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Physico-Chemical and Nutrient Analysis of Vermicompost and Soil for Crop Planning inside a Hi-Tech Poly House on a Hillock of Assam

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Abstract—*Assam state of North Eastern Region of India is surrounded by many hillocks which are lying barren throughout the year. Unsustainable agricultural practices, such as the indiscriminate use of agro-chemicals creates imbalance in soil environment. The application of bio and organic fertilizer for crop production are the only alternative to maintain soil fertility status and protect environment. The readily available vermicompost in the local market is cost effective and eco friendly than chemical fertilizer but it does not contain the available nutrients. In order to achieve sustainable crop production on hillocks with extreme climate variation, the present study was carried out to assess the physico-chemical and nutrient analysis of vermicompost and soil for crop planning inside a hi-tech poly house (100 m^2) on a Hillock of Assam. Soil samples at five number of depths (0-10, 10-20, 20-30, 30-40 and 40-50 cm) from the ground surface at six locations were collected using soil core cutter. The compositions in the vermicompost and soil samples were analyzed using standard method to find out the nutrient requirement for crop planning. The average pH and EC of the soil samples was found to be 5.13 and 0.35 mS, respectively. The average pH and EC of the vermicompost was found 7.73 and 20 mS, respectively. Average N-P-K composition in soil inside the hi-tech poly house was found to be 165.86, 21.98 and 232.09 kg/ha, respectively. The average N-P-K composition in vermicompost was 14.39, 0.34, 2.64 g/kg, respectively which are lower than the composition in chemical fertilizers namely Urea (46%), Di-Ammonium Phosphate (46%) and Muriate of Potash (50%). The analysis of soil samples of the hi-tech poly house and locally available vermicompost revealed that that soil profile is feasible for growing of vegetables (sweet pepper, tomato, cabbage, cauliflower, chili etc.) with the application of vermicompost.*

Keywords*: Assam, crop planning, hillock, hi-tech poly house, soil profile, vermicompost.*

1. INTRODUCTION

Soil fertility refers to the ability of the soil to support organic life. Environmental degradation is a major threat confronting the world, and the rampant use of chemical fertilizers contributes largely to the deterioration of the environment, loss of soil fertility, less agricultural productivity and soil degradation. Unsustainable agricultural practices, such as the indiscriminate use of agro-chemicals, have increased plant yield but have also lead to reduced soil organic matter content, soil biodiversity and degradation of soil physical properties which arises the need for using vermicompost. Vermicompost is a kind of natural eco-manure, which is the product of organic matter degradation through the interaction between earthworms and microorganisms [9]. It contains nutrients such as nitrate, available phosphorus, potassium, calcium and magnesium that are readily taken up by the plants. Traditional composting of organic matter wastes has been known for many years but new methods of thermophilic composting have become much more popular in organic waste treatment recently since they eliminate some of the detrimental effects of organic wastes in the soil. Composting has been recognized as a low cost and environmentally sound process for treatment of many organic wastes [10]. Vermicompost is an excellent soil amendment or conditioner because of high porosity, aeration, drainage, water-holding capacity and microbial activity [5, 14]. Water saving irrigation methods mainly drip and micro sprinkler irrigation methods should be followed in order to save water and maximize yield. The use of drip irrigation has been associated with prevention of leaching of soil nutrients, increase in yield and quality of vegetables whereas sprinkler irrigation system helps in uniform distribution of the water to the plants and also covers large areas. The proper irrigation interval can play a major role in increasing the water use efficiency and the productivity by applying the required amount of water when it is needed.

The physical properties of soils determine their adaptability to cultivation and the level of biological activity that can be supported by the soil. Soil physical properties such as texture, bulk density and water content etc. also largely determine the soil's water and air supplying capacity to plants. Soil texture affects the infiltration and retention of water, soil aeration, absorption of nutrients, microbial activities, tillage and irrigation practices [6, 8]. The bulk density of soil (the mass of a unit volume of dry soil) determine the compactness and also considered as a measure of soil structure, for calculating soil pore space and as indicator of aeration status and water content [3]. The portion of stored soil water that can readily be absorbed by plants is said to be available water. The plant available soil water is held within a potential between field capacity (FC) and permanent wilting point (PWP).

