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IMPACT OF VERMICOMPOST ON SOIL PROPERTIES AND PLANT GROWTH

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ABSTRACT
Vermicompost is the excreta of earthworm, which are capable of improving soil health and nutrient status. Yet its role in the nutrition of agricultural fields has attracted attention of researchers worldwide only in recent decades. Waste management is considered as an integral part of a sustainable society, thereby necessitating diversion of biodegradable fractions of the societal waste from landfill into alternative management processes such as vermicomposting. Earthworms excreta (vermicast) is a nutritive organic fertilizer rich in humus, NPK, micronutrients, beneficial soil microbes; nitrogen-fixing, phosphate solubilizing bacteria, actinomycets and growth hormones auxins, gibberlins and cytokinins. Both vermicompost and its body liquid (vermiwash) are proven as both growth promoters & protectors for crop plants. The present study, discuss about the worms composting technology, its importance, use and some salient results obtained in the globe so far in this review update of vermicompost research.

KEYWORDS: Vermicompost; Worms, Wastes, Nutrients.

1. INTRODUCTION

Traditional agriculture is currently characterized by excessive inputs of chemical fertilizers, pesticides, and herbicides, while the insufficient application of organic fertilizers (Li *et al*. 2007; Gill and Garg. 2014). The excess use of chemical fertilizers and pesticides has resulted in numerous negative effects on the environment, including water, soil (Ju *et al*. 2009) and food pollution (Li *et al*. 2007), degradation of soil quality (Ju *et al*. 2009), and losses of agricultural biodiversity (Minuto *et al*. 2006; Gill and Garg. 2014).

To solve such problems, more sustainable agricultural practices are urgently required. Compared with chemical agriculture, organic farming has been thoroughly proven as beneficial in maintaining both biodiversity and environmental sustainability (Ahmad *et a*.,. 2007; Leite *et al*., 2010). Organic farming has been gradually adopted by agriculturalists, particularly in developed countries (Rigby *et al*., 2001; Lobley *et al*., 2009), because of its higher economic and ecological benefits.

The results of several long-term studies have shown that the addition of compost improves soil physical properties by decreasing bulk density and increasing the soil water holding capacity (Weber, 2007). Moreover, in comparison with mineral fertilizers, compost produces significantly greater increases in soil organic carbon and some plant nutrients (García-Gil, 2000; Bulluck, 2002; Nardi, 2004; Weber, 2007; Esakkiammal *et al*., 2015).). The use of organic amendments such as traditional thermophilic composts has been recognized generally as an effective means for improving soil aggregation, structure and fertility, increasing microbial diversity and populations, improving the moisture-holding capacity of soils, increasing the soil cation exchange capacity (CEC) and increasing crop yields (Zink and Allen, 1998).

Vermicompost contains most nutrients in plant-available forms such as nitrates, phosphates, and exchangeable calcium and soluble potassium (Orozco, 1996). Vermicompost has been shown to have high levels of total and available nitrogen, phosphorous, potassium (NPK) and micro nutrients, microbial and enzyme activities and growth regulators (Parthasarathi and Ranganathan 1999; Chaoui, 2003) and continuous and adequate use with proper management can increase soil organic carbon, soil water retention and transmission and improvement in other physical properties of soil like bulk density, penetration resistance and aggregation (Zebarth, 1999) as well as beneficial effect on the growth of a variety of plants (Atiyeh, 2002; Esakkiammal *et al*., 2016).

Vasanthi and Kumarasamy (1999) who found significant increase in CEC of the soil treated with vermicompost plus NPK. Decreased pH wasobserved in the soils treated with enriched compost of industrial wastes, after harvest of ragi and cowpea (Srikanth, 2000). Vasanthi and Kumarasamy (1999) and Srikanth, (2000) where the incorporation of various enriched compost, vermicompost.

Increased available NPK in the soils were observed where the soils were treated, respectively, with enriched compost from different organic wastes, FYM, vermicompost and vermicompost plus NPK after the harvest of rice, ragi and cowpea (Vasanthi and Kumarasamy, 1999; Srikanth, 2000; Sailajakumari and Ushakumari, 2002; Chaoui, 2003). have been shown to have increased OC content in the soil. Manure application is known to stimulate and improve stable soil structure, fungal and bacterial population and biological activity (Chaoui, 2003).

