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Effect of Fractionation of Potassium Fertilizer and Humic Acid on the Phenotypic and Nutritional Qualities of Eggplant

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Abstract

A field experiment was conducted during the agricultural season 2023-2024 inside the greenhouse at the Second Agricultural Research Station of the College of Agriculture/Al-Muthanna University in the Al-Bandar region. The aim of this study was to evaluate the response of eggplant (variety Barcelona hybrid) to fractionate of potassium fertilizer and humic acid on the phenotypic and nutritional qualities. Potassium was added according to the (N:120 P_2O_5:160 K:120) fertilizer recommendation and the fractionation required was as P1: Without fertilization, P2: Full recommendation for potassium in one does, P3: Full recommendation for potassium in two doses, P4: half recommendation for potassium and in one does, P5: half of the recommendation for fertilizer and in two doses. Humic acid was added by spraying on the plant and soil in three doses and the concentrations were as (0, 5, 10 ml liter^{-1} of water) and symbolized by the symbols (H1, H2, and H3) after three weeks for planting and sprayed on plants in the experimental unit. A factorial experiment was conducted using Random Complete Block Design (RCBD) with three replications and the indicators of study were averaged and compared using the Least Significant Difference (LSD) test at a probability level of 0.05. The results showed that a significant superiority of the full recommendation treatment of potassium in two doses and the treatment of spraying with humic at a concentration of 10 ml liter^{-1} separately in all the studied traits, and the plants of the interaction treatment (H3P3) in the characteristic of plant height, chlorophyll content (SPAD readings), Normalized Difference Vegetation Index (NDVI), and content of elements N, P and K in the plant, where it reached to 102.330 cm, 74.000, 0.901, 5.500%, 0.450%, and 3.780%, respectively.

Key words: Potassium fertilizer, humic acid, vegetative growth, spraying, chlorophyll.

Introduction

The eggplant (*Solanum melongena* L.) is the third most consumed fruit of the nightshade family, as well as has a nutritional value similar to the fruits of tomato. It is an important source of many salts, especially iron, vitamins, especially B vitamins, and minerals such as potassium, calcium, sodium, (Al-Khaqani, 2021). Mahmoud and Abdul Aziz (2014) indicated that eggplant fruits are the richest vegetable crops in terms of iron content (7 mg 100 g^{-1} wet weight), and its seeds are characterized by containing oil and by up to (21%) and the oil is similar in quality to sunflower, peanuts, and finally soybeans. Organic acids (humic and fulvic acids) play an effective role in the availability of nutrients and in plant growth, and that their use, even in a small concentration, will increase the permeability of cell membranes, and thus the processes of absorption of nutrients and water become more effective in the plant. This helps the movement of elements and their movement within the plant, and that the activation of plant enzymes is one of the important properties carried out by humic acid. This can be explained by the presence of the group of carboxyl in it, which acts as a receptor for hydrogen, at the same time, oxygen is an intermediate promoter of redox (Humintech, 2012). In addition, humic acid is an effective source of carbon for microbiology activity as well as an important influence on the growth and development of the root and vegetative system (Buyukkeskin et al., 2011).

Potassium is one of the main and essential elements for plant growth and it found in the plant in the form of dissolved inorganic salts or in the form of salts of organic acids in plant cells, and potassium is unique from the rest of the other nutrients in that it does not enter into the composition of organic matter for plant tissues (Al-Khafaji and Saad, 2014). Al-Jumaili (2012) stated that the addition of organic acids may increase the availability of potassium in the soil due to the lack of potassium fixation as a result of the substitution of hydrogen ion (H^+), which results from the disintegration of organic acids to replace the potassium ion (K^+) on the exchange surfaces.

The research aims to study the effect of fractionation of added potassium within the fertilizer recommendation and spraying with humic acid on the growth and yield of eggplant plants.

Material and methods

In this section you should have multiple paragraphs describing different things. The first paragraph, for instance, describes the experimental site, season, and all relevant work either in the field, glasshouse, greenhouse, etc. treatments and experimental design is shown in this section with all crop and soil management. If you have a graph or table for the experimental site and environments such as soil properties, you should add it below this paragraph in the middle of the page.

Table 1. Summary of chemical and physical characteristics of soil at a depth of 0 to 30 cm.

