**Study on growth and yield performance of various carrot varieties**

 **ABSTRACT**

 A research study entitled "Study on growth and yield performance of various carrot varieties" was conducted at the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) between 2024 and 2025. The experiment comprises of ten varieties of carrots were taken and evaluated in randomized block design (RBD) with three replications. According to the findings of this study, variety V9 (Black Beauty) recorded maximum Germination percentage (100.00 %), plant height of 77.87 cm in 90 DAS, number of leaves per plant of 43.33 in 90 DAS, root weight with 154.80 gm, root length with 30.60 cm, root diameter with 5.60 cm, root girth with 12.08 cm, core diameter with 3.76 cm, total yield of 28.90 t/ha, Beta-carotene content of 10508.57 mg/100g and total soluble solid of 7.450Brix at harvesting stage as compare to other varieties in all terms. Economic evaluation of different combinations showed that V9 (Black Beauty) and promising with highest net income and B: C ratio of 2.12. These findings suggest V9 (Black Beauty) as the most promising variety for cultivation under Prayagraj conditions.

**Keywords:** Carrot; yield, Beta-carotene, cultivation,

# **INTRODUCTION**

# Carrot *(Daucus carota L.)* is a widely grown and nutritious root vegetable of the Apiaceae family with 2n=18 chromosome number, grown in different countries of the world. Generally, it is herbaceous and biennial plant of Apiaceae family that produces an edible taproot. It is native of Europe and South Western Asia. It is cool season crop. It is grown all over the world in spring, summer and autumn in temperate countries and during winter in tropical and subtropical climate. The worldwide consumption of carrot has increased over the years and it is now one of the most popular vegetable crops. Undoubtedly carrot is one of the most ancient vegetables. Its history has been confused with that of parsnip, for the Romans ate it as Pastinaca, a name later transferred to the parsnip when carrot became *Carota* (Burkill, 1935).

 Carrots are cultivated over 108 thousand hectares with a production of 1865 thousand MT in India (Anonymous, 2018). In India, the main carrot growing states are Haryana, Bihar, Punjab, Madhya Pradesh and Uttar Pradesh. In Madhya Pradesh, the carrot is grown in area of 7.43 thousand ha with a production of 138.96 thousand MT (NHB, 2018).

 The chemical composition of fresh carrot root is as Carbohydrates (1 0.6 g), Fat (0.2 g), Protein (0.9 g), Vitamin A (3150 I.U.), Calcium (80 mg), Iron (2.20 mg), Riboflavin (0 .0 2 mg) and Vitamin C (3 mg), (Anon., 2007 b). Carrot is valued as food mainly because of rich source of alpha and beta carotene. Sugar and volatile terpenoids are the two significant factor of carrot flavor (Kabir *et al.,* 2013). Cause of rapid popularity of orange cultivar is high value of provitamin. Significant antioxidant pigments found in carrots is carotenoids and anthocyanins (Yadav, 2020). Carrot is also rich in dietary fiber antioxidant and minerals ethnomedical, the roots are used to treat digestive problem, intestinal parasites and tonsillitis or constipation. An infusion of carrot has long been used as a folk medicine for thread worms.

 The production of carrot is influenced by various factors like use of proper genotypes, cultivation practices, control of diseases, pests and weed control. Among the various factors contributing towards yield, the most important factor is use of good quality seed material of improved variety, as it plays a vital role in yield maximization. Though, carrot is one of the most popular vegetable crops grown in India, the literature revealed that very little work is done on evaluation of suitable genotypes for tropical climatic condition, of various regions of the state.

 Among the factor plant geometry is one of the significant components for the expanded production of carrot. Carrot yield is likewise antagonistically influenced by planting density. There is positive relationship between the quantity of plants and yield of carrot. Plant population has an impact on growth, development and yield. However, numerous laborers have revealed that distinctive plant densities have diverse impact for attractive yield of carrot. In the condition of closer spacing, the distance between two plants is greater and carrot development is inhibited. Individual plants will yield more at wider spacing, however per hectare production may be reduced leading to low plant density. As a result, plant spacing is an essential element in increasing carrot yield. Although the wider spacing promoted carrot vegetative progress and improved root length, planting at a dense spacing resulted in greater overall and commercial yields as well as enhanced profitability (Kharsan *et al.,* 2019).

