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INFLUENCE OF FRUIT WASTES AND RATES ON OKRA *(Abelmoschus esculentus L.)* GROWTH AND FRUIT YIELD IN OGBOMOSO AND OYO TOWN, OYO STATE,

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ABSTRACT

The influence of fruit wastes and rates on okra *(Abelmoschus esculentus l.)* growth and fruit yield were investigated in two locations, at Teaching and research farms, Ladoke Akintola University of Technology, Ogbomoso and Federal College of Education (Special), Oyo. The experiments involved three fruit waste types namely: plantain waste, orange waste and cocoa pod and five rates of application (0, 25, 50, 75 and 100 kg N/ha). The 2 x 3 x5 factorial experiment was fitted into Randomized Complete Block Design (RCBD) and replicated three times. The fruit wastes were sorted, air-dried, milled and analyzed for N.P.K. compositions before application to the experimental plots two weeks before sowing. Data were collected on growth and yield components and subjected to the analysis of variance and the means were separated using least significant difference (LSD) at 5% probability level. The result revealed that location, fruit waste type and rate had significant ($P \leq 0.05$) effects on the growth and yield of okra. At Ogbomoso, highest values for growth parameters were recorded while Oyo location gave the best result for yield and yield components. Application of plantain waste gave the highest number of leaves (21.06), stem girth (1.22cm), leaf area (128.30cm^2), fruit length (6.73cm), fruit weight (100.00g) and total yield (3.96 ton/ha) while orange waste recorded least values for the parameters mentioned. At 100kgN/ha, highest values for number of leaves (23.66), leaf area (154.20cm^2), stem girth (1.42cm), fruit weight (131.01g/ 1.44m^2) and total yield (5.14 ton/ha) were recorded while control recorded the least values. Therefore, it can be concluded that Plantain waste and 100kgN/ha rate gave the highest performance of okra planted in Oyo. Therefore, these could be recommended for optimum growth and yield of okra in Guinea Savannah of South Western Nigeria.

KEY WORDS: *Okra, application rate, fruits waste, optimum yield, two locations.*

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is an herbaceous annual plant from the Malvaceae family, which is cultivated for its edible pods. It is often called lady's fingers and believed to have originated from Ethiopia. The global cultivation of okra spans approximately 2 million hectares, yielding nearly 10 million tons of pods annually (FAOSTAT,2018). India is the largest producer, harvesting around 6 million tons of fresh okra, followed by Nigeria at about 2 million tons (FAOSTAT, 2021). The crop is primarily grown for its young, immature fruits, which are consumed as vegetables, either raw, cooked, or fried in countries such as Sudan, Egypt, and Nigeria. Okra is a highly nutritious vegetable, low in calories and rich in protein, vitamins, minerals, and dietary fiber (Tiamiyu *et al.,* 2012).

The growth and productivity of okra are influenced by various factors, including seed quality, soil fertility, climate, agricultural practices, and the application of plant growth regulators (Shahid *et al.,* 2013). A significant limitation to okra production has been identified as low yield due to inadequate soil fertility (Ajayi *et al.,* 2017).

Okra has a relatively high demand for nutrients (Katyal and Randhawa, 2020). These nutrients can be obtained from both organic and inorganic sources. The required amount of fertilizer depends on the specific needs of the okra crop, the nutrients already present in the soil, and the available organic matter. Based on the nutrients added and those already in the soil, okra requires 100 kg/ha of nitrogen, 60 kg/ha of phosphorus, and 50 kg/ha of potassium (Katyal and Randhawa, 2020). Amina et al. (2023) suggested

for optimal growth and yield of okra.

Fruit peel waste accumulates in significant amounts daily, both at domestic and industrial levels. Typically, people discard fruit skins as waste. This is a critical issue, particularly at the industrial level, requiring proper management to reduce environmental pollution (Jariwala and Syed, 2016). Fruit peels are abundant in both macro and micro nutrients, which are crucial for plant growth (Ibrahim *et al.,* 2016). These fruit scraps are used as fertilizers to improve soil fertility and enrich soil microbiota due to their mineral content, which is vital for plant development.

