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ORIGINAL RESEARCH ARTICLE

EXPERIMENTAL STUDY ON THE USE OF BANANA AND PINEAPPLE PEEL WASTE AS BIOFERTILIZERS, TESTED ON *HIBISCUS SABDARIFFA PLANT*: PROMOTING SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL SANITATION

J. J. Alasa[1], A. U. Bashir[2], M. Mustapha[4]*, and B. Mohammed[3]

Department of Agricultural and Environmental Resources Engineering, University of Maiduguri, Maiduguri, Nigeria
**Corresponding author's email address: mohammedmusty@unimaid.edu.ng*

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ABSTRACT

Synthetic fertilizers are combination of inorganic substances which causes long-term negative effects on the ecosystem. Indiscriminate agricultural waste disposal especially fruits peels waste when neglected and utilized unproperly can cause environmental pollution and spread of diseases. Fruit peels of banana and pineapple are highly rich in numerous bioactive compounds that can enhance plant growth. This study deals with managing banana and pineapple peel waste as organic fertilizer and compared their effects on the growth of Hibiscus sabdariffa. Three different formulations were prepared from sun dried and finely ground fruits peel of banana and pineapple extract, namely; Sample A containing 100g of banana peels powder, Sample B containing 100g of pineapple peels powder and Sample C containing 100g of a mixture of banana and pineapple peels powder. Four containers were used to collect 2kg of soil each, three of which were treated with the three formulations (Sample A, B and C). The fourth container was labeled sample D (Control). After 30 days of treatment, seeds of Roselle plant were sown in each container and plant growth parameters analyzed periodically. From the results, Sample A showed highest mean number of 3 days to germinate. After 21 days; Sample A had average large leaf area of 14cm^2, then Sample B (12.92 cm^2), Sample C (10.2 cm^2) and Sample D having the smallest (9.6 cm^2). After 120 days, average plant height recorded were; Sample A (78cm); Sample B (58), and Sample D (54cm), and sample C showed the lowest average plant height of 47cm. From this study, it was deduced that fruit peel powder formulations can enhance growth and yield of plants, thus limiting the use of chemical fertilizers and protecting the environment. It is recommended that fruits waste should be integrated into farms for enhanced agricultural productivity and clean environment.

1.0 Introduction

Agricultural crop production often requires addition of nutrients towards increasing soil fertility and maximizing yield (Savci, 2012). Nonetheless, achieving this based on inorganic fertilizer application is found to have deleterious effects on the environment and public health (Sönmez *et al*. 2007; Savci, 2012; Morakinyo *et al*., 2013, Sharma and Singhvi, 2017). Inorganic fertilizers are often used by farmers most of whom lack training and knowledge on application leading to excessive application (Abuga, 2014; Rahman and Zhang, 2018; Agmas and Adugna, 2020), which affects the ecosystem, it can result in soil quality declination and toxification of nearby water bodies (Morakinyo *et al*., 2013), hence, agricultural crops grown with such chemicals are unhealthy for consumption due to chemicals ability to bio-accumulate in the food chain (Savci, 2012; Chandini *et al*., 2019). Moreover, inorganic fertilizers are not risk-free during handling; enormous exposure to are connected to blindness, gene related diseases and many other ailments (Sharma and Singhvi, 2017), thus, the need for sustained and healthy method of food production through organic agriculture.

