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Research Article

Influence of vermicompost on tuber yield status of carrot plant *Daucus carota* L.

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Abstract

The influence of different percentages of vermicompost (25%, 50%, 75% and 100%) on the tuber length, width, circumference and weight of the carrot plant (*Daucus carota* L.) was carried out at different period of exposures (30, 60 and 90 days). The maximum tuber length 15.10cm and 23.16cm and weight 11.72, 51.72 and 90.50cm were noticed in 50% vermicompost concentration at 30, 60 and 90 days period of exposures respectively except the tuber length at 30 days period of exposure. At 30 days period of exposure the maximum length was noticed in 50% (10.62cm) as well as in 75 % (10.23cm) vermicompost concentrations and thereafter, both length and weight decrease in commensurate with increasing vermicompost concentration. The maximum tuber width (0.81cm**)** and circumference (4.76cm**)** were noticed in 50% vermicompost concentration at 30 days period of exposures whereas at 60 and 90 days period of exposures the maximum width 2.92cm and 3.92cm and circumference 10.12 and 11.35 cm were noticed in 75% vermicompost concentration respectively. The study reveals that 50% and 75% vermicompost concentrations highly influence tuber yield of the carrot plant.

Keywords: *Eudrilus eugeniae*, Vermicompost, Carrot tuber.

Introduction

India is a country of villages and our economy largely depends on agriculture. In the past, the agriculturists employed the natural organic manure for the improvement of soil fertility, health and agriculture sustainability. In order to reach self-sufficiency in food grains, the green revolution was introduced in 1960's in the name of modern agricultural operation. With the advent of green revolution technology in terms of enhancing hybrid crop production, the extensive use of synthetic agrochemicals such inorganic fertilizers and pesticides have been boosted to promote the plant growth as well as high production rate. The success of industrial agriculture and green revolution in recent decades has often marked significant externalities, affecting natural resources and human health as well as agriculture itself (Rao, 1999; Gupta, 2005; Ranganathan, 2006; Haris Babu et al., 2006).

Even though they promote the growth of crops, their toxic effect is negative impact by means of their over utilization. Although chemical fertilizers have many nutrients and higher laboratory analysis percentages, the ability of the plants to optimally use these nutrients is limited, since the nutrients are not broken down in manner that plant can readily use. Moreover, chemical fertilizers do not have sufficient organic matter that is essential for plant growth. Chemical fertilizers are most often detrimental to physical, chemical and biological activity of the soil. The continuous use of chemical has caused devastating ecological implication on the soil in turn on plant and animal health. It has been now realized that the agriculture does not refer to crop production but also to various other factors that are responsible for crop production (Ismail, 2005).

These factors had been previously overlooked completely. Factors such as soil destruction, top soil erosion and the adverse effect of the prolonged use of chemical fertilizers on the soil health have been neglected. These chemicals have altered the physiological process of crops diminished food quality, destroyed soil biota and promoted resistant varieties of insects pests. Soon the increased use of chemical fertilizers, pesticides and farm machinery resulted in nitrate enrichment of ground waters, river waters and estuaries and release of ammonia and nitrous oxide to the atmosphere, the former added to the problem of acid rain, while the later led to the reduction of ozone layer (Prasad, 2005). In the long run, the excess use of these chemicals leads to major complications like soil sterility, ecological imbalance and accumulation of toxic residues in the environment as well as in the food products. With a view to overcome all these hazardous factors, the alternate agriculture practices such as organic farming, ecofarming, biodynamic farming and traditional farming practices are considered as important alternatives to increase the soil fertility and health. In organic farming the application of organic manure especially vermicompost derived from earthworm is recommended.

Vermicompost is organic manure (biofertilizer) produced as vermicast by earthworms feeding on organic waste material of plants and animals. Vermicompost are organic materials broken down by interactions between earthworms and microorganisms in a mesophilic process (up to 25º C), to produce fully stabilized organic soil amendment with low C: N ratios. Vermicompost improves soil aeration because they do not pack together when mixed in soil. This in turn promotes rapid plant growth and it enhances soil's drainage, reducing water logged soil and root rot. They have been reported to contain higher base exchange capacity and rich in total organic matter and calcium with reduced electrical conductivity, large increase in oxidation potential and significant reductions in water soluble chemical which constitute possibly environmental contaminants (Lourduraj and Yadav, 2005).

