Eco. Env. & Cons. 30 (January Suppl. Issue) : 2024; pp. (S169-S173)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2024.v30i01s.032

Comparative studies on the effect of various biofertilizers on the growth, yield, and quality of carrot (*Daucus carota* L.)

Tanuj Kumar, Rajkumari Asha Devi, Avinash Kumar and Vandana thakur

Department of Horticulture, School of Agriculture, Lovely Professional University, Jalandhar-Delhi G.T. Road, Phagwara, Punjab (India) -144411

(Received 2 July, 2023; Accepted 19 August, 2023)

ABSTRACT

The current experiment was conducted on "Comparative studies on the effect of various biofertilizers growth, yield, and quality of carrot (*Daucus carota* L.)" at experimental field of School of Agriculture, Lovely Professional University, Phagwara, Punjab. The experiment followed a Factorial Randomized Block Design (FRBD) with two factors: Variety and biofertilizers, in which eight treatment combinations were tested, which were *Azospirillum* + 50% RDF, PSB + 50% RDF, VAM + 50% RDF, *Azospirillum* + PSB + 50% RDF, *Azospirillum* + VAM + 50% RDF, PSB + VAM + 50% RDF, *Azospirillum* + VAM + PSB + 50% RDF, and a Control (100% RDF). Two carrot varieties, Pusa Meghali and Pusa Rudhira, were employed in the experiment. The crops were sown with a spacing of 45×15 cm^2 and replicated three times. The results of the experiment indicated that the application of 50% RDF + PSB + *Azospirillum* + VAM exhibited the most favorable outcomes in growth characteristics, including plant height (86.19 cm), number of leaves (17.30), roots fresh weight (57.64 g) and dry weight of root (7.88 g), root yield per plot (0.58 kg), root yield per hectare (1.92 t), carotene content (44.37 mg/100 g), and ascorbic acid (3.46 mg/100 g).

Key words: *Biofertilizers, carrot, VAM, growth, yield.*

Introduction

Carrot (*Daucus carota* L.) is an important root crop belonging to the family Umbelliferae/Apiaceae. It is a biennial, cool season root vegetable, native to South- West Asia and later distributed all around the China and Mediterranean region. In India, Haryana, Andhra Pradesh, Uttar Pradesh, Karnataka, Punjab are the most important carrot-cultivating states. The annual cultivation of carrots in India is 1910 metric tons per hectare (Anonymous 2021). In Punjab, the yearly production of carrots is 224.74 metric tons per hectare (Anonymous 2021).

The nutrient composition in carrot is 86 per cent water, 0.9 g protein, 0.2 g fat, 10.6 g carbohydrates, 1.2 g fiber, 48 kilo calories, 1.1 g minerals, 2.2 mg iron, 1890 mg carotene, 3mg vitamin-c, 80 mg calcium, 30 mg/ 100 g phosphorous and good protein source (Bose *et al.*, 1986).

Its roots are used for making soups, stews, curries, pies, pickles, sweet dishes etc., and are also canned. Roots are wealthy assets of carotenes and incorporate sucrose, glucose, or fructose. Leaves are a very good supply of leaf protein; it is used as fodder and for the training of chicken feeds. It will increase the amount of urine and facilitate the removal of uric acid.

It is generally grown during the cold and warm seasons, with temperatures between 16oC and 20oC. Strong color development when grown at 15oC-20

°C. When the temperature exceeds 30 °C, the roots become light in color and low in carotene. The ideal soil for optimal growth is sandy loam with a pH of 6-7. The recommended seed rate is 4 kg per acre.

Carrot is broadly divided into two groups, Asiatic and European types. Asiatic types contain low carotene content whereas European types are high in carotene content and other quality attributes. European, which are biennial, and Asiatic, which is annual. Asiatic forms generate seed on the plains, but European kinds produce seed in mountainous parts of India.

The steady depletion of the earth's natural resources, as well as the rising usage of harmful chemical fertilizers, are major concerns for agriculture's future. Biofertilizers are gaining popularity as a viable instead of dangerous chemicals in the pursuit of sustainable cultivation Biofertilizers have an important role in enhancing yield of the crop and preserving the ability of soil to provide nutrients, both of which are critical for fulfilling world's demand for food. The interaction with crop plant and microbes improves their resistance and growth. Although they are typically present in insoluble or complex forms, N, potassium, phosphorus, zinc, and silica are essential nutrients for crop growth. They are broken down by specific microbes and made accessible to plants. The current overview discusses possible microorganisms, their mechanism of action, and their impact on crops.

