Effect of Different Levels of Organic and Potassium Fertilization on Growth and Yield of Carrots

Omer AL-Farouq Sh. AL-Dulaimy[1] and Maath M. AL-Abdaly[2]
[1,2] Department of Horticulture and Landscape College of Agriculture - University of Anbar, Anbar, Iraq.

Abstract:

With the aim of studying the response of carrot crops to organic and potassium fertilization, the study was carried out as a field experiment at the research station affiliated with the College of Agriculture (longitude 43.3, latitude 33.41). The study was carried out by distributing factorial experiments with (RCBD) with three replicates on 1/9/2024. The first factor included organic poultry fertilizer in four levels (0-, 10-, 15-, and 20-ton ha-1). The second factor is potassium fertilizer, also at four levels (0, 150, and 200 and 250 kg K2O ha-1). The results of the statistical analysis showed that organic fertilization led to an improvement in vegetative growth and yield indicators, as plants fertilized at the level of were significantly superior in the characteristics of the number of leaves, the dry weight of the plant, the experimental unit yield, and the total yield, compared to plants that were not fertilized with organic fertilizer. Botassium fertilization had a moral impact on the characteristics of growth and the result, as the plants fertilized exceeded the level of K3 and gave the highest values to the attributes of the content of the leaves of chlorophyll and its content of potassium and the sum of the experimental unit and the total yield compared to plants not fertilized with potassium, which gave the lowest indicators for the above characteristics. It can be concluded from the results of this study that increasing the levels of organic and potassium fertilizers added (independently or in combination) to carrot plants led to improved growth indicators, which was reflected in improving yield characteristics.

Keywords: Daucus carota L., K_2O, mineral fertilizer, organic fertilizer

تأثير مستويات مختلفة من التسميد العضوي والبوتاسيوم في نمو وحاصل الجزر

عمر الفاروق شاكر الدليمي، معاذ محي محمد العبدلي
جامعة الانبار – كلية الزراعة- قسم البستنة وهندسة الحدائق

المستخلص:

نفذت الدراسة كتجربة حقلية في المحطة البحثية التابعة لكلية الزراعة /محافظة الانبار، بهدف دراسة استجابة محصول الجزر للتسميد العضوي والبوتاسي. تضمنت التجربة عاملين، العامل الأول هو سماد الدواجن العضوي بأربع مستويات ٠ و١٠ و١٥ و٢٠ طن هكتار-١ بالتتابع، اما العامل الثاني فهو السماد البوتاسي بأربع مستويات ٠ و١٥٠ و٢٠٠ و٢٥٠ كغم K2O هكتار-١. نفذت الدراسة كتجربة عامليه ضمن تصميم RCBD بثلاثة مكررات. ادى التسميد العضوي الى تحسين مؤشرات النمو الخضري والحاصل اذ تفوقت النباتات المسمدة بالمستوى C3 معنويا في صفات عدد الاوراق والوزن الجاف للنبات وحاصل الوحدة التجريبية والحاصل الكلي، مقارنة بالنباتات التي لم تسمد بالسماد العضوي. كان للتسميد البوتاسي اثرا معنويا في صفات النمو والحاصل اذ تفوقت النباتات المسمدة بالمستوىK3 في محتوى الأوراق من الكلوروفيل ومحتواها من البوتاسيوم وحاصل الوحدة التجريبية والحاصل الكلي.

الكلمات المفتاحية: Daucus carota L., K_2O, mineral fertilizer, organic fertilizer.

Introduction

Carrots Carrot, whose scientific name is *Daucus carota* L., belongs to the Apiaceae family. Currently, carrots are grown as an annual crop to produce roots and as a biennial crop to produce seeds. In the first season, its plants give vegetative growth and juicy, colorful storage roots, and in the second season the roots give vegetative growth and flowers in the form of inflorescences. Umbrella containing seeds (1). Carrots are a unique source of vitamin A, represented by carotenoids (2), whose percentage in carrots ranges from 3.2 to 170 mg kg^{-1}. It is also rich in natural biologically active compounds, including vitamin C (21 - 775 mg kg^{-1}), which varies Its concentration depends on the varieties and production conditions. Carrots are also a good source of many other vitamins and minerals, such as biotin, potassium, and vitamin K1. The main carotene found in carrots is beta-carotene, which the body converts into vitamin A, which improves eyesight and increases the body's immunity (2 and 3).

