (0, 2, and 3) ml. L^{-1} The details of its components are shown in Table (1). The first treatment after opening the first four vegetative leaves, then 14 days after the first spraying, then 14 days after the second spraying until complete wetness using a 16-liter knapsack sprinkler. Drops of (Al-Zahi) Na5P3O10 were added as a dispersant to reduce the surface tension phenomenon. Drip irrigation method was used, and a 3x3 factorial search was performed using R.C.B.D with three replicates (Al-Rawi, Khalafallah, 2000). The number of deals reached 27 experimental units; The means were compared according to the Least Significant Difference (LSD) test, and a sample of field soil was taken by digging about 15-35 cm for the purpose of analysis in one of the private scientific laboratories. Table 2.

Table (1) organic compound Terrasorb

components	W/V	Source
Free amino acid	%11.5	Vegetarian
Total nitrogen	%٥.٨	---
Organic nitrogen	%١.٨	Amino acids
Mineral nitrogen	%٤	ammonium hydroxide
density		1.15 g/ml
pH		٥.٣

Table (2) properties of field soil

Type of analysis	unit of measure	Measurement
PH	—	6٩.
Ec	$m.ds^{-1}$	3.41
Na^{+}	$mg.l^{-1}$	٣٩٦.٧

SO_3	$meq.l^{-1}$	583
K	$meq.l^{-1}$	٢٢٧
Mg^{++}	$mg.l^{-1}$	٧.٠6
Cl^{-}	$mg.l^{-1}$	٣٦٩
Ca^{++}	$mg.l^{-1}$	2٢١.4٦

The research included the following measures

1- **Plant height** (cm) The height of the plant was measured from the point of contact with the soil to the end of the leaves.

2- **The number of leaves of**. $Plant^{-1}$ The number of leaves. $plant^{-1}$ for five plants and then average was taken.

3- **Leaves content of chlorophyll** ($mg.\ g^{-1}$)

The fifth leaf of the developing apex (Al-Sahhaf,1989) was measured from three plants of each experimental unit randomly, it was well washed from the dust, and according to the method mentioned before. Two waves are 645 and 663 and calculate the chlorophyll content of the leaves according to the equation of total chlorophyll:

4- **Marketing production per unit area, tons. ha^{-1}**

Calculating the yield of a single plant, the yield of an experimental unit, and the yield of a hectare, after excluding damaged and deformed heads:

5- The percentage of nitrogen content in the leaves.

Leaf total nitrogen (N%) content was estimated using the Microkeldal Page *et al*. (1982) and even the color change by applying the formula for calculating the nitrogen content in leaves (Sahhaf, 1989).

6- The phosphor content in the leaves %.

Leaf phosphorus was determined according to the method described in AOAC 1980- **7- Leaves content of vitamin C (ascorbic acid) (mg/100 gm fresh weight)**

Calculated according to the method described by A.O.A.C. (1975).

Results:

1- **Plant height** (cm)

It appears from the results of table (3) that there is no significant difference between the second and third levels of inoculation with fungus 5 and 10 g per plant in plant height, as it gave 30.84 and 30.57 cm, respectively, while the third concentration exceeded 3 ml. L^{-1} for terrasorb gave the highest average plant height of 32.57 cm compared with the comparison treatment.

While the interaction between the level of inoculation with fungus 5 g / $plant^{-1}$ with the concentration of the organic compound Terrasorb 3 ml. L^{-1} the highest height of the plants was 37.60 cm compared to the untreated plants, the height of the plants was 25.10 cm. $Plant^{-1}$.

Table (3) Response to mycorrhiza inoculation and spraying with an amino acid compound in the characteristic of plant height cm.

Mycorrhiza fungus inoculation g / plant	0	Terrasorb ml/l 2	٣	Average
Without adding	21.87	24.90	27.27	24.68
٥gm.plant^{-1}	25.10	29.00	37.60	30.57
١٠gm.plant^{-1}	28.37	31.33	32.83	30.84
L.S.D 0.884	25.11	28.41	32.57	0.884
		1.531		L.S.D

2- **The number of leaves of**. $Plant^{-1}$

Table (4) shows the superiority of the second level of inoculation with fungus, 5 gm per plant, in the number of plant leaves, as it gave 55.23 leaves / plant, while the third concentration exceeded 3 ml. L^{-1} for terrasorb gave the highest average number of leaves per plant, which reached 57.22 leaves, compared with the comparison treatment.

