

Root Yield and Nutrient Uptake of Carrot (*Daucus carota* L.) as Influenced by the Application of Different Organic Manures

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ABSTRACT

A work has been taken up to study the effect of different organic manures on different root parameters, root yield and nutrient uptake of carrot. All the root parameters were recorded at 30, 60 Days after Sowing (DAS) and at the time of Harvest. All the parameters were improved significantly with the organic manures. At all the three stages, the highest root length of 8.81, 17.17 and 19.74 cm respectively was recorded with the application of neem cake (75%) + groundnut cake (25%). The highest root fresh and dry weights of 76.93 and 7.13 g plant⁻¹ respectively were recorded with the application of groundnut cake (50%) + neem cake (50%) at harvest. The highest total root yield (25.65 t ha⁻¹) and the uptake of N (224.0 kg ha⁻¹), P (66.0 kg ha⁻¹) and K (253.67 kg ha⁻¹) were maximum with groundnut cake (50%) + neem cake (50%).

Key words: Carrot, Neem cake, Vermicompost, Groundnut cake, root yield and Nutrient uptake

INTRODUCTION

Judicious and proper use of manures and fertilizers is essential not only for obtaining higher yield and quality produce but also to maintain soil health and sustainability. Vegetables that are produced by using organic manures are gaining importance because of less chemical residues and better taste. Considering the adverse effects on soil health and environment, besides the residual effect, luxurious usage of inorganic fertilizers is not advisable. In India, very little work has been reported regarding the effect of different organics on vegetable crops and in carrot

particular. Hence the present investigation was taken up to study the effect of different organic manures on root yield (includes all the root parameters) and nutrient uptake of carrot.

MATERIAL AND METHODS

The present investigation was conducted to study the Effect of organic manures on different root parameters, root yield and nutrient uptake of carrot (*Daucus carota* L.) at college farm, College of Horticulture, Dr. Y.S.R. Horticultural University, Rajendranagar, Hyderabad.

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The carrot variety Kuroda used as experimental material and the experiment was laid out in randomized block design with three replicated 16 treatments *viz.*, T₁: Groundnut cake (100%), T₂: Neem cake (100%), T₃: Vermicompost (100%), T₄: Groundnut cake (75%) + Neem cake (25%), T₅: Groundnut cake (75%) + Vermicompost (25%), T₆: Groundnut cake (50%) + Neem cake (50%), T₇: Groundnut cake (50%) + Vermicompost (50%), T₈: Groundnut cake (50%) + Neem cake (25%) + Vermicompost (25%), T₉: Neem cake (75%) + Groundnut cake (25%), T₁₀: Neem cake (75%) + Vermicompost (25%), T₁₁: Neem cake (50%) + Vermicompost (50%), T₁₂: Neem cake (50%) + Groundnut cake (25%) + Vermicompost (25%), T₁₃: Vermicompost (75%) + Groundnut cake (25%), T₁₄: Vermicompost (75%) + Neem cake (25%), T₁₅: Vermicompost (50%) + Neem cake (25%) + Groundnut cake (25%), and T₁₆: Recommended Dose of Fertilizers (RDF). The data were recorded on root parameters like root length (cm), root diameter (cm), fresh and dry weight of root (g plant⁻¹), root to shoot ratio, total root yield (t ha⁻¹) and uptake of N, P and K (kg ha⁻¹).

RESULTS AND DISCUSSION

Root length (cm):

The root length was significantly affected by the application of vermicompost, neem cake and groundnut cake at different stages of plant growth. At 30, 60 DAS and at harvest the highest root length of 8.81, 17.17 and 19.74 cm respectively was recorded in T₉ with neem cake (75%) + groundnut cake (25%) followed by T₆ (8.40, 16.13 and 17.92 cm) with groundnut cake (50%) + neem cake (50%). RDF recorded a root length of 8.03, 15.07 and 16.04 cm at 30, 60 DAS and at harvest respectively (Table 1). The lowest was recorded in T₁₄ (6.88, 12.69 and 14.09 cm at 30, 60 DAS and at harvest respectively) with vermicompost (75%) + neem cake (25%).

