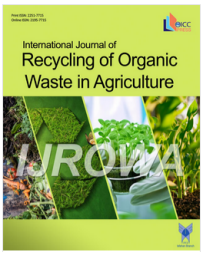

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Comparative study of cucumber (*Cucumis sativus* L.) cultivars under organic fertilizer treatments in the Southern Guinea Savanna, Nigeria

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Abstract:

Purpose: The study investigated the growth and yield of cucumber cultivars under the influence of the organic fertilizers application.
Method: A 4 × 5 factorial combination of four cucumber cultivars (Poinsett, Marketer, Marketmore, and Darina hybrid) and four organic fertilizers (Sunshine, Aleshinloye, Gateway, KWASU organic-based fertilizer-KOBF, and the control) in a completely randomized design at the screen house and a randomized complete block in split-plot fashion in the field were replicated three times.
Results: At 8 WAP in the screen house, the leaf areas and vine length at the control were significantly ($p < 0.05$) lower compared to the treated plots with the application of organic fertilizers. The Darina hybrid had significantly longer fruit (17.8cm), thicker fruits (13.70 cm), and a higher Fruit yield per hectare (10083.23 kg) compared to other cultivars. In the field, regardless of the organic fertilizer applied, leaf area, fruit length, fruit circumference, and fruit yield per hectare produced at the control were significantly lower than where there were soil amendments. The treated plots with the application of KOBF had significantly more leaf area, longer and thicker fruits, and fruit yield per hectare compared to the application of other organic fertilizers. The fruit length (12.74 cm), fruit circumference (12.30 cm), and fruit yield per hectare (4048.29 kg) obtained with the application of Aleshinloye organic fertilizer were significantly ($p < 0.05$) lower compared to other organic fertilizers.
Conclusion: The Darina hybrid was superior to other cultivars with the application of KOBF organic fertilizer.

Keywords: Darina hybrid; Fruit yield; KOBF; Market more; Marketer; Poinsett

1. Introduction

Cucumber (*Cucumis sativus* L.) is an economic vegetable crop in the family Cucurbitaceae. It is mainly grown for its edible fruit, eaten fresh at the immature stage, or cooked to provide vitamins, minerals, and antioxidants for the human body (Jitendra et al., 2013; Mallick, 2022). The recent increase in cucumber production observed in Nigeria, according to Okoli and Nweke (2015), was probably due to awareness created by market demand, economic returns, short maturity dates, and nutritional and medicinal values. Despite the nutritional and medicinal values of cucumber, Olawuyi et al. (2011) opined that the majority of farmers in Nigeria have not considered cucumber cultivation and its utilization as an alternative to other crops due to the poor availability of improved seeds, capital, climatic factors, pests and diseases, and the farmer's inexperience with cucumber cultivation (Umeh and Ojiakor, 2018) and the relatively low yield obtained by the grower as a result of the inherent low nutrient status of the soil (Bernard and Japhet, 2020). Continuous cropping, as often practiced in Nigeria, is associated with inorganic fertilizer usage without considering the need for soil amendment. According to Purbajanti et al. (2019), The decrease in cucumber production is partly due to the shrinking field area and insufficient sup-

ply of essential nutrients. Hence, the application of external soil nutrients, either from organic or inorganic sources, becomes important for optimum yield in cucumber production. Although the application of inorganic fertilizer has been reported to increase cucumber production (Abdel-Mawgoud et al., 2005; Ahmed et al., 2007; Jilani et al., 2008; Mohammed et al., 2021), the recent concept of eco-friendly and the ever-increasing cost of inorganic fertilizer beyond the resource-poor farmer have called for organic fertilizer with suitable cultivars for sustainable and maximum productivity in cucumber production.