A wide range of agricultural fruits and vegetables waste of Banana peel, Orange peel, pineapple, Orange peels, coconut shell, usually generated from households and fruit vendors are mostly discarded indiscriminately affecting environmental quality and health of people (Harir *et al*., 2015); fruit wastes discarded improperly can produce odour, causing discomforts to people around, as the rich nutrients packed in these waste make them vulnerable to microbial spoilage, and may serve as harborage for harmful insects causing diseases and several environmental issues asides contributing to greenhouse gas effect (Raji and Onu, 2017). Large amounts of fruit wastes are also produced during harvesting, processing, storing or post-harvest handling, and are widely available and accumulate in market complexes and agro-industrial yards, due to the high costs of transportation and the limitation of available lands for disposal, thus resulting in environmental problems. However, fruit wastes characterization by various researchers globally have shown potentials as a source of raw materials that can be converted into value added products or incorporated into different biotechnological application such as biofertilizer production, animal foods and feeds production, industrial chemicals/raw materials, biofuels and other alternative renewable energy development, water treatment application and food and pharmaceutical industrial application (Ezejiofor *et al*., 2014; Raji and Onu, 2017; Sagar *et al*., 2018; Javed *et al*., 2019; Kumar *et al*., 2020), for example, banana waste were important as a potent source in textile manufacturing industries (Mohiuddin *et al.,* 2014) and as cellulase production as a resource in biofuel production process (Sarvanan *et al*., 2013), however, of all fruit waste utilization routes, biofertilizer application were more promising, less complex and easily incorporated with maximum benefits and zero environmental consequences. Scientific findings revealed that these wastes contain various natural bioactive compounds that can be beneficial for plant growth (Rudra *et al.,* 2015; Bakry *et al*., 2016; Khattak and Rahman, 2017; Pathak *et al*., 2017, Sagar *et al*., 2018; Vasanthi and Ramadas, 2019),hence utilizing these wastes as fertilizers for crops undoubtedly may lead to sustainable plant growth and clean environment. Fruit wastes based biofertilizers offers numerous benefits for plants such asit helps to improve soil morphology and organic matter content (Adalgisa *et al*., 2005),regulate soil pH and improve soil fertility (Panwar, 2015), enhanced root system and nutritional characteristics (Bakry *et al*., 2016; Arshad *et al*., 2018; Chandini *et al*., 2019), healthier and quality produce (Ndukwe *et al*., 2012), improves seed germination (Mishara and Koshy, 2016), enrich soil microbiota (Rai *et al*., 2014), and protects plants from insects, nematodes, fungi and other plant pathogens (Divina, 2016).

Interest in organic farming has been recently gaining momentum and wider application in different forms is being practiced, all of which are renowned to yield positive result. This research work was intended to be in Maiduguri where banana and pineapple peels are some common fruits consumed, which generally ends at dumpsites causing environmental degradation. Banana peels generated as a waste product is equivalent to 40% of the total weight of fresh banana, (Tchobanoglous *et al.,* 1993), and pineapple peel account for 50% of the total weight of the pineapple (Saravanan *et al.,* 2013). Hence, with the increasing banana and pineapple fruits production and consumption, banana and pineapple waste are also proportionally increasing, thus waste disposal present a serious environmental challenge. Therefore, the present study compares and explores the utilization of banana and pineapple peel waste as a natural fertilizer, the research selected to grow Roselle plant (*Hibiscus sabdariffa*) which is an economically and medicinally important plant widely used in the region. The aim of the research, therefore, is to investigate the growth ability of Rosella Plant on the soil treated with banana and pineapple peel extract; towards promoting the use of fruits waste based organic fertilizers and ensuring production of safe, highly nutritious food and long-term sustainability of the environment.

Corresponding author's e-mail address: mohammedmusty@unimaid.edu.ng

2. Methodology

2.1. *Collection and Preparation of soil*

Clay soil samples were collected in a barren land and were filled in four different containers (made up of rubber) each weighing 2kg,and named sample A, B, C and D (control).

2.2. *Extraction of fruit peel waste*

Waste of banana and pineapple peel wastes were separately collected in households, dumpsites and markets, the collected fruits peels were rinsed adequately in running tap water of debris, sand and foreign materials, the cleaned peels were cut into small pieces (1-5cm) and sun dried for 33 days, which were then ground into powdered form, sieved (Figures 1 and 2) and stored at room temperature, three formulation each of pineapple and banana peel extracts were prepared separately, and an additional preparation containing a mixture of pineapple and Banana was made.

