Eco. Env. & Cons. 26 (August Suppl. Issue) : 2020; pp. (S103-S108)

ISSN 0971–765X

Impact of green tea compost on soil quality and growth of plants

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(Received 3 December, 2019; accepted 30 January, 2020)

ABSTRACT

Compost has multiple benefits which effects soil fertility, plant productivity and environment. However, the speedy action of chemical fertilizers promotes their consistent use and limits the inclusive effects of compost in respect to their slow absorption. The present study has been initiated with the aim to amend the compost quality using green tea dust waste, baggase and vermicompost. The physical and chemical parameters of the compost were analyzed using standard procedures and its plant growth promoting effect on chili pepper plant was assessed through pot experiment. The present investigation showed that proposed compost mixture improved soil quality and enhanced the plant growth. The combined application of green tea dust waste, bagasse and vermi-compost in defined composition can be used as a promising biofertilizer.

Key words : *Green tea waste, Bagasse, Vermin-compost, Insecticidal, Plant growth*

Introduction

With the increase in awareness and concern pertaining to the alarming impact of hazardous chemical fertilizers on environment and health, the use of organic farming as an alternative is being increasingly accepted and adapted among the agriculturists and consumers. In this respect, consistent efforts are being made to amend the quality of compost to ensure healthy crop development. Rich in nutrients, the compost itself is beneficial for the land in many ways, which includes soil conditioning, enrichment of soil fertility, incorporating vital humus, acting as natural and organic pesticide for soil, and enhancing plant growth (Sarkar *et al*., 2016).

The beneficial effects of compost on crop production and soil quality reported in the literature are directly related to the physical, chemical and biological properties of the composts. Application of biological residues such as crop residues, silage, unused bedding materials, manures as co-compost cover materials, enriches the quality and potential of final compost (Pan *et al*., 2012). Thus, quality control during compost production must affirm requisite chemical and physical characteristics, and appropriate degree of stability and maturity in the final product (Atalia *et al*., 2015).

Green tea dust waste has been identified as nutrient rich bio-manure containing potassium, phosphorus, nitrogen, and tannins, which adds on to its nutraceutical value and helps in in promoting plant growth, enrichment of soil nutrients through tea decomposition (Gurav and Sinalkar, 2013; Wazir *et al.*, 2018). It is also evident from experiments that tea induced soil nutrient enrichment in turns promotes soil oxygenation via microbial activity as well as strengthens plant root system (Wazir *et al*., 2018).

Therefore, considering the nutraceutical value of green tea waste and its efficiency in promoting plant growth, the main objective of this study was to pre-

pare novel tea dust waste based compost and to analyse its physical and chemical properties with respect to its role as plant growth promoting biofertilizer. Further, because the secondary metabolites in plants have been recognized to have potential antimicrobial and insecticidal potential (Scott *et al.*, 2015; Parameshwari *et al.*, 2019), both qualitative and quantitative phytochemical study of green tea dust was performed to analyze its individual nutritive contribution in enhancing compost quality and promoting plant growth.

For the present study, three main components namely green tea dust, vermicompost and bagasse were used as the main components of the compost. The green tea dust which is the last and finest powder left after using different gratings, is used either in making of tea bags or is left unused. Vermicompost is a well known composting product acquired following green technology which uses various species of worms like earthworms, decomposing organic waste (Bhadauria and Saxena, 2010; Piya *et al.*, 2018), while sugarcane bagasse, a fibrous matter was used as a bulking agent in composting (Chang *et al.*, 2010; Batham *et al.*, 2013; Chacha *et al.*, 2019).

It is proposed that the novel organic bio-compost could be used as an alternative to regular chemical fertilizer with respect to its ability to enhance the soil fertility and improving plant growth.

Materials and Methods

Collection of the material

Tea Dust: The Green tea dust was collected from Mr. J.K Uniyal, Manager of DTC India Limited, Arcadia Tea Estate Factory located in Premnagar, Uttarakhand.

Vermi Compost: It was collected from Vermicomposting unit set up in Graphic Era (Deemed to be University) Campus.

Bagasse: Sugarcane bagasse was collected from local sugarcane juice shop located in Clement town area, Dehradun. Crushed sugarcane trash was further shredded in mixer grinder to increase the surface area and to improve the decomposition of waste by microorganisms at faster rates.

