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EFFECT OF SPENT MUSHROOM (*Pleurotus pulmonarius*) COMPOST ON THE GROWTH AND YIELD OF TOMATO (*Lycopersicon esculentum*) AND COWPEA (*Vigna unguiculata*)

[*1]Ugioro, O., [2]Kadiri, M., [3]Ogidi, E.G.O., [1]Nduka, B.A. and [1]Idrisu, M.

[1]Cocoa Research Institute of Nigeria, (CRIN), Ibadan, Nigeria.
[2]Department of Biological Sciences, University of Agriculture, Abeokuta, Nigeria.
[3]Rubber Research Institute of Nigeria, Benin City, Nigeria.

**Corresponding author:* ugioro2002@yahoo.com

ABSTRACTS

The effect of spent mushroom substrate of Pleurotus pulmonarius on the growth and yield of Lycopersicon esculentum (tomato) and Vigna unguiculata (cowpea) was studied. The composted and composted mushroom substrates were applied to the soil at ratio 1:9. The Unautoclaved oven dried composted spent mushroom substrate *(UOCSS)* and loamy soil *was found to increase plant growth parameters such as plant height, stem girth, number of leaves, leaf area (65.38, 3.20, 244.4, and 515.6cm respectively) and was significantly increased over the control without spent mushroom substrate (39.5, 1.98, 96.0, 314.68cm) for L. esculentum. Similar result was obtained for V. unguiculata (68.84, 2.56, 36.00 and 1506.8) over the control (53.14, 2.24, 33.80 and 1058.00cm). Result obtained on yield showed that unautoclaved (spent) oven dried composted substrate and loamy soil (1:9) had the highest mean weight (g) of fruits, pods, seeds (77.88, 17.30 and 16.26g) over the control (46.10, 8.32 and 7.60g) for both L. esculentum and V. unguiculata and was significant at 5% probability level.*

Incorporation of spent mushroom substrate of Pleurotus pulmonarius into loamy soil increased the plant height, number of leaves per plant, total leaf area, enlarged the stem girth, and enhanced the fruit yield of tomato and grain yield of cowpea and consequently increased the dry weight of shoot, roots and the whole plant. This substrate will not only serve as a soil amendment to produce higher yield but will also improve the soil properties unlike the synthetic fertilizer amendment.

Keywords: *Pleurotus pulmonarius,* Compost/spent mushroom substrate, Tomato, Cowpea, Plant yield

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INTRODUCTION

Spent mushroom substrate (SMS) is a byproduct of the mushroom industry. In New Zealand, approximately 60,000tonnes are produced each year and applied to the land. The initial materials are chicken litter, cereal straw and gypsum at approximate ratio 13: 17:1, respectively (by weight) after composting and peak heating to drive off ammonia. The compost is then packed into beds 210mm deep and covered with 40mm of a casing layer a mixture of Peak and Chalk (at a ratio of 3:1). The Spent Mushroom

Substrate therefore consists of (by volume) compost (about 84%) relatively undecomposted peat (12%), and granular chalk (4%). As SMS contains a considerable amount of nutrients and is generally not phytotoxic, it has been used in soil amendment (Maynard, 1994., Kaddous and Morgans 1986; Wang et al. 1984). Increased in soil concentration of total Nitrogen (N), Phosphorus (p) and Potassium (K), and cation exchange capacity, have been reported following SMS application (Kaddous and Morgans, 1996; Maynard 1994). The rate of N-mineralization from SMS is often slow (because the organic N in SMS is recalcitrant) and N immobilization may occur readily releasing sulphur, potassium, calcium and magnesium from SMS.

According to Chiu *et al*. (2000), spent mushroom substrate is the solid residues after harvest of the aerial crop in mushroom industry and is generated at a ratio of 2 - 5 to 1 of the edible cop. Over 3.3 million tons of edible mushrooms were produced in 2005 and over 34 % were grown in Europe (http:www.fao.org) with the readily available nutrients released from substrate degradation and high organic matter content. It is employed in soil amendment. (Lau *et al*., 2003; Law *et al*., 2003). The importance of mushrooms in bioremediation and biodegradation has been reported by several authors (Adenipekun and Fasidi, 2005; Estevez *et al*., 2005). Adesina *et al*., (2011) reported that mushrooms grow on different substrates. In this study, oyster mushroom of the genus *Pleurotus* was used as it grows worldwide on a variety of substrates including coffee pulp, sawdust, straw (Chiu *et al*., 2000; Chang and Miles, 2004).

