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PERFORMANCE EVALUATION OF VERMICOMPOSTED COIR PITH BY *EUDRILUS EUGENIAE* KINBERG ON THE GROWTH OF *Abelmoschus esculentus*

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ABSTRACT

The growing awareness about ecofriendly organic farming using natural sources has now been developed among farmers to produce vermicompost, which shows enhanced growth promoting effect on various vegetative crops. Similar trail was made and evaluated in this study. An exotic earthworm, *Eudrilus eugeniae* (Kinberg) was used to prepare vermicompost based on coir pith combined with cow dung in different ratios. These vermicomposted coir piths were amended with garden soil as a pot medium for the growth of the vegetative plant, *Abelmoschus esculentus*. Physico-chemical characteristic features of the vermicomposts as well as in control compost were estimated. N, P and K values were highly increased while the C:N ratio was drastically decreased in vermicompost with equal ratios of coir pith and cow dung. Vermicompost when amended as potting medium enhanced the growth of tested *Abelmoschus esculentus* crop. In case of effect of different ratios compared, the coir pith compost prepared in equal ratio with cow dung was significantly superior to all other treatments and recorded the maximum shoot length, shoot weight, root length, root weight, number of leaves, flowers and fruits.

Keywords: Vermicomposting, *Eudrilus eugeniae*, Performance evaluation, *Abelmoschus esculentus*, Growth parameters.

1.INTRODUCTION

A revolution is unfolding in vermiculture studies for vermicomposting of diverse organic wastes by waste eating earthworms into a nutritive 'organic fertilizer' and using them for production of 'chemical-free safe food', both in quantity and quality without recourse to agro-chemicals. Heavy use of agro-chemicals since the 'green revolution' of the 1960's boosted food productivity, but at the cost of environment and society. It killed the beneficial soil organisms and destroyed their natural fertility, impaired the power of 'biological resistance' in crops making them more susceptible to pests and diseases. Chemically grown foods have adversely affected human health. The scientific community all over the world is desperately looking for an 'economically viable, socially safe and environmentally sustainable' alternative to the agro-chemicals.

Coir pith is known as organic waste composed of lignocellulosic fibrous material, it is separated from the husk of the coconut fruit. It is abundantly available as an agricultural waste from the local coir industry. In India, 7.5 million tons of coirpith are produced every year (Kamaraj, 1994). Disposal problem of accumulated coirpith is a major problem as Coirpith gets decomposed very slowly in the natural environment because of its chemical and structural complexity (Ramalingam *et al*., 2004). Lignin, cellulose and hemicellulose are natural chemical constituents present in all plants at variable rates. Lignin is a complex, heterogenous, phenyl propanoid polymer comprising 25–30% of plant biomass. Lignin, cellulose and hemicelluloses materials are efficiently degraded by microbes in the soil as well as in the ruminants (Anand and Sripathi, 2004).

Earthworm plays a major role in plant material degradation and this concept is used in vermicomposting technology with the supplement of cowdung source to enhance plant growth. Cowdung is an organic and nitrogen rich material, it can be easily degraded in the soil. Biodegradation of this waste by earthworms is generally considered to be a safe, effective and environmentally friendly process. Earthworms are well known natural machineries. They can transform organic waste materials into vermicompost for agricultural applications (Arancon et al., 2008). During vermicomposting important organic nutrients are released by earthworms (Edwards, 1995). Generally earthworms are voracious feeders and they excrete a large part of these consumed materials in a semi digested form. According to Arancon and Edwards (2006) vermicomposts contain plant growth hormones, plant growth regulating substances and humic acids which enhance plant growth and productivity. Therefore vermicomposts are widely used in organic farming. In the present study we aimed to evaluate the vermicomposting of coirpith with cow dung by *Eudrilus eugeniae* and to analyse the growth promoting properties of this combined vermicompost on *Abelmoschus esculentus*.

