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A Study on Vermicomposting of Kitchen wastes using *Eudrilus eugeniae* and *Perionyx excavatus* and its effects on the growth on *Lycopersicon esculentum*

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KEYWORDS

Vermicomposting, Biological degradation, *Eudrilus eugeniae*, *Perionyx excavatus*, plant growth promotion, *Lycopersicon esculentum*

A B S T R A C T

Vermicomposting is an oxidative process using earthworms and associated microbes under non thermophilic environment. This biological organic waste decomposition process yields the biofertilizer namely the vermicompost. Vermicompost is a finely divided, peat like material with high porosity, good aeration, drainage, water holding capacity, microbial activity, excellent nutrient status and buffering capacity thereby resulting the required physiochemical characters congenial for soil fertility and plant growth. Vermicompost enhances soil biodiversity by promoting the beneficial microbes which in turn enhances plant growth directly by production of plant growth-regulating hormones and enzymes and indirectly by controlling plant pathogens, nematodes and other pests, thereby enhancing plant health and minimizing the yield loss. Hence this present study, focuses on the vermicomposting of kitchen wastes using two different earthworms *Eudrilus eugeniae* and *Perionyx excavatus* and their effect on the growth on *Lycopersicon esculentum*. Because of the innate biological, biochemical and physiochemical properties, vermicompost may be used to promote sustainable agriculture and also for the safe management of agricultural, industrial, domestic wastes which usually possesses serious threat to life and environment.

Introduction

Vermicomposting refers to production of compost by growing earthworms. These worms feeds on waste leading to bio-oxidation by relentless turning, fragmentation and aeration of waste by devouring resulting in homogeneous and stabilized humus like product which is an ideal nutrient for plants thus used as manure (Umesh Mathur *et al.*, 2006). Earthworms play an important role in the process by fragmenting and conditioning the substrate, increasing the surface area for growth of microorganisms and altering its biological activity (Dominguez, 2004; Dominguez and Edwards, 2004). The regular inputs of feed materials for earthworms can be in the form of agro waste, kitchen waste and nitrogen rich materials such as cattle dung, goat dung and pig manure (Ismail, 2005). Vermicomposting could serve as a means to stabilize the waste, divert it from legal and illegal dump sites and finally, create an organic fertilizer that can be returned to agricultural land to supply nutrients for crop production and increase soil organic matter pools. In India, about 320 million tonnes of agricultural waste are generated annually (Suthar *et al.,* 2005) of which vegetable waste alone is in major amount. The waste from the vegetable market is collected and dumped into the municipal landfills, causing a nuisance because of high biodegradability (Bouallagui *et al.,* 2004). This results in loss of potentially valuable materials that can be processed as fertilizer, fuel and fodder (Baffi *et al.,* 2005). The biological treatment of these wastes appears to be most cost effective and carry a less negative environmental impact (Coker, 2006). Finally, the success of the vermicomposting technology is closely related to acceptance of the vermicompost as an organic fertilizer by farmers. Vermicompost acts as a biofertilizer enriched with all beneficial soil microbes and also contains all the essential plant nutrients like N, P and K. Further, nutrients in vermicompost are often much higher than traditional garden compost (Alam *et al.,* 2007). It is non-toxic, utilize low energy input for composting and recycled bio-organic product.

Due to absence of toxic enzymes it is also eco-friendly and has beneficial effect on the biochemical activities of the soil (Ali and Jahan, 2001). It also build up water retention capacity of soil because of its high organic matter content and promotes better root growth and nutrient absorption (Nourbakhsh, 2007). The final outcome aids in converting the burden of waste disposal into an opportunity to produce high potential organic fertilizers, capable of enhancing soil fertility, bioremediation and improving crop quality, thereby assisting economic growth and protecting the environment (Padmavathiamma *et al.*,2007). In the present study, two different species of earthworm namely *Eudrilus eugineae* (Indian species) and *Perionyx excavatus* (African species) were used for preparing the vermicompost. Their effects were studied as an organic fertilizer in the growth of *Lycopersicon esculentum.* The physiological and nutritive properties of the composted waste was also analysed.

Materials and Methods

Sample collection

The substrates for the Vermicomposting kitchen waste were collected from Stella Maris Hostel Kitchen, Chennai and two different types of earthworms such as *Eudrilus eugeniae* and *Perionyx excavatus* were collected from the soil.

