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Effect of coir pith compost on growth and yield attributes of onion and cassava

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Abstract
The aim of this study was to examine the effect of organic fertilizer like coir pith compost's effectiveness on production of onions and cassava while at the same time, enhancing the nutrient efficiency, soil fertility and microbes. Field experiment was conducted to study the effect of coir pith compost for the maximization of growth and yield of Onion (*Allium cepa* L.) and Cassava (*Manihot esculenta* L.). For onion, data was recorded on growth parameters such as plant height, number of leaves per plant both at 45 and 90 days after planting. Observation was also made on days to bulb initiation, days to maturity, bulb weight, bulb diameter, total and marketable yields, bulb nitrogen content and soil available nitrogen. For cassava, number of branches per plant, plant height, leaf area index and stem diameter were determined at 8 and 12 WAP. Lodging percentage and tuber yield was also determined. Among the different compost mixtures, the treatment T_6 (75% NPK + Compost Mixture – 2) was found to be the best compost mixture and used for the field application studies on onion and cassava. T_6 (75% NPK + Compost Mixture – 2)showed the highest growth & yield attributes and other qualitative parameters.

Keywords: coir pith compost, growth, yield attributes, onion, cassava.

Introduction

Coir pith is a lignocellulose waste material which consists of Lignin20-50%, Cellulose 40-50% and Hemicellulose 15-35% and protein 2.04% [12]. It decomposes very slowly in soil, because of its pentosan/lignin ratio is 1:0.30; the minimum level required for moderately fast decomposition in the soil is 1:0.50 [3].

Coir pith is very poor in nitrogen content and has higher C: N ratio mounting to 112:1 which is undesirable for any organic waste for application as organic manure in agricultural farms because it causes deleterious effect to the crops. Hence, coir pith has to be composted before application.

If the coir pith is not removed from the site of production, rainwater may percolate through it leaching out polyphenols contaminating both surface and ground waters, this leads to consequent increase of biological oxygen demand (BOD) and chemical oxygen demand (COD), anaerobic condition sets in. In addition to this, hydrogen sulphide, methane and carbon dioxide are also released into the atmosphere.

Microbial degradation of coir pith is considered to be a safe, effective and environmentally friendly process which may reduce the time for lignin degradation (compost formation).

Pleurotus sajor caju is a fast growing, edible oyster mushroom that has the ability to degrade lignin slowly under favorable conditions and leads to 42% reduction in volume of coir pith. The cellulosic compounds present in the coir waste support the initial growth of this fungus and acts as co-substrate for lignin degradation. *Phanerochaete chrysosporium* is one of the most widely studied white rot basidiomycetes fungus with respect to lignin degrading enzymes such as laccase, lignin peroxidase, manganese peroxidase and Hydrogen peroxidase supplying glucose oxidase for the peroxidase reaction [14].

Vermi composting has been recognized as an eco-friendly technology for converting organic wastes into high value organic manure through the interaction between earthworms and microorganisms which stimulates the production of phytohormones. Vermicomposted product has higher nutrient value and rich source of macro and micro nutrients. The earthworms produce enzymes which destroy the complex bio-molecules in the coir pith and converting them into simpler compounds. These simpler compounds are then utilized by the microorganisms present in the gut of the worms to produce useful compounds such as antibiotics, vitamins, enzymes and plant growth hormones [14].

Onion (Allium cepa L.) is one of the most important vegetable crops grown and used throughout the world with significant beneficial effect on human diet [4]. Onion being among the high nitrogen demanding vegetables, its productivity depends on use of optimum fertilizer rates and if not adequately fertilized, considerable yield losses are apparent.

Cassava (*Manihot* esculenta Crantz), sometimes named tapioca, manioc, or yuca, is a perennial woody shrub with tuberous roots in the family Euphorbiaceae [1]. Cassava is now widely cultivated in tropical and subtropical regions of Asia, Africa, and Latin America as the third most important source of calories in the tropics, after rice and maize [2]. Cassava is generally considered as a source of carbohydrate, riboflavin, thiamin and nicotinic acid, but not protein [16]. Cassava is produced is for human food as a major calorie source, with more than 50% in various processed forms. Apart from food and feed consumption, cassava is extensively used for various industrial applications. For example, using cassava to produce biofuel and ethanol [5]. Starchisthemajorcomponentofcassavarootandcanamountupto 80% of dried weight of the root [8]. It is naturally expected that the quality of many cassava-based products is to a large extent determined by the starch quality.

