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Influence of Different Organic Manure Sources and Sowing Dates on The Growth and Yield of Carrot

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ABSTRACT

Carrot (*Daucus carota* L.) is a nutritionally valuable root vegetable whose productivity is highly influenced by soil fertility and climatic conditions. The use of organic manures and appropriate sowing time plays a vital role in enhancing soil health, nutrient availability, and crop performance. A field experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, to evaluate the effects of different organic manure sources, such as (i) cow dung 20 t ha^{-1}, (ii) poultry litter 12 t ha^{-1}, (iii) vermicompost 10 t ha^{-1} and (iv) no organic matter (control); and sowing dates (i) 1st sowing (November 01), (ii) 2nd sowing (November 15), and 3rd sowing (November 30) on the growth and yield of carrot. The experiment was laid out in a randomized complete block design with three replications.

The maximum plant height (47.4 cm), root length (21.5 cm), and yield (22.5 t ha^{-1}) were recorded from organic manure, cow dung 20 t ha^{-1}. For sowing time, maximum plant height (46.8 cm), root length (22.5 cm), and yield (22.6 t ha^{-1}) were found in sowing on 15th November. In the case of the combined effect, the highest yield (28.7 t ha^{-1}) was obtained from sowing on 15th November with cow dung 20 t ha^{-1}, and the lowest (14.8 t ha^{-1}) from sowing on 1st November with no organic matter.

KEYWORDS: Sustainable farming, organic farming, sowing windows, yield, productivity.

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1. INTRODUCTION

Carrot (*Daucus carota* L.) is a herbaceous biennial plant that belongs to the genus Daucus, species carota, and is a member of the Apiaceae family (Peirce, 1987). It is one of the important root vegetables widely used both as a *salad* ingredient and a cooked vegetable (Afrin et al., 2019). Carrots are a rich source of beta-carotene, which is a precursor to vitamin A (Chadha, 2003). They are believed to have originated in the Mediterranean region (Banga, 1976). The plant produces a large, fleshy taproot that is edible and has high nutritional value (Shanmugavelu, 1989).

Carrots are primarily a temperate crop that is cultivated in the spring through autumn in temperate regions and during the winter in tropical and subtropical areas (Bose and Som, 1990). Barnes (1936) noted that the ideal temperature for carrot growth and development ranges from 15.6 °C to 21.1 °C. Both higher and lower temperatures can hinder growth rates and negatively impact the quality of the roots. In Bangladesh, carrots thrive during the *Rabi* season, when temperatures range from 11.2 °C to 28.9 °C (Alim, 1974). The optimal time for planting carrots to achieve a satisfactory yield is from mid-November to early December (Rashid, 1993).

Carrots are a good source of vitamin A (as carotene), as well as vitamins B1, B2, and C (Leclerc et al., 1991; Warman and Harvard, 1996a, 1996b). The flavor of carrots primarily comes from two components: sugar and volatile terpenoids. Glucose, fructose, and sucrose account for more than 95% of the free sugars and 40% to 60% of the stored carbohydrates in carrot roots. The ratio of sucrose to reducing sugars increases as the root matures but decreases after harvest and during cold storage (Freman and Simon, 1983). Addressing blindness in children in rice-dependent countries of Asia, such as Bangladesh, may contribute significantly to overcoming this public health issue (Woolfe, 1989).

Organic manure improves soil structure and increases its water-holding capacity. Additionally, it enhances soil aeration. Recently, organic farming has gained popularity among vegetable consumers due to its ability to enhance the quality of produce. In contrast, inorganic farming can leave residual effects in crops, which are believed to pose risks to public health and the environment. Carrots are considered heavy feeders of nutrients, absorbing approximately 100 kg of nitrogen (N), 50 kg of phosphorus (P_2O_5), and 180 kg of potassium oxide (K_2O) per hectare. Therefore, the judicious and proper use of organic manures and fertilizers is essential not only for achieving higher yields and producing quality crops but also for maintaining soil health and sustainability over the long term.

Among oil cakes, neem and castor cakes are quickly insoluble in water and provide slow, steady nourishment while offering protection from nematodes, ultimately improving yield and quality. Vermicompost, produced by earthworms, is a rich source of both micro and macronutrients, vitamins, growth hormones, and enzymes.

