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Effect of Vermicompost on Growth and Quality of Culantro (*Eryngium foetidum* L.) Grown Under Novel Pro-tray Cultivation System

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Abstract

Culantro (*Eryngium foetidum* L.) is an underutilized spice used for flavouring in the Andaman Islands and North Eastern states of India. The produce fetches premium prices in the urban parts of these regions. To promote cultivation of this high value herb in urban areas, novel methods of pro-tray cultivation (Dweep ProDhaniya) has been developed. This system is suitable for cultivation in urban spaces including shaded terraces. To study the effect of vermicompost supplementation on cultivation in this system, an experiment was conducted with five ratio of soil: vermicompost (1:0, 0:1, 1:1, 1:2 and 2:1, v/v). Each treatment was replicated six times and pro-trays were maintained in shade net house (50% shade). Results revealed that soil or vermicompost alone did not support growth of culantro, while combination of substrates showed positive results. Leaf parameters such as leaf length (10.23 to 13.51 cm), leaf width (1.67 to 2.01 cm) and number of leaves per plant (6.33 to 11.13) were significantly influenced by the treatments and highest mean plant weight was observed in soil: vermicompost (1:1) combination. Quality of the produce in terms of chlorophyll content, total carotenoids content and ascorbic acid content also showed significant variations. These results will be helpful in enhancing the efficiency of the system for production of culantro in urban areas.

Key words: *Apiaceae, herb, substrate, urban horticulture*

Introduction

Culantro (*Eryngium foetidum* L., Apiaceae) is a tropical aromatic culinary rosette herb that was introduced by the Chinese into Southeast Asia (Malaysia, Indonesia, Thailand, Vietnam, Singapore, Myanmar, Sri Lanka, India and Bangladesh) as a substitute to the cilantro (*Coriandrum sativum*) in the late 1800s to the beginning of 1900s (Singh et al., 2014; Ramcharan, 1999; Chowdhury et al., 2007). The herb possesses strong aroma, better shelf life and is hardy in nature (Waman and Singh, 2019). It has been commonly employed for garnishing, marinating, flavouring and seasoning purposes in cuisines and food products (Ramcharan, 1999; Singh et al., 2014). It has been an integral part of the traditional Manipuri cuisines such as *morak-metpa*, *Oottii*, *Chagem-pomba* and *Hawaijar* (Singh and Sundriyal, 2003).

The herb is known to be rich source of various bioactive ingredients as saponins, flavonoids and essential oils have been reported from the aerial parts of the plant, while underground parts contain terpenes, saponins, monoterpene glycosides, phenolic compounds, aldehydes, esters, acetylenes and oligosaccharides. Eryngial (E 2 dodecenal) has been identified as the major constituent of *Eryngium* essential oil and it is commonly used in the flavour and fragrance industry (Shavandi, 2012). The herb is also valued in the traditional medicines for treating fever, burns, hypertension, stomach ache and epilepsy (Natraj et al., 2020). Further, anthelmintic, anti-inflammatory, analgesic, anti-convulsing, anti-carcinogenic and anti-diabetic properties have been reported in it (Saenz et al., 1997; Simon and Singh, 1986; Honeychurch, 1980).

To promote cultivation of this herb in urban areas, novel pro-tray cultivation system has been developed recently (Waman and Bohra, 2022). The growth, yield as well as quality of the produce are known to vary with the substrate. Vermicompost, a product of non-thermophilic biodegradation of organic matter, is a material of choice for use as a soil conditioner due to its high porosity, aeration, drainage, water holding capacity, humic acids and microbial activity (Arancon et al., 2006). It is easily available and is a nutrient-rich manure which could be used by the urban dwellers for growing the herbs. Hence, the present study was undertaken to investigate the influence of using vermicompost as a constituent of substrate for cultivation of culantro in pro-tray system.

Materials and methods

The study was conducted at the Division of Horticulture and Forestry, ICAR-Central Island Agricultural Research Institute, Port Blair, Andaman and Nicobar Islands. Seedlings of *Eryngium foetidum* var. CARI-Broad Dhaniya-1 were planted in pro-trays (53 cm × 28 cm × 4.5 cm) having 50 cavities maintained in the shadenet house (50% agro-shade net). The experiment was laid out in completely randomized design with six replications per treatment (120 plants per treatment). Irrigation was provided with micro-sprinkler system during the course of development of plant.

