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Comparative effects of poultry manure and spent mushroom substrate on the growth and yield of pineapple (*Ananas comosus*) in Nigeria

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The effects of poultry manure and spent mushroom substrate on the growth and yield of pineapple were investigated in Port Harcourt. The aim was to determine the most productive soil enrichment material that will enhance the production of pineapple in the area. A complete randomized block design with three replications was adopted. Data were collected monthly for eight months. Results shows that spent mushroom substrate and poultry manure did not show any significant ($P < 0.05$) difference on growth performance and on yield. But spent mushroom substrate gave a higher plant height (85.5 cm) than poultry manure (81.0 cm) all at 500 g rate of application per plant. Poultry manure gave a higher number of fruits (7) which weighed 13.52 kg/plot than soil enriched with spent mushroom substrate which produced 6 fruits weighing 12.42 kg/plot. The control (No treatment) exhibited a significant ($P < 0.05$) difference among other treatment. Its plant height was 67.75 cm while it gave a yield of 3 fruits (6.95 kg/plot). Therefore, poultry manure was observed to perform better during fruit production while spent mushroom substrate enhanced growth performance on the studied crop.

Key words: Poultry manure, spent mushroom substrate, soil enrichment, pineapple, Nigeria.

INTRODUCTION

Poultry manure is an organic material and is one of the soil enrichment materials. The use of various sources of organic materials has been promoted as one of the principal sustainable management options for improving soil quality and productivity (Widmer et al., 2002).

Organic materials such as green manure, crop residues, cow dung and poultry manure used in improving soil fertility have also been found to control root disease including nematodes (Poswal and Akpal, 1991).

The application of organic materials to the soil is an alternative strategy for sustainable crop production with no documental negative effect of organic soil enrichment on non-target organisms (Agyarko and Asante, 2005).

Oka et al. (2000) indicated that organic addition have constantly produced beneficial effects on soil nutrients, soil physical conditions and soil biological activities thereby improving the health of plants and reducing populations of plant-parasitic nematodes.

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Poultry manure contains high percentage of nitrogen and phosphorus for the healthy growth of plants (Ewulo, 2002). Nitrogen is equally said to be the motor of plant growth (IFA, 2002). Organic matter is the ultimate determinant of the soil fertility in most tropical soils and this account for its use to raise seedling in tropical areas, the fertility of the soil could be sustained with the addition of poultry manure (Ikpe and Powel, 2002).

Substrate is an organic-based material on which mushrooms grow. And a good substrate should be rich in nutrients, have good aeration and water holding capacity. Substrate commonly used in mushroom production include agricultural by-products, such as cereal straws (wheat, barley, rice, maize), cotton, waste, maize cobs, coffee husks and pulp, sawdust etc. The addition of spent mushroom substrate in the nutrient poor soil leads to an improvement in soil texture water holding capacity and nutrient status. Spent mushroom substrate (SMS) incorporation in soil does not have any adverse effects on its alkalinity while its enrichment in the soil leads to an increase in both pH as well as the organic carbon content.

Pineapple (*Ananas comosus*) is a perennial crop and can be cultivated any time of the year, so long as soil moisture is available. In the southern part of Nigeria, the plant grows optimally in well drained sandy loam with a pH of 4.5 to 6.5. Pineapple is propagated from crowns, slips or suckers. The crop can be grown with the application of organic and inorinorganic fertilizers. These depend on the availability of either of them. The trial of the poultry manure and mushroom substrate is borne out of the difficulties experienced in the purchase of inorganic fertilizer. More so, with the increasing rate of mushroom and poultry production within the environment, the waste generated from them are channeled to agricultural purposes, hence the study.

Pineapple is a tropical edible crop grown for its fleshly fruit which is rich in mineral and vitamins. Its production in the tropics and Nigeria is highly at increase because of its nutritive value, its use for livestock feed, and employment to road side seller who sell it as snacks, industries that use it in the manufacturing of juice and textiles industries use the fibres. The waste product is also used as mulch.

