Effect of organic manures and natural farming on soil properties and nutrient uptake by carrot

Abstract

The present investigation carried out at the Research Farm Area of Deen DayalUpadhyayaCenterofExcellenceforOrganicFarming,ChaudharyCharanSinghHaryanaAgriculturalUniversity, Hisarduring*Rabi season* 2022-23withtheobjectivestoevaluatetheeffectoforganic manures andnaturalfarmingongrowth, yield and quality of carrot as well as on microbial count and nutrient uptake and economics of carrot. The experimentconsisting of 8 treatments *i.e.*, T_1- RDN through Farm Yard Manure (FYM), T_2- RDN throughVermicompost (VC), T_3- RDN through Poultry Manure (PM), T_4- RDN through FYM + Biofertilizers, T_5- RDNthrough Vermicompost + Biofertilizerss, T_6- RDN through Poultry Manure + Biofertilizers (*Azatobecter* + PSB), T_7- Cow based bio-formulations and T_8- Control waslaidoutinrandomizedblockdesignwiththreereplications.Total sugar, reducing sugar, non-reducing sugar %, TSS and N content and its uptake in root and shoot was alsorecordedthehighestintreatmentT_5 whereas, P, K contents and their uptake in root and shoot were recorded highest in treatment T_4.Soilorganiccarbon(0.69%),availableN(165.5kgha^{-1}),P(16.82kgha^{-1}),K (369.60 kg ha^{-1}) wereobserved maximum in treatment T_5 and remained at par with the treatments receiving organic manuresconjointly with biofertilizers. Microbial population of soil was recorded the maximum in treatment T_5 (6.94 $\times 10^6$ cfucountg^{-1}ofsoil)whichwasat partotreatmentsT_1, T_2, T_4 and T_7but significantlyhigher overthecontrol(6.52 $\times 10^6$ cfu countg^{-1}ofsoil).

Keywords- Microbial population, organic carbon,Quality.

Introduction

Carrot (Daucus carota) is an important vegetable crop grown all over the world in spring, summer and autumn in temperate regions and during winter in tropical and sub- tropical regions. It falls under the family Umbelliferae. Genus Daucus contains about 60 species of which very few are cultivated (Salunkheeand Kadam, 2005). Carrots possess a unique taproot structure that has been modified into a conical shape. The root is hollow and the stem is short, erect, and not very long. The leaves are quadripinnate(Bhattarai and Maharjan, 2013). The main reason why carrot roots are highly regarded as a food component is due to their abundant content of beta carotene, which serves as a precursor to vitamin A(Ahmad *et al.*, 2019). Additionally, carrots are a good source of carbohydrates and essential minerals such as calcium, phosphorus, and iron. (Ganapathi, 2006).

Organic farming relies on utilizing available knowledge, techniques, and materials to work in harmony with nature and sustainably manage natural resources within a specific agro-ecological system (Rajbhandari and Gautam, 1998). In organic agriculture, there are various sources of nitrogen, phosphorus, and potassium, with Farm Yard Manure (FYM), vermicompost, and poultry manure, along with biofertilizers, being the most popular options(Khayat, 2021).Biofertilizers play a very significant role in improving soil fertility by fixing atmospheric nitrogen, both, in association with plant roots and without it, solubilise insoluble soil phosphates and produces plant growth substances

in the soil(Bhardwaj *et al.*, 2014). They are in fact being promoted to harvest the naturally available, biological system of nutrient mobilization (Venkatashwarlu, 2008).Carrots are heavy consumers of nutrients, uptake around 100 kg of nitrogen, 50 kg of P_2O_5, and 110 kg of K_2O per hectare. They are highly responsive to nutrient availability and soil moisture (Rani and Malla Reddy, 2007). While inorganic fertilization is important for promoting growth and development in plants but organic sources of nutrients offer advantages such as consistent and slow nutrient release, maintaining an ideal CN ratio, enhancing water retention capacity, and improving microbial activity in the soil without adverse residual effects (Yadav *et al.*, 2022). Additionally, organic manures have shown positive effects on the quality attributes of different vegetables. Recognizing the significance of organic manures, this experiment aimed to investigate the impact of various organic manures, either alone or in combination with inorganic fertilizers, on the yield and quality attributes of carrots. Furthermore, the study also assessed their effects on selected soil physical and chemical properties.

