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Degradation of Leaf Litter by Vermicomposting and its Effect of Growth on *Cyamopsis tetragonoloba*

R Pavithra and M Lakshmi Prabha*

Department of Biotechnology, Karunya University, Coimbatore-641 114, India.

***Corres. author: lakshmi.prabha48@gmail.com,09442424136**

Abstract: Vermicompost is the stable, humus-like product resulting from the biological decomposition of organic matter under controlled conditions. Vermicompost is a rich source of vitamins, hormones, enzymes, macro and micro nutrients which when applied to plants help in efficient growth. The present study has been carried out to analyze enzymes, physicochemical characteristics, and micro and macro nutrients present in the compost at regular interval of time and also a comparative study was done on the effect of compost on growth parameters namely germination percentage, root length, shoot length and number of leaf count in Cymopsis tetragonoloba after 30th day of planting. The results of the study revealed that the enzyme activities (amylase, cellulase, protease and invertase) and total macronutrients (N, P, K) and micronutrients (Mn and Cu) showed elevated levels in compost than control. The compost applied plant (Cymopsis tetragonoloba) showed increased germination percentage, root length, shoot length and number of leaves than the compost untreated plant.
Key words*:* vermicompost, macronutrients, micronutrients, germination, amylase, protease.

Introduction

Environmental degradation is a major threat confronting the world, and the unrestrained use of chemical fertilizers contributes largely to the deterioration of the environment through depletion of fossil fuels. It also leads to the generation of carbon dioxide and contamination of water resources. Now there is a growing realization that the adoption of ecological and sustainable farming practices can only reverse the declining trend in the global productivity and environment protection.[1] In nature's laboratory there are number of organisms thatconvert organic waste into valuable resources containing plant nutrients and organic matter which are essential for maintaining soil productivity.

The vermicomposting may result in the production of humus like substance, compost. Microorganisms and earthworms are important biological organisms helping nature to maintain nutrient flows from one system to another and also minimize environmental degradation. They help in balancing the nutrient level in soil and microorganisms decrease during soil degradation and it is 8-10 higher in uncultivated area. Earthworms can therefore be used as a sensitive indicator of soil degradation[2]. Earthworms along with micro organisms breakdown the organic waste into nutrient rich vermicompost which is worm castings. Earthworms will eat amazing variety of food most non-greasy, non-diary or non-meat organic materials. Red earthworm is preferred because of its high multiplication rate and thereby converts the organic matter into vermicompost within 45-50 days. Since it is a surface feeder it converts organic materials into vermicompost from top.

The level of nutrients in compost depends upon the source of the raw material and the species of earthworm. A fine worm cast is rich in N P K besides other nutrients. Nutrients in vermicompost are in readily available form and are released within a month of application. The worm castings contain higher percentage

(nearly twofold) of both macro and micronutrients than the garden compost. Vermicomposting converts household waste into compost within 30 days, reduces the C:N ratio and retains more N than the traditional methods of preparing composts.[3] Vermicompost is a rich source of various vitamins, enzymes, macronutrients and micronutrients which applied to plants help in efficient growth[4].The organic compost contain enzymes like amylase, cellulase, invertase and protease which continue to breakdown organic matter in soil (to release the nutrients and make it available to the plant roots). They also increase the levels of soil enzymes like dehydrogenase, acid and alkaline phosphatase and urease.

Materials and Methods

1. Collection of Waste

The leaf litter waste was collected from the Karunya University campus, Coimbatore, Tamil Nadu, India. The collected wastes were allowed to partial decomposition for 10 days. Then the wastes were mixed with cow dung and soil in the ratio 3:1:1.

2. Vermicomposting technique

Pits of 0.75×0.75×0.75 m size were dug and floor of the pit was covered with a lattice of wood strips to provide drainage. Totally 3 pits were maintained for the experimental purposes. The pit T1 was maintained as control for leaf litter waste (without cowdung).Earthworms were added in the sample pits excluding the control pit. Care was taken to avoid light and rainfall. The control as well as the experimental sample was taken. On 30^{th} and 45^{th} day respectively for the analysis of enzymes, macro and micro nutrients, physicochemical parameters and its effect on growth parameters of Clusterbean (*Cyamopsis tetragonoloba*).