Among the different organic manures T₉ with neem cake (75%) + groundnut cake (25%) improved root length at all the stages of plant growth. This may be due to the higher content of P (1.02%) in neem cake. Phosphorus stimulates root growth, greater absorption and translocation of nutrients. It is also a part of various enzymes, co-enzymes and energy rich ATP resulting in increased root growth⁶. In addition to this, application of organics helps the soil micro-organisms to produce polysaccharides and thus leads to better soil structure useful for root growth.

Root diameter (cm):

At 30 DAS the highest root diameter (1.33 cm) was recorded in T₈ with groundnut cake (50%) + neem cake (25%) + vermicompost (25%) followed by T₆ (1.32 cm) with groundnut cake (50%) + neem cake (50%). Groundnut cake (50%) + neem cake (50%) (T₆) recorded the highest root diameter of 2.67 cm at 60 DAS. The highest root diameter (3.77 cm) was recorded in T₅ with groundnut cake (75%) + vermicompost (25%) followed by T₆ (3.68 cm) with groundnut cake (50%) + neem cake (50%) at harvest which were at par but significantly superior to all other treatments (Table 2). RDF recorded a root diameter of 1.14, 2.32 and 3.59 cm at 30, 60 DAS and at harvest respectively. The higher root diameter recorded may be attributed to enhanced cell division and quick cell multiplication.

Fresh weight of root (g plant⁻¹):

The highest fresh weight of root (11.34 g plant⁻¹) was recorded in T₆ with groundnut cake (50%) + neem cake (50%) at 30. At 60 DAS the highest fresh weight of root (40.12 g plant⁻¹) was recorded in T₁ with groundnut cake (100%). At harvest the highest fresh weight of root (76.93 g plant⁻¹) was recorded in T₆ with groundnut cake (50%) + neem cake (50%). The lowest was recorded in T₁₄ (58.88 g plant⁻¹) with vermicompost (75%) + neem cake (25%). RDF recorded a fresh weight of 10.01, 35.44 and 64.26 g plant⁻¹ at 30, 60 DAS and at harvest respectively (Table 3). Nihad and

Jessykuty⁷ (2010) recorded the highest fresh weight of plants with 50% RDN through FYM and neem cake in *Plumbago rosea*.

Dry weight of root (g plant⁻¹):

At 30 DAS the highest dry weight of root (1.36 g plant⁻¹) was recorded in T₆ with groundnut cake (50%) + neem cake (50%) followed by T₈ (1.25 g plant⁻¹) with groundnut cake (50%) + neem cake (25%) + vermicompost (25%). The highest dry weight of root (4.79 g plant⁻¹) was recorded in T₆ with groundnut cake (50%) + neem cake (50%) followed by T₅ (4.35 g plant⁻¹) with groundnut cake (75%) + vermicompost (25%) at 60 DAS. RDF recorded root dry weight of 1.01 and 3.91 g plant⁻¹ and T₁₄ with vermicompost (75%) + neem cake (25%) recorded the lowest dry weight of root of 0.72 and 3.39 g plant⁻¹ at 30 and 60 DAS respectively. There was no significant difference found among various treatments of organic manures with respect to dry weight of root at harvest (Table 4). The increased fresh and dry weight of roots with groundnut cake (50%) + neem cake (50%) can be attributed to slow release of nutrients from organic manures and their better utilization by carrot throughout the growing period. The same increase in fresh and dry weights were recorded in *Solanum nigrum*¹³. The increase of weight might be due to accelerated mobility of photosynthates from source to sink as influenced by growth hormone, released or synthesized due to organic sources of fertilizers⁹.

Root to shoot ratio:

The highest root-shoot ratio (2.09) was recorded in T₈ with groundnut cake (50%) + neem cake (25%) + vermicompost (25%). RDF recorded a root-shoot ratio of 1.51 and the lowest was recorded in T₁₂ (1.13) with neem cake (50%) + groundnut cake (25%) + vermicompost (25%). The treatment with groundnut cake in combination with neem cake and vermicompost recorded higher root to shoot ratio because of higher root yield and lower shoot yield.

Total root yield (t ha⁻¹):

The highest root yield (25.65 t ha⁻¹) was recorded in T₆ with the application of groundnut cake (50%) + neem cake (50%) followed by T₄ (25.37 t ha⁻¹) with groundnut cake (75%) + neem cake (25%) which were at par but significantly superior to all other treatments (Table 5).

