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Effect of Chemical Fertilizer and Cowdung Manures on the Growth and Yield of Carrots (*Daucus Carota L.*) in Coastal Soil.

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A B S T R A C T :

An experiment was conducted to assess the effect of chemical fertilizer and cow dung manure on the growth and yield of carrots in coastal soil. The experiment included three treatments: T0 as the control, T1 with cow dung manure at 10 tons per hectare, and T2 with chemical fertilizers (NPK) at 180 kg/ha. The experiment was arranged in a randomized complete block design (RCBD) with three replications. Various data were collected during the experiment, such as plant height, number of leaves per plant, root diameter, root length, fresh leaf weight, fresh root weight, dry matter content of leaves and roots, and carrot yield. The application of chemical fertilizer and cow dung manure significantly impacted these parameters. Notably, the maximum plant height (46.21 cm), root weight (70 g), dry root content (69.35%), root length (5.43 cm), root diameter (4.63 cm), and gross yield (17.33 t/ha) were recorded for the treatment of chemical fertilizer at 180 kg/ha. In comparison, the treatment with cow dung at 10 tons per hectare produced a maximum plant height of 39.11 cm, root weight of 52.13 g, dry root content of 62.55%, root length of 4.15 cm, root diameter of 4.30 cm, and gross yield of 12.91 t/ha. The lowest gross yield (10.82 t/ha) was observed in T0. Therefore, the most effective treatment for enhancing the growth and yield of carrots in coastal soil is considered to be 180 kg/ha of chemical fertilizer.

***Key words*:** Chemical fertilizer, Cow dung manure, Coastal soil, salinity, Growth and Yield

Introduction

The carrot (*Daucus carota L.*) is the most important cool-season crop that belongs to the Apiaceae family. It is the main vegetable in the group of tuberous roots. *(Silva et al., 2021)*.It is one of the most important crops cultivated throughout the world in tropical and subtropical regions, especially at high elevations. Originally, wild carrot is indigenous to Europe, Northern Africa, and parts of western Asia, and the first domesticated carrot originated in southwestern Asia in Afghanistan, considered to be the primary center of diversity, and from there spread over Europe, the Mediterranean, and Asia, with Turkey recognized as a second center of diversity. *(Carrot, 2011)*. Through the Rabi season, carrots grown successfully in Bangladesh at Ashwin to Pausha (mid-September to mid-December) are a suitable time for cultivation to yield *(BAMIS 2019)*. Carrot has a various crucial sources of macronutrients and micronutrients, which include carbohydrates, protein, fat, vitamins, antioxidants, minerals like K and Na, folic acid, fibre, and carotenoids. (*Shami, 2019*). The moisture content of carrot varies from 86 to 89% *(Howard et al., 1962)*

According to the Food and Agriculture Organization (FAO), the world's carrot production is continuously increasing. China, the European Union, Russia, and Ukraine are the major carrot-producing countries in the world. In 2018, the global production of carrots (combined with turnips) was 39.99 million tons from 1,875,861 hectares of land. China had the largest share of 45%, totalling 17.90 million tons. In 2021, the global production of carrots reached 41,666,218 tonnes from 2.84 million acres. In Bangladesh, the area under carrot cultivation was 5,736.57 acres in 2020-2021, with a total production of 35 tons *(BBS, 2021)*. In 2021-2022, the production of carrots increased to 31149.77 Metric tonnes from 6,184.94 acres of land *(BBS, 2022)*. Additionally, in Noakhali, 7 acres of land produced 7 metric tonnes of carrots according to *(BBS 2019)*. Carrot growth and yield are influenced by multiple factors, including the variety chosen, climatic conditions, and cultivation practices. Unfortunately, in Bangladesh, there are limited varieties available. However,

carrots are grown worldwide in various colours, such as yellow, orange, and purple, with productivity levels varying by variety. In tropical and subtropical regions, a range of different varieties is available.