Vermicompost is an eco-friendly, non-toxic, consumes low energy input for composting and is a recycled biological product. Vernicomposting is a modified and specialized method of the process uses earthworms to eat and digest farm wastes and turn out a high quality compost in two months or less. Vermicomposting is the bio-oxidative decomposition of organic matter by the mutual interaction between earthworms and microorganisms. vermicomposting through earth worms is an ecobiotechnological process that transforms energy rich and complex organic substances in to a stabilized vermicomposts (Bentize *et al.*,2000).

Vermiwash has great growth promoting as well as pest killing properties (Buckerfield *et al* 1999; Esakkiammal, 2015). The second green revolution started as organic farming (Sathe 2004, Sharma 2004) keeping this view in mind a new vermiwash model, with five major modifications has been developed. The use of vermiwash on different types of crops and fruit trees shows good qualitative and quantitative effects for betterment of mankind and animals.

The activity of earthworms is generally considered about its significance in soil improvement. Furthermore earthworms are very important as prey for various mammals and birds. Man has utilized earthworms for ages, such as for fishing bait, for example, primitive peoples consume the protein rich worms, thereby improving their often-monotonous diets.

2. MATERIALS AND METHOD

2.1 Collection of Earthworms

Eudrilus eugeniae was obtained from a ICAR of Sri Parasakthi College for Women, Courtallam. The stock culture of the earthworm was maintained in plastic containers using partially decomposed bio-waste and cow dung as growth medium in laboratory condition for further use in the vermicomposting experiment. It is about only medium sized earthworms were collected without any damage.

2.2 Preparation of Vermicompost

Preliminary treated animal waste has to be pre-decomposed in a pit size dug in soil in a length 2cm, breadth1-1.5m and height 0.9m-1m. First put one layer of cow dung maintaining 100% leave it for 20-30 days depending on the climatic conditions. When the material is partially decomposed. The material is decomposed the earthworm starts feeding from upper surface of the feed material. When the material becomes granular, blackish in colour. It indicates the materials to ready for harvesting scrapped this materials up to the depth where there is no Vermicompost worms. Collect all scrapped material and make one heap and leave it for 2-3 days. Worms will go down to the bottom of the heap and it will easier to separate the worms manually.

2.3 Preparation of Vermiwash

Take 10 L of mud pot or plastic container for preparation of vermiwash. Arrange a tap for it at the bottom. Then place 10 cm gravel or broken bricks at the bottom. Spread coconut husk up to 4 cm. Place partially decomposed filter mud waste material and dung and moisten the material with water. After wetting the material for 2 days, release 100 earthworms in 2 weeks the wastes get transformed into black compost. At this stage pour 3 L of water. After 24 hrs 2 L vermiwash can be collected through the tap. Continue this method for one week, remove the compost from the container and it can be used as manure.

2.4 Physical Parameters

2.4.1 Temperature

10gms of soil was weighted accurately and it was transferred to a l00ml beaker. To which 25ml of distilled water was added. The beaker was stirred well. Then the thermometer was noticed. From this the actual temperature of the soil was recorded.

2.4.2 Electrometric Method [Ph]

The pH of soil was determined by the method of electronic method using the instrument pH meter. 10g of dried and powdered soil is weighted accurately and is transferred to a 100ml beaker and to which 25ml of distilled water is added. The beaker is stirred well after 30 to60 minutes the pH of the supernatant solution is recorded using the glass electrodes are immersed in the measure the latter may be allowed for the needle to stop drifting and the reading is taken while stirring.

2.4.3 Moisture Content

A freshly homogenized soil sample was taken and weighted than it is dried in an oven at 105^{0}C until a constant weight is obtained subsequently the sample is cooled in a desiccator and the final weight of the sample was noted.

2.4.4 Estimation of Total Nitrogen (N)

The total nitrogen content of the manure was estimated by Kjedahl method as per Tandon (1993). This method involved two steps. Digestion of the sample to convert the N compound in the sample to the NH_4 form. Distillation and determination of NH_4 in the digest.