Consequently, the present study was aimed at determining the effects of spent mushroom substrate application on soil properties and plant growth traits of tomato (*Lycopersicon esculentum*) and cowpea (*Vigna unguiculata*).

MATERIALS AND METHODS

Preparation of *Pleurotus pulmonarius* and Spent Mushroom Substrate *(*SMS): Sawdust, rice bran and cassava peel were mechanically mixed in a ratio 86:10:4 (w/w/w) and piled up for one week fermentation with turning at interval to avoid overheating. It was then packed, autoclaved at 121^{o}C for 30mins and inoculated with *Pleurotus pulmonarius* under sterile condition. The culture was incubated at 27 ±2^{o}C and relative humidity of 60-70% until the mycelium fully colonized the substrate. This took six weeks; the substrate was transferred to fruiting chamber at 28 ±2^{o}C and relative humidity of 80 ± 5%. The solid residue after mushroom harvest, called spent substrate was collected for later use. The same preparation was made for the uncomposted (control) substrate.

Utilization of spent compost as soil manure: The spent mushroom compost and the uncomposted control as prepared above were thereafter covered with plastic nylon and allowed for further composting (fermentation) for 5 weeks. Field trial was established in August 2007 at the University of Agriculture, Abeokuta in a randomized complete block design with 3 replicates. Part of the land was used as treatment plot by having dried spent compost incorporated into it at the ratio of 1:9 (spent compost to soil). The control plots were planted separately with seedlings of tomato and seeds of cowpea. Six treatments were allowed, these are:

- Treatment 1 (T1) = Unautoclaved oven dried composted spent substrate and loamy soil (UOCSS + loamy soil; 1:9).

●Treatment 2 (T2) = Unautoclaved oven dried uncomposted spent substrate and loamy soil (UOUSS + loamy soil; 1:9).
●Treatment 3 (T3) = Autoclaved oven dried composted spent substrate and loamy soil (AOCSS + loamy soil; 1:9).
●Treatment 4 (T4) = Autoclaved oven dried uncomposted spent substrate and loamy soil (AOUSS + loamy soil; 1:9).
●Treatment 5 (T5) = Unautoclaved oven dried loamy soil (UO loamy soil) or control.
●Treatment 6 (T6) = Autoclaved oven dried loamy soil (AO loamy soil) or the control.

Sampling of tomato and cowpea plants commenced at 9 weeks after sowing (WAS). Data were collected on plant height (cm), number of leaves per plant, stem girth (cm), total leaf area (cm^2), fruit yield of tomato and grain yield of cowpea, dry weight of shoot per plant, roots per plant and whole plant (g).

Statistical Analysis: All the data from this investigation were analyzed using Analysis of Variance (ANOVA) of SAS (1999) which was carried out to compare the different treatment means while LSD at 5% probability was used to detect significant differences between the treatment means.

RESULTS AND DISCUSSION

The plant height (cm) and stem girth (cm) of *L. esculentum* and *V.unguiculata* as affected by differently treated spent mushroom substrates and loamy soil at 9 weeks after sowing is as shown in table 1. At 9 WAS, *L. esculentum grown on* loamy soil incorporated with UOCSS (T1) had the highest plant height ($65.38cm^2$) while least plant height ($3.20cm^2$) was obtained for those grown on soil incorporated with AOCSS (T3). Also, *V. unguiculata* grown on loamy soil incorporated with UOCSS (T1) gave the highest plant height ($68.84cm^2$) compared to the control that gave the least height ($53.14cm^2$) value. However, no significant ($p > 0.05$) difference was observed between the treatments and the control. The stem girths were significantly ($p < 0.05$) different. *L. esculentum* grown on loamy soil incorporated with UOCSS (T1) gave the largest stem girth (3.2cm) while tomatoes grown on autoclaved and oven dried loamy soil (control or T6) had the least value (1.98cm) for stem girth. Similar result was obtained for *V. unguiculata* that were grown on UOCSS and loamy soil which had the largest stem girth (2.56cm) while those on control treatment had the least (2.24cm) stem girth.