Experimental setup

The experimental set up had four pots for vermicomposting. Kitchen waste were collected and decomposed for 15 days and the partially decomposed material was used for preparing vermicompost. The pots were set up for vermicompost as follows:

Setup of vermicomposting pots

The composting was prepared using hand sorting method(Walton 1993) and two pots were used as a control without earthworm (Chhotu 2008)**.**The physico-chemical, biological character and moisture content were monitored during vermicomposting at periodic intervals (15 days) for about two and half months. After two and half months, vermicompost soil was collected, air dried and a portion of it was taken for nutrient analysis.

Physiological properities of vermicomposts

The physical properties of the Vermicompost such as pH, temperature, moisture content was evaluated. Since earthworms are very sensitive to $_P$H, it is sometimes a factor that limits the distribution, number and species of earthworms. The activity, metabolism, growth, respiration and reproduction, fecundity and growth period from hatching to sexual maturity of earthworms are greatly influenced by temperature. Moisture level is a significant factor in the set-up of a vermicomposting unit. 5g of soil was weighed which was suspended in 10ml of distilled water, shaken for 30 minutes and $_P$H of the supernatant was measured using pH meter and the temperature was determined by inserting thermometer deep into the composting wastes in the pots.

The moisture content of the soil was determined by comparing the wet soil with dried soil after 24 hours of incubation.

The soil was dried at 105˚c overnight. The percentage of moisture content was determined by the formula given below

% moisture in soil = wet soil – dry soil/dry soil ×100

Nutrient analysis of vermicomposts

The total organic content in the compost was estimated using Walkey and Black method and it is calculated using the following formula:

% of oxidizable organic carbon = (Vol. of blank- Vol. of sample × 0.3 × molarity)

%Total Organic Carbon w/w = 1.334 × %TOC

% organic matter =1.724 × % TOC

The nitrogen content was estimated using Kjeldahl method (TKN) and calculated using the following formula:

% of TKN = (S – B) × 0.02 ×(14/amount of sample)

TKN = (S – B) ×0.02× (14/amount of sample)

The phosphorus content was estimated using Oleson method and absorbance was recorded at 690 nm.

The potassium content was estimated by taking 5 g of air dried vermicompost soil with 33 ml of ammonium acetate, shaken for 5 minutes. It is then filtered and measured in flame photometer. It is calculated using the formula:

K ppm = ppm K × A/wt

Wt = wt of dry sample

Seedling growth of *Lycopersicon esculentum*

Lycopersicon esculentum seeds were inoculated into the labelled pots and that had been substituted or amended with vermicompost soil. The growth of the plant was noted every 15 days interval. The germination percentage was calculated using the following formula:

$$\text{Germination percentage} = \frac{\text{No of seed germinated}}{\text{No of seed sown}} \times 100$$

Root length was measured from the ground level to the tip of the root (cm) and its shoot length was measured from the ground level to the shoot tip (cm).

Results and Discussion

The present study was conducted to evaluate the efficiency of two different species of earthworms for preparing nutrients rich vermicompost and its vital role in supporting the plant growth.

Physiological properties of Vermicompost

pH of the Indian vermicompost was neutral during the 15^{th} and 30^{th} day and by 60^{th} day and 90^{th} day it increased to 7.5 whereas in African vermicompost it was neutral during the 15^{th} and 30^{th} day then it increased to 8 on 60^{th} day and it again decreased to neutral pH on 90^{th} day. In the vermicomposting experiment with different soil proportions the earthworm *E.eugeniae* reduced the pH 6.7 to 6.0 (Munnoli and Bhosle 2009).

Several researchers have stated that most species of earthworms prefer a pH of about 7.0 (Panday and Yadav 2009 ; and Suthar 2008). The maximum temperature of Indian and African vermicompost was on the 30^{th} day of about 28˚C and decreased to 25˚C on the 90^{th} day in Indian vermicompost but on African vermicompost it was about 23˚C on the 90^{th} day. Ansari (2000) reported that temperature during the process of vermicomposting was observed to be 2 8 ± 2°C. A temperature range of 20-30˚C for vermibeds was suggested using *E.eugeniae* and *P.excavatus* (Prakash *et al.*, 2010).The percentage of moisture content of the Indian compost was about 52.3% on 60^{th} day and decreased to 49.2% on 90^{th} day whereas on African vermicompost it was increased during initial period of about 52.1% on 15^{th} day and gradually decreases to 47.2% at the end of 90^{th} day. Trials for vermicomposting showed optimum moisture of 60-70% with a higher number of *E.eugeniae* and *P.excavatus* (Munnoli and Bholse 2008). Figure 1 and 2 shows the physical parameters of Indian and African vermicomposted soil at every 15 days intervals.