Soil reaction (usually expressed as pH value) is the degree of soil acidity or alkalinity, which is caused by particular chemical, mineralogical and/or biological environment. Soil reaction affects nutrient availability and toxicity, microbial activity, and root growth. Electrical conductivity (EC) is a measure of salinity which overcomes some of the ambiguities of total dissolved salts measurements [2].

The trend in increasing the yield by adopting high yielding varieties has resulted in deficiency of nutrients in soils and has reflected as deficiency symptoms in plants. Hence, it is required to know the fertility (NPK) status of the soils of the state for applying the required dosage of fertilizers and planning the regional distribution of fertilizers. Micronutrient deficiencies are reported to be the main cause for stagnant or declining yields in India [11]. While little attention has been paid to assess micronutrient deficiency in soils of the humid areas, large scale yield benefits with the application of Zn and B along with S have been reported [15].

Soils in the hilly areas like Karbi-Anglong, adjoining Arunachal Pradesh have high organic matter status (2.3-2.94%). Nitrogen content in the soil varies from 0.013-0.217% in Brahmaputra Valley. Available Phosphorus status is low in the plains and high in hilly districts. Available Potassium is higher in 20% of the Cachar district.

As few researches has been done on physico-chemical and nutrient analysis of vermicompost and soil for crop planning inside a hi-tech poly house on a hillock, therefore it arises the necessity to carry out this type of current research work.

2. MATERIALS AND METHODS

2.1 Study Area

A hi-tech poly house (100 m^2) situated in the hilly terrains of Assam University, Silchar was considered as the study area. An area of 17.56 m^2 has been selected as the experimental zone inside the hi-tech poly house. The area receives an average of 2196 mm rainfall during the year. Soils of the zone vary from sandy type to clay soil mostly suitable for field crops including horticultural crops. The soil pH ranges from 4.6 to 5.7.

2.2. Layout of the Study Site and Soil Sampling

In order to assess the suitability of soil inside the high-tech poly house for agriculture and classification of soils, land survey was carried out using standard measuring instruments such as measuring tapes. The total area of the hi-tech poly house covered 100 m^2. Two treatment areas, T_1 and T_2 were selected inside the experimental site. Total of 6 observation points (3 from each treatments) were considered for the assessment of soil parameters of the experimental site. The study site, the treatment areas, and the selection of observation points are shown in Figure1, 2 and 3, respectively.

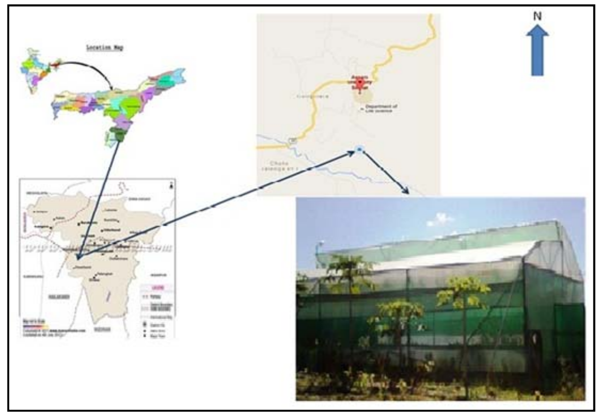

Fig. 1: View of the location of study site.

Fig. 2: View of the treatments of the study site.

Three main factors such as depth, sampling intensity per unit area of site sampled, and the sampling design are usually considered when developing soil-sampling protocols to monitor change in major soil fertility parameters. It is noted that sampling by fixed depths, rather than by generic horizon, underestimated soil carbon losses due to cultivation [4]. So, the sampling by fixed depth (0-10 cm, 10-20 cm, 20-30 cm, 30-40 cm and 40-50 cm) was considered and collected using a soil core cutter and sampler. During collection of samples; dead plants, old manures and areas near trees were excluded.

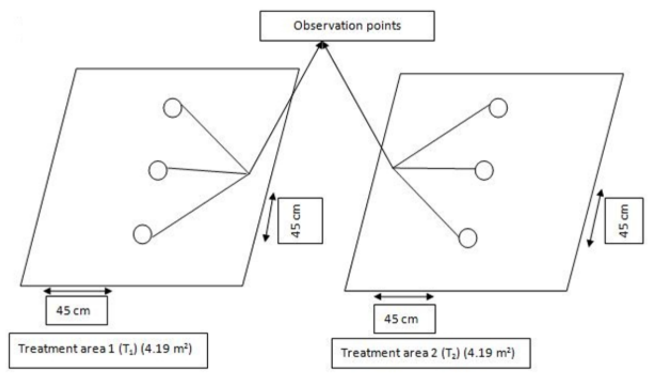

Fig. 3: Layout and soil sampling observation points.

