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Comparative Analysis of the Performance and Yield of Five Varieties of Cucumber (*Cucumis sativus* L.) Under Umudike Condition in Abia State

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Abstract
The experiment to evaluate the performance of five cucumber varieties (CU999, CU986, Smart, Market more, and Local variety) under Umudike condition was carried out at the Western Farm of Michael Okpara University of Agriculture, Umudike. The study was aimed at determining the highest-yielding variety suited for the Umudike agroecosystem. The study was carried out using Randomized Complete Block Design (RCBD) with three replicates. The treatments used in this research were the cucumber varieties (CU999, CU986, smart, market more, and local variety). Cow dung which served as soil amendment material was allowed to decompose for two weeks and uniformly applied on all the plots. Data were collected on the following parameters; Number of days to emergence, vine length, number of leaves, leaf area, number of days from emergence to flower initiation, number of days from emergence to 50% flowering, number of days from emergence to fruit formation, fruit yield per plant, fruit yield per plot and fruit yield per hectare. The result showed that CU999 variety produced the highest yield per plant (0.60kg), per plot (3.40kg), and per hectare (8.50 tons/ha) of cucumber in Umudike. It is therefore recommended that cucumber variety - CU999 be used for production under Umudike conditions.

Keywords: Performance, Yield, Cucumber varieties, Cow dung, Umudike

Introduction

Cucumber (*Cucumis sativus* L.) belongs to the *Cucumis* genus in the *Cucurbitaceae* family and is an economically important fruit vegetable. Vegetables are annual or perennial horticultural crops, with certain sections (roots, stalks, flowers, fruits, leaves, etc.) that can be consumed wholly or partially, cooked or raw (Welbaum, 2015). Cucumber is indigenous to India and likely originated from the foothills of the Himalayan Mountains (Sebastian *et al.,* 2010). Cucumber was cultivated about 3000 years ago in India, and it seems to spread rapidly to Western Asia, and then to Southern Europe. Cucumber was introduced to North China through the Silk Route and to South China from Burma and India-China border, and subsequently spread to East Asia (Lv *et al*., 2012). Vora (2014) reported that nowadays, cucumber is widely cultivated in temperate and tropical regions of the world. Vegetables are important for human nutrition in terms of bioactive nutrient molecules such as dietary fiber, vitamins and minerals, and non-nutritive phytochemicals (phenolic compounds, flavonoids, bioactive peptides, etc.). These nutrient and non-nutrient molecules reduce the risk of chronic diseases such as cardiovascular diseases, diabetes, certain cancers, and obesity (Pennington and Fisher, 2009), (Malaterreb *et al*., 2018). According to Welbaum (2015), vegetables are recognized as a source of essential nutrients that are lacking in many diets and their production is becoming a source of self-employment and income generation in rural areas leading to rural development and a source of foreign exchange in the country. With abundant water, nutrients, and phytochemical composition, cucumber has versatile uses for culinary, therapeutic, and cosmetic purposes (Mukherjee *et al.,* 2013). Sharma *et al*., (2012) proved that cucumber juice can act against acidity and resist changes in pH and have good carminative and antacid potential. Cucumber has multiple advantages such as diploid, small genome, short life cycle, and self-compatible mating system, so it is suitable for genetic studies. Moreover, cucumber has been identified as a model plant for studying sex determination and plant vascular biology (Muruganantham *et al.,* 2016).

Globally, cucumber is considered a very important crop, however, in tropical Africa, its place has not been ranked because of its limited use (Wilcox *et al*., 2015). Cucumbers are classified as accessory fruits but are however perceived, prepared, and eaten as vegetables. Cucumber is an annual deep-rooted crop with tendrils

and hairy leaves. In typical commercial operations, cucumbers are grown in polythene-mulched beds with drip irrigation. Cucumbers are planted year-round. They can be directly seeded or transplanted. The growing of vegetables like cucumber can result in a high yield even on small farmland (Pozderec *et al*., 2010). Their cultivation plays a significant role in the attainment of food security for a country (FAO, 2015). Economically, the gross profit which is realized after accounting for the costs of operating the farm business in a production season, indicates that in examining the first level of profitability, cucumber production is highly profitable (Elum *et al*., 2016). Cow dung has long been recognized as perhaps one of the most desirable animal manures because of its high nutrient and organic matter content (Akande *et al*., 2006). The addition of cow dung increases the organic carbon content of degraded soil which may lead to the increasing activity of beneficial soil microorganisms as well as the fertility status of soil by increasing the availability of nutrients for the plants of the soil. Cow dung significantly increased the growth and yield of plants (Gudugi, 2013; Mehedi *et al.,* 2011).