Recognizing the improvement in environmental sustainability as well as public health inherent in organic materials in crop production, Ojeniyi (2000) and Maritus and Vleic (2002) advocated for increased use of organic fertilizer in crop production. Organo-mineral fertilizer was reported to improve the growth of cucumber varieties (Olaniyi et al., 2009; Ajibola and Amujoyegbe, 2020) since it contains nitrogen that promotes vegetative growth (Akanbi et al., 2005). In an attempt to determine the nutrient requirement of cucumber, Eifediyi and Remison (2010) observed a positive response of cucumber to organic, inorganic, and a combination of organic and inorganic fertilizers for optimum growth and fruit yield. In another study, Shehata et al. (2012) reported enhanced growth and quality fruits with the application of combined organic and inorganic fertilizers to cucumbers. Similarly, Adekiya et al. (2022) observed that the growth, yield, and mineral composition of cucumber were enhanced in a soil-less medium using coco peat and rice husk. Considering the high sand content of most Nigerian soils, Mopelola et al. (2017) observed that cucumber is better produced with organo-mineral fertilizers due to the gradual release pattern of the nutrient as well as the environmental friendliness of this fertilizer. Even though cucumber can be grown in virtually all the eco-logical zones in Nigeria as an alternative to other crops, its production is limited due to insufficient information on the appropriate cultural practices and accessibility of varieties that are suitable for each zone (Ekwu et al., 2007).

Because yield potentials of crops differ across the ecological zone, it has been suggested that testing new crop varieties across the specific ecological zone should be an established practice in plant breeding for selecting cultivars that are adapted for each zone (Ikem and Anusa, 2004). Sajjan et al. (2002) mentioned that plant height, vine length, leaf area, number of branches, and fruit yield of the crop were influenced by genetic factors of different varieties. Similarly, Odeleye and Odeyeye (2001) opined that growth characters, yield, and yield components differed among crop varieties. In an attempt to increase cucumber production in Nigeria, different cultivars have been evaluated and recommended for each zone. Ojeifo et al. (2008) observed that market-more and centriolo marketer cultivars were promising among all cucumbers in South-West Nigeria. Adinde et al. (2016) observed in their study in southern Nigeria that Poinsett-76 was more adapted to the zone and consequently performed better than other varieties. In a recent study in the rainforest zone of Nigeria, Obasi et al. (2019) recommended the Darina cultivar since it out-yielded other cultivars. Studies have shown that cucumber productivity depends to a large extent on applied plant nutrients and varies among cultivars in different ecological zones. To the best of our knowledge, cucumber cultivars have not been studied under organic fertilizers in the Southern Guinea Savanna agro-ecological zone of Nigeria. This study was therefore carried out to evaluate the growth and yield of cucumber cultivars as influenced by organic fertilizers in the Southern Guinea Savanna, Nigeria.

2. Material and methods

Location of the experimental site

The screen and field studies were carried out during the 2019 dry season at the Faculty of Agriculture, Kwara State University, Malete, and the Islamic village of Gerewu Ilorin, West Local Government, respectively. Malete is located at 316.37 m above sea level within the latitude of 08°43′N and longitude of 4°28′E of the equator, while Gerewu village is situated at latitude 08°28′N and longitude 04°35′E and is about 320m above sea level. The two locations are in the Southern Guinea Savannah agro-ecological zone of Nigeria, which is characterized by distinct wet and dry seasons. The wet season commences in March or April and ends in October, with a dry spell from mid-July to mid-August. The Koppen climate of the area of study is tropical with the dry season usually commencing towards the end of October and lasting until March or April of the following year. The land area forms part of the southwestern region of the Nigerian basement complex, a region of basement recurrence and plutonism during the Pan-African orogeny (Olowoake et al., 2022). The soils of Ilorin are predominantly derived from ferruginous and crystalline acidic rocks and are predominantly Alfisols (Olaniyan, 2001).

Soil sampling and analysis

In the screen house, the soil used in the study area was collected from Kwara State University Teaching and Research, Farm Malete, Kwara State. In the field, soil samples were randomly collected at 0–20 cm depth using a soil auger. Collected samples were air-dried and then taken to the laboratory to determine their physiochemical properties. The particle size was determined by the hydrometer method (Bouyoucos, 1962), soil organic carbon was determined by (Nelson et al., 1982), and total nitrogen was evaluated by the (Walkley and Black, 1982) method and the micro Kjeldahl digestion method (Bremner and Mulvancy, 1982), respectively. Available P was extracted using Bray and Kurtz (1945) method and exchangeable bases (Ca, Na, Mg, and K) were extracted (NH4OAC). The flame photometer measured K and Na concentrations, while the atomic absorption spectrophotometer determined Mg and Ca. The pH of the soil water was determined at 0.01M $CaCl_2$ with a glass electrode pH meter and an electrical conductivity of 1:5 (w/v) in the deionized water suspension.