Cow dung, which is produced by animals, is a rich source of both macronutrients NKP (Nitrogen 2-3%, Potassium 1%, and Phosphorus 2-2.25%) and micronutrients. It improves the physical and biological properties of soil *(ARM & MG, 2006)* and contains different species of bacteria such as Bacillus spp., Corynebacterium spp., Lactobacillus spp., Citrobacter koseri, Enterobacter aerogenes, Escherichia coli, Klebsiella oxytoca, Klebsiella pneumoniae and Pseudomonas spp. *(Gupta et al., 2016)*. Cow dung is a very important source of organic fertilizer, which is eco-friendly. It maintains soil health and can increase crop productivity by improving soil fertility. Effective use of cow dung can contribute to reducing environmental degradation and greenhouse gas concentration. *(Raj et al., 2014)*

A mixture of inorganic and organic fertilizers can produce thick carrot root tubers. Early vegetative growth was greatly enhanced by higher doses of Nitrogen fertilizer. Inorganic fertilizer (NPK) showed the highest value (5.17cm) for root tuber and (18.33) for leaf height *(Atakora et al., 2014)*. The

farmer should maintain soil productivity by using a combination of mineral fertilizers and organic fertilizers. The main constraint in using organic and inorganic fertilizers in most parts of the world is the determination of the appropriate rate for a specific crop so that it remains with an acceptable yield quantity and quality *(Habimana et al., 2015)*. A large number of scientists have studied the effect of inorganic nitrogenous fertilizer on the growth and yield of carrots. However, few scientists have studied the effect of cow dung on the growth and yield of carrots. Therefore, the present study was undertaken to study the effect of chemical fertilizer and cow dung manure on the growth & yield of carrots in coastal soil.

Objectives

- To determine the potential of a variety of carrots for growth and yield in coastal areas with saline soil, taking into account the soil types and environmental factors.
- To find the optimal levels of cow dung manure and NPK fertiliser for the growth and yield of carrots in coastal soil.
- To investigate the impact of different applications of NPK and cow dung on the growth and yield of carrots in coastal soil.

Materials and Methods

Experimental site and plant material

The experimental field was located 8 km southwest of Maijdee at 22°47'31" N latitude and 91°06'07" E longitude, with an elevation of 6m above sea level, within the agroecological zone AEZ-18. Situated in the Meghna estuarine floodplain, the region consists largely of young alluvial land with low ridges and depressions. The tropical climate has four distinct seasons: Spring (March to May) with temperatures from 32.4°C to 33.8°C and 131mm of rainfall; Summer (June to August) with temperatures from 31.3°C to 33.8°C and up to 290mm of rainfall; Autumn (September to November) with temperatures from 30.3°C to 28.5°C and rainfall between 35mm and 182mm; and Winter (December to February) with temperatures from 25.8°C to 28.8°C and minimal rainfall of 5mm to 12mm. Meteorological data were sourced from the Bangladesh Meteorological Department, and soil samples indicated sandy loam and saline soils with pH and EC values of 7.5 and 1.67 ds/m, respectively. The soil has medium fertility but low organic matter. The experiment employed a Randomised Complete Block Design (RCBD) with three replications, resulting in a total of nine plots, each measuring 1.05 m². Spacing was 18cm between plants and 20cm between rows. The selected variety for the experiment was New Kuroda 35, known for high yield. The seeds were treated with Mancozeb @3g/100 g seed.

Intercultural operations

Thinning: Seedlings started to emerge 15 days after sowing. The first thinning occurred at 25 days, leaving three seedlings per hill, followed by a second thinning 22 days later, retaining one healthy seedling per hill.

Weeding**:** Conducted five to six times as needed to keep the crop free from weeds and improve soil quality**.**

Irrigation**:** The field was irrigated 12 times throughout growth, with watering every alternate day after germination. Additional watering occurred at 15, 25, 35, 45, 55, 65, 75, and 85 days post-sowing.