They have particulate structure, good moisture holding capacity and contain macro and micro nutrients such as N, P, K.Ca, Fe, Mg and Zn in forms readily taken up by plants (Lavelle and Martin, 1992; Prabha 2005; Arancon and Edward, 2009). Apart from providing the more available nutrients to plants, humic substance (Muscolo, 1999), certain metabolites (Gavrilov, 1962; Nielson, 1965) plant growth regulators such as auxin, gibberellins and cytokinins are produced by a wide range of soil microorganisms such as Actinomycetes such as *Micromonospora purpura*, *Nocardia farcinica*, *Streptomyces bobili*, *Streptosporangium* spp, *Thermomonospora curvata* (Bamane 2005), bacteria such as *Aerobactor* spp., *Agrobactor* spp., *Acetobactor aceti*, *Bacillus* spp., *Cellulomonas flavigera*, *Citrobactor fruindii*, *Pseudomonas* spp., and *Zooeloea ramigera* (Bamane, 2005), cellulolytic aerobes, hemicellulolytic, amylolytic, nitrifying and denitrifying bacteria (Khambata and Bhatt, 1947; Day, 1950; Zrazhevski, 1957; Brusewitz, 1959; Kozlovskaya and Zhdannikova, 1961; Went, 1963; Atlavinyte and Lugauskas, 1971; Elliot 1990; Kale, 1998b) *Azotobactor*, *Rhizobium*, Phosphate solubiliser, Nitrobactor and Fungi such as *Aspergillus niger*, *Aspergillus flavus*, *Mucur pusillus*, *Pencillium notatum*, *Rhizopus nigiricans* (Bamane 2005; Lee, 1992; Edwards and Bohlen, 1996; Parmelee 1998; Ranganathan and Parthasarathi, 2000; Lourduraj and Yadav, 2005) harboured in the earthworm gut and many of which live within the casts (Altanvinyte, 1971; Tomati 1987; Ranganathan and Parthasarathi, 2000). Besides that, earthworms release vitamins such as vitamins A, C and E in the vermicompost (Prabha, 2007), B group vitamins (Gavrilov, 1963), some provitamin D (Zrazhevwkii, 1957), vitamin B_{12} (Atlavinyte and Daciulyte, 1969) and free amino acids (Dubash and Ganti, 1964) in the soil.

Vermicompost and earthworm gut consist of some enzymes such as amylase, invertase, protease, lipase, cellulase, chitinase (Ranganathan and Vinotha, 1998), xylanase, cellubiase, endonucleases, acid phosphatase, alkaline phosphatase, nitrate reductase (Karthikeyan 2004; Prabha, 2007), catalase, peroxidase, polyphenol oxidase, Exo-β 1,4 glucanase, Endo-β 1,4 glucanase, superoxide dismutase and glutathione reductase(Prabha, 2006), orthophosphate and dehydrogenase (Norman, 2003). These enzymes are believed to play a significant role in the process of digestion and humification of soil organic matter (Prabha, 2007) and continue to disintegrate organic matter even after they have been ejected (Bridgens, 1981).