Sowing time is a crucial factor in increasing carrot yields (Rashid and Shakur, 1986). Different sowing times significantly affect carrot growth and yield due to environmental factors such as temperature and light intensity. Mack (1977) noted that carrots should be harvested at the proper stage of maturity; otherwise, they may become fluffy and unfit for consumption. Additionally, the percentage of root splitting, firmness, and the contents of dry matter, carotene, and sucrose increase as the carrots grow, while the levels of glucose, fructose, and the respiration quotient decline. The total sugar content remains relatively constant during the early harvesting period but tends to increase at lower temperatures.

Organically cultivated fruits, crops, and vegetables have gained considerable market value both globally and locally due to their positive contributions to environmental and human well-being. However, limited research has been conducted on the use of organic fertilizers and sowing dates in carrot production (Afrin et al. 2019; Kiraci, S. 2018). In Bangladesh, there are no established guidelines regarding the use of different organic manure sources or suitable sowing times, and their combined effects on carrot productivity remain largely unexplored. Therefore, this study focuses on evaluating the influence of various organic manure sources and sowing dates on the growth and yield of carrot under the specific agro-climatic conditions of Bangladesh. The findings aim to bridge the existing knowledge gap and provide practical recommendations for optimizing sustainable carrot production in the region. The specific objectives of this study were: (i) to determine the optimum sowing time for achieving higher yield of carrot; (ii) to assess the effects of different sources of organic manure on carrot growth and yield; and (iii) to identify the most suitable combination of sowing time and organic manure for profitable carrot cultivation under the agro-climatic conditions of Bangladesh. The outcomes of this study are expected to provide a clearer understanding of the interaction between organic manure and sowing time in influencing carrot growth and productivity. The findings will contribute to the development of sustainable, resource-efficient production practices suited to the agro-climatic conditions. Ultimately, this research aims to enhance yield potential while promoting environmentally responsible and economically viable carrot cultivation.

2. MATERIALS AND METHODS

2.1 Experimental site

The experiment was conducted at the Horticulture Farm of the Sher-e-Bangla Agricultural University, Dhaka during October to March. Laboratory works were done both at Horticulture Laboratory and the Soil Science Laboratory in Sher-e-Bangla Agricultural University. A new Carrot variety name, “Caroda” was used for the experiment.

The experimental area was located in the Sub-Tropical Climatic Zone, characterized by heavy rainfall from October to February, with a drier period for the rest of the year (Anon, 1960). Data on monthly maximum and minimum temperatures (°C), rainfall (mm), and relative humidity (%) were recorded from the Weather Yard Station in Agargaon, Dhaka, during the study period. The experimental area belongs to the Modhupur Tract and Agricultural Ecological Zone (AEZ) 28. The soil type was sandy loam, with a pH value of 6.6. Soil samples were randomly collected from a depth of up to 30 cm in the experimental plot. Analyses revealed nitrogen content of 0.075%, phosphorus at 13 ppm, exchangeable potassium at 0.20 meq/100 g of soil, and organic carbon content of 0.82%.

2.2 Experimental treatments and design

The experiment was conducted to study the effect of four levels of organic manure sources, (i) cow dung 20 t ha^{-1}, (ii) poultry litter 12 t ha^{-1}, (iii) vermicompost 10 t ha^{-1} and (iv) no organic matter (control) and three levels of sowing time (i) 1st sowing (November 01), (ii) 2nd sowing (November 15), and 3rd sowing (November 30). The two-factor experiment was laid out in a RCB design with three replications**.** The whole experimental area was 25.5 m x 10 m which was divided into three blocks. Each block was again divided into 12 plots and hence there were 36 (12 × 3) unit plots. The treatments were assigned randomly in each block separately. The size of unit plot was 2.0 m × 1.5m.

2.3 Seed soaking and treatment

Carrot seeds were soaked into water for 12 hours and then wrapped with a piece of thin cloth prior to sowing. Then they were spread over a polythene sheet in the sun for two hours to dry. The seeds were treated with Vitavex-200@3g/100g seed.

2.4 Land preparation and seed sowing

The selected land for the experiment was initially opened using a disc plough and exposed to sunlight for seven days before the next ploughing. The land was then ploughed six times with a tractor to achieve good tilth. Following each ploughing, laddering was performed to break up soil clods and fragments. All weeds and stubble were removed, and the land was finally prepared with the addition of basal doses of manure and fertilizers. Plots were arranged according to the specified design and layout. To protect the young plants from attacks by mole crickets, cutworms, and ants, the soil in each plot was treated with Sevin 80 WP at a rate of 2 kg/ha. Irrigation channels were constructed around each block.