Plant protection**:** The crop experienced minor pest issues, mainly from ants, and showed yellowing in seedlings due to nutrient deficiencies. No insecticides were used as the infestation was minimal. This was part of an experiment on carrot production involving chemical fertilizers and cow dung.

Harvesting

The crop was harvested on 18th March 2023 after 105 days from seed sowing, when the leaves turned a pale yellow colour. *(Rikabdar, 2000)* Suggested that carrots should be harvested in Bangladesh within 90-105 days after sowing for maximum yield and quality. The crop was harvested plot-wise, carefully by hand. The soil and fibrous roots and hearing to the roots were cleaned with a cloth and water. Five plants were selected at random and uprooted very carefully from each unit plot at the time of harvest, and mean data on the following parameters were recorded.

Observation and data Analysis: Five plants per plot samples were randomly collected from the experimental unit whole plot was harvested to record per plant data.

Plant height (cm): The plant height was measured in centimeters (cm) by measuring scale at 45, 65, 85, and 105 days after sowing (DAS) from the ground level to the tip of the longest leaf**.**

Number of leaves per plant**:** The number of leaves per plant of 5 sampled hills was counted at 45, 65, 85, and at harvest (105) DAS—each plant of leaves where counted individually. Only the smallest young leaves at the growing point of the plant were omitted from the count.

Length of root (cm)**:** The root length was measured in cm from the leaves' attachment point to the root tip for each treatment, and the mean was calculated.

Diameter of root (cm): The average diameter of the root was measured at the three portions (upper, middle, and lower) of the root harvest with the help of Vernier callipers.

Fresh weight of leaves per plant (g)**:** Leaves of each of the collected plants from each unit plot at harvest were detached by a sharp knife, and the average fresh weight of leaves was taken by using an electrical balance and recorded in grams (g) by making the average value.

Fresh weight of root per plant (g): Underground modified roots were detached by a sharp knife from the attachment of leaves, and after cleaning the

soil with running water and thin roots, the fresh weight was taken by using an electrical balance and recorded in grams (g) by making an average value.

Dry matter content of roots (%): After harvesting, the roots were cleaned with water and air dried. A sample of carrot pieces was taken and sun-dried for 3 days. The samples were then weighed using an electronic balance, and the dry matter content was calculated with the formula:

% Dry matter content of root = (Dry weight of root (g) / Fresh weight of root (g)) x 100

Dry matter content of leaves (%): Fresh leaves were weighed, then sun-dried for 3 days. The weight of the dry leaves was calculated using the following formula:

%Dry matter content of leaves = (Dry weight of leaves (g) / Fresh weight of leaves (g)) x 100

Total yield of carrot roots per hectare (tons): The yield of roots per hectare was computed from the per plot yield and was recorded in tons *(Jamil,2021),* calculated by using the following formula:

Total gross yield = Yield per plot (kg) × 10000 m2 / Area of plot in square meters (m2) × 1000 Kg

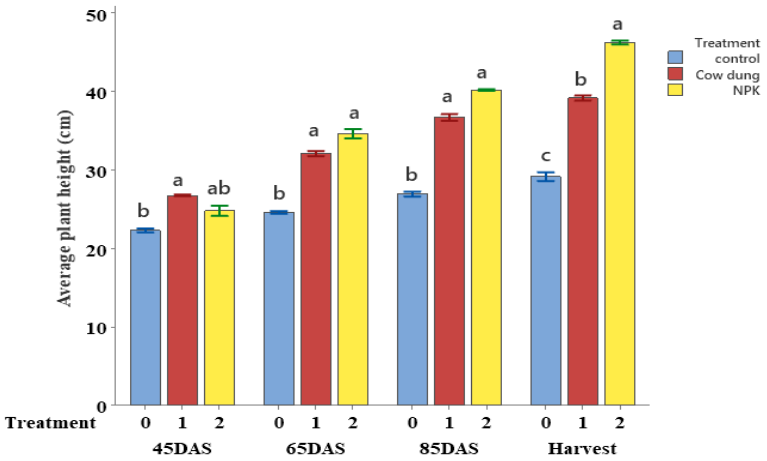
Statistical analysis

The experimental plots' data were statistically analysed using Minitab 20 software and a Microsoft Excel worksheet. The mean values for all the parameters were calculated, and analysis of variance for most characters was accomplished by the F variance test. The significance of the difference between the pair of means was performed by the Least Signification Difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984)

