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Effects of planting density and farm yard manure on the growth and yield of carrot (*Daucus carota* L) in a Forest-Savanna Transition Zone of Edo State, Nigeria

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Abstract

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A field study was conducted to investigate the impact of planting density and farmyard manure on the growth and yield of carrots (Daucus carota L.) in a forest-savanna transition zone of Edo State, Nigeria. The factors were density (30×10, 30×20, 40×10, and 40×20 cm) and farmyard manure (0 and 5 t/ha). The treatments were laid out in a 2×4 factorial scheme fitted into a randomized complete block design (RCBD) to give eight (8) treatment combinations and replicated three times. The data obtained were plant height (cm), Number of leaves/plant, and stem girth. Length of root (cm), weight of roots/plant (g), and root yield (/ha) were also determined. Generally, planting density and farmyard manure did not significantly influence the vegetative parameters measured. Carrots treated with 5 t/ha at a spacing of 40×20 cm had the highest plant height (44.30 cm) and stem girth (2.24 cm), while those at 40×10 and 30×10 cm had the lowest values of 38.53cm and 1.38cm, respectively. The highest number of leaves/plant (14.77) was obtained with 5/ha FYM at 40×20 cm, while the unfertilized crops at 40×20 cm yielded the least, at 10.90 cm. Farmyard manure application and planting density had no significant effect on the yield components of carrots. However, crops treated with 5 t/ha FYM at 30×20 cm had the longest roots, while unfertilized plants at 30 × 10 cm had the shortest. Density and farmyard manure significantly affected the root yield of carrots. The application of 5t/ha FYM at 40×10 cm produced the highest root yield (14.45 t/ha), while the unfertilized treatment at 30x10 cm gave the least (5.33 t/ha). Sowing of carrots at 40×10, fertilized with 5 t/h FYM, is recommended for carrot production in this locality.

Keywords: clay; silt; plant density; organic carbon; phosphorus; potassium

Introduction

Carrot (*Daucus carota* L.) is herbaceous biennial plant belonging to the genus Daucus, species carota and the member of *Apiaceae* family (Remison, 2005). Carrots are one of the most important and central root vegetables used as a salad ingredient and a cooked vegetable. It is a rich source of beta-carotene, a precursor to vitamin A (Chadha, 2003). It is said to have originated from the Mediterranean region and produces an enlarged, fleshy taproot that is edible and possesses high nutritional value (Jeptoo et al., 2012). Carrots are mainly a temperate crop grown during spring through autumn in temperate countries and during winter in tropical and subtropical countries worldwide (Akand, 2003).

According to Remison (2005), a temperature range of 15.6°C to 21.1°C is ideal for its growth and development.

Higher and lower temperatures reduce the rate of growth and adversely affect the quality of the roots. Carrots grow successfully under available temperatures ranging from 11.17°C to 28.9°C (Rashid, 1993). The stem is thick and lacks lateral roots with a single leaf attached to a node. The roots are long and thin, and either purple or yellow in color. High-quality carrots have a large proportion of cortex compared to the core. The root diameter can range from a few centimeters to as much as 10 centimeters at the widest part. The root length ranges from five to 50 cm, although most are between 10 and 25 cm (Simon et al., 2001).

Organic manure improves soil structure and increases its water-holding capacity. Moreover, it facilitates aeration in soil. Recently, organic farming has gained appreciation among vegetable consumers for its enhancement of product quality. Carrots are heavy feeders of nutrients and absorb 100 kg N, 50 kg P_2O_5, and 180 kg K_2O/ha. Therefore, the judicious and proper use of organic manures and fertilizers is essential not only for achieving higher yields and quality production, but also for maintaining soil health and sustainability over a longer period. Among the oil cakes, neem and castor cakes are quickly insoluble in water, providing slow and steady nourishment and protection from nematodes, and improving the yield and quality of production (Garu et al., 1992). Vermicompost, produced by earthworms, is a rich source of both micro- and macro-nutrients, vitamins, growth hormones, and enzymes (Simon et al., 2001).

Plant density, a practice that determines the spatial distribution of plants, affects canopy structure, light interception, and radiation use efficiency and, consequently, crop yield (Muck, 2010). Appropriate planting density and resource competition relationships are crucial in crop productivity (Uddin et al, 2014). Plant population and row width determine light interception, which in turn affects photosynthesis and yield (Kumar et al., 2017). Generally, the report by Muck (2010) clearly indicates that the yield per single plant decreases as the plant density per unit area increases. Kumar et al. (2017) reported that root diameter, mean root weight, and plant height decreased as population density increased.