3.Enzymes involved in the Degradtion of Complex Organic Material into Simple Compounds

Amylase, cellulase, invertase and protease are the enzymes involved in the degradation of complex organic material into simple compounds

3.1Amylase[5]

Principle

Starch degrading enzymes act on glycogen and related polysaccharides,α-amylase causes endo-cleavage of substrate and hydrolysis α1, 4 linkage in a random manner. It has the ability to by-pass α-1,6 branch points. β-amylase hydrolyses alternate bond from the non-reducing end of the substrate. The enzyme degrades amylose, amylopectin or glycogen in an exo or stepwise fashion by hydrolyzing alternate glycosidic bonds. The end product is β-maltose.

3.2Cellulase[6]

Principle

Hydrolysis of crystalline cellulose is a complex process. Initiation of hydrolysis of native cellulose is done by exo – β1, 4 glucanase (c1 –cellulase). This enzyme split alternate bonds from the non-reducing end of cellulose chain yielding cellobiose. The endo-glucanase (cx – cellulase) act on carboxy methylcellulose. This enzyme does not act on native cellulose. β– glucosidases (cellobiase) play an important function in the degradation of cellulose by hydrolyzing cellobiose which is an inhibitor of exo-glucanase.

3.3 Invertase[7]

Principle

Invertase is the enzyme that catalyzes the hydrolysis of sucrose to fructose and glucose.

3.4 Protease[8]

Principle

The blue colour developed by the reduction of phosphomolybdic phoshotungustic components in the

Folin-Ciocalteau reagent by the aminoacids tyrosine present in the protein plus the blue colour developed by biuret reaction of the protein with alkaline cupric tartarate were measured in the Lowry's method.

4. Estimation of Physicochemical Parameter

4.1. pH [9]

3gm of finely powdered organic vermicompost was taken in a volumetric beaker and 50 5o ml of distilled water was added and the pH was measured by pH meter.

5 Nutrient Content Macronutrients and micronutrients

Organic vermicompost is a rich source of macro nutrients and micro nutrients like nitrogen, phosphorus, potassium, and micro nutrients namely copper, manganese.

5.1 Estimation of Total Nitrogen[10]

Principle

The nitrogen in organic material is converted to ammonium sulphate by sulphuric acid during digestion. This salt, on steam-distillation, liberates ammonia which is collected in boric acid solution and titrated against standard acid.

5.2 Estimation of Total Phosphorus[9]

Principle

Inorganic phosphate reacts with ammonium molybdate in an acid solution to form phosphomolybdic acid. Addition of a reducing agent reduces the molybdenum in the phosphomolybdate to give a blue colour, but does not affect the uncombined molybdic acid. The blue colour produced is proportional to the amount of phosphorus present in the samples.

5.3 Estimation of Total Potassium [9]

Principle

In flame photometry, the solution under test is passed under carefully controlled conditions as a very fine spray in the air supply to a burner. In the flame, the solution evaporates and the salt dissociates to given neutral atoms. A very small proportion of this move into a higher energy state. When these excited atoms fall back to the ground state, the light emitted is of characteristic wavelength which is measured.

5.4 Estimation of Manganese and Copper [11]

Principle

The technique involves determination of concentration of a substance by the measurement of absorption of the characteristic radiation by the atomic vapour of an element. When radiation characteristic to a particular element passes through the atomic vapour of the same element, absorption of radiation occurs in proportion to the concentration of the atoms in the light path.

6. Studies on the Effect of Organic Compost on Growth Parameters of Clusterbean

The seeds were sowed in three different pots 1, 2 and 3.The following parameters were observed on 30th day of planting.

1. Gemination percentage.
2. Root length
3. Shoot length
4. Leaf count

1. Germination percentage

Germination percentage is an estimate of the viability of a population of seeds. The equation to calculate germination percentage is: GP = seeds germinated/total seeds x 100 . The germination rate provides a measure of the time course of seed germination.