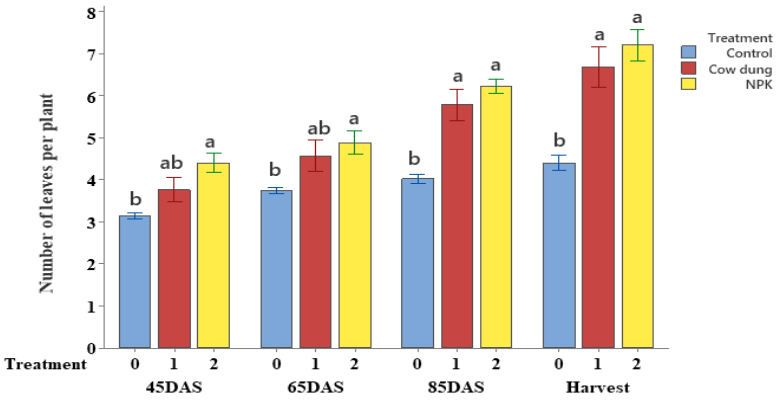
Result and Discussion

Growth Parameter

Plant Height: The height of carrot plants was significantly affected (P<0.05) by chemical fertilizers and cow dung manure in coastal soil. Measurements were taken at 45, 65, and 85 days after sowing, as well as at harvest. Chemical treatments generally increased plant height, with the maximum heights observed at harvest using chemical fertiliser (34.37 cm, 40.2 cm, and 46.21 cm). In contrast, the control treatment (T0) recorded the lowest height at 28.93 cm. Overall, the study indicates that chemical fertilizers significantly enhance carrot plant height compared to other treatments. *(Annisha Afrin et al. 2019)* also noted that both organic and inorganic fertilizers, along with proper irrigation, positively impacted carrot growth and yield.

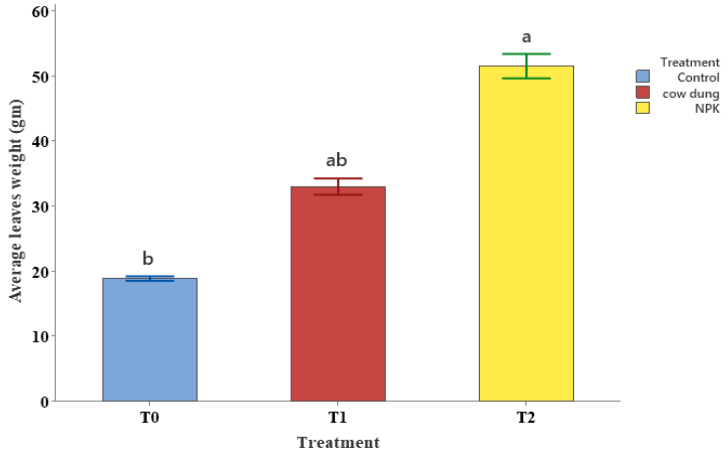


Number of leaves per plant: There was a significant difference (P<0.05) in the number of leaves per carrot plant between the chemical fertilizer and cow dung treatments. The number of leaves, which is vital for growth, was recorded at 45, 65, and 85 days after sowing and at harvest. Chemical fertilizer treatments yielded the highest number of leaves, reaching a maximum of 7.13 at harvest for the 180 kg/ha application, while the control group had a minimum of 4.4 leaves. The cow dung treatment averaged 6.54 leaves.

