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Effect of organic amendments on soil chemical and biological properties under Green Coriander (*Coriandrum sativum* L.) cultivation

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ABSTRACT

A field experiment was carried out during 2021-22 to find out the effect of organic amendments on soil chemical and biological properties under Green Coriander (Coriandrum sativum L.) cultivation in the organic block of Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat. The experiment was laid out with seven treatments in Randomized Block Design and replicated three times. The results revealed that the treatment T_7 (Enriched compost @ 5 t ha^{-1}) recorded the best for all the soil parameters viz. , soil pH (5.15), organic carbon (0.90%), available nitrogen (270.33 Kg ha^{-1}), available phosphorus (52.71 Kg ha^{-1}), available potassium (173.31 Kg ha^{-1}), microbial biomass carbon (298.41 µg g^{-1} soil 24hr^{-1}), phosphomonoesterase activity (67.05 µg p-nitrophenol g^{-1} soil 24hr^{-1}) and fluorescein diacetate hydrolysis (10.17 µg fluorescein g^{-1} h^{-1}).

Keywords: Enriched compost, Coriander, Biomass, Phosphomonoesterase

INTRODUCTION

Coriander (*Coriandrum sativum* L.) is an aromatic, herbaceous annual plant belonging to the family Umbelliferae. The young green leaves of the plant are used as a garnishing agent in the preparation of salads, sauces, sea food, poultry dishes and a variety of traditional dishes (Singletary, 2016). *Coriandrum sativum* is widely grown in Eastern and Central Europe, the Mediterranean region (Morocco, Malta, and Egypt), USA, Russia and Asia (India, China, Iran, Turkey, Pakistan and Bangladesh) (Pandey, 2010). India tops the list of countries producing coriander globally, followed by Turkey and Mexico. Presently, it is commercially cultivated in Madhya Pradesh, Rajasthan, Gujarat, Assam, Haryana, Maharashtra, Uttar Pradesh, Bihar, Telengana and Chattisgarh. Coriander demands sufficient fertilizer input for increased production. Today, expanding population constraints have compelled many countries to use pesticides and fertilizers to boost farm production in order to fulfil their ever-increasing food demand. The advent of green revolution has led to increased crop production perhaps at the expense of excessive chemical fertilizers and insecticides. The dependence of the farmers on those synthetic inputs to accelerate production and profit has increased considerably. It is well known that the physico-chemical and biological properties of the soil deteriorate when chemical fertilizers are used haphazardly without organic manures (Saket *et al*. 2014)

Organic amendments including manure, compost and biofertilizers play a vital role in organic farming. These amendments can improve soil fertility and crop development by increasing soil essential nutrient content over time, regenerating soil biological matter, increasing bulk soil density and improving soil water retention capabilities and soil structure (Sharma and Reynnells, 2018). Biofertilizers are one of the most efficient agricultural tools used to enhance soil fertility and quality (Singh *et al*. 2015). Bio-fertilizers which are applied to soil, seed, or composting regions with the goal of maximizing the number of such micro-organisms and accelerating those microbial processes that enhance the availability of nutrients that are easily assimilated by plants (Mahdi *et al*. 2010). In the same way, vermicompost can increase the number, diversity, and activity of microbes in soil while also adding organic matter and minerals. Again, microbial consortia play a critical role in nutrient mobility, crop defence and disease prevention, stress tolerance management, soil conservation and entire ecosystem functioning (Padmaperuma *et al*. 2020). Much work on soil

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properties under organic Green Coriander cultivation has not been reported. Thus, the present investigation was taken up.

MATERIALS AND METHODS

The field experiment was conducted during 2021-22 in the organic block of the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat. The experimental site was situated at 26.45ºN latitude and 94.12ºE longitudes and an elevation of 86.8 m above mean sea level and under upper Brahmaputra valley Agro Climate Zone of Assam. The experiment was laid out with seven treatments in Randomized Block Design and replicated three times. The treatments included: T_1 (Absolute control), T_2 (Vermicompost @ 2.5 t ha^{-1}), T_3 (Vermicompost @ 2.5 t ha^{-1}+ microbial consortium), T_4 (Vermicompost @ 5 t ha^{-1}), T_5 (Vermicompost @ 5 t ha^{-1}+ microbial consortium), T_6 (Enriched compost @ 2.5 t ha^{-1}) and T_7 (Enriched compost @ 5 t ha^{-1}). The soil textural class of the experimental site was sandy loam and each size of the experimental plot was 3m^2. The soil analysis was performed prior to the layout of the experiment to gain a better understanding of the soil condition. Soil samples ranging in depth from 0-15 cm were taken with the help of a soil auger from various locations of the experimental field. A representative composite sample was prepared by processing, mixing and sieving through a 2 mm sieve which was then analyzed for physical and chemical properties. The soil in the experimental plot was acidic in nature with pH 4.52, low in available nitrogen (216.01 Kg ha^{-1}), medium in available phosphorus (32.95 Kg ha^{-1}) and available potassium (146.77 Kg ha^{-1}). Before sowing in each replication, organic manures including vermicompost, enriched compost and microbial consortium (Azotobacter, Phosphate Solubilizing Bacteria and Rhizobium) were applied at random. As a soil application, microbial consortium was applied at the rate of 3.5 Kg ha^{-1}. The seeds were split in half by gentle rubbing and then soaked in water for 16 hours. After removing the floated seeds, the viable seeds were sown in a straight row in a furrow that was opened to a depth of 2.5 to 3 cm while maintaining a 20 cm inter-row distance.