2. Root length

The length of the root was measured from collar region to the growing tip of the root and expressed in cm.

3. Shoot length

The length of the shoot was measured from collar region upto tip of the shoot and expressed in cm.

4. Number of leaves

The total number of leaves per needles in each plant was counted and expressed as number of leaves per plant.

Result and Discussion

Enzymes present in Vermicompost

1. Amylase

The activity of Amylase preset in compost on 30th and 45th day of compost is depicted in figure 1. The values of data are expressed as mean ± SD. **P<0.001.The results revealed that higher amylase activity was noticed on 30th day of organic composting when compared to control. Then the amylase content was decreased after 30th day steadily. With increase in incubation time, the amylase activity had decreased steadily to 40th day of composting with leaf litter wastes. Ageing processes greatly affected the activity of amylase; since 30th and 40th day old casts, there was a significant continuous decline in the substrate, namely starch present in leaf litter wastes.

2. Cellulase

Activity of cellulase present in compost on 30th and 45th day of compost is depicted in figure 2.The values of data are expressed as mean ± SD. **P<0.001. In the present study, the cellulase activity was increased in compost when compared to control. The enzyme cellulase acts upon the substrate carbohydrate which is metabolized by the reproductively active microorganism. The cellulase activity was decreased on 45th day of composting. The cellulase activity was decreased due to the catabolism of carbohydrates during composting.

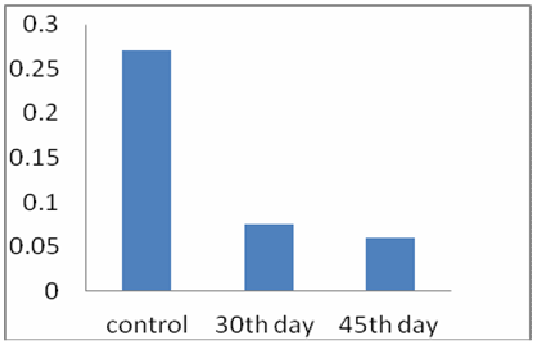

Figure -1: Amylase present in vermicompost

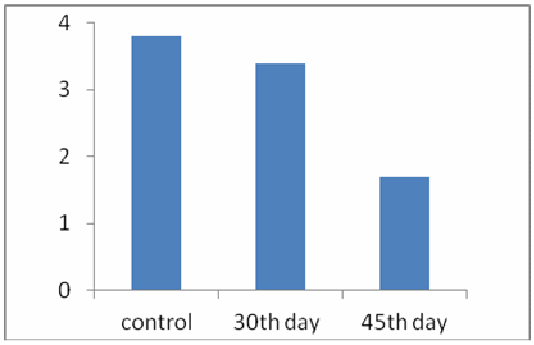

Figure -2: Cellulase present in vermicompost

3. Invertase

. The activity of invertase preset in compost on 30th and 45th day of compost is depicted in Figure-3.The values of data are expressed as mean ± SD. **P<0.001.The activity of invertase on leaf litter waste composted is found to be increased. In the present study, the invertase activity was decreased as the composting period increases and maximum invertase activity was noticed with leaf litter on 30th day of inoculation and decreases significantly to 45th day.

4 . Protease

The activity of protease preset in compost on 30th and 45th day of compost is depicted in Figure 4.The activity of protease on leaf litter waste composted is found to be increased. In the present study, the protease activity was decreased as the composting period increases and maximum protease activity was noticed with leaf litter on 30th day of inoculation and decreases significantly to 45th day The enzyme protease was found to be elevated in the compost due to the presence of proteolytic enzyme producing microbes which enhanced the trypsin activity.

