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Evaluation the effects of biofertilizers on growth and yield of carrot (*Daucus carota* L.)

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Abstract
At the Horticulture Research Farm, (CRC-1) Department of Horticulture, School of Agriculture, ITM University, Gwalior (M.P.), the current study, named Evaluation the Effects of Organic Manures and Bio fertilizers on Growth and Yield of Carrot (*Daucus carota* L.), was carried out. Vegetables are understood to be a crucial ally in the upkeep of good health and in ensuring nutritional security. Important vitamins, minerals, carbohydrates, proteins, and roughages are all provided by them in significant amounts. The carrot's expanded fleshy taproot, which is made up of a phloem- and xylem-rich cortex, is its edible portion. Carrots of high grade have the most cortex and the least core. When applied with chemical fertilizers, biofertilizers increase crop production and optimize nutrient usage. Because chemical fertilizer is more expensive and it is getting harder to satisfy the nutrient needs of farming, the idea of an integrated plant nutrient supply system is gaining popularity. The physio-chemical characteristics of soil (aggregation, stability, pH, EC, bulk density, water holding capacity, organic matter) are improved by the use of vermicompost. The main waste products from the poultry business are by far chicken manure and litter, which are frequently employed as sources of nutrients for crop development. The overall N and P contents of poultry wastes are among the highest of all wastes. Three replications were used in the experiment, which was set up using a randomized block design. In the carrot (*Daucus carota* L.) cultivar Super Red, 10 treatments totalling FYM, Vermicompost, Azotobactor, and PSB with varying RDF doses were utilized in each replication. The findings showed that the growth and yield characteristics of carrots at various growth stages were strongly impacted by the various organic manures and biofertilizers. It was noted that the greatest treatment for boosting carrot growth and yield was determined to be T_9 (Vermi + Azo + Psb 100% greater).

Keywords: Carrot, biofertilizers, organic manures, FYM, vermicompost, *Azotobacter* and PSB

Introduction

The preservation of good health and ensuring nutritional security are both acknowledged as goals of eating vegetables. They are essential for supplying essential vitamins, minerals, carbohydrates, proteins, and roughages. The root vegetable carrot (*Daucus carota* L.) is one of the most widely grown cool-season root crops in the world. It is a biennial plant in the Apiaceae subfamily of the Umbellifer genus, and its edible portion is an expanded fleshy taproot made up of cortex (phloem) and core (xylem). Carrots of high grade have a high cortical content and low core content. Carrots are cultivated all throughout India. Leading producers include Haryana, Andhra Pradesh, Punjab, Bihar, Tamil Nadu, and Assam. In India, it will have a 108 thousand hectare production area and produce 1867 million tons year in 2021-2022, according to an anonymous source. In Madhya Pradesh, it has a surface area of 9.57 thousand hectares and a production volume of 179.79 million tons per year (Anonymous, 2021-22).

When used with chemical fertilizers, biofertilizers increase crop productivity and optimize nutrient usage. Because chemical fertilizer is more expensive and it is getting harder to meet the nutrient needs of farming, the idea of an integrated plant nutrient supply system is gaining popularity. Due to the volatility of soil particles, a constant reliance on synthetic fertilizers may result in a decrease in the amount of organic material in the soil, a rise in soil acidity, a deterioration of the soil's physical qualities, and an increase in the rate of erosion (Olowoake & Adeoye, 2010) [11]. The physio-chemical characteristics of soil (aggregation, stability, pH, EC, bulk density, water holding capacity, organic matter) are improved by the use of vermicompost.

The main waste products from the chicken business are by far poultry manure and litter, which are frequently employed as sources of nutrients for crop production. The overall N and P contents of poultry wastes are among the highest of all wastes (Amanullah *et al*. 2007) [2].

The roots are rich with nutrients that are beneficial to the body, including carotene (provitamin A), sucrose (88.6% moisture), 1.1% protein, 0.2% fat, 9.1% carbs, 1.1% fiber, and 12,000 IU of vitamin A (Banga, 1963) [19]. They are also a good source of traces of vitamin B1, B2, C, and other minerals. By delivering vitamin A, carrot roots are essential in protecting children with vision impairment. There is a serious problem with vitamin A deficiency right now in India. Therefore, it is vital to implement various programs for the development of carotene-rich crops. Along with peas, carrots are widely used in pickles, maintains, and salads. They can also be eaten fresh.

When utilized with synthetic fertilizers, bio Fertilizers increase yields of crops and optimize nutrient usage. Because chemical fertilizer is more expensive and it is getting harder to meet the nutrient needs of farming, the idea of an integrated plant nutrient supply system is gaining popularity. Due to the instability of soil aggregates, a constant reliance on chemical fertilizers may result in a decrease in the amount of organic matter in the soil, a rise in soil acidity, a deterioration of the soil's physical qualities, and an increase in the rate of erosion (Olowoake & Adeoye, 2010) [11]. Maintaining the organic matter in the soil is one technique to keep it fertile or make it more fertile.

