International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 28-10-2022, Accepted: 14-11-2022, Published: 30-11-2022
Volume 7, Issue 11, 2022, Page No. 104-106

Effect of *Pleurotus sajor-caju* and earthworm co-inoculation in organic matter, carbon and NPK content in coir pith compost

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Abstract

Coir – pith is a by-product of Coconut industry with wider Carbon and Nitrogen ratio, high Lignin content and lower biodegradability. In this present study, we analysed the effect of *Pleurotus sajor-caju* and Earthworm Co-inoculation in Organic matter, Carbon and NPK content in Coir pith compost. The results of the present research clearly revealed that the collected Coir pith waste have high potential for using as an organic manure. The physico-chemical parameters, NPK content and nutrient contents were studied in the present research. The results showed that pH was bought down to neutral state by composting and electrical conductivity was also reduced effectively. The NPK content and nutrients were rich in the treatment T_4 (Coir pith waste + Cow dung + *Pleurotus sajor-caju* + Earthworm) followed by the treatment T_3 (Coir pith waste + Cow dung + *Pleurotus sajor-caju*) and T_2 (Coir pith waste + Cow dung). Least NPK content and nutrients were recorded in the treatment T_1 (Coir pith waste alone). The treatment T_4 showed maximum efficiency on 90 days of incubation rather than 120 days of incubation due to the maturity of compost, there are no carbonic compounds to be break down and used for inoculated metabolism.

Keywords: coir pith waste, earthworm, *Pleurotus sajor-caju*, organic matter, organic carbon and nutrient content

Introduction

Coconut is an important reservoir, produced in 92 countries of about 11.8 million hectares of land with estimated production of 61.7 million tons (Gandhi, 2017) [1]. In India it is produced in all the coastal, north-eastern and island region in an area of 2.14 million hectares with the total production of 21.67 billion nuts. Large quantity of coir waste of about 7.5 million tonnes is available annually from coir industries in India. Southern states of India, especially Kerala, Tamil Nadu, Andhra Pradesh, Karnataka, and Orissa, face this problem. Composting is a revolutionary method to reduce the coir pith waste and it also be recycled into a desirable organic manure. Composting is an aerobic oxidative process that demands excessive quantities of oxygen. Microorganisms consume the substrates and liberate large quantities of carbon dioxide as end products. The composting process is exothermic and usually conducted in heaps. As a result of the heap structure, access of oxygen into the bulk of the heap and release of carbon dioxide and heat are slow. These conditions result in the lowering of the rates of composting.

Materials and Methods

1. Collection of Coir pith waste and Cow dung

Coir pith waste was collected from Tirupattur district, Tamil Nadu, India and used as the substrate for developing the Vermicomposting process. Before the pretreatment, the Coir pith material was cleaned without any fibers and impurities. Cow dung as inoculants source was used for preliminary treatment in the present study.

2. *Pleurotus sajor-caju* inoculant

The fungus *Pleurotus sajor-caju* was also employed for pretreatment after partial degradation with cow dung flora. The Sorghum grain based fungal inoculums of *Pleurotus sajor-caju* called spawn was prepared and used for the composting.

3. Earthworms

The earthworms belonging *Lambido maurtii* and *Eisenia foetida* collected from Department of Zoology, College of Basic Science and Humanities, Bangalore has been used for the study.

4. Pretreatment methods and Treatment schedule

The Coir pith was composted by adding different pretreatment sources including cow dung, *Pleurotus sajor-caju*, and Earthworms. The Treatment schedule includes: T_1 - Coir pith waste alone; T_2 - Coir pith waste + Cow dung; T_3 - Coir pith waste + Cow dung + *Pleurotus sajor-caju* and T_4 - Coir pith waste + Cow dung + *Pleurotus-sajor-caju* + Earthworm.

5. Vermicomposting of Coir pith

Vermicomposting was carried out after partial degradation of wastes for two weeks duration. After the two weeks time of fermentation earthworms at 100 numbers, 10 kg^{-1} of substrate were inoculated. After 120 days inoculation, the Vermicompost was removed by scooping the vermicompost layer by layer after heaping them over plain surface in direct sunlight falling the advantage of negative phototrophic behavior of earthworms because the population of worms tend to decrease and move to the bottom. During this period,

65 - 75 per cent of moisture was maintained with periodical turning at twice a week to regulate the temperature produced due to fermentation. Fermentation makes the organic residues more access to earthworm as it becomes very soft.