Planting materials and organic fertilizers

The cucumber cultivars Poinsett, Marketer, Marketmore, and Darina Hybrid used as planting materials were purchased from a reliable agro-outlet in Amilegbe, Ilorin,

Kwara State, Nigeria. Poinsett is an open-pollinated cucumber that is highly vigorous and monoecious, with maturity dates of 50–55 days. The fruit is dark green, non-bitter, cylindrical, with a round end and smooth, thin skin. Marketer is also an open-pollinated, rugged, and hardy vigorous cucumber cultivar with short, dark green, smooth, and thornless fruits. Marketmore is a monoecious cucumber with broad leaves, cylindrical and uniform fruits, and maturity dates between 45 and 55 days. Darina is characterized by a parthenocarpic, vigorous growing habit with dark green fruit accompanied by white thorns. The fruit is also rounded and hollow in shape.

The fertilizers treatments used for the study were: Sunshine grade A, Aleshinloye grade B, Gateway, KOBF, and the control. Sunshine organic fertilizer is an un-amended compost commercial fertilizer developed by Ondo State Government, Nigeria while Aleshinloye is a composted household waste amended with mineral fertilizer, a commercial fertilizer produced from Aleshinloye Fertilizer Company, Ibadan, Oyo state. Gateway is an un-amended compost and a commercial fertilizer produced by Aratibiotech Limited, Abeokuta, Ogun-State, Nigeria. KOBF was a non-commercial fertilizer developed by crop scientists at Kwara State University from tithonia plants mixed with poultry manure and certain organic residues amended with inorganic fertilizer. The chemical composition of the fertilizers is presented in Table 1.

Treatments and experimental design

In the screen house, four organic fertilizers and the control were combined with four cucumber cultivars as a 4 × 5 factorial combination in a completely randomized block design (CRD) and replicated three times. The field experiment was designed as a 4 × 5-factorial in a randomized complete block design (RCBD) on a split-plot fashion and duplicated three other times. The main plot consists of four cucumber cultivars (Poinsett, Marketer, Market More, and Darina Hybrid), while the subplot was made of five organic fertilizer types (Sunshine, Aleshinloye, Gateway, KOBF, and the control without soil amendment). Each plot measured 3.0 m × 3.0 m with 0.5 m between plots and 1.0 m between blocks.

Field and screen house experiments

The experimental site was manually cleared of existing vegetation with a hoe and cutlass; thereafter, the debris was packed, after which the soil was tilled and marked into its respective plots. At the screen house, three seeds were sown per stand and were thinned to two plants per stand two weeks after planting. In the field, the crops were planted at a spacing of 60 cm by 30 cm, with one plant maintained per stand, giving a plant population of 55,555 plants per hectare. The plants were watered every morning and evening to ensure an adequate water supply.

Agronomic management practices

The organic fertilizers were applied two weeks before planting at a rate of 100 kg N/ha. The weeds on the pot and field were controlled manually using hand weeding and hoe weeding, respectively, throughout the experimental period. Neembicidine, an organic insecticide, was applied at a rate of 20 ml per 10 liters of water to control insect pests using a knapsack sprayer at 4 and 6 WAP. The crops were staked 3 weeks after planting to expose the leaves and also prevent the fruits from touching the ground to avoid disease infection.

Data collection and analysis

Data were collected on the following parameters: vine length, number of leaves, leaf area at 4, 6, and 8 WAP, and the number of days to attain 50% flowering. The weight of fruit per plant, fruit length, fruit circumference, and fruit yield per hectare were taken at harvest. All data collected were subjected to an analysis of variance using the DSAASTAT.1.101 version. (2011). The treatments mean where significant differences exist were separated using the least significant difference at a 5% level of probability.

3. Results and discussion

Soil analysis

The results of some physical and chemical properties of the soil at the experimental site are presented in Table 2. The result shows that the soil is moderately acidic, sandy, and high in organic matter and organic carbon, and low in available phosphorus. Potassium, effective cation exchange capacity, and nitrogen are moderate.

