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Effects of integrated nutrient management on growth, yield and quality and economics of carrot

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Abstract
To find out the response of various sources of integrated nutrient management on growth attributes with nine fallowing treatment *viz*. A sandy loam texture, a low nitrogen content, and a pH of 8.5 characterized the soil. The field was disced and harrowed to pulverize the soil after having been cross-deep ploughed twice. Thereafter, field was leveled properly and plots were prepared according to the layout plan. There are nine treatments in total, including the control (no fertilizers and manures were applied), the optimal fertilizer and manure application rates, and two additional treatments. (RDF- N: P: K - 80:60:60 kgha-1) organic manures (farm yard manure and vermicompost), rhizosphere bacteria alone and in combination. Seeds of cv. Early Nantes were sown in the field by ridge and furrow method on October 2021 spaced at 30 x 10 cm. Farm yard manure @ 10 t per ha and vermicompost @ 4t per ha Half of the nitrogen (40 kgha-1), all of the phosphorus (60 kgha-1), and all of the potassium (60 kgha-1) were administered at sowing, per the instructions. Before planting, a dose of rhizosphere bacteria was applied to the seeds.
Maximum plant height at harvest, leaf length, leaf count, and leaf fresh weight were recorded in treatment T7 (1/2 recommended NPK + ½ green leaf manure + biofertilizer i.e. Azotobacter and phosphobacteria each at 5kg/ha) followed by the application of T9 (recommended dose of NPK @ 80:60:60kg/ha). The yield and yield attributes were significantly improved the various of integrated nutrient management. The maximum length of root, diameter of root, yield per plot (kg), yield per hectare (q) were recorded by the application of T7 (1/2 recommended dose of NPK + ½ Green leaf manure + Biofertilizer i.e. Azotobacter and Phosphobacteria each at 5kg/ha) followed by the application of T9 besides, improvement in quality parameter were observed by the various sources of integrated nutrient management. The maximum TSS content were recorded by the application of T7. However, the TSS was statistically nonsignificant.

Keywords: Carrot, organic manures, inorganic fertilizers, growth, yield

Introduction

Carrot (*Daucus carota* L.; 2n=18), a member of family Umbelliferae is a popular cool season root vegetable with high nutritional and medicinal benefits. Although, its origin is in Southwest Asia, its cultivation spread later throughout China and the Mediterranean basin.
It is a biennial but grown as an annual crop, characterized by relatively moderate requirements for climate and soil. Carrot has a main tap-root which becomes tuberous with absorbent hairs but without secondary roots. The roots may grow up to 20 cm in length and attain a diameter of 3-4 cm. It is made up of a central cylinder (core) which is more or less fibrous and an external part (cortex) which is tender and of a deeper colour than the inner core (De Lannoy, 2000). The colour was yellow in the 17th century and mutated to become orange.
Carrot growing states are Haryana, Punjab, Uttar Pradesh, Karnataka, and others. In India, total growing area of carrot 108 thousand hectares with production of 1865 thousand MT in 2018-19 (NHB, 2019).
It is taken raw as well as in cooked form. It is used in to pickles, sweets, curries and pies etc. Carrot juice is commonly used to add colour to butter and other foods because of its high carotene content. Orange colored carrots are rich in carotene, a precursor of vitamin "A" and contain appreciable quantity of thiamine and riboflavin. Black carrot is used for the preparation of a beverage called kanji considered to be a good appetizer. The Asiatic types have more of anthocyanin pigments and less of carotene and may be less nutritive. Green carrot leave is highly nutritive, rich in protein minerals and vitamins, and used as fodder and also for preparation of poultry feed. The edible fresh root contains 85% moisture and large number of chemical components including vitamin "A" and "C" (3150 L.U. and 3.0 mg respectively) and minerals contents in ample quality, which are valuable for human nutrition. Carrot roots are good source of potassium, calcium, phosphorus.

Soils of India having low organic matter content are generally poor in fertility. These soils have consistently been depleted of their finite nutrient resource due to continuous cultivation for many centuries. Because of this, the country had faced food shortages and depends on imports. However, India's agriculture has a net negative balance of plant nutrients on the order of 8-10 million tons/year because of insufficient and imbalanced fertilizer application. When we include in the anticipated need for food in the future, the implications of the ongoing depletion and imbalance of soil nutrients might be frightening.

