

***VERMICOMPOST AND EARTHWORMS:
AN ECO-FRIENDLY APPROACH FOR REPAYING NATURE'S DEBT***

Submitted in partial fulfilment of the requirements for the award of Bachelor of
Technology degree in Biotechnology

By

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**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work Dhinesh Kumar.M (38770002) who carried out the project entitled **“VERMICOMPOST AND EARTHWORMS: AN ECO-FRIENDLY APPROACH FOR REPAYING NATURE’S DEBT”** under my / our supervision from

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DECLARATION

Dhinesh Kumar.M (38770002), hereby declare that the Project Report entitled **“VERMICOMPOST AND EARTHWORMS: AN ECO-FRIENDLY APPROACH FOR REPAYING NATURE’S DEBT”** done by me under the guidance of

Dr. R. Jayashree is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Biotechnology.

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PLACE: Chennai

SIGNATURE OF THE CANDIDATE

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ABSTRACT

The huge tremendous increase in industrialization, urbanization, population and agricultural production results in the accumulation quantities of solid wastes. In order to dispose this waste safely, it should be converted useful and effectively. This is achieved by bio composting and vermicompost. Recycling organic waste through vermicomposting is being considered as an economically viable solution.

Earthworms are useful and considered as natural bioreactors and provide required conditions for the biodegradation of waste. Vermicomposts have the higher level of available nutrients like carbon, nitrogen, phosphorous and potassium. For this study *Perionyx excavates* has been used. A mixture of kitchen waste, plant debris, cow dung was mixed in a ratio 1:1:1 and was introduced into the vermibins. This ratio was found to be best than 5(kitchen waste): 3(plant debris):2(cow dung). In 40 days' time excellent quality and quantity of compost was produced. The pre-decomposition of 10 days and subsequent vermicomposting of 30 days indicates the role of this species in vermibiotechnology. Moreover in every 3 to 4 days, 200ml of vermiwash was collected.

During lockdown, all these products were treated on plants. Every week a handful of vermicompost was added to the plant. We were able to see vast difference in physical growth in the size of the plant and size of the vegetables. Measurements on the sizes were taken every 5 days. Even when used on flowering plants we were able to produce the maximum amount of flowers that lasts longer and healthier. By spraying vermiwash, pests like meal bugs were not able to survive. This was done every 15 days.

Key words: solid waste, composting, vermi-compost, earthworm, Perionyx excavates, kitchen waste, cow dung, plant debris, vermi wash.

Chapter number	Table of content	Page number
	Abstract	I
	Table of content	ii
	List of figures	iii
	List of tables	iv
1	Introduction	1
1.1	Geographical Distribution	2
1.2	Earthworms	3
1.3	Burrowing	3
1.4	Feeding	3
1.5	Casting	4
1.6	Species suited for vermicomposting	4
1.7	Factors influencing culturing of earthworms	5
	A. Food	
	B. Moisture	
	C. Temperature	
	D. Light	
	E. pH	
	F. Predators	
2	Review of literature	7
3	Aim and Scope	8
4.1	Materials required	9
4.2	Method	9
4.3	Worm food	11
4.4	Harvesting	13
4.5	Application	14
5.1	Result	16
5.2	Discussion	21
	Conclusion	22
76	References	23

LIST OF FIGURES

Figure 1: Earthworms (Perionxy excavates)

Figure 2: Setup of Vermicompost bin

Figure 3: Final result of Vermicompost at the end of 30 days

Figure 4: Fine granules of Vermicompost i.e. ready for application

Figure 5: Diluted vermiwash

Figure 6: Comparison graph of ridge gourd

Figure 7: Size of ridge gourd at the end of 12 weeks

a) Without Vermicompost

b) With Vermicompost

Figure 8: Size of the plant at the end of two months

a) without Vermicompost

b) with Vermicompost

Figure 9: Comparison graph of Hibiscus plant

Figure 10: size of the hibiscus plant at the end of two months

a) without vermicompost

b) with vermicompost

LIST OF TABLES

Table 1: Different forms of worm food used with their pros and cons

Table 2: Comparison chart of ridge gourd from the time of fruiting on application of Vermicompost

Table 3: Comparison chart of hibiscus plant from the time of application of Vermicompost

VERMICOMPOST AND EARTHWORMS: AN ECO-FRIENDLY APPROACH FOR REPAYING NATURE'S DEBT

CHAPTER 1

INTRODUCTION

1 VERMIMPOSTING:

Every day around 5400 MT of solid waste is collected from the Chennai city.