Further, it has been reported that application of vermicompost showed a significant increase in the dry matter production, yield and grain weight of wheat (Nainawatt, 1997; Garg and Bhardwaj, 2000a, b), sunflower (Chinnamuthu and Venkatakrishnan, 2001), soybean (Thanunathan 2002; Maheshbabu, 2008), paddy ((Jayabal and Kuppuswamy, 1997; Nagarajan, 1997; Vasanthi and Kumuraswamy, 1999), nutrient content of green gram(Grappelli, 1985; Reddy, 1988; Rajkhowa 2000), sugarcane (Ismail, 1995) and growth parameters such as plant height, number of leaves of *Adhatoda vasica* Nees (Srinivasa Rao 2004), African daisy (*Gerbera jamesonii* H. Bolus)(Rodriguez 2000), leaf area, number of tillers, dry weight of root, stem, leaf ear and shoot and ear length of another wheat varieties (Garg and Bhardwaj, 2000a,b), shoot weight, root weight, root and shoot length (Gunathilagaraj, 1994; Edwards, 1998; Kale and Bano, 1996;), straw yield (Angadi and Redder, 1996), vegetative growths in rice (summer paddy-IR-20) (Kale, 1992), mulberry leaf yield ((Sreenivasulu 2001), spinach leaf yield (Hangarge, 2002; Ansari, 2008), growth of variety of crops including cereals like maize (Spain 1992), legumes, vegetables such as bhendi (Gupta, 2008), chillies (Hangarge, 2002), watermelon (Ismail, 1995), tomato(Azarmi, 2008), cucumber, pepper (Arancon 2003; Arancon and Edwards, 2009), potato (Saikia and Rajkhowa, 1998; Upadhayay 2003; Alam, 2007), carrot (Tomati, 1998; Alam, 2005),Cauliflower (Noor, 2002), cabbage (Azad, 2000; Kabir, 1998), onion (Ansari, 2008), horticultural plants such as Petunias, marigolds, asters and chrysanthemums and fruit crops like strawberries, raspberries and grapes (Arancon and Edward, 2006 and 2009), ornamental plants (Kale, 1987; Edwards and Burrow, 1988; Wilson and Carilile, 1989; Bucker field and Webster, 1998; Nethra 1999; Atiyeh 1999, 2000 a,), flower yield and shelf life of Marigold and Chrysanthemum (SivaSubramanian, 1999) and chlorophyll content, number and diameter of peduncle and number and diameter of inflorescences (Rodriguez , 2000).

Though number of studies on the influence of vermicompost on growth of different plant varieties is available, the extensive study on tuber of the carrot plant is not available. So, the present investigation is carried out to study the influence of vermicompost on tuber yield of the carrot plant.

Materials and Methods

Collection and culturing of earthworms

The earthworm, *Eudrilus eugeniae* was collected from worm farm, Kondegoundampalayam village, Pollachi Taluk, Coimbatore District, Tamil Nadu, India and cultured at Kongunadu Arts and Science College premises, Coimbatore-29, Tamil Nadu, India.

The collected earthworms were acclimatized under the laboratory condition for a period of three months by providing predecomposed cow dung as feeding material in the cement tank. The water was sprinkled on alternate days to maintain the optimum (60-70%) moisture content and temperature ranges between 25ºC and 30ºC by using hygrometer and thermometer respectively. Care was taken to avoid the entry of natural enemies. At the end of 75 days vermicompost was collected and stored in a shady place.

Different percentages of vermicompost (25%, 50%, 75% and 100%) were prepared by mixing red soil (w/w) (collected from Kanuvai village situated 10 km north of Coimbatore where intensive cultivation is going on) in plots (2m length x 50cm breadth x 30cm height) for the Carrot plant (*Daucus carota* L.). 20 Carrot plants were cultivated in each plot in two rows (30cm distance row to row) with 15cm inter-plant distance at 30, 60 and 90 days period of exposures. The control plant was also grown in the red soil alone separately for a period of 90 days. The plants were watered daily and at the end of 30, 60 and 90 days the plants grown in the above-mentioned percentages of vermicompost were harvested and the carrot tubers were collected. The length, width and circumference of tuber were measured using scale and the values were expressed as cm. Similarly, the tuber was weighed and the values were expressed as gram. The experiment was repeated six times. The result of the influence of different percentages of vermicompost on tuber parameters were analyzed by employing Duncan's multiple range test (DMRT).

Results

The study on the influence of vermicompost on tuber length, width, circumference and weight of carrot plant revealed that tuber length and weight were noticed higher in 50% vermicompost concentration at

30 (50%-10.62 as well as 75%-10.23cm; 11.72g respectively), 60 (15.10cm; 51.72g respectively) and 90 days (23.16cm; 90.50g respectively) period of exposures. At the same time, tuber length was lower in 100% vermicompost concentration at 60 (4.73cm) and 90 (6.85cm) days period of exposures. However, the minimum tuber weight (1.38 and 4.01g) was noticed in control plants tested at 60 and 90 days period of exposures. The maximum tuber width (0.81cm) was noticed in 50% vermicompost concentration at 30 days period of exposure whereas at 60 days period of exposure the maximum tuber width was noticed in 50% (2.90 ± 0.02cm) as well as 75% (2.92 ± 0.02cm) vermicompost concentration. However, at 90 days period of exposures the maximum tuber width (3.92cm) was noticed in 75% vermicompost concentration. The similar trend of observation was noticed in the tuber circumference as like of that of tuber width. However, the tuber was not appeared in control and 100% vermicompost concentration at 30 days period of exposure. Statistically the values were found to be significant at 1% level (Table 1 and Figure 1).