Carrots are often grown as a winter crop in the cold season, which requires the use of organic fertilizers such as plant and animal waste, such as poultry waste, cow waste, sheep waste, and other organic waste, due to their effective role in improving the properties of the soil, increasing its ability to retain water, and raising the temperature of the root zone, as well as About its role in maintaining soil fertility and productivity due to the micro- and macronutrients it contains, vitamins, growth hormones, and enzymes (4). Organic fertilizers play an effective role in improving physical cultivation properties such as porosity, permeability, movement of air and

*Corresponding author.
Email: oma22g5006@uoabar.edu.iq
https://10.36531/ijds.2024.149796.1076
Received 2024-05-13; Received in revised form 2024-05-13; Accepted 2024-11-03

water in the soil, penetration and spread of roots, and retention of heat and moisture in the soil, which reflects positively on plant growth, provides a suitable medium for the growth of the roots of most root vegetable crops, facilitates their penetration by soil, gives them a regular shape, and reduces the deformities that occur. occurs in the roots (5).

Potassium is also one of the nutrients necessary for plant growth, and it is also considered the third most important macronutrient, as potassium has many functions in plant cells, including biophysical functions, such as increasing the plant's ability to withstand various environmental stresses, such as infection with pathogens, exposure to insects, tolerance to heat, drought, salinity, osmotic regulation, and movement. Carbohydrates from their formation sites to their storage sites and biochemical functions such as protein metabolism and enzyme activation, as it activates more than 70 enzymes and increases the efficiency of the photosynthesis process as well as other important plant functions (6). The element potassium plays an effective role in regulating the osmotic pressure in the soil and inside the cell, which works to regulate the absorption of water by the cells, increases the concentration of total dissolved solids, and increases the content of root crops of carbohydrates, especially sugars, which reflects positively on improving the quality of the roots produced. It is not necessary the addition of potassium represents an increase in productivity, but rather an improvement in the quality and quantity of marketable carrot roots (7). From the above, this study aimed to study the effect of adding organic and potassium fertilizer and determine the best level of them that achieves the best growth and yield in carrots, and to determine the best combination of organic and potassium fertilizer that gives the best growth and yield in carrots.

Material and Methods:

The study was carried out as a field experiment at the research station of the College of Agriculture / Al-Bu Aitha village / Anbar Governorate (longitude 43.3, latitude 33.41) in 1/9/2024The field soil was prepared for cultivation by plowing it in two perpendicular plows, smoothing it well, and then dividing it into long terraces.2 m wide and 1 m wide. The drip irrigation method was adopted using T-tape type drip tubes, with two tubes for each area. The study included two factors: the first was the levels of organic fertilization by adding decomposed poultry waste at four levels: 10, 15, and 20 tons^{-1} and symbolized respectively as C1, C2, and C3. As for the comparison treatment, it represented not adding organic fertilizer and symbolized by C0 (8). The second factor is the addition of potassium fertilizer (K_2O) during soil preparation at four levels, in addition to the comparison treatment, which is without potassium fertilization and the addition of fertilizer in concentrations of 150, 200, and 250 kg K_2O ha^{-1}, and its symbols are K0, K1, K2, and K3 (9). The study parameters were randomly distributed in a factorial experiment with a completely randomized block design with three replications. The experiment included sixteen treatments resulting from the interaction between the levels of the two study factors. It was repeated with three replications so that we had 48 experimental units. The seeds of the approved hybrid Nantes were used. The seeds were scattered in two lines on both sides of each drip tube, with a distance of 20 cm between one line and another, so that the number of lines became four lines per platform. Planting took place on September 15, 2023, and after field emergence was completed, the plants were thinned so that the distance between one plant and another became approximately 5 cm, at a rate of 160 plants per unit. Experimental. After the plants had completed growing and the roots had reached the appropriate size, in mid-December, a random sample of ten plants from each treatment was taken to establish growth and yield indicators. It included the following:

1. Number of leaves (leaf plant^{-1}) were counted for randomly selected plants in the experimental unit.
2. Chlorophyll concentration in leaves (mg per100 gm fresh weight^{-1}): The Goodwin method (10) was used to estimate total chlorophyll.
3. Dry weight of shoots (g): The shoots of randomly selected plants were taken from each experimental unit and placed in an electric oven at 60-70°C until the weight is stable.
4. Potassium concentration K in leaves: It was determined using a flame photometer (11).
5. Yield of Experimental unit (kg): The experimental unit yield index was recorded for randomly selected plants according to the following equation: Experimental unit yield = weight of carrot × number of selected plants.
6. Total yield (ton ha $^{-1}$): The total quotient in H = the quotient of the experimental unit ×10000/2

Statistical analysis:

After sorting the data, it was analyzed according to the statistical program Genstat, and the arithmetic means were compared using the least significant difference (LSD) test at the 0.05 probability level (12).

Results:

The effect of organic fertilization on the growth and yield of carrots:

It appears from the results of the (Table 1) There are significant differences between the treatments in the number of leaves index. The individual factors when treating the organic fertilizer C recorded a significant effect on this studied trait, as the treatment C3 was significantly superior to the comparison treatment C0 by recording the highest value in the number of leaves amounting to 11.58 leaf plant^{-1} While the comparison treatment recorded the lowest value of 7.65 leaf plant^{-1}. The effect of these different levels of organic fertilizer on the chlorophyll content in the leaves had a significant effect, as the C3 treatment of organic fertilizer was significantly superior in increasing the chlorophyll concentration, which amounted to 3.953 mg, over the comparison treatment C0, which gave 2.808 mg. The results showed the effect of the study factors on the vegetative dry weight index. The C3 treatment of organic fertilizer was superior in increasing the vegetative dry weight, which amounted to 4.619 gm, over the comparison treatment C0, which gave 2.320 gm. As for the concentration of potassium, the results showed that the C3 organic fertilizer treatment at the level of 4.8 kg was superior in increasing the potassium concentration and gave 3.79, while the comparison treatment C0 decreased to the lowest value of 2.64. The results of the table showed that the effect of the individual treatments on the yield of the experimental unit was superior to the treatment. Organic fertilizer C3 recorded a significant effect of 25.01 kg, and the percentage decreased to 15.84 kg in the comparison treatment C0. The results of the statistical analysis showed a significant difference in the index of yield per hectare between the different treatments, as the highest value of the effect of organic fertilizer was recorded at treatment C3 for the 4.8 kg level, which amounted to 125.07-ton ha^{-1}, and it exceeded the comparison treatment C0, which gave a value of 79.25-ton ha^{-1}.

Table1: The effect of organic fertilization on the growth and yield of carrots

Transactions	Number of leaves (leaf plant $^{-1}$)	Chlorophyll content (mg per 100 gm fresh weight^{-1})	Dry weight of shoots (gm)	Percentage of potassium in the leaves (%)	Yield of the experimental (kg)	Total yield (ton ha^{-1})
C0	7.65	2.808	2.320	2.64	15.84	79.25
C1	8.70	2.825	2.653	3.02	21.44	107.22
C2	10.07	2.958	3.720	3.44	24.49	122.46
C3	11.58	3.953	4.619	3.79	25.01	125.07
LSD α 0.05	0.136	0.050	0.046	0.052	0.22	1.123

The effect of potassium fertilization on the growth and yield of carrots:

The results are shown in the (Table 2) There are significant differences between the potassium fertilizer treatments in the number of leaves index. The K3 treatment recorded the highest value for this studied trait, which amounted to 8.23 leaf plant^{-1}, and the lowest value with the comparison treatment amounted to 7.16 leaf plant^{-1}. As for the chlorophyll content in the leaves, the treatment was superior K3 was significantly higher, which gave the highest value of 3.205 mg 100 gm fresh weight, while the lowest value was recorded in the comparison treatment K0 which was 3.070 mg 100 gm fresh weight. While treatment K3 was significantly superior in the average dry weight of the shoot, as it gave the highest rate of 3.687 gm, comport with the K1 recorded 3.120, which recorded 3.322 gm. In contrast, its value decreased in the comparison treatment C0, which gave the lowest value of 3.182 gm. The results of the table showed the percentage of potassium in the leaves, where the K3 treatment of potassium fertilizer was significantly superior in increasing the concentration of the potassium element and gave a value of 3.40, and this was at the level of 120 kg, while the concentration of the element decreased in the comparison treatment K0, which gave a value of 3.11. While the highest value of the experimental unit yield was recorded in treatment K3 at the level of 120 kg, reaching 22.45 kg. Thus, it surpassed the comparison treatment k0, which recorded the lowest value of 20.60 kg. As for the total yield rate per hectare, the highest value was recorded in treatment K3, which amounted to 112.25 tons ha^{-1}, and the lowest value was recorded in the comparison treatment K0, which was 103.00-ton ha^{-1}.

Table 2: The effect of potassium fertilization on the growth and yield of carrots

Transactions	Number of leaves (leaf plant $^{-1}$)	Chlorophyll content (mg per100g fresh weight^{-1})	Dry weight of shoots (gm)	Potassium in the leaves (%)	Yield of the experimental unit (kg)	Total yield (ton ha^{-1})
k0	8.95	3.070	3.182	3.11	20.60	103.00
k1	9.36	3.114	3.120	3.16	21.59	107.97
k2	9.64	3.154	3.322	3.21	22.15	110.78
k3	10.04	3.205	3.687	3.40	22.45	112.25
LSD α 0.05	0.136	0.050	0.046	0.052	0.22	1.123

The effect of the interaction between levels of organic and potassium fertilization on the growth and yield of carrots:

The results shown in the (Table 3) there were significant differences between the interaction coefficients between organic and potassium fertilization in the growth characteristics and yield of carrots, as the C3K3 fertilization treatment (fertilization with 20-ton ha^{-1} of organic fertilizer and 250 kg K_2O ha^{-1}) was superior in giving it the highest number of leaves in the plant, the highest content of chlorophyll in the leaves, and the highest dry weight. For the shoot, the highest percentage of potassium in the leaves, the highest yield per experimental unit, and the highest yield per unit area, which amounted to 12.16 leaf plant $^{-1}$, 4.263 mg per 100 gm fresh weight, 5.220 gm, 3.92%, 25.37 kg, and 126.85-ton ha^{-1}, respectively. Compared to the lowest values for the above-mentioned traits given by the plants of the other treatments, which amounted to: 7.16 plant leaves^{-1} and 2.730 mg 100 g fresh weight, 2.133 gm, 2.54%, 15.70 kg, 78.53-ton ha^{-1}.

Table3: The effect of the interaction between levels of organic and potassium fertilization on the growth and yield of carrots

Organic and potassium fertilization	leaves Number (leaf plant $^{-1}$)	Chlorophyll content (100 gm FW^{-1})	shoots Dry weight (gm)	potassium of the leaves (%)	Yield unit (kg)	Total yield (ton ha^{-1})
C0K0	7.16	2.790	2.243	2.55	15.70	78.53
C0K1	7.43	2.730	2.276	2.54	15.73	78.67
C0K2	7.76	2.830	2.280	2.58	15.86	79.33
C0K3	8.23	2.883	2.480	2.87	16.09	80.45
C1K0	8.30	2.816	2.923	2.83	17.82	89.12
C1K1	8.76	2.886	2.133	2.95	21.32	106.61
C1K2	8.66	2.783	2.630	3.03	23.11	115.57
C1K3	9.06	2.813	2.926	3.27	23.51	117.57
C2K0	9.30	2.930	3.216	3.39	24.08	120.43
C2K1	10.00	2.970	3.690	3.43	24.37	121.87
C2K2	10.30	3.070	3.853	3.40	24.68	123.41
C2K3	10.70	2.863	2.123	3.56	24.82	124.13
C3K0	11.06	3.746	4.346	3.67	24.78	123.92
C3K1	11.27	3.870	4.383	3.17	24.94	124.72
C3K2	11.833	3.933	4.526	3.86	24.96	124.80
C3K3	12.16	4.263	5.220	3.92	25.37	126.85
LSD α 0.05	0.27	0.100	0.092	0.105	0.449	2.246