Preparation of tea dust extract

For the preparation of green tea dust extract, dried tea dust was separately soaked in 70 % methanol in the ratio of 1:1 in a sterilized flask. The solution was mixed gently and was allowed to macerate for consecutive 3 days in the shaking incubator at the speed of 100rpm at 25 ^{o}C. After maceration, the extract was filtered using Whatman filter paper No.1 and the solvent was completely evaporated at appropriate temperature till it gave a viscous mass. The crude extract was weighed and its percentage yield was recorded. Further, the crude extract was kept in refrigerator at 4 ^{o}C until further use (Anand *et al.*, 2018).

Qualitative analysis of green tea dust

The preliminary analysis of green tea dust extract was done to detect the presence of terpenoids, alkaloids, steroids, glycosides, saponins, flavonoids, catecholic tannins, anthocyanins, amino acids and carbohydrates using standard procedures (Anand *et al.*, 2018).

Quantitative analysis of green tea dust

Determination of Total Flavonoid Content

The total flavonoid content of the green tea dust extract was determined by the aluminum chloride calorimetric method. The standard curve of hydrated catechin was used for quantification of total flavonoid content (Anand *et al.*, (2018).

Determination of Total Phenolic Content

The total phenolic content present in green tea dust extract was assessed by following Folin-Ciocalteu reagent (FCR) assay. The standard curve of gallic acid was used for quantification of total flavonoid content (Anand *et al.*, 2018).

Determination of Antioxidant Activity

The antioxidant activity of green tea dust was assessed following 1,1-Diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging assay using ascorbic acid as reference (Anand *et al.*, 2018).

Preparation of Compost

The proposed green tea dust compost was named S4G. To prepare the compost, we followed reference of Ghorbani *et al.*, 2008 with slight modifications. The composition of the S4G compost included 40 gm of green tea dust waste, 20 g of vermicompost and 10 gm of Bagasse and 400 mL of sterilized distilled water. The components were kept for incubation in sterilized flask for incubation inside shaker

incubator for 7 days at 26%C (RT) at 100rpm. To assess the decomposition and composting process, the temperature and pH of the compost was monitored regularly. On seventh day, the liquid mixture was separated from the crude mixture and further examined for its physical and chemical properties.

Fig. 1. (a) Compost mixture

Fig. 1. (b) Liquid Extract is separated from crude extract

Physical and Chemical Properties of compost

To produce a sound and a good quality of compost, physical and chemical properties of the compost should be determined by the end of processing period. The physical properties of S4G compost such as moisture content (%), water holding capacity (g water/g dry sample), electrical conductivity (S^{-1}), bulk density (kg/m^3) and porosity(%) were determined using the standard procedures (Benito *et al*., 2003; Ahn *et al*., 2008). The soil sample untreated with the compost served as control and was also assessed for its physical and chemical parameters. The C/N ratio and nitrogen content in untreated soil and in the compost treated soil were determined and compared to assess their respective chemical properties.

Plant growth promoting effect of the compost

The plant growth promoting effect of the S4G compost was studied on chili pepper plant (n=2) in the month of June 2018 for a period of one and half month. Chili pepper plant is a fruit plant belongs to genus *Capsicum* and family Solanaceae. The plant was grown in two separate pots labeled as pot 'A', pot 'B' having proper amount of soil. Pot 'A' contained only soil with the plant. This pot was taken as a control to compare the plant growth in the presence of S4G compost. In pot 'B', soil with dry compost (S4G) was added to the plant. The plant growth was observed for 3-4 weeks. The chili pepper plant leaves were checked every two or three days and the number of leaves, average length and width of leaf were measured and recorded following the standard procedures.

Results and Discussion

Green tea is always been considered a healthy nutraceutical pertaining to its rich presence of primary metabolites and secondary metabolites like flavonoids, phenolic compounds (Puligundla *et al*., 2017). The qualitative analysis of green tea dust extract also showed the presence of presence of carbohydrates, proteins tannins, steroids, alkaloids, terpenoids (Table 1 and 2), which indicates its nutritive potential.

Physical and chemical properties of compost

The pH of different samples was estimated in the range of 6.0 and 6.9, which is an optimum range that promotes plant growth as stated by Gentili *et al*., 2018. Mositure content of compost was estimated to be 32.29% which is in agreement with the required amount for optimum plant growth and prevention

Table 1. Qualitative analysis of green tea dust extract

Phytochemicals	Presence (+) or absence (-)
1 Catecholic tannin	+
2 Saponin	-
3 Steroid	+
4 Glycoside	-
5 Alkaloid	+
6 Terpenoid	+
7 Gallic tannin	+
8 Anthocyanin	-
9 Proteins	+
10 carbohydrates	+
11 Flavonoid	**+**

Table 2. Quantitative analysis of green tea dust extract

Test	Concentration (µg/ml)
Total Flavonoid Content	26.5
Total Phenolic Content	59.3

of bad odour, and creating anaerobic condition in soil (Zameer *et al*., 2010).