2.3. Vermicompost Collection

1 kg of vermicompost was collected from the market and 100 g of sample was tested for essential nutrients i.e., Nitrogen, Phosphorus and Potassium.

2.4. Analysis of Chemical Properties of Soil and Vermicompost

The chemical properties (pH and electrical conductivity) of soil and vermicompost were analysed to assess the acidity and conductivity levels and detailed in the following section.

2.4.1. pH

By definition, 'pH' is a measure of the active hydrogen ion (H^+) concentration. It is an indication of the acidity or alkalinity of a soil, and also known as "soil reaction". Soil and vermicompost pH was measured by "Electrometric method" using pH meter.

2.4.2. Electrical Conductivity

Soil utilizes organic materials for a variety of uses, including providing plants with nutrients, aiding in irrigation, lowering evaporation rates, increasing the nutrient-holding capacity of the soil and providing food for worms, bacteria and other soil organisms. The EC of both soil and vermicompost was calculated with the help of a conductivity meter.

2.5. Analysis of Nutrient Status of Soil and Vermicompost

2.5.1. Total Nitrogen

Nitrogen (N) is the forth plant nutrient taken up by plants in greatest quantity next to carbon, oxygen and hydrogen, but it is one of the most deficient elements in the tropics for crop production [16,13,12]. The total N content of a soil is directly associated with its OC content and its amount on cultivated soils is between 0.03% and 0.04% by weight [13, 17]. Total nitrogen in soil was determined by Micro Kjeldahl method.

2.5.2. Total Phosphorous

Phosphorus (P) is known as the master key to agriculture because lack of available P in the soils limits the growth of both cultivated and uncultivated plants [7]. Following N, P has more wide spread influence on both natural and agricultural ecosystems than any other essential elements. The main sources of plant available P are the weathering of soil minerals, the decomposition and mineralization of soil OM and commercial fertilizers. Phosphorus in soil was estimated by Olsen's method.

2.5.3. Total Potassium

Potassium is the third most important essential element next to N and P that limit plant productivity. Its behavior in the soil is influenced primarily by soil cation exchange properties and mineral weathering rather than by microbiological processes. Unlike N and P, K causes no off-site environmental problems when it leaves the soil system. It is not toxic and does not cause eutrophication in aquatic systems [1]. It was reported that the variation in the distribution of K depends on the mineral present, particles size distribution, degree of weathering, soil management practices, climatic conditions, degree of soil development, the intensity of cultivation and the parent material from which the soil is formed [18]. Total potassium in young leaf, mature leaf, stem, root and soil were determined by Flame photometer method.

3. RESULTS AND DISCUSSION

3.1. Soil and Vermicompost Chemical Properties Status

The observed pH and EC of different soil samples of the study site and the vermicompost sample is also shown in Fig. 4 and 5, respectively. The average EC of the soil samples and vermicompost was found to be 0.35 mS and 20 mS, respectively. It has been found from the graph that the EC is highest at the soil profile 10-20 cm in treatment 1. The EC of the soil in treatment 2 is found to be decreasing with the soil depth with the highest EC value in soil profile of 0-10 cm.

The average pH of the soil samples and vermicompost was found to be 5.13 and 7.73, respectively which indicate that the soil is strongly acidic in nature and about 50% of applied fertilizer may be available to plants whereas, the vermicompost was quite basic in nature. The pH in treatment 1 was found to be increasing with the increase in soil depth whereas; in treatment 2 the highest pH was observed in the soil profile of 30-40 cm.

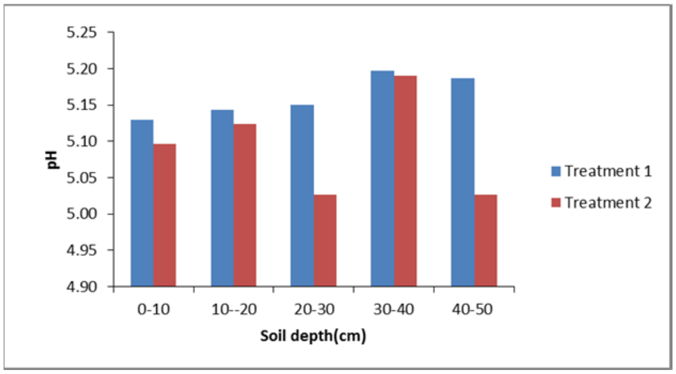

Fig. 4: Depth wise average pH status observed in the treatment areas.

