Research Article

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Effect of organic manures and zinc in enhancing the growth, yield and quality of carrot (*Daucus carota* L.)

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ABSTRACT

The application of poultry manure applied at 4 t/ ha significantly improved plant height, number of leaves per plant, leaf area, root weight, root diameter, root length, root yield, as well as nitrogen and zinc content in carrot roots. Similarly, foliar application of $ZnSO_4$ @ 0.75% significantly improved the growth attributes, yield parameters, and quality characteristics such as nitrogen and zinc content in carrot roots. The combined application of poultry manure @ 4 t/ ha with $ZnSO_4$ @ 0.75% proved to be the most effective in improving growth, yield and quality of carrot.

Introduction

Carrot (*Daucus carota* L.) is an important vegetable crop widely consumed due to its high nutritional and medicinal value, as well as its role in disease prevention. It is a member of Apiaceae family. It is considered to be native of Mediterranean region. It consists of above 250 genera and approximately 2800 species of widely distributed, generally herbaceous plants (Rubatzky *et al.*, 1999). From a nutritional perspective, carrot is a highly valuable root crop. It contains appreciable amount of carotene, thiamine and riboflavin. It is an excellent source of of carotene (10 mg/100g), thiamine (0.04 mg/100g), riboflavin (0.05 mg/100g) and also serves as source of carbohydrate, protein, fat, minerals, iron, Vitamin A, Vitamin B, Vitamin C and sugar. Carrot is one of the important and major root vegetable used as salad and cooked vegetable, pickles, preserve, sweets, carrot powder, kanji an appetizing drink (Chadha, 2001).

Although carrots are known as medium feeders, they still require a fertile soil, allowing for normal growth of plants. FYM is a source of food for the innumerable number of microorganisms and creatures like earthworm who breaks down these to micronutrients, which are easily absorbed by the plants. It plays a direct role in plant growth as a source of all necessary macro and micronutrient in available forms during mineralization, improving the physical and physiological properties of soils. Poultry manure is rich in nutrient content than many bulky manures. On an average, it contains 3 per cent N, 2.6 per cent P, 1.4 per cent K (Singh *et al.*, 2020).

Vermicompost is a nutrient-rich, microbiologically-active organic amendment that results from the interactions between earthworms and microorganisms during the breakdown of organic matter. It is stabilized, finely divided peat-like material with a low C:N ratio, high porosity and high water holding capacity.

Zinc affects many functions of the plant such as hormone movement, flowering and fruiting process, pollen

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germination, carbohydrates and nitrogen metabolism and water relations in the plants. Zinc is a trace element that plays an essential role in several organisms, being essential for human and plants growth (Mohanta *et al*., 2013).

Therefore, in the present research an attempt was made to investigate the effect of organic manures and zinc on growth, yield and quality related traits in order to get higher yields and economic returns per unit area.

Material and Methods

The current study was carried out at Experimental Farm of Department of Horticulture, SKN College of Agriculture, Jobner during October to January months of 2020-21. This location is geographically positioned at 26°5' North latitude, 75°20' East longitude and at an altitude of 427 meters above mean sea level. It falls under Agro-Climatic Zone-III A (Semi-Arid Eastern Plain Zone) of Rajasthan. The experiment was set up in a factorial randomized block design with three replications. It consisted of 16 treatment combinations comprising four levels of organic manure (control, FYM @ 12 t/ ha, vermicompost @ 3.5 t/ ha, and poultry manure @ 4 t/ ha) and four levels of zinc (control, $ZnSO_4$ @ 0.25%, $ZnSO_4$ @ 0.50%, and $ZnSO_4$ @ 0.75%). The treatments were applied during October 2020-21. Five randomly chosen and labelled plants per plot were used to collect the data before harvesting while after harvest five roots from each plant were taken for recording growth, yield and quality parameters. In order to evaluate the importance of variance in data derived from different growth, yield and quality characteristics, the Fisher (1950) randomized block design technique was utilized to apply analysis of variance.

Results and Discussion

The results presented in Table 1 demonstrate the effects of organic manures and zinc on the vegetative growth characteristics of carrot. The treatment T_3 (poultry manure @ 4 t/ ha) led to the maximum plant height at 50 DAS (41.16 cm), the highest number of leaves per plant at 50 DAS (8.64) and the largest leaf area per plant (1710.9 cm^2), significantly surpassed T_0 (control), T_1 (FYM @ 12 t/ ha) and T_2 (vermicompost @ 35 t/ ha). These results are in close conformity with the findings of Duncan (2005), Bhattarai and Maharjan (2013) and Pal *et al.* (2021).