VARIABLES	VALUES	UNITS
pH	7.8	-
EC	6.4	ds m^{-1}
AVAIL. NITROGEN	30.8	mg kg^{-1} soil
AVAIL. PHOSPHOROUS	17.3	mg kg^{-1} soil
AVAIL. POTASSIUM	178	mg kg^{-1} soil
ORGANIC MATTER	0.2	%
CLAY	46.53	%
SAND	21.30	%
SILT	32.17	%
TEXTURE	Clay Loam	-

pH= Soil Reaction, EC= Electrical Conductivity, ds m^{-1} = desimines per meter, mg kg^{-1} soil = milligram per kilogram.

The greenhouse was divided into 6 rows with a length of 47 m and the distance between rows was 75 cm and each row represents one repeater by 15 experimental units, the distance between an experimental unit and another was 75 cm as a boundary between them. In addition, the distance between one plant and another was 50 cm, and each experimental unit contains 6 cultivated eggplant plants. Barcelona eggplant hybrid (F1) seedlings was used in the experiment, and it produced by the Vito Spanish Company. The drip irrigation system was used, and the rows were covered by black nylon (mulching process) to prevent the growth of the weeds, maintain soil moisture, reduce irrigation water and its spacing periods, and reduce its evaporation and salt accumulation.

Chemical fertilizers were added according to the recommended fertilizer recommendation (K120 :P 2O5 160:N120) kg ha^{-1} (Kazem, 2021), superphosphate was added in full dose after two weeks of seedling, urea fertilizer was added in two doses, the first one month after planting and the second dose was 20 days after the first dose. While potassium fertilizer was added according to the required fractionation P1: without fertilization, P2: Full recommendation for potassium in one dose, P3: Full recommendation for potassium and two doses, P4: half recommendation for potassium and one dose, and P5: half recommendation for fertilizer and two doses. Humic acid was added by spraying in three doses and concentrations (0, 5, 10 ml liter^{-1} of water) and symbolized by the symbols (H1, H2, and H3) and sprayed on plants in the experimental unit, where the first dose was added after a month on the seedling and the second dose was added after two weeks for the first dose, and finally, the third dose was added after two weeks also from the previous dose. A factor experiment was carried out using Random Complete Block Design (RCBD) with three replications and by 15 experimental units and the phenotypic and physiological characteristics of the plant for each treatment were measured and the average were compared at the Least Significant Difference (LSD) test at the level of probability 0.05.

Results and Discussion

Plant Height (cm)

The results of Table (2) showed that there were significant differences between the study variables in the plant height characteristic, the H3 treatment of humic acid (10 ml liter^{-1}) outperformed the highest average plant height (96.000 cm), significantly superior to the rest of the H1 and H2 treatments, which amounted to (78.000 and 86.330 cm) with an increase of (23.070, 11.200%), respectively.

It was also noted that there were significant differences between the fractionation treatment of potassium fertilizer, as it significantly outperformed the P3 treatment (90.780 cm) over the rest of the treatments P1, P2, P4 and P5 (83.000, 88.330, 85.000, 86.780 cm), with an increase of (9.370, 2.770, 6.800, 4.600%), respectively. From the table (2), the significant differences were evident in the form of plant height in the bilateral interactions between the humic acid treatments and the fractionation treatments of potassium fertilizer, the highest height of the plant in the H3P3 treatment was 102.330 cm, while the lowest height of the plant was recorded (75.000 cm) in the H1P1 treatment.

Table (2): Effect of fractionation of potassium fertilizer and humic acid and their interaction on the plant height (cm) characteristic of the eggplant plant of the Barcelona variety.

Potassium / Humic	P1	P2	P3	P4	P5	Mean of Humic
H1	75.000	79.000	81.000	77.000	78.000	78.000
H2	83.000	88.000	89.000	85.000	86.670	86.330
H3	91.000	98.000	102.330	93.000	95.670	96.000
Mean of Potassium	83.000	88.330	90.780	85.000	86.780	
L.S.D$_{(0.05)}$	H=0.817		P=1.055		HP=1.827	

Chlorophyll content (SPAD meter)

The results of Table (3) indicated that there were significant differences between the study variables in the characteristic of chlorophyll content, as the H3 treatment of humic acid (10 ml liter^{-1}) gave the highest rate of chlorophyll content by SPAD meter with 69.600, significantly superior to the rest of the H1 and H2 treatments, which amounted to (54.070 and 62.130) with an increase of (28.720, 12.020%), respectively. It was also noted that there were significant differences between the fractionation treatment of potassium fertilizer, as the P3 treatment (65.000) significantly outperformed the rest of the treatments P1, P2, P4 and P5 (58.780, 63.560, 60.560, 61.780), with an increase of (10.580, 2.260, 7.330, 5.210%), respectively.

