Effect of different rates of spent mushroom substrate on the growth and yield of fluted pumpkin (*Telfairia occidentalis* HOOK. F) in South – South, Nigeria

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Abstract: An experiment was conducted during the wet season of 2015 at the Teaching and Research Farm of the Faculty of Agriculture, University of Port Harcourt, to evaluate the effect of different rates of spent mushroom substrates (SMS) of *Pleurotus ostreatus* (an edible fungus) as a bio fertilizer on the growth and yield of *Telfairia occidentalis*. The treatments consisted of four levels of spent mushroom substrate namely: 0 (control), 1,667kg/ha, 3333kg/ha, and 5,000kg/ha which were laid out in a randomized complete block design (RCBD) and replicated three times. Data were collected on emergence count at 10 days after planting (DAP) and on vine length, number of leaves, leaf area and fresh shoot yield at 4, 6,8,10 and12 weeks after planting (WAP). Results of the study indicated that there was no significant difference (P>0.05) on emergence counts among the various rates of spent mushroom substrate (SMS). There were no significance differences among the various rates of SMS on number of leaves throughout the observation periods except at 6 WAP, where5,000kg/ha had the highest number (27) but statistically similar with that of 1,667kg/ha (24.667).The leaf area differed significantly (P<0.05) throughout the observation periods except at 4 WAP; at the maximum period (12 WAP) 5,000kg/ha had the highest leaf area (350.28cm^2) while the control had the lowest (177.59cm^2). Similar trend was also observed on vine length as that of leaf area. At 12 WAP, 5000kg /ha had the longest vine (326.80cm) and highest fresh shoot yield (6000kg/ha) while the control plot had the shortest vine (187.33cm) and lowest fresh shoot yield (3166.7kg/ha). Within the limit of this work it was observed that SMS at 5,000 kg/ha improves *Telfairia occidentalis* performance and is therefore recommended for *Telfairia occidentalis* production in the study area.

[Orluchukwu, J. A., Mac-Aboh, A. R., and Omovbude, S. **Effect of different rates of spent mushroom substrate on the growth and yield of fluted pumpkin (*Telfairia occidentalis* HOOK. F) in South – South, Nigeria.** *Nat Sci* 2016;14(3):40-44]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 6. doi:10.7537/marsnsj14031606.

Key words: Spent mushroom substrate; *Telfairia occidentalis;* South-South, Growth and Yield

1.Introduction

Telfairian occidentalis (Hook.F.) is an edible vegetable belonging to the family Cucurbitaceae. It is a tropical vine grown in West Africa as a creeping leaf vegetable shrub that spreads low and for its edible seeds. Common names for the plant include fluted gourd, fluted pumpkin, iroko and ugu. The young shoots and leaves of the female plant are the main ingredient of Nigerian ugu soup, which is harvested between 120-150 days after sowing for that purpose (Agatemor, 2006). It has been shown that leaf protein concentrates from *T. occidentalis* are rich in protein and minerals (Aletor *et al*., 2002).

The leaves and seeds of *T. occidentalis* are widely eaten as they are good sources of minerals (potassium, magnesium, sodium, phosphorus and iron), vitamins, fibres, fats. It is rich in amino acids, vitamins and minerals. It is a ready source of proteins because of its ability to synthesize amino acids from a wide range of virtually available primary materials such as water, carbon dioxide and atmospheric nitrogen (Schipper, 2000).

Edible mushrooms are a group of fungi species (Basidiomycetes) that grow naturally on tree trunks, leaves, roof of trees as well as decaying woody materials (Stamets, 2000). They are Achlorophylous organisms and thus can be grown in jars, bottles devoid of sun light. From these mushrooms are deposits of lots of nutrients, very vital for the use as crop enhancer (Lindequist *et al*., 2005). Nutrients such as vitamins, minerals and micro and macro nutrient have been detected in most oyster mushrooms (Jonathan *et al*., 2012). Oyster Mushrooms such as *Pleurotus ostreatus* is a fungus generally understood to be called white rot fungi, because of their ability to degrade lingo cellulosic materials. *Pleutorus species* as primary rot fungi are able to colonize different agricultural wastes as substrates. *P. ostreatus* is among the edible mushroom reported to be cultivated in Nigeria (Jonathan *et al.*, 2012). Spent mushroom substrate (SMS) is the remnant of substrates (sawdust or any other agricultural substrates) used to cultivate mushrooms (Jonathan *et al.*, 2012). The importance of industrial fertilizers in developing modern farming practices and its implication in sustainable food production cannot be over emphasized. However, the adverse effect of inorganic fertilizer on leafy vegetable such as fluted pumpkin was widely noted by the local communities and farmers (personal communication). Some of these inorganic fertilizers could pose adverse effects on crops which in any case can be avoided when alternative organic materials such as spent mushroom substrate (SMS) is used. However, when SMS is allowed as waste in the environment it can be a source of environmental pollution hence posing environmental hazard. Such negative or hazardous effect can be turned around to fortune, when used as a substrate for growing agricultural crops. The use of organic waste such as spent mushroom compost in growing agricultural crops especially leafy vegetable has been recognized in recent times as a possible means of enhancing sustainable agriculture or sustainable production of food crops (Okokon *et al*., 2009).

