Influence of Soil Parameters on Carrot Cultivation in Ooty

Merlin Seles J and Chitra K

C A R A S

Influence of Soil Parameters on Carrot Cultivation in Ooty

Merlin Seles J[1] and Chitra K*[2]

A B S T R A C T

Agricultural soil is mainly consisting of minerals, organic matter, water and air. Soil fertility is the ability to improve the plant growth. Carrots are widely cultivated in high lands. For the present study the area Manihatti was selected. The soil parameters were assessed in the Manihatti field at the stages of before, after applying fertilizers, and harvest stage. The pH of the soil is acidic in condition. The EC value indicated that the soil is healthy. The macronutrients such as nitrogen, potassium was present below the low level but phosphorus was present at the high level in all the stages. The heavy metals present in the soil are very toxic to the living organism. The heavy metal cadmium was present within the threshold and permissible limit and the other metals such as chromium, copper, nickel was present below the threshold and permissible limit. The metal arsenic was present below the detectable limit. The morphological parameters of carrot indicated that the length of shoot and root increased with maximum height 60 cm and 18 cm. The study concluded that the soil proved good and healthy with the presence of micro and macro nutrients and heavy metals within the critical level.

Key words: Carrot, Soil parameters, Heavy metals, Morphological parameters

The crop carrot is being referred to as *Daucus carota* L. in taxonomy. This crop is described to be a short duration vegetable of tuber by nature. They are widely grown in high land and in moist soil. The inclusion of nutritional analysis has also been justified on the ground that, many of the elements such as phosphorus, calcium, iron, riboflavin, thiamine and carotene were previously done by other researchers reported to be varied by soil climate and its yield and nutritional characteristics are really affected by soil physiochemical properties and also that fertility of the soil is associated with many of the other factors such as effects of pesticides and fertilizers [1]. Tamil Nadu accounts for 6.60 % of the total share of carrot production in India. The plant absorbs inorganic nutrients at a rapid rate rather than organic fertilizer.

There are several conclusions made from the previous literature. The maximum yield of carrots is best cultivated on moist soil. They reluctantly yielded maximum productivity in low land under water shortage condition. It was also important to note that the roots splitted gradually when the field had excess synthetic nitrogen fertilizer [2]. Previous study suggested that, for maximum yield of carrot it was often necessary to add 100 Kg N per hectare. The relation of soil physiochemical characteristics and carrot nutritional status is interesting and the low recorded physiochemical characteristics of soil was analyzed and comparison was done between the

yield and nutritional variability between nutritionally rich and poor soil sample. Soil organic carbon is an important for nutrient management in tropical farming systems. Some scientists have stated that the soil organic carbon is a 'universal keystone indicator' in soil fertility management [3-4]. The presence of micro and macro nutrients in soil is the essential nutrition for the growth of the plant [5]. Nitrogen is one of the important nutrients which increase the leaf growth and it improves the biochemical activities. The lack of nitrogen in soil it mainly based on soil type and soil moisture. The excessive irrigation and heavy rains lead to nitrogen deficiency. Soil acidity also leads to deficiency of nitrogen availability for crops. The potassium deficiency is a plant disorder that is mainly depended on light, sandy soils, it is mainly due to potassium ions are highly soluble and it leach out from soil without colloids [6]. The phosphorus nutrient is used for the ATP synthesis and it controls the fungal infection in plants. The plants uptake the potassium nutrient from soil and it activates the function such as photosynthesis, transport of sugars. The micro nutrients such as zinc, boron, magnesium, calcium etc., which activates the oxidation and reduction reaction, nitrate functions. The deficiency of both the nutrients which leads to the appearance of plant diseases and it causes death of plants.

The heavy metal pollution of agricultural soils is mainly due to long term farming or usage of excessive amount of agrochemicals. The main heavy metal contaminants are Cd, As, Cr, Cu, Hg, Pb, Ni, and Zn. Some of these metals such as Zn, Cu, Mn, Ni, and Co are micronutrients which are necessary for plant growth, and others such as Cd, Pb, As, and Hg are very toxic to human health. The sources of heavy metals are anthropogenic and recreational activities [7].

