



Effect of organic manures, inorganic fertilizers and varieties on growth, yield and quality of tropical carrot

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ABSTRACT

A field trial was conducted during *rabi* season 2014-15 to study the effect of organic manures, inorganic fertilizers and varieties on growth, yield and quality of carrot. Two varieties V_1 (Pusa Rudhira) and V_2 (Pusa Kesar) and nine nutrient levels *i.e.* N_1 (100 % NPK through inorganic fertilizer), N_2 (100 % N through FYM), N_3 (100 % N through vermicompost), N_4 (100 % N through poultry manure), N_5 (100 % N through neem cake), N_6 (50 % NPK + 50 % N through FYM), N_7 (50 % NPK + 50 % N through vermicompost), N_8 (50 % NPK + 50 % N through poultry manure) and N_9 (50 % NPK + 50 % N through neem cake) were evaluated in factorial randomized block design (FRBD) with three replications. Result indicated that variety V_1 (Pusa Rudhira) recorded maximum plant height, number of leaves per plant, length of leaves, fresh weight and dry weight of plant, length, diameter, root girth, fresh and dry weight of root, yield of root and TSS at harvesting stage as compare to Pusa Kesar. Application of N_7 recorded higher values of plant height, number of leaves per plant, length of leaves, fresh and dry weight of plant, length, diameter, root girth, fresh and dry weight of root, yield of root and TSS as compare to other nutrient levels. Economic evaluation of different combinations showed that V_1 (Pusa Rudhira) and nutrient level N_7 were promising with highest net income and B:C ratio(1:3.78).

Key words: *Daucus carota*, vermicompost, neem cake, quantitative traits.

INTRODUCTION

Carrot (*Daucus carota* L.) is a popular cool season root vegetable of umbelliferae family. It is a heavy feeder of nutrients, which removes 100 kg N, 50 kg P_2O_5 and 180 kg K_2O ha⁻¹ and is very sensitive to nutrient and soil moisture (Sunanadarani and Mallareddy, 14).

Since root vegetables are an exhaustive crop therefore, use of organic manures alone may not be able to supply the desired amount of nutrients to the crop. However, it has been observed that use of organic manures with inorganic fertilizers play vital role and hold great promise in pushing up the production of root vegetables. Although inorganic fertilization is very important for the healthy plant growth and development, the organic source of nutrients have the advantage of consistent and slow release of nutrients, maintaining ideal C:N ratio, improvement in water holding capacity and microbial biomass of soil profile, without any adverse residual effects (Yadav *et al.*, 17). Furthermore, there have been positive responses of organic manures for quality attributes in different vegetables. Therefore, a balanced and integrated supply of various nutrient supplements is of great relevance for the quality and sustainable carrot production. Moreover, integrated use of inorganic and organic fertilizers reduces erosion, improves water

infiltration, soil aeration and plant root growth, and also minimizes the risk of downstream flooding (Kumar *et al.*, 9). Keeping the above facts in view, an experiment was carried out to study the effect of different organic manure, inorganic fertilizer and varieties on growth, yield and quality of carrot.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season, 2014-15 at Research Field, College of Horticulture, Mandsaur, Madhya Pradesh. The soil of the experimental field was light alluvial soil having sandy loam texture, having 8.22 pH, 0.27 dSm⁻¹ EC, 327.5 kg ha⁻¹ available N, 20.1 kg ha⁻¹ available phosphorus and 728.0 kg ha⁻¹ available potassium. The experiment was laid out in factorial randomized block design with three replications. The treatments were two varieties (V_1 - Pusa Rudhira and V_2 - Pusa Kesar) and nine nutrient levels namely N_1 - Recommended dose of fertilizer (80:50:50 Kg NPK/ha), N_2 -100 % N through FYM, N_3 - 100 % N through vermicompost, N_4 - 100 % N through poultry manure, N_5 - 100 % N through neem cake, N_6 - 50 % NPK + 50 % N through FYM, N_7 - 50 % NPK + 50 % N through vermicompost, N_8 - 50 % NPK + 50 % N through Poultry manure and N_9 - 50 % NPK + 50 % N through neem cake. Fertilizers were applied through urea (46% N), diamonium phosphate (46% P, 18% N) and muriate of potash (60% K) according to the treatment. Recommended