While the interaction between the level of inoculation with fungus 5 g / $plant^{-1}$ with the concentration of the organic compound Terrasorb 3 ml. L^{-1} the highest number of leaves for the plants was 65.07 cm compared to the untreated plants, the height of the plants was 43.67 leaves. $Plant^{-1}$.

Table (4) Response to mycorrhiza inoculation and spraying with an amino acid compound in the characteristic of The number of leaves of a plant

Mycorrhiza fungus inoculation g / plant	Terrasorb ml/l 0	2	٣	Average
Without adding	43.67	46.30	48.50	46.16
٥gm.plant^{-1}	46.30	54.33	65.07	55.23
١٠gm.plant^{-1}	49.87	55.13	58.10	54.37
L.S.D 1.322	46.61	51.92	57.22	1.322 L.S.D
		2.291		

3- **Leaves content of chlorophyll** (mg. g^{-1})

We note from Table (5) that the third level of inoculation with fungus, 10 gm per plant, was superior in the plant leaves content of chlorophyll pigment, as it gave 13.50 mg. g $^{-1}$, while there were no differences between the second and third concentrations 2 and 3 ml. L^{-1} for terrasorb by giving close values.

While the interaction between the level of inoculation with fungus 5 g / plant^{-1} with the concentration of the organic compound Terrasorb 3 ml. L^{-1} had the highest chlorophyll content in leaves of plants, reaching 15.80 mg. GM-1 compared with the untreated plants, the leaves content of dye was 7.83 mg. g^{-1}.

Table (5) Response to mycorrhiza inoculation and spraying with an amino acid compound in the characteristic of the Leaves content of chlorophyll

Mycorrhiza fungus inoculation g / plant	Terrasorb ml/l 0	2	٣	Average
Without adding	7.83	8.33	9.60	8.59
٥gm.plant^{-1}	9.00	11.70	15.80	12.17
١٠gm.plant^{-1}	12.77	13.83	13.90	13.50
L.S.D 1.112	9.87	11.29	13.10	1.112 L.S.D
		1.927		

4- **Marketing production per unit area, tons. ha^{-1}**

It appears from table (6) that the second level of inoculation with fungus, 5 gm per plant, exceeded the quantity of the marketing yield as it gave ٥٢.١٢ T. h $^{-1}$, while the

third concentration gave a significant and clear superiority for the trait, and it was 48.51 T. h $^{-1}$ compared with the comparison treatment

While the interaction between the level of inoculation with fungus 5 g / plant $^{-1}$ with the concentration of the organic compound Terrasorb 3 ml. Liter $^{-1}$ is the highest quantity with a marketing yield of 71.86 T. h $^{-1}$ compared with untreated plants, the marketable yield was 9.38 T. h $^{-1}$.

Table (6) Response to mycorrhiza inoculation and spraying with an amino acid compound in the characteristic of Marketing production per unit area, tons. ha^{-1}

Mycorrhiza fungus inoculation g / plant	Terrasorb ml/l 0	2	٣	Average
Without adding	9.38	14.48	20.30	14.72
٥gm.plant^{-1}	36.44	48.04	71.86	52.12
١٠gm.plant^{-1}	43.12	53.08	53.36	49.85
L.S.D 2.367	29.65	38.53	48.51	2.367
		4.099		L.S.D

5- The percentage of nitrogen content in the leaves.

The results of table (7) showed that there was no significant difference between the second and third levels of inoculation with fungus5 and 10 g per plant in the nitrogen content of the leaves, as it gave 3.69% and 3.84%, respectively, while the third concentration exceeded 3 ml. L^{-1} of terrasorb gave the highest average leaf nitrogen content of 4.13% compared with the comparison treatment.

While the interaction between the level of inoculation with fungus 10 g / plant $^{-1}$ with the concentration of the organic compound Terrasorb 3 ml. L^{-1} the highest height of plants reached 5.10% compared to untreated plants, the height of plants was 1.99%.