Figure 1: Grounded Banana Peel Powder

Figure 2: Grounded Pineapple Peel Powder

2.3. *Formulation of different fruit peels fertilizer*

Four grams of each the three formulations of banana peel, pineapple peel and combined mixture of the two fruits peels powder extract were diluted in 400ml of water and applied to the collected soils samples A, B, C respectively and were mixed properly for uniform distribution, controls and two replications maintained for each of preparation, addition of the powder extract was carried out continuously for 32 days.

2.4. *Seeding of Rosella Plant*

After 32 days of application of the fruit peels extract, two seeds of Rosella Plant (*Hibiscus sabdariffa*) were sown in each container, and are being watered everyday with equal volume of water. and plant growth observed in terms of germination period and other plant growth parameters of Plant height, leaves area, number of branches, number of leaves per branch were being observed and recorded for up to 120days, a period in which growth plant is expected to have advanced.

3. Results and Discussion

The results of the various growth parameters on rosella plant seed sown after 21 and 120 days were shown in Tables 1 and 2.

Corresponding author's e-mail address: mohammedmusty@unimaid.edu.ng

Table 1: Growth Parameters of Roselle plant 21 days after germination

Samples	Average Plant Height (cm)	Initial Average number of leaves per plant	Average number of leaves per branch	Average Leaves Area per plant (cm^2)
Sample A (Banana peel with soil sample)	19	6	6	14
Sample B (Pineapple Peel with soil sample)	18.5	6	6	12.92
Sample C (Banana and Pineapple peel with soil sample)	17.5	6	6	10.2
Sample D (controlled)	16	5	5	9.6

Table 2: Growth Parameters of Roselle plant 120 days after germination

Samples	Average Plant Height (cm)	Average number of leaves per plant	Average number of leaves per branch
Sample A (Banana peel with soil sample)	78	32	28
Sample B (Pineapple Peel with soil sample)	58	21	15
Sample C (Banana and Pineapple peel with soil sample)	47	14	8
Sample D (controlled)	54	18	12

3.1. *Germination period*

From the result, there was no significant difference in number of days for germination. However, Sample C (Banana and Pineapple peel with soil sample), Sample A (Banana peel with soil sample) and Sample B (Pineapple peel with soil sample) showed minimum average number of days to germinate, which is 2 days, while Sample D (controlled) took average of 3 days to germinate. This supports a related study finding by Mishary and Koshy, (2016), in which significant improvement in seed germination were observed; the research analysed effect of vegetable and fruit waste on seed germination and growth of *Solanum lycopersicum* (tomoto plants). Similar results were also observed by Wazir *et al.* (2018), study on the significance of biofertilizers on growth of crops. Furthermore, similar research findings by Hussein *et al.* 2019 showed significant increase in rate of germination from 14% (control) to 97%, after 7 days of plantation of tomato plant. Also, same trend was noticed for fenugreek crop where the germination percentage was enhanced from 25% (control) to 93.14%. However, Banana and Pineapple peels increase soil fertility and enrich soil minerals with potassium, calcium including phosphorus. Phosphorus plays a significant role in seed germination and viability, deficiency in soil phosphorus contents retards early plant growth (Ascher *et al.*, 1994)and reduces root growth and development of plants (Hamid *et al.*, 2019).

3.2. *Average Plant height*

In the first 9 days after germination, Sample C (Banana and Pineapple peel with soil sample) initially showed the highest mean plant height of 10 cm, and Sample D (controlled) showed lowest mean height of 7cm. Sample A (Banana Peel with soil sample) 9cm and Sample B (Pineapple peel with soil sample) 8cm.The next 21 days after germination, Sample A (Banana peel with soil sample) showed mean plant height of 19cm and Sample D (controlled) showed lowest mean height of 16cm. Sample B (Pineapple Peel with soil sample) 18.5 cm and Sample C

