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Influence of vermicompost and vermiwash on physico chemical properties of rice cultivated soil

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ABSTRACT

In this study the effect of vermicompost on soil chemical and physical properties was evaluated during samba rice cultivation studies. The experiments were arranged in a completely randomized block design manner with three replications. The soil sampling and plant growth measurements were carried out for two months, ie., during initial and final stages. The present study has been carried out to study the impact of various vermiproduct such as vemicompost, vermiwash and mixture of vermicompost and vermiwash on soil physico-chemical properties during the pot culture studies of samba rice. The physical properties such as the pH, electrical conductivity (EC), porosity, moisture content, water holding capacity and chemical properties like nitrogen, phosphorous, potassium, calcium and magnesium were found distinctly enhanced in vermicompost treated soil, where as the corresponding physico-chemical values in control were minimum. The soil treated with vermicompost had significantly more electrical conductivity in comparison to unamended pots. The addition of vermicompost in soil resulted in decrease of soil pH. The physical properties such as water holding capacity, moisture content and porosity in soil amended with vermicompost were improved. The vermiproduct treated plants exhibit faster and higher growth rate and productivity than the control plants. Among the treated group, the growth rate was high in the mixture of vermicompost and vermiwash treated plants, than the vermicompost and vermiwash un-treated plants. The maximum range of some plant parameter's like number of leaves, leaf length, height of the plants and root length of plant, were recorded in the mixture of vermicompost and vermiwash. The results of this experiment revealed that addition of vemicompost had significant positive effects on the soil physical, chemical properties and plant growth parameters.

Introduction

The compost prepared through the application of earthworm is called vermicompost and the technology of using local species of earthworms for culture or composting has been called vermi tech. Vermicompost is usually of a finely divided peat like material possessing excellent structure, porosity, aeration, drainage and moisture water holding capacity [Ismail, 2005].

Vermicompost improves the physical, chemical and biological properties of soil. There is a good evidence that vermicompost promotes growth of plants and it has been found to have a favourable influence on all yield parameters of crops like, wheat, paddy, and sugarcane [Ismail., 1997; Ansari., 2007].

Hidlago *et al.,* [2006] reported that the incorporation of earthworm increased plant growth, leaf growth and root length. The suitability of vermicompost amended soil for sustaining plant growth and biological activity is a function of physical properties and the chemical properties which depend on soil organic matter. Soil plays a key role in completing the cycling of major demands required by biological systems decomposing organic wastes and detoxifying certain hazardous compounds.

The present work was carried out to study both the combined and individual effect of vermicompost and vermi wash (i) on growth parameter's of samba rice and (ii) on the physico-chemical property changes of samba rice cultivated soil.

Materials and Methods

Preparation of Vermibed and Collection of Vermiwash

The raw materials used for vermicompost were leaf litter and cow dung. The earthworm species used for vermicomposting was *Lampito mauritii* - an anecic indigenous species and two exotic species *Eisenia fetida* and *Eudrilus eugineae. Lampito mauritii* feeds on soft part of the leaves that are at the initial stage of degradation. They consume large amount of organic matter along with the soil. (Bouche, 1977). The vermipits were prepared in the dimension of (2 x 2 x 2m) (lbh). The bottom layer was filled with pebbles or coconut shell to absorb the excess water from the composting pit. The second layer was filled with garden soil and old compost inoculum. Cow dung and leaf litter were mixed at 1:2 ratio and added in the pit. Finally the pit was covered by coconut fronds in order to prevent the moisture evaporation due to direct sunlight. Once in 2 or 3 days, the contents of the pit were turned for even decomposition and enhanced aeration. After 30 days the compost was collected and packed in a large vermibed. Vermiwash is a liquid extract from vermicompost and is used as a foliar spray. It contains plant growth hormones like auxins, cytokinins apart from soluble micro and macro nutrients.

Physico Chemical Analysis

To determine soil physical and chemical properties, the soil samples were collected two months after addition of vermicompost from depth of 15cm. The pH of the potting mixtures were determined using a double distilled water suspension of each potting mixture in the ratio of 1:10 (W:V) (Inbar *et al.,* 1993) that has been agitated mechanically for 2 hours filtered. The same solution was used for measuring electrical conductivity with a conductance meter that had been standardized with 0.01 and 0.1M kcl. The water holding capacity (WHC) (% volume) was also calculated as [(wet weight - dry weight) / volume X 100 (Inbar *et al.,* 1993). The Gas Pycnometer method was used for determining total porosity of soil. The method is based on Boyle's law ($p_1v_1 = p_2v_2$). The moisture content was determined after drying at 105°C for 24hrs. The nitrogen was measured by following Kjeldhal *method (*Jackson, 1975). Available phosphorous was measured using the method described by Anderson and Ingram Olsen *et al.,* (1954) Exchangeable potassium, calcium and magnesium were determined after extracting the sample using ammonium acetate (Simard, 1993) and analyzing with a Perkin-Elmer 3110 double beam atomic absorption spectrophotometer (AAS).