Material and Methods

The experimental material comprised of one cultivar including check, which was collected from different source are grown in Gwalior Chambal region which comes under Grid Region of Agro-climatic zone. The experimental field of Crop Research Centre, ITM University, Gwalior is located in the Gird belt (MLS) at an elevation of 211.5 m above sea level and latitudes 26° 13' N and 78° 20' E. It is located in the northern region of MP and has a subtropical climate. Summers are sweltering and arid. The hottest months are May and June, when the mean maximum temperature ranges from 38.40 C to 47 °C, respectively. The coldest months of the year are December and January, with average low temperatures ranging from 10 ° to 12 °C. The average annual rainfall falls around 760 and 1060 mm throughout the course of three months from the middle of June to the end of September. During the winter, three replicates of the carrot cultivar were grown in a randomized block design with a row-to-row distance of 45 cm and a plant-to-plant distance of 10 cm. while seeds are placed about 2.5 cm deep during rabi season of the year 2022-2023. The experiment comprised of ten treatments and replicated thrice, treatments include T0 (Control), T1(RDF 100:80:50 Kg/ha), T2(FYM 15t/ha + Azotobacter 25% more + PSB 25% more) T3(FYM 15t/ha + Azotobacter 50% more + PSB 50% more) T4 (FYM 15t/ha + Azotobacter 75% more + PSB 75% more) T5 (FYM 15t/ha + Azotobacter 100% more + PSB 100% more) T6 (Vermicompost 10t/ha + Azotobacter 25% more + PSB 25% more) T7(Vermicompost 10t/ha + Azotobacter 50% more + PSB 50% more) T8 (Vermicompost 10t/ha + Azotobacter 75% more + PSB 75% more) T9 (Vermicompost 10t/ha + Azotobacter 100% more + PSB 100% more).

Statistical Analysis

The initial and most significant step is to perform an analysis of variance in accordance with Panse and Sukhatme's (1985) [20] advice and assess the importance of demographic differences. A critical difference (C.D.), which was determined using the Panse and Sukhatme (1985) [20] formula, was used to assess the importance of the treatment variation.

Result and Discussion

Result reported that the different organic manure and biofertilizers were significantly influenced the growth parameters of carrot at different growth stages. It was recorded that the maximum vegetative growth parameters (*viz*., plant height, number of leaves and length of leaves at 30, 60 DAS and at harvest were registered in treatment T_9 (Vermi + Azo + Psb 100% more) and of all the treatments, it was the most effective. However, treatment T0 (Control) only showed the minimal vegetative growth characteristics, such as plant height, number of leaves, and length of leaves at 30, 60 DAS, and at harvest. It could be attributed to the action of applied organic manures, which contained all the macronutrients and the majority of the micronutrients required for crop growth, which results in an improvement in soil structure and increased nutrient and moisture availability and uptake, which may have boosted up the plant's growth and thus improved the plant's architecture by enhancing the height of the plant and leaves, as well as due to the ability of biofertilizers to increase in availability of N through biological N fixation and P and produce ammonia, vitamins and plant growth substances like IAA (auxins), gibberellins and cytokinin and greater availability of phosphorus by *Phosphobacteria*, which helped the plants in better nutrient absorptions as resulted in gradual increase in plant height of carrot plant. Findings are in agreement with those of Qureshi *et al.* (2015) [14], Kumar and Pandita (2016) [6], Agbede *et al.* (2017) [1], Kumar *et al.* (2017) [7], Khede *et al.* (2019) [4], Pal *et al.* (2019) [12], Shanu *et al.* (2019) [16] and Rani *et al.* (2022) [15].