 The plants require cool to moderate temperatures and are not grown in summer in the warmer regions. They require deep, rich, but loosely packed soil. Modern machines sow the seeds sparsely in bands to give room for plant development without need for thinning. An erect rosette of doubly compound, finely divided leaves develops above ground normally in the first season. The edible carrot and attached roots are below. If left unharvested, the plant survives through the winter, and large branched flower stalks arise the following growing season. The tiny white or pinkish flowers are borne on large compound clusters (umbels) at the ends of the main stalk and branches. The spiny seeds are produced in small segmented fruits called schizocarps. Seeds that are sold for planting have the spines removed. Fresh carrots should be firm and crisp, with smooth and unblemished skin. Bright-orange color indicates high carotene content; smaller types are the most tender. Carrots are used in salads and as relishes and are served as cooked vegetables and in stews and soups.

# **MATERIALS AND METHODS**

The present investigation entitled “Study on growth and yield performance of various carrot varieties” was conducted at Vegetable Research Farm, Department of Horticulture, Naini, Agricultural Institute, Sam Higginbottom University of Agriculture, Technology &Sciences, Prayagraj (UP) during 2024-2025. The aim of experiment was carried out to study the growth parameter, yield and quality attribute of carrot in different varieties. Details are mentioned in this chapter regarding the materials used and the technique used throughout the course of investigation. The varieties included in the study were V1 – Pusa Rudhira, V2 – Lal Pari, V3 – Gitanjali, V4 – Rose Red, V5 – Scarlet Nantes, V6 – Little Finger, V7 – Super Early Nantes, V8 – Imperator, V9 – Black Beauty, V10 – Kalika.

# **RESULT AND DISCUSSION**

**Growth parameters**

**Number of days to germination in**

 The results pertaining to the performance of different varieties of Carrot for number of days taken to germination of seeds are presented in Table 1. Among different varieties of carrot the maximum no. of days to germination 13.87 were observed in V8 (Imperator) and the minimum no. of days to germination 9.40 were observed in V9 (Black Beauty) and V1 (Pusa Rudhira) followed by V4 (Rose Red) i.e., 9.53.

**Germination Percentage of carrot varieties**

The maximum germination percentage of carrot varieties were found 100 % in V9 (Black Beauty), V1 (Pusa Rudhira) and V4 (Rose Red) and the minimum germination percentage was found 81.67 % in V8 (Imperator). This variation is influenced by environmental factors like sunlight, temperature, and soil fertility.

**Plant height of carrot varieties**

Plant gradually increased with advancement of growth period. Data presented in Table 1 revealed that all the variety significantly increase plant height of the carrot plants at 90 DAS. Maximum plant height *i.e.,* 77.87, 70.07 and 69.00 cm was recorded in V9 (Black Beauty) followed by V1 (Pusa Rudhira) and V4 (Red Rose) respectively, while the minimum plant height *i.e.,* 49.87 was found in V8 (Imperator) at 90 DAS. There was increase in plant height with advancement of growth period. This might be due to genetic phenomena of these varieties (Kushwah *et al.,* 2019). The results are in agreement with Pandey and Sharma (2017), Melese *et al.,* (2018) and Sharma *et al.,* (2020) in carrot.

**Number of leaves per plant of carrot varieties**

Maximum number of leaves of carrot was observed in V9 (Black Beauty) with an average number of leaves of 44.00 followed by V1 (Pusa Rudhira)with an average number of leaves was 43.33 and V4 (Rose Red) with 42.33. Plants in all other variety also showed significant increase in number of leaves. Minimum number of leaves was the recorded in V8 (Imperator) an average number of leaves of 40.67. Significant variation was observed among varieties for number of leaves per plant in carrot. The difference in number of leaves among varieties was probably due to the rate of leaf initiation which would be an inherent character of the varieties (Kushwah *et al.,* 2019).