Samples of the soil were taken both before and after the crop were harvested to estimate chemical and biological properties of the soil. Soil pH was determined by glass electrode method (Jackson, 1973). Available nitrogen, available phosphorus and available potassium of the soil were determined by Modified Kjeldahl's method, Bray's I method and Flame Photometric method respectively (Jackson, 1973).Organic carbon content of the soil was estimated by Wet digestion method (Piper, 1966). Soil Microbial Biomass Carbon was determined by Chloroform fumigated extraction technique (Vance *et al*. 1987). Phosphomonoesterase activity (PMEase) was determined colorimetrically as described by Tabatabi and Bremner (1969). Fluorescein Diacetate hydrolysis was also determined colorimetrically following extraction with organic solvent mixture as described by Adam and Duncan (2001). The data of the respective soil parameters were subjected to appropriate statistical analysis following the methods suggested by Panse and Sukhatme (1995).

RESULTS AND DISCUSSION

Soil Chemical properties

The results revealed that the highest soil pH (5.15) was recorded in T_7 (Enriched compost @ 5t ha^{-1}). Soil pH is an expression of H$^+$ and OH$^-$ activity by dissociation of water molecules. The release of basic cations and subsequent deactivation of Al^{3+} caused by the addition of organic matter may be the cause of the higher pH (Gogoi *et al*. 2017). Higher pH levels in the soil may be caused by the activities of microbes that aid in the decomposition of organic matter and the conversion of unavailable mineral nutrients into available forms that satisfy crop requirements for growth and development, increase organic carbon content and stabilize soil pH (Tekasangla *et al.* 2015). This finding is in accordance with Hazarika *et al*. (2017) who recorded a higher pH value of 5.69 and Barik *et al*. (2018) who observed a value of 5.64 by application of Enriched compost @ 5t ha^{-1} respectively in comparison to the other treatments. It was revealed in Table 1 that the highest organic carbon (0.90%) was obtained in T_7 (Enriched compost @ 5t ha^{-1}). The reason can be attributed to the relatively higher carbon content in enriched compost compared to the other organic treatments. The increased organic carbon content could be attributed to less dispersion of carbon to the soil, which promotes greater sequestration. The lowest organic carbon content was recorded in T_1 (0.70%). This might be caused by the limited organic matter in the surrounding soil, which is used by plants and other soil bacteria, thereby resulting in exhaustion of the organic carbon in the soil (Barik *et al*. 2018). Similar results have been reported by Dinesh *et al.* (2010) in turmeric under the influence of organic manures and fertilizers.

Table 1: Effect of organic amendments on soil chemical properties

Treatments	Soil pH	Org. carbon (%)	Available N (Kg ha^{-1})	Available P (Kg ha^{-1})	Available K (Kg ha^{-1})
Absolute control	4.53	0.70	215.55	32.27	144.41
Vermicompost @ 2.5 t ha^{-1}	4.75	0.72	238.43	35.63	149.25
Vermicompost@ 2.5 t ha^{-1} + microbial consortium	4.78	0.76	253.61	40.22	151.38
Vermicompost @ 5 t ha^{-1}	4.92	0.81	256.39	44.61	153.66
Vermicompost@ 5t ha^{-1}+microbial consortium	4.98	0.86	263.01	50.09	168.51
Enriched compost @ 2.5 t ha^{-1}	5.10	0.87	267.22	49.22	167.21
Enriched compost @ 5 t ha^{-1}	5.15	0.90	270.33	52.71	173.31
S.Ed(±)	0.01	0.01	0.52	0.30	0.12
CD (5%)	0.02	0.02	1.15	0.66	0.27