Solid wastes can be disposed of by sanitary land filling, incineration method, conversion into biogas, Salvaging procedure, and composting, but its overproduction has led to inappropriate disposal practices such as their indiscriminate and inappropriately timed application to agricultural fields that ultimately leads to water and soil pollution.

However, if handled properly, these organic wastes can be used for vermicompost; it is an effective recycling technology that improves the quality of the products which is disinfected, detoxified, and highly nutritive. Vermicompost is a biodegradable process in which organic waste like agricultural waste, food waste, and bio solids are recycled using earthworms. In recent years earthworms have been increasingly employed in Vermicomposting biodegradable solid wastes (Bhawalkar U S 1993). The aim of this study was to evaluate the process of vermicompost using an indigenous species of earthworms (*Perionyx excavates*) on a small domestic scale as a system for waste management. Earthworms consume raw materials and excrete it in digested form called worm cast which is rich in nutrients, growth promoting substances, beneficial soil micro flora etc. Presently, in organic farming systems, commercial vermin-culturists have begun to promote a product called vermiwash. Such products would definitely have the soluble plant nutrients aside from some enzymes, organic acids, growth hormones and mucus of earthworms. It seems to possess an inherent property which acts not only as a liquid organic but also as a light biocide. Earthworms continuously till and aerate the soil, supply it with organic matter, and help moisture reaching it via the burrows they make (Bhawalkar US 1996). Vermiwash is one of the by-products of vermiculture and vermicompost which have a combination of wash and secretion of earthworms.

It's an organic obtained from units of vermiculture /vermicompost within the sort of drainage. There's no special device required to gather the vermiwash apart from a faucet which is fitted at rock bottom of the containers where earthworms are cultured. Even during the amount of normal management of the vermiculture, water is sprayed regularly to take care of adequate moisture and excess water is drained which contains some essential plant nutrients. The standard of vermiwash produced by earthworms depends on the vermicompost that's used.

Vermicomposting is that the term given to the method of conversion of biodegradable matter by earthworms into vermicast. In the process, the nutrients contained in the organic matter are partly converted to more bioavailable forms. Vermicast contains hormones and enzymes which were acquired during the passage of the organic matter through the earthworm gut. The enzymes and hormones stimulate plant growth and discourage plant pathogens. All-in-all, the vermicast is believed to be excellent organic and soil conditioner. In this paper, the authors present a review of vermicomposting within the background of the attributes of the most agents behind vermicomposting—the earthworm.

Good quality compost productions in ambient temperature are often accomplished in shorter time by the method of vermicomposting that involves use of proper species of earthworms. The native cellulose activity of earthworms and microorganisms that are in earthworm gut promotes faster decomposition of ingested organic material. The combined effect of grinding of organic materials and enzymatic activity to fineness by earthworms produces the vermicompost. Recent experiments by the authors confirm the earlier reports that vermicompost has more beneficial impact on plants than compost. (Gajalakshmi S & Abbasi S 92 (2004), (2002).

1.1 Geographical Distribution

Earthworms are found in most parts of the world except deserts (where they are rare), areas under frequent snow and ice, mountain ranges, areas bereft of soil and vegetation. Such features are natural barriers against the spread and migration of earthworm species, and same the seas, because most species cannot tolerate salt water even for a short period of time.

Some species are widely distributed. Michaelsen has used the term peregrine to describe such species (Michaelsen W 1910).

Such of the species which occur only in specific areas and are not able to spread widely have been termed endemic.

1.2 EARTHWORMS

Earthworms are invertebrates in phylum *Annelida* with class *Oligochaeta*. The earthworms are long, elongated, soft bodied animals with uniform ring like structures along their body. Their bodies consist of segments in a linear series with outwardly highlighted by circular grooves called annuli. The setae provide traction for movement helping the worm to cling into burrows when sensed by predators.

Earthworms possess both male and female gonads. They deposit eggs in a cocoon without the free larval stage and at maturity; a cover-like tissue develops just behind the anterior segments, called the clitellum.

1.3 BURROWING:

Earthworms can create tunnels through the soil as they move around. During hot dry seasons they move several feet underground. At the end of each burrow there is a wide space which allows the worms to take turns. To stop the flow of water and to keep out of predators the entrance of the burrows is covered by faecal matters, pebbles, and with bits of leaves. The internal sides of the burrows are cemented by secretion of the worm's cutaneous glands. During dry weather, they burrow to several feet underground, coil up and become dormant (Abbasi S A & Ramasamy E V) 2001, 1-178.