Initial pH of the substrate was determined in 1:2.5 water-substrate suspensions by digital pH meter (Hanna). Treatments consisted of T_1- soil: vermicompost (1:0, v/v), T_2- soil: vermicompost (0:1, v/v), T_3- soil: vermicompost (1:1, v/v), T_4- soil: vermicompost (2:1, v/v) and T_5- soil: vermicompost (1:2, v/v). Urea (0.1%) application was carried out through foliar sprays at weekly interval. All necessary cultural practices and plant protection measures were followed uniformly for all the treatments during the entire period of study.

Morphological observations on leaf length (cm), leaf width (cm) and number of leaves were recorded on 20 plants per treatment. The crop was harvested by uprooting after 4 months of transplanting and used for estimating yield parameters. Moisture content, photosynthetic pigments content using DMSO as a solvent, ascorbic acid content and total carotenoids (β- carotene equivalent) content were estimated following standard procedures (Shivashankara et al., 2017; Waman et al., 2022). The experimental data was subjected to statistical analysis by using Web Agri Stat Package WASP 2.0 (ICAR-CCARI, Ela, India).

Results and discussion

Promotion of cultivation of high value horticultural crops in urban areas is crucial for meeting the ever increasing demand of these commodities. Culantro is a popular herb that fetches premium prices in the island markets. To promote its cultivation, novel pro-tray based systems of cultivation have been developed in recent past by authors' institute. In the present study, effect of vermicompost was studied on performance of this herb, which revealed significant differences among the treatments studied.

Morphological growth parameters

Perusal of data suggested significant influence of vermicompost-soil substrate interaction on morphological traits. Leaves are the economic part of culantro. In some places of cultivation, individual mature leaves are plucked and used while in other parts whole herbs are uprooted and sold with roots. In Andaman Islands, the produce reaching in the market is of the latter type (Waman and Singh, 2019). Number of leaves produced on a seedling and their morphological parameters showed variations when observed after 30, 60, 90 and 120 days of planting (Fig. 1). In general, mean number of leaves increased from 30 to 90 days of planting, while there was a decline in this number after 120 days in all the treatments studied. As the plant reaches maturity, lower leaves start senescing and thus, such reduction in number of leaves per plant at harvest is justifiable.

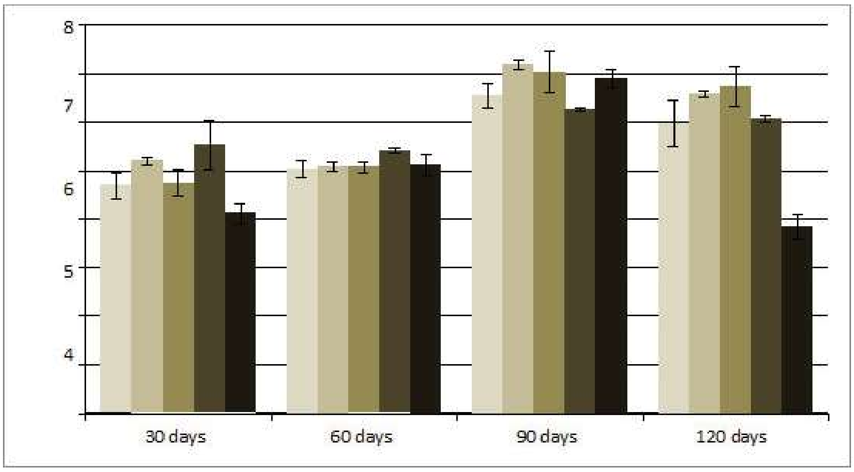

Fig. 1. Mean number of leaves per plant as influenced by vermicompost supplementation over a period of time [Soil: VC (v/v):: T_1 (1:0), T_2(0:1), T_3(1:1), T_4(2:1), T_5(1:2)]