In order to sustain and increase the production of pineapple in the tropics, a more nutritive material is advocated so as to maintain its role in the society, hence the use of poultry manure and spent mushroom substrate as soil enrichment materials.

This study is aimed at comparing and determining the best nutritive soil enrichment material that can improve the growth and yield of pineapple in Rivers State of Nigeria.

MATERIALS AND METHODS

The experiment was conducted over the period of March 2012 to April 2013 at the University of Port Harcourt, Rivers State, Nigeria. The area is located in a tropical humid zone with distinct wet and dry season.

Port Harcourt is in latitude 4° - 6°N and longitude 7.01°E with an elevation of 18 m above sea level (FAO, 1984). The rainfall pattern is essentially bimodal with peak in June and September while in April and August there are periods of lower precipitation (Ukpong, 1992, Uniuyo Agromet, 1997).

The dry season is short lasting from December through February; the wet rainy season begins from March and continues through November. Maximum rainfall occurs during the months of June to October with mean annual rainfall of 2680 mm. The mean monthly temperature ranges between 28 and 33°C, while the monthly minimum is between 20 and 23°C. The highest temperature figures are recording during the months of December to March.

The experimental area has acidic sandy loam to soil classified as typical paleudult. Planting material used was pineapple suckers (cv. smooth cayenne) collected from the base of the mother plant. These were planted in three (3) rows per plot size of 3 m x 3 m (9 m^2) with 9 plants per plot, but with a total of 9 plots in all. A space of 1 m was used to separate each plot from the other. A planting space of 70 cm x 90 cm and the cultural practices were maintained. A land area of 15 m x 15 m (0.0225 ha) was used for the experiment. The statistical design was a simple randomized complete block design (RCBD) of two treatments with three replications and control. The treatment included poultry manure and spent mushroom substrate at the rate of 500 g/plant for each treatment. These treatments were applied at the depth of 10 and 20 cm away from the plant stand. They were applied one week after planting. There was no watering of the plant; rather the crop relied on natural rainfall.

On data collection, the initial and final fertility status of the soil was taken and recorded (Table 1). Other data collected was on growth parameter which includes plant height, number of leaves, leaf area and length of leaves, while the yield parameter was on number of fruits and fruits weight.

The growth parameters were collected at 4, 8, 12, 16, 20, 24, 28, and 32 weeks after planting (WAP), while yield data collection started at 8 months after planting. The parameters taken were statistically analyzed by analysis of variance (ANOVA) mode as recommended by Steele and Torrie (1960), and the differences between treatment means were separated using Duncan's Multiple Range Test (DMRT) at 5% probability.

RESULTS AND DISCUSSION

The results of the initial soil mechanical analysis are shown in Table 1. The soil surface layers (0 to 5, 5 to 10, 10 to 15 cm) at the experimental sites were sandy clay loam with sand between 58 to 65%, silt 22 to 27% and clay 11 to 15%. From the result of the final soil analysis, there was increase in the nutrient status of the soil after harvest of the fruits resulting from the application of poultry manure and spent mushroom substrate as soil enrichment material (Table 1). There was decrease in nutrient status in the soil where no soil enrichment was applied. This was as a result of nutrient uptake by pineapple without any replacement of nutrient by soil enrichment material. The soil nutrient was enhanced in the enriched soil as a result of application of organic material. This confirms the findings of Poswal and Akpal (1991) who reported that organic amendments such as green manure, crop residues, cow dung and poultry manure are used in improving soil fertility.

Table 1. Result of soil fertility status.

Nutrient element	Poultry manure		Spent mushroom substrate		Control	
	Initial	Final	Initial	Final	Initial	Final
% N	0.05	0.07	0.05	0.06	0.05	0.05
$P_20_{5(ppm)}$	28.0	28.85	28.0	28.45	28.0	28.0
K_20(ppm)	21.10	21.60	21.10	21.50	21.10	21.10
pH(ppm)	4.60	4.60	4.60	4.60	4.60	4.60

Table 2. Effect of poultry manure and spent mushroom substrate (SMS) on growth of pineapple at 24 weeks after planting (WAP).