Growth Components of Rice

Growth parameters such as number of leaf, leaf length (cm), root length (cm) and plant height (cm) were calculated. The leaf area was calculated by using Licor 3100 leaf area meter (LICOR, model LI-3100, Lincoln, USA). The sampling was done at the initial and final stage of plant cultivation two months interval. The samba rice growth present in the control, vemicompost, vermiwash and mixture of vermicompost and vermiwash applied pots were recorded and analysed.

Results and Discussion

The result on effect of vermicompost on physical properties of the soil observed during initial and final stages of samba rice cultivated in pots is given in Table 1. Following are the initial physical properties observed in vermicompost applied soil during the samba rice pot culture studies. The minimum pH of 7.0 ± 0.03 was observed in vermicompost and vermiwash applied pot and the maximum pH of 7.5 ± 2.02 in control pot.

The minimum electrical conductivity of 0.02 ± 0.01 dsm^{-1} was observed in vermicompost and vermiwash applied pot and the maximum of 2.12 ± 1.1 dsm^{-1} in control pot. The reduction of pH and EC of the soil were also observed in vermicompost manure by Wahid *et al.,* [1998]. The electrical conductivity of vermicompost depends on the raw materials used for vermicompost and their ion concentration [Atiyeh *et al.,* 2002]. The maximum water holding capacity, porosity and moisture content observed in the initial stage were 41 ± 0.02 %, 34 ± 2.10 % and 36 ± 1.02 % respectively. The increased water holding capacity, porosity and moisture content was also noticed in mixture of vermicompost and vermiwash treated pots the respective values were 49 ± 1.0 %, 44 ± 1.0% and 46±1.0 %. The water holding capacity of vermicomposted cowdung was similar to that of vermicomposted pig manure [Atiyeh *et al.,* 2001]. The water holding capacity of the vermicomposted soil mixture increased with increased application rates of vermicompost and was significantly greater in the vermicompost soil mixture than in the control treatment.

The total porosity was improved by the use of vermicompost. Greater porosity in the soil treated with vermicompost was due to an increase in the amount of pores Marinari *et al.,* [2000]. Compost addition caused a significant increase of moisture content due to the more porosity addition to the soil [Bazzoffi *et al.,* 1998].

The result on effect of Vermicompost on Chemical Properties of the Soil Observed During Initial and Final Stages of Samba Rice Cultivated in Pots is Given Table 2. The results showed that the maximum nitrogen content was on the mixture of vermicompost and vermiwash applied pot, the recorded value was 69 ± 0.2 ppm the soil treated with vermicompost manure possess high nitrogen content, where as the respective control value was 55 ± 2.1ppm. The decrease in nitrogen content of control in because there is no manure supplementation, where as in cermicompost and vermiwash added pots it is greater than in the soil vermicompost manure that could have provide a large source of nitrogen for mineralization '[Arancon *et al.,* 2006].

Soil treated with vermicompost had significantly high content of phosphorous when compared to control. The control recorded phosphorous content value was 64 ± 2.0ppm. The mixture of vermicompost and vermiwash applied pot was noticed with maximum phosphorus content and it was 77±1.0ppm.

Slaton *et al.,* [2002] showed that broadcast application of phosphate fertilizers to the soil surface between seeding and active tillering were equally effective in increasing rice yields. Chattopadhyay *et al.,* [1992] noticed that rice performance was greater in the vermicompost plus phosphorous treatment than application of phosphorous alone. Soil treated with vermicompost had significantly high content of potassium when compared to control 180±2.0ppm. The vermicompost and vermiwash applied pot was noticed with maximum potassium content and it was 195±1.0ppm. Das *et al.,* [2002] reported that application of 50% vermicompost and 50% NPK fertilizers produced the maximum straw and grain yields in rice. Bhasker *et al.,* [1992] reported that the increase in potassium uptake by vermicompost application may be due to enhancement in potassium availability by shifting the equilibrium among the forms of potassium from relatively exchangeable potassium to soluble potassium forms in the soil. The results indicated that vermicompost increased calcium content of soil. The highest increase recorded value was 5.0±1.0ppm mixture of vermicompost and vermiwash applied pots, when compared to control where the recorded value was 1.0± 1.0ppm.