Table (7) Response to mycorrhiza inoculation and spraying with an amino acid compound in the characteristic of nitrogen content % in the leaves

Mycorrhiza fungus inoculation g / plant	Terrasorb ml/l 0	2	٣	Average
Without adding	1.99	2.86	3.61	2.82

٥gm.plant^{-1}		3.18	4.21	3.69	3.69
١٠gm.plant^{-1}		2.61	3.80	5.10	3.84
L.S.D	0.581	2.60	3.63	4.13	0.581
			1.007		L.S.D

6- The percentage of phosphor content in the leaves.

It appears from the results of table (8) that there is a clear significant difference between the second and third levels of inoculation with fungus 5 and 10 gm per plant in the leaf content of phosphorus, as it gave 0.60 and 0.47%, respectively, while there was no clear difference between the second and third concentrations 3 and 2 ml. L^{-1} for terrasorb compared with the control treatment that gave the lowest values.

While the interaction between the level of inoculation with fungus 5 g / plant^{-1} with the concentration of the organic compound Terrasorb 2 ml. L^{-1} The highest percentage of phosphorus content in the leaves was 0.72% compared to untreated plants, which amounted to 0.34%.

Table (8) Response to mycorrhiza inoculation and spraying with an amino acid compound in the characteristic of phosphor content % in the leaves

Mycorrhiza fungus inoculation g / plant		Terrasorb ml/l 0	2	٣	Average
Without adding		0.34	0.44	0.46	0.42
٥gm.plant^{-1}		0.52	0.72	0.55	0.60
١٠gm.plant^{-1}		0.40	0.46	0.55	0.47
L.S.D	0.046	0.42	0.54	0.52	0.046
			0.080		L.S.D

7- Leaves content of vitamin C (ascorbic acid) (mg/100 gm fresh weight)

It appears from the results of Table (9) that there is a clear significant difference between the second and third levels of inoculation with mushrooms 5 and 10 gm per plant in the vitamin C content of the leaves, as it gave 13.07 and 61.12 mg.100 $^{-1}$, respectively, while the readings for the second and third concentrations were 3 and 2 ml. L^{-1} for terrasorb was 13.03 and 12.17 mg.100 $^{-1}$ compared with the control treatment that gave the lowest values.

While the interaction between the level of inoculation with fungus 10 g / plant^{-1} with the concentration of the organic compound Terrasorb 3 ml. L^{-1} had the highest vitamin C content in the leaves, amounting to 14.03 mg.100-1 compared to untreated plants, which amounted to 10.56 mg.100^{-1}.

Table (9) Response to mycorrhiza inoculation and spraying with an amino acid compound in the characteristic of vitamin C (ascorbic acid)

Mycorrhiza fungus inoculation g / plant	Terrasorb ml/l 0	2	٣	Average
Without adding	10.56	11.04	11.03	10.88
٥gm.plant^{-1}	12.24	13.29	13.69	13.07
١٠gm.plant^{-1}	11.29	12.18	14.35	12.61
L.S.D 0.526	11.36	12.17	13.03	0.526
		0.912		L.S.D

Discussion: -

Tables (3, 4, 5, and 6) show a clear superiority of the experimental treatments in the vegetative characteristics and the content of leaves of chlorophyll and yield. This can be explaining to the effect of the effectiveness of the microorganisms of fungi in acidifying the center of the periphery of the roots of the riser sphere, which contributes to increasing the chelation of the elements and their readiness for absorption. and the effectiveness of stomata and photosynthesis (belt *et al*., 2017). Also, the use of spraying amino acids in the Terrasorb compound may have contributed to the regulation of vital activities through the processes of protein synthesis, photosynthesis units, and the synthesis of nucleic acids in the cell, in addition to contributing to other vital activities, and this was reflected in the effectiveness in increasing biomass and then increasing growth indicators and yield (Al-Ibrahimi, 2015).

Conclusions:

We conclude from the research that increasing the levels of biofertilization does not necessarily lead to the desired results, as the microorganisms, when appropriate conditions are available, multiply and perform the required purpose, and the addition of organic compounds as a spray on the vegetative system contributes to increasing the vegetative indicators and yield.

References

-A.O.A.C .1980. Official Methods of Analysis. 13th Ed. Association of Official Analytical Chemists. Washington. USA. D.C.