Treatment	Plant height (cm^2)	No. of leaves	leaf area (cm^2)	Length of leaf (cm^2)
Poultry manure	81.0^a	38.75^b	71.75^{ab}	65.25^b
Spent mushroom substrate	85.5^a	42.75^a	88.25^a	82.25^a
Control	67.75^b	37.75^b	67.25^b	68.75^b
SE±	2.67	1.03	3.14	2.25

Means followed by the same letter in the same column do not differ significantly according to Duncan's multiple range test ($P < 0.05$).

Table 3. Effect of poultry manure and spent mushroom substrate (SMS) on yield of pineapple.

Treatment	No. of fruits	Weight of fruits (kg)
Poultry manure	7.00^a	13.52^a
Spent mushroom substrate	6.70^a	12.42^{ab}
Control	3.75^b	6.95^b
SE±	0.53	1.08

Means followed by the same letter in the same column do not differ significantly according to Duncan's multiple range test ($P < 0.05$).

Growth parameters

The effects of poultry manure (PM) and SMS on plant height, number of leaves, leaf area and length of leaf of pineapple are presented in Table 2. The plant height of pineapple and leaf area at 24 WAP did not show any significant difference on the application of PM and SMS. Spent mushroom is high in organic matter making it desirable for use as a soil enrichment or soil conditioner.

Study by Warman (1986), Duncan (2005), Oagile and Namasiku (2010), observed that poultry manure is preferred amongst other animal wastes because of its high concentration of macro-nutrients. The effects of the organic matter used were significantly different on number of leaves and length of leaves. The SMS showed a significant difference ($P < 0.05$) on number of leaves, leaf area and length of leaves from poultry manure.

Spent mushroom substrate mixed with loamy soil produced significantly, greater plant height, stem girth, no of leaves and total leaf area than only loamy soil for both cowpea and tomato (Kadiri and Mustapha, 2010).

It is obvious in Table 2 that the application of SMS enhanced the growth of pineapple in terms of the growth parameters measured, followed by the poultry manure. While the lowest values were observed in the control plots at 24 WAP.

Yield parameters

The effect of the treatments on the yield of fruits is shown in Table 3. There was no significant difference ($P > 0.05$) on the number of fruits and fresh weight of pineapples among the poultry manure and SMS. But the highest fruit weight of 13.52 kg/plot was obtained with the application of poultry manure compared to 12.42 kg/plot obtained with the application of spent mushroom substrate. This is in accordance with Schjegel (1992) who observed that the need and utilization of poultry manure has overtaken the use of other animal manure, because of its high content of nitrogen, phosphorous and potassium. It also corroborated the previous studies by Warmar (1986), Duncan (2005), Oagile and Namasiku (2010), who observed that poultry manure is preferred amongst other

animal wastes because of its high concentration of macro-nutrients. The lowest value of 6.95 kg/plot was recorded in the control treatment and it showed significance ($P < 0.05$) difference among other treatments. Poultry manure gave 95% and SMS 65% increase over the control for number of fruits obtained, while flesh weight gave a similar trend for both treatments over the control.

This trial clearly indicates that the application of either poultry manure or spent mushroom substrate as soil enrichment material has resulted in the better performance of pineapple in terms of growth and yield compared to the control where no soil enrichment was used. But in contrast, the experiment shows that the soil enriched with poultry manure gave more productive yield than spent mushroom substrate while on growth rate, spent mushroom substrate was better. Further trials are required in order to determine the different rates of the treatments for the production of pineapple in Port Harcourt, Rivers State, Nigeria. Another trial can be conducted to determine the effects of the amendment materials on the nutritional value of pineapple.

Conflict of Interests

The authors have not declared any conflict of interests.

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