International Journal of Plant & Soil Science
8(6): 1-5, 2015; Article no.IJPSS.19228
ISSN: 2320-7035

SCIENCEDOMAIN *international*
www.sciencedomain.org

Response of Growth and Yield of Pineapple (*Ananas comosus)* on Spent Mushroom Substrates and Inorganic Fertilizer in South – South, Nigeria

J. A. Orluchukwu[1*] and O. M. Adedokun[1]

[1]Department of Crop and Soil Science, Faculty of Agriculture, University of Port Harcourt, P.M.B. 5323 Choba Port Harcourt, Rivers State, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author OMA designed the study. Author JAO wrote the protocol and wrote the first draft of the manuscript, managed the literature searches, analyses of the study, performed the spectroscopy analysis and managed the experimental process and author OMA identified the species of the plant. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2015/19228
Editor(s):
(1) Fatemeh Nejatzadeh, Department of Horticulture, Faculty of Agriculture, Khoy Branch, Islamic Azad University, Iran.
Reviewers:
(1) Raúl Leonel Grijalva Contreras, Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, Mexico.
(2) Anonymous, Universiti Putra Malaysia, Malaysia.
(3) Muhammad Shehzad, The University of Poonch Rawalakot, AJK, Pakistan.
(4) Maria José Alves Bertalot and Eduardo, Instituto Elo de Economia Associativa, Botucatu, SP, Brazil.
Complete Peer review History: http://sciencedomain.org/review-history/11759

Original Research Article

Received 30th May 2015
Accepted 26th August 2015
Published 9th October 2015

ABSTRACT

Aim: The experiment on pineapple (*Ananas comosus*) was conducted in 2013 at the Teaching and Research Farm of Faculty of Agriculture, University of Port Harcourt, Nigeria using soil enrichment materials. The experiment was aimed at comparing the best soil enrichment material that can enhance the production of pineapple in southern part of Nigeria.
Study Design: The experimental design used was a randomized complete block design in three (3) replications.
Methodology: The soil enrichment materials used for the study were spent mushroom substrate (SMS), and inorganic fertilizer (NPK 15:15:15) and no treatment as control. The growth and yield attributes measured in the field included plant height, number of leaves, leaf area, length of leaves, number of fruits and fruits weight.

**Corresponding author: E-mail: josephorluchukwu@yahoo.com;*

Results: These attributes increased significantly due to application of the soil enrichment materials which led to continuous supply of nutrients as against the control (no treatment) which gave lower values in all the growth and yield parameters measured. The results of the trial on growth parameter showed that spent mushroom substrate gave a significant difference ($P<0.05$) against the inorganic fertilizer used. On fruit production, it was observed that spent mushroom substrate and inorganic fertilizer did not show any significant difference ($P>0.05$), though a higher fruit yield of 6.7 (12.42 kg/plot) was obtained in SMS than in inorganic fertilizer (NPK 15:15:15) which had 6.0 (9.87 kg/plot).
Conclusion: Therefore, farmers in South-South of Nigeria are advised to plant pineapple using spent mushroom substrate more than inorganic fertilizer (NPK 15:15:15) as soil enrichment material for better growth and increase in yield.

Keywords: Spent mushroom substrates; NPK 15:15:15; pineapple; growth and yield.

1. INTRODUCTION

The production of pineapple in south – south of Nigeria is constrained by low soil fertility due to continued cultivation without replenishment of the soil with any soil amendment materials. This has also led to reduction of crop yields in the region. Soil amendments are substances used for correcting the acidity or alkalinity of the soil which was as a result of high rainfall associated in the region.

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. The crop can be grown with the application of organic and inorganic fertilizers. Pineapple is a tropical edible crop, grown for its fleshy fruit which is rich in mineral and vitamins, useful for man as snack, livestock as feed; industries as raw materials for juice, textile and garbage as mulch in agriculture. It is one of the economic bases to small scale farmers in the southern part of Nigeria.