The number of leaves and total Leaf area (mm) of *L. esculentum* and *V.unguiculata* as affected by differently treated spent mushroom substrates and loamy soil at 9 weeks after sowing was shown in table 2 below. Results obtained for *L. esuclentum grown on* unautoclaved oven dried loamy soil (T5 or control) revealed that significantly ($p < 0.05$) highest number of leaves per plant (264.8) and total leaf area ($578.8cm^2$) were produced. Results obtained for *V. unguiculata (cowpea) raised on UOUSS and loamy soil* mixture (1:9) showed the highest number of leaves per plant (36.00) and the largest total leaf area ($1506.8cm^2$). Similar observation was made by Eitizinger *et al*. (2002) in their study with wheat where they observed that application of spent mushroom substrate (SMS) increased growth parameters

. The weight (g) of fruits of L. *esculentum* and pods and seeds of *V. unguiculata* as affected by differently treated spent mushroom substrates and loamy soil at 9 weeks after sowing is as shown in table 3. *L. esculentum raised on*

UOCSS and loamy soil mixture gave significantly highest fruit yield (77.88g) compared to those grown on Unautoclaved oven dried loamy soil mixture (T5 or control) which had the least (46.16g) value. Significantly highest pod weight (17.30g) and seed weight (16.26g) of *V. unguiculata* were obtained when grown on UOCSS and loamy soil mixture (T1) compared to those raised on unautoclaved oven dried loamy soil (control or T6) which had the least pod weight (8.32g) and seed weight (7.60g). These findings were similar to the results of Stewart (1995) with potato crop where he reported that spent mushroom substrate (SMS) application to soil increased potato yield. Harris (1992) also reported that manure application to a potato crop improved the moisture holding capacity of the soil and increased the plant nutrients uptake. The amount of water retained in the soil was increased following the application of SMS in the trail (Stewart, 1995).

Table1: Plant height (cm) and stem girth (cm) of *L.esculentum and V.unguiculata* as affected by differently treated spent mushroom substrates and loamy soil at 9 weeks after sowing

		Lycopersicon	***Esculentum***	***Vigna***	***Unguiculata***
	Treatment Type	**Plant height**	**Stem girth**	**Plant height**	**Stem girth**
1	UOCSS+ loamy soil (1:9)	65.38[a]	3.20[a]	68.84[a]	2.56[a]
2	UOUSS + loamy soil(1:9)	58.80[a]	2.60[a]	66.76[a]	2.52[bc]
3	AOCSS + loamy soil(1:9)	36.14[b]	2.10[b]	34.50[d]	2.28[c]
4	AOUSS + loamy soil(1:9)	38.40[b]	1.86[c]	44.64[c]	2.34[ab]
5	UO loamy soil (control)	63.06[a]	2.66[ab]	56.10[b]	2.42[b]
6	AO loamy soil (control)	39.50[b]	1.98[c]	53.14[b]	2.24[c]

[a-d]Mean values within the same column with different superscripts are significantly ($p< 0.05$) different.

The dry weight of the root, shoot and whole L. *esculentum* and *V. unguiculata* plants as affected by differently treated spent mushroom substrates and loamy soil at 9 weeks after sowing is as shown in tables 4 and 5 respectively. The unautoclaved (spent) oven dried composted substrates and loamy soil significantly produced the highest dry weight of root/plant, shoot/plant and whole plant for both *L. esculentum* and *V. unguiculata.*

Table 2: Number of leaves and total Leaf area (mm) of *L. esculentum* and *V.unguiculata* as affected by differently treated spent mushroom substrates and loamy soil at 9 weeks after sowing.