Using fruit peels as a natural fertilizer presents an efficient, cost-effective, and eco-friendly method for promoting sustainable okra cultivation. This approach is gaining attention as an alternative to synthetic fertilizers due to its affordability, availability, and accessibility for farmers (Alasa, 2021). In spite of the aforementioned growth promoting potentials of fruit peels, there is scanty information on their appropriate application rates and effects on growth and fruit yield of okra. Therefore, it becomes imperative to assess the influence of different fruit wastes and rates on okra performance in Ogbomoso and Oyo, Oyo State, Nigeria

MATERIALS AND METHODS

The trials were conducted at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso and Research farm, Federal College of Education (Special), Oyo. Oyo and Ogbomoso are located in the south west savannah agroecological zone of Nigeria. Ogbomoso is located on 8° 10'N latitude and 4° 10'E longitude. The maximum temperature is 33°C and minimum temperature is 28°C and the annual rainfall is over 1000mm. (Olaniyi,2006). Oyo is located on latitude 7°51'13.2''N and longitude 3°55'56.5''E. It has an equatorial climate with wet season and dry season and relative high humidity. Average daily temperature ranges between 25^0C and 35^0C almost throughout the year (Geodatos, 2024).

Orange and plantain wastes were sourced from Owode open market at Oyo town, Cocoa pod was sourced from Ibafon village at Ogbomoso while LD88 variety of okra which is noted for superior growth and yield performance (Akintokun *et al.,*2019) was sourced from National Horticultural Research Institute, Idi Ishin Ibadan, Oyo State. The wastes were manually sorted to remove impurities and air dried for two weeks. The dried wastes were milled into powder using small feed pellet plant with 600-1000KG/H milling machine to increase its surface area and stored at room temperature (Mercy *et al.,*2014). The various milled fruit wastes were analyzed at IAR&T, Ibadan for Nitrogen, Phosphorus and Potassium contents and based on the result of the analysis obtained, the quantity of fruit wastes applied was determined. The result of the analysis is presented in Table1.

Table 1: Result of nutrient components of the fruit wastes type.

Parameters determined	Orange waste	Plantain waste	Cocoa waste
N (%)	0.26	0.70	1.55
P (%)	7.54	8.94	9.84
K (%)	18.69	89.17	47.85
Ca (%)	52.95	58.20	29.65
Mg (%)	0.74	0.79	1.81

N= Nitrogen, P= Phosphorus, K= Potassium, Ca= Calcium, Mg= Magnesium

The experimental site was manually cleared followed by field layout. The area of the land was 32m x 5.6m thereafter it was divided into 45 plots, each measuring 1.2m x 1.2m with a spacing of 1m. The 2 x 3 x 5 factorial experiment was fitted into randomized complete block design (RCBD) and replicated three times. The treatments involved three fruit waste types (Plantain, Orange and Cocoa waste), five rates of nitrogen contents; 0, 25, 50, 75, 100kg N/ha (Amina *et al*, 2023) and their various treatment combinations which amounts to 30 treatments.

Seeds were sowed at a spacing of 50cm by 50cm on a bed of 1.2m by 1.2m which gave 9 plants per bed. Missing stands were supplied a week after planting and the treatments were applied to the experimental units two weeks before sowing. Weeding, thinning, pest and diseases control were carried out at appropriate time to ensure optimum yield.

Table size okra fruit were hand harvested at 4 days interval. The agronomic parameters measured were number of leaves, leaf area, stem girth, plant height, yield and yield components.

Statistical Analysis

Data collected were analyzed using analysis of variance with the aid of Genstat 5.2 and significant means were separated using least significant difference (LSD) at 5% probability level.

Results and Discussion

Number of leaves

Location, waste type and rate had significant

($p \leq 0.05$) effect on number of leaves at 8WAS. The highest (24.79) number of leaves was recorded in Ogbomoso while Oyo gave the least value (14.86). This might be attributed to differences in climatic factors like sunlight, temperature and rainfall. Though fertilization has a great impact on vegetable production at a certain level but a number of soil factors such as soil type, soil pH, and soil salinity and environmental factors such as light, temperature, humidity, drought and flooding are responsible for the variation of the growth and yield of vegetable production (Divya *et al.,*2020). At 8WAS, highest number of leaves (21.06) was obtained from plant treated with Plantain waste followed by plants under Cocoa pod waste (20.11) while orange waste recorded the least value (18.29). The highest number of leaves obtained with plantain waste at higher rate might be attributed to its high Nitrogen content which enhanced vegetative growth and cell division. These findings corroborate the report of Gbenga *et al*. (2022) who in his findings singled out plantain fruit peel as a suitable bio-organic for enhancing growth of okra. At 100kgN/ha application rate, highest number of leaves (23.66) was recorded, closely followed by 75kgN/ha which gave (23.44) while the least value (14.52) was recorded at 0kgN/ha for all waste types. This suggests higher concentration of fertilizer may increase the nutrient uptake by the plant. Olaniyi *et al.* (2010) reported that the use of extra N on vigorous plants as the practice may result in plants producing heavy foliage which will delay flowering. At interaction level, location and waste rate with waste type and waste rate had significant ($p \leq 0.05$) effect on number of leaves at 8WAS.