-Aboohanah.M. A, Aqeel. K. H. Al-Tufaili, Hayder. A. M. Turk and Nasser. M. .2019. Effect of Adding Biofertilizer Azotobacter and Foliar Spry with Nitrogen on Growth Parameters of Potato Plant *Solanum Tuberosum* L. CV–BELLINI. Int. J. Agricult. Stat. Sci. Vol. 15, No. 2, pp. 591-594, 2019

-Ahmad, R.A.H.2022. Response of growth, flowers yield and active medicinal compounds Chamomile (*Matricaria chamomilla L*.) Plant to Bio-Organic Fertilization and kinetin. Ph.D. thesis. College of Agricultural Engineering Sciences. University of Baghdad.

-AL-assady. M. H. S.and Ali.H. J. Al-Khikani .2019. Noble hormones and their physiological effects. Al-Qasim Green University. faculty of Agriculture. National Books and Documents House in Baghdad. p.p. 322.

-Al-Ibrahimi, T. A. 2015. The effect of mycorrhizal fungi and the substance Organic wilt disease caused by Fusarium oxysporum in tomato plant. PhD thesis. Department of Life Sciences. College of Education for Pure Sciences ibn Al-Haytham. Baghdad University.

-AL-Rawi, humbled by Mahmoud and Abdel Aziz Khalfallah. 2000. Design and Analysis of Agricultural Experiments, Dar Al-Kutub for Printing and Publishing, University of Mosul, Ministry of Higher Education and Scientific Research, Iraq.

-Al-Sahhaf, Fadel Hussain. 1989. Applied Plant Nutrition. Baghdad University - House of Wisdom for Publishing translation and distribution. Higher Education Press in Mosul, Iraq. p.260.

-**Aseel** M.H. H. Al-Khafaji.D. H. Al-jubouri.2023. Upgrading Growth, Yield, And Folate Levels of Lettuce Via Salicylic Acid and Spirulina, Vermicompost Aqueous Extracts. Iraqi Journal of Agricultural Sciences –2023:54(1).

-**Association** of Official Analytical Chemists .1975. Official Method of Analysis, 12th. Ed. A. O. A. C. Washington.

-**Belt**, K., S. Huang, L. F. Thatcher, H. Casarotto, K. B. Singh, O. Van Aken, and A. H. Millar. 2017. Salicylic Acid Dependent Plant Stress Signaling via Mitochondrial Succinate Dehydrogenase. Plant Physiology. 173, 2029-2040.

-**Kolton**, A., O. Długosz Grochowska, R. Wojciechowska, and M. Czaja, 2022. Biosynthesis regulation of folates and phenols in plants. Scientia Horticulturae, 291: 1-15.

-**Lee** Y, H.; M. K. Kim; J. Y. Heo and Yun, H. D .2013. Organic fertilizer application increases biomass and proportion of fungi in the soil microbial community in a minimum tillage Chinese cabbage field. Canadian Journal of Soil Science, 93(3): 271-278.

-**Mataroiev**, I.A. 2002. Effect of humate on diseases plant resistance. Ch. Agri. J.1, 15-16. Russian.

- **Natesh**, H. N., L. Abbey, and S. K. Asiedu. 2017. An overview of nutritional and anti-nutritional factors in green leafy vegetables. Horticult Int J. ;1(2):58-65.

-**Oliveira**, J. S. F., L. P. Xavier, A. Lins, E. H. A. Andrade, J. G. S. Maia, A.H. de Mello, W. N. Setzer, A. R. Ramos, and J. K. da Silva .2019. Effects of inoculation by arbuscular mycorrhizal fungi on the composition of the essential oil, plant growth, and lipoxygenase activity of Piper aduncum L. AMB Express. 9 (29).

-**Page**, A. L.; R. H. Miller and D. R. Keeney .1982. Methods of soil analysis. Part 2, 2nd Ed. Madison Son, Wisconson, USA: PP. 1159.

-**Pérez-**López U, J. Miranda Apodaca, A. Muñoz-Rueda, and A. Mena-Petite. 2013. Lettuce production and antioxidant capacity are differentially modified by salt stress and light intensity under ambient and elevated CO2. J Plant Physiol 170:1517–1525

- **USDA**. 2015. National Nutrient Database for Standard Reference Release 28. USDA,