Materials and Methods

Effect of composted coir pith for the improvement of growth and yield of Onion (*Allium cepa* L.)

Field experiment was conducted to study the effect of coir pith compost for the maximization of growth and yield of Onion (*Allium cepa* L.) The onion seed were sowed at the spacing of 10 cm x 15 cm. Data was recorded on growth parameters such as plant height, number of leaves per plant both at 45 and 90 days after planting. Observation was also made on days to bulb initiation, days to maturity, bulb weight, bulb diameter, total and marketable yields, bulb nitrogen content and soil available nitrogen.

Effect of composted coir pith for the improvement of growth and yield of cassava (*Manihot esculenta* L.)

Field experiment was conducted to study the effect of coir pith compost for the maximization of growth and yield of cassava (*Manihot esculenta* L.). Plot size was 8m X 7m. Cassava was planted1m X 1m a part, giving 10000 plants ha^{-1}. The number of branches per plant was measured at12 WAP, and plant height and stem diameter were determined at 8 and 12 WAP by randomly selecting five plants per plot on each occasion. Leaf area index (LAI) was determined by removing two plants from the outer rows on each plot to record leaf area (LA) using the leaf dry weight method described by Ramanujam and Indira (1978) [10]. Cassava tuber yield was determined by uprooting five plants per plot from the penultimate rows at 20 and 28 WAP and 20 plants from the center rows at 52 WAP.

Statistical analysis

The experimental data were processed statistically by applying the SPSS software, version 11.5[9]. The critical difference was worked out at five per cent probability level for significant results (p=0.05).

Result

Effect of coir pith compost on growth and yield attributes of onion Plant height and number of leaves per plant

At 45 days after transplanting (DAT), only plant height was significantly influenced due to application of 75% NPK + Compost Mixture – 2 (T_6) and followed by treatment T_9 (Table 1). However, at 90 DAT both plant height and number of leaves per plant (Table 2) was significantly influenced due to application of 75% NPK + Compost Mixture – 2 (T_6) and followed by treatment T_9. The minimum value of plant height and number of leaves per plant were recorded in control (T_1).

Table 1: Effect of coir pith compost on plant height of onion

Treatments	Plant height (cm)	
	45 DAT	**90 DAT**
T_1 – Control	27.67	44.17
T_2 – Compost Mixture – 2	34.10	54.69
T_3 – Compost Mixture – 3	30.88	50.43
T_4 - Compost Mixture – 4	29.18	47.95
T_5 - Compost Mixture – 5	32.72	52.79
T_6 – 75% NPK + Compost Mixture – 2	39.63	59.63
T_7 - 75% NPK + Compost Mixture – 3	37.24	58.70
T_8 - 75% NPK + Compost Mixture – 4	36.87	57.65
T_9 - 75% NPK + Compost Mixture – 5	38.26	59.03
T_{10} – 100% NPK	35.12	56.06
SE_D	1.26	1.64
CD (P=0.05)	2.86	3.72

Where compost mixture2 =Coir pith+1.25% mushroom spawn+5% poultry manure;
Compost mixture 3 = Coir pith+1.25% mushroom spawn+5% panchagavya;
Compost mixture 4 = Coir pith+1.25% Phanerochaete chrysosporium+
5% cow dung+5%panchagavya;
Compost mixture 5 = Vermicomposted coir pith+20% cowdung+ 5%panchagavya