Effect of INM on growth parameters

According to Netra Pal (2001), carrot root splitting or cracking is a major issue in many carrot-growing areas. Although hereditary factors appear to govern the inclination to divide, a variety of additional factors could be at play. Low N reduces splitting and increases when the amount of N in the soil increases. Ammonium compounds at high concentrations in the soil cause more serious splitting than other forms of nitrogen. Carrot split is unaffected by planting timing or cultivar. The larger the root, the more likely it is to divide, and large roots are more prone to split than little ones. Irrigation and pesticides have no effect on the quantity of root splitting in carrots.

Sharma *et al*. (2003) Using the high hills and dry, temperate conditions typical of the northwestern Himalayas as a natural laboratory, we tested the effects of an integrated application of nitrogen, phosphate, potassium, and farmyard manure on the agronomic attributes and commercial production of carrots. They studied maximum (pooled data during 2000 and 2001) root length (15.13 cm), root weight (113.17 g), root diameter (3.96 cm) and root yield (40.19 t/ha) with application of 100% NPK + FYM (10 t/ha).

Uddin *et al*. (2004) [6] studied the effect of nutrients on the yield of carrot. They observed that the maximum plant height (58.60 cm), root length (15.13 cm) and root diameter (3.85 cm) with application of 120-45-90-30 kg/ha NPKS and cowdung (5 t/ha) while individual root weight (104.5 g) and root yield (29.93 t/ha) applied with 120-45-120-30 kg/ha NPKS and cowdung (5 t/ha).

Effect of INM by fertilizers

Kumar *et al*. (2007) [11] investigated the influence of crop residues and farmyard manure on carrot output and quality. With the application of RDF, they saw an increase in maximum root length (24.97 cm), shoot length (51.63), average crown diameter (6.77 cm), TSS (8.47 °B), ß-carotene (168.36 mg/100 g), and yield (377.67 q/ha).

Effect of INM by irrigation

Under drip irrigation, Mahmoud *et al*. (2007) We investigated the impact of cyanobacterial inoculation on carrot yield and soil characteristics in sandy environments with and without organic and inorganic amendments. They discovered that using 50 percent RSCRPF + 50 percent N2-fixing cyanobacteria resulted in a maximum plant height of 52.30 cm, while using 50 percent RSCRPF + 100 percent N2-fixing cyanobacteria resulted in a root length of 17.20 cm, a root diameter of 3.85 cm, and a root yield of 12.25 t/ha.

Jeptoo *et al*. (2013) did a study to see if bio-slurry manure may improve carrot productivity and quality. They measured maximum shoot dry biomass (1.83 and 3.62 t/ha), root dry biomass (5.67 and 6.51 t/ha), total yield (44.78 and 61.39 t/ha), shoulder diameter (2.45 cm and 2.93 cm), core diameter (1.12 and 1.55 cm), root length (19.1 and 20.85 cm), and TSS (12.90 and 11.11 °B) from October to January and February to May, respectively, with bio-slurry (7.8 t/ha).

Effect of INM by Manures

Moniruzzaman *et al*. (2013) investigated the effects of nitrogen on carrot growth and yield. With a 100 kg N/ha application, they discovered the maximum plant height (39.87 cm), root length (17 cm), root diameter (10.40 cm), fresh weight of leaves (145.10 g/ plant), gross yield (22.55 t/ha), marketable yield (20.67 t/ha), and minimum cracked root (2.03 percent).

Vithwel and Kanaujia (2013) The impact of INM on carrot yields and soil fertility was studied. They measured the height of the plant (25.00 cm), the length of the roots (18.88 cm), the diameter of the roots (4.14 cm), and the weight of the roots (90.37 g). With the treatment of 50 percent NPK + 50 percent FYM+ biofertilizers, the maximum carotene content (3.41 mg 100) was achieved.

Baloch *et al*. (2014) [6] investigated the effects of nitrogen, phosphorus, and potassium fertilizers on radish growth and yield characteristics. With 150 kg N/ha in the form of urea, they achieved maximum plant height (36.98 cm), root length (31.07 cm), root diameter (10.53 cm), root weight (189.33 g), and root production (72.60 t/ha).