Plant density is a function of spacing and is regarded as one of the most important factors affecting carrot productivity. However, an increase in plant density can reduce water availability to individual plants and lead to water deficiency, followed by a yield decrease.

Decline in soil fertility is particularly severe in tropical regions, where the soil lacks adequate plant nutrients due to leaching and erosion of topsoil by intense rainfall. Farmers in this zone seeking to increase the yield of carrots face a short supply of planting materials (seeds) and a high cost of inorganic fertilizers.

Organic manure and spacing in carrot production involve no extra cost in acquiring the manure for the carrot plants. However, it is not known whether these cultural practices result in a yield increase of carrots to warrant their adoption.

Regardless of the agronomic conditions provided for carrot cultivation (Kumar et al., 2017), yields remain low on a subsistence level. The reasons for this are the way most peasant farmers carry out their farm practices without designated spacing under native soil conditions. There is a dearth of information regarding the combined practice of population density and fertilizer (farmyard manure) management in this area of study, which necessitated the present research.

Although poultry manure is the most frequently used organic manure in vegetable production in Ekpoma, the quantities applied by farmers are often not based on research recommendations.

However, the study of this nature is necessary as it will strengthen the management of plant populations for adequate organic manure, thereby avoiding crop competition, yield reduction, and soil structure destruction.

The overall aim of this study was to determine the effects of density and farmyard manure on the growth and yield of carrots. The specific objectives were to determine the effects of density and farmyard manure on the growth of carrots, yield components of the crop, and Root yield of carrots.

Materials and Methods

Experimental location

The field experiment was conducted on April, 02, 2022, at the onset of the rainy season at the Teaching and Research Farm, Ambrose Alli University, Emaudo Annex, Ekpoma. Ekpoma is situated between latitudes 6°45′ North and longitudes 6°08′ East. The area falls within the rainforest-savanna transition zone of Edo State, Nigeria. Ekpoma is situated within the northern boundary of the rainforest zone of Nigeria, with a mean annual rainfall of approximately 1200 mm to 1500 mm and a mean air temperature of 29°C (Ighalo and Remison, 2010).

Soil and farm yard manure (FYM) analysis

Prior to planting, representative soil samples were randomly collected from the surface soil (0–15 cm depth) at the experimental site using a soil auger to determine routine physicochemical properties according to the procedure described by Okalebo et al. (2002). This was repeated after cropping with a carrot.

The FYM was analyzed for chemical properties as described by Anderson and Ingram (1993).

Experimental materials

A variety of carrots was obtained from the International Institute of Tropical Agriculture (IITA). Ibadan. The source of the farmyard manure used was poultry droppings, collected from the Livestock Unit, Teaching and Research Farm, Faculty of Agriculture, Ambrose Alli University, Ekpoma, Edo State.

Experimental layout

The experiment was a 2×3 factorial scheme fitted into a randomized complete block design (RCBD) with two levels of farmyard (poultry manure) and four population densities, replicated three times. The farmyard manure treatments were: control (0) and 5 t/ha, and the four planting densities were: 30×10 cm (333,333 plants/ha), 30×20 cm (166,667 plants/ha), 40×10 cm (250,000 plants/ha), and 40×20 cm (125,000 plants/ha).

Land preparation

The land preparation was done manually, and planting took place when the rains were reliable. Carrot seeds were sown on 26 February 2022 on prepared beds at various densities: 30×10 cm, 30×20 cm, 40×10 cm, and 40×20 cm. The Individual plot size was 2.4×3 m², with a spacing of 1m within plots and between replicates. A total of twenty-four plots were involved. The area used was 19.2×9 m, giving a total land area of 172.80 m² (0.02 ha). The manure was incorporated into the soil 2 weeks before planting to facilitate proper mineralization. Weed control was manually done with a hoe at 3 and 7 Weeks after planting.

Data collection

The data collected were grouped into vegetative and yield parameters.

Vegetative traits

Vegetative traits were taken from three randomly selected plants at 2, 4, 6, 8, and 10-week intervals after planting. These were:

Plant height (cm): A measuring tape was used to measure the height of the three randomly selected plants from the soil surface to the tip of the crop, where the youngest leaf branches and the average value were recorded.

