Maturity/Phytotoxicity test of Organic-fertilizer produced from coffee husk and pulp with other organic wastes on maize plant

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Abstract

This research was undertaken to transform coffee processing wastes to Organic-fertilizer using windrow composting. In this study, the compost samples were placed in (6*3) treatments in RCBD in which 6 is the treatment and 3 is the replication for 90 days. coffee pulp + coffee husk (pile 1), coffee pulp + coffee husk + cow dung (pile 2), coffee pulp + coffee husk + khat waste (pile 3), coffee pulp + coffee husk + cow dung + khat waste (pile 4), coffee pulp + cow dung (pile 5) and coffee husk + cow dung (pile 6) were used to prepare compost. The compost maturity tests (germination and plant bioassay) were conducted using maize (BH540).

Key Words: Maturity/Phytotoxicity test, Germination Index, Plant bioassay

Introduction

Immature compost may contain phytotoxins that will often kill seed embryos. Seeds grown in immature compost won't sprout or may die immediately after sprouting. Seed germination and plant growth bioassay are the most common techniques used to evaluate compost phytotoxicity (Kapanen and Itavaara 2001) (quality).

A widely used maturity index is the germination index (GI); it is based on relatively simple to perform seed phytotoxicity tests, which are germination bioassays that quantify seed growth upon the application of compost to the seeds. The GI was first introduced by Zucconi et al.(1981). According to Zucconi et al., (1981), GIs allow to evaluate both low levels of toxicity, that affect root growth, as well as high levels of toxicity, which affect seed germination. Based on that, it would be reasonable to state that GIs lower than 100% indicate a potential phytotoxicity, whilst values greater than 100% indicate a beneficial effect on seed growth, and therefore indicate a mature compost (Dimitrios et al., 2009).

Table1.1 Plant Phytotoxicity tests

	Units Rating		
Test methods	Very mature	Mature	Immature

Seed germination % of control	>90	80-90	<80

Source: California environmental protection Agency (2002) and Brinton (2000)

2. Materials and Methods

2.1 Description of the study Area

The experiment was conducted at Dale district agricultural research center. Dale district is one of the 19 districts in Sidama Zone and covers a total area of 30,212 ha, located at about 320 km south of Addis Ababa along the main highway to Moyale, about 5km to the left after traveling 40km from the region capital Hawassa. The district shares boarder with Wonsho district in the east, Loka-Abaya district in the west, Aleta Wondo and Chuko districts in the south, and Shebedino district in the north. In addition, the district is located in 6^0 44" latitude to the north and 38^0 28'' longitude to the east. The district is subdivided into 36 Kebeles and all those produces coffee (WoFED, 2013).

2.2.1 Phytotoxicity Test/Seed Germination and Growth

Phytotoxicity test of the compost was done using 10 liter plastic pots which are perforated on maize variety (BH540) in field. The pots were set up in the shade under randomized completely block design (RCBD) in the composting site in triplicate. A total of 21 pots were used, 18 for compost samples and 3 for the control. Crop sowing was three seeds per pot to have available spaces for the plant to grow. At the end of 15^{th} day's root length and germination index of maize was checked. Maize plant was selected as a test for germination index due to its availability at the dale district research center during the research period.

The percentage of relative seed germination (RSG), relative root length (RRL), and germination index (GI) was calculated by relating them with number of viable seeds in the sample (nVSS), number of Viable seeds in the control (nVSC), root length in the sample (RLS) and root length in the control (RLC) using the formula (Zucconi et al., 1981):

$$\text{RSG (\%)} = \frac{\text{nVSS}}{\text{nVSC}} * 100 \quad \text{……..1}$$

$$\text{RRL (\%)} = \frac{\text{RLS}}{\text{RLC}} * 100 \quad \text{……..2}$$

$$\text{GI (\%)} = \frac{\%\text{RSG} * \%\text{RRL}}{100} \quad \text{……..3}$$

2.2.2 Data collection for Maize seedling growth parameters

From the maize seedling the following data was recorded:

Shoot length (cm): was measured in centimeter (cm) with the help of ruler from soil surface to the top of plants. Average plant height of all three replications was calculated.

Root length (cm): Each plant roots was dug out, washed with tap water and length of each longest root was recorded in centimeter (cm) from point of emergency to the tip by using ruler and the average was taken.

Whole seedling fresh weight (g): The weights of whole plant seedling were measured by using sensitive balance and the average was taken.

Total dry matter (Total dry biomass) (g): After drying the whole plant parts (shoots plus roots) in oven drier for about 24 hours at 103 ^{o}C, the average weight of dried whole plant parts (shoots plus roots) were measured by using sensitive balance and averages were taken.

Leaf number: The newly growing leaves were counted and the average was taken.

Leaf area: The leaf area was determined according to the formula of Mokhtarpour, et al,. (2010).While calculating the leaf area the maximum leaf width was taken from the selected stem.