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dose was based on previous research work done at Mandsaur. Full quantity of phosphorus, potash and 1/3 of nitrogen was applied as basal dose at the time of sowing while the remaining nitrogen was applied at 30 and 45 days after sowing. Organic manures viz., FYM, vermicompost, poultry manure and neem cake were incorporated as per treatment to respective plots prior to sowing on the basis of nitrogen percentage. The nitrogen content in FYM, vermicompost, poultry manure and neem cake was 0.45 %, 1.60 %, 1.00 % and 5.80 %, respectively. The standard cultural practices recommended for the crop were followed for all the experimental plots. Five plants were selected randomly from each plot to observe growth parameters such as plant height (cm), number of leaves per plant, length of leaves (cm), fresh weight and dry weight of plant (g) at 30, 45, 60 DAS and at harvesting stage. Similarly, yield parameters namely root length (cm), root diameter (cm), root girth (cm), fresh and dry weight of root (g plant⁻¹) and total root yield (q ha⁻¹) and root quality parameter TSS (°Brix) was also recorded from five plants at the time of harvest, net income (Rs/ha) and B:C ratio.

RESULTS AND DISCUSSION

The findings on growth parameters indicated significant influence of variety and nutrient level.

There was increase in growth parameters with advancement of growth. Variety V₁ (Pusa Rudhira) recorded maximum plant height at all the stages while minimum from V₂ (Pusa Kesar) (Table 1) which could be due to differences in their genetic makeup. These findings are in line with Rawat *et al.* (13) in radish. Among the nutrient levels, N₇ (12.72, 21.43, 36.96 and 93.70 cm) recorded the maximum value of plant height during the different stages followed by N₆, while the minimum value of plant height was observed with N₅ (8.88, 16.78, 28.58 and 80.38 cm) at all the stages of crop growth. The increase in height of plant by the use of vermicompost with integration of NPK may, be due to beneficial influence of nitrification inhibition properties of vermicompost in the soil. Besides, it may also be due to rapid elongation and multiplication of cell in the presence of adequate quantity of nitrogen (Barman *et al.*, 2). Similar results were reported by Bhattarai and Maharjan (4) in carrot and Mahokar *et al.* (10) in radish.

Among the varieties, maximum number of leaves per plant was recorded with V₁ (Pusa Rudhira) as compared to variety V₂ (Pusa Kesar) at all the growth stages (Table 1). The difference in number of leaves in varieties was probably due to rate of leaf initiation which would be an inherent character of a variety. These results are in agreement with

Table 1. Effect of organic manure, inorganic fertilizers and varieties on growth of carrot.

Treatment	Plant height (cm)				Number of leaves per plant				Leaf length (cm)			
	30 DAS	45 DAS	60 DAS	At harvesting	30 DAS	45 DAS	60 DAS	At harvesting	30 DAS	45 DAS	60 DAS	At harvesting
Varieties												
V ₁ (Pusa Rudhira)	10.79	18.90	34.24	88.73	4.50	6.71	10.16	12.62	4.71	12.62	23.26	64.60
V ₂ (Pusa Kesar)	10.11	17.70	31.22	84.51	4.18	6.14	9.41	11.96	4.16	11.76	21.76	61.39
S.Em ±	0.22	0.33	0.71	1.41	0.08	0.17	0.23	0.20	0.11	0.22	0.35	1.06
CD at 5 %	0.65	0.95	2.04	4.07	0.24	0.50	0.66	0.58	0.32	0.63	1.00	3.07
Nutrient levels												
N ₁	10.46	18.03	32.16	86.33	4.30	6.40	9.83	12.58	4.35	12.16	22.30	62.70
N ₂	9.63	17.35	30.48	83.98	3.90	5.86	8.56	11.18	3.88	11.38	21.78	59.78
N ₃	10.26	17.86	31.28	85.30	4.20	6.26	9.60	11.48	4.10	11.98	21.96	61.61
N ₄	9.26	16.90	29.78	81.21	3.70	5.70	7.66	10.45	3.60	10.96	21.56	57.95
N ₅	8.88	16.78	28.58	80.38	3.36	5.36	7.23	9.45	3.35	10.88	20.55	57.45
N ₆	11.18	19.06	35.18	91.70	4.86	6.93	11.20	13.85	5.13	12.95	23.21	65.86
N ₇	12.72	21.43	39.96	93.70	5.43	8.05	12.70	15.35	5.98	14.46	25.40	74.45
N ₈	10.95	18.88	34.11	89.48	4.70	6.73	10.90	13.31	4.95	12.63	23.06	63.86
N ₉	10.66	18.38	33.03	87.46	4.56	6.53	10.36	12.91	4.60	12.28	22.76	63.30
S.Em ±	0.48	0.70	1.50	3.00	0.17	0.37	0.48	0.42	0.24	0.46	0.74	2.26
CD at 5%	1.38	2.03	4.33	8.63	0.51	1.07	1.40	1.23	0.69	1.34	2.13	6.52