Nutrient analysis of vermcomposting

Total Organic Carbon

The highest organic carbon was found in the African earthworm of about 21.8% at the end of the 1^{st} month of incubation period whereas it was about 16.8% in Indian earthworm and also that at the end of maturation cycle it was decreased to 14.5% in Indian earthworm but it was increased in African earthworm to 38%. During the germination period, organic carbon was decreased to 9.7% and11.4% in Indian and African vermicompost respectively, then increased to 14.7% and decreased to 3.65% in African vermicompost during the seedling growth. A study has reported that total organic carbon present in vermicompost was 42.1% (Brunello *et al.*, 2006). Organic carbon for Indian vermicompost and African vermicompost was illustrated in Figure 3.

Total kjeldhal nitrogen

The nitrogen content was initially increased in Indian vermicompost of about 0.81% in Indian earthworm and about 0.76% in African compost at the end of the 1^{st} month but the end of maturation it was increased to 0.98% whereas in Indian earthworm it was only 0.95%. During the growth and germination period the nitrogen content was found to be high in African vermicompost of about 1.5% than Indian vermicompost which was only 1.4%. A study reported that the N content present in vermicompost was 2.49% (Brunello *et al.*, 2006) and 2.12% of N was reported in vermicompost prepared by using *E.eugeniae* (Monson *et al.*, 2007). Figure 4 illustrates the total kjeldhal nitrogen in Indian and African vermicompost.

Available phosphorus

The available phosphorus was very high in African vermicompost which was about 0.061% initially and 0.074% at the end of maturation. But during germination period it decreased and then increased to 0.079% in seedling growth. Monson *et al.*, (2007) stated that the vermicompost prepared by using *E. eugeniae* showed that 0.7% of phosphorus content present in vermicompost. Figure 5 illustrates the available phosphorous in Indian and African vermicompost.

