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SOIL AGRO-ECOLOGICAL MANAGEMENT BY VERMICOMPOST A POTENTIAL ORGANIC NUTRIENT SOURCE FOR THE STATE OF UTTAR PRADESH

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ABSTRACT

Uttar Pradesh is the most populous state and country subdivision in the world. With land as one of the limited resources, with soil quality degrading each day, dependence on chemical additives has made agriculture a costly affair. A lot of biomass from agricultural practices is left unused. The most crucial phase for a plant's life is germination period. In this study the use of agricultural waste as a substrate for vermicompost production and then helping seeds achieve a healthy germination period has been performed. The Carbon (%), Phosphate (PO_4^{3-} Kg/ha), Potash content (Kg/ha) and pH for each soil type (Chemical fertilizers (CF, 1.11, 13.5, 907, and 7.6); Vermicompost (VC, 0.91, 40.5, 1377, and 7.5), natural manure treated (AD, 0.52, 9.0, 728, and 7.1) and additives free normal soil (NS, 0.28, 4.5, 549 and7.7) was observed. The seed germination support for *Cosmos sulphureus*, *Helianthus annuus*, *Cucumis sativus*, and *Raphanus sativus* was also best in the case of vermicompost. This study has targeted the small farms and land, can make economic gains with the vermicompost and organic farming.

KEYWORDS: Vermicompost, organic farming, soil management *Cosmos sulphureus, Helianthus annuus, Cucumis sativus*, and *Raphanus sativus.*

1. INTRODUCTION

Present time is observing an alarming situation of soil degradation and with this decline in the crop yields, and threatening a sustainability of soil fertility. And to maintain the fertility, use of costly and non-ecofriendly chemical fertilizers has increased. It is the utmost urgency to use those agricultural practices which maintain the balance between degradative and restorative properties of soil.[1, 9] All sustainable agricultural practices benefits the soil in restoring its properties either equals or greater than the overall degradative effects. One of the important agricultural practices that is used in maintaining the restorative properties of the soil is use of organic wastes as manure. India is a developing economy where a lot of people are not able to have one meal per day. Pollution is also threatening its sustainable development.[2] India is the country with major part of its GDP comes from agricultural activities. And from these agricultural activities, for various agrarian societies like India which generate almost 500Mt of biomass wastes and uses only a small part of it in other alternative activities. Rest of it is burnt or dumped creating environmental troubles. India also the maximum number India has the largest cattle followed by Brazil & China in the world.[3,4, 11] Vermicompost contains 5-11 times more nitrogen, phosphorous and potassium than normal soil because of the mutual interaction between microbes and earth worms based bio-concentration which adds humic acid and plant hormones. Humic acid is responsible for binding of minerals, and plant growth homones helps in early germination of plants with higher yields and deeper roots penetration. Nutrient content of vermicompost is different form compost obtained from heap. Adult *Eisenia fetida* were used as potential epigenic species for decomposing the animal and agricultural wastes. The most suitable temperature for their growth is 25° C. But out of various known species of earth worms used in vermi-composting like *Eudrilus eugeniae, Perionyx excavatus* and *Eisenia fetida*, the most temperature resistant species is *Eisenia fetida*.[5, 10] Seed germination is the most important phase of a plants's life cycle. If seeds breaks its dormancy on time and in sufficient number then it can help the reduction of wastage of seeds, seed dormancy and economical loss the farmers. In this article the vermicopost preparation and use of it in seed germination was studied.

2. MATERIAL AND METHOD

2.1 Eisenia fetida and vermicompost

This species is most suitable for physical condition like temperature and soil type and other conditions prevalent in UP, and consumes half it's weight of organic matter

per day and give high output. Grows at pH 6 to 8 provided by organic wastes and animals wastes, with 70% moisture content and can grow fast in dark.

Fig.a): Cocoon of *Eisenia fetida* and

Fig.b) Mature *Eisenia fetida*

2.2 Production/breeding of earthworms and vermi-composting takes place simultaneously

Beds of 10X2X2 feet dimensions were prepared. Waste material (Animal dung and agricultural wastes) were spread on the ground (2 inches layer) for overnight, to lower down the temperature. These organic wastes were then mixed properly and temperature was allowed to cool down to room temperature. (The ambient temperature for the growth of *Eisenia fetida* ranges from 20˚C to 47˚C±5). This organic waste material was mixed with water to maintain moisture content of 535±3 g/kg. The pH of the sample was kept in the range of 7-7.5. This was then filled into fill the beds with maintaining space for air to pass in and out. After proper bed formation it was inoculated with fertilized eggs in cocoons (fig.a). It takes them several weeks to sexually mature and to reproduce. At around six weeks, they will reach full maturity and continue living until they die. The life cycle is typically the same for most species of earthworms. In this project *Eisenia fetida*, cocoons were purchased from biotech park Lucknow. These pits were then left out for 60 days to allow the multiplications of the earth worms. The beds were also tested time to time (Fig C). The top most matter is decomposed by the earth worms first.