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2.MATERIALS AND METHODS

Coir pith and cow dung

The coir pith required for the present study was collected from the coir pith mount near the coir factory located at Pettai, Tirunelveli. Fresh cow dung was collected from the local cowshed near the vicinity of Manonmaniam Sundaranar University, Tirunelveli, India. Collected coir pith and cow dung were immediately brought into the laboratory and maintained properly.

Earthworm and culture

Exotic earthworm species *E. eugeniae* was used in this study and was obtained from the Vermiculture laboratory of Manonmaniam Sundaranar University. The stock culture was maintained at room temperature in the laboratory. Earthworms were cultured in the plastic trays containing wet soil and cattle manure.

Composting process

15 numbers of worms were implied for composting 1 kg of medium in every replicate. The worms at pre-clitellate stage were selected and introduced into the experimental tubs (45 × 30 × 30 cm) containing coir pith and cow dung in different ratios (1:1, 2:1 and 3:1) and maintained for 60 days. Adequate tap water was supplied to the bed regularly for maintaining the wet condition. A separate set of the coir pith was maintained without worms and it was used as a control. Five replicates were maintained for vermicompost and control compost.

Physico-chemical properties of coir pith, cow dung and vermicompost

Coir pith, cow dung and the vermicompost samples were collected and their physiochemical properties were analysed. Analysis of lignin was carried out by modified Klason lignin assay, cellulose and organic carbon content by Updegraff (1969) and Walkley and Black (1934), respectively, N by Kjeldahl method, P by APHA (1998), Na and K by Flame photometer. Calcium and Magnesium by APHA (1992). pH and Electrical conductivity (EC) were estimated by pH and conductivity meter respectively.

Plant growth and estimation

Abelmoschus esculentus was selected for the present study which is widely cultivated and used in India. Viable seeds were obtained from the Tamil Nadu Agricultural College, Killikulam, India. Mud pots (20 × 20 cm) were used for raising the crops. Three replicates were maintained for test and control. The potting medium consisted of the combination of three materials i.e. garden soil: sand: coir pith vermicompost in 1:1:1 ratio. This ratio was considered as an ideal for experiment purpose. Initially, the pots were filled with sufficient level of garden soil. Two seeds were sown at a depth of 2 cm in each pot. The weeds were removed regularly and watering was done at regular interval. On the completion of growth, (i.e. fruiting stage) the plants were removed and the growth parameters such as number of leaves, number of flowers, shoot length, root length, net weight of the plant, wet weight of the shoot, wet weight of the root and fruit weight were measured.

Statistical analysis

The significance of treatments was analysed using one way ANOVA. Significant differences between treatments were determined using Tukey's multiple range tests (P 6 0.05).

3.RESULTS AND DISCUSSION

Physico-chemical properties of coir pith and cow dung:

The physico-chemical properties of coir pith and cow dung before vermicomposting were presented in Table 1. The pH and electrical conductivity of raw coir pith collected was 5.43 and 3.49 mS/cm. The pH and EC of cow dung was neutral and normal (i.e. 7.75 and 0.2mS/cm). Mak and Yeh (2001) studied that higher EC of a coir pith based medium caused high physiological stress to *Spathiphyllum* when grown under sub-irrigation conditions. Too low an EC (0.14 and 0.19 mS/cm) may lead to nutrient deficiency in plants (Ngamau, 2004). It is also evident that electrical conductivity being an index of the dissolved salt position, governs the suitability of a soil potting medium for plant growth (Ross *et al*., 2010). High salinity (>3.5 dS/m) had adverse effects on the rate of seed germination and on the growth and development of seedlings (Bernstein, 1975).

Earlier, Bunt (1988) and Cox and Smith (1997) have reported the salt level of coir pith samples from Mexico and Thailand as significantly high, which adversely affected the growth of certain salt sensitive plants and reduced the nutrient availability. Thus the EC must be present in a normal level. The ideal EC was reported to be 0.2 to 0.5 mS/cm. The task of the output was also out shown by several researchers and indicated that low electrical conductivity was ideal for further utility (Chin, 2001). Pennisi and Thomas (2005) reported that if pH is too low (<4), micronutrients become more mobile and are absorbed in excess by the plant, resulting in a state of potential toxicity. If it is too high (>9), micronutrients are less mobile and the plant cannot absorb enough that result in deficiencies.