Another important parameter of compost is its increase water holding capacity (Hepperly). As indicated in our study, the implementation of S4G compost in soil increases its water holding capacity with respect to untreated soil. The addition of bagasse as bulking agent could play an important role in enhancement in water holding capacity of the compost enriched soil (Chacha *et al*., 2019).

The C/N ratio of soil, S4G compost and soil treated with S4G ranged from 11.28: 1 – 30.75: 1. The lowest value of C/N ratio (11.28) was found for soil treated with S4G compost and the highest value of C/N ratio of 30.75 observed for S4G compost alone. These results are in agreement with the observation of Khater, 2012 according to which the C/N ratio ranged from 20: 1-30:1 is considered ideal for ready-to-use as compost (Table 4).

The ideal value of total organic carbon content

Table 4. Chemical properties of green tea dust compost

Samples	Total C%	Total N%	C/N ratio
Soil	6.508	**0.0420**	16.2
S4G	7.7748	**0.1681**	30.75
Soil +S4G	10.588	**0.1701**	11.28

Table 5. Plant growth measurements in Pot 'A' containing Chili pepper plant with soil only.

Day (D)	Height of plant (cm)	No of leaves	Leaf length (cm)
D1	15.0cm	08	2.0cm
D3	15.2cm	10	2.1cm
D5	15.4cm	12	2.2cm
D7	15.6cm	12	2.2cm
D10	15.8cm	16	2.2cm
D12	16.0cm	20	2.5cm
D14	16.0cm	20	2.8cm
D18	16.2cm	19	2.9cm
D20	16.2cm	19	3.0cm
D22	16.4cm	19	3.2cm
D24	16.4cm	20	3.3cm
D26	17.0cm	18	3.3cm
D28	17.2cm	15	3.2cm
D30	17.2cm	15	3.0cm
D32	17.0cm	13	2.2cm
D34	17.0cm	13	2.0cm
D36	17.0cm	11	2.0cm

withn respect to the toatal organic matter should be higher than 10%. In the present study, a total organic carbon content for soil treated with S4G was depicted highest with an optimum value of 10.5%. The total nitrogen values ranged from 0.04% to 0.17% for different compost types under study.

Plant growth promoting effect of compost

The Chili Pepper plant potted in soil "(Pot A) and potted in soil supplemented with S4G showed characteristic growth pattern as indicated by the measurements of their plant height, leaves count and leaves length (Table 6 and Table 7).

Table 3. Physical properties of green tea dust compost

Samples	Water Holding capacity (gm of water/gm of sample)	Moisture content (%)	Electrical conductivity is (millimoles/ cm.)	pH
Soil	2.64	16.43	0.378	6.9
Dry Compost S4G	5.26	32.29	0.499	6.1
Soil + S4G	6.35	39.87	0.809	6.0

Table 6. Plant growth measurements in Pot B containing Chili pepper plant with soil and compost (S4G)

Day (D)	Height of plant (cm)	No of leaves	Leaf length (cm)
D1	15.4cm	10	2.7cm
D3	15.4cm	11	2.7cm
D5	15.6cm	14	2.8cm
D7	15.8cm	17	3.0cm
D10	16.0cm	17	3.0cm
D12	16.0cm	18	3.4cm
D14	16.0cm	18	3.6cm
D18	17.0cm	18	4.0cm
D20	18.0cm	20	4.2cm
D22	18.2cm	21	4.2cm
D24	19.0cm	21	4.3cm
D26	20.0cm	23	4.5cm
D28	20.0cm	20	4.7cm
D30	21.5cm	18	4.9cm
D32	22.8cm	18	5.1cm
D34	23.0cm	17	5.3cm
D36	23.5cm	17	5.6cm

Plant height formula.

Conclusion

Based on the study of different physical and chemical parameters, and plant growth promoting efficacy, it can be considered that S4G compost comprising green tea as a natural phytonutrients, bagasse as bulking agent and vermi-compost as a source of rich organic matter enhances the soil quality and therefore improves the growth of chili pepper plant. Therefore, the present compost composition could be used as a biofertilizer for other plant crops. Further, considering the presence of natural secondary metabolites of green tea, it is noteworthy that the S4G compost could serve as an insecticide and have a promising role in controlling loss of plant crops due insect pest attack. However, further insight in respect to its insecticidal potential and its application as biofertilizer needs to be investigated through its practical uses in agricultural fields.

Acknowledgement

The authors are thankful to Graphic Era Deemed to be University for providing technical and financial support for conducting the study.

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