1.4 FEEDING:

The worms mainly feed on decaying organic matters. First the food is moistened by an alkaline enzymatic secretion, digesting starch content making it easier to tear it into shreds.

1.5 CASTING:

After complete feeding process the food emerges as a compact mass termed as casting. The cast of earthworms contain microorganisms, organic and inorganic matters in a form available for plants.

The main enzyme that a cast contain are protease, amylase, lipase, cellulose and chitinase which place a important role to disintegrate the organic matter even after they have been excreted.

1.6 SPECIES SUITED FOR VERMICOMPOSTING:

The main criteria for selection are

- Must be easy to culture
- High rate of vermicast output per worm
- High affinity for the organic content to be vermicomposted.

Among the three types of earthworms (epigeic, anecic, and endogeic) epigeic is more suitable for vermicomposting as they display high rates of consumption, digestion, and assimilation of organic matter and play a key role as litter transformers, producing vermicasts. For all these reasons *E. eugeniae* and *P. excavates* have been extensively used in vermicomposting throughout the world 27-29 and have proved to be efficient converters of organic feed, especially manure, into vermicast (Tinn G, Brussaard L & Kang B T, 1995). The use of endogenic and anecics that are native to the local soil has been recommended by many others. (Mitra A, 1997.) *Eisenia fetida*, *Eudrilus eugeniae* and *Perionyx excavates* are the most common epigeic species found in India. In this study *Perionyx excavates* was used because of its ability to create fine worm casting.

Figure 1: Earthworms (*Perionyx excavates*)



1.7 FACTORS INFLUENCING CULTURING OF EARTHWORM

A. Food:

The most important factor that controls the establishment of earthworm population is food and its quantity. Higher nitrogen content helps in faster growth and greater production of cocoons. The carbon or nitrogen is the critical factor that limits earthworm population. The worms find it difficult to survive in low carbon content in soil.

B. Moisture:

Moisture levels have to be maintained at around 50% so that the microbial activity is high. Excess water creates anaerobic condition, which in turn lowers the pH and creates acidic conditions

C. Temperature:

Temperature affects metabolism, growth and reproduction. Earthworms prefer lower temperature than their surroundings.

D. Light:

Earthworms are very sensitive to light. The photoreceptor cells detect light and the earthworms moves away to avoid strong light.

E. pH:

Earthworms are sensitive to changes in pH. They prefer conditions of neutral reaction. It is difficult for the worm to survive if the pH falls below 6.

F. PREDATORS:

Earthworms consist of many predators including ants, birds, toads, snakes, etc. A variety of invertebrates also feed on them including flatworms, centipedes, etc.

CHAPTER 2

REVIEW OF LITERATURE

Charles Darwin, and numerous scientists before and after him, has described earthworms as great benefactors of soil and agriculture. (Satchell J E,) 1983, 1-495. Evans and Guild have distinguished earthworms into surface dwelling and deep dwelling species (Evans A C & Guild W J Mc L, 1947). Graff inferred that a deep pigmented surface living variety generally occurs predominantly in habitats with sufficient organic matter. (Graff O, 1953). Byzova was the first to distinguish surface living smaller worms with high metabolic rate from deep dwelling larger worms with less metabolic rate (Byzova Yu B, 1965). Bouche proposed an ecological classification of earthworms into 3 generalised life forms:

- (i) epigeics,
- (ii) anecics and
- (iii) endogeics. (Bouche M B, (1977)

Perel classified earthworms, which feed on plant debris that is only slightly decomposed as humus formers and those which feed on plant debris that is already much decomposed as humus feeder. (Lee K E, 1985). A status report prepared by CAPART recommends epigeic species such as *E. eugeniae*, *E. foetida*, *P. excavatus* and *P. sansibaricus* as good converters of waste (Kumar C A, 1994). The Institute of Natural Organic Agriculture (INORA) in Pune also advocates the use of surface worms because they consume all types of garbage and multiply quickly. In the study conducted by Gajalakshmi et al four species of detritivorous (humus-former) earthworms were tested for their ability to vermicompost paper waste blended with cowdung in 6:1 (w/w) ratio. According to Parkin and Beery, earthworm castings are enriched in mineral N, and compared with the surrounding soil, vermicompost has lower C/N ratio and pH than normal compost irrespective of the source of organic waste. (Parkin T & Berry E (1994). The studies carried out by Basker³⁸ under field conditions indicated that the castings of earthworms contained two to three times more available potassium than the surrounding soil (Basker A, Macgregor A N, 1993).