**Table 1: Growth parameter of carrot varieties**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variety Symbol** | **Variety** | **Number of Days to Germination** | **Germination Percentage** | **Plant height** | **Number of leaves per plant** |
| **V1** | **Pusa Rudhira** | 9.40 | 100.00 | 70.07 | 43.33 |
| **V2** | **Lal Pari** | 9.73 | 98.33 | 68.87 | 41.67 |
| **V3** | **Gitanjali** | 10.00 | 98.33 | 59.53 | 41.33 |
| **V4** | **Rose Red** | 9.53 | 100.00 | 69.00 | 42.33 |
| **V5** | **Scarlet Nantes** | 11.20 | 91.67 | 52.80 | 40.67 |
| **V6** | **Little Finger**  | 13.47 | 85.00 | 52.53 | 40.67 |
| **V7** | **Super Early Nantes** | 10.80 | 93.33 | 58.93 | 41.33 |
| **V8** | **Imperator** | 13.87 | 81.67 | 49.87 | 40.67 |
| **V9** | **Black Beauty** | 9.40 | 100.00 | 77.87 | 44.00 |
| **V10** | **Kalika**  | 10.00 | 95.00 | 59.13 | 41.33 |
|  | **F test** | **S** | **S**  | **S**  | **S**  |
|  | **S. Em (±)** | **0.52** | **2.07** | **2.9** | **0.36** |
|  | **C.D.** | **0.26** | **1.03** | **1.45** | **0.18** |
|  | **C.V.** | **14.94** | **6.93** | **14.84** | **2.76** |

**Root Parameters**

**Root length of carrot varieties**

Maximum root length (cm) of carrot was observed in V9 (Black Beauty)with an average root length of 30.60 cm followed by V1 (Pusa Rudhira) with an average root length was 27.40 cm and V4 (Rose Red) with 27.30 cm. Plants in all other variety also showed significant increase in root length of carrot varieties. Minimum root length of carrot was the recorded in V8 (Imperator)with an average root length of 16.46cm. This variation is influenced by both genetic traits, such as leaf elongation and branching, and environmental factors like sunlight, temperature, and soil fertility.

**Root weight of carrot varieties**

Varieties had exerted significant influence on root weight of carrot. V9 (Black Beauty) registered maximum Root weight of 154.80 g followed by V1 (Pusa Rudhira) was 115.80 g and V4 (Red Rose) was 88.40 g respectively. Minimum Root weight of 36.10 g was found under variety V8 (Imperator). There was found significant effect of varieties on fresh and dry weight of root of carrot. Higher root length and diameter of root might have resulted in higher fresh weight and dry weight of root in carrot (Kushwah *et al.,* 2019). Therefore, cultivar Black Beauty produced highest fresh weight of root as compared to other cultivars as they have a greater number of leaves, plant height and root length. The results of the present investigation are similar to that of Pandey and Sharma (2017), Ladumor *et al.,* (2020) and Nikmatullah *et al.,* (2021) in carrot.

**Root girth of carrot varieties**

Maximum root girth (cm) of carrot was observed in V9 (Black Beauty) with an average root girth of 12.08 cm and followed by V1 (Pusa Rudhira)with an average root girth was 8.78 cm and V4 (Red Rose) with 8.18 cm respectively. Plants in all other variety also showed significant increase in root girth of carrot varieties. Minimum root girth of carrot was recorded in Imperator -V8 with an average root girth of 5.68 cm.