Materials and methods

Initial soil samples were collected randomly from several field locations in a zig-zag pattern at 0-15 cm of soil depth before crop sowing with a hand auger. A combined sample was ground and passed through a 2 mm sieve and thereafter put away in the polythene pack for further analysis. The chemical analysis of soil samples for texture, pH, EC, available N, P, K and organic carbon, was done by standard methods as outlined by Antil. However, organic manures (FYM, PM and VC) were collected from the DDUCE-OF CCS HAU, Hisar, and incorporated into the field before sowing of crop. Before analysis, the manure's samples were air-dried, ground and passed through a 2 mm sieve. Digestion (with the di-acid mixture) is the main step followed, thereafter; standard methods were adopted for analysis purpose.

Experimental site, design and field management

The experiment was carried out at Research farm of Deen Dayal Upadhyaya Centre of Excellence for Organic Farming of CCS Haryana Agricultural University, Hisar during the *rabi* season 2022-23 under organic system of cultivation without using any chemicals is located at 29°8'20" N latitude and 75°42'04" E longitude at an elevation of 213 metre above mean sea level (MSL) in the sub-tropics of the country and characterized by semi-arid climatic zone. The soil of experimental field was sandy loam in texture containing 157, 15.70 and 364.00 kg ha^{-1} available nitrogen, phosphorus and potassium, respectively in 0-15 cm soil depth with EC 0.78 dS m^{-1}, pH 7.80 and organic carbon content 0.67 per cent.

The treatment combinations were setup as per recommended dose of Nitrogen for carrot crop in that is 60 Kg ha^{-1}. The experiment was laid out in a randomized block design (RBD) with three replications and 8 treatment combinations. Seed of carrot cultivar Punjab carrot 161 was sown in net plot of 4.5m × 4.0 m on 16 October, 2023. FYM, vermicompost, poultry manures and biofertilizers applied @ 9210, 3157, 2143 kg ha^{-1} and 50 ml each of *Azatobecter* and PSB for seed treatment. Cow based bio-

formulations (Ghanajeevamrit and Jeevamrit) was applied @ 250 kg Ghanajeevamrit + 250 FYM kg/ha and 125 litre Jeevamrit in three split doses at 20, 40 and 60 DAS @ 5 %, 10% and 10%, respectively was applied in the treatments were T_1: RDN through FYM, T_2: RDN through vermicompost, T_3: RDN through poultry manure, T_4: RDN through FYM + biofertilizers, T_5: RDN through vermicompost + biofertilizers, T_6: RDN through poultry manure + biofertilizer, T_7: cow based bio-formulations (Ghanajeevamrit and Jeevamrit) and T_8: control.

Data collected

Soilparameters *viz.*, pH, electric conductivity, organic carbon %, available NPK in soil and microbial population in soil before and after harvest was calculated. Nutrient content and uptake by carrot roots and leaves were also analysed after the harvest.

Results and discussion

Application of organic manures alone and with biofertilizers significantly influence the soil parameters *i.e.*, pH, EC, OC%, available NPK, soil microbial population and nutrient content and uptake by roots and leaves.

The significant maximum value of nitrogen content and uptake by roots and leaves (2.30, 2.80% and 71.04, 53.12 kg/ha, respectively) were recorded in T_5 with the application of RDN through vermicompost and seed was treated with the biofertilizers (*Azotobactor* + PSB) which was statistically higher than other treatments except T_4, T_2 and T_1 respectively (table 1). P content in roots, leaves and uptake by roots were recorded significantly maximum in T4 (0.90, 0.86 % and 25.62kg/ha, respectively) with application of RDN through FYM and seed was treated with the biofertilizers (*Azotobactor* + PSB) which was statistically at par with treatments T6 and T1, whereas, P utake by leaves was recorded maximum with treatment T_5(14.80 kg/ha) which was at par with treatments T_4, T_2 and T_1 (table 2). K content and uptake were recorded maximum with treatment T_4 (2.40, 2.20 % and 68.33 and 37.59 kg/ha, respectively) which was closely followed by treatment T_1 (table 1). However, the minimum nutrient content and uptake by roots and leaves was recorded in control in which no external manures or formulations were applied. The nutrient content of soil might have enhanced due to breakdown of organic sources of manures which become readily accessible to plants and increase the concentration of NPK in plants. Furthermore, applications of biofertilizers might have enhanced the root proliferation coupled with increased availability of nutrients in the rhizosphere by N_2 fixation, P and K solubilization which led to augmented nutrient uptake by the plants. These findings corroborate the results of Mansuri *et al*. (2019). The solubilization and mobilization of native nutrients and micronutrients by soil micro fauna, chelation of complex intermediate organic compounds formed during the breakdown of organic manure, accumulation of various nutrients in different plant parts may be responsible for the increased nutrient uptake with organic manure and biofertilizers (Kumar *et al.*, 2022).

