Indian Journal of Agricultural Sciences **94** (8): 904–907, August 2024/Short Communication
https://doi.org/10.56093/ijas.v94i8.123245

Productivity and economics of carrot (*Daucus carota*) as influenced by interactive effect of potassium and micronutrients

GULAB CHOUDHARY[1]*, O P GARHWAL[2], L N BAIRWA[2], K K MEENA[3] and MANJU NETWAL[4]

Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan 303 329, India

Received: 11 April 2022; Accepted: 07 June 2024

Keywords: Micronutrients, Potassium, Root diameter, Shoot: root ratio

The root vegetable known as the carrot (*Daucus carota* L.) is a biennial plant that is typically grown as an annual crop in tropical climates. According to Peirce (1987), it is thought to be a native of the Mediterranean region. Carrot greens are also edible, but the tap root is the part that people most frequently eat. It is frequently used in preserves, salads and pickled tender roots. It is eaten both raw and cooked in curries with peas. Carrots are used to make the delectable dessert known as "Gajar Halwa". Carotene-rich carrot juice is occasionally used as a culinary colouring. 'Kanji', a beverage that is made with black carrot and is regarded as a tasty appetizer, is made with this vegetable. The main reason why carrots are as highly valued as food is that they are the best source of carotene, which is a precursor to vitamin A (Zeb and Mahmood 2004).

Being a root crop, carrots also need a balanced application of fertilizers, particularly potassium and micronutrients. Potassium is essential for photosynthesis, cell expansion, protein synthesis, sugar transport, nitrogen and carbon metabolism, and all root crops respond well to liberal potassium applications (Inam *et al*. 2011). Additionally, it is essential for higher carrot quality. Muriate of Potash (MOP) is a common source of potassium because it is mobile in plants, which helps to balance cations and anions in the cytoplasm and regulates osmotic pressure within the cell (Hu *et al*. 2016). Carrots are a plant that requires potassium (Kadar 2008). Potassium administration may therefore be advantageous for enhancing carrot output. Zinc is one of the micronutrients that are also necessary in small amounts for plant growth. Zinc improves photosynthesis and raises the chlorophyll content of leaves, both of which boost the assimilation capacity of the entire plant (Tripathi *et al*. 2015). A zinc deficit results in severely dwarfed plants, older leaves that may die, and new leaves that emerge white in colour. Hence, the experiment was planned to study the effect of variable potassium and micronutrients formulations on performance of carrot.

The experiment was conducted during winter (*rabi*) season of 2018–19 at Sri Karan Narendra Agriculture University, Jobner, Jaipur (26 °05' N and 75°20' E), Rajasthan. This region falls under agro-climatic zone-IIIA (Semi-Eastern Plains) of Rajasthan. The experiment was laid out in a factorial randomized block design (F-RBD) with 4 doses of potassium (K_0, Control; K_1, 50 kg; K_2, 100 kg; and K_3, 150 kg) and 4 micronutrient formulations (M_0, Control; M_1, $FeSO_4$ @0.5%; M_2, Borax @0.5%; and M_3, $ZnSO_4$@ 0.5%), replicated thrice. Potassium (MOP-muriate of potash) was applied in soil at sowing time and micronutrient formulations were applied after 45 days of sowing as foliage spray. The row and plant distance was kept 30 cm × 10 cm and all the cultural practices were carried out to better results. The observations like average weight of root (g), diameter of root (cm), shoot: root ratio, core diameter of root (cm), length of edible root (cm) and root yield (q/ha) of carrot were recorded manually. Net returns (₹/ha) and B: C ratio of crop production in all treatment combinations was carried out after harvest of the crop.

Statistical analysis: Data of experiment was statistical analyzed by analysis of variance (ANOVA) method as suggested by Panse and Sukhatme (1985).

The root yield and B:C ratio were calculated as:

$$\text{Root yield (q/ha)} = [\text{Root yield (kg/plot)} \times 10{,}000/\ \text{Net area of plot (m}^2)] \times 100$$

$$\text{B:C ratio} = \text{Net return (₹)/Total cost of cultivation (₹)}$$

Soil application of MOP and micronutrient formulations significantly affected the root yield, yield parameters and