From the table (3), the significant differences in chlorophyll quality can be seen in the bilateral interactions between the humic acid and the fractionation treatments of the potassium fertilizer, the chlorophyll content (SPAD) in the H3P3 treatment was 74.000, while the lowest chlorophyll content (51.000) was recorded in the H1P1 treatment.

Table (3): Effect of fractionation of potassium fertilizer and humic acid and their interaction on the chlorophyll content (SPAD) characteristic of the eggplant of the Barcelona variety.

Potassium Humic	P1	P2	P3	P4	P5	Mean of Humic
H1	51.000	55.670	57.000	52.670	54.000	54.070
H2	59.330	64.000	64.000	61.000	62.330	62.130

H3	66.000	71.000	74.000	68.000	69.000	69.600
Mean of Potassium	58.780	63.560	65.000	60.560	61.780	
L.S.D$_{(0.05)}$	H=0.659		P=0.851		HP=1.474	

Normalized Difference Vegetation Index (NDVI)

It can be seen from the results of Table (4) that there were significant differences between the study variables in the NDVI index, which refers to plant biomass, the H3 treatment of humic acid (10 ml liter^{-1}) outperformed the highest rate (0.872), significantly superior to the rest of the H1 and H2 treatments, which amounted to (0.834 and 0.800) with an increase rate of (4.556, 9.000%), respectively. It was also noted that there were significant differences between the fractionation treatment of potassium fertilizer, as the P3 treatment (0.855) significantly outperformed the rest of the P1, P2, P4 and P5 treatments (0.820, 0.843, 0.826, 0.833), with an increase of (4.268, 1.423, 3.510, 2.640%), respectively.

From the table (4), the significant differences in the nature of plant biomass were evident in the bilateral interactions between the humic acid treatments and the fractionation treatments of potassium fertilizer, the highest rate in the H3P3 treatment was (0.901), while the lowest rate was recorded (0.785) in the H1P1 treatment.

Table (4): Effect of fractionation of potassium fertilizer and humic acid and their interaction on the NDVI index of the eggplant plant of the Barcelona .

Potassium Humic	**P1**	**P2**	**P3**	**P4**	**P5**	**Mean of Humic**
H1	0.785	0.808	0.817	0.791	0.798	0.800
H2	0.821	0.842	0.846	0.826	0.836	0.834
H3	0.853	0.880	0.901	0.860	0.866	0.872
Mean of Potassium	0.820	0.843	0.855	0.826	0.833	
L.S.D$_{(0.05)}$	H= 0.006		P= 0.008		HP= 0.013	

Nitrogen content in plants (%)

The results of Table (5) showed that there were significant differences between the study variables in the characteristic of the element nitrogen, the treatment of H3 for humic acid (10 ml liter^{-1}) gave the highest rate of nitrogen (4.296%) significantly superior to the rest of the treatments H1 and H2, which amounted to (3.451 and 3.762%) and an increase of (24.480.14.190%) respectively.

It was also noted that there were significant differences between the fractionation of potassium fertilizer, as the P3 treatment (4.487%) significantly outperformed the rest of the treatments P1, P2, P4 and P5 (3.373, 4.247, 3.475 and 3.600%), with an increase of (33.020, 5.650, 29.120, 24.630%), respectively. From the table (5), the significant differences in the character of the element nitrogen in the bilateral interactions between the humic acid treatments and the fractionation treatments of potassium fertilizer were evident, the highest rate of the element in the P3H3 treatment was (5.500%) while the lowest rate of the element was recorded (3.000%) in the P1H1 treatment.

Table (5): Effect of fractionation of potassium fertilizer and humic acid and their interaction on the characteristic of nitrogen in plants (%).