Table 2: Effect of coir pith compost on number of leaves per onion plant

Treatments	No. of leaves/plant	
	45 DAT	**90 DAT**
T_1 – Control	3.39	6.13
T_2 – Compost Mixture – 2	4.05	7.85
T_3 – Compost Mixture – 3	3.66	7.05
T_4 - Compost Mixture – 4	3.53	6.88
T_5 - Compost Mixture – 5	3.92	7.50
T_6 – 75% NPK + Compost Mixture – 2	4.87	8.67
T_7 - 75% NPK + Compost Mixture – 3	4.45	8.35
T_8 - 75% NPK + Compost Mixture – 4	4.30	8.22
T_9 - 75% NPK + Compost Mixture – 5	4.60	8.50
T_{10} – 100% NPK	4.12	8.10
SE_D	0.15	0.25
CD (P=0.05)	0.34	0.58

Days to bulb initiation and maturity

Among the enriched coir pith compost treatment, the T_6 treatment (75% NPK + Compost Mixture – 2) followed by treatment T_9 (75% NPK + Compost Mixture – 5) showed quickest days to bulb initiation and bulb maturity and their values were given in the Table 3.

Table 3: Effect of coir pith compost on days to bulb initiation and bulb maturity

Treatments	Days to bulb initiation	Days to Bulb maturity
T_1 – Control	88.00	148
T_2 – Compost Mixture – 2	78.10	133
T_3 – Compost Mixture – 3	83.30	140
T_4 - Compost Mixture – 4	85.60	143
T_5 - Compost Mixture – 5	80.38	135
T_6 – 75% NPK + Compost Mixture – 2	70.33	120
T_7 - 75% NPK + Compost Mixture – 3	72.80	125
T_8 - 75% NPK + Compost Mixture – 4	74.69	127
T_9 - 75% NPK + Compost Mixture – 5	71.65	122
T_{10} – 100% NPK	75.55	128
SE_D	1.92	2.95
CD (P=0.05)	4.36	6.68

Bulb diameter and 10 bulb weight

An overall increase of 11.2% and 8.5% higher horizontal and vertical bulb diameter respectively over the control treatment (T_1) were obtained due to inoculation of 75% NPK + Compost Mixture – 2 (T_6) and it was closely followed by the treatment (T_9) 75% NPK + Compost Mixture – 5. Similar trend was observed for weight of 10 bulbs. Application of75% NPK + Compost Mixture – 2 (T_6) resulted in 15 and 12.5% increased weight of bulbs over the control (T_1). The values of bulb diameter and bulb weight were given in the respective Table 4 and Table 5.

Table 4: Effect of coir pith compost on bulb diameter

Treatments	Bulb Diameter (cm)	
	Vertical	Horizontal
T_1 – Control	3.73	4.37
T_2 – Compost Mixture – 2	5.05	4.60
T_3 – Compost Mixture – 3	4.25	4.52
T_4 - Compost Mixture – 4	4.02	4.45
T_5 - Compost Mixture – 5	4.78	4.57
T_6 – 75% NPK + Compost Mixture – 2	7.10	5.12
T_7 - 75% NPK + Compost Mixture – 3	6.92	4.88
T_8 - 75% NPK + Compost Mixture – 4	6.10	4.80
T_9 - 75% NPK + Compost Mixture – 5	7.05	5.02
T_{10} – 100% NPK	5.88	4.72
SE_D	0.40	0.07
CD (P=0.05)	0.92	0.17

Table 5: Effect of coir pith compost on 10 bulb weight

Treatments	10 Bulb weight(g)	
	Fresh	Dry
T_1 – Control	560	49.07
T_2 – Compost Mixture – 2	712	74.36
T_3 – Compost Mixture – 3	620	61.16
T_4 - Compost Mixture – 4	597	50.26
T_5 - Compost Mixture – 5	685	70.12
T_6 – 75% NPK + Compost Mixture – 2	920	97.40
T_7 - 75% NPK + Compost Mixture – 3	810	90.20
T_8 - 75% NPK + Compost Mixture – 4	770	85.12
T_9 - 75% NPK + Compost Mixture – 5	860	93.65
T_{10} – 100% NPK	780	80.10
SE_D	37.19	5.48
CD (P=0.05)	84.14	12.41

Onion yield

Among the enriched coir pith compost treatment, the T_6 treatment (75% NPK + Compost Mixture – 2) followed by treatment T_9 (75% NPK + Compost Mixture – 5) showed maximum onion yield over the control and their values given in the Table 6.