The sources of applied nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O) were urea, triple superphosphate (TSP), and muriate of potash (MP), respectively. The entire amounts of TSP and MP were applied during the final land preparation. Urea was applied in three equal installments at 15, 30, and 45 days after seed sowing, as indicated by Rashid (1993). Seeds were sown at a rate of 3 kg/ha, resulting in a total of 60 grams of seeds used for the experimental area. The seeds were sown at different times according to the treatments, at a spacing of 20 cm × 25 cm, and were placed in shallow furrows at a depth of 1.5 cm in each plot.

2.5 Intercultural operations

When the plants were established in the plots, they were always kept under careful observation. Various intercultural operations were accomplished for the better growth and development of germinated plants. The emergence of seedlings started about six days after snowing. Thinning was done at two stages, at 15 and 30 days after sowing (DAS), in order to keep a healthy plant in each hill. The wedding was done at two times (15 and 30 DAS). The field was irrigated five times during plant growth: light watering after sowing, followed by irrigations at 20, 35, 55, and 75-days post-sowing. Precautionary measure against Fusarium rot was taken by spraying Dithane M-45 @ 2g /litter water. The crop was ingested by cutworms (*Agrotisypsilon*) during the early stage of growth of seedlings in February. This insect was controlled initially by beating and hooking, afterwards by spraying Dieldrin 20 EC @ 0.1%. Recommended Urea was top dressed after four weeks of sowing, followed by light irrigation.

2.6 Collection of data

The plant height was measured with the help of a meter scale from the ground level of the root up to the tip of the leaf at 30, 60, and 90 DAS**.** The number of leaves was counted at 30-day intervals and started from 30 DAS and continued to harvest, i.e., 30, 60 and 90 DAS. Ten plants in each plot were used to count the number of leaves per plant. The length of the largest leaf was considered the foliage length. Ten plants in each plot were used to measure foliage length per plant. Leaves of ten fresh plants in each plot were detached by a sharp knife, and the fresh weight was taken by using a balance and recorded in gram (g). Leaves were detached from the root and kept in an oven at 70 ºC for 72 hours until reached constant weight. After drying, the leaves were kept in a desiccator containing blur silica gel. Fifteen minutes later, the samples were weighed using an electric balance and recorded in gram (g).

$$\text{Dry matter content of leaves (\%)} = \frac{\text{Dry weight of leaves} \times 100}{\text{Fresh weight of leaves}}$$

Ten plants are uprooted and detached from foliage parts. Then the length of modified roots was measured. Ten selected plants are used to determine root diameter. Root diameter was measured at the time of harvesting from the middle portion with slide calipers. Ten selected carrot roots were used to determine the fresh weight of the roots. Modified roots were detached by knife from the foliage part, and fresh weight was taken using a balance. Ten selected carrot roots were used to determine root dry weight. Immediately after harvesting, roots were weighed initially, then chopped and kept in an oven at 70 ºC for 48 hours to get a constant weight. The dry weight of the root was measured electric balance and was considered as dry weight and recorded.

$$\text{\% of dry meter} = \frac{\text{Dry weight of root} \times 100}{\text{Dry weight of root}}$$

The percentage of cracked root was estimated by using the following formula:

$$\text{\% of cracking root} = \frac{\text{Number of cracked root} \times 100}{\text{Total number of root}}$$

After harvest the branched roots are counted and the percentage was calculated by the following formula:

$$\text{\% of branched root} = \frac{\text{Number of branched root} \times 100}{\text{Total number of root}}$$

Gross yield of roots per plot was calculated by using the following formula:

$$\text{Gross yield (kg/plot} = \frac{\text{Area of single plot (m} \times \text{m)} \times \text{Average yield per plant (g)}}{\text{Spacing} \times 1000}$$

Gross yield of roots per hectare was calculated by using the following formula:

$$\text{Gross yield (t/ha)} = \frac{\text{Area (ha)} \times \text{Average yield per plant (g)} \times 10000}{\text{Spacing} \times 1000 \times 1000}$$

Marketable yield was recorded, excluding cracked and branched roots from each plot and expressed in kg.
Marketable yield (kg/plot) = Gross yield - Non marketable yield (number of cracked root and branched roots)
Marketable yield of roots per hectare was calculated by conversion of the marketable root weight per plot.