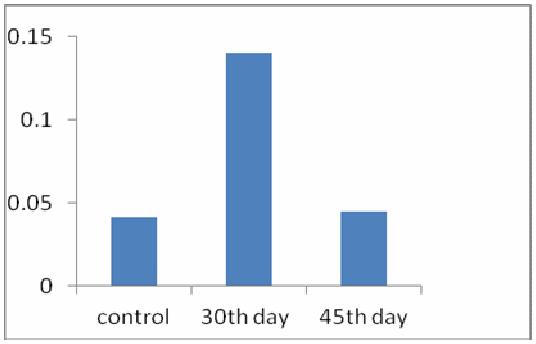

Figure -3: Invertase present in vermicompost

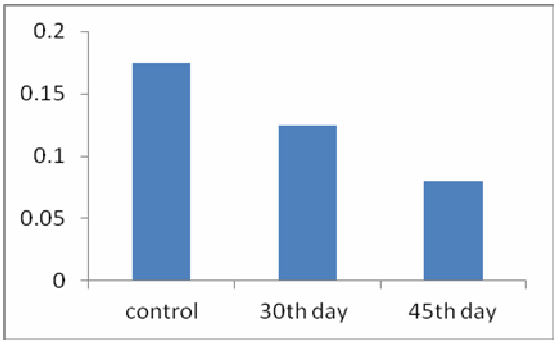

Figure -4: Protease present in vermicompost

Assay of Physicochemical Parameter in Organic Compost

Assay of various physicochemical parameters play a key role in determining the quality of organic compost obtained from decomposition of leaf litter.

1. pH: The level of pH during decomposition of leaf litter waste composted various effective microorganism is depicted in Figure 5.The values of data are expressed as mean ± SD. **P<0.001.The level of pH was increased in compost when compared to control. Increase of pH in compost might be due to participation of microbes in the degradation of organic wastes representing aerobic metabolism.Figure-5 illustrates level of pH in compost and which indicates that they are non- acidic.

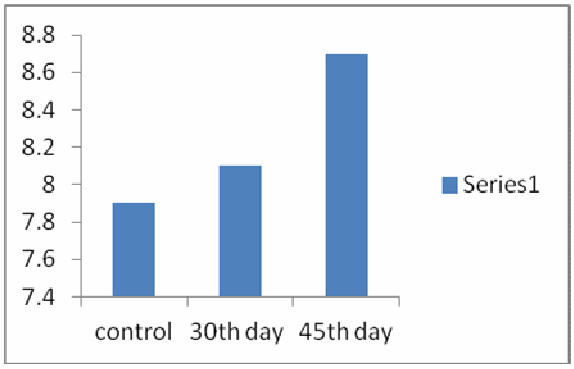

Figure -5: pH of vermicompost

Macronutrients and Micronutrients Present in Vrmicompost
1 Macronutrients

1.1. Nitrogen

The Nitrogen content present in *leaf litter* waste composted by *Eudrilus eugeniae* is represented in Figure-6.The values of data are expressed as mean ± SD. **P<0.001.In the present study the nitrogen content in vermicompost is found to be increased significantly and the variation of control at 5% level. Increase in nitrogen content in the vermicompost is due to earthworm recycle nitrogen in very short time, addition of their metabolic and excretory products (vermicast), mucus, body fluid, enzymes and decaying tissues of dead worms.

[12] The increase in nitrogen content was found in the final product in the form of mucus, nitrogenous excretory substances, growth simulating hormones and enzymes from earthworms.

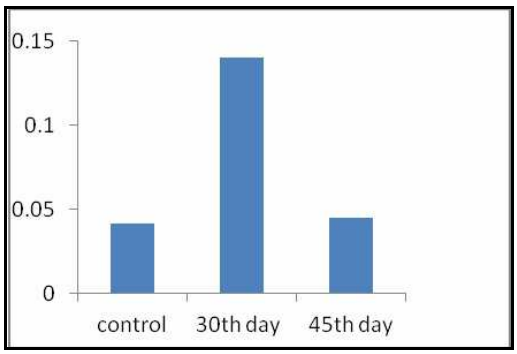

Figure -6: Nitrogen content present in vermicompost

1.2 Phosphorous

Figure-7 depicts the Phosphorous content present in vermicompost. Values are means of four replicates in two repetitive experiments. The values of data are expressed as mean ± SD. **P<0.01.The above Figure-7 illustrates the level of high phosphorous content present in vermicompost when compared to control. The maximum level of phosphorous content was noticed on 60th day of vermicomposting. The leaf litter was found to contain more available phosphorus after ingestion by earthworms, which may be due to the breakdown of the leaf material by worms[13].