Table 6: Effect of coir pith compost on onion yield

Treatments	Yield (q/ha)
T_1 – Control	200
T_2 – Compost Mixture – 2	310
T_3 – Compost Mixture – 3	250
T_4 - Compost Mixture – 4	230
T_5 - Compost Mixture – 5	280
T_6 – 75% NPK + Compost Mixture – 2	430
T_7 - 75% NPK + Compost Mixture – 3	388
T_8 - 75% NPK + Compost Mixture – 4	350
T_9 - 75% NPK + Compost Mixture – 5	412
T_{10} – 100% NPK	325
SE_D	24.75
CD (P=0.05)	55.99

Soil available and bulb nitrogen content

A remarkable increase in soil available nitrogen after crop harvest was observed due to application of 75% NPK + Compost Mixture – 2 (T_6) and it was followed by 75% NPK + Compost Mixture – 5 (T_9) over the control. Similarly the bulb nitrogen content was maximum in T_6 treatment over the control. The values were given in the Table 7.

Table 7: Effect of coir pith compost on available nitrogen in soil and nitrogen content in bulb

Treatments	Available nitrogen in soil(Kg ha^{-1})	Nitrogen content (%) in bulbs
T_1 – Control	191.0	2.40
T_2 – Compost Mixture – 2	254.5	3.16
T_3 – Compost Mixture – 3	241.2	2.79
T_4 - Compost Mixture – 4	231.4	2.67
T_5 - Compost Mixture – 5	245.3	2.89
T_6 – 75% NPK + Compost Mixture – 2	295.5	3.57
T_7 - 75% NPK + Compost Mixture – 3	271.9	3.33
T_8 - 75% NPK + Compost Mixture – 4	269.7	3.22
T_9 - 75% NPK + Compost Mixture – 5	290.6	3.49
T_{10} – 100% NPK	267.6	3.21
SE_D	9.71	0.11
CD (P=0.05)	21.98	0.26

Effect of coir pith compost on nutrient uptake, growth and yield attributes of Cassava Nutrient uptake

Among the enriched coir pith compost treatment, the maximum nutrient uptake by plants was recorded after 28 WAP (week after planting) in the T_6 treatment (75% NPK + Compost Mixture – 2) followed by treatment T_9 (75% NPK + Compost Mixture – 5) over the control and their values were given in the Table 8.

Table 8: Effect of coir pith compost on nutrient uptake by soil

Treatments	Nutrient uptake (Kg ha^{-1}) 28 WAP		
	N	P	K
T_1 – Control	169	7.3	61
T_2 – Compost Mixture – 2	231	15.3	105
T_3 – Compost Mixture – 3	225	14.7	98
T_4 - Compost Mixture – 4	220	14.1	93
T_5 - Compost Mixture – 5	229	15.1	102
T_6 – 75% NPK + Compost Mixture –2	260	18.5	135
T_7 - 75% NPK + Compost Mixture – 3	251	17.6	129
T_8 - 75% NPK + Compost Mixture – 4	250	17.1	125
T_9 - 75% NPK + Compost Mixture – 5	255	17.9	132
T_{10} – 100% NPK	244	16.7	120
SE_D	8.36	1.01	7.24
CD (P=0.05)	18.91	2.30	16.37

WAP – Weeks after Planting

Plant height

Among the enriched coir pith compost treatment, the maximum plant height was recorded after 8 and 12 WAP (week after planting) in the T_6 treatment (75% NPK + Compost Mixture – 2) followed by treatment T_9 (75% NPK + Compost Mixture – 5) over the control and theirwere values given in the Table 9.