Table 1 Influence of vermicompost on Tuber Length, Width, Circumference (cm) and Weight (gm) in Carrot plant (*Daucus carota* L.)

Exposure period (in days)	Percentage of vermicompost	Tuber parameters			
		Length	**Width**	**Circumference**	**Weight**
30	**Control**	0	0	0	0
	25	8.00 ± 0.15	0.60 ± 0.01	3.53 ± 0.21	8.41 ± 1.35
	50	**10.62 ± 0.09**	**0.81 ± 0.03**	**4.76 ± 0.15**	**11.72 ± 0.93**
	75	10.23 ± 0.37	0.60 ± 0.03	3.85 ± 0.06	7.07 ± 0.12
	100	0	0	0	0
60	**Control**	5.89 ± 0.06	0.31 ± 0.03	0.92 ± 0.15	1.38 ± 0.04
	25	10.31 ± 0.36	2.26 ± 0.06	7.69 ± 0.25	30.65 ± 1.32
	50	**15.10 ± 0.44**	**2.90 ± 0.02**	9.57 ± 0.13	**51.72 ± 1.40**
	75	13.92 ± 0.45	**2.92 ± 0.02**	**10.12 ± 0.25**	25.15 ± 1.16
	100	4.73 ± 0.08	0.97 ± 0.02	5.02 ± 0.14	8.80 ± 0.32
90	**Control**	9.69 ± 0.13	0.79 ± 0.02	4.45 ± 0.19	4.01 ± 0.17
	25	14.28 ± 0.46	2.62 ± 0.11	8.80 ± 0.25	46.20 ± 1.02
	50	**23.16 ± 1.00**	3.71 ± 0.16	10.81 ± 0.17	**90.50 ± 1.42**
	75	19.08 ± 0.43	**3.92 ± 0.04**	**11.35 ± 0.40**	50.53 ± 1.29
	100	6.85 ± 0.07	1.40 ± 0.03	6.83 ± 0.09	17.60 ± 1.99
CD (p<0.01)		**0.931**	**0.0384**	**0.0347**	**1.604**

Values are expressed by mean ± SD of six samples

Discussion

The result of the present study proved that the tuber length and weight were noticed in 50% vermicompost concentration but at the same time the maximum tuber width and circumference were noticed in 50% as well as 75% vermicompost concentrations. It could be suggested that the better tuber yield in carrot plant exposed to particular concentration of vermicompost may be due to the influence of combined effect of various ingredients of vermicompost such as macro (N, P, K) and micro (Ca, Mg, Mn, Iron, sulfur, Zinc and Copper) nutrients, plant growth hormones (Indole acetic acid, Indole butyric acid, Naphthalene acetic acid and Gibberellic acid), vitamins (Vitamin A, B_1, B_2, B_3, C and E), enzymes, and many beneficial microbes such as Nitrogen fixation bacteria and hormones synthesizing microbes such as *Azospirillum brasilence*(Kolb and Martin, 1985; Kucey, 1988; Molla, 2001), *Azospirillum lipoferum* (Lee, 1988), *Azotobacter paspali* (Barea and Brown, 1974) and *Pseudomonas putida* (Glick, 1986; Caron 1995; Xie 1996).