Number of leaves per plant: The numbers of leaves from the three randomly selected plants/plot were visually counted and the average value recorded.

Stem girth: The stem girth of three randomly selected plants per plot was measured with the help of a venier calliper, and the mean value was recorded.

Yield and yield components

Yield parameters were measured. These were:

Root length (cm): A measuring tape was used to measure the root from the apex of the root to the base of the root stalk of the three randomly selected plants/plot, and the average value was recorded.

Root weight/plant: The weight of the roots of three randomly selected plants was measured using a weighing balance, and the mean was recorded.

Fruit yield: A Weighing balance (Electronic compact scale) was used to take the fruit yield/plot. The values were approximated to t/ha using the formula below.

$$\text{Root yield (t/ha)} = \frac{\text{Weight of roots (kg)}}{\text{Harvested area (m}^2\text{)}} \times \frac{1000\ (\text{m}^2)}{1000}$$

Statistical analysis

All growth and yield data collected were analyzed using analysis of variance (ANOVA) with the help of SAS (2008) computer software programs, and the means were separated using the Duncan Multiple Range Test at a 5% level of probability.

Results

Physico-chemical properties of the soil in the experimental site and the chemical properties of the manure used for the study

Table 1. Physico-chemical properties of the experimental site soil prior to planting and after cropping, and chemical properties of the poultry manure used

Parameters	Soil	
	Before Planting	After Planting
pH (H_2O)	5.57	5.69
Fine sand (0%)	89.55	89.54
Clay (0%)	8.90	8.92
Silt (0%)	1.55	1.54
Texture	Sand	Sand
Organic carbon (0%)	0.27	1.75
Total Nitrogen (%)	0.03	0.50
Available Phosphorus (mg/kg)	2.92	35.68
Exchangeable cations (cmo1/kg)		
Exchangeable calcium	0.34	0.98
Exchangeable Magnesium	0.25	0.50
Exchangeable Potassium	0.06	0.11
Exchangeable Sodium	0.05	1.09
Total Exchangeable Bases	0.70	1.68
Exchangeable Acidity (cmo1/kg)	0.80	0.59
Effective cation exchange capacity (cmo1/kg)	1.50	2.27
Base saturation %	46.67	74.00

Source: Authors' own elaboration

Table2. Physico-chemical properties of the experimental site soil prior to planting and after cropping, and chemical properties of the farm yard manure used

Parameters	Soil	
	Before planting	After cropping
pH (H_2O)	8.14	8.21
Organic carbon (%)	3.80	4.91
Total nitrogen	0.82	0.95
Available phosphorus	73.30	76.53
Exchangeable cations (cmol/kg)		
Exchangeable calcium	0.93	0.96
Exchangeable magnesium	0.79	0.86
Exchangeable potassium	1.20	1.35
Exchangeable sodium	1.35	1.47
Total exchangeable bases	4.27	4.64

Source: Authors' own elaboration

The results of the physico-chemical properties of soil of the experimental site before and after cropping and the chemical properties of the farm yard manure are presented in Tables 1 and 2. The textural class of the soils was sand, and they were slightly acidic before and after cropping (Table 1). The available phosphorus and total nitrogen levels were low prior to planting and subsequently increased, exceeding the critical levels. Some macronutrients were initially low, but there was a slight increase after carrot planting. The results for the chemical properties of the manure showed that the farmyard manure had high organic carbon and sufficient total nitrogen, available phosphorus, and the macro-nutrients (Table 2).

Vegetative traits

Plant height (cm)

FYM significantly affected the plant height of carrots from 2 to 4 weeks after planting, whereas the effect of planting density was only significant at 2 weeks after planting (Table 3). There was no consistent significant interaction between FYM and density at any of the sampling periods, except at 2WAP. The height of the crop treated with 5 t/ha FYM was taller than that of the control. At 10WAP, the planting densities used were not comparable in height. The plants spaced 30×20 cm grew tallest, followed by those spaced 40×20 cm, and both were significantly taller than the closely spaced plants at 30×10 cm and 40×10 cm. Although the application of 5 t/ha FYM at 40×20 cm resulted in taller carrots, it was not significantly different from other treatments.