An inoculum containing active or inactive microorganisms named as bacteria, fungi, actinomycetes, and algae that helps bind and mobilize soil nutrients, secrets growth-promoting chemicals, and atmospheric nitrogen. The influence on soil fertility has been studied by scientists and classified into nitrogen-fixing, phosphorus-solubilizing, composting accelerators, and plant growth-promoting rhizobacteria. It may have increased NPK supply and enhanced soil fertility, assisting the plant in improving water absorption, appropriate aeration, and productivity, resulting in an increase in carrot output and its distinguishing qualities (Patola *et al*., 2017). It is the most important component to improve the nutritional status of the soil. Improves nutrient uptake and stimulates plant growth. In addition, increased soil organic matter content because of the use of biofertilizers has helped improve soil health.

Biofertilizers which were commonly used for carrot production are *Azospirillum*, Phosphate Solubilizing bacterium, vesicular-arbuscular mycorrhizae, etc. *Azospirillum* is a spiral-shaped N-fixing bacterium, it is widely unfolded in soils and roots. In association with roots, it will fix 20-50 metric N/ha. It provides several hormones like indole acidic acid, gibberellin cytokinin, and vitamins. The second was Phosphate Solubilizing bacterium that can solubilize phosphate, which implies it's going to convert insoluble phosphatic compounds into soluble forms within the soil, creating them obtainable for plants to soak up. And third was vesicular-arbuscular mycorrhizae (VAM) that naturally infect most plants. Increased soil exploration by mycorrhizal mycelium is associated with increased plant growth and increased accumulation of plant nutrients, especially phosphorus, zinc, copper, and sulphur. An effective combination would have a synergistic impact on nutrient absorption, enhanced economic development, and increased soil area explored by the roots, all of which would boost yield quality.

Material and Methods

The experiment was carried out at research farm of School of Agriculture, Lovely Professional University, Phagwara during the rabi season of 2022. The experiment site is located between 31014'48" N and 750 41'57"E longitude. The experiment was carried out with 8 treatments and two varieties: Pusa Meghali (V1), Pusa Rudhira (V2) was used. The total number of ridges was 48, length of each ridge was 3 meters.

Field preparation

To attain fine tilth, the field had been ploughed with primary tillage viz. tractor, cultivator and rotovator followed by secondary tillage. The experimental plot was made weed free. After proper levelling, experimental layout was marked and prepared. The Recommended dose of fertilizer was used NPK (55:75:50) kg/acre. Biofertilizers viz. Azospirillum, PSB, VAM were applied at the time of sowing.

Soil condition

Most of the soil in the experimental field is composed of sandy loam. To prepare for sowing, soil samples were randomly gathered from the field using a soil auger, reaching a depth of 15 cm. These samples were later combined to form a composite sample, the results are displayed in Table 1.

Table 1. Chemical properties of the soil in the experimental site

Serial No.	Properties of soil		Procedure used
	Chemical properties	Readings	
i.	Soil pH	6.6	Using pH meter (Jackson,1973)
ii.	Electrical conductivity (dSm-1 at 25°C)	0.47	Conductivity meter (Jackson, 1973)
iii.	Organic carbon (%)	0.6	Walkley and Black (1973)
iv.	Available Nitrogen (kg/ha)	137.64	Alkaline permanganate method (Jackson,1973)
v.	Available Phosphorus (kg/ha)	38.91	Olsen's extraction method (1954)
vi.	Available potassium (kg/ha)	179.22	Flame photometer (Metson,1956)

Treatment details

Treatments	Treatment details	Variety 1	Variety 2
T1	Azospirillum+50% RDF	V1T1	V2T1
T2	PSB+50% RDF	V1T2	V2T2
T3	VAM+50%RDF	V1T3	V2T3
T4	Azospirillum+PSB+50%RDF	V1T4	V2T4
T5	Azospirillum+VAM+50%RDF	V1T5	V2T5
T6	PSB+VAM+50%RDF	V1T6	V2T6
T7	Azospirillum+VAM+PSB+50%RDF	V1T7	V2T7
T8	(100% RDF) (Control)	V1T8	V2T8