those of Jogdande *et al.* (5) and Bharathi *et al.* (3) in onion. Nutrient level had exerted significant effect on number of leaves during all the stages. The highest number of leaves per plant were observed with N₇ (5.43, 8.05, 12.70 and 15.35) followed by N₆ (4.86, 6.93, 11.20 and 13.85) and N₈ (4.70, 6.73, 10.90 and 13.31), while the minimum value of plant height was observed with N₅ (3.36, 5.36, 7.23 and 9.45) at all the stages of crop growth. The highest number of leaves in N₇ was due to slow release of nutrients through vermicompost thus enriching available nutrient pool of the soil that resulting in more number of leaves per plant (Bhattarai and Maharjan, 4). Similar findings have been reported by Barman *et al.* (2) in potato and Suthar (15) in garlic.

Length of leaves increased with advancement of growth stage up to harvesting stage. Variety V₁ had significantly higher length of leaves at 30, 45, 60 DAS and at harvesting stage than V₂ (Table 1). Anjanappa *et al.* (1) in radish also reported significant effect of varieties on length of leaves. Among nutrient level maximum length of leaves per plant was recorded with the nutrient level N₇ (5.98, 14.46, 25.40 and 74.45 cm) which was followed by N₆ (5.13, 12.95, 23.21 and 65.86 cm), while the minimum length of leaves per plant was observed under nutrient level N₅ (3.35, 10.88, 20.55 and 57.45 cm). The highest length of leaves in N₇ due to vermicompost which

provide the micronutrients such as zinc, copper, iron and manganese in the adequate amount to the plant (Bhattarai and Maharjan, 4). Similar findings have been reported by Kumar *et al.* (8) in radish.

The results revealed that the varieties had significant difference on fresh weight of plant at all the stages of plant growth (Table 2). Variety V₁ (Pusa Rudhira) recorded maximum fresh weight of plant as compared to Variety V₂ (Pusa Kesar). Higher plant height and number of leaves might have resulted in more photosynthesis and accumulation of food material in V₁ resulting in higher fresh weight of plant. Nutrient level indicated significant effect on fresh weight of plant at all stages. Maximum fresh weight of plant was observed with N₇ (2.33, 12.53, 72.01 and 254.13 g) followed by N₆ (2.03, 10.86, 64.31 and 230.71 g) and N₈ (1.93, 10.41, 63.15, 224.28 g). The minimum fresh weight of plant was observed with N₅ (1.21, 8.28, 51.76 and 172.11 g) at all the stages of crop growth. Similar findings have been reported by Suthar (15) in garlic.

Dry weight of plant was significantly higher in variety V₁ (Pusa Rudhira) than in variety V₂ (Table 2). More number of leaves and greater leaf length enhance the photosynthesis, accumulation of photosynthates consequently in higher dry weight of plant in variety V₁. Among the nutrient levels, the maximum dry weight of plant was recorded with

Table 2. Effect of organic manure, inorganic fertilizers and varieties on fresh and dry weight of plant in carrot.