The study showed that the application of organic fertilizers enhanced the growth and yield components of cucumbers irrespective of organic fertilizer types. This implies that the soil in the zone is relatively low in both micro and macro elements and cannot support cucumber growth and yield without external amendments. This inherent low nutrient status of Savannah soils has been reported by Labaran and Idris (2016) due to continuous farming and the indis-criminate

Table 1. Chemical composition of Gateway compost, Aleshinloye Grade B, Sunshine Grade B, and KOBF organic fertilizers.

	Nutrient (%)		
Fertilizer type	Nitrogen (N)	Phosphorus (P)	Potassium (K)
*Gateway compost (un-amendedcompost)	1.23	1.58	0.23
*Aleshinloye Grade B (un-amendedcompost)	1.20	0.80	2.90
*Sunshine Grade B (un-amendedcompost)	3.50	1.00	2.50
**KOBF (amended)	4.98	4.68	4.72

*Source: Olowoake, 2019, **Source: Afe et al., 2018.

Table 2. Physical and Chemical Properties of the Experimental sites before planting.

Soil parameter	**Location**	
	Gerewu Village (Field)	Malete (Screen house)
Sand (%)	96.40	96.76
Silt (%)	0.36	0.36
Clay (%)	2.52	2.88
Textural class	sand	sand
Organic carbon (%)	0.57	0.53
Organic matter (%)	0.97	0.92
Total Nitrogen (%)	0.21	0.12
Available phosphorous (mg/kg)	15.82	18.27
pH(water)	8.40	7.25
pH(CaCl)	5.93	6.91
Exchangeable bases (cmol/kg)		
Mg	0.60	1.15
Ca	0.55	0.55
Na	0.04	0.03
K	2.55	2.40
Exchangeable acidity (cmol/kg)	3.24	2.88

application of synthetic fertilizers that are common among the farmers in the zone. For instance, the Teaching and Research Farm, where soil was collected for the screen house study, has been under continuous cultivation over the years during the farm practical training of the students at the Faculty of Agriculture. Tivet et al. (2013) had earlier observed that changes in the soil properties due to continuous cultivation were a major factor responsible for soil degradation and a decline in crop yield.

Growth and yield parameters of cucumber in the screen house and the field

The significant interactive effect of the number of leaves and leaf area at 6 and 8 weeks after planting (WAP) is presented in Table 3. Among the cucumber cultivars, the Darina hybrid significantly produced more leaves with a higher leaf area compared to other cultivars. Although the marketer cultivar seemed to have more leaf area than the Marketmore at 6 and 8 WAP, the difference was not significantly manifested until the crop was planted in the field. The number of leaves produced at 6 WAP (9.62) and 8 WAP (24.12) with the application of KOBF at the screen house was significantly higher compared with other organic fertilizers. The number of leaves produced and the leaf area at the control plots at both the screen house and in the field were significantly lower compared to the treated plots with the application of organic fertilizers. Application of KOBF and gateway organic fertilizer produced a similar number of leaves at 4, 6, and 8 WAP in the field. The vine length and the number of days taken to attain 50% flowering in cucumber cultivars as influenced by organic fertilizers are presented in Table 4. The Darina hybrid significantly produced longer vines, 75.81 cm. and 55.06 cm., respectively, at the screen house and in the field at 6 WAP compared to other cultivars. The Darina cultivar took fewer days to attain flowering compared to other cultivars, either in the screen house or in the field. Application of KOBF was superior to other treatments in terms of vine length at 6 WAP. The control treatment significantly produced shorter vines and took longer days to attain flowering at both the screen house and in the field compared to other treatments. The treatment with the application of KOBF significantly had shorter days to attain flowering compared with the application of other organic fertilizers. Ibrahim et al. (2000) had earlier reported that the differences in growth indices of crops were normally attributed to their genetic constitution. Similarly, Sajjan et al. (2002) mentioned that growth characteristics of crops such as plant height, vine length, leaf area, number of leaves or branches, and fruit yield were influenced by genetic factors.

Although all the cucumber cultivars responded positively to the application of organic fertilizers, their responses differed. Regardless of organic fertilizer, the growth and yield increased in descending order with Darina > marketer > market more > poinsett. This significant difference in yield and yield components showed that there could be genetic variation among cucumber cultivars. Genetic variations among cucumber cultivars have been reported (Ojeifo et al., 2008; Adinde et al., 2016).