Values with the same letter(s) superscript indicated in columns are not significantly different using DMRT at 5% level of probability; FYM: farm yard manure: PD: planting density: ns: not significant.

Number of leaves/plant

There were no significant differences in the planting density on the number of leaves borne by the carrot plants throughout the weeks after planting (Table 4). The FYM application did not significantly affect the number of leaves borne by the crops throughout the sampling periods. The FYM-treated plants developed the most leaves, which were not compared to the untreated plants. At 10 WAP, the highest number of leaves/plant (about 15) borne by the FYM-treated plants at 40×20 was not comparable with other densities, combined with and without FYM. The results showed that slightly fewer leaves were produced in the control or unfertilized crops (Table 4). However, 5 t/ha FYM-treated plants produced 12.54

Table 3. Effect of farmyard manure application and planting density on the plant height (cm) of carrot

Farmyard Manure (t/ha)	Planting Density (cm)	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
0	30 × 10	18.23^{abc}	27.10^{ns}	29.67^{ns}	32.77^{ns}	41.37^{ns}
	30 × 20	18.77^{abc}	27.20	33.00	38.33	46.20
	40 × 10	14.13^{c}	24.40	30.00	32.43	40.70
	40 × 20	16.33^{bc}	23.67	30.13	34.00	43.00
	Mean	16.87^{b}	25.59	30.70	34.40	42.08
5	30 × 10	18.33^{abc}	28.50	31.37	35.43	42.10
	30 × 20	23.67^{a}	30.40	29.43	40.30	49.43
	40 × 10	22.57^{ab}	29.87	32.43	34.00	38.53
	40 × 20	19.33^{abc}	28.53	30.80	36.67	47.20
	Mean	20.98^{a}	29.32	31.00	36.60	44.30
LSD (P < 0.05)						
	Farmyard manure	*	*	ns	ns	ns
	Planting density	*	ns	ns	ns	ns
	Interaction (FYM × PD)	*	ns	ns	ns	ns

Source: Authors' own elaboration

leaves/plant compared to the control (11.97). Generally, plants spaced widely (40×20 cm/30×20 cm) produced taller plants compared with those spaced closely (40×10 cm/30×10 cm).

Values with the same letter(s) superscript indicated in columns are not significantly different using DMRT at 5% level of probability; FYM: farm yard manure: PD: planting density: ns: not significant

Stem girth (cm)

There were no significant differences among the four densities of carrot on the stem girth throughout the sampling periods except at 6WAP (Table 5). All the densities of carrots used for the study produced similar stem girths, about 1cm from 2-6WAP and 2cm from 8-10WAP. Farmyard manure applied did not, at the stage of data collection, affect the stem girth of carrots significantly. The interaction between FYM and planting density significantly affected the stem girth of carrots at 10 weeks after planting (WAP). At 14 WAP, crops at the various densities used produced similar stem girths, approximately 2 m. Although the crops treated with 5 t/ha FYM had higher stem girth than the control, the difference was approximately 2 cm. The effects of the interaction between FYM x planting density were compared by LSD at 0.05 with 5t/ha FYM at 40×20 cm and 30×10 cm producing the most significant and the least significant girth values of 2.24 cm and 1.38 cm, respectively (Table 5).

Values with the same letter(s) superscript indicated in columns are not significantly different using DMRT at 5% level of probability; FYM: farm yard manure: PD: planting density: ns: not significant.

Table 4. Effect of farm yard manure application and planting density on the number of leaves/plant of carrot

Farmyard Manure (t/ha)	Planting Density (cm)	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
0	30 × 10	4.33^{ns}	5.47^{ns}	7.30^{ab}	9.43^{ns}	11.43^{ns}
	30 × 20	4.13	5.90	7.77^{ab}	9.43	12.67
	40 × 10	5.53	5.87	8.20^{a}	10.57	12.87
	40 × 20	5.33	6.33	7.10^{ab}	9.57	10.90
	Mean	4.83	5.89	7.59	9.75	11.97
5	30 × 10	4.67	5.80	6.77^{ab}	8.33	11.77
	30 × 20	4.90	5.57	6.53^{ab}	9.43	12.53
	40 × 10	4.23	4.97	6.23^{b}	7.77	11.10
	40 × 20	4.33	6.23	7.73^{ab}	10.80	14.77
	Mean	4.53	5.64	6.82	9.08	12.54
LSD (P < 0.05)						
	Farmyard manure	ns	ns	ns	ns	ns
	Planting density	ns	ns	ns	ns	ns
	Interaction (FYM × PD)	ns	ns	*	ns	ns