Results and Discussion

The study investigates that the various biofertilizers combination on carrot cv. Pusa Meghali and Pusa Rudhira showed significant results in growth, yield, and quality attributes As per the data presented in table 2, the various growth, yield, and quality attributes found significantly maximum in parameters named as plant height (86.19 cm), diameter of roots (4.75), fresh root weight (57.64 g), number of leaves (17.30), dry root weight (7.88 g), length of roots (26.00 cm), root yield per plot (0.58 kg), total yield (1.92 t/ha), T.S.S. (6.23 oBrix), Ascorbic acid (3.46 mg/100g), carotene content (44.37 mg/100g), T7 **(**Azospirillum + PSB + VAM + 50% RDF), observed the superior results in among all the parameters, the lowest was found in T8 (100% RDF) (Control) in term of plant height (67.45 cm), number of leaves (14.30), length of roots (20.12 cm), T.S.S. (5.22 oBrix), carotene content (35.37 mg/100g), while in dry weight (3.83 g), root yield per plot (0.34 kg), total yield (1.15 t/ha) was observed lowest in T1 (Azospirillum+ 50% RDF).

This could be because Azospirillum works as a free nitrogen fixer, improving soil nitrogen content by atmospheric nitrogen fixation. This encourages higher plant height. P.S.B transforms insoluble phosphorus into a soluble form that plants may use, and VAM colonizes the plant root system which will increase the growth & yield. The combination of biofertilizers along with conventional fertilisers would help to acquire more nutrients for improved crop development & yield, as well as contribute to significantly sustainable soil properties in years to come (Roshani *et al*., 2019). The highest observation was observed by applying Azospirillum, Phosphate solubilizing Bacteria, VAM and 50% RDF. The addition of PSB, which promotes growth, helps improve phosphorus levels, while other organic fertilizers aid cell elongation and nutrient uptake. Similar reports also have been reported by (Murthy *et al.*, 2019). The observed effect can be due to both direct mechanism, such as plant hormone production and the ability of the microorganisms to solubilize insoluble compounds minerals in the rhizosphere and indirect mechanisms, the process involves the production of enzymes, antibiotics, fungicidal compounds, and the competition with injurious microorganisms. The similar results were also reported by (Abdel *et al.*, 2012). This could be because biofertilizers are assumed to increase the availability of nutrients in the soil by mineralizing nutrients to increase the uptake capacity of carrot plants (Negi *at al*., 2022). With the application of various combinations, quality indicators like carotene content, total soluble solids, and ascorbic acid demonstrated the best correlation (Sharmila *et al*., 2022).

Table 2. Effect of various biofertilizers on growth, yield, and quality of carrot (*Daucus carota* L.)

Treatments	Plant Height (cm)	Number of leaves	Fresh weight (g)	Dry weight (g)	Length of roots (cm)	Diameter of roots (cm)	Root yield/ plot (kg)	Yield/ hec (tons)	T.S.S. (OBrix)	Carotene content (mg/100g)	Ascorbic acid (mg/ 100g)
T1 (Azospirillum+ 50% RDF)	71.94	16.33	34.48	3.83	20.29	3.03	0.34	1.15	6.15	36.53	3.10
T2 (PSB+50%RDF)	73.18	15.73	45.02	5.00	20.23	3.06	0.45	1.50	5.56	37.07	2.22
T3 (VAM+50%RDF)	72.97	13.87	42.32	4.61	20.93	2.88	0.43	1.41	5.77	38.09	3.30
T4 (Azospirillum+PSB+50%RDF)	71.38	14.40	49.93	6.10	20.94	3.49	0.50	1.66	5.78	36.37	3.13
T5 (Azospirillum+VAM+50%RDF)	71.99	14.97	49.66	6.28	24.27	3.16	0.50	1.66	5.79	40.17	3.71
T6 (PSB+VAM+50%RDF)	70.51	14.97	50.86	6.47	22.45	2.96	0.51	1.70	5.42	39.02	2.21
T7 (Azospirillum+PSB+VAM+50%RDF)	86.19	17.30	57.64	7.88	26.00	4.75	0.58	1.92	6.23	44.37	3.46
T8 (100% RDF) (Control)	67.45	14.30	47.33	4.72	20.12	3.04	0.48	1.58	5.22	35.37	2.40
C.D. at 5% (Factor A×B)	0.94	0.82	2.78	0.36	0.92	0.29	0.03	0.09	0.18	0.76	0.16
S.E.(d) (Factor A×B)	0.46	0.40	1.36	0.18	0.45	0.14	0.01	0.05	0.09	0.37	0.08
S.E.(m) ± (Factor A×B)	0.32	0.28	0.96	0.12	0.32	0.10	0.01	0.03	0.06	0.26	0.06