Fruit length and circumference and fruit yield per hectare of cucumber cultivars as influenced by organic fertilizers are presented in Table 5 and Fig. 1. There was no significant difference between a marketer and marketmore cultivars in the fruit length and circumference. The fruit length, fruit circumference, and fruit yields per hectare of the Poinsett cultivar were significantly lower compared with other cultivars in both the greenhouse and the field. The Darina cultivar was superior to other cultivars in fruit length, fruit circumference, and fruit yield per hectare. At the screen house, the fruit length (17.76 cm) and fruit circumference (14.64 cm) with the application of KOBF were significantly higher compared to other organic fertilizers. Superior fruit

Table 3. Response of cucumber cultivars to organic fertilizers on the number of leaves and leaf area at the screen house and the field.

Cultivars	Number of leaves					Leaf area (cm^2)				
	Screen house			Field		Screen house			Field	
	6WAP	8WAP	4WAP	6WAP	8WAP	6WAP	8WAP	4WAP	6WAP	8WAP
Point Set	7.70c	16.31d	6.86c	17.86c	29.04a	125.9d	170.50c	45.64c	82.91d	130.30d
Marketer	7.60c	20.00b	7.56b	18.77b	28.52a	140.70b	202.22b	47.72b	100.60b	152.10b
Market More	8.50b	17.72c	7.43b	20.60a	31.64a	140.30b	195.63b	45.65c	88.12c	132.90c
Darina	8.70a	21.50a	8.92a	20.76a	28.88a	147.10a	296.95a	56.40a	144.8a	187.90a
LSD	0.52	0.59	0.21	0.20	7.18	0.50	20.75	0.11	0.22	0.14
Organic fertilizers										
Sunshine	7.87c	19.00c	7.25c	19.07c	28.48a	147.80c	191.3b	49.77c	110.20c	165.91c
Aleshinloye	7.00d	17.12d	8.22b	20.44b	29.90a	140.40d	221.80a	49.85c	110.50c	165.68d
Gateway	8.50b	22.25b	8.59a	22.27a	35.15a	152.63b	213.30a	57.42b	130.10b	188.8b
KOBF	9.62a	24.12a	8.80a	22.35a	35.10a	168.80a	232.6a	61.02a	138.40a	194.4a
Control	6.50d	18.87e	5.60d	13.35d	18.90b	80.04e	97.10c	26.20d	31.27d	39.30e
LSD	0.52	0.59	0.21	0.20	7.18	0.50	20.75	0.11	0.22	0.14
C × OF	*	*	*	*	*	*	*	*	*	*

Values with the same letter(s) in the same column under the same treatment are not significantly different at a 5% level of probability by the least significant difference.
KOBF=KWASU organic based fertilizer, C=Cucumber cultivar, OF= Organic fertilizer *=Significant LSD= Least significant different.

yield at both the screen house and the field was recorded with the Darina cultivar.

The interactive effects of cucumber cultivars and organic fertilizers on the number of leaves, leaf area, vine length, fruit length, and fruit yield per hectare in the screen house are presented in Table 6. Regardless of the cucumber cultivar, the application of KOBF produced more leaves with a higher leaf area at 8 WAP. The vine length, fruit length, and fruit yield per hectare were also higher compared to the application of other organic fertilizers. The untreated plots significantly recorded a lower number of leaves, accompanied by a lower leaf area, shorter vine and fruit length, and a lower fruit yield per hectare, irrespective of cucumber cultivar.

The interactive effects of cucumber cultivars on organic fertilizers on the number of leaves, leaf area, and vine length at 8 weeks after planting, fruit length, and fruit yield in the field are presented in Table 7. Regardless of the cucumber

Table 4. Response of cucumber cultivars to organic fertilizers on vine length and days to 50% flowering at the screen house and the field.