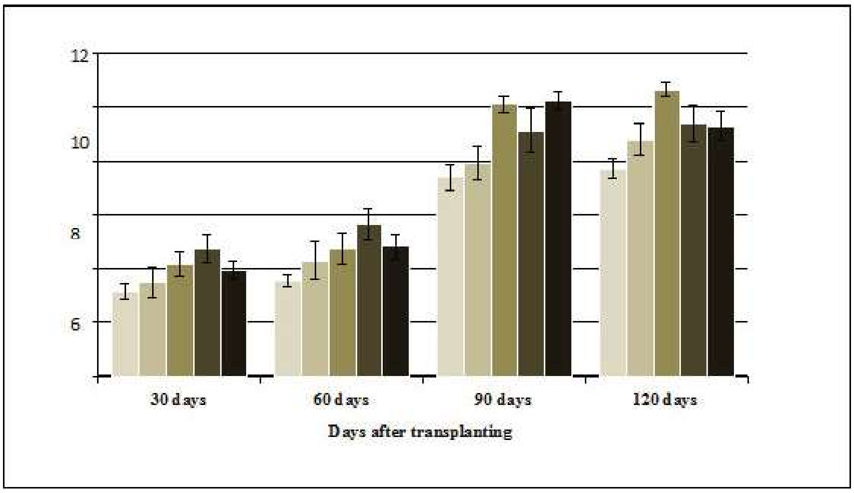

Fig. 2. Mean leaf length (cm) as influenced by vermicompost supplementation over a period of time [Soil: VC (v/v):: T_1 (1:0), T_2(0:1), T_3(1:1), T_4(2:1), T_5(1:2)]

Mean length of the recently matured leaf increased progressively with the age of the plant (Fig. 2). Significant differences were noticed among the treatments throughout the study period and use of soil alone was found to be the poorest of all. This clearly suggested that the herb responded to application of organic nutrient. However, identification of optimum levels of constituents is required as pure VC showed decline in the leaf length at later stage of crop growth. Irrespective of the treatment used, mean width of leaf increased with crop age up to 120 days. Use of soil alone showed lowest values for this parameter throughout the experimental period (Fig. 3). These findings are in accordance with earlier report (Rayhaneh and Shahrzad, 2017), who observed that success obtained with use of vermicompost is influenced by proportion of vermicompost as well as plant developmental stage in thyme.

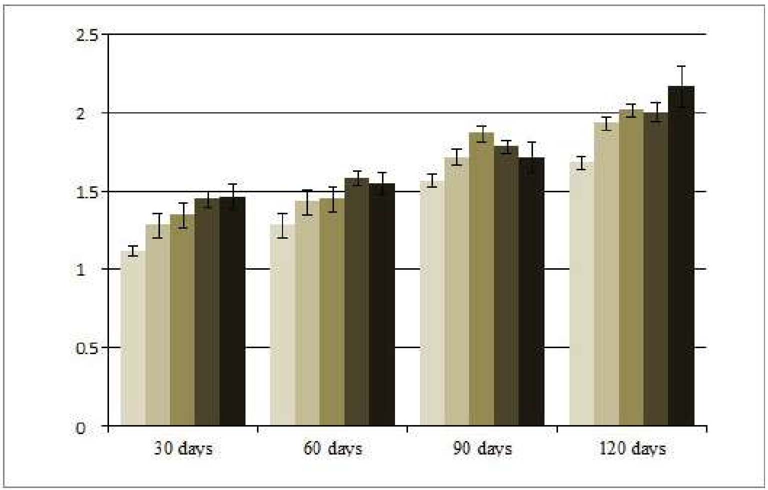

Fig. 3. Mean leaf width (cm) as influenced by vermicompost supplementation over a period of time [Soil: VC (v/v):: T_1 (1:0), T_2(0:1), T_3(1:1), T_4(2:1), T_5(1:2)]

Morphological parameters recorded at the time of harvesting the herb revealed significant differences among the treatments (Table 1). In general, use of equal proportion of soil and vermicompost as substrate significantly improved the plant growth, when compared with other treatments (Fig. 4). Mean length of leaves varied between 10.2 cm (T_1) and 13.5 cm (T_3). Widest leaves (2.0 cm) were observed in vermicompost alone; however, this treatment remained statistically similar with T_3. Leaf width is an important parameter influencing the interception and conversion of solar energy (Sarkar et al., 1995). Soil derived seedlings weighed 2.8 g at harvest, while the highest weight of individual plants was recorded in T_3 (5.7 g). Number of leaves per plant was the highest in T_4 (7.4), which was closely followed by T_1 (7.1) and T_3 (7.0). Importance of identification of optimum level of vermicompost in the substrate for better growth has been emphasized by Rayhaneh and Shahrzad (2017).