The expansion of the mushroom industry is a global phenomenon. Production of mushroom however is accompanied with the generation of millions of tons of residue referred to as spent or used mushroom substrates (SMS/UMS) which remains after the mushroom crop has been harvested. In a report by [1], used mushroom growing substrates are not utilized but can be put to various other uses. In Nigeria, although few mushroom farmers are available at present, if farmers are advised, the SMS generated from mushroom production can be well utilized and rightly channeled to agricultural productivity and environment rather than increasing load on dump sites [2]. Nitrogen (N) is an essential nutrient which is a determining factor in crop production and is absorbed primarily in the form of nitrate [3]. It constitutes about 1.5 - 6% of the dry weight of many crops apart from being a constituent of many organic compounds, nucleic acids and protein compounds [4]. Nitrogen also plays a role in chlorophyll synthesis and hence the process of photosynthesis and carbon dioxide assimilation [5] and occurs in soil in organic and inorganic forms [6]. Nitrogen also mediates the utilization of potassium, phosphorus and other elements in plants and the optimum amounts of these elements in the soil cannot be utilized efficiently if nitrogen is deficient in plants [7]. Under nitrogen deficiency, plants exhibits stunted growth and small leaves while excess nitrogen results in shoot elongation, weak succulent tissues and lateness in maturity [8]. Phosphorus (P) is a major constituent of the nucleic acid and the phospholipids in plants and usually it forms a building block in the formation of nucleon protein. Adequate phosphorus in the soil enhances the fundamental processes of plants such as photosynthesis, nitrogen fixation, flowering, fruiting (including seed production). It improves the development of both shoot and root systems. Potassium (K) has been found to be of great value to crops in improving nitrogen use efficiency sustaining crop productivity and tolerance to pests and diseases when adequately supplied [9]. Johnson and Krauss [10] reported that potassium plays an essential and irreplaceable role in a number of biochemical and physiological activities in plants such as osmoticum to control turgor in plant cells, enhance plant water use efficiency, assist crops tolerate cold conditions and improve crop quality. In another study, Grzebisz [11] observed that adequate potassium fertilization practice seems to be one of the cheapest ways to diminish the negative effects of naturally occurring short-lasting drought on crop growth and yield.

In this study, the use of inorganic fertilizer (NPK15:15:15) and spent mushroom substrates as soil amendment material in the south-south region of Nigeria was designed to compare which of them that will enhance the growth and yield of pineapple in the region. This is in view of the economic benefit the small holder farmers derive from the cultivation of the crop.

2. MATERIALS AND METHODS

The research was conducted in 2013 cropping season at the Faculty of Agriculture Research and Teaching farm of the University of Port Harcourt Rivers State, Nigeria. The site was located on latitude 4° – 6° N and longitude 7.01℄E with an elevation of 18 m above sea level [12]. The rainfall pattern is essentially bimodal with peak in June and September while in April and August there are periods of lower precipitation [13,14].

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℃, while the monthly minimum is between 20℃ and 23℃. The highest temperature figures are recorded during the months of December to March.

The experimental area has acidic sandy loam. The 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 ($9m^2$) with 9 plants per plot at a planting space of 70 cm x 90 cm and the cultural practices were maintained. A land area of 15 m x 15 m (0.0225ha) 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 treatments used as soil amendments are spent mushroom substrate and inorganic fertilizer (NPK 15:15:15) at the rate of 500 g/stand for each of the treatments, in two split applications. These treatments were applied at the depth of 10 cm and 20 cm away from the plant stand. They were applied one week and twelve weeks after planting.

On data collection, soil samples were collected from the top soil at a depth of 0 – 15 cm using soil auger. The soil was collected before planting. Soil pH was determined 1:2.5 soil – water ratio using a pH meter [15]. Total nitrogen was determined by semi-micro Kjeldahl digestion method [16], while available P was extracted by Bray 1 method, and determined by the molybdenum blue method [17]. Exchangeable K were extracted and measured by flame photometric method [18]. The results of the chemical soil analysis of some soil properties are recorded in Table 1. The chemical analysis of spent mushroom substrates was determined and the results are recorded in Table 2. Other data collected was on growth parameter which includes plant height, leaf area and length of leaves, while the yield parameter was on number of fruits and fruits weight.