Cultivars	Vine length (cm)				Days to 50% flowering	
	6WAP	6WAP	8WAP	8WAP		
	Screen house	Field	Screen house	Field	Screen house	Field
Point Set	55.92c	39.70b	107.32c	72.31a	46.20b	48.32ab
Marketer	61.95b	44.50b	119.42b	69.73a	46.00b	50.16a
Market More	54.00c	31.30b	107.70c	71.92a	47.41a	44.75ab
Darina	75.81a	55.06a	132.01a	78.16a	36.00c	40.78b
LSD	0.72	7.82	2.63	23.06	0.87	5.03
Organic fertilizers						
Sunshine	59.00c	41.42b	122.52c	74.35a	43.00c	46.98a
Aleshinloye	55.00d	40.85b	124.31bc	75.99a	44.25b	44.30a
Gateway	76.80b	45.14b	127.00ab	86.43a	41.00d	44.73a
KOBF	80.50a	53.07a	127.30a	87.20a	38.10e	40.73b
Control	38.20e	26.07c	78.00d	55.17b	53.25a	49.30a
LSD	0.72	7.82	2.63	2.31	0.97	5.62
C × OF	*	*	*	NS	*	NS

Values with the same letter(s) in the same column under the same treatment are not significantly different at a 5% level of probability by the least significant difference. KOBF=KWASU organic based fertilizer, C=Cucumber cultivar, OF= Organic fertilizer.
*=Significant, NS= Non significant, LSD= Least significant different.

Table 5. Response of cucumber cultivars to organic fertilizers on fruit length and circumference, fruit yield per plant at the screen house, and the field.

	Fruit length (cm)		Fruit circumference (cm)		Fruit yield (kg/ha)	
Cultivars	**Screen**	**Field**	**Screen**	**Field**	**Screen**	**Field**
Point Set	8.90c	12.82c	7.90c	10.76c	3205.52d	4646.62d
Marketer	13.30b	14.94b	11.5b	11.60b	4677.73b	5130.50b
Market more	13.50b	13.40b	11.30b	11.51b	3566.63c	4985.51c
Darina	17.80a	16.88a	13.70a	14.22a	10083.2a	7546.59a
LSD	0.21	0.46	0.19	0.20	7.22	13.88
Organic fertilizers						
Sunshine	13.62b	13.50b	10.92c	10.17d	4483.29c	6420.49c
Aleshinloye	12.43c	12.74c	9.73d	12.30c	4349.92d	4048.29d
Gateway	13.55b	17.35a	12.15b	14.75b	6677.73b	7294.92b
KOBF	17.76a	17.77a	14.64a	15.35a	7999.92a	7763.81a
Control	9.60d	11.18d	8.30e	7.60e	3399.90e	2367.75e
LSD	0.58	0.46	0.51	0.20	19.44	18.50
C × OF	*	*	*	*	*	*

Values with the same letter(s) in the same column under the same treatment are not significantly different at a 5% level of probability by the least significant difference. KOBF=KWASU organic based fertilizer, C=Cucumber cultivar, OF= Organic fertilizer.
*=Significant LSD= Least significant different.

cultivar, the application of organic fertilizer enhanced the growth and yield of the cucumber more than the control without soil amendment. The untreated plots significantly recorded a lower number of leaves, accompanied by a lower leaf area, shorter fruit length, and lower fruit yield, irrespective of cucumber cultivar. The Darina hybrid with the application of KOBF produced more leaves with a higher leaf area and a longer vine and fruit yield than other treatments. The application of Aleshinloye fertilizer was superior to sunshine fertilizer in the growth and yield of the Darina hybrid.

The superior fruit yield of the Darina cultivar as observed in this study is in harmony with that of Obasi et al. (2019). As expected, the Darina cultivar, being a hybrid, is tolerant and resistant to several diseases and pests, like the mosaic virus from cucumber and powdery mildew. The hybrid nature of this cultivar accompanied by the vigorous growth habit and shorter number of days to attain flowering and fruiting, might have given this cultivar an advantage over others. This was evident at both the screen house and field study, as this cultivar had more leaves and leaf area that could have enhanced photosynthesis better than other cultivars; hence, the observed superiority in growth and yield compared to other cultivars. The low yield of the Poinsett cultivar irrespective of fertilizer applied as observed in this study did not conform to the earlier studies of this cultivar (Adinde et al., 2016; Yaduma et al., 2016). The discrepancy could be attributed to environmental factors and the period of planting, as the two trials were carried out in two contrasting ecological zones. The implication of this is that cucumber cultivars appeared to be location-specific. This suggests constant evaluation of cucumber cultivars that are suitable for cultivation and/or adapted for each ecological zone. Recognizing the differences in crop yield among crop