Treatment	Fresh weight of plant (g)				Dry weight of plant (g)			
	30 DAS	45 DAS	60 DAS	At harvesting	30 DAS	45 DAS	60 DAS	At harvesting
Varieties								
V ₁ (Pusa Rudhira)	1.85	10.40	61.68	230.43	0.31	1.36	6.89	31.57
V ₂ (Pusa Kesar)	1.57	9.25	58.14	186.32	0.25	1.13	5.78	29.37
S.Em ±	0.04	0.24	1.17	3.65	0.004	0.02	0.16	0.54
CD at 5 %	0.13	0.70	3.38	10.49	0.014	0.07	0.47	1.56
Nutrient levels								
N ₁	1.71	9.56	60.53	207.56	0.27	1.22	6.22	30.03
N ₂	1.45	8.98	55.88	192.16	0.23	1.11	5.78	29.04
N ₃	1.60	9.26	57.16	198.86	0.25	1.15	6.02	29.34
N ₄	1.30	8.38	53.55	181.06	0.22	1.05	5.56	28.51
N ₅	1.21	8.28	51.76	172.11	0.19	0.92	5.41	28.00
N ₆	2.03	10.86	64.31	230.71	0.34	1.44	6.84	31.69
N ₇	2.33	12.53	72.01	254.13	0.38	1.61	7.97	35.70
N ₈	1.93	10.41	63.15	224.28	0.32	1.35	6.70	31.21
N ₉	1.80	10.13	60.81	214.46	0.29	1.29	6.51	30.67
S.Em ±	0.09	0.51	2.49	7.74	0.01	0.05	0.35	1.15
CD at 5%	0.28	1.48	7.16	22.25	0.03	0.15	1.01	3.32

nutrient level N₇ (0.38, 1.61, 7.97 and 35.70 g) which was followed by N₆, N₈ and N₉. Minimum dry weight of plant was recorded in case of nutrient level N₅ (0.19, 0.92, 5.41 and 28.00 g). Similar findings have been reported by Suthar (15) in garlic.

The data indicated significant effect of varieties on length of root. Variety V₁ (Pusa Rudhira) recorded maximum length of root (cm) at harvest stage which was followed by variety V₂ (Pusa Rudhira) with significant difference (Table 3). Similar findings have been reported by Kalia (6). Maximum length of root recorded under the nutrient level N₇ (28.36 cm) and it was followed by N₆ (24.98 cm). Nutrient level N₅ (21.40 cm) recorded minimum length of root. The beneficial effect of combined application of organic manure (vermicompost or compost) and fertilizer might be attributed to the increased efficacy of inorganic fertilizers and supply of all the essential nutrients in a balanced amount owing to their control release coinciding with the stage of root growth (Kumar *et al.*, 8). Similar findings have been reported by Sunandarani and Malareddy (14).

Data recorded in the present study indicated that variety V₁ (Pusa Rudhira) recorded a maximum diameter of root and root girth of carrot which was followed by the variety V₂ (Pusa Kesar) (Table 3).

Similar findings have been reported by Anjanappa *et al.* (1) in radish. Nutrient level recorded significant effect on diameter of root and root girth of carrot. Maximum diameter of root and root girth of carrot was found under the nutrient level N₇ (4.65 cm) followed by N₆ (4.09 cm) and N₈ (3.94 cm) while the minimum diameter of root and root girth of carrot was observed with N₅ (100% N through cake). These findings are in agreement with those reported by Kumar *et al.* (9) in radish and Kumar *et al.* (10) in carrot.

The results revealed that different varieties had significant difference in fresh weight and dry weight of root at harvesting stage (Table 3). Variety V₁ (Pusa Rudhira) recorded highest fresh weight and dry weight of root followed by the variety V₂ (Pusa Kesar). Higher root length, root girth and diameter of root might have resulted in higher fresh weight and dry weight of root. Nutrient level indicated significant effect on fresh weight and dry weight of root. Maximum fresh weight and dry weight of root was observed with nutrient level N₇ (127.03 and 12.55 g) followed by N₆ (108.92 and 10.62 g) and N₈ (105 and 10.26 g) while the minimum fresh weight and dry weight of root was observed with N₅ (87.07 and 8.93 g). This was attributed due to

Table 3. Effect of organic manure, inorganic fertilizers and varieties on yield, quality and economics of carrot.