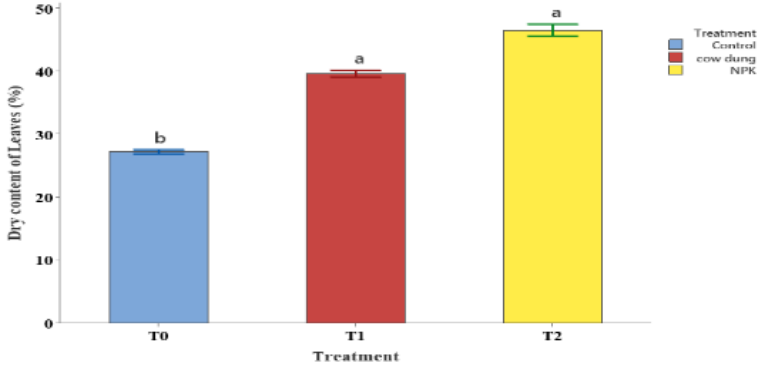


Maturity/Yield parameters

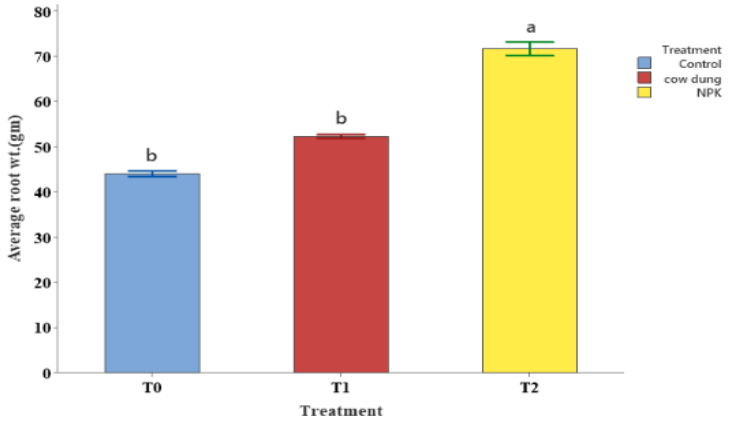
***Fresh leaf weight (g)*:** The application of 180 kg ha-1 of chemical fertilizer resulted in the highest fresh leaf weight (49.13 g) in the T2 treatment, compared to 18.8 g in the control plot (T0) and 31.46 g in the T1 treatment (10 tha-1 cow dung). Previous studies have indicated that salinity stress reduces photosynthesis and leaf stomatal function *(Jahan et al., 2019)*, while integrated manure and fertilizers enhance leaf weight by supplying more nutrients *(Vikram et al., 2022)*.



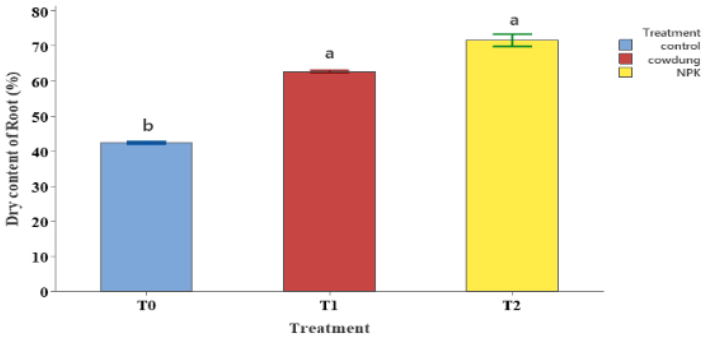
Dry matter content of leaves (%): The results indicated a significant difference (P<0.05) in the dry matter of carrots among treatments. The chemical fertilizer T2 had the highest dry content at 45.83%, while the Control T0 had the lowest at 27.15%. The T1 treatment with cow dung had a dry content of 39.41%. *Olorunmaiye et al., 2019)* found that lower leaf water content resulted in increased biomass of carrot leaves. Additionally, high salinity reduced K content and increased Cl content in leaves, leading to decreased plant water consumption and water use efficiency.