* **Chitra K**
✉ drkchitraa@gmail.com

1-2 Bharathiar University, Coimbatore - 641 046, Tamil Nadu, India

CARAS

MATERIALS AND METHODS

The soil samples were collected from the field Nilgiris hills-Manihatti. The weather reports were obtained from meteorological department, Nilgiris hills (Fig 1). The soil samples prior to sowing the seeds and fully grown carrot were used as the representative soil samples. These samples were taken from six different sites of field and collected in polythene Cipla cover. The identical soil samples were taken to the Botany laboratory, Bharathiar University, Coimbatore for quantitative analysis. Some identical soil samples were stored at 4°C sealed in a cardboard box for future. From each site, more samples were collected and tested separately. The assessment of variability was analyzed within the same units. The samples were not mixed and analyzed separately to permit natural heterogeneity of the soil chemical report. It was ensured that the soil climate a fertilizer application was also uniform throughout the field surface. Estimation of soil chemical and physical analysis indicated the variation in their trace metal composition of soil. Depending upon available moisture irrigation was employed. For inorganic field the carrot seed were sown in September 4 and it harvested in December 14. Irrigation was done for six days in a week. To encourage the soil fertility inorganic fertilizer 100 Kg NPK per ha and were added to the field. The field has three plots measuring 1 x 1 m. The result was monitored based on the shoot length, and root length of carrot.

Fig 1 Inorganic field- Manihatti

pH: The soil was measured by using glass electrode ph meter after stirring with water suspension for 30 minutes.

Electrical conductivity: The salts which are present in soils are determined by electrical conductivity. The electric current passes through the soil based upon salt content.

Available nitrogen: The soil is distilled with alkaline potassium permanganate solution and then titrated with standard sulphamic acid.

Available phosphorus: Available phosphorus was determined by the ascorbic acid method.

Available potassium: The 5 gm of soil was treated with ammonium acetate by shaking and the process followed by filtration and centrifugation and it is determined by flame photometer.

Micro nutrient: The micronutrients in soils was estimated by the method developed by [13] using DTPA (Diethyl Triamine Penta Acetic Acid).

Heavy metals: The heavy metals were analyzed- Wet digestion method by using ICPMS instrument.

Table 1 Methods for different parameters

Particulars	Methods
pH	pH meter
Electrical conductivity (mili mhos)	Solubridge conductivity meter method [8]
Organic matter	Walkely and Black [9]
Available N (kg ha^{-1})	Alkaline permanganate method [10]
Available P (kg ha^{-1})	Olsen's method [11]
Available K (kg ha^{-1})	Flame photometric method [12]
Micro component (Zinc, iron, copper, manganese) ppm	Atomic absorption spectrophotometric method

Data analysis

IBMMSPSS software was used for the calculation of macro and micro nutrients.

RESULTS AND DISCUSSION

The monthly percolation differed from September 2021 to December 2021. The minimum temperature was seen in the month of December (7.1 °C). The Highest temperature recorded in September (23.47 °C). The highest relative humidity was recorded in the month of October (83) and the lowest relative humidity was seen in the month of December (71.7). The heavy rainfall was occurred during the month of November (9.16 mm) and the lowest rainfall was seen during the month of December (1.08mm).

Table 2 Meteorological data of Nilgiris during the cultivation of carrot

During 2021	Minimum Temperature °C	Maximum Temperature °C	RH (%)	Rainfall (mm)
September	11.9	23.47	81.6	2.7
October	13.8	20.5	83	7.05
November	11.9	19.1	82	9.16
December	7.1	17.5	71.7	1.08

Table 3 Critical levels of macro nutrients

Macronutrients (kg/ha)	Low	Medium	High
Nitrogen	<280	280-560	>560
Phosphorus	<10	10-24.6	>24.6
Potassium	<108	108-280	>280

Source: Muhr *et al.* [14]

Table 4 Critical levels of micro nutrients

Micronutrients (ppm)	Critical limit
Iron	2.5-5.8
Manganese	1.0-2.0
Zinc	0.5-1.0
copper	0.2-0.5

Source: Fundamentals of Soil Science [15]

Table 5 Physicochemical parameters of soil

Parameters	Before applying manure	After applying manure	Harvest stage
Soil texture	Sandy clay loamy	Sandy clay loamy	Sandy clay loamy
pH	5.9	5.6	5.4
EC	0.07	0.07	0.05
Organic carbon (%)	0.02	0.12	0.32
Nitrogen (kg/ha)	21.73± 0.104	23.09± 0.601	22.39± 1.757
Phosphorus (kg/ha)	19.91± 0.497	30.57± 0.512	43.76± 0.652
Potassium(kg/ha)	40.25± 0.332	47.92± 0.620	82.58± 0.421
Iron (ppm)	6.176± 0.248	7.106 ±0.285	7.41± 0.170
Manganese (ppm)	3.26± 0.07	4.143± 0.015	1.045± 0.015
Zinc (ppm)	4.64± 0.08	5.06± 0.026	0.236± 0.020
Copper (ppm)	0.343± 0.025	0.426± 0.020	0.61± 0.435