The reason for the increase in the characteristics of vegetative growth indicators and carrot yield can be attributed (Table1) To the role of organic fertilizer in improving the physical properties of the soil by improving

its granular structure and increasing its ability to retain moisture as well as increasing its porosity, which encourages increased growth and penetration of the root system into the soil, which reflects positively on increasing the characteristics of vegetative growth such as the number of leaves and the dry weight of the shoot (13). On the other hand, organic fertilizer is one of the sources of supplying the soil with organic matter that revitalizes the beneficial soil, which increases the growth of the root system and the speed of its spread in the soil, in addition to the fact that organic fertilizer is one of the sources of supplying the soil and plants with the macro- and micro-nutrient elements necessary to enhance the growth and yield of the plant and improve its quality. The resulting roots increase the availability of many nutrients such as nitrogen, phosphorus, potassium, calcium, magnesium, iron and copper as a result of the mineralization process. Mineralization, of organic matter elements and their conversion from an organic form to an inorganic form by microorganisms, as well as preventing their fixation by forming complexes with them (14). On the other hand, the reason for the superiority of plants fertilized with organic fertilizer can be attributed to the fact that the organic matter added to the soil works to increase enzymatic activity by adding substances that microbial enzymes work on to decompose them, as well as preparing them for raw materials involved in chemical reactions to produce various enzymes such as alpha-amylase and beta-amylase. Amylase (15 and 16). The reason for increased growth may be that the decomposed organic matter contains growth regulators such as cytokinin, auxin, gibberellin, vitamins, and amino acids that encourage and improve plant growth through their effect on cell elongation, and increase the plant's ability to absorb nutrients that work to encourage an increase in yield in quantity and quality (17), similar results were obtained by (18 and 19).

Moreover, the treatments treated with potassium fertilizer were superior in terms of growth characteristics and yield (Table 2) due to the role it plays in various physiological processes within plants, potassium fertilization also contributes to improving the efficiency of water absorption, drought tolerance, and increasing its tolerance to various stresses. Additionally, potassium plays a major role in carbohydrate metabolism and the synthesis of organic compounds, which are very important in increasing growth, and the roots expand (20). The reason for the superiority may be due to the role of potassium fertilization in enhancing carrot productivity and increasing the quality standards of the roots produced. There is a direct relationship between the amounts of potassium added and increasing the biomass of the roots, improving the quality of their storage, and enhancing resistance to biotic and abiotic stresses. In addition, the use of potassium affects In the nutritional content of carrot roots, which leads to higher levels of important nutrients such as carotenoids and vitamin C (3), these results agreed with Wajda (21).

This could be due to the superiority of the interference treatment C3K3 in growth traits and the synergistic role of both organic matter and potassium in improving the growth traits and yield of carrot plants. Similar results were obtained (22).

Conclusions:

In light of the results, we obtained from this study, we can conclude that increasing the levels of organic and potassium fertilization added (independently or interdependently) to carrot plants led to a clear improvement in the characteristics of vegetative growth, which was significantly reflected in an increase in yield. This calls for testing higher levels of these two. Fertilizers, taking into account the critical economic limit of fertilization.