6. Physico-chemical and Nutrient analysis of Composted material

Adequate amounts of samples were taken and shade dried. The nutrient content of the samples was analyzed by using the method of Jackson (1973) [2].

7. Estimation of Organic matter content and Carbon content

Organic matter content and Carbon content was estimated by following the method of Walkeley and Black (1934) [6].

8. Estimation of NPK content

Nitrogen, Phosphorous and Potassium content were estimated by following the method of Jackson (1973) [2].

9. Quantitative estimation of Bacteria

The quantitative estimation of bacteria was done by Serial dilution technique (Spread plate method) using Nutrient agar.

Results and Discussion

1. Effect of pretreatment on the Organic matter content during Coir pith waste composting

During composting process, the organic matter content of the coir pith waste almost reduced to 55 % with incubation of 120 days. The effect of coir pith waste composting on organic matter content was presented in Table - 1. The treatment T_4 showed maximum of 46.18 % reduction which was followed by T_3 and T_2.

Table 1: Effect of pretreatment on the organic matter content (%) during coir pith waste composting

Treatments	Sampling time in days						Percentage decrease after composting (%)
	0	15	30	60	90	120	
T_1	41.38	39.12	38.36	36.78	32.12	30.48	14.82
T_2	40.92	39.02	37.12	35.68	31.68	28.68	14.62
T_3	40.98	36.98	36.21	34.52	30.96	18.12	37.98
T_4	40.92	37.29	35.96	33.48	29.36	9.18	46.18

2. Effect of pretreatment on the carbon content (%) during coir pith waste composting

The effect of composting on carbon content was presented in Table - 2. During composting process, the carbon content was almost reduced to 50 % with incubation of 120 days. The treatment T_4 showed maximum of 31.46 % reduction which was followed by treatments T_3 and T_2.

Table 2: Effect of pretreatment on the carbon content (%) during coir pith waste composting

Treatments	Sampling time in days						Percentage decrease after composting (%)
	0	15	30	60	90	120	
T_1	23.12	13.16	22.18	21.16	20.18	19.06	36.18
T_2	23.32	19.48	18.17	14.28	13.06	11.26	34.16
T_3	23.32	18.16	17.26	13.26	13.86	10.18	34.46
T_4	23.32	17.43	15.63	11.16	9.48	7.16	31.46

3. Effect of pretreatment on the Nitrogen content during Coir pith waste composting

The nitrogen content of coir pith waste composting was presented in Table - 3. The initial nitrogen content of coir pith waste was 0.45 and it was increased with period of incubation. The treatment T_4 showed of 1.27 per cent which was almost 50.15 per cent increase than the control. The treatments T_4 (Coir pith waste + Cow dung + Earthworm + *Pleurotus sajor-caju*) was followed by T_3 (Coir pith waste + Cow dung + *Pleurotus sajor-caju*) and T_2 (Coir pith waste + Cow dung).

4. Effect of pretreatment on the Phosphorous content during Coir pith waste composting

The phosphorous content of coir pith waste composting was presented in Table – 4. The initial phosphorus content of coir pith waste was 0.14 and it was increased with period of incubation. The treatment T_4 showed maximum of 0.20 per cent which was almost 40.67 percentage increase than the control. The treatment T_4 was followed by T_3 and T_2.

Table 3: Effect of pretreatment on the Nitrogen content during Coir pith waste composting

Treatments	Sampling time in days						Percentage increase after composting (%)
	0	15	30	60	90	120	
T_1	0.45	0.68	0.52	0.53	0.55	0.69	15.00
T_2	0.46	0.60	0.64	0.74	0.81	1.01	39.12
T_3	0.45	0.62	0.66	0.75	0.83	1.07	41.15
T_4	0.45	0.63	0.67	0.77	0.85	1.27	50.15

Table 4: Effect of pretreatment on the Phosphorous content during Coir pith waste composting

Treatments	Sampling time in days						Percentage increase after composting (%)
	0	15	30	60	90	120	
T_1	0.14	0.15	0.17	0.18	0.19	0.19	19.85
T_2	0.13	0.16	0.18	0.21	0.22	0.23	35.00
T_3	0.14	0.17	0.20	0.24	0.24	0.26	37.86
T_4	0.14	0.21	0.24	0.26	0.27	0.28	40.67