CHAPTER 3

AIM AND SCOPE

3.1 AIM

The aim is to determine the effect of vermicompost and its byproduct on various potted plants

3.2 SCOPE:

There is tremendous scope of vermiculite as people are giving preference to organic food, organic vegetables, and organic fruits for better health. People are using organic fertilizer instead of chemical fertilizer.

Vermicompost acts as conventional compost, provides many benefits to agricultural soil, including increased ability to retain moisture, better nutrient-holding capacity, better soil structure, and higher levels of microbial activity

CHAPTER 4

MATERIALS AND METHODS

4.1 MATERIALS

- Bin (each batch with 4 numbers like fruits and vegetables tray, lid with fabric or air holes)
- Bedding:
 - a) Paddy straw or coconut coir
 - b) A bag of red soil
- Kitchen waste, vegetable and fruit waste
- Shredded non-glossy newspaper
- Leaves
- Gunny bags
- Water sprayer
- Worms
- Terracotta pot
- Mosquito net

4.2 METHOD:

The experiment for this study was conducted as follows:

- A cuboidal plastic container with dimension 15 inches deep, 25 inches wide, 5 inches high was prepared.
- Several small holes (approximately 0.5 cm in diameter) were made in the bottom of the container to provide aeration and to avoid water logging.
- The first step after creating worm bin is to add bedding for the worms.

- Bedding holds moisture and provides a medium in which the worms can work.
- It must be light and fluffy enough to allow air exchange.
- Bedding must be well soaked in water and wrung out before adding to the bin.
- A layer rice straw and coconut coir are used as bedding.
- As a second layer, handful of fine sand, ground egg shells or other clean gritty material.

The above Base materials were added as a third layer which included 1kg of compostable household organic waste which had been chopped to reduce its size and volume.

It should be noted that to avoid disordering in the vermicompost production process, materials considered unacceptable to earthworms including citrus, garlic and onions, meat, dairy products, fish and beans were separated and removed.

The pre-mentioned bed was left for 10 days under shaded place for pre-digestion.

Then, 20 adult earthworms were inoculated into the experimental set (vermicompost), and then a little water was added to the initial worm bedding to maintain its moisture. It was then topped by 2.5 cm of sieved garden soil. The organic waste was turned periodically (once every 20 days) for better aeration and to mix its content. A container with same dimensions without holes is placed under this setup to collect vermiwash.

Figure 2: Setup of Vermicompost



4.3 WORM FOOD

Under ideal conditions, earthworms are able to consume in excess of their body weight each day, although the general rule-of-thumb is $\frac{1}{2}$ of their body weight per day. They will eat almost anything organic, but they definitely prefer some other food source too. Manures are the most commonly used worm feedstock, with dairy and beef manures generally considered the best natural food.

Table1: Different forms of worm food used with their pros and cons

Food	Advantages	Disadvantages
Cattle manure	Good nutrition; natural food, therefore little adaptation required	Weed seeds make pre-composting necessary
Poultry manure	High N content results in good nutrition and a high-value product	A high protein level is dangerous to worms, so it must be used in small quantities.
Rabbit manure	N content second only to poultry manure, therefore good nutrition; contains very good mix of vitamins & minerals; ideal earth-worm feed	high urine content can overheat if quantities too large; availability usually not good
Pre-composted food wastes	Good nutrition; with partial decomposition helps digestion by worms easier and faster	Nutrition less than with fresh food wastes.
Fish, poultry offal	High N content provides good nutrition to the bin;	Must be pre-composted until past thermophilic stage

4.4 HARVESTING:

After 30 days vermicompost is harvested. One of the methods for harvesting the compost is to place the compost on some plastic sheeting in small piles and expose the piles to the sun or bright lights. Because the worms don't like light, they will move to the bottom of their pile. The compost pile may be spread for about 24 to 36 hrs. and the worms may be removed from the lower layers of the compost (Ismail S A, 1996)

After about a quarter of an hour you one removes the upper inch the compost from each pile. At the end of this process, worms will be separated from the compost.

Removed worms can be used again in the same bin with new bedding and the process is repeated.