The data summarized in the table 2 showed the result of pH, EC and OC% of soil which was recorded in the range of 7.60 to 7.87, 0.74 to 0.78 (dS/m) and 0.67 to 0.69%. Different treatments of organic manures alone or with biofertilizers and cow based bio-formulations have non-significant effect on the pH, EC and OC% of soil after harvest. Sur *et al.* (2010) who have also reported the beneficial effects of organic manures over inorganic fertilizers.The maximum available NPK in soil (164.9, 16.82 and 369.3 kg/ha) was observed with the T_5, application of RDN through vermicompost and seed treated with biofertilizers (*Azotobector*+ PSB) which was significantly higher than other treatments except T_2 and T_1, whereas, available N was also at par with T_4 and available K also with T_3, T_4 and T_6. Whereas, minimum available N (155.1 kg/ha) was found in control (table 2). Significantly maximum soil microbial population (6.94×10^6 cfu/g) was recorded with T5, the application of RDN through vermicompost along with biofertilizers (*Azotobector* + PSB) used as seed treatment, which was closely followed by the T_1, T_2, T_4 and T_7,whereas, minimum soil microbial population recorded in control treatment**.** However, all treatments including control significantly improved soil microbial population than observed before sowing (5.56×10^6). Application of solely organic manures or in combination with biofertilizers and cow based bio-formulations enhanced soil organic matter availability and provided substrate that act as an energy source for soil microbes growth and increased bacterial multiplication. The introduction of organic matter into soil resulted in increasing soil microbial populations and soil biological activity Weon *et al.,* (1999) and Alvarez *et al.,* (1995).

Table 1. Effect of organic manures and natural farming on NPK content and uptake by roots and leaves after harvest

Treatments	N content (%)		N uptake (kg ha^{-1})		P content (%)		P uptake (kg ha^{-1})		K content (%)		K uptake (kg ha-1)	
	Roots	Leaves	Roots	Leaves	Roots	Leaves	Roots	Leaves	Roots	Leaves	Roots	Leaves
T_1-	2.15	2.60	0.88	0.84	2.31	2.10	65.15	34.24	2.31	2.10	65.15	34.24
T_2-	2.20	2.72	0.77	0.77	1.93	1.66	55.77	30.62	1.93	1.66	55.77	30.62
T_3-	1.83	2.39	0.83	0.80	2.10	1.82	55.20	25.91	2.10	1.82	55.20	25.91
T_4-	2.30	2.65	0.90	0.86	2.40	2.20	68.33	37.59	2.40	2.20	68.33	37.59
T_5-	2.30	2.80	0.79	0.78	2.00	1.63	61.78	30.92	2.00	1.63	61.78	30.92
T_6-	1.85	2.39	0.85	0.81	2.14	1.90	59.39	29.18	2.14	1.90	59.39	29.18
T_7-	1.53	2.20	0.75	0.74	1.90	1.54	49.23	23.92	1.90	1.54	49.23	23.92
T_8-	1.32	2.09	0.72	0.71	1.84	1.50	45.30	22.95	1.84	1.50	45.30	22.95
SEm (±)	0.9	0.24	0.03	0.02	0.05	0.03	1.20	1.40	0.05	0.03	1.20	1.40
CD at 5 %	0.22	0.35	0.06	0.05	0.21	0.14	5.70	4.23	0.21	0.14	5.70	4.23