The soil texture showed sandy clay loamy soil in all the stages. The pH of soil was determined by soil composition, the exchange processes of cation and hydrolysis processes which is associated with some of the soil components such as organic and inorganic [16] constituents. Some soils have pH values range between 3.5 and 10 [17]. The result of the present study showed that, before applying fertilizer, after applying fertilizer and during the harvest stage the pH was acidic in condition. The EC of soil is used as an indicator in managing the soil for agricultural purposes [18]. EC directly affects the growth of plants in the soil or media.

The soil EC is influenced by some of the factors such as porosity of soil, soil texture, organic matter and water content in soil [19]. The soil EC mainly depends upon the amount of moisture present in soil particles. Sands have a low conductivity, silts have a medium conductivity, and clays have a high conductivity. Mostly EC range between the value 0–1 dS/m it indicates good soil health; EC values above 1–2 dS/m indicates the reduction in the growth of salt sensitive plants and disturbance in the processes of denitrification [20]. The result of the present study showed that in all stages, the EC value indicated that the soil was good in quality. Mapfumo [21] conducted a study in Zimbabwe on a sandy soil the SOC values in a range 4.6 and 6.5 g C kg^{-1} resulted based on fertilizer response. The soil organic carbon of top soil ranges from 0.5% to 3.0%. soils containing greater than 12-18% organic carbon are tend to be organic soils. The present study of organic carbon showed that it ranged within 0.5% in all the stages. The SOC thresholds can vary depending on soil type.

Plants can grow in a variety of soils but they need nutrients for their growth. There are two types of nutrients they are macro and micro nutrients. The macro nutrients are nitrogen, phosphorus and potassium and the micro nutrients are copper, zinc, iron, magnesium etc. In addition to the macro elements, some special elements may also be needed for cultivation of any types of crops. These are drawn from the soil along with the water. The amendment of NPK fertilizer gradually increased the availability of N, P, K at the growing stages. But some of the micronutrients were absorbed at the harvest stage.

The amount of macronutrients such as nitrogen and potassium were present below the low level in all the three stages. The result of phosphorus was showed that the before applying manure, after applying manure and at the harvest stage was seen at the high level. The availability of all the micronutrients is due to soil environment [22]. The presence of higher concentration of Fe, Mg, Cu and Zn in soils was reported by Choudhary *et al.* [23]. Panda *et al.* [24] and Ramesh *et al.* [25]. The result showed that the micronutrients such as iron, manganese, zinc were present above the critical limit in all the three stages. The result of copper showed that, before and after applying manure, copper was present within the critical limit, at the harvest stage copper was present above the critical level. The results showed in the (Table 4).

Heavy metal accumulation in soil

The results indicated that cadmium was present within the threshold and permissible limit before applying manure and after applying manure it was present within the permissible limit. The other metals such as chromium, lead, nickel were present below the threshold and permissible limit before and after applying manure. The heavy metal arsenic was present below the detectable limit.

Table 6 Threshold and permissible limits of heavy metals in soil

Heavy metals	Threshold limit (mg/kg)	Permissible limit (mg/kg)
Cadmium	1.0	10.0
chromium	100.0	200.0
Lead	60.0	200.0
Nickel	50.0	100.0
Arsenic	5.0	50.0

Table 7 Heavy metals in soil

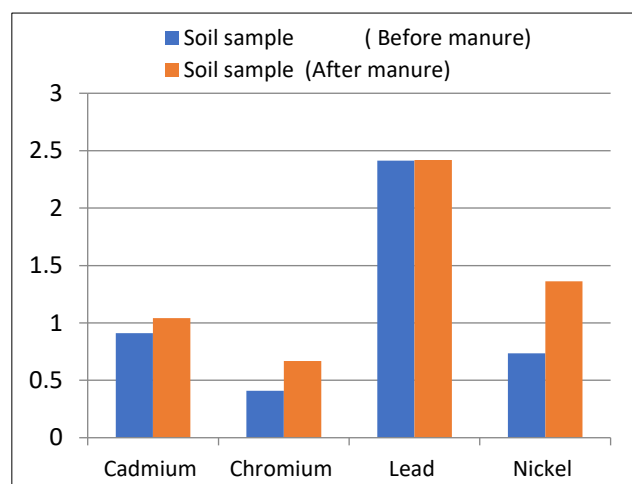| Parameters (mg/kg)	Soil sample (Before manure)	Soil sample (After manure)
Cadmium	0.910	1.042
Chromium	0.410	0.668
Lead	2.412	2.419
Nickel	0.736	1.362
Arsenic	BDL	BDL