Treatment	Root length (cm)	Root diameter (cm)	Root girth (cm)	Fresh weight of root (g)	Dry weight of root (g)	Root yield (q/ha)	TSS (°Brix)	Cost of Cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B:C ratio
Varieties											
V ₁ (Pusa Rudhira)	24.87	4.09	11.85	115.13	11.25	268.63	7.81	37015.89	132146.7	95130.81	2.57
V ₂ (Pusa Kesar)	23.29	3.12	11.17	87.94	8.77	254.35	7.03	37126.68	125116.9	87990.22	2.37
S.Em ±	0.48	0.08	0.18	2.38	0.22	4.96	0.12	-	2481.80	2481.80	0.06
CD at 5 %	1.39	0.23	0.53	6.84	0.63	14.26	0.36	-	7132.78	7132.78	0.18
Nutrient levels											
N ₁	23.93	3.60	11.36	100.69	9.70	265.01	7.29	29191.77	132530.60	103338.83	3.54
N ₂	22.98	3.22	11.10	94.02	9.27	239.16	7.07	45050.17	119833.50	74783.33	1.66
N ₃	23.39	3.38	11.24	96.77	9.53	250.52	7.15	38214.54	125343.70	87129.16	2.28
N ₄	22.71	3.11	10.84	90.34	9.19	226.15	6.99	42096.07	113238.40	71142.33	1.69
N ₅	21.40	2.88	10.64	87.07	8.93	206.46	6.85	52367.04	103686.70	51319.66	0.98
N ₆	24.98	4.09	11.94	108.92	10.62	290.35	7.77	37052.33	145245.00	108192.67	2.92
N ₇	28.36	4.65	13.17	127.03	12.55	321.73	8.55	33657.80	160884.30	127226.50	3.78
N ₈	24.71	3.94	11.74	105.80	10.26	282.60	7.67	35606.83	141359.00	105752.17	2.97
N ₉	24.23	3.79	11.55	103.29	9.97	271.40	7.39	40666.70	135826.70	95160.00	2.34
S.Em ±	1.03	0.17	0.39	5.05	0.46	10.52	0.26	-	5264.70	5264.70	0.14
CD at 5%	2.96	0.50	1.12	14.51	1.35	30.26	0.76	-	15130.91	15130.91	0.40

solubilizing effect of plant nutrients by the addition of vermicompost leading to increased uptake of NPK. Organic manure plays a direct role in plant growth as a source of all necessary macro and micro-nutrients in available forms during mineralization, improving physical and physiological properties of soil. Similar findings have been reported by Kumar *et al.* (8).

Higher growth and yield attributes enhanced the total root yield resulting in maximum yield of root with variety V₁ (Pusa Rudhira) which was followed by V₂ (Pusa Kesar) with significant difference (Table 3). Similar results were reported by Kalia (6). Yield of root of carrot significantly affected by nutrient level. The maximum yield of root recorded under the nutrient level N₇ (321.73 q/ha) followed by N₆ (290.35 q/ha) and N₈ (282.60 q/ha) while the minimum yield of root was observed with N₅ (100 % N through neem cake). Similar findings have been reported by Rao *et al.* (12) in onion, Barman *et al.* (2) in potato, Narayan *et al.* (11) in potato and Kumar *et al.* (9) in carrot.

Observations on T.S.S. content in roots revealed that variety V₁ (Pusa Rudhira) had higher T.S.S. than variety V₂ (Pusa Kesar) with significant difference (Table 3). Koley *et al.* (7) also reported significant difference in total soluble solid content among different varieties. Among the nutrient level N₇ (8.55 °Brix) recorded the maximum T.S.S. followed by N₆ (7.77 °Brix), while the minimum T.S.S. was determined in case of N₅ (6.85 °Brix). Similar findings are in line with Kumar *et al.* (9).

There was significant effect of varieties and nutrient levels on gross income, net income and B:C ratio. Among the varieties highest gross income, net income and B:C ratio was found with V₁ (Pusa Rudhira) which was significantly superior over V₂ (Pusa Kesar). Similar results have been reported by Rawat *et al.* (13) in radish. Nutrient levels indicated significant effect on gross income, net income and B:C ratio. Highest gross income, net income and B:C ratio was found with N₇ (127226.5 Rs/ha and 3.78) which was significantly superior over all other nutrient levels (Table 3). The results are in agreement with Vithwal and Kanaujia (16) in carrot, Sunandarani and Mallareddy (14) in carrot and Narayan *et al.* (11) in potato, they reported highest B:C ratio with application of organic manures.

The study concludes that variety Pusa Rudhira recorded significantly higher growth, yield and quality parameter in comparison to variety Pusa Kesar. The application of 50 % recommended dose of fertilizer + 50 % N through vermicompost registered the highest growth and yield as well as maximum net return and B:C ratio in carrot.

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- Received : October, 2017; Revised : May, 2019;
Accepted : May, 2019