Table 1: Physico-chemical parameters of coir pith and Cow dung

Physico-Chemical Parameters	Coir pith	Cow dung
pH	7.45±0.12	7.65±0.9
EC in mS/cm	0.21±0.041	0.20±0.026
Lignin in %	46.26±0.3	7±0.1
Cellulose in %	31.07±0.2	18.09±0.3
TOC in %	34.8±1.2	32.9±0.9
Nitrogen in %	0.68±0.02	1.271±0.07
Phosphorus in %	0.024±0.05	0.13±0.01
Potassium in %	0.752±0.04	0.641±0.02
Calcium in %	0.7±0.07	0.6±0.11
Magnesium in %	0.32±0.01	0.11±0.03
Sodium in ppm	0.22±0.02	0.1±0.01
C:N ratio	51.17	25.88

The potassium and sodium salts were found to be higher in amount than the phosphorus and calcium in raw coir pith collected for this study (Table 1). Savithri and Khan (1994) and Abad (2002) observed an increase of potassium in the soil due to the application of coir pith. High concentration of sodium in the pore space may result in poor calcium absorption in plant as well (Bennett and Adams, 1970 and Shear, 1975). The above indicated unfavourable characteristics of the raw coir pith, i.e. high level of potassium and Sodium (Handreck, 1993 and Konduru *et al*., 1999) and low level of Ca (Rose and Haase, 2000) was solved by the process of vermicomposting.

Physico-chemical properties of coir pith vermicomposts:

A marginal decrease in the values was observed in pH and Electrical Conductivity (Table 2). This proves that effective mineralization process took place in composts with almost all the combinations with cow dung than the control. The coir pith composted with *Eudrilus eugeniae* showed the superior results of pH (7.24 to 7.46) and EC (1.1 to 1.7mS/cm) and their values were closely parallel to the values of other treatment and vice versa. In addition to this, earthworms were also seen efficient in composting the raw coir pith. The values of pH and EC of vermicomposted coir pith were reduced from the values of the control.

The vermicomposts looks brown color which is said to be the apt conditioner as soil amendment for pot culture and the pH of all the composts was found neutral in nature. pH plays a significant role in the availability of nutrients especially micronutrients (Landis, 1990) and consequently it reveals upon plant growth and yields (Rippy *et al*., 2004). The optimum pH range for growing media for greenhouse crops is 5.5 to 6.5 (Poole *et al*., 1981; Warncke and Krauskopf, 1983 and Landis, 1990). The near neutral pH in vermicomposted coir pith is beneficial for plant growth (Hidalgo *et al*., 2006).
The values of lignin and cellulose were reduced by the earthworms. Lignin and cellulose contents of fresh coir pith were 46.26% and 31.07% respectively. The lignin content was decreased during composting with *Eudrilus eugeniae* ranging from0.62 to 1.06%(in control and treatment with cow dung in various ratios). Similarly, the cellulose content decreased ranging from2.17 to 2.14% with *Eudrilus eugeniae* in control and other treatments respectively. *Eudrilus eugeniae* is capable of over production of vermicompost within a short period.

Table 2: Physico-chemical properties of *Eudrilus eugeniae* vermicompost

Physico-Chemical Properties	Control	1:1	2:1	3:1
pH	7.41±0.11	7.24±2.65	7.25±0.01	7.46±0.02
EC in mS/cm	0.17±0.028	0.10±0.063	0.11±0.085	0.12±0.014
Lignin	1.06±0.3	0.62±0.1	0.71±0.2	0.64±0.7
Cellulose	2.17±0.2	2.14±0.4	2.15±0.6	2.16±0.8
TOC in %	23.1±0.04	21.2±0.07	22.7±0.01	22.8±0.03
Nitrogen in %	0.623±0.02	1.023±0.05	0.995±0.01	0.974±0.01
Phosphorus in %	0.024±0.05	0.052±0.09	0.044±0.08	0.036±0.04
Potassiumin %	0.783±0.04	0.992±0.04	0.852±0.05	0.794±0.05
Calcium in %	0.81±0.01	0.92±0.14	0.87±0.12	0.8±0.13
Magnesiumin %	0.48±0.05	0.51±0.01	0.46±0.02	0.41±0.02
Sodiumin ppm	0.26±0.02	0.28±0.06	0.27±0.08	0.27±0.09
C:N ratio	37.07	20.92	22.81	23.40