Vermicompost contains most nutrients in plant available forms such as phosphates, exchangeable calcium, and soluble potassium [Oro-Zco *et al.,* 1996]. The highest content of magnesium was recorded as 4±0.1ppm in mixture of vermicompost and vermiwas applied pots, when compared with control the value was 1.0±1.0ppm [Deepa Devi, 1992] reported that the available soil calcium and magnesium was enhanced significantly due to the application of vermicompost manure and composted sugarcane trash.

The results on effect of Vermicompost on Growth Parameters of Samba Rice Pot Cultivated Studies in Pots is given Table 3. During the two months observation of samba rice growth the maximum leaf length, number of leaves, root length and height of the plants were recorded in vermicompost and vermiwash applied pot. The observed values were 19±0.1cm, 9± 0.01, 15±0.01cm and 23±0.01cm. The minimum leaf length, number of leaves, root length and height of the plants were recorded in control. Their respective values of control pot 7.1±2.1cm, 2.0±1.1, 3.0±2.1cm and 10±2.1cm respectively. Arancon *et al.,* [2004] reported positive effects of vermicompsot on the growth and yield in strawberry, especially increase of leaf area, root length and fruits weight in the field conditions. Mishra *et al.,* [2005]. Reported that vermicompost had beneficial effects on growth and yield of rice, especially caused significant increase of many growth parameters, seeds germination and yield.

The excellent plant growth in vermicompost application was possibly due to some plant growth promoters in worm casts. The earthworm casts and vermicompost influenced the development of the plants and promoted leaf length, root length, and number of leaves, which suggest the linkage between biological effects of vermicompost and microbial metabolites that influenced the plant growth and development [Tomati *et al.,* 1995]. However, the effect of vermicompost and its effects on quality of samba rice may depend on a variety of factors, which needs further investigations [Table – 3].

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Table – 1: Effect of Vermicompost and Vermiwash (Individual and Combined) on Physical Property Changes During Initial and Final Stages of Samba Rice Cultivation Studies

Treatments	pH		Electrical Conductivity dsm-1		Water holding capacity (%)		Porosity (%)		Moisture Content (%)	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Control	7.5±2.02	7.4±2.01	2.12±1.1	2.0 ± 1.0	41±0.02	44±1.02	34±2.10	39±2.0	36±1.02	41±1.1
Vermicompost	7.4±0.01	7.1±0.01	1.02±1.0	1.01±1.0	43±0.01	47±1.0	36±1.0	41±1.0	39±1.1	44±1.0
Vermiwash	7.3±2.0	7.2±1.02	2.1±1.1	2.0±1.1	42±1.0	46±1.1	35±1.1	40±1.1	38±1.0	43±1.1
Vermicompost and vermiwash	7.0±0.03	7.0±0.03	1.01±0.01	0.02±0.01	45±0.03	49±1.0	39±0.03	44±1.0	41±1.0	46±1.0

Table – 2: Effect of Vermicompost and Vermiwash (Individual and Combined) on Chemical Property Changes During Initial and Final Stage of Samba Rice Cultivation Studies

Treatments	Nitrogen (ppm)		Phosphorous (ppm)		Potassim (ppm)		Calcium (ppm)		Magnesium (ppm)	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Control	55±2.1	61±2.0	64±2.0	69±2.0	180±2.0	184±2.1	1.0±1.0	1.5±1.0	1.0±1.0	1.5±1.0
Vermicompost	59±1.1	64±1.0	68±1.1	73±1.0	184±1.0	189±1.0	2.0±1.1	2.5±1.0	2.0±1.1	3±1.0
Vermiwash	58±1.0	63±1.1	67±1.1	72±1.1	183±1.1	188±2.0	1.5±1.1	2.0±1.0	1.2±1.1	2±1.0
Vermicompost and vermiwash	63±1.1	69±0.2	72±1.0	77±1.0	188±1.0	195±1.0	3.2±1.0	5.0±1.0	3.1±1.1	4±0.1

Table – 3: Showing the Chronological Growth Performance of Samba Rice Cultivation with Various Vermitreatments in Two Months Interval

Treatments	Number of leaves		Leaf length (cm)		Height of the plant (cm)		Root length (cm)	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Control	7.1±2.1	13±2.0	2.0±1.1	5±1.2	10±2.1	14±2.0	3.0±2.1	7.0±2.0
Vermicompost	9.2±1.0	16±1.0	4.0±2.0	7±1.0	14±1.0	19±1.0	6.0±1.2	12.0±1.0
Vermiwash	8.5±2.1	15±1.1	3.0±1.1	6±1.2	13±1.1	18±1.1	5.0±2.1	11.0±2.0
Vermicompost and vermiwash	12.1±1.0	19±0.1	6.0±1.0	9±0.01	17±0.1	23±0.01	7.1±1.0	15±0.01

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