Source: Authors' own elaboration

Table 5. Effects of farm yard manure application and planting density on the stem girth (cm) of carrot

Farmyard Manure (t/ha)	Planting Density (cm)	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
0	30 × 10	0.44^{ns}	0.73^{ns}	0.86^{ns}	1.59^{ns}	1.65^{ab}
	30 × 20	0.48	0.91	0.99	1.59	1.66^{ab}
	40 × 10	0.53	0.81	1.09	1.83	1.97^{ab}
	40 × 20	0.56	0.91	1.17	1.56	1.62^{ab}
	Mean	0.50	0.84	1.03	1.64	1.73
5	30 × 10	0.52	0.71	0.83	1.31	1.38^{b}
	30 × 20	0.52	0.77	0.88	1.38	1.65^{ab}
	40 × 10	0.47	0.68	1.17	1.63	1.96^{ab}
	40 × 20	0.44	0.85	1.41	1.93	2.24^{a}
	Mean	0.49	0.75	1.07	1.56	1.81
LSD (P < 0.05)						
	Farmyard manure	ns	ns	ns	ns	Ns
	Planting density	ns	ns	*	ns	ns
	Interaction (FYM × PD)	ns	ns	ns	ns	*

Source: Authors' own elaboration

Fruit yield and components of yield

Length of roots

The results obtained for root length ranged from 24.30 cm in the unfertilized 30×10 cm density to 44.30 cm in FYM when treated with a 30×20 cm density (Table 6). Although the 30.20 cm density of carrot had longer roots (i.e., about 44.30 cm) than the other densities, while the closest plants produced roots with the least value (about 30.73 cm), all four were comparable in root length.

Although crops fertilized with 5t/ha FYM had longer roots (40.44 cm) than the unfertilized plants (32.90 cm), the difference was not significant. The root length of crops fertilized with farmyard manure interacted significantly with the density of carrots.

Weight of the root plant

There was no significant difference among the four densities of the carrot in root weight/plant (Table 6). Crops spaced at 40×10 cm, however, had a higher weight of roots per plant (77.08 g) than the other densities. Manure application and the interaction between density and FYM did not significantly influence the weight of roots borne by the carrot plant. Farmyard manure-treated plants produced a higher weight of roots/plant than the control plants. FYM crops had 73.60 g, while 68.40 g was for the control plants (Table 6).

Root yield

The results on the effects of density and farm yard manure application on the root yield of carrot are presented in Table 6. The application of FYM (organic) had a significant impact on the root yield of the carrots. Similarly, density had a significant impact on the root yield of carrots. In the same vein, there was a significant density x FYM application interaction effect on the root yield of carrot. The root yield ranged from 5.33–11.83 t/ha in control plants and 8.55–14.45 t/ha in 5t/ha FYM. The root yield of 5t/ha of FYM was significantly higher (12.541ha) than that of the unfertilized carrot crop (9.46). The density of 40×10 cm root yield also responded remarkably to the application of FYM compared to the control. The root yields of crops spaced at 30×20, 40×10, and 40×20 cm were not comparable by LSD at 0.05.

Values with the same letter(s) superscript indicated in columns are not significantly different using DMRT at 5% level of probability: FYM: Farm yard manure; PD: Planting Density; ns: not significant.

Discussion

The vegetative attributes of plants are a significant parameter for assessing the growth and development of crops. Soil fertility management is important due to the depletion of nutrient status in tropical soils. From this study, taller plants, a higher number of leaves/plant, the number of branches per plant, and the stem girth of carrots were favored by the FYM application compared to the control. Crops spaced at 40×20 cm, fertilized with 5 t/ha FYM, showed dominance in the number of leaves/ plant, number of branches/plant, and stem girth compared to the other treatments investigated. The higher values obtained for vegetative traits in the fertilized crops may be due to the fact that the crop has adapted to this environment, which may have complemented its genetic ability in utilizing the applied FYM for better growth and

Table 6. Effects of farm yard manure application and planting density on the root yield and components of yield of carrot