2.7 Harvesting

The crop was harvested periodically for data collection. Randomly selected ten plants were harvested each time from each unit plot at 10-day intervals. Harvesting was done when the roots attained 90 DAS at each plot for all treatments.

2.8 Statistical Analysis

The recorded data on different growth and yield parameters were calculated for statistical analysis. Analyses of variances (ANOVA) for most of the characters under consideration were performed with the help of the MSTAT program. Treatment means were separated by Duncan's Multiple Range Test (DMRT) at 5% level of significance for interpretation of the results.

3. RESULTS AND DISCUSSION

3.1 Plant height

Different levels of organic manure significantly influenced the plant height of carrot (Table 1). At 30, 60, and 90 DAS, the highest plant heights were recorded from Cow dung 20 t ha^{-1} which were statistically similar to Vermicompost 10 t ha^{-1}. The plant height was always lower for control.

Table 1: Effect of different organic manures on the plant height of carrot

Treatment	30 DAS	60 DAS	90 DAS
Cow dung 20 t ha^{-1}	17.03 a	34.74 a	47.77 a
Poultry litter 12 t ha^{-1}	16.40 b	33.50 b	44.89 c
Vermicompost 10 t ha^{-1}	16.73 b	33.89 b	46.42 b
Control (No manure)	15.67 c	33.37 c	42.91 d
CV (%)	3.04	2.71	1.78

Among the various organic manures, the tallest plants were observed for seeds sown on November 15, which had a height statistically similar to those from seeds sown on November 30 (Table 2). In contrast, the shortest plants were recorded from seedlings that emerged from seeds sown on November 1.

Plant height is an important indicator of vegetative vigor, and it was significantly influenced by both the type of manure used and the sowing date. Among the organic amendments, cow dung applied at 20 tons per hectare resulted in the tallest plants, comparable to those grown with 10 tons per hectare of vermicompost. This suggests that cow dung is highly effective in promoting vegetative growth, likely due to its nutrient-rich profile, which provides essential macro- and micronutrients in readily available forms to support cell division and elongation.

Table 2: Effect of sowing time on plant height of carrot

Treatment	30 DAS	60 DAS	90 DAS
November 01	16.23 b	33.31 bc	44.92 c
November 15	16.82 a	34.22 a	46.83 a
November 30	16.33 b	33.89 b	45.48 b
CV (%)	3.04	2.71	1.78

S_1 = 1st sowing (November 01); S_2=2nd sowing (November 15); S_3= 3rd sowing (November 30)

Considering the combined effect, the maximum plant height was recorded from when sowing date was November 15 and application of cowdung @ 20 t/ha (Table 3). On the other hand, the minimum plant height was found from sowing on November 01 and no application of manure (control).

Table 3. Combined effect of organic manure and sowing time on the plant height of carrot

Treatment	Plant height (cm)		
	30 DAS	60 DAS	90 DAS
S_1O_0	13.67 f	13.67 f	31.10 g
S_1O_1	18.67 b	18.67 b	46.67 cd
S_1O_2	16.87 cd	16.87 cd	44.97 e
S_1O_3	15.53 e	15.53 e	48.77 b
S_2O_0	13.90 f	13.90 f	39.83 f
S_2O_1	20.77 a	20.77 a	53.67 a
S_2O_2	17.07 c	17.07 c	47.27 cd
S_2O_3	16.03 de	16.03 de	46.73 cd
S_3O_0	13.90 f	13.90 f	40.67 f
S_3O_1	18.63 b	18.63 b	48.80 b
S_3O_2	16.73 cd	16.73 cd	46.47 d
S_3O_3	15.73 e	15.73 e	48.03 bc
CV (%)	3.04	2.71	1.78

*O_0 = Control (No manure); O_1= Cowdung; O_2= Poultry litter; O_3=Vermicompost; S_1 = 1st sowing (November 01); S_2 =2nd sowing (November 15); S_3 = 3rd sowing (November 30)

The differences in plant height observed with varying sowing dates highlight the importance of the planting schedule. Plants sown on November 15 achieved the greatest height, while those sown on November 1 were the shortest. The interaction between sowing date and manure application was particularly noteworthy, as the combination of sowing on November 15 and the application of cow dung resulted in the tallest plants. This indicates that crops sown later may benefit more from organic manure, potentially because this timing aligns better with the availability of soil nutrients and favorable climatic conditions.