Fig.1 Physical parameters for Indian compost

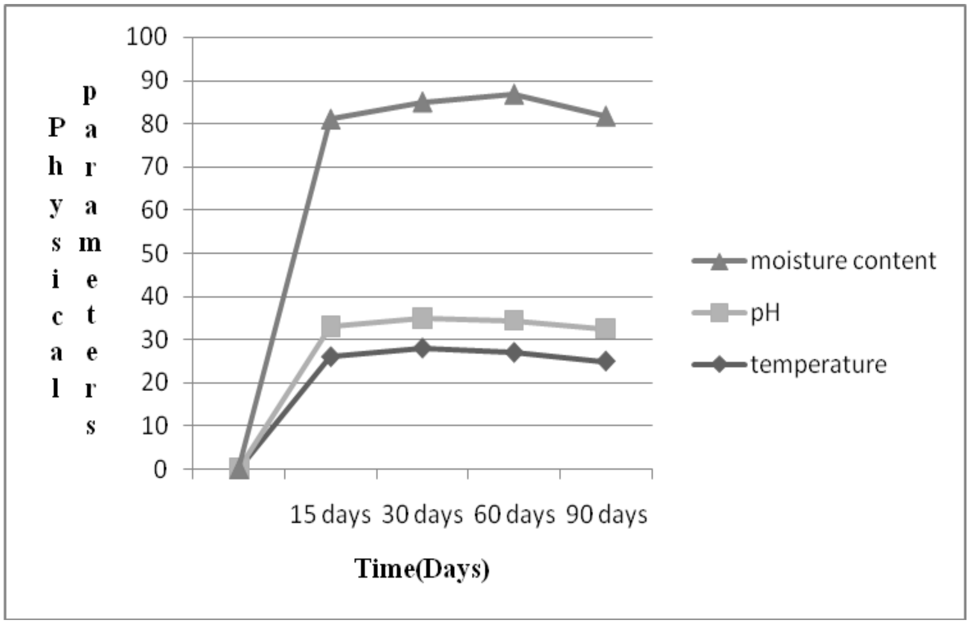


Fig.2 Physical parameters for African compost

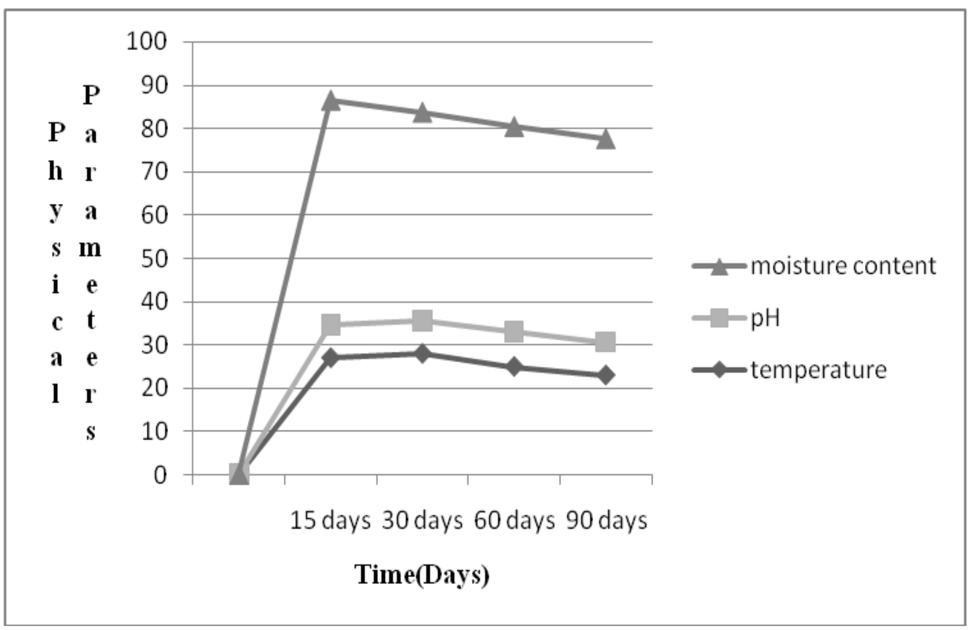


Fig.3 Total organic carbon in Indian vermicompost and African Vermicompost

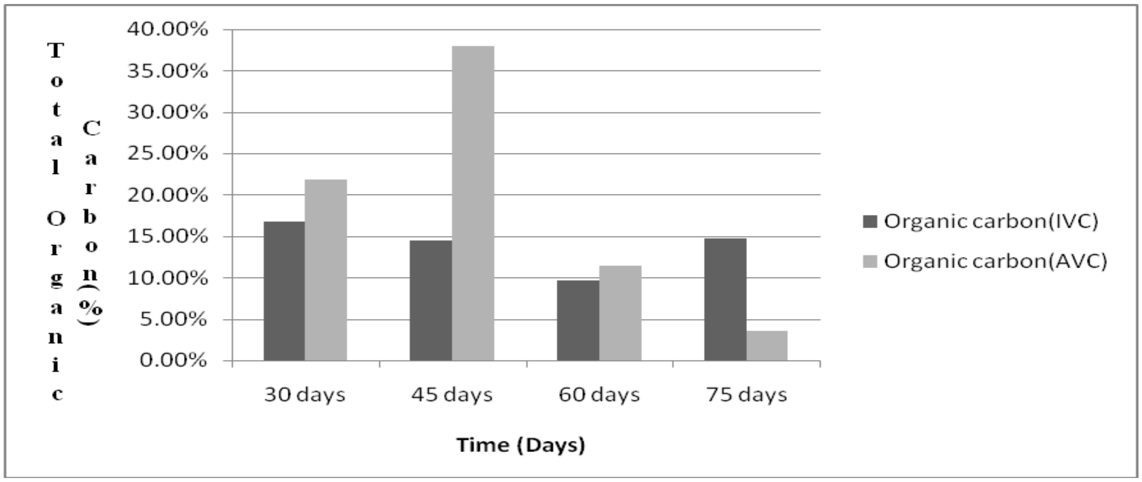