2.5 Antimicrobial Activity in Vermiwash

2.5.1 Preparation of the inoculum

Stocks cultures of the above mentioned organisms were maintained at 4^{o}C on the sloped of nutrient agar medium. Active culture of microorganisms were prepared by transferring a loopful of cells from the stock culture to test tubes that contain broth and was incubated without agitation of 24 hours at 37^{o} C. This was used for the study of antibacterial activity of cow dung.

2.5.2 Antibacterial activity

Petridishes with nutrient agar were inoculated with 5 different human bacterial species. Sample is were sterilized by passing each through a 0.22gm Millipore GV filter, Round paper discs with a radius of 0.8cm were dipped into each vermiwash extract and placed in the center on inoculated petridishes. Bacterial colonies were allowed to grow overnight at 37^{o} C the inhibition zone around the disc was measured.

2.5.3 Antifungal activity

Petridishes with dextrose agar were inoculated with 3 different species of fungus. The sample were sterilized by passing each through a 0.22gm Millipore GV filter, round paper discs with a radius of 0.8cm were dipped into each sample and placed in the centre on inoculated petridishes. Fungal colonies were allowed to grow 48hrs at 28^{o} C and then the inhibition zone around the disc was measured.

3. RESULT AND DISCUSSION

The activity metabolism growth respiration and reproduction of earthworm are all greatly influenced by temperature. Temperature is the most familiar environmental factor with multi sided effects on plants and animal. In Egypt, Duwelini and Ghabbour (1965) reported that optimum temperature range was between 26-30^{o}C. Bareley (1961) reported that the possible significance of earth worm in a agricultural land, the beneficial effect of earthworms on crop grow in temperature zone was often pointed. The growth rate of the young worms was very low through positive, at 15^{0}C it increased with temperature reaching a maximum at 25-28^{0}C after and then decreased at 30^{0}C adult growth was much slower and showed a rather different pattern, with a maximum at 30^{0}C.

In the present study the temperature was found to be 27.5^{0}C in the experiment- I and the temperature was found to be 29^{0}C in the experiment II cocoons also hatch soon at high temperature. The growth period from hatching to sexual maturity is also dependent on temperature by Evens and Guild (1948). Earthworm can be killed by extreme temperature.

pH is defined as the negative logarithm of hydrogen ion concentration. The earthworms are very sensitive to the hydrogen ion concentration. So it is factor that limits the distribution number and species of earthworms that line in any particular sample. The earthworms thrive best with pH range close to neutral. In the present study the pH was found to be 6.68 and 7.5 in sample I and II. Most of the species of earthworms prefer soil pH 7 was studied by Arhenius (1921). An increase pH form 6-7.2 was associated with decrease in the number of earthworm in the fourteen Egyptian soil studied by Duweini and Ghabbour (1965).

Earthworm cannot tolerate dry environment as moist environment because of adverse effect of dessication often encountered in a dry environment. They can avoid dry sample because they can survive the loss of a large part of the total water content of their bodies Lavellee (1983), observed a linear increase in earthworm biomass with increase in rainfall amount. Thomson and Davies (1974), observed that high bulk density could compensate with low moisture level in supporting maximum number of earthworms.

In the present work the moisture content in the cow dung was found to be 20.2 and 17.75 in sample I and II. This shows that there was an more moisture level in experimental I sample. In the present study the bulk density in the cow dung was found to be 0.63 and 0.61 in sample I and II. This shows that there was a low bulk density in experimental II sample.

Specific gravity is weight/unit volume of over dried sample. The specific gravity of fertilized sample is less when compared to unfertilized soil. The specific gravity was found to be 0.56 and 0.53 in sample I and sample II. The specific gravity was decreased in experiment II sample when compared with that of the experiment I. II the fertilized sample the organic sample have very low specific gravity compared to mineral soils Foth and Durk(1973).

In the present study the electrical conductivity was found to be 0.8 and 0.59 in sample I and II. Sample one contain more electrical conductivity than the experiment II sample. The chemical properties analysed were nitrogen phosphorus, potassium, carbon, c/n ration and c/p ration. Table II shows the variation in chemical parameters such as nitrogen phosphorus, pottassium, carbon and c/n ratio,c/p ratio was estimated in both sample I and II. In the present work the amount of nitrogen in the sample I and II is 0.72% and 1.9%. When compared to the experiment I and II the nitrogen content was increased, experimental II sample.