Fig C: Bed prepared for the production of vermicompost.

2.3 Nutrients content analysis

Macro and micro nutrients are important for plants to grow. Out of all nutrients Carbon, Phosphate and potash are the three main nutrients which are used as a parameter to decide the quality of a soil. Soil free from any additives, soil treated with manure, soil treated with vermicompost and soil treated with fertilizers were send to the lab for analysis. The samples were kept undisturbed for 30 days to give all the nutrients to enough time to mix up the soil. The samples were test at government laboratory "Mrida Parikshan Prayogshala" (Soil Testing Laboratory), Lucknow.

2.4 Comparative study of vermi-compost, chemical fertilizers and manure treated soil as a medium for plant growth

To test the efficacy of the vermi compost over the manure and chemical fertilizers, a comparative study was carried out. Vegetable and flower plants seeds were taken namely *Cosmos sulphureus* (Benary seed private ltd.), *Helianthus annuus* (Benary seed private ltd.), *Raphanus sativus* (Chandra Seeds) and *Cucumis sativus* (Chandra Seeds). Fertilizer used was Urea, (Shaktiman) 0.69 g/5 kg soil. Manure added was 100g/Kg of soil. Similarly, vermicompost taken was 50g/kg of soil. Normal soil was used as standard. 100 seeds were used of each plant type for each soil set.

3. RESULTS AND DISCUSSION

World is observing a rise in pollution level affecting quality of air, water and land. Among them all, land is the most limited resource we are available with. The upper most layer of the earth crust is composed of inorganic unconsolidated minerals and organic materials, in which plants find all the nutrients to grow, having specific moisture and organic and inorganic contents. Soil differs on the basis of its source, biological, chemical, physical and morphological properties and characteristics. But due to the soil pollution and problems arising with the use of chemical fertilizers, insecticides and other chemicals in agricultural practices and problems arising from the soil waste mismanagement the land degradations is a threat for human survival. There is an urgent need to find an ecofriendly solution to deal with the problem.

3.1 Eisenia fetida and physical conditions of Uttar Pradesh

To make vermicompost feasible at this temperature the species of *Eisenia fetida* was used. In the state of Uttar Pradesh the temperature reaches upto 50^{o} C in the summers and up to 2^{o} C ±2 in winters. So it is utmost important that the species that can withstand this temperature range should only be cultured. Reinecke et al., (1992) found the temperature suitability for different species of earth worms and their efficacy in converting the biomass into vermicompost.[5] Four species of earth worms namely *Eudrilus eugeniae*, *Perionyx excavatus* and *Eisenia fetida* were tested for vermicompost production at high temperature. The vermicompost production was compared at 25^{o} C (optimum Temp.) to the 43^{o} C for all species. And it was found that *Eisenia fetida* has wider range of temperature tolerance. Similarly the vermicompost production by *Eisenia fetida* at temperature 20^{o} C also had been high compared to other species. In this study also, the temperature during the vermicompost preparation was within the range of *Eisenia fetida*.

3.2 Substrate for Eisenia fetida feed

Substrate chosen for the growth of *Eisenia fetida* was mixture of animal and plant waste. This organic waste material was mixed with water to maintain moisture content of 535±3 g/kg. The pH of the sample was kept in the range of 7-7.5. it was observed that earth worms were showing a healthy growth as shown in fig.b. **Gunadi et al., (2013)** studied the effects of variety of organic wastes on the growth, mortality and vermicompost production ability of *Eisenia fetida*.[6] The substrates chosen in this study were fresh cattle manure, pig manure (young pigs, growing pigs and sow pigs), pre composted cattle manure, fruits and vegetables wastes from super markets. Two types, of culture techniques were used, namely batch and continuous culture. In continuous culture groups, for each type the second and third substrate change, the feed was added at 15 weeks and 22 weeks intervals. The growth of *Eisenia fetida* was good and long lasting in the manure prepared from growing and sows pigs. From the study it was observed *Eisenia fetida* had high growth rate and vermi-compost production ability in case of compost than fresh animal wastes. But the growth rate for *E. fetida* keep on decreasing with the time interval post addition of the third feed. It was lower for cocoon and hatchling post adding the third substrate. Out of various Use of *Eisenia fetida* for eco-friendly environmental treatment has found multiple uses.[7] **Maboeta et al., (2003)** used *Eisenia fetida* for vermi-composting of sewage sludge and woodchips coming from the platinum mines as wastes.[7] But they found bio-concentration of heavy metals was possible with the use of micro-organism inoculated along *Eisenia fetida* for vermicompost preparation by synergistic effect of worms and microbes. The main aim of the study was to test long-term feasibility on a large-scale for developing an understanding for bio-concentrating heavy of heavy metals in the presence of microbes and for possible environmental implications. So from the above study it was observed that for presence of microbes boost the vermicompost preparation by worms.