Table 9: Effect of coir pith compost on Cassava plant height

Treatments	Plant height (cm)	
	8WAP	12 WAP
T_1 – Control	68	98
T_2 – Compost Mixture – 2	80	127
T_3 – Compost Mixture – 3	73	115
T_4 - Compost Mixture – 4	72	110
T_5 - Compost Mixture – 5	75	120
T_6 – 75% NPK + Compost Mixture – 2	110	153
T_7 - 75% NPK + Compost Mixture – 3	96	145
T_8 - 75% NPK + Compost Mixture – 4	90	140
T_9 - 75% NPK + Compost Mixture – 5	102	150
T_{10} – 100% NPK	83	132
SE_D	4.46	5.77
CD (P=0.05)	10.09	13.07

WAP – Weeks after Planting

Leaf area index

Among the enriched coir pith compost treatment, the maximum leaf area index was recorded after 8 and 12 WAP in the T_6 treatment (75% NPK + Compost Mixture – 2) followed by treatment T_9 (75% NPK + Compost Mixture – 5) over the control and their values were given in the Table 10.

Table 10: Effect of coir pith compost on leaf area index

Treatments	Leaf Area Index	
	8WAP	12 WAP
T_1 – Control	0.35	0.60
T_2 – Compost Mixture – 2	0.46	1.18
T_3 – Compost Mixture – 3	0.40	0.95
T_4 - Compost Mixture – 4	0.39	0.88
T_5 - Compost Mixture – 5	0.43	1.10
T_6 – 75 % NPK + Compost Mixture – 2	0.57	1.49
T_7 - 75 % NPK + Compost Mixture – 3	0.52	1.40
T_8 - 75 % NPK + Compost Mixture – 4	0.50	1.37
T_9 - 75 % NPK + Compost Mixture – 5	0.55	1.42
T_{10} – 100 % NPK	0.48	1.26
SE_D	0.02	0.08
CD (P=0.05)	0.05	0.20

WAP – Weeks after Planting

Stem diameter

Among the enriched coir pith compost treatment, the maximum stem diameter was recorded after 8 and 12 WAP in the T_6 treatment (75% NPK + Compost Mixture – 2) followed by treatment T_9 (75% NPK + Compost Mixture – 5) over the control and their values given in the Table 11.

Table 11: Effect of coir pith compost on stem diameter

Treatments	Stem Diameter (cm)	
	8WAP	12 WAP
T_1 – Control	0.5	1.5
T_2 – Compost Mixture – 2	0.9	2.0
T_3 – Compost Mixture – 3	0.6	1.6
T_4 - Compost Mixture – 4	0.7	1.4
T_5 - Compost Mixture – 5	0.8	1.8
T_6 – 75% NPK + Compost Mixture – 2	1.9	3.0
T_7 - 75% NPK + Compost Mixture – 3	1.5	2.6
T_8 - 75% NPK + Compost Mixture – 4	1.2	2.4
T_9 - 75% NPK + Compost Mixture – 5	1.7	2.8
T_{10} – 100% NPK	1.0	2.2
SE_D	0.15	0.20
CD (P=0.05)	0.34	0.45

Branches per plant

Among the enriched coir pith compost treatment, the maximum branches per plant was recorded after 12 WAP in the T_6 treatment (75% NPK + Compost Mixture – 2) followed by treatment T_9 (75% NPK + Compost Mixture – 5) over the control and their values were given in the Table 12.

Table 12: Effect of coir pith compost on branches per plant

Treatments	Branches perplant (12 WAP)
T_1 – Control	1.5
T_2 – Compost Mixture – 2	2.3
T_3 – Compost Mixture – 3	2.0
T_4 - Compost Mixture – 4	1.9
T_5 - Compost Mixture – 5	2.2
T_6 – 75% NPK + Compost Mixture – 2	3.3
T_7 - 75% NPK + Compost Mixture – 3	2.7
T_8 - 75% NPK + Compost Mixture – 4	2.6
T_9 - 75% NPK + Compost Mixture – 5	3.0
T_{10} – 100% NPK	2.5
SE_D	0.16
CD (P=0.05)	0.38

Lodging percentage

Among the enriched coir pith compost treatment, the maximum lodging percentage was recorded after 16 WAP in the T_6 treatment (75% NPK + Compost Mixture – 2) followed by treatment T_9 (75% NPK + Compost Mixture – 5) over the control and their values were given in the Table 13.