The growth parameters were collected at 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 variable (ANOVA) mode as recommended by [19], and the differences between treatment means were separated using Duncan's Multiple Range Test (DMRT).

3. RESULTS AND DISCUSSION

The results of the soil mechanical analysis and the chemical analysis of spent mushroom are shown in Table 1 and Table 2 respectively. The soil surface layers (0-5, 5-10, 10-15 cm) at the experimental sites were sandy clay loam with sand between 58-65%, silt 22-27% and clay 11-15%. This analysis assisted in determining the quantities of materials that was applied on the crop.

Table 1. Chemical soil analysis of the experimental site

Elements	Values
Total N (%)	0.05
Available P (mg/kg)	28.0
Exchangeable K (mg/kg)	21.10
Soil pH	4.60

Table 2. Chemical analysis of spent mushroom substrates

Elements	Values
Total N (%)	0.430
Available P (%)	44.50
Exchangeable K (%)	0.047
Soil pH	4.8

3.1 Growth Parameters

The effects of inorganic fertilizer (NPK 15:15:15) and SMS on plant height, number of leaves, leaf

Table 3. Effect of treatments on mean growth parameters of pineapple

Treatment	Plant height (Cm)	Number of leaves	Leaf area (cm)	Length of leaf (cm)
Spent mushroom substrate.	85.5[a]	42.75[a]	88.25[a]	82.25[a]
NPK 15:15:15	67.75[b]	37.75[b]	74.75[b]	68.75[b]
Control	64.75[b]	33.50[c]	67.25[b]	63.25[b]
SE±	2.67	1.03	3.14	2.25

Means with the same letter in the same column do not differ significantly at 5% level of probability

area and length of leaf of pineapple are presented in Table 3.

The effects of Spent mushroom substrates showed a significant difference (P<0.05) on the application of NPK (15:15:15) and control on plant height, number of leaves, leaf area and length of leaves measured. In a related study by [20-22], observed that poultry manure is preferred amongst other animal wastes because of its high concentration of macro-nutrients. Spent mushroom substrates mixed with loamy soil produced significantly, greater plant height, stem girth, number of leaves and total leaf area than only loamy soil for both cowpea and tomato [23].

The significant difference in the vegetative parameters measured in this study indicates that SMS positively improved the growth of the vegetative parameters most likely because of the mushroom mycelia present in the SMS which was absent from the control soil. This observation is similar to report of [1] who reported that spent mushroom substrate has nutrient remaining in it after mushroom harvest and is useful in crop production, vegetable production, fruit tree production, soil amendment among other uses.

3.2 Yield Parameters

The effect of the treatments on the yield of fruits is shown in Table 4. There was no significant difference (P>0.05) on the number of fruits and fresh weight of pineapples among the inorganic fertilizer and SMS. This is in accordance with [24] 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. The control (no treatment) had a lower number of fruits - 3.75 (6.95 kg/plot) and it showed significance difference (p<0.05) among other treatments. The SMS gave a 55% and inorganic fertilizer 70% increase over the control for number of fruits obtained, while the flesh weight gave a similar trend for both treatments over the control.

Table 4. Effect of treatments on mean yield parameters of pineapple

Treatment	Number of fruits	Weight of fruits (kg/plot)
Spent mushroom substrate	6.7[a]	12.42[a]
NPK 15:15:15	6.0[a]	9.87[a]
Control (no treatment)	3.75[b]	6.95[b]
SE±	0.53	1.08

Means with the same letter in the same column do not differ significantly at 5% level of probability

4. CONCLUSION

This trial clearly indicates that the application of spent mushroom substrate as soil enrichment material has resulted in better performance of pineapple in terms of growth and yield compared to the application of inorganic fertilizer (NPK 15:15:15) and the control where no soil enrichment was used. Further trials are required in order to determine the different rates of the treatments for the production of pineapple in South – South of Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Rinker DL. Handling and using “spent” mushroom substrate around the world. In: Sanchez JE, Huerta G, Montiel E (eds). Mushroom biology and mushroom products. Impresos Jupiter, Cuemavaca. 2002;43-60.
2. Adedokun OM, Orluchukwu JA. Pineapple: Organic production on soil amended with spent mushroom substrate. Agriculture and Biology Journal of North America. 2014;4(6):590–593.