The most effective organic manure and biofertilizer treatment was discovered to be treatment T_9 (Vermi + Azo + Psb 100% more), which also provided the highest yield indicators (including the length of the root, root diameter, germination percentage, fresh weight of root, dried weight of root, and yield per plot). However, under treatment T0 (Control), the minimal yield characteristics (namely, root length, root diameter, germination %, fresh weight of root, dry weight of root, and yield per plot) were noted. The availability of sufficient amounts of vital nutrients for plants from organic sources, a balanced C: N ratio, the production of auxin and other growth-promoting compounds, and the conversion of insoluble phosphate to soluble form by Phosphorous Solubilizing Bacteria (PSB) may have all contributed to the increase in carrot yield. When neither organic manure nor biofertilizer was used, a minimum output was observed, which may have been caused by a lack of nutrients needed for crops to go through their productive phase. The use of various organic manures, biofertilizers, FYM, and vermicompost, which provide all the macronutrients and nearly all the micronutrients required for plant growth, appears to have a direct impact on crop yield by either accelerating the respiratory processes by increasing the permeability of cells or by hormone growth action. It provides the plants with readily usable types of nitrogen, phosphorous, and sulphur through biological breakdown. According to Uikey *et al*. (2015) [18], pea crop production (26.54 q/ha), maximum plant height (65.87 cm), number of pods per plant (26.40), and number of seeds per pod (7.01) all increased significantly under 10t FYM /ha + 45:75:60 kg/ha NPK + Rhizobium + PSB culture. Mali *et al*. (2018) [9] investigated the effects of organic manures and bio-fertilizers on radish root crop growth and yield. Plant height (34.5 cm) and root yield per plot (6.70 kg) reached their maximum levels as a result of the application of PSB 4 kg/ha plus vermicompost 5 t/ha. In a field experiment, Khede *et al*. (2019) [4] used the treatment (50% RDF + 25% vermicompost + 25% poultry manure) to record the highest growth in terms of plant height (32.43 cm) and yield of radish roots (498.89 q ha-1).

Table 1: Effect of organic manure and biofertilizers on growth parameters of carrot

Treatment symbols	Treatment details	Plant height (cm)			Number of leaves			Length of leaves (cm)		
		30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest
T_0	Control	7.63	22.53	42.27	3.60	6.63	10.69	5.54	16.37	23.97
T_1	Rdf	10.40	25.90	52.33	4.87	8.15	12.87	7.83	20.91	29.50
T_2	Fym+Azo+Psb 25% more	8.20	22.86	44.80	3.67	7.70	11.33	5.57	17.13	25.77
T_3	Fym+Azo+Psb 50% more	9.47	23.53	49.53	4.00	8.10	11.67	7.09	19.93	28.03
T_4	Fym+Azo+Psb 75% more	10.43	26.43	52.47	4.93	8.45	13.40	8.47	21.63	30.37
T_5	Fym+Azo+Psb 100% more	11.73	26.58	56.53	5.13	8.67	13.47	8.72	21.70	30.67
T_6	Vermi+Azo+Psb 25% more	8.40	23.47	48.80	3.80	7.90	11.40	6.50	17.22	26.50
T_7	Vermi+Azo+Psb 50% more	9.60	25.47	50.93	4.47	8.13	12.77	7.47	20.70	28.60
T_8	Vermi+Azo+Psb 75% more	12.03	28.13	58.20	5.40	9.33	13.87	8.78	21.93	31.17
T_9	Vermi+Azo+Psb 100% more	13.21	29.13	64.87	6.80	10.63	13.97	8.97	22.27	32.97
	SEm ±	0.980	1.314	3.843	0.604	0.654	0.645	0.549	0.943	1.110
	CD 5%	2.911	3.903	11.420	1.794	1.944	1.915	1.631	2.803	3.299
	CV%	16.781	8.957	12.784	22.414	13.538	8.902	12.693	8.178	6.689

Table 2: Effect of organic manure and biofertilizers on yield parameters of carrot

Treatment symbols	Treatment details	Root length (cm)	Root diameter (cm)	Germination percentage (%)	Fresh weight of root (g)	Dry weight of root (g)	Yield per plot (kg)
T_0	Control	18.53	2.59	73.33	60.33	5.80	2.34
T_1	Rdf	20.13	2.88	86.67	83.00	7.47	3.72
T_2	Fym + Azo + Psb 25% more	18.73	2.69	75.00	70.67	6.07	2.75
T_3	Fym + Azo + Psb 50% more	19.07	2.73	86.67	72.00	6.87	3.38
T_4	Fym + Azo + Psb 75% more	20.33	2.89	86.67	84.67	7.87	3.87
T_5	Fym + Azo + Psb 100% more	20.70	2.94	86.67	86.67	8.27	4.11
T_6	Vermi + Azo + Psb 25% more	19.07	2.70	85.00	71.33	6.57	2.92
T_7	Vermi + Azo + Psb 50% more	19.13	2.78	86.67	78.00	6.93	3.57
T_8	Vermi + Azo + Psb 75% more	21.20	3.00	88.33	88.33	8.43	4.12
T_9	Vermi + Azo + Psb 100% more	22.23	3.38	91.67	98.33	8.90	4.18
	SEm ±	0.655	0.138	2.026	5.186	0.565	0.310
	CD 5%	1.947	0.409	6.020	15.408	1.679	0.921
	CV%	5.699	8.339	4.145	11.322	13.376	15.359

Conclusion

The findings showed that the development and yield parameters of carrots at various growth stages were strongly influenced by the various organic manures and bio fertilizers. It was noted that the greatest treatment for boosting carrot development and yield was determined to be T9 (Vermi + Azo + Psb 100% more).

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