RDF recorded a yield of 23.76 t ha⁻¹ and the lowest was recorded in T₁₁ (20.35 t ha⁻¹) with neem cake (50%) + vermicompost (50%).

The root yield of carrot was also significantly affected with the application of organic manures especially groundnut cake in combination with neem cake. This increase in root yield might be due to the cumulative effect of all yield components viz., root length, root diameter, fresh and dry weight of root. The slow release of nutrients from organic manures and their better utilization by carrot throughout the growing period might have resulted in higher root yields of carrot. The increased root yield with the application of groundnut cake and neem cake might also be attributed to their higher N content of 1.46 and 1.20 % respectively. Similar results of increased yields with neem cake were reported in radish¹¹. Increased yield due to better availability of nutrients and the balanced C/N ratio might have increased synthesis of carbohydrates which ultimately promoted greater yield. It can also be attributed to better carbon assimilation and better accumulation of carbohydrates in the plants. Similar findings with the application of organics were observed by Kamla Singh⁴ in the tuber yields of potato. The translocation of photosynthates from source (leaves) to sink (root) might have contributed to increased root length and diameter resulting in root yield.

Nitrogen uptake (kg ha⁻¹):

The highest nitrogen uptake (224.0 kg ha⁻¹) was recorded in T₆ with the application of groundnut cake (50%) + neem cake (50%) followed by T₁₀ (220.56 kg ha⁻¹) with neem

cake (75%) + vermicompost (25%) which were at par but significantly superior to all other treatments. RDF recorded a nitrogen uptake of 191.56 kg ha⁻¹ and the lowest was recorded in T₁₄ (124.0 kg ha⁻¹) with vermicompost (75%) + neem cake (25%). The increased N uptake could be due to increased and prolonged availability of N to the plants in these treatments and also due to increased dry matter yield. Nutrient uptake is a positive function of dry matter yield¹⁰. This is in consonance with the findings of Chalapathi *et al*²., in stevia and Mallangouda *et al*⁵., in onion and garlic.

Phosphorus uptake (kg ha⁻¹)

The highest phosphorus uptake (66.0 kg ha⁻¹) was recorded in T₆ with the application of groundnut cake (50%) + neem cake (50%) followed by T₅ (62.0 kg ha⁻¹) with groundnut cake (75%) + vermicompost (25%) which were significantly superior to all other treatments. RDF recorded a phosphorus uptake of 60.34 kg ha⁻¹ and the lowest was recorded in T₂ (45.0 kg ha⁻¹) with neem cake (100%). Normally phosphorus is said to be in fixed form and its absorption is a slow process or sometimes not available. Interestingly, in the present study plants supplied with the organic manures have recorded larger uptake of phosphorus. This could be attributed to their chelating action in making ions available and maintaining soil physical condition. It could also be due to the increased availability of P due to the solubility effect of organic acids which were produced from the decomposing organic manures. Further groundnut cake might also have reduced the fixation of P and thus increased the availability of P in soil solution for its better absorption resulting in increased uptake of P in carrot. Neem cake contains 1.02% of P in addition to nitrogen. The additional phosphorus might be one of the reasons for improving the uptake of P by the plants. More over neem cake might have enriched the soil with additional phosphorus and might have improved the water retention

capacity of the soil and there by maintained a conducive environment in the soil for making phosphorus more available to the plants in higher quantities¹.

Potassium uptake (kg ha⁻¹)

Similar to nitrogen uptake, the highest potassium uptake (253.67 kg ha⁻¹) was also recorded in T₆ with the application of groundnut cake (50%) + neem cake (50%) followed by T₁₀ (244.30 kg ha⁻¹) with neem cake (75%) + vermicompost (25%) which were at par but significantly superior to all other treatments. RDF recorded a potassium uptake of 213.0 kg ha⁻¹ and the lowest was recorded in T₁₄ (145.0 kg ha⁻¹) with vermicompost (75%) + neem cake (25%). Nitrogen possibly might have influenced the potassium uptake by virtue of its complementary action with potassium.