(PSB: Phosphate solubilizing bacteria, VAM: Vesicular arbuscular mycorrhizal, RDF: Recommended dose of fertilizers, T.S.S.: Total soluble solids).

Conclusion

Based on the findings of current study, it was determined that the application of T7 consisting of Azospirillum + PSB + VAM + 50% RDF showed the superior results in various growth attributes like days to emergence, emergence percentage, plant height, number of leaves, length of roots, dry root weight, fresh root yield per plot, total yield, root diameter and in quality attributes like total soluble solids, ascorbic acid, beta carotene. In term of interactions with both varieties V1, V2 the application of T7, Azospirillum + PSB + VAM + 50% RDF reported the superior performance. After evaluating all the parameters and treatments, it was determined that V2T7 showed best performance.

References

Abdel Naby, H. M. E., Dawa, K. K., El-Gamily, E. E., El-Hameed, A. and Samar, M. 2013. Effect of organic, bio and mineral fertilization on yield and quality of carrot plants. *Journal of Plant Production*. 4(2): 335-349.

Anonymous 2021. National horticultural data http://nhb.gov.in/

Bose, T.K. and Som, M.G. 1986. Vegetable crops in India. Naya Prakash, Calcutta

Monika, M. L., Verma, A. and Tejinder Singh, K. S. 2022. Effect of manure and biofertilizers on growth and yield parameters of carrot seed crop in Northern plains of India. *The Pharma Innovation Journal.* 11(2): 06-09.

Murthy, Roshni, P., D. K., Salomi and D. R. 2019. Studies on biofertilizers and inorganics on growth and yield of carrot. *Journal of Pharmacognosy and Phytochemistry.* 8(2): 1559-1562.

Negi, A., Rana, D. K., Shah, K. N., Agnihotri, A., Rai, S. and Singh, V. 2022. Studies On Integrated Nutrient Management On Growth, Yield And Quality Of Carrot (*Daucus Carota* L.) Cv. Pusa Vasuda Under Valley Condition if Garhwal Hills. *Journal of Pharmaceutical Negative Results*. 572-577.

Nisar, F., Mufti, S., Afroza, B., Khan, F. A., Din, S., Andrabi, N. and Nabi, J. 2019. Effect of integrated nutrient management on growth and yield attributes of black carrot (*Daucus carota* subsp. sativus var. atrorubens Alef.). *International Journal of Chemical Studies*. 7(4): 2019-2022.

Nosheen, S., Ajmal, I. and Song, Y. 2021. Microbes as biofertilizers, a potential approach for sustainable crop production. *Sustainability.* 13(4): *1868.*

Roshni, P., Narasimha Murthy, D. K. and Salomi, D. R. 2019. Studies on biofertilizers and inorganics on

growth and yield of carrot. *Journal of Pharmacognosy and Phytochemistry*. 8(2): 1559-1562.

Roshni, P., Murthy, N., Jyothi, K.U. and Suneetha, D.R.S. 2019. Effect of Biofertilizers in Combination with Inorganics on Quality Characters of Carrot. *International Journal of Current Microbiology and Applied Science. 8*(01): 2698- 2704.

Sharmila, A., Kumar, A., Devi, Rajkumari., Kropi, R. and Narayan, L. 2022. Comparative studies on the effect of certain biofertilizers on growth, yield, and quality of carrot (*Daucus carota* L.) under Punjab conditions. *Ecology, Environment and Conservation*. 28(4): 1784-1787.