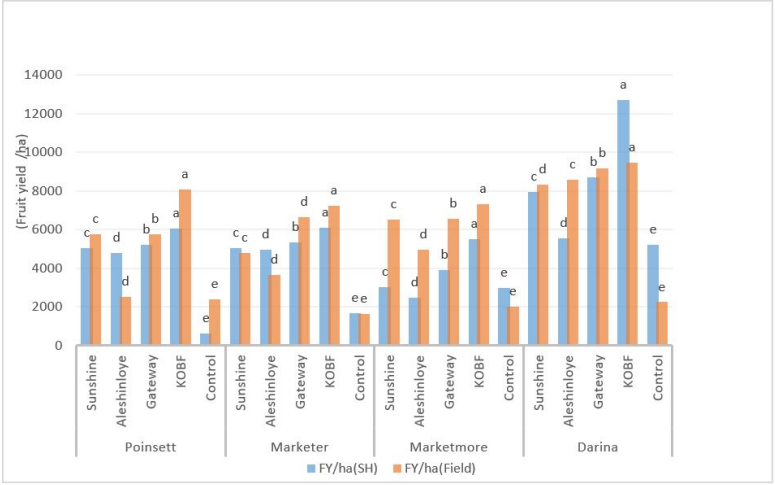

Figure 1. Interaction between cucumber cultivars and organic fertilizers on fruit yield at the screen house and in the field.

Table 6. Interactive effects of cucumber cultivars and organic fertilizers on the number of leaves and leaf area at 8 weeks after planting, vine length, and fruit yield/plant (screen house).

Cucumber cultivars	Organic fertilizers	Number of leaves @8WAP	Leaf area @8WAP	Vine length @ 8WAP	Fruit yield (kg/ha)
Poinset	Sunshine	20.50c	189.06b	102.51d	5041.61b
	Aleshinloye	15.55d	186.70b	123.33b	4774.95c
	Gateway	26.00b	212.50a	119.21c	5194.39b
	KOBF	29.50a	200.50ab	138.00a	6057.71a
	Control	8.50e	61.60c	54.30e	627.77e
Marketer	Sunshine	23.50b	227.20b	125.00b	5027.72d
	Aleshinloye	23.00b	160.80c	123.00b	4972.17d
	Gateway	21.00c	256.00a	124.50b	5333.00b
	KOBF	25.00a	262.30a	140.12a	6111.05a
	Control	15.00d	105.01d	84.50c	1672.76e
Market more	Sunshine	16.50c	202.00bc	130.53c	3005.53c
	Aleshinloye	15.00d	216.09b	140.05b	2466.62e
	Gateway	20.00b	195.70c	152.00a	3894.41b
	KOBF	24.00a	265.00a	154.00a	5505.50a
	Control	13.00e	99.60d	83.50d	2977.75d
Darina hybrid	Sunshine	15.50c	213.51b	106.00b	7955.48c
	Aleshinloye	15.00c	173.33c	110.03a	5527.72d
	Gateway	18.00b	217.80b	109.21a	8708.80b
	KOBF	22.00a	258.20a	108.51a	12719.32a
	Control	11.00d	122.00d	90.00c	5203.28e
LSD		0.48	16.94	2.15	29.00

Values with the same letter(s) in the same column under the same treatment are not significantly different at a 5% level of probability by the least significant difference. KOBF=KWASU organic based fertilizer, C=Cucumber cultivar, OF= Organic fertilizer, *=Significant LSD= Least significant different.

Table 7. Interactive effects of cucumber cultivars and organic fertilizers on the number of leaves and leaf area at 8 weeks after planting, vine length, fruit length, and fruit yield (kg/ha).