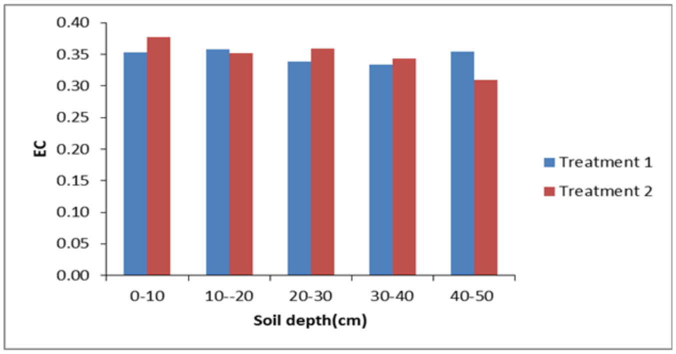

Fig. 5: Depth wise average EC status observed in the study site.

3.2. Nutrient Status of Soil and Vermicompost

The variations in the nutrient status of both soil and vermicompost are shown in Table 1 and 2, respectively.

Table 1: Average soil nutrients observed in the treatment areas

Treatment areas	Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)
T1	175.26	20.52	322.96
	137.98	23.08	139.64
	150.52	17.95	191.25
T2	249.9	25.67	274.21
	156.54	22.85	265.20
	124.95	21.79	199.25
Average	165.86	21.98	232.09

Table 2. Average vermicompost nutrients observed from the vermicompost sample

Sl.no.	Sample name	Total Nitrogen (g/kg)	Total Phosphorus (g/kg)	Total Potassium (g/kg)
1	R1	14.29	0.32	2.60
2	R2	14.29	0.35	2.95
3	R3	14.60	0.34	2.36
Average		14.39	0.34	2.64

4. AGRICULTURAL PLANNING

A sound agriculture policy should be able to reconcile three basic needs: the production of food and agricultural products, protection of the environment and the maintenance of the agricultural farm. The hillocks of Assam University, Silchar is not suitable for the cultivation of rice as it is a well drained land and rice requires lot of water during its plantation period. However, low water requirement crops like capsicum, tomato, cabbage, cauliflower, peas and flowers like roses, cosmos, marigold, hibiscus and calendula are suitable for cultivation. Based on the basic research with the parameters of soil, the crop planning for sustainable agriculture in hillocks is proposed and presented in the Table 3.

Agricultural intensification without adequate restoration of soil fertility may threaten the sustainability of agriculture. Quantitative estimation of plant nutrient depletion from soils is useful for comprehending the state of soil degradation and for devising corrective measures.

Table 3. Status of soil and vermicompost properties and crop plan for a hillock

Soil					Crop plan
pH	**EC (mS)**	**N (kg/ha)**	**P (kg/ha)**	**K (kg/ha)**	Tomato, cabbage, sweet pepper, cauliflower, rose, calendula, cosmos, marigold, pineapple etc.
5.13	0.35	165.86	21.98	232.09	
Vermicompost					
7.73	20	14.39	0.34	2.64	

5. CONCLUSIONS

Since, soil physical properties change with change in land use system and its management and also extensive use of chemical fertilizers. So, the present study was carried out to determine the nutrient status of vermicompost and soil physicochemical properties of hillocks situated in Assam University, Silchar to minimize the use of agro chemicals in agriculture. The study reveals that soil is acidic but the vermicompost was found basic in nature. So, the vermicompost and organic base manure could be used to maintain the soil acidity in permissible level and enhance soil fertility for sustainable crop planning.

The average N-P-K composition (14.39, 0.34, 2.64 g/kg) in vermicompost was found lower than the composition in chemical fertilizers namely Urea, Di-Ammonium Phosphate and Muriate of Potash but it could be eco-friendly to the soil system and environment. The analysis of soil samples of the hi-tech poly house and locally available vermicompost revealed that that soil profile is feasible for growing of vegetables (sweet pepper, tomato, cabbage, cauliflower, chili etc.) with the application of vermicompost. The effect of vermicompost on growth and yield of the crops with suitable irrigation method could be studied further for enhancing productivity in a hillock.

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