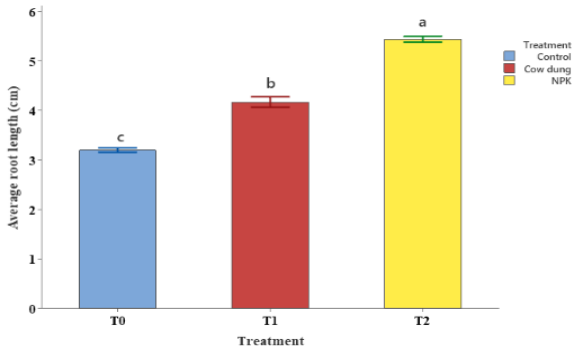
***Fresh root weight (g)*:** The study found that 180 kg ha-1 of chemical fertilizer produced the highest average root weight of 70.10 g, compared to 43.73 g in the control group (T0) and 52.13 g for 10 tha-1 of cow dung (T1). *Ahmad et al. (2005)* noted that low saltwater concentrations don't impact plant growth with adequate soil moisture, while *Yadav et al. (1998)* indicated that high salinity reduces root weight. Additionally, *Olorunmaiye et al. 2019)* showed that combining organic manures with mineral fertilizers significantly enhances root weight.



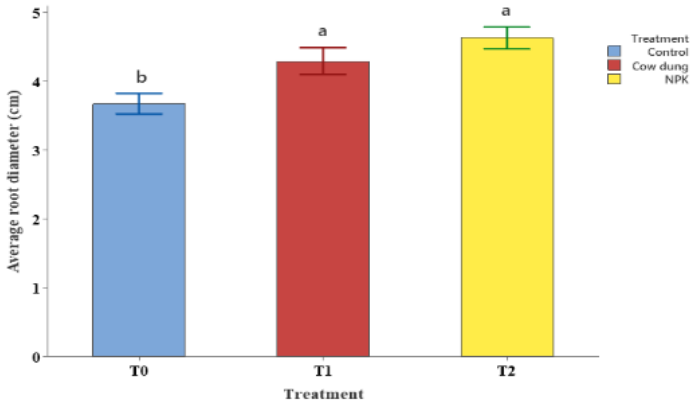
***Dry matter content of root (%)*:** The highest dry matter content (69.35%) was found in T2 chemical fertilizer, while the control (T0) had the lowest at 42.37%. T1, with cow dung, had a dry content of 62.56%. According to *Olorunmaiye et al. (2019),* higher NPK treatment results in increased dry matter content due to reduced water levels and decreased cell expansion in roots.



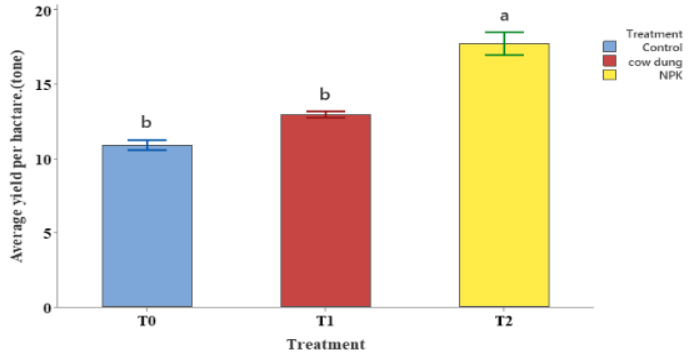
***Root length (cm)*:** The highest average root length of 5.43 cm was observed during the treatment with fertilizer. In contrast, the lowest average of 3.20 cm occurred in the control group without fertilizer. The T1 treatment with cow dung yielded an average root length of 4.15 cm. *Uddin et al. (2004)* and *Olorunmaiye et al. (2019)* suggested that the increased root length in untreated conditions was likely due to sufficient moisture, promoting rapid cell elongation. Similarly, *Ahmad et al. (2005)* noted that higher water levels resulted in longer carrot roots.