Fig.4 Total Kjeldahl nitrogen in Indian vermicompost and African vermicompost

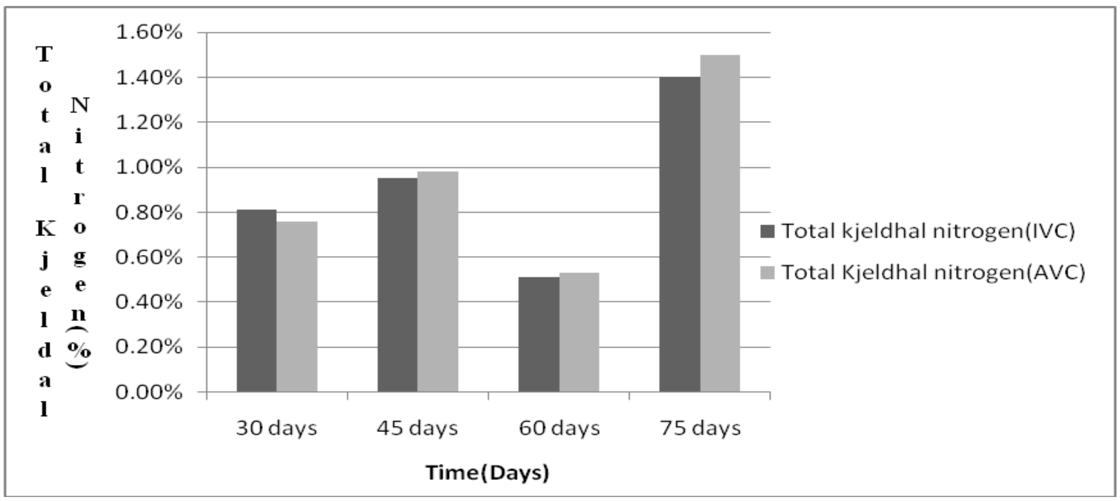


Fig.5 Available Phosphorous in Indian vermicompost and African vermicompost

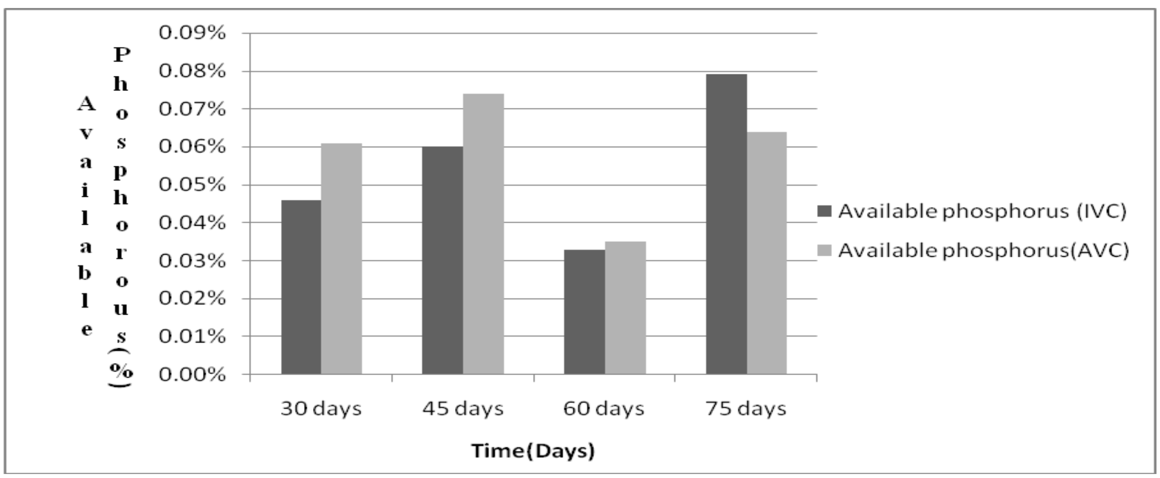


Fig.6 Available Potassium in Indian vermicompost and African vermicompost