Leaf area of maize: LA = L × W × constant(0.75)

2.3 Statistical Analysis

Statistical analysis of maturity/phytotoxicity test of the bio-fertilizer produced from different treatments were analyzed by using excel software.

3. Results and Discussions

Plant height

Response of bio-fertilizer on plant height after 15 days of plantation is shown in Figure 3.1. Data clearly indicated that application of compost significantly affected the plant height. Minimum plant height (29 cm) 15 days after plantation was observed in control. All treatments containing compost caused an increase in plant height ranging from 31 to 49 cm 15 days after plantation. The maximum plant height (49 cm) 15 days after plantation was observed on (T4) and the increase was significantly more than that of control. Comparative analysis of compost indicates that effect of compost amended with organic matter showed better results on plant height than control and even than compost produced from coffee residue only.

Root length

Effect of compost on root length is graphically shown in Figure 3.1. The data clearly depicted that application of compost significantly affected the root length. Minimum root length (8 cm) was observed in control and T1. All other treatments containing coffee residue and other organic amendments caused an increase in root length ranging from 10-12 cm. The maximum root length (12 cm) was observed in T4 where coffee residue was amended with both cow dung and khat waste which is significantly more than that of the control and T1. This was followed by T2 (10 cm) where compost was made from coffee residue with cow dung.

Table 3.1: Comparative studies on plant bioassay (plant height)

T	RL (cm)	SL (cm)	TL (cm)	No. of leaves	T	RL(cm)	SL(cm)	TL(cm)	No.of Leaves
Control	8	21	29	3	T4	12	37	49	3
T1	8	23	31	3	T5	9	26	35	3
T2	10	30	41	3	T6	9.5	27	36.5	3
T3	9.7	29	38.7	3					

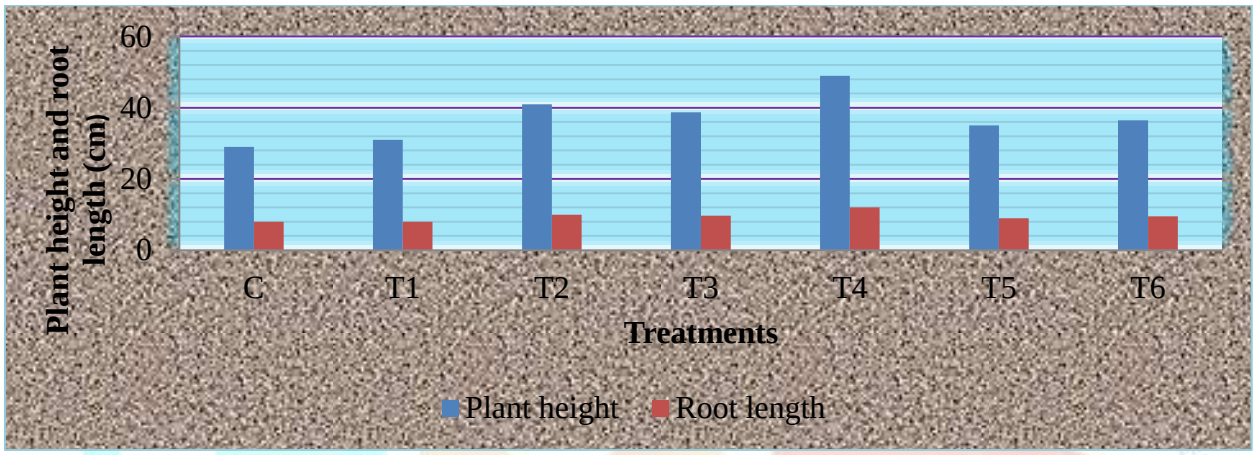

Fig 3.1 Effect of compost on plant height and root length

Seed germination

Full germination of all planted maize was observed at the seventh day. The germination was 100% in all test samples and control. Table 3.2 shows that the compost is matured; no more decomposition is going on that release toxic substances that would have the potential to inhibit seed germination and intact root elongation. As indicated in the table below, relative root length is greater than 100 % and above, which indicated that the relative root length of the studied compost samples was much greater than that of the control.

Table 3.2 Comparative studies on plant bioassay (seed germination) and relative root length using each treatment

Treatments	Seed germination (%)	Relative root length (%)	Treatments	Seed Germination (%)	Relative Root Length (%)
T1	100	100	T4	100	150
T2	100	125	T5	100	112.5
T3	100	121	T6	100	118.75

Phytotoxicity test/ Germination index

The entire studied sample produces full germination of the seed that were planted on to the pot. There were no differences between treatments for relative seed germination. The germination index values recorded were more in T4 compared to other compost samples. The data in table 3.3 depicts germination index is greater than 100% for all treatments; due to the availability of plant nutrients in the compost root length is much greater in compost sample than the control. Application of compost will enhance the nutrient status of the soil (Gutser et al,.2005).