Plant height

Location, fertilizer type and rate significantly ($p \leq 0.05$) influenced plant height of okra. Ogbomoso recorded tallest (41.21cm) plant was recorded while the shortest (20.57cm) was obtained in Oyo at 8WAS. Plants treated with orange waste produced the highest (33.01cm) plant height while plants under Cocoa waste gave the least (29.15cm) value. The increased plant height overtime particularly with orange waste might be attributed to its potassium content which may help to create new cells and then organize into plant tissues. This finding is in line with the report of Dayanrathna *et al* (2012) who reported significant performance of plant grown with orange waste powder after two weeks of planting. Application of 100kgN/ha rate recorded the highest value (39.73) while the control gave the lowest value (21.70cm) at 8WAS for all waste types. Similarly, Singh *et al*. (2007) reported significant increase in plant height of okra with the application of 100kgN/ha. At interaction level, location and waste type, location and waste rate with waste type and waste rate had significant ($p \leq 0.05$) effect on plant height of okra at 8WAS.

Leaf area

location, waste type and rate had significant ($p \leq 0.05$) effect on the leaf area of okra. In Ogbomoso, higher (165.00cm^2) leaf area was recorded while the lower value (56.90 cm^2) was observed at Oyo. Plants treated with Plantain waste recorded highest (128.30 cm^2) leaf area while plants under Cocoa waste recorded the lowest value (96.30 cm^2). The widest leaf area produced with the application of plantain waste might be attributed to fast rate of mineralization of the organic components present in the fruit wastes. Alasa *et al.* (2021) in his findings discovered that plantain waste contained appreciable amount of nutrients which helps to improve soil fertility thereby increasing both growth parameters like plant height, number of leaves, leaves area and yield of roselle plants. Application of 100kgN/ha recorded the highest (154.20 cm^2) leaf area while the lowest value (73.90 cm^2) was observed at 0kgN/ha for all waste types. These findings are in line with Mercy *et al*. (2014) who stated that leaf area of the rye plant was higher in fruit peel powder applied soil than control. The result also agreed with the findings of Amina *et al.* (2023) who reported widest leaf area of okra with the application of NPK fertilizer at 100kgN/ha. At interaction level, location and waste type, location and waste rate, waste type and waste rate with location and waste type and waste rate had significant ($p \leq 0.05$) effect on number of leaf area of okra at 8WAS.

Stem girth

The main effect of location, waste type and rate on stem girth of okra showed that location, fertilizer type and rate had significant ($p \leq 0.05$) effect on stem girth of okra. Plants with highest (1.32cm) stem girth was recorded in Ogbomoso while the lowest (1.00cm) was observed at Oyo. Plants treated with Plantain waste recorded highest (1.22cm) stem girth while plants under orange waste gave the least value (1.11cm). This might be attributed to fast rate of mineralization than other fruit waste types. This result is in line with the findings of Nweke *et al* (2020) who affirmed that plantain waste at different rates increased vegetative growth and yield of okra.

waste rate significantly ($p \leq 0.05$) affects stem girth of okra plant at 8WAS but not significantly different at 2,4 and 6WAS. Application of

100kgN/ha rate recorded the highest value (1.42cm) for stem girth, followed by 75kgN/ha which gave (1.23cm) while the lowest value was obtained under 0kgN/ha for all waste types. The sequence of response shown by plant stem girth under varying rates of different fruit wastes were in accordance with the findings of Singh *et al.* (2007) who reported significant increase in stem girth of okra with the application rate of 100kgN/ha. At interaction level, location and waste rate had significant (p≤0.05) on stem girth of okra.