Potassium Humic	P1	P2	P3	P4	P5	Mean of Humic
H1	3.000	3.890	3.900	3.300	3.165	3.451
H2	3.660	3.845	4.060	3.460	3.785	3.762
H3	3.460	5.005	5.500	3.665	3.850	4.296
Mean of Potassium	3.373	4.247	4.487	3.475	3.600	
L.S.D$_{(0.05)}$	H= 0.074		P= 0.095		HP= 0.165	

Phosphorus content in the plant (%)

The results of Table (6) indicated that there were significant differences between the study variables in the characteristic of the element phosphorus, as the H3 treatment of humic acid (10 ml liter^{-1}) gave the highest rate of phosphorus (0.348%) significantly superior to the rest of the treatments H1 and H2, which amounted to (0.208 and 0.340%) and an increase of (67.300,2.350%) respectively. It was also noted that there were significant differences between the fractionation treatment of potassium fertilizer, as the P3 treatment

(0.367%) significantly outperformed the rest of the treatments P1, P2, P4 and P5 (0.189, 0.320, 0.330 and 0.290%), with an increase of (94,170,14,680, 11,210,26.550%), respectively.

From the table below, the significant differences in the nature of the element nitrogen in the bilateral interactions between the humic acid treatments and the fractionation treatments of potassium fertilizer were evident, the highest rate of the element in the P3H3 treatment was (0.450%) while the lowest rate of the element was recorded (0.102%) in the P1H1 treatment.

Table (6): Effect of fractionation of potassium fertilizer and humic acid and their interaction on the characteristic of phosphorus element in plants (%).

Potassium Humic	**P1**	**P2**	**P3**	**P4**	**P5**	**Mean of Humic**
H1	0.102	0.230	0.280	0.190	0.240	0.208
H2	0.205	0.335	0.370	0.490	0.302	0.340
H3	0.260	0.395	0.450	0.310	0.328	0.348
Mean of Potassium	0.189	0.320	0.367	0.330	0.290	
L.S.D$_{(0.05)}$	H= 0.033		P= 0.043		HP= 0.074	

Potassium content in the plant (%)

The results of Table (7), showed that there were significant differences between the study variables in the characteristic of the element potassium, as the H3 treatment of humic acid (10 ml liter^{-1}) gave the highest rate of potassium (3.022%) significantly superior to the rest of the H1 and H2 treatments, which amounted to (2.336 and 2.727%) and an increase of (29.360.10.810%), respectively.

It was also noted that there are significant differences between the fractionation of potassium fertilizer, as it significantly outperformed the P3 treatment (2.9517%) over the rest of the treatments P1, P2, P4 and P5 (2.498, 2.720, 2.648 and 2.656%), with an increase of (18,140,8,510, 11,450,11,100%) respectively. From the table below, the significant differences in the form of nitrogen in the bilateral interactions between the humic acid treatments and the fractionation treatments of potassium fertilizer were the highest rate of the element in the P3H3 treatment was (3.780%) while the lowest rate of the element was recorded (2.080%) in the P1H1 treatment.

Table (7): Effect of fractionation of potassium fertilizer and humic acid and their interaction on the characteristic of potassium element in plants (%).

Potassium Humic	P1	P2	P3	P4	P5	Mean of Humic
H1	2.080	2.680	2.340	2.320	2.260	2.336
H2	2.535	2.740	2.735	2.735	2.890	2.727
H3	2.880	2.740	3.780	2.890	2.820	3.022
Mean of Potassium	2.498	2.720	2.951	2.648	2.656	
$L.S.D_{(0.05)}$	H= 0.026		P= 0.034		HP= 0.060	

The reason for the effect of adding potassium may be due to the fact that it is one of the important basic elements in the plant, as it plays the role of a catalyst for many physiological processes, including the formation of nucleic acids and photosynthesis. In addition to its role in activating the enzymatic systems of cell division and elongation, which increases the height of the plant (Table 2) for its role in the division of meristem cells, the formation of leaf principles, the increase in chlorophyll pigment content and the measurement of NDVI (Tables 3, 4). Which reflected positively on the absorption of important nutrients (Table 5, 6, 7), especially since potassium has been given in two doses, which facilitated its absorption along the growing season and reduce its loss. This is consistent with Jaafar (2012) in his study of multiple sprinkles of potassium fertilizer on the eggplant plant grown inside greenhouses, where the succession of times of addition has helped to increase vegetative growth and yield. This is also consistent with Mohammed (2013) when using potassium fertilization K_2SO4 at different levels studied on eggplant (inside the greenhouse) found an increase in vegetative growth, number of fruits and yield. This results are also consistent with Hussein and Muhammad (2017) when they studied the response of white eggplant plants to spraying with potassium silicate K_2 SiO_3 (SiO_2 25%, K_2O 10%) and found the significant effect of potassium in increasing plant height, leaf area, chlorophyll pigment and increasing the percentage of phosphorus and potassium, as well as the role of potassium in encouraging the absorption of other nutrients (Sun et al., 2011). The reason may be attributed when increasing the concentration of spraying with humic acid to 10 ml liter^{-1} in increasing vegetative growth and concentrations of essential nutrients important to the plant (Table 2, 3, 4, 5, 6, 7) for its effective role in increasing the absorption of nutrients to the plant and creating nutritional balance of the elements, which led to increased cell division and then the formation of a good vegetative total for the plant. Thus, increase metabolic processes by metabolism, the manufacture of plant hormones, the manufacture of metabolic products in the leaves, and its positive reflection in the processes of increasing growth. This is consistent with Meenu et al. (2007) and agrees with Duhami and Lami (2018).