The need to maintain a cleaner environment that will sustain crop productivity arises as a necessity to consider the use of bio-fertilizer, devoid of toxic metals, which has the ability to prevent the depletion of the soil organic matter, according to Mullen and McMahon (2001). Such organic waste material can be easily obtained, from mushroom farms at little or no cost. As there is a paradigm shift towards “Organic Farming”, the need to embrace the use of bio-fertilizer, such as SMS should be encouraged. Therefore the objective of the present study is to determine the effects of different rates of SMS on the growth and yield attributes of *T. occidentalis.*

2. Materials and Methods

2.1 Experimental site

The experiment was carried out at Faculty of Agriculture Teaching and Research Farm, University of Port Harcourt, Choba, Rivers State. University of Port Harcourt lies on latitude 4^{0}31' to 5^{0}00N and longitude 6^{0}45' to 7^{0}00E, with an average temperature of 27^{0}C, relative humidity of 78% and average rainfall that ranges from 2500-4000mm (Nwankwo *et al.*, 2010).

2.2 Field preparation and treatments

The conventional land preparation which include land clearing and preparation of beds were carried out to conserve the soil and its nutrients. The land was cleared and beds were constructed. The experiment was a randomized complete block design (RCBD) and replicated three times. The experimental land was divided into three blocks each containing 4 beds to give a total of 12 beds. Each bed size was 2m x3m and with about 0.5m gap between beds. The blocks were spaced to ease movement during cultural operations. A bed contained 12 plants. The treatment involved spent mushroom substrate applied at 0kg (control), 1kg, 2kg, and 3kg per 2x3m ($6m^2$) which is equivalent to 0kg/ha, 1667kg/ha, 3333kg/ha, 5000kg/ha. The treatments were assigned into the beds in a randomized complete block design with three replicates. Spent mushroom substrate (SMS) was obtained from the Faculty of Agriculture Teaching and Research Farm, University of Port Harcourt, Choba, Rivers State. It was formulated with standard sawdust, austine white lime and wheat bran in the ratio (by weight) of 1: 0.04: 0.08 and used to grow oyster mushroom (*Pleurotus spp*). After three mushroom harvests, the fresh SMS was collected from the mushroom houses and kept in sac bags for four (4) months for additional composting. This weathered SMS was then incorporated into the soil seven days before planting as suggested by Fubara- Manuel, *et al.,* (2011).

2.3 Source planting material

A total number of 160 *Telfairia occidentalis* seeds were obtained from pods purchased from Agricultural Demonstration Farm, Rivers State University of Science and Technology, Port Harcourt, Rivers State.

2.4 Planting and other cultural practices

Telfairia seeds were extracted from pods. They were air dried for 48 hours before planting. Planting was done late in June. One viable seed was sown per hole at a spacing of 50cm x 75cm given a plant population of 26666 stands per hectare. Application of spent mushroom substrate was done a week before sowing. Weeds were controlled manually by hoeing first at 3 weeks after sowing and continued bi-weekly. The fresh vine (shoot) was harvested every fortnight for yield determination.

2.5 Pre planting analysis

The soil and SMS were tested for their physicochemical properties, prior to utilization for the study. The initial soil samples were collected from surface 15cm for laboratory analysis prior to land clearing. The soil sample was analyzed by using the procedure of Mylavarapus and Kennelley (2002). The mineral element compositions of the SMS were determined before their application to the soil. This was done in order to know the various elements that were present in the spent mushroom substrate before usage. The mineral element analyses were carried out using the procedures of AOAC (2005).