Table 2: Effect of Location, waste type and rate on number of leaves, plant height, leaf area and stem girth of okra at 8WAS

Agronomic parameters				
Treatments	Number of leaves	Plant height(cm)	leaf area(cm^2)	Stem girth(cm)
Location(L)				
Ogbomoso	24.79	41.21	165.00	1.32
Oyo	14.86	20.57	56.90	1.00
LSD (p≤0.05)	1.01	1.40	5.65	0.03
Waste type (WT)				
Cocoa	20.11	29.15	96.30	1.14
Orange	18.29	33.01	108.20	1.11
Plantain	21.06	30.51	128.30	1.22
LSD (p≤0.05)	1.23	1.71	6.92	0.04
Waste rate (WR) (kgN/ha)				
0	14.52	21.70	73.90	0.90
25	18.37	26.38	88.30	1.07
50	19.11	29.90	111.40	1.16
75	23.44	36.75	127.00	1.23
100	23.66	39.73	154.20	1.42
LSD (p≤0.05)	1.59	2.21	8.94	0.05
Interaction				
L X WT	Ns	2.42	9.79	Ns
L X WR	2.25	3.12	12.64	0.07
WT X WR	2.76	3.83	15.48	Ns
L X WT X WR	Ns	Ns	21.89	Ns

LSD= Least Significant Difference

The main effect of location, waste type and rate on number of leaves, plant height, leaf area and stem girth of okra plant are presented in Table 2.

Yield components

The main effect of location, waste type and rate on number of days to first flowering and yield components of okra are shown in Table 3. Location and waste rate significantly (p≤0.05) affect number of days to first flowering while waste type had no significant effect on number of days to first flowering. Higher (64.78) number of days to first flowering was recorded in Oyo while the lower value (55.49) was observed at Ogbomoso. This result might be attributed to climatic differences. Application of 75kgN/ha rate recorded the highest (61.67) number of days to first flowering, closely followed by 100kgN/ha rate which gave (61.56) while 0kgN/ha recorded the least (54.94) number of days to first flowering. This agreed with the report of Badamasi *et al*. (2023) who reported that control had the earliest days to first flower bud opening (71.0) than the plots with nitrogen application compared with the application of 120 kg N ha-1 which took longer days to first flower bud opening (75.0).

Location significantly (p≤0.05) affects number of fruits and fruit weight. Oyo recorded highest number of fruits (8.46) and fruit weight (92.17) while the least number of fruits (8.32) and fruit weight (86.42) were obtained at Ogbomoso. Waste type had significant (p≤0.05) effect on number of fruits, fruit length and fruit weight. Plants treated with Plantain waste recorded highest number of fruits (9.25), fruit length (6.73cm) and fruit weight (100.00g) while plants treated with orange waste produced the least values. This may be attributed to the presence of potassium in plantain waste which might have induced fruiting at the expense of vegetative growth. Mustapha *et al.* (2021), reported that Plantain and Pineapple wastes are substantially rich in soil micro and macro nutrients to enhance soil fertility and increase plant yield, thus sanitizing the environment and reducing the negative impacts of inorganic fertilizers. Waste rate had significant(p≤0.05) effect on number of fruits, fruit length, fruit diameter and fruit weight. Application of 75kgN/ha gave the highest number of fruits (11.17), 100kgN/ha produced highest fruit length (7.66), diameter (8.58) and fruit weight (131.01), while application at 0kgN/ha for all waste types recorded the least value for number of fruit (4.71), fruit length (4.08), fruit diameter (5.30) and fruit weight (37.35). Notably, application at 75 and 100kgN/ha emerged as effective fruit rate for the yield components. This might be as a result of wider stem girth at 100kgN/ha application rate which results in longer and bigger roots thereby increasing the surface area which promotes the availability and assimilation of other nutrients, hence increased vegetative parameters which could also culminate into increased yield. This result is in line with the findings of Amina *et al.* (2023), who reported increased yield components of okra at 100kgN/ha application rate. At interaction level, location with waste type, location with waste rate, waste type with waste rate and location with waste type with waste rate had significant (p≤0.05) effect on number of fruits, fruit length and fruit diameter.

Table 3: Effect of location, fertilizer type and rate on yield and yield components of okra.

Yield component

Treatments	DF	NF	FL (cm)	FD (cm)	FW(g)
Location					
Ogbomoso	55.49	8.32	6.32	7.01	86.42
Oyo	64.78	8.46	6.11	7.09	92.17
LSD (p≤0.05)	0.58	0.13	Ns	Ns	0.30
Waste type(WT)					
Cocoa	60.20	8.60	6.13	6.98	90.02
Orange	60.07	7.32	5.80	7.09	77.87
Plantain	60.13	9.25	6.73	7.08	100.00
LSD (p≤0.05)	Ns	0.16	0.19	Ns	0.37
Waste rate (WR) (KgN/ha)					
0	54.94	4.71	4.08	5.30	37.35
25	61.28	6.90	5.40	6.25	70.64
50	61.22	8.23	6.35	7.00	88.66
75	61.67	11.17	7.58	8.12	118.82
100	61.56	10.95	7.66	8.58	131.01
LSD (p≤0.05)	0.92	0.21	0.25	0.36	0.48
L X WT	Ns	0.23	0.27	Ns	0.52
L X WR	Ns	0.30	0.35	0.51	0.67
WT X WR	ns	0.36	0.43	0.63	0.83
L X WT X WR	ns	0.51	0.61	0.89	1.17

LSD= Least Significant Difference

Note: DF =Days to first flowering * NF= Number of fruit /plants *FL= Fruit length/plant*FW= Fruit weight/plant* FD=Fruit diameter.