The increase in K uptake was due to the increased availability of nutrients from the native, as well as from the mineralized organic manures which might have increased the concentration of K in soil solution making it readily available for absorption. Similar trend was recorded in onion by Geeta³. Potash is likely to be maintained in exchangeable form in soil treated with organic manures, which in turn might have restricted the K⁺ ions getting fixed by inorganic clay particles in soil.

The increased uptake of NPK due to addition of organic manure can be attributed to the action of organic acids which form organic matter complex. Some of organic manures in addition to influencing pH, form stable complexes or chelated compounds with cations responsible for phosphate fixation⁸. The application of groundnut cake in combination with neem cake significantly increased yield, improved the chemical properties of the soil, increased the nutrient availability and thereby led to increased nutrient uptake by carrot. The uptake of NPK was increased significantly with the application of neem cake in *Plumbago rosea*⁷ and wheat¹².

Table 1: Root length (cm) of carrot at different stages of crop growth as affected by vermicompost, neem cake and groundnut cake

| Treatments | 30 DAS | 60 DAS | At harvest |
|---|--------|--------|------------|
| T ₁ : Groundnut cake (100%) | 7.84 | 14.24 | 15.22 |
| T ₂ : Neem cake (100%) | 8.29 | 16.02 | 17.44 |
| T ₃ : Vermicompost (100%) | 7.40 | 14.82 | 16.60 |
| T ₄ : Groundnut cake (75%) + Neem cake (25%) | 7.42 | 14.20 | 17.78 |
| T ₅ : Groundnut cake (75%) + Vermicompost (25%) | 7.12 | 13.45 | 14.50 |
| T ₆ : Groundnut cake (50%) + Neem cake (50%) | 8.40 | 16.13 | 17.92 |
| T ₇ : Groundnut cake (50%) + Vermicompost (50%) | 7.33 | 13.56 | 15.59 |
| T ₈ : Groundnut cake (50%) + Neem cake (25%) + Vermicompost (25%) | 6.83 | 12.34 | 16.15 |
| T ₉ : Neem cake (75%) + Groundnut cake (25%) | 8.81 | 17.17 | 19.74 |
| T ₁₀ : Neem cake (75%) + Vermicompost (25%) | 7.91 | 15.11 | 15.99 |
| T ₁₁ : Neem cake (50%) + Vermicompost (50%) | 7.43 | 13.15 | 15.65 |
| T ₁₂ : Neem cake (50%) + Groundnut cake (25%) + Vermicompost (25%) | 7.43 | 14.44 | 17.24 |
| T ₁₃ : Vermicompost (75%) + Groundnut cake (25%) | 8.08 | 15.41 | 16.25 |
| T ₁₄ : Vermicompost (75%) + Neem cake (25%) | 6.88 | 12.69 | 14.09 |
| T ₁₅ : Vermicompost (50%) + Neem cake (25%) + Groundnut cake (25%) | 7.71 | 14.77 | 17.24 |
| T ₁₆ : RDF @ 50 kg N; 40 kg P ₂ O ₅ ; 50 kg K ₂ O | 8.03 | 15.07 | 16.04 |
| CD | 0.53 | 0.71 | 0.83 |
| S Em± | 0.18 | 0.24 | 0.28 |

Table 2: Root diameter (cm) of carrot at different stages of crop growth as affected by vermicompost, neem cake and groundnut cake