[1]Krishi Vigyan Kendra (Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan), Nohar, Hanumangarh, Rajasthan; [2]Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan; [3]Rajasthan Agriculture Research Institute (Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan), Durgapura, Jobner, Rajasthan; [4]College of Agriculture (Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan), Kishangarh Bas, Alwar, Rajasthan. *Corresponding author email: gulabchoudhary8796@gmail.com

economics of carrot (Table 1). Results indicated that the better values of yield, yield attributes and economics of carrot i.e. average root weight (189.3 g), root diameter (3.7 cm), shoot: root ratio (0.5), edible root length (23.7 cm), root yield (28.3 t/ha), net returns (₹205161/ha) and B:C ratio (2.7) were recorded in treatment soil application of potassium @150 kg/ha as compare to remaining treatments but endured statistically at par to soil application of potassium @100 kg/ha in given yield parameters and economics. Application of potassium @150 kg/ha recorded (34.0 and 22.3%), (23.2 and 10.4%), (18.6 and 8.8%), (23.8 and 8.3%), (31.1 and 19.8%) and (42.3 and 26.4%) more average root weight, root diameter, edible root length, shoot: root ratio, root yield and net returns, respectively over control and treatment K_1 (K_2O 50 kg/ha), respectively. The enhanced values of yield, yield parameters and economics under given treatments might be due to the higher photosynthetic activity that results from the soil application of potassium could be responsible for much of the much movement of photo-assimilates from foliage to the roots (Haque *et al.* 2019). Potassium is transferred from older tissues to the plant's growth sites of the leaves and roots, it occupies a very intermediate position in their tissues. Increases in the root and sugar production occur by the movement of sugar and other carbohydrates from the foliage to the roots. These results are in conformity with Thapa *et al.* (2023) in carrot and Amin *et al*. (2023) in radish.

Similarly, significant response of carrot crop to the micronutrient formulation in terms of average root weight (182.8 g), root diameter (3.7 cm), shoot: root ratio (0.5), edible root length (24.2 cm), root yield (27.8 t/ha), net returns (₹202576/ha) and B:C ratio (2.7) in treatment foliar application of $ZnSO_4$ @0.5% in comparison to other treatments. Foliar application of $ZnSO_4$ @0.5% recorded 23.2, 22.2, 18.2, 27.9, 23.4, 34.4 and 33.2 % more average root weight, root diameter, edible root length, shoot: root ratio, root yield, net returns and B:C ratio, respectively in comparison to control. The better values of growth parameters under $ZnSO_4$ @0.5% might be due to zinc sulphate quickly increase the uptake of nutrients in the organs and tissues of the carrot which resulted in decrease of the nutritional deficiencies. Zinc increased certain enzyme's activity which is required for cell division and K: Ca ratio regulation in plants. The reasons responsible for better performance of yield, yield parameters and economics might be due to decisive role of zinc in improving the productivity of the crop (Alam *et al.* 2021). The increased foliage growth provided better sites for photosynthesis and diversion of photosynthates towards roots. Similar findings were reported by Ahamad *et al.* (2023) in carrot.

Interactive effect of potassium and micronutrients (Fig. 1 and 2, Table 2) was found to have significant influence on overall improvement of yield, yield parameters and economics of carrot. Significantly higher average root weight (209.56 g), root yield (31.4 t/ha), net returns (₹235918/ha) and B:C ratio (3.03) were noted under treatment combination K_3M_3 (Potassium @150 kg/ha with $ZnSO_4$ @0.05%) over rest of treatment combinations except potassium @100 kg/ha along with $ZnSO_4$ @0.05% (K_2M_3). The positive effects of potassium and micronutrients on carrot root yield may also be attributed to the accessibility of adequate amounts of plant nutrients in adequate form all over the growth period, especially at crucial growth duration of the crop, which results in better uptake, plant vigour, and greater yield parameters.

It may be concluded soil that application of MOP @150 kg/ha significantly enhanced the average root weight (189.3 g), root diameter (3.7 cm), shoot: root ratio (0.5), edible root length (23.7 cm), root yield (28.3 t/ha), net returns

Table 1 Effect of potassium and micronutrient formulations on root yield, yield parameters and economics of carrot

Treatment	Average root weight (g)	Root diameter (cm)	Core diameter (cm)	Edible root length (cm)	Shoot: root ratio	Root yield (t/ha)	Net returns (₹/ha)	Benefit: cost ratio
Potassium level								
K_0 (Control)	141.3	3.0	1.0	20.0	0.42	21.6	144130	2.0
K_1 (K_2O 50 kg/ha)	154.8	3.4	1.2	21.8	0.48	23.6	162273	2.2
K_2 (K_2O 100 kg/ha)	183.0	3.6	1.4	23.2	0.52	27.9	203525	2.6
K_3 (K_2O 150 kg/ha)	189.3	3.7	1.5	23.7	0.54	28.3	205161	2.7
SEm±	2.8	0.08	0.03	0.48	0.01	4.1	4263	0.05
CD (P=0.05)	8.0	0.24	0.09	1.39	0.03	11.9	12309	0.16
Micronutrient formulation								
M_0 (Control)	148.3	3.0	1.2	20.4	0.43	22.5	150676	2.0
M_1 (Fe_2SO_4 @0.5%)	171.4	3.6	1.3	22.6	0.47	26.0	185325	2.5
M_2 (Borax @0.5%)	165.9	3.4	1.3	21.5	0.51	25.2	173513	2.3
M_3 ($ZnSO_4$ @0.5%)	182.8	3.7	1.3	24.2	0.55	27.8	202576	2.7
SEm±	2.8	0.08	0.03	0.5	0.01	4.1	4263	0.05
CD (P=0.05)	8.0	0.24	NS	1.4	0.03	11.9	12309	0.16