Fig 2 The heavy metal accumulation in soil

Morphological parameters
Plant length

The shoot length of vegetative part of carrot from field had shown that the tallest growth (60 cm) was measured and shortest shoot length (33 cm) was obtained. The results of the plant height are supportive in agreement to the similar work conducted by [26]. They reported that, the growth rate was maximum to the height of 70.68 cm. Even though the variation in chemical and physical properties of the soil samples are clearly identified, yet the variation in the trace metals should have played an important role in maximizing the yield of carrot in open field cultivation system (Fig 4).

The root length was increased to the maximum measure of 18 cm and shortest 12 cm root length (Fig 3). All the samples collected from the field had exhibited the length that ranges between 12 cm and 18 cm. The results are in line with [27]. Similar study carried out by [28] reported that the root length was increased up to 20 cm.

Table 8 The root and shoot length of carrot samples

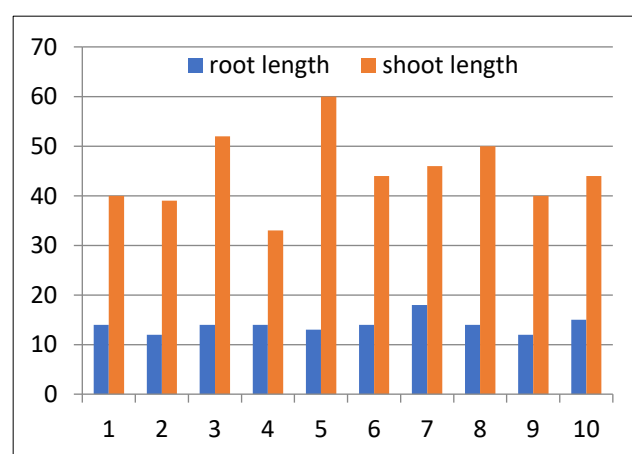| Carrot samples	Root length (cm)	Shoot length (cm)
Sample 1	14	40
Sample 2	12	39
Sample 3	14	52
Sample 4	14	33
Sample 5	13	60
Sample 6	14	44
Sample 7	18	46
Sample 8	14	50
Sample 9	12	40
Sample 10	15	44

Fig 3 Growth characteristics of carrot crop with respect to its vegetative structure

Fig 4 Carrot crop during harvest stage

CONCLUSION

The soil parameters such as pH, EC indicated that the soil is good and healthy. The heavy metals of soil also showed nontoxic. The cadmium was present within the threshold limit before applying manure and after applying manure it was present within the threshold and permissible limit. The other metals such as chromium, nickel, lead was present below the threshold and permissible limit. The presence of low level of nitrogen and potassium it should be improved by the application of nitrogen and potassium fertilizers.

CARAS

LITERATURE CITED

1. Kabir J, Sen H, Bhattacharya N, Panda PK, Bose TK. 2000. Production technology of vegetable crops. *Tropical Horticulture* 4: 72-240.

2. Moniruzzaman MMH, Akand MI, Hossain MD Sarkar Ullah A. 2013. Effect of nitrogen on the growth and yield of carrot (*Daucus carota* L.). *The Agriculturists* 11: 76-81.

3. Ssali H. 2000. *Soil Resources of Uganda and their Relationship to Major Farming Systems*. Resource paper. Soil and Soil Fertility Management Programme, Kawanda, NARO, Uganda.

4. Loveland P, Webb J. 2003. Is there a critical level of organic matter in the agricultural soils of temperate regions? A review. *Soil and Tillage Research* 70: 1-18.

5. Acosta-Durán CM, Ocampo D, Cedillo E, Nava LM. 2007. Effect of calcium sulphate and biosolids in crop yield peanut (*Arachis hypogaea* L.). *Agric. Research* 4(1): 31-38.

6. Datnoff LE. 2007. *Mineral Nutrition and Plant Disease*. The American Phytopathological Society, 2007 ISBN 0-89054-346-1

7. Osobamiro MT, Adewuyi GO. 2015. Levels of heavy metals in the soil: effects of season, agronomic practice and soil geology. *Journal of Agricultural Chemistry and Environment* 4: 109-117.