Graff (1970) also reported that, the increasing amount of nitrogen in the earthworm casts Russel (1910) reported that the amount of nitrogen was increased in soil in which worms were reared Bhanari et al (1967) showed considerable amount of organic nitrogen in their studies. Gupta and Sakal (1967) reported that earthworm soil contained more available nitrogen nitrate and phosphorus. In the present work the amount of phosphorus in cow dung sample was found to be o1.28 and 1.12 in sample I and II. Sample I contain more phosphorus level.

In India Nijhawan and Kanwar (1952) observed that earthworm sample contain more organic matter total phosphorus than the parent soil. In tropical conditions where soil temperatures all higher than those of subtropics the phosphorus mineralization rates by the faecal phosphatases could be stable and higher. However Lant and Jacobsonc (1944) and Graff (1971). In view of the many reference existing on the functions of alkaline phosphorus in earthworm (Haase 1964; Devand Vyase, 1972).

In the present study the amount of Potassium in the cow dung sample was found to be 0.48% and 0.4% in sample I and II when compared to sample I in the sample II the Potassium content was increased in sample I than sample II. The earth worm sample contain more organic matter and total potassium than the parent soil by Nijhawan and Kanwar (1952). Recently in 1993, Tiwari Shawed that the effect of potassium fertilizer on earthworm activity.

In present study the amount of Sulphur in the sample I and II found to be 0.71 and 0.1. in sample I Sulphur was increased when compared to the experimental sample the amount of Sulphur was increased. In present study the amount of Calcium in the sample I and II found to be 1.49 and 1.49 in both sample Calcium was increased. In present study the amount of Magnesium in the sample I and II found to be 1.36 and 1.3 in sample I Magnesium was increased when compared to the experimental sample the amount of Magnesium was increased.

In present study the amount of carbon in the sample I and II found to be 28.48 and 31.39. in sample II carbon was increased when compared to the experimental sample the amount of carbon was increased. In present study the amount of Dissolved solid in the sample I and II found to be 1.28 and 0.94 in sample I Dissolved solid was increased when compared to the experimental sample the amount of Dissolved solid was increased. In present study the amount of Organic matter in the sample I and II found to be 49 and 54 in sample II Organic matter was increased when compared to the experimental sample the amount of Organic matter was increased.

In present study the amount of C/N ratio in the sample I and II found to be 39.56 and 16.52 in sample I C/N ratio was increased when compared to the experimental sample the amount of C/N ratio was increased. In present study the amount of C/P ratio in the sample I and II found to be 22.25 and 28.03 in sample II C/P ratio was increased when compared to the experimental sample the amount of C/P ratio was increased.

Earthworm paste prepared from *Eudrilus eugeniae* was tested for antibacterial and antifungal activities. For antimicrobial assay five strains of bacteria viz. *E.coli, Staphyloccocal aureus, Klebsiella pnuemonia, Vibrio cholerae, and Salmonella aboni* were used, For antibacterial assay two concentration of the EP 50 µl and 100 µl were used, Of the five bacteria tested, the growth of bacteria were well inhibited by EP. The disc diffusion assay and well assay indicated a dose dependent effect of the EP to inhibit the growth of bacteria. EP at a dose of 100 µl was able to inhibit the growth of *S. aureus* at a maximum level (17.66±0.33), *S. aboni* was less inhibited when compared with others (11.33±0.66mm). In the well assay *K. pneumonia* was highly inhibited (23.66±0.33mm).

The present study clearly indicates that EP contains a good antibacterial potency and the active compound in it has to be explained Anti-fungal assay was also carried out using five different strains of fungi. The fungal strain was inhibited by EP in a dose dependent manner. The high dose of EP (100µl) showed highest anti-fungal potential. Of the five strains tested, the growth of *C. albicans* was much inhibited (16.33±0.33). The inhibitory potential of the EP was less in the case of *T. rubrum* (12.33±0.33).

The present study clearly indicates that the earthworm paste has bioactive compounds to inhibit the growth of bacteria and fungi. Hence EP has a good potential to develop a new drug.

Table 1: Analysis of Physical Parameters of Vermicompost Obtained From Two Different Earthworms.