It is evident that the treatment Z_3 ($ZnSO_4$ @ 0.75 %), significantly maximum the plant height at 50 DAS (40.32 cm), number of leaves per plant at 50 DAS (8.27) and leaf area per plant (1696.45 cm^2) which was significantly superior over Z_0, Z_1 and Z_2. The data showed that application of $ZnSO_4$ @ 0.75 % significantly increased the plant height, number of leaves per plant and leaf area per plant over control, $ZnSO_4$ @ 0.25% and $ZnSO_4$ @ 0.50%. The results are in align with the findings of Catmak (2000) and Dhaka *et al.* (2022).

Application of different organic manure and zinc significantly affected the average weight of root, diameter of root, length of root and root yield (Table 2 and Fig. 1). The administration of treatment of T_3 (poultry manure @ 4 t/ ha) yielded the highest attainment in average weight of root (186.95 g), length of root (22.19 cm), diameter of root (3.71 cm) and root yield (278.34 q/ha). The application of poultry manure at 4 t/ ha significantly improved root weight, diameter, length, and overall yield compared to the control. Previous studies of Dawuda *et al.* (2011), Mbatha *et al.* (2014) and Pal *et al.* (2021) support these findings. Additionally, the combination of organic matter with NPK improved root diameter (Mehedi *et al*., 2012). Poultry manure promotes better arable growth and food production, aligning with prior research (Yourtchi *et al*., 2013; Kumar *et al*., 2014 and Rahman *et al*., 2018).

The application of Z_3 ($ZnSO_4$ @ 0.75%) yielded the highest attainment in average weight of root (183.17 g), length of root (22.00 cm), diameter of root (3.65 cm) and root yield (277.39 q/ ha). The application of $ZnSO_4$ at 0.75% significantly improved carrot yield and attributes, including root weight, diameter, length, and overall yield. These findings align with previous studies on carrots and other vegetables as reported by Mohanta *et al.* (2013), Deepika *et al.* (2015), Pongener *et al.* (2018) and Alam *et al.* (2021).

It is amply clear from the data (Table 3) that different levels of organic manures and zinc significantly increased the N content and zinc content in roots of carrot. The maximum N content (0.351%) and zinc content (77.92 ppm) was recorded under treatment T_3 (poultry manure @ 4 t/ ha) which was significantly better than rest of the organic manures. These findings align with previous studies conducted by El-Tohamy *et al*., 2011; Kumar *et al.* (2014) and Kashyap *et al.* (2014). The maximum N content (0.339%) and zinc content (78.39 ppm) was recorded under treatment Z_3 ($ZnSO_4$ @ 0.75%) which was significantly better than rest of the zinc application. These results are in agreement with the findings of Ramesh *et al.* (2015), Singh (2016) and Singh *et al.* (2020).

Table 1. Effect of organic manures and zinc on growth attributes of carrot

Treatments	Plant height at 50 DAS (cm)	Number of leaves per plant at 50 DAS	Leaf area (cm^2)
Organic manures			
T_0 (Control)	30.12	5.45	1239.34
T_1 FYM (12 t/ ha)	35.66	6.75	1551.64
T_2 Vermicompost (3.5 t/ ha)	38.65	7.74	1668.67

T_3 Poultry manure (4.0 t/ ha)	41.16	8.64	1710.85
SEm±	0.81	0.20	38.02
CD (P=0.05)	2.33	0.58	109.79
Zinc spray at 30 DAS			
Zn_0 (Control)	30.07	5.44	1263.88
Z_1 ($ZnSO_4$ @ 0.25%)	36.27	6.94	1549.23
Z_2 ($ZnSO_4$ @ 0.50%)	38.93	7.93	1660.94
Z_3 ($ZnSO_4$ @ 0.75%)	40.32	8.27	1696.45
SEm±	0.81	0.20	38.02
CD (P=0.05)	2.33	0.58	109.79

Table 2. Effect of organic manures and zinc on yield attributes of carrot

Treatments	Average weight of root (g)	Length of root (cm)	Diameter of roots (cm)	Yield of roots (q/ ha)
Organic manures				
T_0 (Control)	144.00	19.12	3.03	204.09
T_1 (FYM (12 t/ ha)	163.90	20.38	3.32	244.24
T_2 Vermicompost (3.5 t/ ha)	177.26	21.42	3.53	267.95
T_3 Poultry manure (4.0 t/ ha)	186.95	22.19	3.71	278.34
SEm±	2.99	0.41	0.05	5.08
CD (P=0.05)	8.64	1.19	0.16	14.67
Zinc spray at 30 DAS				
Zn_0 (Control)	146.53	19.01	3.03	207.14
Zn_1 ($ZnSO_4$ @ 0.25%)	164.17	20.45	3.34	244.95
Zn_2 ($ZnSO_4$ @ 0.50%)	178.24	21.64	3.56	265.13
Zn_3 ($ZnSO_4$ @ 0.75%)	183.17	22.00	3.65	277.39
SEm±	2.99	0.41	0.05	5.08
CD (P=0.05)	8.64	1.19	0.16	14.67