Habimana *et al*. (2014) investigated the effects of chicken manure and NPK (17-17- 17) fertilizer on carrot growth and yield. They found that applying chicken manure 5 t/ha + NPK (17-17-17) at a rate of 150 kg/ha increased the maximum plant height (45.59 cm), length of root (19.50 cm), shoulder diameter of root (5.2 cm), total root yield (11.3 t/ha) and marketable yield (10.48 t/ha), forked roots (0.73 t/ha), and cracked roots (0.23 t/ha).

Effect of INM by organic fertilizers

Kumar *et al*. (2014) [11] investigated the impact of organic and inorganic nutrient sources on carrot soil quality and health. They discovered that with a 75 percent NPK + 25 percent N vermicompost treatment, they were able to achieve the maximum root length (17.16 cm), root diameter (3.34 cm), and root yield (32.43 t/ha).

Umuhoza *et al*. (2014) conducted a study on the nutritional quality of carrots as a result of farm yard manure. They discovered the highest levels of beta-carotene (11188 g/100 g) and vitamin C (7.98 mg/100 g) when using FYM (20 t/ha) and the lowest levels of TSS (10.27 °B) when using FYM (5 t/ha).

Birhanu (2015) [10] investigated the impact of combining organic P and inorganic N fertilizers on carrot yield. With an application of 309 kg organic + 68 kg urea per hectare, he achieved the highest average plant height (44.27 cm), root weight (105.47 g), root volume (96.67 cm), and root yield (11.33 t/ha).

Effects of INM on yield and quality

Since carrots can be grown in a relatively short amount of time and high yields per unit area, they are often a popular business choice for small-scale, resource-poor farmers (Ahmad *et al*., 2005). However, yields of carrots per acre are still below the suggested global average in most poor nations. A lack of technological know-how in production procedures has been cited as a cause of the low yields (Muendo & Tschirley, 2004). In order to get high and quality yields of carrots excellent soil fertility and continual growth is required

to allow the generation and transport of carbohydrates from leaves to roots.

The necessary nutrients (nitrogen, phosphorous, and potassium) and water are the primary limiting variables in crop growth, development, and yield (Glass, 2003; Parry *et al*., 2005). When trying to increase yields and crop quality, most carrot farmers rely on synthetic fertilizers as their primary source of nutrients (Stewart *et al*., 2005; Dauda *et al*.,2008). However, inorganic fertilizer use has been linked to negative effects on human health and the environment (Arisha & Bardisi, 1999). Most small-scale farmers simply cannot afford the ever-increasing prices of inorganic fertilizers.

Instead of using mineral fertilizers, you may use organic manure. Manures provide essential nutrients, enhance soil structure, boost microbial populations, and protect crop quality. (Wong *et al*., 1999; Nehra *et al*., 2001; Suresh *et al*., 2004; Dauda *et al*., 2008). Soil fertility and production can be increased with the use of organic fertilizers, despite the fact that inorganic fertilizers typically contain more plant nutrients per unit weight. (Sanwal *et al*., 2007).

Organic manure has been lauded as a vital component in soil revitalization and nutrient provision by a number of authors. (Ghurman& Sur, 2006; Adeleye *et al*., 2010). Bio-slurry is a high-quality organic fertilizer that is the byproduct of anaerobic decomposition of a wide variety of organic materials (Islam, 2006) [4]. The anaerobic fermentation process converts about 25-30% of the organic matter into biogas, and the rest can be used as manure (bio-slurry).

Macro and micronutrients abound in this type of residual manure (Isam, 2006; Thu, 2007) [4]. Several vegetable crops, including okra (Shahbaz, 2011), maize, and cabbage, have shown positive yield responses in response to bio-slurry manure treatment (Karki, 2001). Most regions where carrots are grown have not yet explored the use of decomposed bio-slurry manure in their crop.

Conclusion

Carrot was improved due to application of rhizosphere bacteria in combination with farm yard manure which gave better chance for multiplication of microbes resulting in soil enrichment provides sustainable amounts of nitrogen and phosphorus. Farm yard manure provides organic matter and macro- and micronutrients which increase water holding capacity and aeration for better root formation. Primary nutrient requirements were fulfilled by NPK. The cumulative effect of treatment (½ RDF + ½ FYM + rhizosphere bacteria) associated with higher vegetative growth, maximum photosynthates production and better establishment of source sink relationship resulting higher root yield (Das, 2004) and could result in lowered levels of chemical fertilizers and enhanced quality traits.

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