3.2 Number of leaves per plant

Different levels of organic manure influenced the number of leaves per plant (Table 4). The maximum number of leaves per plant was recorded when applying organic manure, cow dung 20 t ha^{-1}, which was statistically similar to vermicompost 10 t ha^{-1}.

Table 4: Effect of organic manure on the number of leaves per plant of carrot

Treatment	30 DAS	60 DAS	90 DAS
Cow dung 20 t ha^{-1}	7.40 a	9.30 a	14.09 a
Poultry litter 12 t ha^{-1}	6.5 c	8.42 c	12.43 bc
Vermicompost 10 t ha^{-1}	7.01 b	9.01 b	12.80 b
Control (No manure)	6.3 d	8.02 d	12.09 c
LSD (0.05)	0.48	0.20	0.37

The leaves per plant were significantly affected by sowing times (Table 5). The maximum number of leaves per plant was observed from the sowing date of November 15, whereas the minimum number of leaves per plant was found from the sowing date of November 01.

Table 5: Effect of sowing time on the number of leaves per plant of carrot

Treatment	30 DAS	60 DAS	90 DAS
November 01	6.63 b	8.34 c	12.65 b
November 15	7.08 a	9.03 a	13.22 a
November 30	6.74 b	8.70 b	12.69 b
CV (%)	4.68	2.42	2.97

S_1 = 1st sowing (November 01); S_2 =2nd sowing (November 15); S_3 = 3rd sowing (November 30)

There was a significant interaction between sowing time and manure sources (Table 6). The maximum number of leaves per plant was observed in the sowing on November 15 + cowdung 20 t ha^{-1}. The minimum number of leaves per plant was found from plots sown in November 01 with control (Table 6).

Table 6. Combined effect of organic manure and sowing time on number of leaves per plant of carrot

Treatment	Number of leaves per plant		
	30 DAS	**60 DAS**	**90 DAS**
S_1O_0	4.49 e	7.09 g	8.433 e
S_1O_1	7.43 bcd	8.23 f	14.30 bc
S_1O_2	7.59 bc	8.76 de	14.57 b
S_1O_3	7.59 bc	8.75 de	13.57 d
S_2O_0	4.76 e	7.26 g	9.06 e
S_2O_1	8.69 a	11.03 a	15.77 a
S_2O_2	7.00 d	8.63 e	13.73 cd
S_2O_3	7.19 cd	9.38 c	13.67 cd
S_3O_0	4.91 e	7.26 g	8.86 e
S_3O_1	7.90 b	10.35 b	14.87 b
S_3O_2	7.13 cd	8.50 ef	13.73 cd
S_3O_3	7.16 cd	9.06 cd	13.67 cd
CV (%)	4.68	2.42	2.97

O_0 = Control (No manure); O_1= Cowdung; O_2= Poultry litter; O_3= Vermicompost; S_1 = 1st sowing (November 01); S_2 =2nd sowing (November 15); S_3 = 3rd sowing (November 30)

The number of leaves per plant is another important growth trait that is associated with photosynthetic capacity and potential yield. Similar trends were observed for leaf count. The maximum number of leaves was recorded with cow dung applied at a rate of 20 t ha^{-1}, especially when sowing occurred on November 15. Leaf development is crucial as it directly affects the crop's ability to photosynthesize and accumulate biomass. The significant interaction suggests that both the timing of sowing and the source of fertilizer influence the vegetative growth of carrot plants. Late sowing combined with organic manure optimizes leaf production.

3.5 Root length and diameter of carrot

There was an interaction between organic manure and sowing time on the root length of carrot (Table 7). The longest root 20.98 (cm) was observed from the treatment combination of sowing on November 15 + cowdung 20 t ha^{-1} followed by the same sowing date with Poultry litter 12 t ha^{-1}. The shortest root length was recorded from sowing in November 01 with the control treatment. The root diameter followed almost similar trend to root length (Table 7).