Table 1. Morphological parameters at harvest as influenced by vermicompost supplementation

Treatment (Soil: VC, v/v)	Leaf length (cm)	Leaf width (cm)	Weight of seedling (g)	No. of leaves/ plant
T_1 (1:0)	10.2 ± 0.49c	1.6 ± 0.04c	2.8 ± 0.18a	7.1 ± 0.42
T_2 (0:1)	11.7 ± 0.43b	1.6 ± 0.05c	3.0 ± 0.17b	6.8 ± 0.27
T_3 (1:1)	13.5 ± 0.30a	1.8 ± 0.04ab	5.7 ± 0.30c	7.0 ± 0.23
T_4 (2:1)	11.8 ± 0.30b	1.8 ± 0.03bc	3.9 ± 0.27d	7.4 ± 0.27
T_5 (1:2)	12.1 ± 0.40b	2.0 ± 0.05a	4.8 ± 0.32d	6.9 ± 0.22

Values are presented as mean ± standard error of mean. Values followed by similar alphabets in a column do not differ significantly following least significant different at 5% level of significance.

Vermicompost has been reported to be rich in beneficial microflora such as nitrogen fixers, P-solubilizer and cellulose decomposers, apart from being rich source of enzymes, vitamins and plant hormones (Perucci 1990). These micro-flora and phytohormones along with humic acids might have contributed for superior leaf morphological parameters in the vermicompost supplementation treatments in the present study. These compounds are known to promote the plant growth due to proliferation of root hairs, release of mineral nutrients, and assisting in oxidative phosphorylation, cellular respiration, photosynthesis and other enzymatic activities. Improvement in plant morphological parameters due to vermicompost has already been reported in marigold (Ali et al., 2014).

Fig. 4. General view of harvested plants from different treatments (top to bottom, T_1 to T_5)

Biochemical parameters

Significant changes were noticed for biochemical parameters due to different treatments assigned. Apart from the basic function of photosynthesis in a plant system, chlorophyll pigments impart 'greenness' to the produce, which is used as a parameter to judge the quality of fresh herbs. During present study, chlorophyll a, chlorophyll b, total chlorophylls and ratio of chlorophyll a: chlorophyll b were influenced by the treatments studied (Table 2). Substrates involving higher proportions of soil *viz*. T_1 and T_4 showed poorest accumulation of chlorophyll a (1.5 ± 0.01 mg/g and 1.5 ± 0.00 mg/g, respectively), chlorophyll b (0.5 ± 0.02 mg/g and 0.5 ± 0.02 mg/g, respectively) and total chlorophylls (2.0 ± 0.03 mg/g and 2.0 ± 0.02 mg/g, respectively). On the other hand, these parameters were significantly boosted in treatments involving equal or higher proportions of VC. In general, use of soil: VC in equal proportions helped in maximum accumulation of chlorophylls in the leaves. Ratio of chlorophyll a: chlorophyll b varied between 2.82 (T_3) and 3.24 (T_5).

Table 2. Photosynthetic pigments variation due to vermicompost supplementation

Treatment (Soil: VC, v/v)	Chlorophyll content (mg/g)			
	Chl. a	Chl. b	Total chl.	Chl. a: Chl. b
T_1 (1:0)	1.5 ± 0.01	0.5 ± 0.02	2.0 ± 0.03	2.91
T_2 (0:1)	2.5 ± 0.00	0.8 ± 0.00	3.3 ± 0.00	2.92
T_3 (1:1)	2.5 ± 0.01	0.9 ± 0.01	3.4 ± 0.02	2.82
T_4 (2:1)	1.5 ± 0.00	0.5 ± 0.02	2.0 ± 0.02	3.06
T_5 (1:2)	2.4 ± 0.00	0.8 ± 0.14	3.2 ± 0.14	3.24

Vermicompost is known to enrich the substrate with essential nutrients, many of which are directly or indirectly involved in the process of photosynthesis (Sinha et al., 2011) and hence, higher accumulation of chlorophyll pigments could be observed in VC supplemented treatments (Tadayyon et al., 2018). Positive influence of vermicompost on increasing photosynthetic pigments has been demonstrated in thyme and marigold (Ali et al., 2014; Rayhaneh and Shahrzad, 2017).

Moisture content of the produce is generally high in case of leafy greens/ herbs as earlier reports suggest presence of 60.23 to 88.33% moisture in culantro and 82.4% in coriander var. Arka Isha (Varalakshmi et al., 2012; Lepcha et al., 2018). In the present study, moisture content of the freshly harvested leaves did have high moisture content of 85.508% to 86.524%; however, the values did not differ significantly among the substrates studied (Fig. 5).