Table 3.3: Plant phytotoxicity test/Germination index using each treatment

Treatments	Plant	RSG (%)	RRL (%)	Phytotoxicity test (%)
T1	maize	100	100	100
T2		100	125	125
T3		100	121	121
T4		100	150	150
T5		100	112.5	112.5
T6		100	118.75	118.75

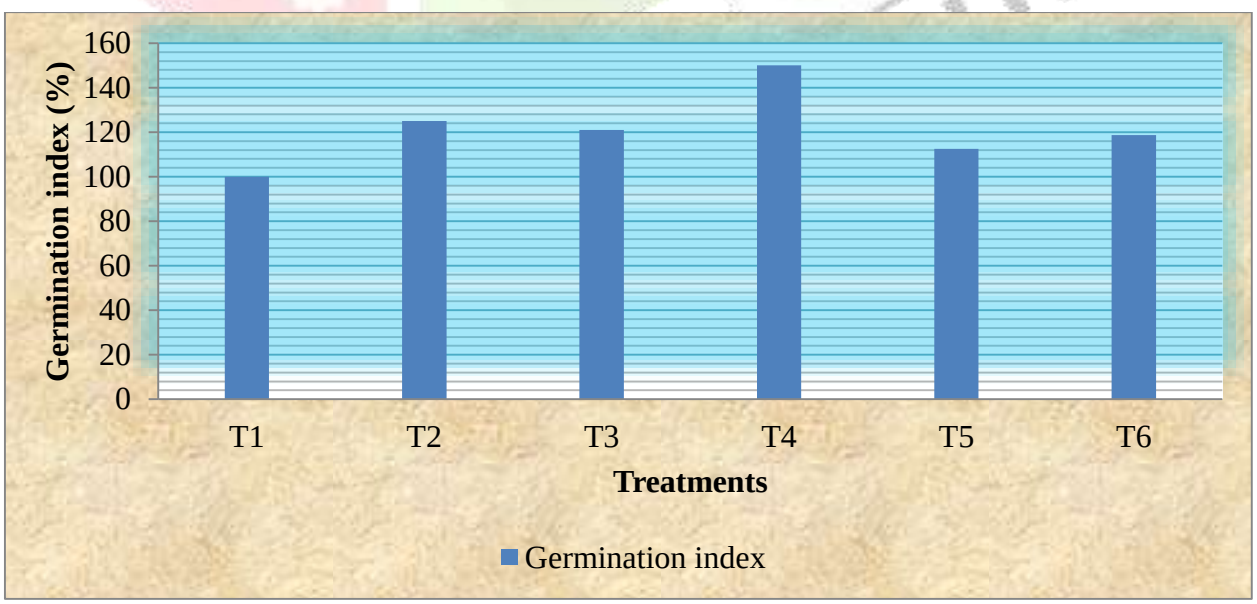

Fig 3.2 Effect of compost on plant germination

Leaf Area

As the data depicted below T4 has the largest leaf area than the other treatments, which is significantly different from that of the control, when this happen the plant leaf is more exposed to sunlight which enables it to synthesize more protein through chlorophyll. The effect of compost application on leaf area is indicated here under fig 3.3.

Table 3.4 Comparative studies on plant bioassay (leaf area) using each treatment and control

Treatments	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)
Control	12	2	18
T1	15	2.3	25.87
T2	20.5	3.3	50.7
T3	19.7	2.5	36.9
T4	26	3	58.5
T5	17	2.5	31.87
T6	18	2.7	36.45