Table 13: Effect of coir pith compost on lodging percentage

Reatments	Lodging percentage (16 WAP)
T_1 – Control	8.3
T_2 – Compost Mixture – 2	12.0
T_3 – Compost Mixture – 3	10.56
T_4 - Compost Mixture – 4	9.25
T_5 - Compost Mixture – 5	11.5
T_6 – 75% NPK + Compost Mixture – 2	20.5
T_7 - 75% NPK + Compost Mixture – 3	16.5
T_8 - 75% NPK + Compost Mixture – 4	14.5
T_9 - 75% NPK + Compost Mixture – 5	18.2
T_{10} – 100% NPK	12.3
SE_D	1.25
CD (P=0.05)	2.84

Tuber yield

Among the enriched coir pith compost treatment, the maximum tuber yield was recorded after 52 WAP in the T_6 treatment (75% NPK + Compost Mixture – 2) followed by treatment T_9 (75% NPK + Compost Mixture – 5) over the control and their values given in the Table 14.

Table 14: Effect of coir pith compost on tuber yield

Treatments	Tuber yield (t ha^{-1})
T_1 – Control	14.5
T_2 – Compost Mixture – 2	18.6
T_3 – Compost Mixture – 3	16.8
T_4 - Compost Mixture – 4	15.0
T_5 - Compost Mixture – 5	17.5
T_6 – 75% NPK + Compost Mixture – 2	23.5
T_7 - 75% NPK + Compost Mixture – 3	21.6
T_8 - 75% NPK + Compost Mixture – 4	20.9
T_9 - 75% NPK + Compost Mixture – 5	22.6
T_{10} – 100% NPK	19.3
SE_D	0.98
CD (P=0.05)	2.22

Discussion

1. Onion cultivation studies

At 45 days after transplanting (DAT), only plant height was significantly influenced due to application of 75% NPK + Compost Mixture – 2 (T_6) and followed by treatment T_9. However, at 90 DAT both plant height and number of leaves per plant was significantly influenced due to application of 75% NPK + Compost Mixture – 2. Similar results have also been reported by [11, 6]. In onion.

The earliness in bulb initiation and maturity may be attributed to the ability of the bacterium to produce growth promoting substances which might have induced bulbing at earlier stage and there by enhanced chance of early crop maturity [11]. Furthermore, inoculation along with high dose of nitrogen could not be as effective as inoculation along with moderate or lower doses in reducing days to maturity due to prolonged vegetative growth period in the former case.

An overall increase of 11.2% and 8.5% higher horizontal and vertical bulb diameter, respectively obtained in the treatment with application 75% NPK along with coir pith compost mixture over the control.

The increase in nitrogen content in bulbs might be due to better root development that was achieved as a result of inoculation with nutrient rich compost mixture along with fertilizer which led to enhanced nutrient uptake. The present result was well supported by findings of Meshram and Shende (1982) [7].

2. Cassava cultivation studies

The nutritional content of cassava stems changed with different levels of soil fertility. These changes affected the quality of stakes (planting material) obtained from these stems, which, in turn, affected yields of subsequent crops. According to the five levels of fertilization used, mother plants had different heights and vigor, and stems produced stakes of different weights. Both the concentration and content of N, P, and K in the stems varied with fertilization treatment, being least with no nutrients applied to the soil.

Sprouting rate was strongly influenced by the N, P, and K contents in the stakes. Sprouting potential was not affected by plantings takes in fertilized or unfertilized soils, however, indicating that nutritional reserves contained in the stakes was more important. Stakes from plots with moderate level of N, P, and K application resulted in plants that had the greatest leaf area, foliage and stems suited as propagation material. Plants produced from these stakes also had the highest total root yield and highest production of commercial roots in both fertilized and unfertilized soils. The increase in yield in the subsequent crop attributed to stake quality was more than the increase due to application coir pith compost.

Starch isolation from the cassava roots on industrial scale has been reviewed previously [13]. Cassava starch innative or modified forms has nutritional benefits such as cholesterol lowering, hypoglycaemic and antidiuretic effects [15].

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