Table 3. Effect of organic manures and zinc on N and Zn content in carrot

Treatments	N content (per cent)	Zn content (ppm)
Organic manures		
T_0 (Control)	0.218	59.93
T_1 FYM (12 t/ ha)	0.281	69.61
T_2 Vermicompost (3.5 t/ ha)	0.321	75.89
T_3 Poultry manure (4.0 t/ ha)	0.351	77.92
SEm±	0.004	0.71
CD (P=0.05)	0.013	2.05
Zinc spray at 30 DAS		
Z_0 (Control)	0.218	59.92
Z_1 ($ZnSO_4$ @ 0.25%)	0.283	68.38
Z_2 ($ZnSO_4$ @ 0.50%)	0.330	76.66
Z_3 ($ZnSO_4$ @ 0.75%)	0.339	78.39
SEm±	0.004	0.71
CD (P=0.05)	0.013	2.05

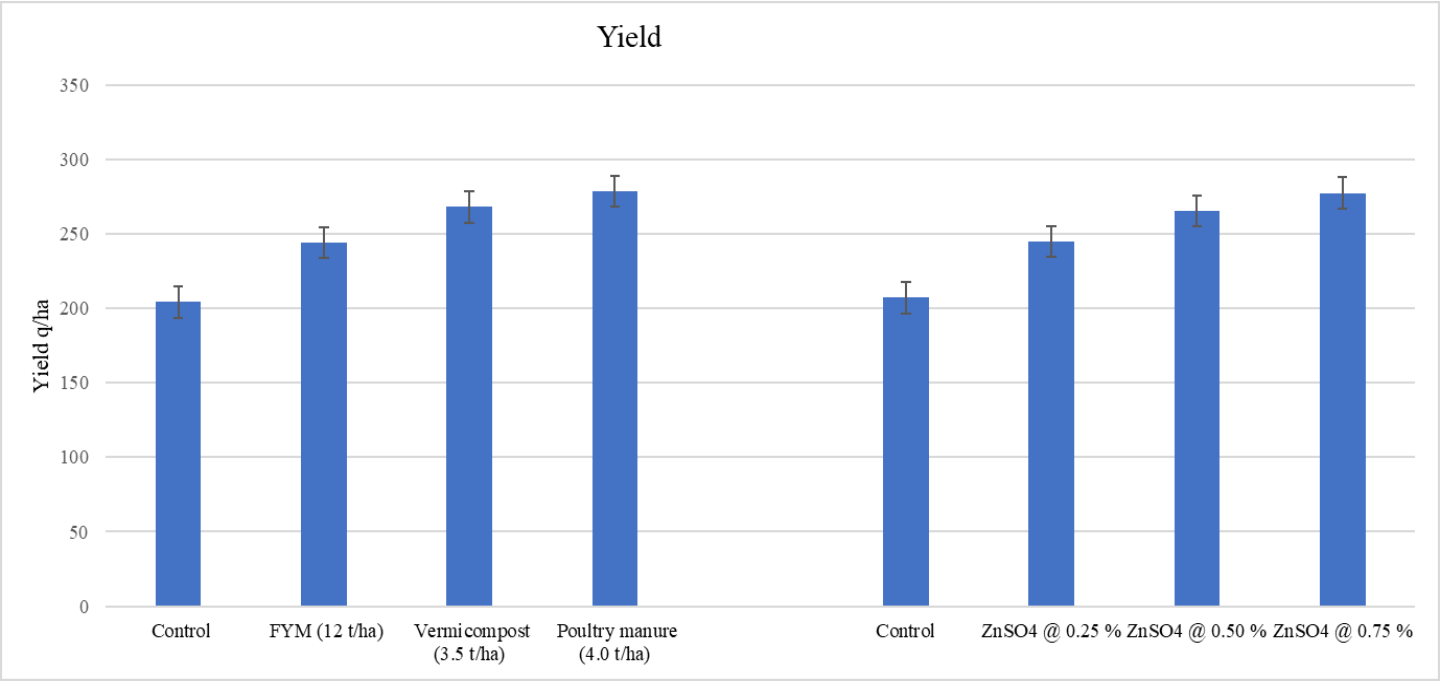

Fig. 1. Effect of organic manures and zinc on yield of carrot

Conclusion

The study concluded that the application of poultry manure @ 4 t/ ha combined with $ZnSO_4$ @ 0.75% significantly enhanced carrot growth, yield and quality. However, suggesting that farmers can adopt either combination based on resource availability and economic feasibility. Further studies are recommended to validate these findings across different soil types and agro-climatic conditions.

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Conflict of Interest

The authors have no conflict of interest.

Data Sharing

All relevant data are within the manuscript.

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