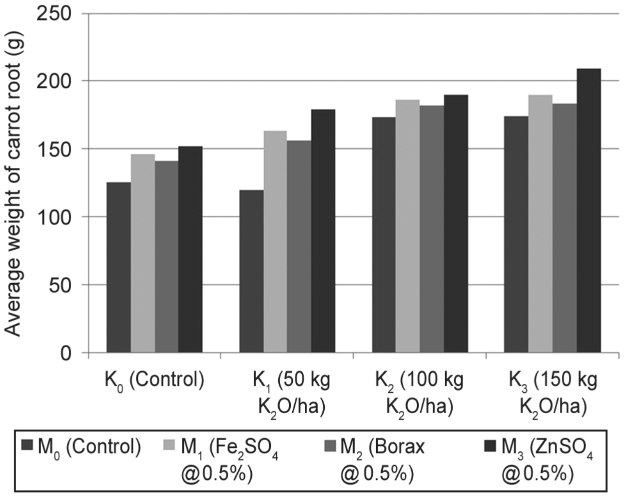

Fig. 1 Interactive effect of potassium and micronutrients on average weight of carrot root.

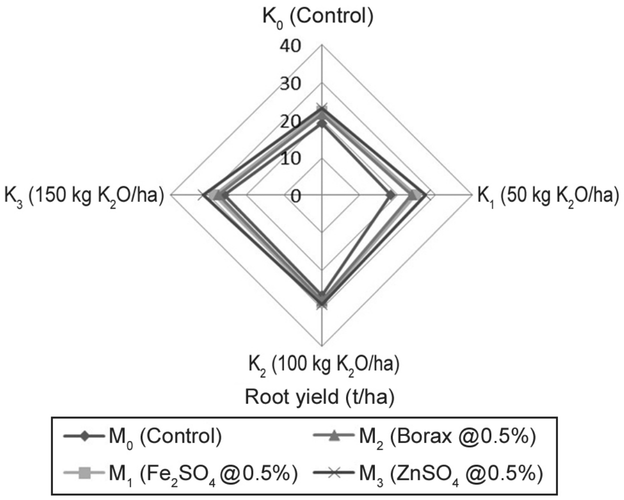

Fig. 2 Interactive effect of potassium and micronutrients on root yield.

Table 2 Interactive effect of potassium and micronutrients on net returns (₹/ha) and Benefit cost ratio of carrot

Treatment	K_0	K_1	K_2	K_3
Net returns (₹/ha)				
M_0 (Control)	120730	109860	189600	182514
M_1 (Fe_2SO_4 @0.5%)	151351	175297	208769	205881
M_2 (Borax @0.5%)	143788	164283	201648	196333
M_3 ($ZnSO_4$ @0.5%)	160650	199653	214082	235918
SEm±				8525
CD (*P*=0.05)				24619
B:C ratio				
M_0 (Control)	1.7	1.5	2.5	2.4
M_1 (Fe_2SO_4 @0.5%)	2.1	2.4	2.7	2.6
M_2 (Borax @0.5%)	2.0	2.2	2.6	2.5
M_3 ($ZnSO_4$ @0.5%)	2.2	2.7	2.8	3.0
SEm±				0.1
CD (*P*=0.05)				0.3

K_0, Control; K_1, 50 kg K_2O/ha; K_2, 100 kg K_2O/ha; K_3, 150 kg K_2O/ha.

(₹205161/ha) and benefit cost ratio (2.7) of carrot. Among the micronutrients formulations $ZnSO_4$ @0.5% recorded the best performance in terms of yield, yield attributes and economics. The combined application of MOP @150 kg/ha with foliar spray of $ZnSO_4$ @0.5%) was reported significantly enhanced root yield, net returns and B:C ratio (313.90 q/ha, ₹235918/ha and 3.03), respectively over remaining treatment combinations but remained statically at par with K_2M_3 (MOP @100 kg/ha with foliage spray of $ZnSO_4$ @0.5%). Thus, soil application of potassium @100 kg/ha and foliage application of $ZnSO_4$ @0.5% (K_2M_3) is suggested for carrot growing areas in semi-arid region of Rajasthan.