Worm bin has holes in the bottom to allow the liquids to flow through, known as compost tea or vermiwash which is harvested every 4 days once from the tray that you keep under your worm bin.

This tea can be used as a liquid fertilizer for plants.

Figure 3: Final result of Vermicompost at the end of 30 days



4.5 APPLICATION

Collected vermicompost is applied to required plant every 20 days. In this study we used Ridge Gourd (*Luffa*) and Hibiscus plant were used.

The collected vermiwash was sprayed on plants as a insecticide.

Figure 4: Fine granules of Vermicompost i.e. ready for application



Figure 5: Diluted form of vermiwash



CHAPTER 5

RESULT and DISCUSSION

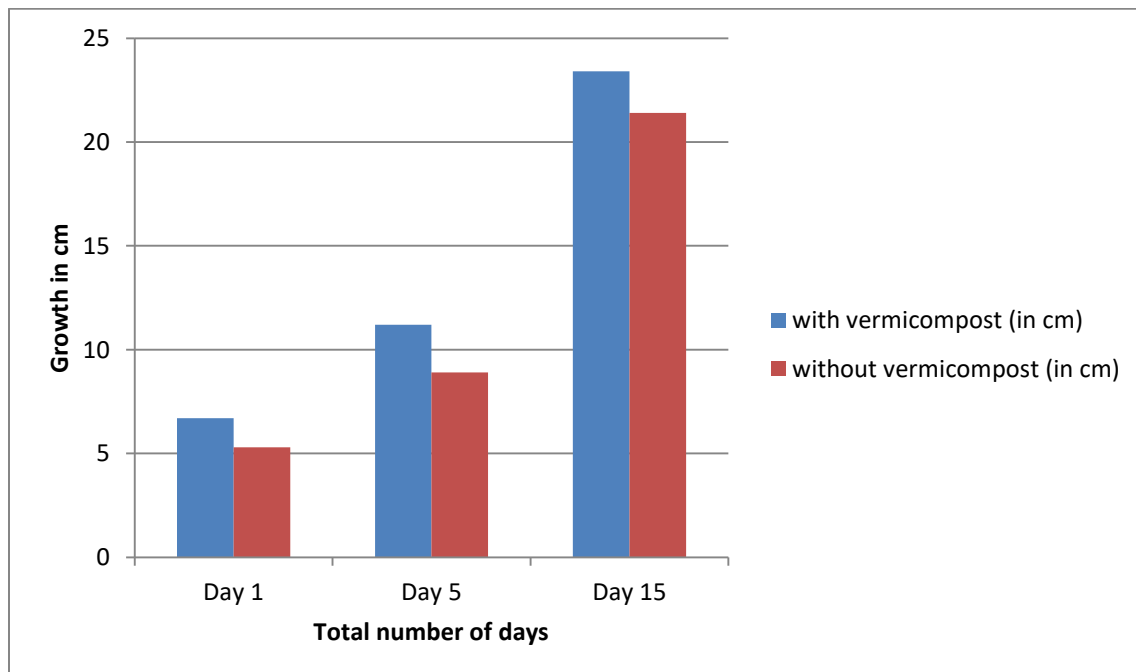
5.1 RESULTS

Measurements like height of the plant and length of the vegetable were taken every 5 days. Tremendous difference was seen in the size of the plant growth and size of the vegetable growth and in the rate of flowering. By an average 2cm difference in the height of the plant and the length of the vegetable was noted between plants grown with vermicompost manure and without vermicompost manure.

Table 2: Comparison chart of ridge gourd from the time of fruiting on application of vermicompost

Time intervals (after 12 weeks of time)	With vermicomposting (in cm)	Without vermicomposting (In cm)
DAY:1	6.7cm	5.3cm
DAY:5	11.2cm	8.9cm
DAY:15	23.4cm	21.4cm