3.3 Quality of the vermicompost produced

Carbon and Nitrogen content of vermi-compost determines the quality of it. In this study vermi-compost soil was compared with the soil treated with pesticides treated soil; manure treated soil, and blank soil sample (Table 1). The carbon content was highest in the pesticide treated soil followed by vermi-compost > natural soil > blank soil. Similarly the PO_4^{3-} (Kg/ha), was highest in the vermi-compost, followed by pesticide treated soil > natural manure > blank soil sample. Potash (K) content in the vermicompost soil was highest followed by pesticide treated soil > natural manure > blank soil sample. Similarly **Azarmi et al., (2008),** studied and compared the nutrient content or the soil with the vermicompost.[8] The C, N, P, K, Fe content (%) in the vermi-compost was 15, 1.3, 1.3, 1 and in blank soil the content (%) was 1.07, 0.09, 0.001, 0.032 respectively. The pH of vermicompost and soil was 7.7 and 7.94 respectively. By the use of vermicompost plants gets the required nutrients for long time since humus hold up moisture and increase the microbial population by providing required physical and chemical

environment.[8] In comparison to the heap based compost the vermicompost have 10^3 times more microbes.

3.4 Comparative study of vermi-compost, chemical fertilizers and manure treated soil as a medium for plant growth

To test the efficacy of the vermi compost over the manure and chemical fertilizers, a comparative study was carried out. Vegetable and flower plants seeds were taken namely *Cosmos sulphureus* (Benary seed private ltd.), *Helianthus annuus* (Benary seed private ltd.), *Raphanus sativus* (Chandra Seeds) and *Cucumis sativus* (Chandra Seeds). The germination of seed was fast in the vermicompost treated soil. The detail of all the germination data is given in the table 2.

4. CONCLUSION

From this study it was concluded that the use of vermicompost as a source of healthy and balanced nutrient for plants and support fast germination in seeds, can help farmers especially the small land farmers of the state of Uttar Pradesh. Use of *Eisenia fetida* for the production of vermicompost is most suitable for the small scare farmers with less inputs they can make substantial economica gain and not just only benefits their crops with healty nutrient but by organic farming can help environment too.

Table.1 a comparative analysis of vermin-compost treated, natural manure, pesticide treated and blank soil samples for their nutrient analysis.

S.no	Soil Type	Date of deposition	Date of testing	C (%)	Fertility	PO_4^{3-} Kg/ha	Fertility	Potash (K)/Kg/ha	Fertility	pH of the sample
1	Chemical Fertilizers	12/4/16	17/4/16	1.11	High	13.5	Low	907	High	7.6
2	Vermicompost soil	12/4/16	17/4/16	0.91	High	40.5	High	1377	Very High	7.5
3	Natural manure	12/4/16	17/4/16	0.52	Medium	9.0	Very low	728	High	7.1
4	Blank soil	12/4/16	17/4/16	0.28	Low	4.5	Very low	549	High	7.7

Table.2: Comparative study on the seed germination of different plants in different soil treated with vermicompost, fertilizers and manure.

No of days	*Cosmos sulphureus*				*Helianthus annuus*				*Cucumis sativus*				*Raphanus sativus*			
	CF	***VC***	***AD***	***NS***	***CF***	***VC***	***AD***	***NS***	***CF***	***VC***	***AD***	***NS***	***CF***	***VC***	***AD***	***NS***
1	0/100	0/100	0/100	0/100	0/100	0/100	0/100	0/100	0/100	0/100	0/100	0/100	0/20	0/20	0/20	0/20
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	9	14	8	3	3	8	4	6	9	14	8	3	3	7	5	2
5	16	26	23	8	12	14	13	7	16	26	19	8	5	9	7	4
6	23	40	32	14	20	19	28	9	23	40	32	14	8	11	10	6
7	29	46	42	18	28	46	33	11	29	46	42	14	8	11	10	6
8	34	57	47	18	34	56	48	12	34	57	52	18	8	11	10	6
9	36	65	52	19	37	59	52	12	36	65	54	19	8	11	10	6
10	36	70	52	19	38	67	54	12	40	70	55	20	8	11	10	6
11	39	70	54	20	--	--	--	--	--	--	--	--	--	--	--	--

(VC= vermicompost; CF= chemical fertilser; NS= normal soil, AD=animal dung treated soil.)

CONFLICTS OF INTERESTS

"The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper."

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