1.3 Potassium

The Potassium content in vermicompost is represented in Figure-8. The values of data are expressed as mean ± SD. **P<0.01. The effect of worm action on vermicompost was found to be more on 60th day of composting when compared to control and the level of potassium was found to be significant at 5% level on 60th day of composting. Consistently, our data is supported by Orozco *et al*, [14] who reported an increased in potassium level during vermicomposting may be due to the microbes present in the gut of earthworms which might have played an important role in this process.

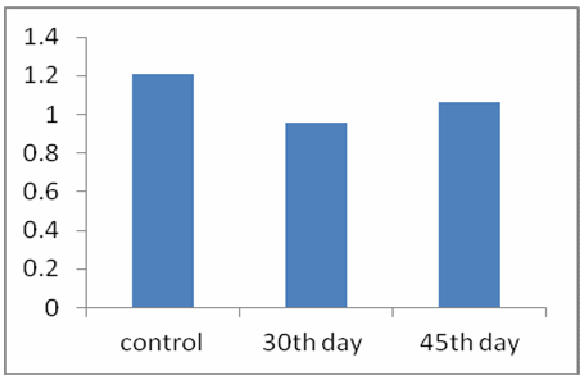

Figure -7: Phosphorus content present in vermicompost

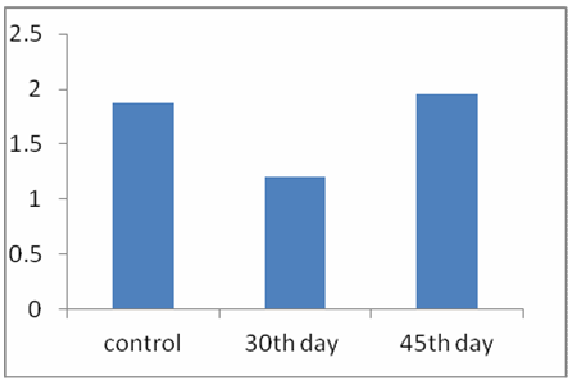

Figure -8: Potassium content present in vermicompost

2.Micronutrients

2.1 Manganese

Figure-9 represents the contents of Manganese in vermicompost. Higher manganese content was observed in vermicompost when compared to that of the control. Increase of manganese content in vermicompost is due to mineralization of this element by the earthworm activity. Manganese is a catalyst for many enzymes and also facilitates the photosynthesis and chlorophyll production. The values of data are expressed as mean ± SD. **P<0.01.

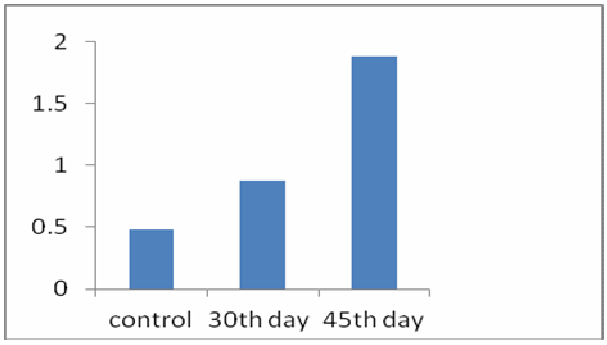

Figure -9: Manganese content present in vermicompost

2.2 Copper

Figure-10 depicts the Copper content present in vermicompost. The values of data are expressed as mean ± SD. **P<0.01.The results revealed that in vermicompost the copper content is higher in 60th day of composting when compared to control. The copper content was found to be significant at 5% level on 60th day of composting[10]. Higher levels of copper content in vermicompost might be due to the presence of copper containing oxidizing enzymes. Copper is responsible for healthy, vigorous growth and strengthens stalks, stems and branches.