Table 7. Combined effect of organic manure and sowing time on growth of carrot

Treatment	**Length of root (cm)**	**Diameter of root (cm)**
S_1O_0	11.64 f	3.40 f
S_1O_1	15.86d	4.80 bc
S_1O_2	14.81e	4.16 de
S_1O_3	15.71d	8.43 cd
S_2O_0	16.75c	3.76 ef
S_2O_1	20.98 a	7.50 a
S_2O_2	19.93b	4.80 bc
S_2O_3	20.83 ab	4.36 cd
S_3O_0	16.50 c	3.66 ef
S_3O_1	20.72 ab	5.20 b
S_3O_2	19.67b	4.66 bcd
S_3O_3	20.57 b	4.66 bcd
LSD (0.05)	0.282	0.556
CV (%)	2.46	3.81

O_0 = Control (No manure); O_1= Cowdung; O_2= Poultry litter; O_3= Vermicompost; S_1 = 1st sowing (November 01); S_2 =2nd sowing (November 15); S_3 = 3rd sowing (November 30)

Root characteristics are essential for ensuring both the quality and quantity of yield. The longest roots and the largest diameters were observed when sowing took place on November 15 in conjunction with cow dung application. This combination appears to positively influence root development. Root growth is sensitive to various physiological and environmental factors, so the increased root length and diameter likely indicate improved nutrient uptake and overall plant health, facilitated by organic amendments and optimal sowing time. The impact of manure on root morphology further confirms that organic fertilizers, particularly cow dung, enhance root system expansion, likely due to better soil structure and increased nutrient availability.

3.8 Yield

Fresh and dry wt. of root, cracking root per plant, branched root per plant, gross yield (t ha^{-1}), and marketable yield (t ha^{-1}) were significantly affected by both manure applied and sowing date. Considering manure application, except for cracking root per plant and branched root per plant, other parameters were highest for the cow dung application (Table 8). A similar marketable yield was recorded from the manure application of cow dung and vermicompost. Considering the sowing time, the highest gross and marginal yield was recorded from the sowing date of November 15 (Table 9). There was no interaction between manure application and sowing dates for most of the yield parameters.

Table 8. Effect of organic manure on the yield of carrot

Treatment	Fresh wt. of root per plant	Dry wt. of root per plant	Cracking root per plant	Branched root per plant	Gross yield (t ha^{-1})	Marketable yield (t ha^{-1})
Cow dung 20 t ha^{-1}	117.9 a	13.57 a	4.08 b	4.60 b	23.58 a	22.53 a
Poultry litter 12 t ha^{-1}	109.4 c	12.60 b	4.52 a	4.86 b	21.89 c	20.92 b
Vermicompost 10 t ha^{-1}	114.8 b	12.75 b	4.10 b	4.81 b	22.96 b	22.19 a
Control (no manure)	102.7d	11.76 c	4.81 a	5.10 a	20.53 d	19.74 c
CV (%)	2.74	1.63	9.66	20.66	2.74	3.12

O_0 = Control (No manure); O_1= Cowdung (20 t/ha); O_2= Poultry litter (12 t/ha); O_3=Vermicompost (10 t/ha)

Table 9. Effect of sowing time on the yield of carrot

Treatment	Fresh wt. of root per plant	Dry wt. of root per plant	Cracking root per plant	Branched root per plant	Gross yield (t ha^{-1})	Marketable yield (t ha^{-1})
November 01	107.2 b	12.27 c	4.54 a	5.20 a	21.43 b	20.53 b
November 15	117.5 a	13.11 a	4.13 b	4.60 b	23.50 a	22.63 a
November 30	108.9 b	12.63 b	4.46 ab	4.74 b	21.78 b	20.89 b
CV (%)	2.74	1.63	9.66	20.66	2.74	3.12

S_1 = 1^{st} sowing (November 01); S_2 =2^{nd} sowing (November 15); S_3 = 3^{rd} sowing (November 30)

The yield parameters clearly demonstrated the positive effects of using organic manure and choosing specific sowing dates. The highest fresh and dry weights, along with both gross and marketable yields, were observed with the application of cow dung, especially when combined with sowing on November 15. Although most parameters did not show a significant interaction between the type of manure and the sowing date, the effects of each factor highlight their importance in maximizing yield. The application of organic manure enhanced yield components, likely due to improved nutrient supply, increased microbial activity, and better soil physical properties. Additionally, sowing at the optimal time ensures that crop development coincides with favorable environmental conditions, ultimately leading to increased productivity.

In conclusion, integrating organic manure application—particularly cow dung at 20 t ha^{-1}—with a late sowing schedule (November 15) can significantly improve growth characteristics and yield outcomes in carrot cultivation. These findings advocate for the adoption of organic fertilization and strategic sowing timing as sustainable practices to enhance productivity while maintaining soil health. Future research could explore the long-term impacts of such practices and their economic viability for large-scale farming.

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