		Lycopersicon	*esculentum*	*Vigna*	*unguiculata*
	Treatment Type	**No of leaves**	**Total leaf area**	**No of leaves**	**Total leaf area**
1	UOCSS+ loamy soil (1:9)	244.40b[c]	515.60[a]	36.00[a]	1506.80[a]
2	UOUSS + loamy soil(1:9)	248.60[ab]	471.40[ab]	41.40[a]	1565.80[a]
3	AOCSS + loamy soil(1:9)	94.80[c]	480.60[ab]	38.80[a]	1105.20[bc]
4	AOUSS + loamy soil(1:9)	98.40b[c]	351.00[b]	33.80[a]	1247.20[b]
5	UO loamy soil (control)	264.80[a]	578.80[a]	33.80[a]	1190.20[c]
6	AO loamy soil (control)	96.00[bc]	314.68[c]	33.80[a]	1058.00c

[a-c]Means values within the same column with different superscripts are significantly different ($p< 0.05$).

Table 3: Weight (g) of fruits of L. *esculentum* and pods and seeds of *V. unguiculata* as affected by differently treated spent mushroom substrates and loamy soil at 9 weeks after sowing

		L. esculentum	*Vigna*	*Unguiculata*
	Treatment Type	**Fruit weight**	**Pod weight**	**Seed weight**
1	UOCSS+ loamy soil (1:9)	77.88[a]	17.30[a]	16.26[a]
2	UOUSS + loamy soil(1:9)	52.60ab	13.90[ab]	12.84[ab]
3	AOCSS + loamy soil(1:9)	25.80b	13.32 [ab]	12.26[ab]
4	AOUSS + loamy soil(1:9)	38.52b	13.60 [ab]	12.82 [ab]
5	UO loamy soil (control)	46.10[ab]	8.32[b]	7.60[a]
6	AO loamy soil (control)	28.24[b]	10.18[b]	9.48 [b]

[a-c]Means values within the same column with different superscripts are significantly different ($p< 0.05$).

Table 4: Dry weight of the root, shoot and whole L. *esculentum* plant as affected by differently treated spent mushroom substrates and loamy soil at 9 weeks after sowing

Treatments	**Treatment Type**	**Root weight (g)**	**Shoot weight(g)**	**Whole plant weight(g)**
1	UOCSS+ loamy soil (1:9)	6.68a	28.18[a]	39.12[a]
2	UOUSS + loamy soil(1:9)	4.20[ab]	16.48[b]	23.76[bc]
3	AOCSS + loamy soil(1:9)	4.90[ab]	21.20[bc]	28.74[ab]
4	AOUSS + loamy soil(1:9)	2.20[ab]	6.46[c]	12.04[bc]
5	UO loamy soil (control)	4.00[ab]	13.20[ab]	19.90[bc]
6	AO loamy soil (control)	2.94[b]	12.44[bc]	19.90[bc]

[a-c]Means values within the same column with different superscripts are significantly different ($p< 0.05$).

Table 5: Dry weight (g) of the root, shoot and whole *V. unguiculata* plant as affected by differently treated spent mushroom substrates and loamy soil at 9 weeks after sowing

Treatments	Treatment Type	Root weight (g)	Shoot weight(g)	Whole plant weight(g)
1	UOCSS+ loamy soil (1:9)	1.84[a]	7.00[a]	12.31 [a]
2	UOUSS + loamy soil(1:9)	1.78[ab]	6.08[ab]	11.88[a]
3	AOCSS + loamy soil(1:9)	1.36[ab]	4.80[bc]	10.04[ab]
4	AOUSS + loamy soil(1:9)	1.54[ab]	3.56[b]	8.46[ab]
5	UO loamy soil (control)	1.06[b]	3.04[b]	7.46[b]
6	AO loamy soil (control)	1.30[ab]	4.08[ab]	8.32[ab]

[a-c]Means values within the same column with different superscripts are significantly different ($p< 0.05$).

CONCLUSIONS

●Incorporation of spent mushroom substrate of *Pleurotus pulmonarius* into loamy soil increased the plant height, number of leaves per plant, total leaf area, enlarged the stem girth, and enhanced the fruit yield of tomato and grain yield of cowpea and consequently increased the dry weight of shoot, roots and the whole plant.

●Production of arable crops like tomato (*L. esculentum*) and cowpea (*V. unguiculata*) can be improved by the utilization of spent mushroom substrate an agricultural waste which may be ideal in this era of organic farming since it is sustainable.

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