**Root diameter of carrot varieties**

Maximum root diameter (cm) of carrot was observed in V9 (Black Beauty)with an average root diameter of 5.60 cm and followed by V1 (Pusa Rudhira)with an average root diameter was 3.98 cm and V4 (Rose Red) with 3.76 cm respectively. Plants in all other variety also showed significant increase in root diameter. Minimum root diameter was the recorded in V8 (Imperator) with an average root diameter of 3.00 cm. The root diameter was significantly influenced by different varieties. Root diameter depends upon environmental factors, soil conditions and genetic makeup and root length which increases root diameter. In general, the variety having produced taller plant height and higher number of leaves per plant had higher root diameter. The similar variations in diameter of root among different varieties have reported by Latha et al. (2012), Kharsan *et al.,* (2019), Ladumor *et al.,* (2020) and Nikmatullah *et al.,* (2021) in carrot.

**Table 2: Root parameters of carrot varieties**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variety Symbol** | **Variety** | **Root length (cm)** | **Root weight (g)** | **Root Girth (cm)** | **Root diameter (cm)** |
| **V1** | **Pusa Rudhira** | 27.40 | 115.80 | 8.78 | 3.98 |
| **V2** | **Lal Pari** | 25.58 | 87.30 | 8.18 | 3.74 |
| **V3** | **Gitanjali** | 24.98 | 87.10 | 7.92 | 3.64 |
| **V4** | **Rose Red** | 27.30 | 88.40 | 8.18 | 3.76 |
| **V5** | **Scarlet Nantes** | 22.20 | 69.30 | 7.04 | 3.46 |
| **V6** | **Little Finger** | 19.30 | 60.00 | 6.96 | 3.00 |
| **V7** | **Super Early Nantes** | 22.70 | 72.96 | 7.16 | 3.52 |
| **V8** | **Imperator** | 16.46 | 36.10 | 5.68 | 3.00 |
| **V9** | **Black Beauty** | 30.60 | 154.80 | 9.08 | 5.60 |
| **V10** | **Kalika** | 24.20 | 84.10 | 7.54 | 3.64 |
|  | **F test** | S  | S  | S  | S  |
|  | **S. Em (±)** | 1.31 | 10.14 | 0.53 | 0.23 |
|  | **C.D.** | 0.65 | 5.07 | 0.27 | 0.11 |
|  | **C.V.** | 17.15 | 43.81 | 21.21 | 20.96 |

**Yield parameters and Quality Parameters of Carrot crop**

**Total root yield (t/ha)**

The maximum total root yield 28.90 t/ha was recorded with variety V9 (Black Beauty) which was followed by V1 (Pusa Rudhira) with 27.35 t/ha and V4 (Red Rose) with 23.96 t/ha while variety V8 (Imperator) was recorded the minimum total root yield 19.74 t/ha under study of carrot.

Root yield was significantly influenced by the varieties. The total root yield per hectare is a result of translocation of more quantum of carbohydrates from the source to the sink. As the varieties which have shown superior performance in yield have significantly a greater number of vigorous leaves on it and more plant height, which could have synthesized more food material and supplied to the roots, that might have resulted in increasing the weight and diameter of roots and ultimately resulted in getting higher root yield (Ladumor *et al.,* 2020). Similar result found in Latha *et al.* (2012), Sharma and Singh (2018) and Sharma *et al.,* (2020) in carrot.

**Beta-carotene content**

Varieties had denoted significant effect on Beta-carotene content in roots of carrot. Variety V9 (Black Beauty) was recorded maximum Beta-carotene content of 10508.57 ml in roots of carrot followed by V1 (Pusa Rudhira) of 10334.62 ml and V4 (Red Rose) of 10245.84ml respectively. Minimum Beta Carotene content 9732.15 ml in roots of carrot was found under variety V8 (Imperator).

**Total soluble solids (TSS) content**

Varieties had denoted significant effect on total soluble solids content in roots of carrot. Variety V9 (Black Beauty) has maximum total soluble solids content 7.450Brix in roots of carrot followed by V1 (Pusa Rudhira) of 7.400Brix and V4 (Red Rose) respectively. Minimum total soluble solids content 6.850Brix in roots of carrot was found under variety V8 (Imperator). Total soluble solid had showed significant effect on different variety. The variation in total soluble solids might be due to genetic make-up of varieties (Ladumor *et al.,* 2020). Such kind of genetic variations for quality characters had also reported by Singh *et al.,* (2018) and Kushwah *et al.,* (2019) in carrot.