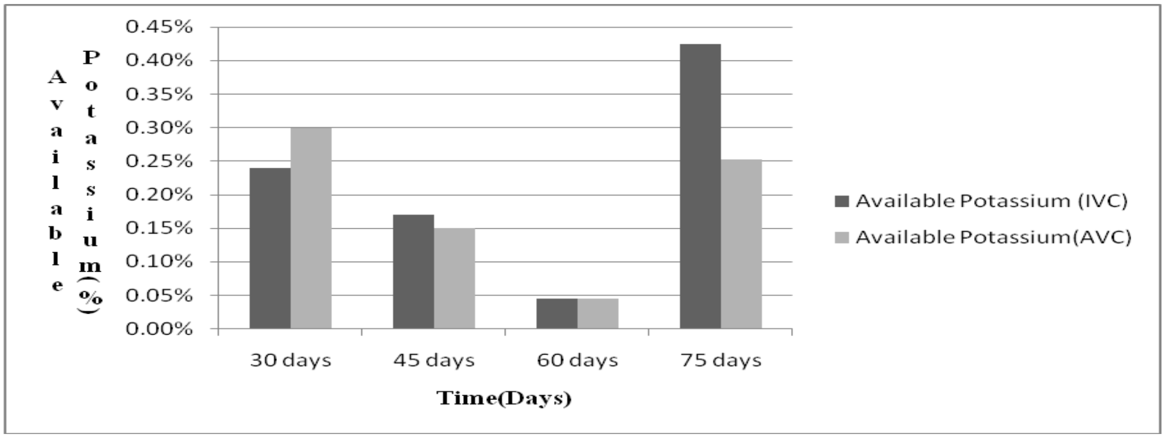


Fig.7 Seedling growth of the plant *Lycopersicum esculentum* in control, Indian vermicompost and African Vermicompost

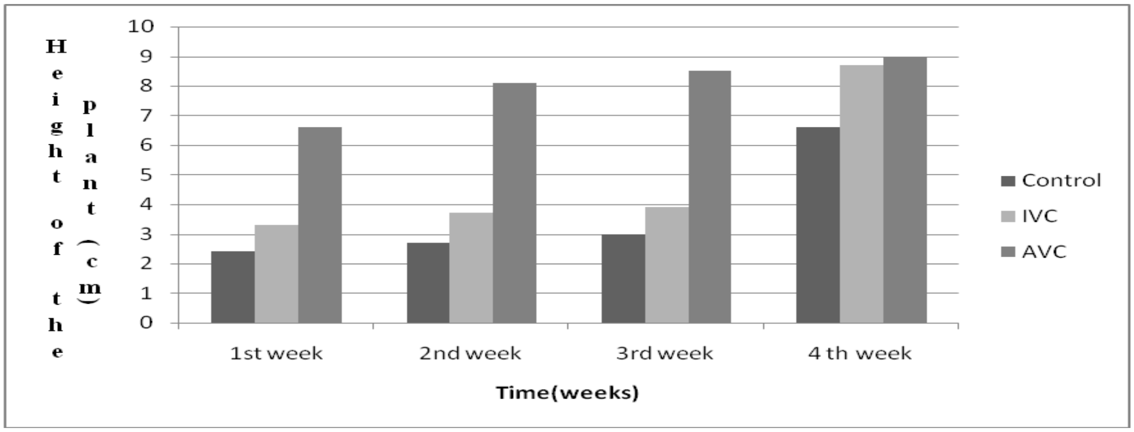


Fig.8 Length of the root in *Lycopersicum esculentum* in control, Indian vermicompost and African vermicompost