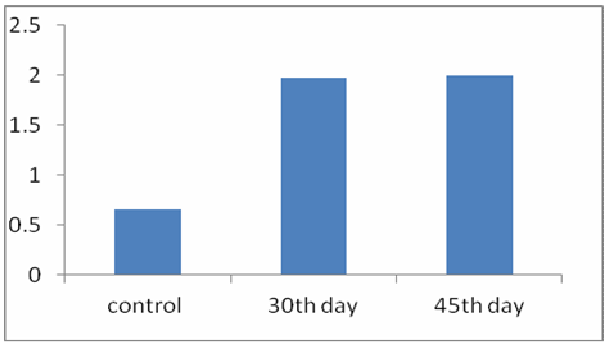

Figure -10: Copper content present in vermicompost

Studies On The Effect Of Vermicompost On Growth Parameters Of Selected Vegetable Plants

Growth parameters

Figure 11, 12, 13, and 14 elucidates the effect of compost and inorganic fertilizer on growth parameters of selected vegetable plants. Based on the data presented it is evident that the pronounced effects could be noticed in germination percentage, root length, shoot length and number of leaf count when the seeds were sowed in the compost. The selected plant namely *Cyamopsis tetragonoloba* showed the maximum germination percentage, root length (4.2cm), shoot length (13.8cm) and leaf count 16) in compost treatment on 30th day after sowing. Compost contains macro and micro plant nutrients in an available form that plants can easily assimilate for their growth and development.

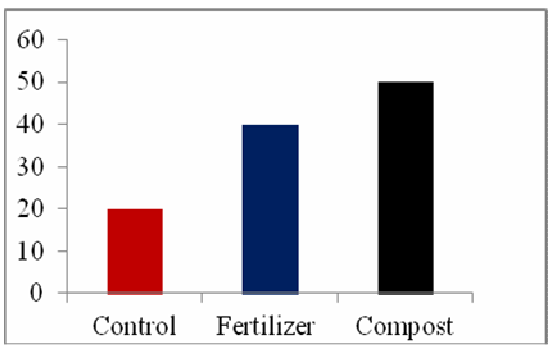

Figure 11 Germination Percentage

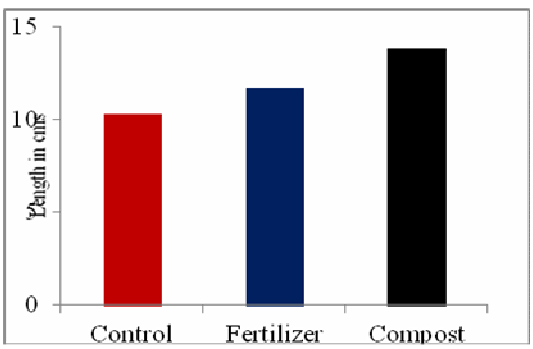

Figure 12 Root length

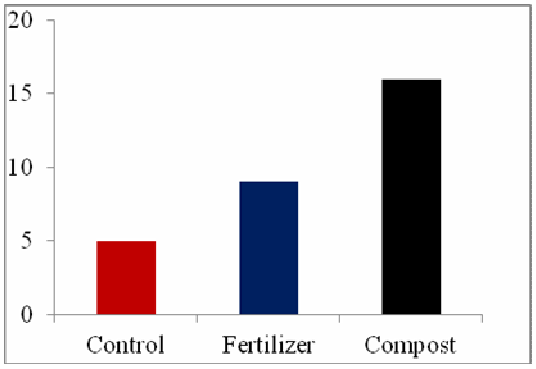

Figure 13 Shoot length

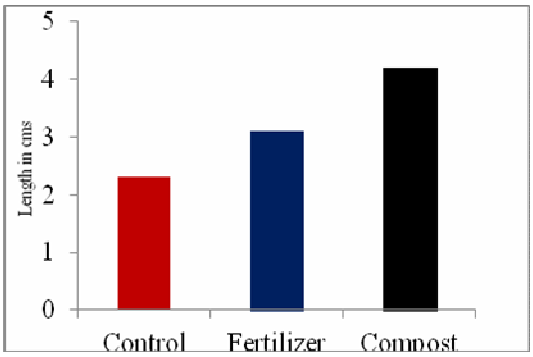

Figure 14 Number of leaves

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