Conclusion

We conclude from this experiment that the possibility of improving the efficiency of potassium fertilization by fragmenting it and giving it to the plant in two doses within the fertilizer recommendation instead of one dose with spraying with humic acid at a concentration of 10 ml liter^{-1}, which gave the best results in increasing vegetative growth qualities and improving the absorption of nutrients in the plant.

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References

1. **Al-Khaqani,** T. S. A. (2021). Response of the nightshade plant Solanum melongena L. to foliar spraying with nano-amino acids and zinc in growth and production indicators. Master's Thesis, Faculty of Agriculture, University of Kufa, Ministry of Higher Education and Scientific Research, Republic of Iraq.
2. **Mahmoud,** H. A. A. and M. M. Abdel Aziz (2014). A summary of the cultivation and production of some vegetable crops in the protected environment. Faculty of Agriculture. Tikrit University. Ministry of Higher Education and Scientific Research. Iraq.
3. **Humintech,** M. (2012). Its possible to replace Humus with organic manure. http://www.humintec.com/001/industry/inform ation/foog/.hitml#top.
4. **Buyukkeskin,** T. and S. Akince (2011). The effect of humic acid above ground parts of bean seedling under all toxicity. Fresennus Env.bull, 20(3):539-548.
5. **Al-Khafaji,** M. H. K. and T. M. Saad (2014). Effect of organic fertilization on the growth and yield of cucumbers grown in greenhouses. Al-Muthanna Journal of Agricultural Sciences. 2 (2): 51-58.
6. **Al-Jumaili,** M.O. S. (2012). The overlapping effect of spraying with humic acids (humic and Volvic) and the method of potassium fertilization on potato growth and yield. PhD thesis. College of Agriculture - University of Baghdad.
7. **Kazim,** M. T. (2021). Scheduling irrigation and levels of mineral and nano-NPK fertilizers for eggplants under greenhouse conditions. Al-Muthanna University, College of Agriculture.
8. **Jaafar,** H. S. (2012). Effect of several concentrations of multiple workshops of potassium fertilizer (For Max) on the growth and yield of eggplant solanum melongena L. grown inside greenhouses. Kufa Journal of Agricultural Sciences. 4 (1) : 186_195.
9. **Mohammed,** W. S. (2013). Effect of potassium addition and spraying with foliar fertilizer agro leaf on the growth and yield of eggplant Solanum melongena l. Barcelona variety under greenhouse conditions. Al-Furat Journal of Agricultural Sciences 5 (4): 20-27.

10. **Hussein,** W. A.and M. M. Mohamed (2017). The response of eggplant plants to spraying with boron and potassium silicate. Journal of Agricultural Sciences. 48 (1):393-401.
11. **Sun,** H. M.; T. L. Li; and H. Xu (2011). Effects of potassium fertilizer on nutrient absorption and growth of tomatoes in the greenhouse. China Vegetables, no.4:14-16.
12. **Meenu** C.; A.K.Soni and R.G.Jat (2007). Effects of organic and inorganic sources of nutrients on quality of brinjal (Solanummelongena L.) cv.PusaUttam. Haryana Journal of Horticultural Sciences 368. 119-118: (2/1), ref.
13. **Al-Duhami,** A. S. M. and K. A.Al-Lami (2018). The effect of organic fertilizer spelt peat and its extract on the growth and yield of eggplant plant. (Karbala Journal of Agricultural Sciences) Proceedings of the Third Agricultural Scientific Conference: 740-752.