Graph 1: Comparison graph of ridge gourd



Size of Ridge gourd at the end of 12 weeks

a) without vermicompost



b) with vermicompost



Size of the plant at the end of two months

a) without vermicompost



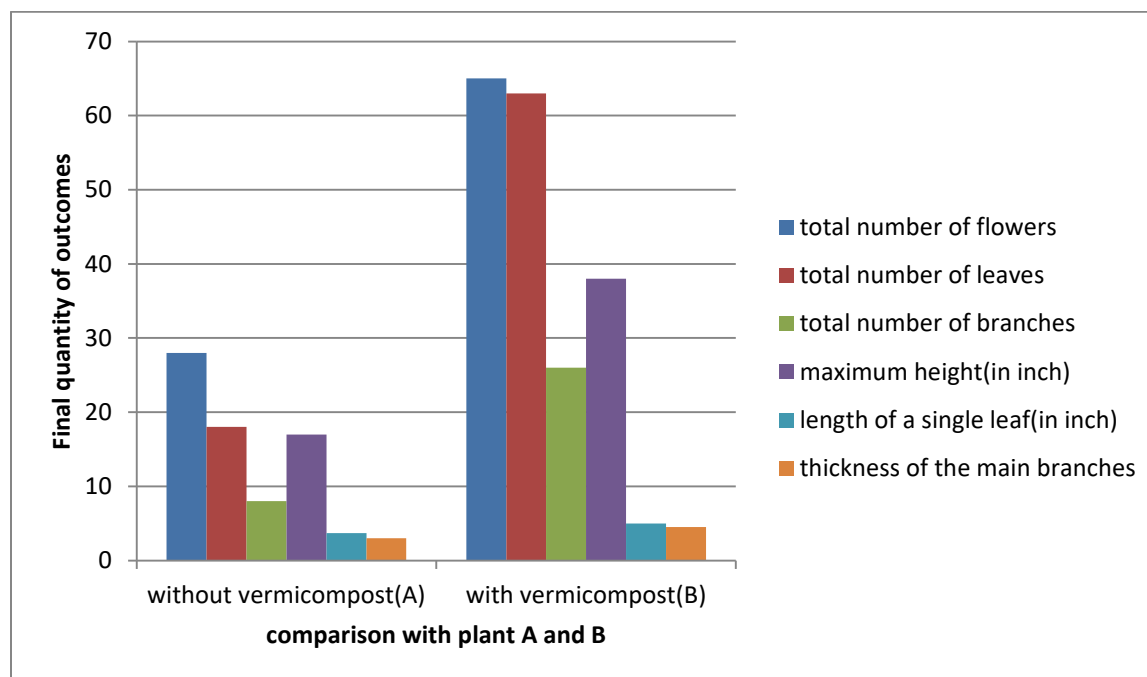
b) with vermicompost



Table 3: Comparison chart of hibiscus plant from the time of application of Vermicompost

6 month of time	TOTAL NO. OF FLOWERS	TOTAL NO. OF LEAVES	TOTAL NO. OF BRANCHES	MAXIMUM HEIGHT (in inch)	Length of a single leaf (in inch)	Thickness of the main branches (in inch)
PLANTS WITH VERMICOMPOST	65	63	26	38	5	4.5
PLANTS WITHOUT VERMICOMPOST	28	18	8	17	3.7	3

Graph 2: Comparison graph of Hibiscus plant



Size of hibiscus plant at the end of two months

a) without vermicompost



b) with vermicompost



5.2 DISCUSSION

The present study showed that vermicompost that it has good ability to help plants to shoot out new growth after each application. Moreover vermiwash has the ability to prevent microbial and fungal attacks on plants. Vermicasts are believed to have several components, which improve the soil to which they are applied (Joshi N V & Kelkar B, 1951).

The worm casting is very important for the fertility of the soil. The castings contain high amounts of nitrogen, potassium, phosphorus, calcium, and magnesium which acts as the major growth promoter. The Castings contain: 5 times the available nitrogen, 7 times the available potash, and 1½ times more calcium than found in good topsoil.

Several researchers have demonstrated that earthworm castings have excellent aeration, porosity, structure, drainage, and moisture-holding capacity.

The content of the earthworm castings, along with the natural tillage by the worms burrowing action, enhances the permeability of water in the soil. Worm castings can hold close to nine times their weight in water.

The nutrients content in vermicompost vary depending on the waste materials that are being used for compost preparation.

If the waste materials are heterogeneous one, there will be wide range of nutrients available in the compost. If the waste materials are homogenous one, there will be only certain nutrients are available.

CHAPTER 6

CONCLUSION

In summary, according to the above discussion and in order to properly plan for efficient management of the environment and the economy and to implement the priorities of municipal solid waste management especially in terms of reducing household waste at the source of production, vermicompost household waste presents a very effective solution and an appropriate management of municipal solid waste by homeowners. Moreover vermicompost plays a vital role when compared with chemical fertilizers which cause root rot due to over heat. While vermiwash acts as a plant tonic which helps in reducing many plant fungi pathogen and gives a better health for soil and disease management for sustainable crop production.

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