**Table 3: Yield and quality parameters of carrot varieties**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variety Symbol** | **Variety** | **Total root yield (t/ha)** | **Beta carotene (mg/100g)** | **Total soluble solid (0Brix)** |
| **V1** | **Pusa Rudhira** | 27.35 | 10334.62 | 7.40 |
| **V2** | **Lal Pari** | 23.59 | 10190.25 | 7.17 |
| **V3** | **Gitanjali** | 23.59 | 9938.86 | 7.13 |
| **V4** | **Rose Red** | 23.96 | 10245.84 | 7.17 |
| **V5** | **Scarlet Nantes** | 22.71 | 9805.12 | 7.09 |
| **V6** | **Little Finger** | 21.20 | 9768.61 | 6.89 |
| **V7** | **Super Early Nantes** | 23.13 | 9813.35 | 7.10 |
| **V8** | **Imperator** | 19.74 | 9732.15 | 6.85 |
| **V9** | **Black Beauty** | 28.90 | 10508.57 | 7.45 |
| **V10** | **Kalika** | 23.42 | 9837.97 | 7.11 |
|  | **F test** | S | S | S |
|  | **S. Em (±)** | 0.84 | 87.7 | 0.06 |
|  | **C.D.** | 0.42 | 43.85 | 0.03 |
|  | **C.V.** | 11.74 | 2.77 | 2.64 |

**Economics of carrot crop**

Cost of cultivation (₹/ha), Gross income (₹/ha), net income (₹/ha) and B:C ratio of carrot were significantly influenced with the different varieties. Highest Cost of cultivation (138900.00 ₹/ha), gross income (433500.00 ₹/ha), net income (294600.00 ₹/ha) and B:C ratio (2.12) were observed under V9 (Black Beauty) variety, which was superior over all other varieties. Variety V8 (Imperator) was found minimum Cost of cultivation (131200.00 ₹/ha), gross return (296100.00 ₹/ha), net return (160550.00 ₹/ha) and B:C ratio (1.18) in carrot.

**Table 4: Economics and benefit cost ratio of carrot varieties**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variety** | **Variety** | **Cost of cultivation (₹/ha)** | **Gross income (₹/ha)** | **Net income (₹/ha)** | **B:C Ratio** |
| **V1** | **Pusa Rudhira** | 135000.00 | 410250.00 | 275250.00 | 2.04 |
| **V2** | **Lal Pari** | 135550.00 | 353850.00 | 222650.00 | 1.70 |
| **V3** | **Gitanjali** | 140200.00 | 353850.00 | 213650.00 | 1.52 |
| **V4** | **Rose Red** | 132400.00 | 359400.00 | 227000.00 | 1.71 |
| **V5** | **Scarlet Nantes** | 137750.00 | 340650.00 | 202900.00 | 1.47 |
| **V6** | **Little Finger** | 136600.00 | 318000.00 | 181400.00 | 1.33 |
| **V7** | **Super Early Nantes** | 138000.00 | 346950.00 | 208950.00 | 1.51 |
| **V8** | **Imperator** | 131200.00 | 296100.00 | 160550.00 | 1.18 |
| **V9** | **Black Beauty** | 138900.00 | 433500.00 | 294600.00 | 2.12 |
| **V10** | **Kalika** | 139010.00 | 351300.00 | 212290.00 | 1.53 |

**Conclusion**

From the above experimental finding it may concluded that, among the ten varieties of carrot, variety V9 (Black Beauty) followed by V1 (Pusa Rudhira) V4 (Rose red) were found to best in terms of growth, yield and performance.Additionally,the highest net return was found in V9 (Black Beauty) and highest B:C ratio was found in the same with 2.12 under the Prayagraj agro-climatic conditions.

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