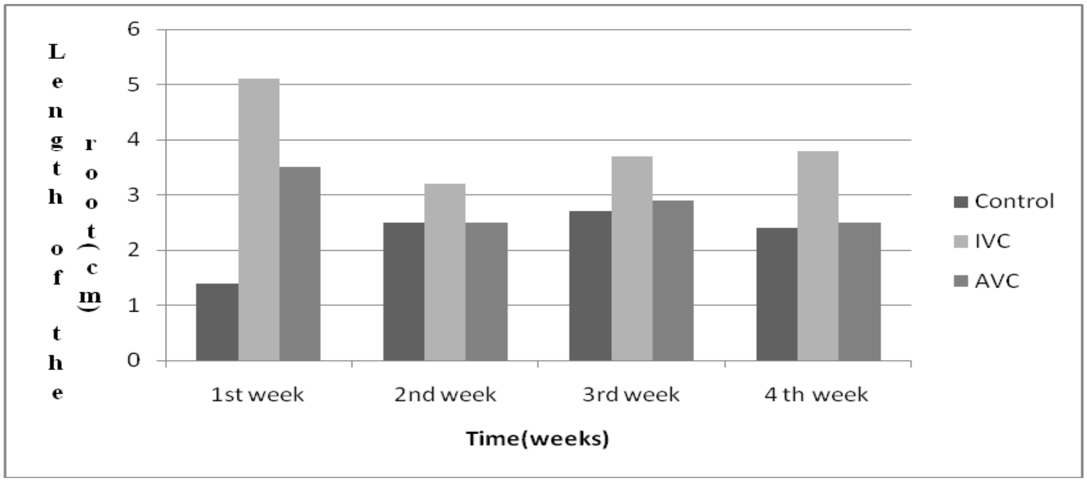


Fig.9 Length of the leaves in *Lycopersicum esculentum* in control, Indian vermicompost and African vermicompost

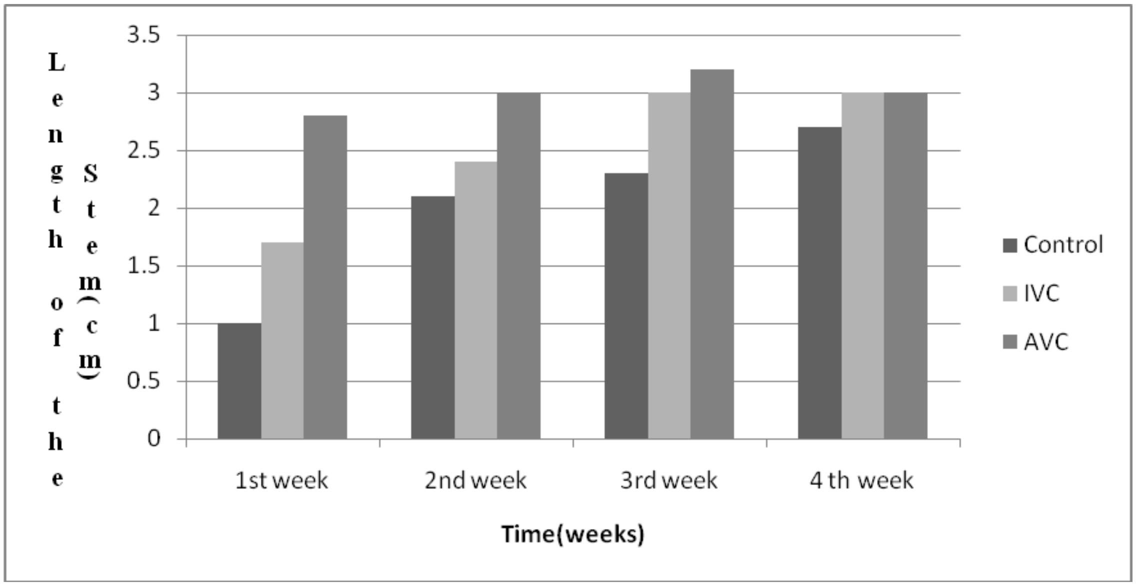
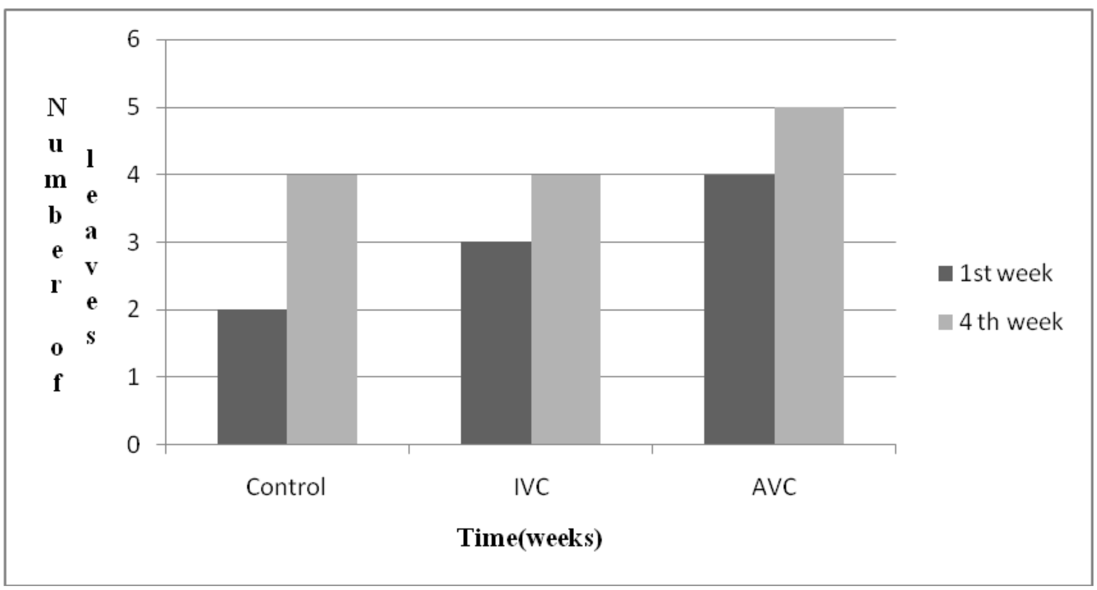