References

1. Hassan, A.A.M. 2015. Basics and technology of vegetables. Vegetable Technology and Physiology Series, Arab Publishing and Distribution House, Cairo, Arab Republic of Egypt, p220.
2. Bjarnadottir, A. (2023). Carrots 101: nutrition facts and health benefits. Authority Nutr.
3. Ahmad, T., Cawood, M., Iqbal, Q., Ariño, A., Batool, A., Tariq, R. M. S., & Akhtar, S. (2019). Phytochemicals in Daucus carota and their health benefits. Foods, 8(9), 424.
4. Que, F., Hou, X.L., Wang, GL, Xu, ZS, Tan, GF, Li, T., ... & Xiong, S. (2019). Advances in research on the carrot, an important root vegetable in the Apiaceae family. Horticulture research, 6.
5. Pal, V. K., & Maurya, L. K. (2019). Effect of Organic Manures and Bio- Fertilizers on Floral and Commercial Yield Characters of Strawberry (Fragaria × ananassa Duch.) cv. Chandler. Int. J. Curr. Microbiol. App. Sci, 8(2), 392-397.
6. Taiz, L., E. Zeiger, I. Max Moller and A. Murphy. 2014. Plant physiology and development. Sixth Edition Sinauer Associates, Inc., Publishers Sunderland Massachusetts. pp: 761.
7. de Andrade Bonetti, J., Zanuzo, M.R., Josefer, E.C., & Correa, R. (2017). Potassium fertilization and yield parameters of carrots. Brazilian Journal of Agriculture, 92(1): 27-36.
8. Kumar, S., Meena, R. S., Jinger, D., Jatav, H. S., & Banjara, T. (2017). Use of pressmud compost for improving crop productivity and soil health. International Journal of Chemical Studies, 5(2), 384-389.
9. Papree, F.E. (2008). Growth and yield of carrots as influenced by potassium and plants per hill. PhD Thesis. Department of Horticulture & Postharvest Technology Sher-e-Bangla Agricultural University, Dhaka. Bangladesh.
10. Oudah, M. A., and Hamad, R. M. (2024, July). Effect of Shading and Foliar Spraying with Nutrient Solution on Vegetative Growth and Yield Traits of Sweet Orange Trees cv. Local. In IOP Conference Series: Earth

and Environmental Science (Vol. 1371, No. 4, p. 042010).
11. Al-Sahhaf, F.H. (1989). Applied plant nutrition. University of Baghdad/Ministry of Higher Education and Scientific Research/House of Wisdom for Publishing, Translation and Distribution/Higher Education Press in Mosul/Iraq. p.258.
12. Al-Mohammadi, S.M. and Al-Mohammadi F.M. (2012). Statistics and experimental design. Dar Osama for Publishing and Distribution - Amman - Jordan.
13. Amartey, J.N.A., J.S-Addo., M.E. Essilfie and H.K. Dapaah. 2022. Growth and yield of carrots affected by integrated nutrient management of organic and inorganic fertilizers. African Journal of Agricultural Research, 8(7), pp. 576-585.
14. Devi, C. and Khwairakpam M. (2020). Bioconversion of Lantana camera By vermicomposting with two different earthworm species in onoculture. Bioresource technology. Journal Pre-Proofs, (296):122308.
15. . Musalat M.M. and Musleh, O.H (2015). Basics in organic agriculture. Anbar University/Department of Horticulture and Landscape Engineering/College of Agriculture/Iraq.
16. Al-Jumaili, H. S., & Mahmood, S. A. (2023). Effect of Adding Poultry Manure and Spray with Foliar Nutrients on the Growth and Yield of Broccoli Brassica oleracea Var. Italica. In IOP Conference Series: Earth and Environmental Sciences, 1252(1). (012101). IOP Publishing
17. Guevara, H.A.P. (2019). Effect of phosphorus fertilization on rhizosphere microbiome of crops (Doctoral dissertation, Colorado State University).
18. Al-Amri, B.K. & Alabdaly, M.M. (2021). Effect of spraying with potassium, organic fertilization and plant densities in growth and yield of onion. In IOP Conference Series: Earth and Environmental Science, 904(1): 012068. IOP Publishin.
19. Almohammedi, O. H. M., & Musleh, S. H. (2024). Response of Potato to Organic Fertilizer and Zinc Spraying on Some Growth Characteristics and Yield. Sciences, 22(1), 383-397.
20. Rodrigues, J., Pereira, D. P., Torres, J. L. R., Carvalho, F. J., & Charlo, H. C. D. (2021). Potassium sources and calcium and magnesium doses in carrot crop fertilization. Horticultura Brasileira, 39(2), 127-132.
21. Al-Mohammadi, R. K., & Al-Abdaly, M. M. (2022). Effect of Potassium and Sulfur Fertilizer on the Growth, Yield and Some Nutrients of Local Garlic (Allium sativum L.). Iraqi Journal of Desert Studies, 12(2), 31-39
22. Zaili, S. A., & Alabdaly, M. M. (2023). Response of growth and yield of local Garlic Allium Sativum to Potassium fertilization and planting date. date. Sciences, 12(1), 54-63.