Farmyard Manure (t/ha)	Planting Density (cm)	Length of Root (cm)	Weight of Root/Plant (g)	Root Yield (t/ha)
0	30×10	24.30^{b}	60.64^{ns}	5.33^{d}
	30×20	34.20^{ab}	64.39	10.80^{abc}
	40×10	33.87^{ab}	75.94	11.83^{abc}
	40×20	39.42^{ab}	72.45	9.86^{bc}
Mean		32.95	68.40	9.46
5	30×10	37.17^{ab}	78.11	8.55^{cd}
	30×20	44.30^{a}	74.18	14.08^{a}
	40×10	43.20^{a}	78.22	14.45^{a}
	40×20	37.07^{ab}	63.74	13.07^{ab}
Mean		40.44	73.56	12.54
LSD (P<0.05)				
	Farm yard manure	ns	ns	*
	Planting density	ns	ns	*
	Interaction (FYM×PD)	*	ns	*

Source: Authors' own elaboration

development compared to the unfertilized crops. Planting at wider spacing produced higher vegetative parameters than the closely spaced plants. This may be attributed to better light penetration, which enhanced high photosynthesis for food production. This report is in agreement with the earlier results by Koriem and Farag (1990), who found that onions planted at a wider spacing produced more leaves and higher foliage dry matter. Splittstoesser (1990) also reported that carrot vegetative growth is adversely affected by low planting density. Fertilizer application on carrots increased the plant height, number of leaves/ plant, and stem girth compared to the control. This may be attributed to the plant's ability to absorb the applied fertilizers (manure) for vegetative growth. A report by Aduwa et al. (2021) revealed that the vegetative growth of crops was increased with the addition of organic cattle manure. Gerba et al. (2018) in a study revealed that application of organic manure on carrots showed a highly significant effect for growth parameters (plant height and canopy diameter).

Yield is the primary factor for crop production. However, farmers' selection of an appropriate density is achieved by planting at random. This practice is not only wasteful of planting materials but also results in competition between plants within the same stand. Generally, wider densities produced higher yield components than the closer densities, as observed in this present study. This may have been made possible by a higher rate of plant dry matter accumulation during the period from exponential growth to physiological maturity. Fertilized crops had better root length and root weight per plant than the control due to the availability of nutrients, which enhanced the development of yield components. The application of FYM increased the root yield of carrots compared to the control. This may be as a result of the crop's ability to absorb and mobilize the available nutrients for root production. This result is in agreement with the report by Kahangi (2004), who recommended applying 10-20 t/ha of poultry manure for improved growth and yield of carrots in the tropics.

Conclusions

An experiment was conducted to investigate the effect of density and farmyard manure on the growth and yield of carrots in a forest-savanna transition zone of Edo State. The results obtained from this research showed that the soil at the experimental site prior to planting was a sandy loam, slightly acidic, with moderate organic carbon content, and deficient in some macro-nutrients. The organic carbon, total N, available P, and macro-nutrients were slightly increased by the applied manure after cropping. The application of farmyard manure and planting density had no significant effect on the vegetative parameters of carrots. Carrots fertilized with 5 t/ha at 40×20 and 40×10 cm had the highest and lowest plant height. The number of leaves and branches/plant was highest when carrots were planted with 5th FYM at 40×20 cm, compared to the other intra-row spacings and the control. Farmyard manure application and planting density had no significant effect on the components of carrot yield. Crops treated with 5 t/ha FYM at 30×20 cm had the longest roots, while unfertilized plants at 30×l0 cm had the least. The applied 5 t/ha FYM gave at 40×10 cm produced the highest root yield compared with those at other densities and the control. The applied 5th FYM gave higher root yield than the unfertilized, and generally, the root yield of carrot was favoured by the wider spacing (40×10 cm) than the closely spaced plants (30×10 cm).

Based on these results, the following recommendations can be reached: Carrot fertilized with FYM planted at a wider spacing (40×20 cm) is regarded as the best treatment for vegetative characters and ideal for carrot grown for forage, and also the application of 5 t/ha FYM with a spacing of 40×10 cm is recommended for root yield of carrot in this locality.

Recommendations

Based on these results, the following recommendations can be reached:

Carrots fertilized with farmyard manure and planted at a wider spacing (40×20 cm) are regarded as the best treatment for vegetative characters and are ideal for carrots grown for forage.

Applied 5 t/ha farm yard manure with a spacing of 40×40 cm is recommended for the root yield of carrots in this locality.

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