Fig.10 Number of leaves in *Lycopersicum esculentum* in control, Indian vermicompost and African vermicompost



Setup of vermicomposting pots

Eudrilus eugineae (Indian earthworm)	Layer of gravel	Garden soil	Decomposed kitchen waste	Cow dung slurry
Perionyx excavatus (African earthworm)	Decomposed kitchen waste	Newspaper	Cow dung slurry	-

Available potassium

The available potassium was higher at the initial period in both Indian and African earthworm and decreased during maturation period to 0.17% and 0.15% in Indian and African earthworm respectively. During germination period it was found to be decreased to 0.046% and 0.045% in Indian and African vermicompost respectively and during the seedling growth it increased to 0.424% in Indian vermicompost whereas in African vermicompost it was about 0.253. Monson *et al.*, (2007) reported that 0.48% of K was present in vermicompost prepared by using *E.eugeniae.* Figure 6 illustrates the available potassium in Indian and African vermicompost.

Seedling growth of *Lycopersicon esculentum*

The seedling growth of the *Lycopersicon esculentum* plant was measured in the control and in Indian and African vermicompost soils till 4th week. In the control, soil growth of the plant is slightly increased from 2.4 to 4.5 cm. The plants which were grown in African vermicompost soil showed higher growth than the control and Indian vermicompost. In African vermicompost soil, initially the plant stem was about 6.6 cm, which then gradually increased to 9.0 whereas in Indian vermicompost it was about 8.7 cm. Figure 7 illustrates the seedling growth of *Lycopersicon esculentum* in control, Indian and African vermicompost.

Length of the root

In control and in other test samples the height of the root was measured at one week interval. Initially it was 1.4 cm then it increased slowly and finally it reached 2.4 cm. In Indian vermicompost soil, 5.1 cm growth was measured by the end of 1st week. At the end of 4th week, root growth was maximum of 3.8 cm. The plants grown using African vermicompost showed a root growth of 3.5 cm and at the end of the fourth week it was decreased to 2.5 cm. Figure 8 illustrates the length of the root of *Lycopersicon esculentum* in control, Indian and African vermicompost

Length of the leaves

In control, leaves height showed a marked increase from 1.0 cm to 2.7 cm. The plants which were grown in Indian vermicompost soil showed 1.7 cm growth by the end of 1st week and at the end of 4th week it was about 2.7 cm whereas in African vermicompost soil, initially the growth was 2.8 cm which increased to 3.0 cm. Figure 9 illustrates the length of the leaves of *Lycopersicon esculentum* in control, Indian and African vermicompost

Number of leaves

In control, number of leaves was two by the end of 1st week and then it increased to 4. In Indian vermicompost soil, initially the number of leaves was 3 which then increased to 4. In African vermicompost soil, it was showed that the number of leaves increased from 4 to 5. Figure 10 illustrates the number of leaves in the plantlets of *Lycopersicon esculentum* in control, Indian and African vermicompost. Thus it is concluded that high level of plant growth was found in African vermicompost soil. The plant which was grown in Indian vermicompost showed less growth than the plant grown in African vermicompost but it was higher than the control. A better growth of stem, root, leaves of the plant and also the number of leaves was observed in African vermicompost. So African vermicompost act as an efficient biofertilizers for plant growth.

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