Cultivars	Organic fertilizers	Number of leaves @8WAP	Leaf area @8WAP	Vine length @ 8WAP	Fruit length	Fruit yield(kg/ha)
Poinset	Sunshine	30.3a	156.72c	73.06d	13.21c	5755.54c
	Aleshinloye	29.9a	135.34d	76.60c	13.18c	2527.77d
	Gateway	33.93a	160.96b	84.21ab	13.72c	5766.66b
	KOBF	34.41a	168.51a	86.80a	18.12a	8094.43a
	Control	16.70b	30.10e	40.90e	15.31b	2399.99e
Marketer	Sunshine	29.20b	153.00c	65.80c	11.21b	4783.32c
	Aleshinloye	28.32b	143.00d	56.73d	10.20c	3633.32d
	Gateway	32.81ab	159.20b	82.50b	16.41a	6661.10b
	KOBF	35.13a	173.90a	94.56a	16.55a	7233.32a
	Control	17.23c	35.30e	49.16e	10.00c	1611.10e
Market more	Sunshine	33.12a	153.50d	76.83c	9.86d	6533.32c
	Aleshinloye	32.20a	170.31c	67.73d	12.41c	4955.55d
	Gateway	37.33a	195.20b	80.52b	17.10b	6572.21b
	KOBF	36.84a	199.92a	83.96a	18.40a	7305.54a
	Control	18.80b	42.00e	52.56e	9.33e	1988.88e
Darina	Sunshine	21.35c	200.40d	77.80d	16.10d	8311.10d
	Aleshinloye	21.22b	213.90c	81.73c	17.16c	8572.21c
	Gateway	36.60a	235.4b	90.16b	19.72b	9155.54b
	KOBF	34.10ab	240.10a	95.00a	20.90a	9455.54a
	Control	22.90c	50.00e	46.00e	10.12e	2238.88e

Values with the same letter(s) in the same column under the same treatment are not significantly different at a 5% level of probability by the least significant difference. KOBF=KWASU organic based fertilizer, C=Cucumber cultivar, OF= Organic fertilizer, *=Significant LSD= Least significant difference.

varieties in the different ecological zones, Ikem and Anusa (2004) suggested that testing new crop varieties across the ecological zones should be an established practice in plant breeding.

The application of KOBF was found to be superior to other organic fertilizers, followed by Gateway, Sunshine, and Aleshinloye. This implies that variation exists among the organic fertilizers applied to the growth and yield components of cucumber. The variation could be attributed to the differences in the materials from which these fertilizers were formulated, which might have affected their rate of mineralization and plant uptake. For instance, Aleshinloye Organic Fertilizer Grade B and Sunshine Grade B are un-amended compost. KOBF was recently developed by crop scientists at Kwara State University from tithonia plants, poultry manure, and certain organic residues amended with inorganic fertilizer. The superiority of KOBF over other organic fertilizers in the growth and yield of okra and maize has been reported (Afe et al., 2018; Fasakin et al., 2019). This positive response of the cucumber cultivars to applied organic fertilizers agreed with the findings of other researchers (Akanbi et al., 2005; Olaniyi et al., 2009). Combinations of organic and inorganic fertilizers present at KOBF could have been responsible for the superiority of the fertilizer over others. This is because the nitrogen would have been released early, followed by the release of other nutrients from the organic components and, hence, an adequate supply of plant nutrients throughout the growing periods. This observation corroborated the earlier studies (Belay et al., 2001); Eifediya and Remison 2010. Shehata et al. (2012) similarly observed that combinations of organic and inorganic fertilizers enhanced higher and better fruit quality in cucumbers. In another study, Olowoake (2014) reported that the application of sunshine and Aleshinloye fertilizers enhanced the growth and yield of *Amaranthus cruentus* and had additive effects on soil properties after harvest.

4. Conclusion

Generally, using organic fertilizers enhanced the growth and fruit yield of cucumbers. The response varied among the cucumber cultivars, with Darina hybrid > marketer > marketmore > poinsett. The effect of the organic fertilizers on cucumber growth and fruit yield also varied among the fertilizer types, with KOBF ranking first, followed by Gateway, Sunshine, and Aleshinloye, respectively. These positive effects revealed the importance of organic fertilizers for sustainable crop production and soil management strategies. Among the four cucumber cultivars, the Darina hybrid was found to be the best in both field and screenhouse studies. This study has shown the need for a proper selection of cucumber cultivars across the ecological zone with appropriate organic fertilizer for sustainable cucumber production. Based on the results of this study, the application of KOBF fertilizer and Darina cultivars is recommended for organic cucumber production.

Author contribution

The authors confirm the study conception and design ; A. I. Afe, A. A. Olowoake, data collection: M. R. Babatunde; analysis and interpretation of results: A. I. Afe, A. A. Olowoake. Author draft manuscript preparation: A. I. Afe , C. O. Akure. The results were evaluated by all authors and the final version of the manuscript was approved.

Conflict of Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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