2.6 Data collection

Data were obtained on growth parameters which include percentage emergence at ten (10) days after planting (DAP), length of vine, and number of leaves, leaf area and fresh shoots weight of harvested vines at 4, 6,8,10 and 12 weeks after planting (WAP).Three plants were randomly selected from each plot for data collection. The average values from the selected plants were then used to determine the data collected.

The procedure taken for collection of vine length was by placing a non-elastic thread from the soil level to the tip of the vine and the length of the thread was measured with a flexible measuring tape to determine the vine length, while the number of leaf was recorded by counting. The leaf area was estimated using the formula: LA = 0.9467 + 0.2475 LW + 0.9724 LWN; where, N =number of leaflets in a leaf, L=the length of the central leaflet, W=Maximum width of the central leaflet (Akoroda, 1993).

2.7 Statistical analysis

Data obtained were analyzed using analysis of variance (ANOVA). The means were separated by using least significant difference (LSD) at 5% level of probability.

3. Results

3.1 Chemical analysis of soil and spent mushroom substrate

Table 1 shows the chemical composition of the soil and spent mushroom substrate (SMS) before planting. The result showed that SMS had value of Nitrogen, N (0.186%); Phosphorous, P (70.0mg/kg) and Potassium, K (3.36cmol/kg) which was higher than the experimental soil.

Table 1. Chemical composition of soil and spent mushroom substrate before planting

Materials	N (%)	P(mg/kg)	K(cmol/kg)
Soil	0.078	6.67	1.11
SMS	0.186	70.00	3.36

3.2 Emergence

The percentage emergence was taken to determine the effect of the spent mushroom substrate on the emergence of the fluted pumpkin. Table 2 shows that the highest percentage emergence of 72.92% was obtained at 3333kg/ha at 10 DAP which was statistically similar (P>0.05) with other rates. The 1667kg/ha had the lowest (54.70%) emergence count.

Table 2. Effect of spent mushroom substrate on (%) emergence count at 10DAP

Rate of SMS (kg/ha)	% Emergence count per ha
0 (control)	70.84a
1,667	54.70a
3,333	72.92a
5,000	62.50a
LSD (P=0.05)	18.406

Means of the same letter are not significantly different at 5% probability

3.3 Growth parameters

On the number of leaves as indicated in Table 3, there were no significance differences among the various rates of SMS throughout the observation periods except at 6 WAP, where 5,000kg/ha had the highest number (27) but statistically similar with that of 1,667kg/ha (24.667). The leaf area in Table 4 differed significantly (P<0.05) throughout the observation periods except at 4 WAP; at the maximum period (12 WAP) 5,000kg/ha had the highest leaf area (350.28cm^2) while the control had the lowest (177.59cm^2). The length of vine in Table 5 also gave the same response as leaf area, where the highest value was also recorded in 5000kg/ha of SMS in all the sampling periods compared to other rates.

Table 3. Effect of spent mushroom substrate rates on number of leaves

Rate of SMS (Kg/ha)	4WAP	6WAP	8WAP	10WAP	12WAP
0 (control)	23.200a	20.533c	22.000a	25.767a	28.233a
1,667	24.533a	24.667ab	22.100a	24.900a	26.667a
3,333	23.900a	23.333bc	19.900a	25.333a	27.900a
5,000	27.000a	27.000a	22.767a	26.133a	30.900a
LSD (P=0.05)	4.1558	3.4012	3.8517	6.7286	5.1072

Means of the same letter are not significantly different at 5% probability

Table 4. Effect of spent mushroom substrate rates on leaf area (cm^2)

Rate of SMS (Kg/ha)	4WAP	6WAP	8WAP	10WAP	12WAP
0 (control)	183.50a	142.00b	126.13b	168.48a	177.59b
1,667	196.39a	144.70b	148.31b	227.87a	251.17ab
3,333	207.51a	187.85b	183.02ab	214.44a	280.27ab
5,000	273.28a	287.62a	261.21a	287.93a	350.28a
LSD (P=0.05)	144.32	64.516	78.199	124.350	138.750

Means of the same letter are not significantly different at 5% probability

Table 5. Effect of spent mushroom substrate rates on length of vine (cm)

Rate of SMS (Kg/ha)	4WAP	6WAP	8WAP	10WAP	12WAP
0 (control)	147.80a	116.67b	114.430b	170.12ab	187.33c
1,667	160.06a	163.37a	115.036a	151.87b	219.77bc
3,333	144.47a	157.77a	146.109b	191.00a	247.90b
5,000	168.03a	179.05a	171.360a	202.37a	326.80a
LSD (P=0.05)	32.907	32.829	32.5250	34.394	35.040

Means of the same letter are not significantly different at 5% probability

3.4 Yield parameter

In Table 6, the highest fresh shoot yield value was obtained at 5,000kg/ha of SMS at 4 to 12 WAP while the lowest was obtained at control (no application). There was no significant (P>0.05)) difference in all the rates of application within the sampling periods except at 3333kg/ha in 6 and 12 WAP.