***Root diameter (cm)*:** In T2 treatment, the highest average root width (4.63 cm) resulted from chemical fertilizer, while the control (T0) had the lowest (3.67 cm). Cow dung treatment (T1) showed an average of 4.31 cm. *Ahmed et al. (2005)* noted that adequate soil moisture promotes thicker carrot roots and higher yields, while *Vikram et al. (2022)* found that integrated nutrient application positively affects root diameter.



***Yield ha*-1:** The highest root yield of 17.33 t ha-1 was achieved with T2 treatment, while the control (T0) yielded 10.82 t ha-1, and T1 produced 12.91 t ha-1. According to *Singh et al. (2023),* combining organic and inorganic fertilizers enhances nutrient uptake and improves carrot yields while reducing nutrient loss.



Table

Analysis of variance (ANOVA) for growth and yield parameters of carrots in coastal soil under different treatments

1.1) ***Growth parameter of plant height and No. of leaves plant*-1**

Traits	Variance	DF	SS	MS	F- Value	P- Value
45DAS	Treatment	2	30.4659	15.2329	3.817	0.085NS
	Error	6	23.9469	3.9912		
	Total	8	54.4128			
65DAS	Treatment	2	155.7489	77.8744	12.255	0.008**
	Error	6	21.2507	6.3544		
	Total	8	193.8756			
85DAS	Treatment	2	284.9238	142.4619	40.223	0.000**
	Error	6	21.2507	3.5418		
	Total	8	306.1745			
At harvest	Treatment	2	452.6408	226.3204	37.761	0.000**
	Error	6	35.9606	5.9934		
	Total	8	488.6014			

Traits	Variance	DF	SS	MS	F- Value	P- Value
45DAS	Treatment	2	2.4139	1.2069	9.64	0.013**
	Error	6	0.7509	0.1252		
	Total	8	3.1648			
65DAS	Treatment	2	1.909	0.9544		
	Error	6	1.653	0.2756	3.46	0.10NS
	Total	8	3.562			
85DAS	Treatment	2	7.902	3.9511		
	Error	6	1.707	0.2844	13.89	0.006**
	Total	8	9.609			
At harvest	Treatment	2	12.403	6.2014		
	Error	6	5.12	0.8534	7.27	0.025*
	Total	8	17.523			

1.2) Maturity/yield parameter

Traits	Variance	DF	SS	MS	F- Value	P- Value
Leaves weight	Treatment	2	1392.7	696.33	8.42	0.018*
	Error	6	496.3	82.72		
	Total	8	1885			
DL%	Treatment	2	540.5	270.23	12.54	0.007**
	Error	6	129.3	21.54		
	Total	8	669.7			
F.RWt.	Treatment	2	1079.7	539.86	8.04	0.020*
	Error	6	402.8	67.13		
	Total	8	1482.5			
DR %	Treatment	2	1180.6	590.28	6.97	0.027*
	Error	6	508	84.67		
	Total	8	1688.6			
RL	Treatment	2	7.5585	3.77923	203.67	0.000**
	Error	6	0.1113	0.01856		
	Total	8	7.6698			
RD	Treatment	2	1.4209	0.71043	7.83	0.021*
	Error	6	0.5447	0.09079		
	Total	8	1.9656			
Y/ha	Treatment	2	66.2	33.101	8.04	0.02*
	Error	6	24.7	4.116		
	Total	8	90.9			

NS: Non-Significant, **: Significant at 1% level of probability,*: Significant at a 5% level of probability, DF: Degree of freedom, SS: Sum of squares, MS: Mean square, DAS: Day After Sowing, DL%: Dry leaves content% %, FRWt.: Fresh Root Weight, DR% : Dry Root content% %, RL: Root length, RD: Root diameter, Y/ha: Yield per hectare

Conclusion

The application of chemical fertilizer at a rate of 180 kg/ha significantly enhances carrot yield and growth in coastal soil. Cow dung manure provides moderate benefits and improves soil health, making it a suitable complementary input. For farmers in saline regions, integrated nutrient management is recommended.

Acknowledgement

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