The results of nitrogen, phosphorous, potassium and carbon contents during vermicomposting and in control composting are given in Table 2. Nitrogen, phosphorous and potassium contents were gradually increased from raw coir pith to the vermicompost and in control compost. An increase in the values of organic carbon and nitrogen was observed and simultaneously all the C: N ratios recorded reached the optimum range (i.e. decreased from 51.17 in pre-processed coir pith to 20 to 37.9 in vermicomposts). Carbon content was gradually decreased in all composts. The results of the present study indicated that coir pith ingested by the worms underwent physical, chemical and biological degradation.

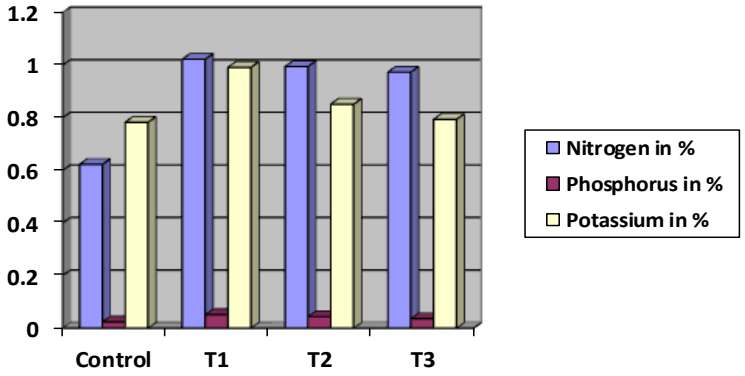

Figure 1. Graph depicting the nutritional status of *Eudrilus eugeniae* compost

Figures 1 presents the available nitrogen, phosphate and potash content in the vermicomposts of *Eudrilus eugeniae* vermicomposts. The average value of NPK content was significantly increased in the vermicomposts and contained more nitrogen, phosphorous and potassium compare to raw coir pith. The nitrogen, phosphorus and potassium values ranged from 0.623 to 1.023%, 0.024 to 0.052% and 0.783 to 0.992% in *Eudrilus eugeniae* composts. Coir pith treated with *E. eugeniae* exhibited significant elevation in total Nitrogen, total phosphorus, total potassium and calcium. Similar results were recorded in studies made by Lee (1985).

Levels of exchangeable cations (Ca and Mg) were also significantly higher in the worm casts than in the raw coir pith. In all the chemical parameters analyzed the control showed the low values than the experimental ratios. In the control, due to the lack of cow dung and absence of degrading bacteria and fungi along with organic supplements, its breaking activity was found to be very low whereas due to the earthworm inoculated treatments, the heavier particles are broken down into smaller particles due to the passage of coir pith through the gut of earthworm. Thus the soluble salts present in the raw coir pith were a major constrain for both vermicomposting and also for plant growth. This issue was overcome by the process of vermicomposting

Naturally, coirpith degradation is very slow in the soil because of the chemical and structural complexity of its lignin–cellulose complex (Ramalingam et al., 2004). In the present study coirpith degradation by earthworm was carried out with 60 days composting process and the obtained product was used as vermicompost. Microflora in the intestine of earthworm is involved

in the decomposition (Arancon et al., 2008). The biochemical composition of the used coirpith and cowdung materials suggested that the materials have potential as alternative nutrient sources. The low composition of lignin and cellulose in cowdung than the coirpith indicates that coirpith would be a more effective source. However, cowdung was used as a supplementary source to improve the efficiency and quality of vermicompost. Similarly, Vasanthy *et al*. (2005) stated that the cowdung influenced the rate of vermicomposition and increased the amount of macronutrients in the vermicompost.