Table 6. Effect of spent mushroom substrate rates on fresh shoot yield (kg/ha)

Rate of SMS (Kg/ha)	4WAP	6WAP	8WAP	10WAP	12WAP
0 (control)	1666.7a	1055.6c	944.4c	1500.0b	3166.7c
1,667	2055.6a	2055.6b	1666.7a	1944.4a	4916.7b
3,333	2222.2a	2500.0ab	2500.0a	2000.0a	5555.6ab
5,000	2666.7a	2777.8a	3111.1a	2250.0a	6000.0 a
LSD (P=0.05)	1122.40	649.58	681.96	410.64	752.29

Means of the same letter are not significantly different at 5% probability

4. Discussions

The K value in the soil was adequate while N and P were inadequate and below the critical level outlined by Ibedu *et al.,* (1988). The low values of N and P obtained from the soil could be attributed to eco physiological effect from excessive rainfall, low moisture content, leaching of nutrients, horizontal removal of nutrients through soil erosion, solar radiation, high temperature characterized by tropical soils, and continuous cultivation of the soils used for previous experiments in the experimental site hence the need for soil amendment in form of organic materials application such as SMS. The low emergence count recorded in 1,667kg/ha and 5,000kg/ha when compared with the control plots indicates that at 10 DAP SMS had probably not completely mineralized into absorbable forms that plants can take into their system for their growth and yield. It could also be that the emergence is not a function of the treatment based on the physiology of the *Telfairia* seeds.

The observed increased growth parameters (number of leaves, leaf area and vine length) could be attributed to release of SMS into the soil This result is in accordance to the findings of Ezugwu *et al*., (2000) who worked on the influence of organic manure rates and inorganic fertilizer formulations on some quantitative parameters of fluted pumpkin. Macrere *et al.,* (2001) obtained similar effect on tomato and associated it to balanced nutrients obtained in organic manure thereby enhancing root uptake of nutrients, vigorous growth and leaf expansion of vegetables. Grubben and Denton (2004) observed that organic fertilizer contributed significantly to the number of vines, vine length and number of leaves in vegetable depending on the rate of application. These results are in agreement with the report of Saalu *et al*., (2010) that there was a significant influence on the growth and yield of *T. occidentalis* by application of organic fertilizer.

According to Akanbi *et al.,* (2005), organic fertilizer improved cell activity, enhanced cell multiplication and enlargement of fluted pumpkin. Organic manure is known to be capable of activating many species of micro-organisms which release phyto-hormones that stimulate nutrient absorption and plant growth *(*Arisha *et al.,* 2003). The significant influence of SMS on the yield of *Telfairia* revealed that SMS can be used as soil amendment to promote the yield of crops as stated in the work of Dauda *et al.,* (2008). The study generally revealed that there is always a proportional increase in yield assessed when additional nutrients are applied. This may be as a result of the higher availability of nitrogen, phosphorus and potassium which encouraged higher yield as explained in the findings of Ndor *et al.,* (2010). The higher yield on manure treated plots appeared to indicate moderating effect of organic manure on soil moisture and plant nutrient uptake. Generally the superiority of SMS applied over the control in growth and yield performance of *Telfairia occidentalis* indicated that the control plants had inherent poor nutrients.

5. Conclusion

This study showed that the different concentrations of SMS of *Pleurotus ostreatus* in the soil have a direct effect on the growth and yield of *T. occidentialis*. All plants cultivated on soil treated with SMS showed yield different from those of the control. This established the fact that, SMS has positive effect on the growth of the vegetable.

On the rate of application, it is evidence that 5,000kg/ha of SMS had the best performance of pumpkin's growth. However, this study did not indicate the harmful application rates of SMS, that is, the rate at which SMS becomes harmful to the plant. It is therefore recommended that further studies on SMS as bio-fertilizer for *Telfairia occidentalis* need to be conducted in this agro-ecological zone to validate the results obtained from this study which could serve as a guide to interested fluted pumpkin growers.

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2/24/2016