5. Effect of pretreatment on the Potassium content during Coir pith waste composting

The potassium content of the coir pith waste *viz*., T_1 (Coir pith waste alone) T_2 (coir pith waste + *Pleurotus sajor-caju*), T_3 (Coir pith waste + Cow dung + *Pleurotus sajor-caju*) and T_4 (Coir pith waste + Cow dung + *Pleurotus sajor-caju* + Earthworm) was 0.15, 0.16, 0.17 percent respectively (Table - 5). The treatment T_1 recorded the percentage of 6.02 in K content. It was followed by T_2 (10.29), T_3 (14.19) and maximum increased percentage of T_4 (17.74).

Table 5: Effect of pretreatment on the Potassium content during Coir pith waste composting

Treatments	Sampling time in days						Percentage increase after composting (%)
	0	15	30	60	90	120	
T_1	0.14	0.12	0.14	0.17	0.18	0.18	6.02
T_2	0.15	0.13	0.14	0.18	0.18	0.19	10.29
T_3	0.16	0.14	0.15	0.19	0.19	0.20	14.19
T_4	0.17	0.15	0.16	0.20	0.22	0.21	17.74

6. Effect of pretreatment on the Bacterial population (10^6) during Coir pith waste composting

The data pertaining the bacterial population of coir pith waste compost was presented in Table - 6. The maximum number of colonies was observed in the treatment T_4 (Coir pith waste + Cow dung + *Pleurotus sajor-caju* + Earthworm) and recorded the value of 37.33 it was followed by the treatment T_3 and T_2. The lowest number of colonies was observed in the treatment T_3 and T_2. The number of colonies was observed in the treatment T_1 and obtained the value of 21.33. The treatment T_4 the maximum colony was observed on 90 days of incubation rather than 120 days of incubation due to the maturity of compost, there are no carbonic compounds to be break down and used for inoculated metabolism. But in other treatments, T_1, T_2 and T_3 there was increasing trend was observed showing that the process was not yet finally matured.

Table 6: Effect of pretreatment on the Bacterial population (10^6) during Coir pith waste composting

Treatments	Sampling time in days					
	0	15	30	60	90	120
T_1	11.66	15.00	16.33	17.66	19.33	21.33
T_2	11.33	19.33	27.00	32.66	34.33	34.00
T_3	12.00	21.66	31.66	35.66	36.33	35.00
T_4	12.33	22.66	35.33	39.66	42.33	37.33

Karuna Shrestha *et al*. (2011) [4] investigated the physico-chemical and microbiological investigations on rumen content material composted for nine months, fresh vermicasts (obtained after passing the same compost through the guts of a mixture of three species of earthworms: *Eisenia fetida*, *Lumbricus rubellus* and *Perionyx excavates*) and microbially enhanced extracts derived from rumen compost, vermicast and vermicast leachate incubated for up to 48 hrs. Compared to composted rumen contents, vermicast was only improved in terms of microbial biomass C, while vermicast leached extract was significantly higher in NH_4 -N; PO_4 -P, humic acid, bacterial counts and total microbial activity compared to rumen compost extract.

Application of vermicomposting in combination with NPK fertilizers resulted in higher content of total nitrogen compared to FYM in combination with NPK fertilizers or control. It also resulted in higher content of phosphorus significantly (Kale *et al.*, 1992) [3]. The casting by earthworms was seen to improve, the soil organic matter and nutrient status, by recycling available nutrients especially N, P, K, Ca and Mg. Application of coir dust coir pith into soil contributes 20.7 kg N, 10.5 kg, P_2O_5 and 30.8 kg K_2O ha annually. Coir pith being a rich potash source also helps to retain moisture in the soil for a long time. Yasir *et al*. (2009) [7] showed that changes in bacterial community play a major role during vermicomposting. In addition to bacteria, fungi especially cellulolytic fungi also play an important role during vermicomposting. Population of cellulolytic fungi was found to be increased during vermicomposting of different organic wastes (Pant *et al*., 2009) [5]. Cellulase produced by these fungi plays a major role in decomposition of cellulolytic materials of organic wastes.

Conclusion

From this present study, we concluded that the coir pith waste is effectively recycled by microorganisms followed by earthworms and plays a major role in the development of growth and yield of agricultural crops. The nutritive value of compost material is high and the composting process effectively converts the waste product into useful by-product.

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