Table 2. Effect of organic manures and natural farming on pH, EC, OC, available NPK and soil microbial population in soil after harvest

Treatmentss	pH	EC (dS/m)	OC (%)	Available NPK (kg ha^{-1})			Soil micobial population (10^6 cfu count g^{-1} soil)
				N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	
T_1-	7.63	0.77	0.68	163.6	16.08	367.2	6.75×10^6
T_2-	7.60	0.75	0.68	164.0	16.51	368.8	6.87×10^6
T_3-	7.77	0.77	0.67	159.0	15.85	367.0	6.65×10^6
T_4-	7.63	0.75	0.68	164.9	16.19	367.7	6.80×10^6
T_5-	7.60	0.74	0.69	165.3	16.82	369.3	6.94×10^6
T_6-	7.73	0.76	0.67	159.6	15.91	367.2	6.67×10^6
T_7-	7.70	0.77	0.67	157.3	15.81	364.9	6.74×10^6
T_8-	7.87	0.78	0.67	155.1	14.75	361.3	6.52×10^6
SEm (±)	0.12	0.01	0.01	1.586	0.31	1.42	0.08
CD at 5 %	N.S	N.S	N.S	4.9	0.9	4.3	0.21
Initial	7.80	0.78	0.67	157	15.70	364.0	5.56×10^6

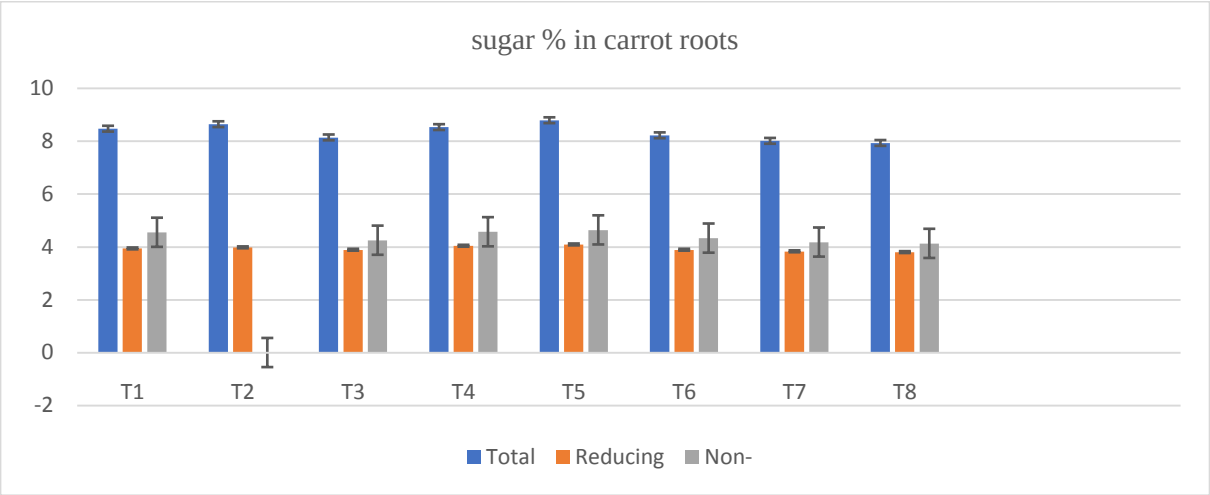

Figure 1- Effect of organic manures and natural farming on total, reducing and non-reducing sugar %