The status of available N was recorded highest in treatment T_7 (270.33 Kg ha^{-1}) in Table 1. It might be caused by the use of bio- and organic fertilizers as nutrition sources. *Rhizobium,* together with *Azotobacter,* is thought to fix atmospheric N into the rhizosphere throughout the cropping period, which may be the reason for the increase in available N in soil. Sumbul *et al.* (2020) reported that *Azotobacter* has the efficiency of fixing N, about 20 kg ha^{-1} per year. Similar findings were also reported by Ullah *et al.* (2008), Dinesh *et al.* (2010) and Barik *et al.* (2018). However, the lowest value of available N was recorded in T_1 (Absolute control) with 215.55 Kg ha^{-1}. Such an outcome might be brought about by rapid leaching and other losses, such as the plant's uptake of available N (Babu *et al.*2007). On the other hand, the available phosphorus of 52.71 Kg ha^{-1} was obtained highest in T_7 (Enriched compost @ 5t ha^{-1}) followed by 50.09 Kg ha^{-1} in T_5 (Vermicompost @ 5 t/ha+ microbial consortium). The increased content in treatment could be the result of both organic acids being released during the decomposition of organic matter and other organic acids being produced by phosphate solubilizing bacteria (PSB). This organic acid, which is present in large quantities in acid soil, acts as a chelating agent and combines steadily with aluminium and iron to generate persistent complexes. Similar findings were reported by Ullah *et al.* (2008), Shiriyappagoudar *et al.* (2019) and Demir (2020). Shiriyappagoudar *et al*. (2019) recorded higher available N, P, K values of 293.80 Kg ha^{-1}, 65.96 Kg ha^{-1} and 141.33 Kg ha^{-1} respectively by the application of Enriched compost @ 5 t ha^{-1}. A significant increase in available K content was recorded as 173.31 Kg ha^{-1} in T_7 (Enriched compost @ 5t ha^{-1}) followed by 168.51 Kg ha^{-1} in T_5 (Vermicompost @ 5 t/ha+ microbial consortium). The mineralization of insoluble substances by the action of organic acids released during the breakdown of organic manures or generated by biofertilizers may be the cause of the greater K content in the treatment T_7 (Enriched compost @ 5t ha^{-1}). Additionally, it can be attributed to increased K retention by organic sources, which prevents leaching loss. The availability of potassium in soil is positively impacted by organic manure, according to Srikanth *et al.* (2000).

Soil Biological properties

In the present study, the microbial biomass carbon content of 298.41 µg g^{-1} soil $24hr^{-1}$ exhibited highest in T_7 (Enriched compost @ 5t ha^{-1}) followed by 285.60 µg g^{-1} soil $24hr^{-1}$ in T_6 (Enriched compost @ 2.5 t ha^{-1}) and the lowest value of 188.40 µg g^{-1} soil $24hr^{-1}$ was recorded in T_1 (Absolute control). The improved microbial enzymatic activity in soil caused by applied enriched compost's carbon may be the cause of these improved results in organic treatment. Additionally, Saikia *et al.* (2018)

observed that adding enriched compost to soil causes an increase in soil microbial biomass carbon. When organic inputs are applied to the soil, its biological characteristics improve, which is directly related to the increase in organic carbon, nitrogen and phosphorus content. Similar findings were reported by Gogoi *et al.* (2017) and Barik *et al.* (2018).

Table 2: Effect of organic amendments on soil biological properties

Treatments	Soil microbial biomass carbon (μg g^{-1} soil $24hr^{-1}$)	Phosphomonoesterase activity (μg p-nitrophenol g^{-1} soil $24hr^{-1}$)	Fluorescein diacetate hydrolysis (μg fluorescein g^{-1} h^{-1})
Absolute control	188.40	45.56	8.87
Vermicompost @ 2.5 t ha^{-1}	198.89	52.90	8.97
Vermicompost@ 2.5 tha^{-1} + microbial consortium	237.37	57.45	9.13
Vermicompost @ 5 t ha^{-1}	254.03	59.62	9.28
Vermicompost@ 5t ha^{-1}+microbial consortium	272.10	62.44	9.55
Enriched compost @ 2.5 t ha^{-1}	285.60	64.67	9.96
Enriched compost@ 5 t ha^{-1}	298.41	67.05	10.17
S.Ed(±)	0.73	0.18	0.02
CD (5%)	1.61	0.39	0.05

The maximum activity of PMEase enzyme (67.05 μg p-nitrophenol g^{-1} soil 24 hr^{-1}) was recorded in T_7 (Table 2). The activity of this soil enzyme is enhanced by the application of enriched compost. The enzyme's production, which is initiated by the presence of organic substrate, might result from the liberation of organically bound P (Biswas and Narayanaswamy, 2006). These results were in conformity with Nath *et al.* (2012), Gogoi *et al.* (2017) and Barik *et al*. (2018). A similar trend was followed in FDA activity where the highest value of 10.17 μg fluorescein g^{-1} h^{-1} was recorded in T_7 (Enriched compost @ 5t ha^{-1}) while the lowest value of 9.96 μg fluorescein g^{-1} h^{-1} was recorded in T_1 (Absolute control). The number of living cells in the soil is determined by FDA activity. The addition of organic substances serves as a useful supply of carbon and energy for heterotrophs or bacteria, extending their life span. These results are in conformity with Albiach *et al.* (2000), Chang *et al.* (2007), Nath *et al.* (2012), Gogoi *et al.* (2017) and Barik *et al*. (2018).

The results of the present study indicated that the incorporation of organic amendments improved the soil health by increasing available NPK, organic carbon content, soil microbial biomass carbon and soil enzyme activities. Hence, it can be concluded that the enhanced soil chemical and biological properties can be achieved by application of enriched compost @ 5 t ha^{-1}.

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