Corresponding author's e-mail address: mohammedmusty@unimaid.edu.ng

(Banana and Pineapple peel with soil sample) 17.5cm. After 120 Days of growth, Sample A (Banana peel with soil sample) showed significantly highest mean plant height of about 78cm, Sample (Pineapple peel with soil sample) with average height of 58cm, Sample C (Banana and Pineapple peel with soil sample) with average height of 47cm and Sample D (controlled) with average height of 54cm, as shown in Figures 3 and 4. However, Banana peel exhibiting high increase in plant height coincides well with many similar studies; Bakry *et al.*(2016) observed similar outcomes with Quinoa Plants (*Chenopodium quinoa*Wild) tested under water deficit condition. Arshad *et al.*(2018); Wazir *et al.*(2018) and Qader (2019)equally noted substantial improvement in height with banana peel extract, on Lettuce plant (*Lactuca Sativa L*) grown under hydroponic condition, Potato and pea vegetables and growth of Chickpea (Cicer areitinum) L. plants respectively. This can be attributed to the high sufficient nitrogen content associated with banana peels extract (Khairnar and Nair, 2019). However, the initial lowest plant height indicated by the banana peel was due to the number of days taken for the treated materials to decomposed and release nutrients.

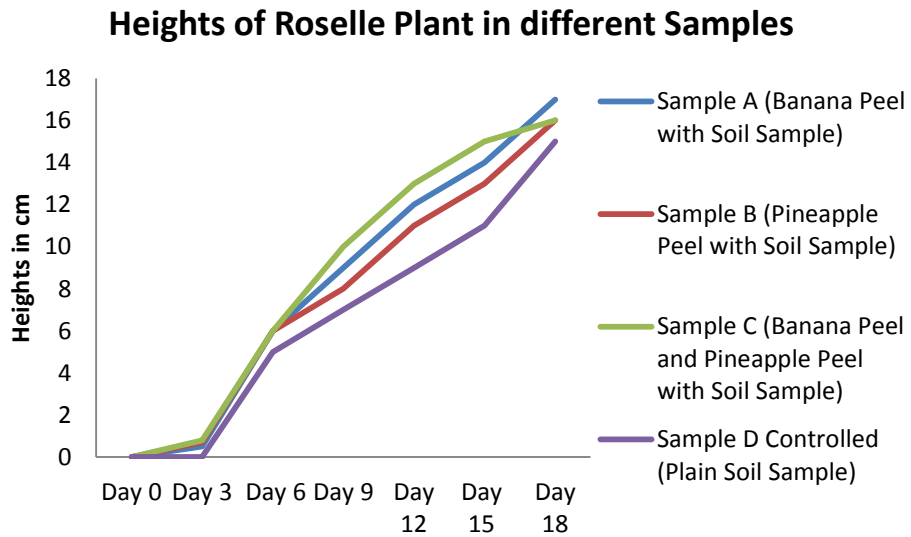

Figure 3: Heights of Plants using the different Samples after 21 Days.