In support to the present study Ansari *et al*. (2008) have reported that the better yield in the Spinach and Onion treated with different proportion of vermicompost may be due to slow release of nutrients for absorption with additional nutrients like gibberlin, cytokinin and auxin which increase the bioavailability of phosphorus and more exchangeable nutrients. Brattsten (1979) also suggested that the vermicompost consists of beneficial microbes, Vesicular Arbascular Mycorrhizae and important enzymes like amylase, protease, cellulase, kitinase and invertase which might have promoted the better yield and secondary metabolic synthesis. Martens *et al*. (1992) and Hendrix *et al*. (1994) revealed that the higher yields in the plants may due to the fact that organic manure(vermicompost) supplies direct available nutrients such as nitrogen to the plants and these organic manures improves the proportion of water stable of aggregates of the soil. This was attributed to cementing action of polysaccharides and other organic compounds released during the decomposition of organic matter thus leading to taller plant, increased number of leaves, tillers and in turn in final yield. It has been also suggested that the higher yield in bhendi, chillies, watermelon and paddy and number of canes per hill, internodes distance, stem length, shoot length, cane yield and quality(Ismail, 1995) when they were exposed to different concentration of vermicompost than the farm yard manure. Jayabal and Kuppusamy (1997) also revealed that the integrated application of organic nitrogen through vermicompost, fertilizer nitrogen and biofertilizer enhanced the better yield of rice. It has also been suggested that the compost produced by earthworm from municipal wastes and grape processing increase the dry matter production of maize(Ferreira, 1992) the grape yield by 20-50% at the first harvest(Edwards and Steele, 1997).

It has also been proved that supplying one third to one quarter of nitrogen as vermicompost increased the plant grain yield and yield components of rice and productive (Rani and Srivastava, 1997), productive tillers, panicle length, filled grain, grain weight and straw yield than recommended dose of NPK application in rice (Sudhakar, 2000), total yield, dry matter production, grain yield, number of grains per plant and total grain weight of the wheat (Garg and Bhardwaj, 2000a). Rajkhowa *et al*.(2000) have also proved that higher yield, dry matter production, nutrient content and nodule dry weight per plant in green gram was obtained when it was exposed to different concentration of vermicompost. Besides that the application of vermicompost increased higher yield of sunflower (Chinnamuthu and Venkatakrishnan, 2001), soybean (Thanathan 2002), Chilli (Hangarge 2002), dry matter and grain yield of wheat (*Triticum aestivum*) and Coriander (*Coriandrum sativum*) (Desai *et al*.(1999). The positive response was obtained with application of vermicompost to other field crops such as Sorghum (*Sorghium bicolor*) (Patil and Sheelavantar, 2000), Sunflower (*Helianthus annus*) (Devi and Agarval, 1988; Devi *et al*., 1998).

In addition to this Alam et al. (2007) reported that the yield, number, dry matter, weight of tuber of potato (*Solanum tuberosum* L.) exposed to 10 tone of vermicompost in combination with 100% NPK/ha fertilizer was maximum when compared to control. It has also been revealed that the three tomato plant varieties sprayed with vermicompost extract increased total and marketable yield, fruit quality and fresh mass per fruit (Siminis 1998; Atiyeh 2000a; Arancon 2003; Zaller, 2006). Recent laboratory and green house research has provided that earthworm activity on organic matter can lead to the production of water extractable plant growth influencing substance in quantities that could significantly influence crop germination and yield (Edwards 2004).

Alam *et al*. (2007) confirmed that the increasing rate of vermicompost (2, 2.5 and 10t/ha) gave the increasing trend of yield (5.63, 7.33 and 8.6t/ha) of red amaranth. Gowda et al. (2008) mentioned that the number of ear heads per meter square, 1000 seed weight and seed yield per meter square in wheat plant were significantly higher with treatment combination of vermicompost and poultry manure. Similarly, Kale et al. (1992) and Patil and Bhilare (2000) have also reported that the higher yield was obtained in groundnut and wheat exposed to different concentration of vermicompost. Gowda et al. (2008) also proved that the differential action of Farm yard manure and glyricidia when compared to vermicompost and poultry manure, may be because of the fact that the poultry manure and vermicompost have high yield and slow release of nitrogen due to slow mineralization which helps in availability of nutrients to the plants throughout the growth of the plant and thus resulting in higher yields. Maheshbabu et al. (2008) suggested that the plant yield parameters such as yield and yield components such as number of pods, seeds per pod and seed yield of groundnut were increased significantly due to the application of organic manures.

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