Performance evaluation of vermicomposts:

The aim of the present work was to verify whether the composts are able to induce maximum growth. The performance evaluation of *Eudrilus eugeniae* vermicompost was studied by the culturing of the plant *Abelmoschus esculentus* commonly

called Lady's finger. Utilization of enriched coir pith vermicompost prepared by combining cow dung as a potting mixture was found encouraging than the control compost. The oncoming table 3 shows the data for the growth parameters. Growth and yield parameters of bendhi were significantly influenced by the ratio of cow dung applied. Application of 1:1 ratio compost (coir pith: cow dung) enhanced stem elongation during vegetative and reproductive growth stages than the 2:1 and 3:1 ratio composts of both worms. The least fruit yield was recorded on control pots applied until harvest which was prepared without combining cow dung (Table 3).

Table 3: Effects of *Eudrilus eugeniae* vermicomposts recorded in *Abelmoschus esculentus* plants grown in pots compost

Growth Parameters	Control	1 : 1	2 : 1	3 : 1
Number of Leaves	26.14	31.98	29.70	28.23
Number of Flowers	3	5.66	5	4.66
Fruit yield in gm	4.32	24.87	14.72	12.37
Shoot Length in cm	39.56	1.83	52.35	47.24
Root Length in cm	14.83	22.33	20.66	16.33
Shoot Wt (Wet) in mg	10.43	21.7	18.7	21.03
Root Wt (Wet) in mg	3.8	5.8	4.73	4.66
Total Wt (Wet) in mg	14.23	27.53	23.43	25.63

The plant *Abelmoschus esculentus* possesses taproot system. The taproot was about 0.3 to 0.5 cm in width and below 6 gms in weight. The results showed only slight variations in the length of the roots between the experimental plants. The maximum weight was seen in 1:1 ratio plants treated with *Eudrilus eugeniae* compost while the minimum was observed in 4:1 ratio plants treated with both the composts. The increasing order of plant parameters observed is 4:1 < 3:1 < 2:1 < 1:1 < control.

The flowers start emerging from the 25th -27th day onwards. Table 3 showed almost equal number of flowers in plants grown in *Eudrilus eugeniae* compost while it was found decreased in the following order 1:1>2:1>3:1 ratio. Reduced number of flowers was found in the control alone. Total wet weight of the *A. esculentus* plants showed a significant difference in varying treatment levels. In 1:1 ratio, the maximum weight of the plant (27.53) was observed.

Significant increases in fruits yield were produced by all the treatments. The highest numbers of fruits were obtained from pots treated with 1:1 ratio. Vermicompost treatment gave more than twice the number of fruit produced when 3:1 ratio compost was applied alone and about six times the number produced than the untreated control. There was no significant difference in the number of fruits obtained when 2:1 and 3:1 ratio composts were applied. This confirms the importance of the composts treatments in the vegetative and reproductive life of bendhi plants. Furthermore, the result is indicative of the ability of composts to release soil nutrients for plant use. The presence of a low quality of compost (i.e. 3:1 ratio compost) has reduced the amount of nutrients required for optimum crop performance. This is consonance with the report of Kamprath and Foy (1971). A decline in number of fruits was observed with the use with control compost. This is probably an indication of the non-availability of the required nutrients which might have caused nutrient imbalance in the soil. The yield of fruits presented a somewhat different trend.

However the results confirm that the greater properties like longer shoot, greater weight and many numbers of leaves depend on the high enrichment of the composts. There was a general pattern observed in our study, where the growth parameters showed a typical trend of gradual reduction as the treatment proceed from 1:1 ratio to control. The values of all these parameters in 1:1 ratio showed the increase in almost all the growth parameters which may be attributed to the selective optimal growing conditions as well as the photosynthetic capacity which reflect on the leaf phenology and physiological performance at that particular optimum condition (Litton *et al*., 2007). Thus the present study will be useful to enhance this crop production and it may combat global demand. Further field efficacy research needs to be carried out before they can be used as manure.

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