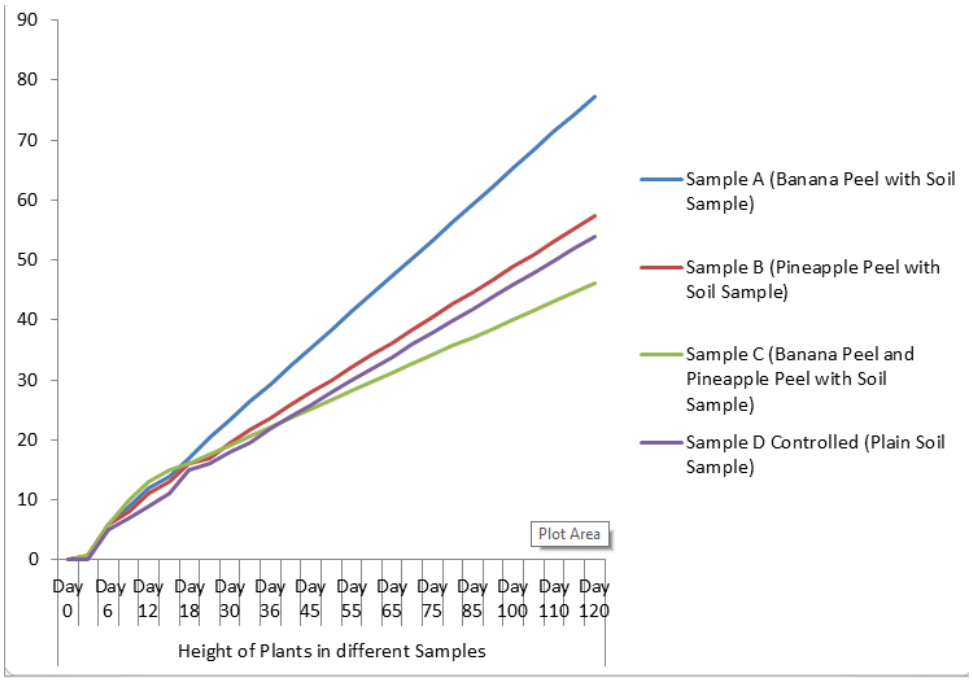

Figure 4: Heights of Plants using the different Samples after 120 Days.

Corresponding author's e-mail address: mohammedmusty@unimaid.edu.ng

3.3 *Average number of leaves per branch*

Pertaining to average numbers of leaves per branch after 21 days, there was not any difference in the number of leaves to the number of branches. This is so because the Roselle plants were still in their early stage. However, Sample A (Banana peel with soil sample) had an average number of 6 leaves per branch, Sample B (Pineapple Peel with soil sample) had an average number of 6 leaves per branch, Sample C (Banana and Pineapple peel with soil sample) also had an average number of 6 leaves per branch and Sample D (controlled) had an average of 5 leaves per branch. This corresponds with Adiah *et al*. 2017; Wazir *et al*. 2018Arshad et al. 2018 and Qader, 2019 studies in which different organic treatments of eggshell powder, banana peel Cassava peel and used tea waste were found best as organic fertilizer source for the plant growth, indicated by a substantial increase in plant leaves.

3.4 *Average Leaves Area per plant*

Pertaining to average leaves area per plant after 21 days, sample A (banana peel with soil sample) had an average area of 14cm^2, sample B (pineapple peel with soil sample) had an average area of 12.92 cm^2, sample C (banana and pineapple peel with soil sample) had an average area of 10.2 cm^2, while sample D (controlled) had an average leave area of 9.6 cm^2.In comparison with inorganic fertilizer, Sakpare*et al.*(2018)and Tuttobene *et al.*(2009) observed that some growth parameters especially leaf area and shoot height were enhanced by fruit peel extracts of banana and orange peel waste tested on the growth *Solanum scabrum*, and durum wheat (Triticum durum Desf.) and sunflower (Helianthus annuus L.). Similar findings by Wazir *et al.* (2018) also showed higher increase in leaves area per plant with application of banana peels on potato and peas vegetables.

4. Conclusion

Comparative study on the utilization of Banana and Pineapple fruit peel waste as organic fertilizer was carried out to know and compare their growth effectiveness on Rosella Plant, aiming at both sustainable agricultural and environmental sanitation. The study concluded that banana and Pineapple peels waste contain appreciable amount of nutrients to enhance soil fertility and increase plant yield, furthermore, the study found substantial improvement in terms of growth and yield parameters such as germination period, plant height, leaves area and number of leaves per branch. Banana Peel waste was found more suitable for Rosella plant growth. The research concludes that chemical fertilizers can be replaced by the fruit peel powder and extract for sustainable agriculture and environment. It is recommended that the public and farmers should make beneficial use of fruits waste as organic fertilizers and not discarded indiscriminately towards ensuring efficient agricultural productivity and reducing the ill-effect of synthetic fertilizer.

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Corresponding author's e-mail address: mohammedmusty@unimaid.edu.ng