3. Tisdale SL, Nelson WL. Soil fertilizer and effect of magnesium on the yield and chemical of crops. Michigan Agricultural Experimental Statistics. Bull Press, Mechigan, American. 1990;29-31.
4. Sanjuan N, Clemente G, Ubeda L. Environmental effect of fertilizers In: Dris R, Niskanen R, Jain MS, (eds). Crop Management and Post-harvest Handling of Horticultural Products: Crop Fertilization, Nutrition and Growth Enfield, USA: Science Publishers, Inc. 2003;53.
5. Jasso-Chaverria C, Hochmuth GJ, Hochmuth RC, Sargent SA. Fruit yield, size, and colour responses of two Greenhouse cucumber types to nitrogen fertilization in perlite soilless culture. Horticulture Technology. 2005;15:565.
6. Jones JB. Agronomic handbook: management of crops, soils, and their fertility. New York, USA: CRC Press; 2003.
7. Brandy C. The nature and properties of soils. Macmillan Publishing Company, New York; 1984.
8. Wolf B. The fertile triangle: The interrelationship of air, water and nutrients in maximizing soil productivity. New York, USA: Food Products Press. New York, USA; 1999.
9. Grzebisz W. Inter relationship between water and nutrient supply and response to potassium. In: Johnson AE, (ed.) Essential role of potassium in diverse cropping system. IPI Basel, Switzerland. 1999;39–46.
10. Johnson AE, Krauss A. The essential role of K in diverse cropping systems: Future research needs and benefits. A workshop paper presented at 16th World congress of Soil Sc., Switzerland. 1999;101–120.
11. Prokoshev V. Rational use of K fertilizer in Central Russia. Inter Fertilizer Correspondences. 1993;34:4.
12. Food and Agricultural Organisation, FAO. Agro climatological data in Africa, FAO publications, Rome; 1984.
13. Ukpong IE. The structure and soil relations of *Avicenia* mangrove swamps in South Eastern Nigeria. Tropical Ecology. 1992; 33(3):5-16.
14. University of Uyo Agricultural Meteorological station, *University* of Uyo publications, Uyo; 1997.
15. Thomas GW. Soil pH and Soil acidity. In: Sparks DL, (Editor) Pp 475 – 490. Methods of Soil Analysis Part 3 – Chemical Methods, SSSA Book Series 5, Madison, Wisconsin, USA; 1996.
16. Bremner JM. Total nitrogen. In: Sparks DL, (Editor) Methods of Soil Analysis Part 3 – Chemical Methods, Soil Science Society of America. Book series 5, Madison, Wisconsin, USA. 1996;1085–1122.
17. Kuo S. Phosphorus. In: Sparks DL, (Editor). Methods of soil analysis Part 3 – Chemical methods, SSSA Book Series 5, Madison, Wisconsin, USA. 1996;869-92
18. Jackson ML. Soil Chemistry Analysis Prentice – Hall Englewood Cliffs, New York. 1964;498.
19. Steel RGD, Torrie JH. Principles and procedures of statistics: A biometrical approach, McGraw Hill publishers, New York; 1960.
20. Warman PP. The effect of fertilizer chicken manure on Timothy yield tissue composition and soil fertility. Agric. Wastes. 1986;18:289-298.
21. Duncan J. Composting chicken manure. WSU Cooperative Extension, King County Master Gardener and co-operative Extension Livestock Adviser; 2005.
22. Oagile D, Namasiku M. Chicken manure enhanced soil fertility and productivity. Effect of application rates. Journal of Soil Science and Environmental Management. 2010;1(3):46-54.
23. Kadiri M, Mustapha Y. The use of spent mushroom substrate of L. Subnuclus Berk as a soil conditioner for vegetables. Bayero Journal of Pure and Applied Sciences. 2010;3(2):16-19.
24. Schjegel AJ. Effects of composted manure on soil chemical properties and nitrogen use by grain sorghum. J. Prod. Agric. 1992;5:153-157.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/11759