Total yield

Main effect of location, waste type and rate are presented in figure 1,2 and 3. Location, waste type and rate had significant (p≤0.05) effect on total yield of okra. Higher yield (3.68 ton/ha) was recorded at Oyo while Ogbomoso gave the lower value for total yield (3.39 ton/ha). Application of plantain waste gave highest total yield (3.96 ton/ha), followed by cocoa which recorded (3.55 ton/ha) waste while the least value (3.09 ton/ha) was obtained from orange waste. Nweke *et al.* (2020), in their findings also affirmed that plantain waste at different rates increased vegetative growth and yield of okra. The result revealed that at 100kgN/ha application, higher total yield (5.14ton/ha) was observed, followed by 75kgN/ha which recorded (4.70kgN/ha) while control gave the lower value (1.47ton/ha) for total yield. This is similar to the findings of Akinmutimi and Amaechi, (2015) who reported that higher rates of poultry manure gave the highest okra fruit performance.

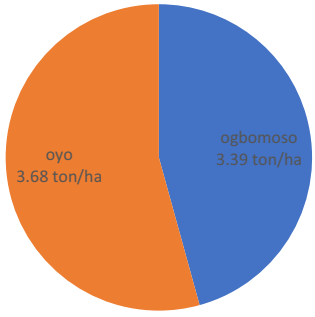

Fig.1.The main effect of location on total yield of okra.

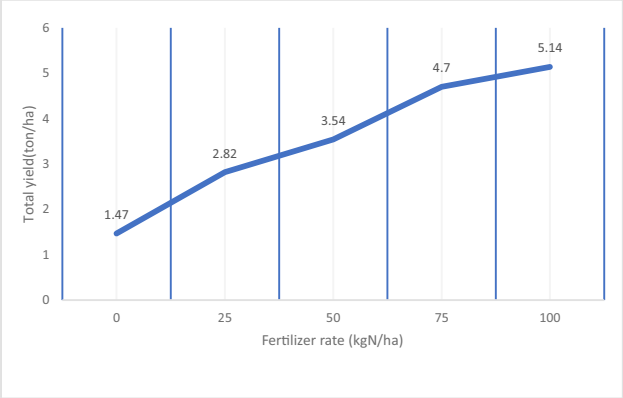

Fig. 2. The main effect of fertilizer rate on total yield of okra

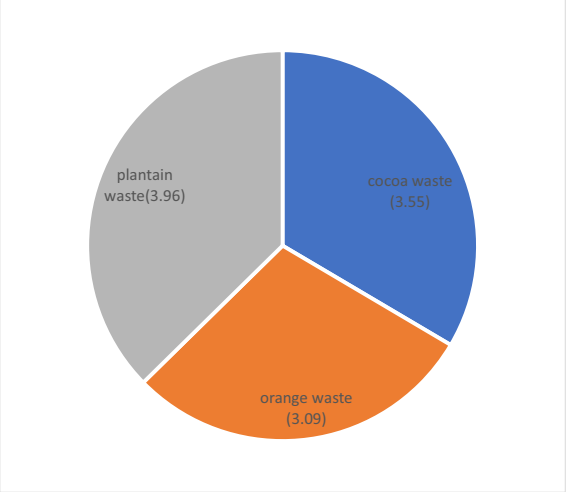

Fig.3. The main effect of fruit waste type on total yield (ton/ha) of okra.

Conclusion

The result showed that location, waste type and rate had significant (p≤0.05) effect on the growth and yield of okra. Higher values of agronomic parameters were recorded at Ogbomoso while oyo location recorded optimum yield. Plantain waste and 100kgN/ha rate recorded optimum growth and yield while orange waste and 0kg N/ha gave lower values of the parameters mentioned at both locations. Therefore, Plantain waste and 100kgN/ha can be recommended for optimum growth and yield of okra in Ogbomoso and Oyo.

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