8. Black CA, Evans DD. 1965. *Methods of Soil Analysis*. American Society of Agronomy, Madison, Wisconsin, USA. 1965. pp 131-137.

9. Walkley AJ, Black IA. 1934. Estimation of soil organic carbon by the chromic acid titration method. *Soil Science* 37: 29-38.

10. Subbaiah BV, Asija GL. 1956. A rapid procedure for the estimation of available nitrogen in soil. *Current Science* 25: 259.

11. Olsen SR, Cole CV, Wantanable FS, Dean LA. 1954. Estimation of available phosphorus in soil by extraction with Sodium bicarbonate. United State Dept. of Agric. CIRC., Washinton, D. C. pp 939.

12. Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi.

13. Lindsay WL, Norvell WA. 1978. Development of DTPA soil test for zinc, iron, manganese and copper. *Soil Science Society of America Journal* 42: 421-428.

14. Muhur GR, Datta NP, Subramany NS, Dever F, Lecy VK, Donahue RR. 1965. *Soil Testing in India*. USDA Publication. pp 120.

15. Anonymous. 2009. *Fundamentals of Soil Science*. Indian Society of Soil Science, NASC Complex, Pusa, New Delhi-110012.

16. Thomas GW, Hargrove WL. 1984. The chemistry of soil acidity. *In*: Soil acidity and liming. Agronomy Monograph No. 12, 2nd Edition. American Society of Agronomy. pp 3-57.

17. Narsimha A, Narshimha CH, Srinivasulu P, Sudarshan V. 2013. Relating apparent electrical conductivity and pH to soil and water in Kanagal surrounding area, Nalgonda district, Andhra Pradesh. *Der Chemica Sinica* 4(2): 25-31.

18. Arnold SL, Doran JW, Schepers JS, Wienhold BJ, Ginting D, Amos B, Gomes S. 2005. Portable probes to measure electrical conductivity and soil quality in the field. *Communication in Soil Science and Plant Analysis* 36(15/16): 2271-2287.

19. Rhoades JD, Raats PA, Prather RJ. 1976. Effects of liquid-phase electrical conductivity, water content, and surface conductivity on bulk soil electrical conductivity. *Soil Science Society of America Journal* 40: 651-655.

20. Smith JL, Doran JW. 1996. Measurement and use of pH and electrical conductivity for soil quality analysis. *In*: (Eds) Doran J.W. and Jones A.J. *Methods for Assessing Soil Quality* 49: 169-185.

21. Mapfumo P. 2006. Defining soil organic carbon thresholds that could favour maize responses to mineral fertilizers on a granitic sandy soil (Arenosol) in Zimbabwe. The 18th World Congress of Soil Science (July 9-15, 2006). Philadelphia, Pennsylvania, USA.

22. Brady NC. 1995. *The Nature and Properties of Soils*. Prentice Hall of India Private Ltd., New Delhi.

23. Choudhary S, Ramkesh, Choudhry SD, Yadav P. 2015. Mineral status of livestock, soil, feeds and fodders in Ajmer district of Rajasthan. *In*: 13th International Grassland Congress (IGC 2015) held on 24-24 Nov, 2015.

24. Panda MK, Panda N, Swain RK, Behera PC, Sahoo SP, Jena SC. 2015. Minerals profile of soil, feed, fodder and serum of dairy cattle in North Eastern Ghat (Neg) of Odisha. *Journal of Animal Research* 5(2): 341-346.

25. Ramesh S, Nagalakshmi D, Reddy YR, Reddy AR. 2014. Mineral status of soils, water, feeds and fodders of dairy animals in Mahaboobnagar district of Andhra Pradesh. *Global Journal of Biological Science and Biotechnology* 3(3): 273-277.

26. Alam MS, Mallik SA, Costa DJ, Alam MS, Alam A. 2010. Effect of irrigation on the growth and yield of (*Daucus carota* ssp. *sativus*) carrot in hill valley. *Bangladesh Journal of Agricultural Research* 35: 323-329.

27. Mehedi TA, Siddique MA, Shahid SB. 2012. Effects of urea and cow dung on growth and yield of carrot. *Journal of Bangladesh Agricultural University* 10: 9-13.

28. Boadi NO, Badu M, Kortei NK, Saah SA, Annor B, Mensah MB, Okyere H, Fiebor A. 2021. Nutritional composition and antioxidant properties of three varieties of carrot (*Daucus carota*). *Scientific African*. pp e00801.