| Treatments | 30 DAS | 60 DAS | At harvest |
|---|--------|--------|------------|
| T ₁ : Groundnut cake (100%) | 1.08 | 2.49 | 3.67 |
| T ₂ : Neem cake (100%) | 1.06 | 2.65 | 3.48 |
| T ₃ : Vermicompost (100%) | 1.02 | 2.23 | 3.44 |
| T ₄ : Groundnut cake (75%) + Neem cake (25%) | 1.03 | 2.51 | 3.59 |
| T ₅ : Groundnut cake (75%) + Vermicompost (25%) | 1.28 | 2.64 | 3.77 |
| T ₆ : Groundnut cake (50%) + Neem cake (50%) | 1.32 | 2.67 | 3.68 |
| T ₇ : Groundnut cake (50%) + Vermicompost (50%) | 1.00 | 2.24 | 3.48 |
| T ₈ : Groundnut cake (50%) + Neem cake (25%) + Vermicompost (25%) | 1.33 | 2.68 | 3.07 |
| T ₉ : Neem cake (75%) + Groundnut cake (25%) | 0.96 | 2.80 | 3.05 |
| T ₁₀ : Neem cake (75%) + Vermicompost (25%) | 1.03 | 2.53 | 3.65 |
| T ₁₁ : Neem cake (50%) + Vermicompost (50%) | 1.09 | 2.42 | 3.19 |
| T ₁₂ : Neem cake (50%) + Groundnut cake (25%) + Vermicompost (25%) | 1.00 | 2.48 | 3.22 |
| T ₁₃ : Vermicompost (75%) + Groundnut cake (25%) | 0.95 | 2.22 | 3.02 |
| T ₁₄ : Vermicompost (75%) + Neem cake (25%) | 1.07 | 2.33 | 3.50 |
| T ₁₅ : Vermicompost (50%) + Neem cake (25%) + Groundnut cake (25%) | 1.17 | 2.55 | 3.46 |
| T ₁₆ : RDF @ 50 kg N; 40 kg P ₂ O ₅ ; 50 kg K ₂ O | 1.14 | 2.32 | 3.59 |
| CD | 0.17 | 0.33 | 0.3 |
| S Em± | 0.060 | 0.11 | 0.11 |

Table 3: Fresh weight (g plant⁻¹) of carrot root at different stages of crop growth as affected by vermicompost, neem cake and groundnut cake

| Treatments | 30 DAS | 60 DAS | At harvest |
|---|--------|--------|------------|
| T ₁ : Groundnut cake (100%) | 9.65 | 40.12 | 67.41 |
| T ₂ : Neem cake (100%) | 8.98 | 38.88 | 68.93 |
| T ₃ : Vermicompost (100%) | 8.08 | 35.86 | 72.65 |
| T ₄ : Groundnut cake (75%) + Neem cake (25%) | 9.12 | 39.72 | 76.20 |
| T ₅ : Groundnut cake (75%) + Vermicompost (25%) | 10.56 | 39.41 | 74.13 |
| T ₆ : Groundnut cake (50%) + Neem cake (50%) | 11.34 | 39.98 | 76.93 |
| T ₇ : Groundnut cake (50%) + Vermicompost (50%) | 9.87 | 35.62 | 66.12 |
| T ₈ : Groundnut cake (50%) + Neem cake (25%) + Vermicompost (25%) | 10.96 | 39.58 | 71.16 |
| T ₉ : Neem cake (75%) + Groundnut cake (25%) | 7.53 | 37.06 | 61.87 |
| T ₁₀ : Neem cake (75%) + Vermicompost (25%) | 8.91 | 38.56 | 70.81 |
| T ₁₁ : Neem cake (50%) + Vermicompost (50%) | 9.65 | 38.64 | 61.08 |
| T ₁₂ : Neem cake (50%) + Groundnut cake (25%) + Vermicompost (25%) | 10.03 | 36.35 | 65.54 |
| T ₁₃ : Vermicompost (75%) + Groundnut cake (25%) | 10.41 | 34.27 | 69.16 |
| T ₁₄ : Vermicompost (75%) + Neem cake (25%) | 9.88 | 35.01 | 58.88 |
| T ₁₅ : Vermicompost (50%) + Neem cake (25%) + Groundnut cake (25%) | 10.03 | 36.74 | 59.39 |
| T ₁₆ : RDF @ 50 kg N; 40 kg P ₂ O ₅ ; 50 kg K ₂ O | 10.01 | 35.44 | 64.26 |
| CD | 0.72 | 0.01 | 0.02 |
| S Em± | 0.25 | 0.00 | 0.00 |

Table 4: Dry weight (g plant⁻¹) of carrot root at different stages of crop growth as affected by vermicompost, neem cake and groundnut cake