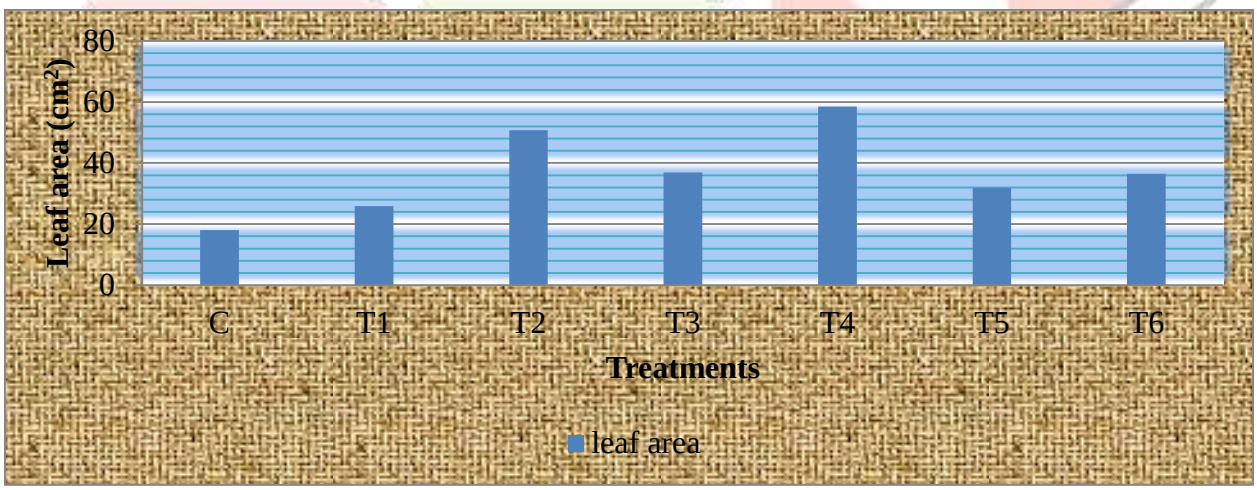

Fig 3.3 Effect of compost on leaf area of a plant

Plant fresh weight

Effect of compost on plant fresh weight is graphically shown in Figure 3.4. The data clearly depicted that the application of compost affected the plant fresh weight. Minimum plant fresh weight (6 g) was observed in control. All treatments containing compost caused an increase in plant fresh weight ranging from 7-12 gm. The maximum root fresh weight (12 g) was achieved at T4 which is significantly different from that of the control, which is produced from the application of coffee residue with that of cow dung and khat waste.

Plant dry weight

Effect of compost on plant dry weight graphically is shown by Figure 3.4. The data clearly depicted that application of compost affected the plant dry weight. Minimum plant dry weight 0.9 g was observed in control. All treatments containing compost caused an increase in plant dry weight ranging from 1.23-2.32 gm. Maximum plant dry weight (2.32 g) was observed in T4. The same is true for plant dry mass as that of plant fresh mass. It is due to the readily available nutrients for the plant that increases plant biomass in the compost than the control.

Table 3.5 Comparative studies on plant bioassay (plant fresh and dry weight) using compost

Treatments	Total weight (g)	
	FW(g)	DW(g)
Control	6	0.9
T1	7	1.23
T2	10	1.87
T3	10	1.83
T4	12	2.32
T5	8	1.41
T6	9	1.49

FW: fresh weight in (g), DW: Dry weight in (g)

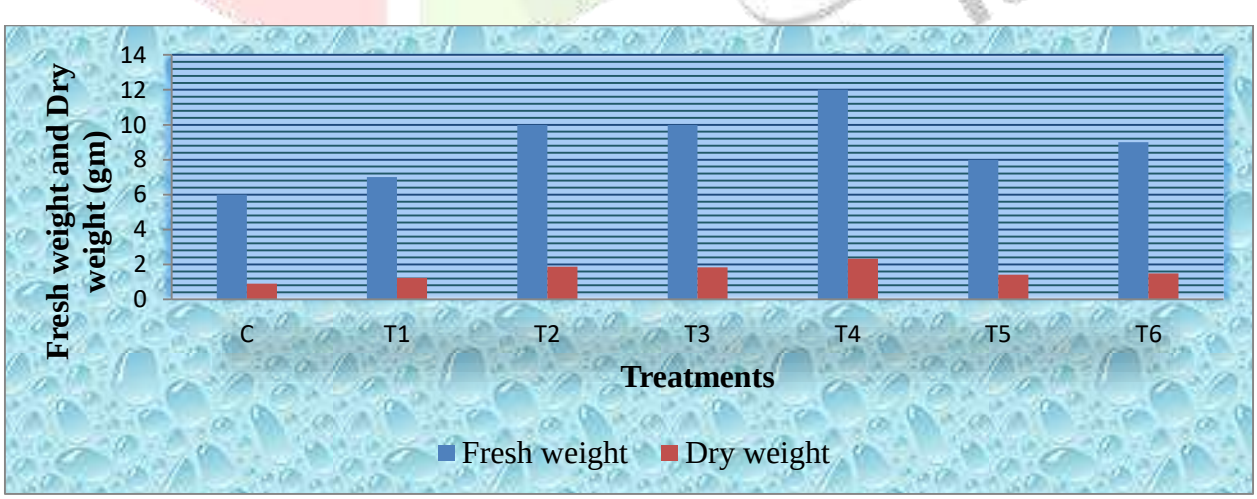

Fig 3.4 Effect of compost on plant fresh and dry weight

Conclusions

On looking at the parameters assessed for maturity determination, all compost samples were found to be fully mature. Results reveals that all compost samples have the germination index over 100% which mean that all composts are mature, don't have any potential of phytotoxicity. Despite the fact that, the germination index values recorded were more in T4 compared to other treatments. The values of the germination index for compost sample, 100%, 125%, 121%, 150%, 112.5% and 118.5 for T1, T2, T3, T4, T5 and T6 respectively. Results obtained showed differences between control where the GI was lower and the compost where the GI was highest.

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