Physical parameters	Experiment I	Experiment II	Standard deviation	T-test
Temperature	27.5	29.0	0.75	1.0
PH	6.68	7.5	0.41	0.99
Moisture content	20.2	17.75	1.23	1.0
Bulk Density	0.63	0.61	0.12	1.02
Specific gravity	0.56	0.53	0.02	0.1
Electrical conductivity	0.8	0.59	0.11	1.0

Table 2: Analysis of Chemical Parameters of Vermicompost Prepared From Two Different Earthworms.

Chemical Parameters	Experiment-I	Experiment-II	Standard Deviation	T-Test
Nitrogen	0.72	1.9	0.59	0.98
Phosphorus	1.28	1.12	0.08	1.0
Potassium	0.48	0.4	0.4	1.0
Sulphur	0.71	0.1	0.31	1.0
Calcium	1.49	1.49	0	0
Magnesium	1.36	1.3	0.03	1.0
Carbon	28.48	31.39	1.46	1.0
Dissolved Solids	1.28	0.94	0.17	1.0
Organic Matter	49.0	54.0	2.5	0.99
C/N-ratio	39.56	16.52	11.52	1.0
C/P-ratio	22.25	28.03	2.89	1.0

Table 3: Analysis of Physical Parameters of Vermiwash Obtained From Two Different Earthworms.

Physical Parameters	24-Hours				48-Hours			
	Experi Ment -I	Experi Ment -II	Standard Deviation	T-test	Experi Ment -I	Experi Ment -II	Standard Deviation	T-test
Ph	7.42	7.14	0.14	0.99	7.51	7.12	.36	
Electrical Conductivity	4.1	2.4	0.85	1.0	3	1.3	0.8	1.06

Table 4: Analysis Chemical Parameters of Vermiwash Obtained From Two Different Earthworms.

Chemical Parameters	24-Hours				48-Hours			
	Experi Ment-I	Experi Ment-II	Standard Deviation	t-Test	Experi Ment-I	Experi Ment-II	Standard Deviation	t-Test
Nitrogen	85	119	17	0.99	204	119	5	0.99
Phosphorus	97	103	3	1.0	80	57	11.5	1.0
Potassium	675	162	256.5	0.009	204	84	60	1.0
Sulphur	12	11	0.5	1.0	2	5	1.5	1.99
Calcium	214	86	64	0.009	86	107	10.5	1.0
Magnesium	273	143	65	0.99	117	65	26	0.99
Organic matter	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace

Table 5: Germination Percentage of Snake Gourd.

Germination percentage	Experiment -I	Experiment -II
4^{th} Day	7	8
6^{th} Day	12	13
8^{th} Day	14	14

Table 6: Effect of Vermicompost on Plant Fruits.

Day	Experiment -I	Experiment -II
40	3	4
50	7	7

Table 7: Antibacterial Activity of Crude Earthworm Paste in Disc Assay Method.

S.no	Organisms	Zone of inhibition in concentration (mm)		
		50µl	100µl	Tetracycline(30µl)
1	***Escherichia coli***	11.33±0.33	13.66±0.33	17.66±0.33
2	***Staphylococcus aureus***	10.00±0.00	17.66±0.33	26.66±0.33
3	***Klebsiella pneumonia***	10.33±0.33	13.66±0.33	17.33±0.33
4	***Vibrio cholerae***	10.33±0.33	12.66±0.33	19.66±0.33
5	***Salmonella abony***	11.33±0.66	11.33±0.66	17.66±0.33

P-value =5.33E-13.

Table 8: Antifungal Activity of Crude Earthworm Paste in Disc Assay Method.

S.no	Organisms	Zone of inhibition in concentration (mm)	
		50 µl	100µl
1	*T.rubrum*	0.00±0.00	12.33±0.33
2	*Aspergillus niger*	11.00±0.57	13.33±0.33
3	*Aspergillus flavus*	10.33±0.33	15.00±0.57
4	*Penicillin sps*	10.66±0.33	14.33±0.33
5	*Candida albicans*	12.33±±0.33	16.33±0.33
6	**Standard drugs**	14.33±0.33	26.66±0.33

P-value =1.97E-16.

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