| Treatments | 30 DAS | 60 DAS | At harvest |
|---|--------|--------|------------|
| T ₁ : Groundnut cake (100%) | 1.18 | 4.28 | 6.31 |
| T ₂ : Neem cake (100%) | 1.03 | 4.17 | 6.67 |
| T ₃ : Vermicompost (100%) | 0.92 | 3.88 | 6.77 |
| T ₄ : Groundnut cake (75%) + Neem cake (25%) | 0.99 | 4.30 | 6.62 |
| T ₅ : Groundnut cake (75%) + Vermicompost (25%) | 0.94 | 4.35 | 6.92 |
| T ₆ : Groundnut cake (50%) + Neem cake (50%) | 1.36 | 4.79 | 7.13 |
| T ₇ : Groundnut cake (50%) + Vermicompost (50%) | 0.61 | 3.63 | 6.61 |
| T ₈ : Groundnut cake (50%) + Neem cake (25%) + Vermicompost (25%) | 1.25 | 4.18 | 6.90 |
| T ₉ : Neem cake (75%) + Groundnut cake (25%) | 1.22 | 3.94 | 6.33 |
| T ₁₀ : Neem cake (75%) + Vermicompost (25%) | 1.03 | 3.86 | 6.65 |
| T ₁₁ : Neem cake (50%) + Vermicompost (50%) | 0.83 | 3.72 | 6.38 |
| T ₁₂ : Neem cake (50%) + Groundnut cake (25%) + Vermicompost (25%) | 0.76 | 3.39 | 6.35 |
| T ₁₃ : Vermicompost (75%) + Groundnut cake (25%) | 1.16 | 3.65 | 6.57 |
| T ₁₄ : Vermicompost (75%) + Neem cake (25%) | 0.72 | 3.39 | 6.22 |
| T ₁₅ : Vermicompost (50%) + Neem cake (25%) + Groundnut cake (25%) | 0.82 | 4.09 | 6.26 |
| T ₁₆ : RDF @ 50 kg N; 40 kg P ₂ O ₅ ; 50 kg K ₂ O | 1.01 | 3.91 | 6.30 |
| CD | 0.33 | 0.51 | N.S |
| S Em± | 0.11 | 0.17 | 0.20 |

Table 5: Root yield (t ha⁻¹), shoot yield (t ha⁻¹) and root –shoot ratio of carrot at harvest as affected by vermicompost, neem cake and groundnut cake

| Treatments | Root Yield (t ha ⁻¹) | Shoot Yield (t ha ⁻¹) | Root-Shoot ratio |
|---|----------------------------------|-----------------------------------|------------------|
| T ₁ : Groundnut cake (100%) | 22.50 | 15.91 | 1.41 |
| T ₂ : Neem cake (100%) | 23.29 | 14.94 | 1.55 |
| T ₃ : Vermicompost (100%) | 23.88 | 15.23 | 1.56 |
| T ₄ : Groundnut cake (75%) + Neem cake (25%) | 25.37 | 13.42 | 1.89 |
| T ₅ : Groundnut cake (75%) + Vermicompost (25%) | 24.72 | 16.18 | 1.52 |
| T ₆ : Groundnut cake (50%) + Neem cake (50%) | 25.65 | 16.95 | 1.51 |
| T ₇ : Groundnut cake (50%) + Vermicompost (50%) | 22.01 | 14.32 | 1.53 |
| T ₈ : Groundnut cake (50%) + Neem cake (25%) + Vermicompost (25%) | 23.73 | 11.35 | 2.09 |
| T ₉ : Neem cake (75%) + Groundnut cake (25%) | 20.63 | 11.45 | 1.80 |
| T ₁₀ : Neem cake (75%) + Vermicompost (25%) | 23.59 | 11.77 | 2.00 |
| T ₁₁ : Neem cake (50%) + Vermicompost (50%) | 20.35 | 14.87 | 1.36 |
| T ₁₂ : Neem cake (50%) + Groundnut cake (25%) + Vermicompost (25%) | 21.85 | 19.18 | 1.13 |
| T ₁₃ : Vermicompost (75%) + Groundnut cake (25%) | 23.18 | 14.94 | 1.55 |
| T ₁₄ : Vermicompost (75%) + Neem cake (25%) | 22.27 | 12.65 | 1.76 |
| T ₁₅ : Vermicompost (50%) + Neem cake (25%) + Groundnut cake (25%) | 23.19 | 15.66 | 1.48 |
| T ₁₆ : RDF @ 50 kg N; 40 kg P ₂ O ₅ ; 50 kg K ₂ O | 23.76 | 15.73 | 1.51 |
| CD | 0.63 | 1.08 | 0.06 |
| S Em± | 0.22 | 0.37 | 0.02 |

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