SUMMARY

Deficiency and insufficient nutrients application are the major factor responsible to reduced carrot root yield. Nutrients in balanced amount are critical aspect for getting optimal root yield for a particular agro-climatic condition. An appropriate nutrient management including potassium and micronutrients might rise and improve the productivity of carrot. The experiment was conducted at Sri Karan Narendra Agriculture University, Jobner, Jaipur, Rajasthan to study the effect of variable potassium and micronutrients formulations on performance of carrot. Results were found to be significant for the yield attributes, yield and economics of carrot. Soil application of potassium (MOP) @150 kg/ha significantly enhanced the average root weight (189.3 g), root diameter (3.7 cm), shoot: root ratio (0.5), edible root length (23.7 cm), root yield (28.3 t/ha), net returns (₹205161/ha) and B:C ratio (2.7) of carrot. Among the micronutrients formulations, significantly higher average root weight (182.8 g), root diameter (3.7 cm), shoot: root ratio (0.5), edible root length (24.2 cm), root yield (27.8 t/ha), net returns (₹202576/ha) and B:C ratio (2.7) were noticed in foliar application of $ZnSO_4$ @0.5%. Results of interaction shown that soil application of potassium (MOP) @150 kg/ha and $ZnSO_4$ @0.5% significantly better in the average root weight (209.6 g), root yield (31.4 t/ha), net returns (₹2,35,918/ha) and B:C ratio (3.03).

REFERENCES

Ahamad S, Kumar J, Silas V J, Lal M, Kumar Y and Maurya R. 2023. Effect of bio-fertilizer and micronutrient on growth and yield of radish (*Raphanus sativus* L.) var. Pusa Himani. *The Pharma Innovation Journal* **12**(7): 472–74.

Alam M S, Mehedi M N H, Islam M R and Islam M R. 2021. Effects of cow dung, boron and zinc on growth and yield of carrot. *Journal of Agriculture and Veterinary Science* **14**(10): 26–32.

Amin B, Ghani A, Jan I, Mahmood A, Aslam M, Shaikh A R, Shafqat M, Ali B, Amin M, Azam M, Haseeb A, Aslam M Z, Murad T, Shaiban M, Hussain M and Shahzad K. 2023. Response of radish (*Raphanus sativus* L.) to various doses of phosphorous and potassium fertilizers. *Journal of Pharmaceutical Negative Results* **14**(3): 2243–50.

Haque M S, Haque A F M Z, Hossain B, Naher N and Eakram

M S. 2019. Effect of potassium fretilization to increase the yield of carrot (*Daucus carota* L.). *International Journal of Bioinformatics and Biological Science* **7**(1–2): 15–19.

Hu W, Jiang N, Yang J, Meng Y, Wang Y, Chen B and Zhou Z. 2016. Potassium (K) supply affects K accumulation and photosynthetic physiology in two cotton (*Gossypium hirsutum* L.) cultivars with different K sensitivities. *Field Crops Research* **196**: 51–63.

Inam A, Sahay S and Mohammad F. 2011. Studies on potassium content in two root crops under nitrogen fertilization. *International Journal of Environmental Sciences* **2**(2): 1030–38.

Kadar I. 2008. The effect of fertilization on carrot in calcareous sandy soil. *Novenytermeles* **57**(2): 135–47.

Panse V G and Sukhatme P V. 1985. *Statistical Methods for Agricultural Workers*, pp. 167–74. Indian Council of Agricultural Research, New Delhi.

Peirce L C. 1987. *Vegetable Characteristics, Production and Marketing,* pp. 251–52. John Wiley and sons Inc, New York, USA.

Thapa A, Bhandari S, Srivastava A, Shrestha A K and Giri H N. 2023. Effect of different levels of potassium and boron on growth, yield and quality of carrot (*Daucus carota* cv. New Kuroda) in Nawalparasi, Nepal. *International Journal of Innovative Science and Research Technology* **8**(2): 1640-47.

Tripathi D K, Singh S, Singh S, Mishra S, Chauhan D K and Dubey N K. 2015. Micronutrients and their diverse role in agricultural crops: advances and future prospective. *Acta Physiologiae Plantarum* **37**: 139.

Zeb A and Sultan M. 2004. Carotenoids contents from various sources and their potential health applications. *Pakistan Journal of Nutrition* **3**(3): 199–204.