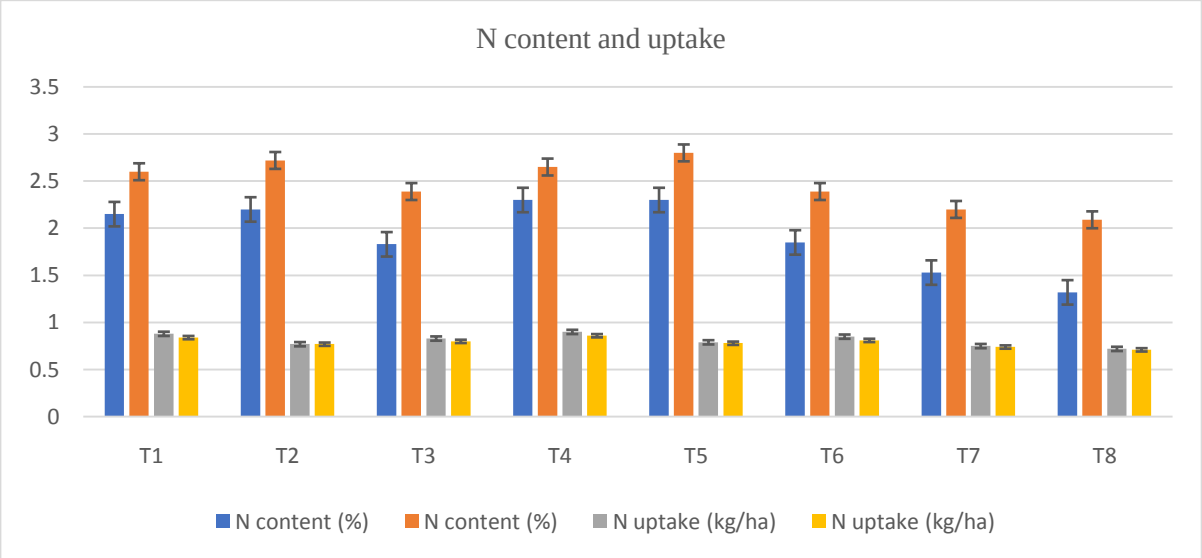

Figure 2- Effect of organic manures and natural farming on N content and uptake by carrot roots and leaves

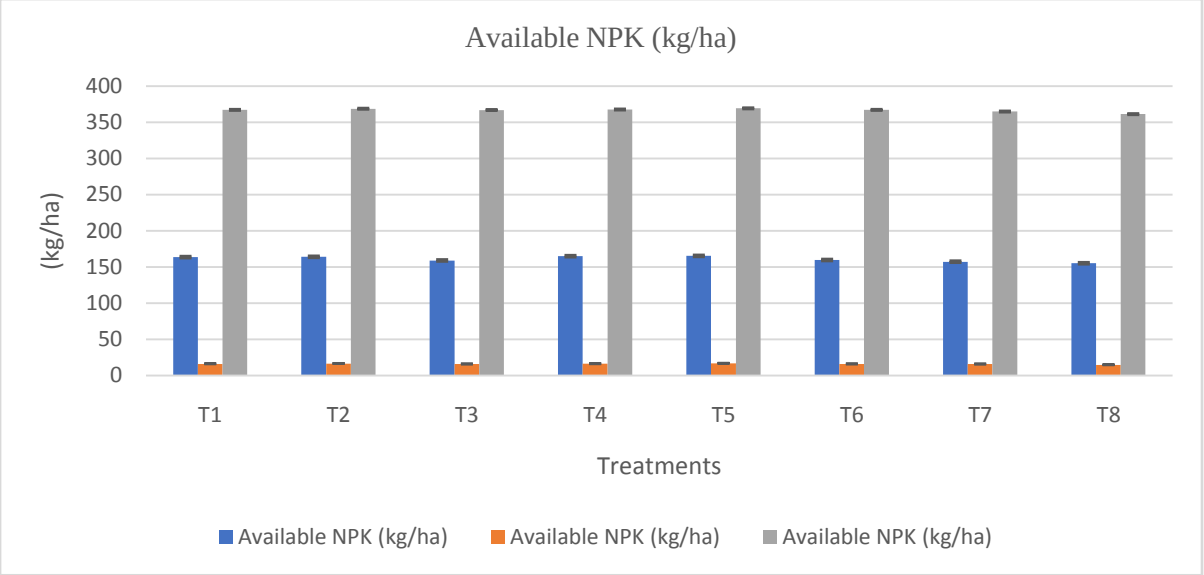

Figure 3- Effect of organic manures and natural farming on NPK in soil after harvest.

Conclusion

The study's findings indicate that applying the recommended dose of nutrients (RDN) using vermicompost and biofertilizers leads to notable improvements in the quality attributes of carrots. Moreover, when these nutrient sources are used together (FYM, vermicompost and poultry manure), they contribute to enhancing soil properties and increasing the population of beneficial soil microorganisms. As a result, this combined approach has the potential to sustain higher yields and improve the quality of carrots over the long term.

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