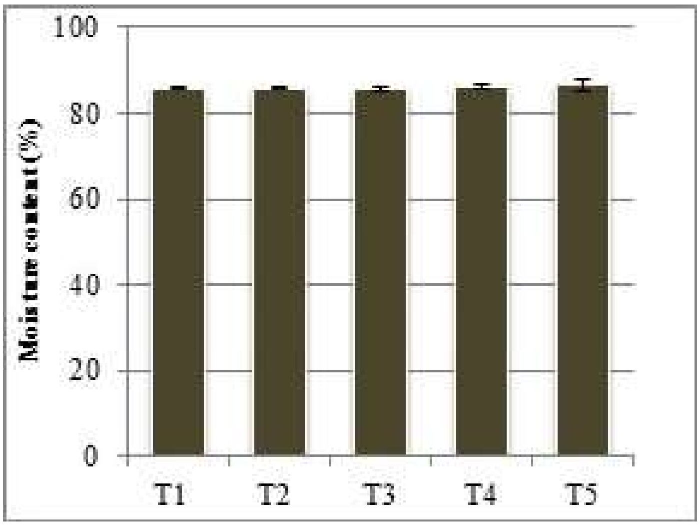

Fig. 5. Moisture content in freshly harvested leaves as influenced by different substrates [Soil: VC (v/v):: T_1 (1:0), T_2(0:1), T_3(1:1), T_4(2:1), T_5(1:2)]

Ascorbic acid content is one of the important nutritional parameter in the herbs (Varalakshmi et al., 2012; Lepcha et al., 2018). In the present study, the ascorbic acid content in the fresh leaves was the lowest (23.97 mg/ 100g) in plants grown in soil alone, which was followed by vermicompost alone (29.97 mg/ 100g). The highest content of ascorbic acid (Fig. 6) was reported from treatment T_5 (65.93 mg/ 100g). As the substrates had different levels of VC, the release of various growth promoting substances would have been different and thus the variations could be justified. Earlier reports have suggested 18.33 to 32.33 mg/100g ascorbic acid in culantro grown in Sikkim (Lepcha et al., 2018), while the levels of ascorbic acid observed in the present study was higher.

Carotenoids are non-enzymatic antioxidants that are known to protect the chlorophylls from oxidative stress. Carotenoid content (β carotene equivalent) showed drastic differences among the treatments studied. Plants grown with soil alone as a substrate showed the lowest content of carotenoids (15.4 mg/ 100g) among the treatments studied (Fig. 6). Use of VC at all the proportions had beneficial influence on the accumulation of carotenoids in the herb and soil: VC (1:2) had the highest content (74.7 mg/100g) of carotenoids in the present study. Similar findings have been reported by earlier researchers who observed improved carotenoids in vermicompost supplied plants than soil alone (Ali et al., 2014; Rayhaneh and Shahrzad, 2017).

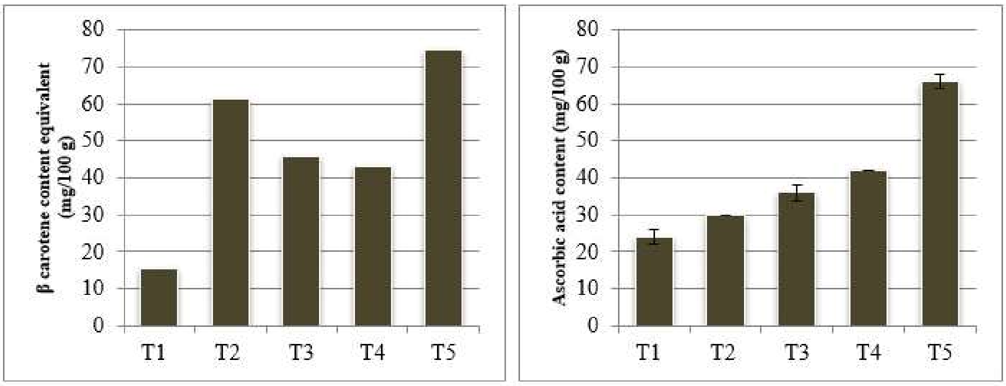

Fig. 6. Total carotenoids (β carotene equivalent) and ascorbic acid content of leaves as influenced by substrates [Soil: VC (v/v):: T_1 (1:0), T_2(0:1), T_3(1:1), T_4(2:1), T_5(1:2)]

Conclusion

The present study exhibited the supplementation of vermicompost with soil to be effective in profusely elevating the morphological parameters such as leaf length, leaf width, number of leaves, moisture and biochemical parameters *viz*. photosynthetic pigments, ascorbic acid content and β-carotene content.

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