Despite the nutritional and economic importance of this crop, its yield per hectare is very low. This could be majorly due to the use of unimproved varieties, and unimproved cultural practices which include the non-use of fertilizer, inappropriate plant population, and varying amounts of moisture. It is a highly nutrient-demanding crop that performs poorly on nutrient-deficient soils leading to low yields, and bitter and misshapen fruits (Grubben and Denton, 2014). In Nigeria today, cucumber producers are still faced with a lot of problems concerning its production in terms of yield, preservation, and improving the quantity and quality of the fruit. Some of these problems could be caused by certain factors such as poor climatic factors in some parts of the country like excessive rainfall and inadequate sunshine, weeds, insects, cucumber beetles, aphids, mites, pickle worms, bacteria wilt, powdery and downy mildew, angular leaf spot, etc. Considering the nutritional and economic importance of cucumber and its low production majorly due to the use of local varieties, and driven by the desire to improve productivity while maintaining low-cost cucumber production, this study was undertaken to evaluate the performance of some cucumber varieties under Umudike conditions.

Purpose of the Study

The general purpose of this study was to do a comparative analysis of the performance and yield of five varieties of cucumber under Umudike conditions in Abia State. Specifically, the study sought to achieve the following objectives:

1. Determine the performance of the five varieties of cucumber under Umudike conditions in Abia State
2. Determine the yield of the five varieties of cucumber under Umudike conditions in Abia State
3. To study the correlation between growth and yield components of cucumber under Umudike conditions in Abia State.

Research Questions

The following are the research questions guiding this study:

1. What is the performance of the five varieties of cucumber under Umudike condition in Abia State
2. What is the yield of the five varieties of cucumber under Umudike condition in Abia State

Hypothesis

This hypothesis guided this study (p=0.05)

There is a significant difference between the yield of CU999 and other varieties of cucumber under Umudike conditions in Abia State.

There is a significant difference between the performance of CU999 and CU986, and other varieties of cucumber under Umudike conditions in Abia State.

There is a highly significant and positive correlation between the growth and yield characteristics of cucumber under Umudike conditions in Abia State.

Materials and Methods

The experiment was carried out at the Michael Okpara University of Agriculture Teaching and Research farm situated at longitude 7°33'E and 5°29'N with an altitude of 122m above sea level. Soil sample from the experimental site was collected using soil auger from the field at a depth of 0-25cm. The soil was mixed thoroughly to have a uniform sample. The sample was analyzed in a soil laboratory to determine its chemical and physical properties. Meteorological data was gotten from the Meteorological Station of National the Root Crop Research Institute (NRCRI), Umudike. The experimental site was cleared of existing vegetation using cutlass. The land was ploughed and tilled manually using a shovel and hoe. Well-decomposed cow dung from cattle feedlots with no visible straw was used in the experiment. The manure was spread evenly on the soil surface in each plot at the rate of 15 tons per hectare (6kg/plot) and then incorporated into the soil using a hoe at a depth of 15cm within the plots. The experiment setup was a randomized complete block design (RCBD) with five varieties of cucumber as treatment and was replicated four times. The land area was 12 m x 9.5 m which had a total of twenty plots. Each of the plot areas was 2 m x 2 m with a furrow of 0.5 m separating one plot from another. There were six (6) cucumber stands per plot with two (2) seeds sown per hole at a spacing of 100 cm x 50 cm. The planting materials were sourced from National Horticultural Institute (NIHORT) Okigwe and a local market in Umudike. The treatments include five varieties of cucumber which are; CU999, CU986, Market morMoremart, and Local variety. Well-decomposed cow dung from cattle feedlots with no visible straw was

used in the experiment. The manure was spread evenly on the soil surface in each plot at a rate of 15 tons per hectare (6kg/plot) and then incorporated into the soil using a hoe at a depth of 15cm within the plots. The field was ploughed, harrowed and beds made. The cucumber seeds were planted at inter- and intra-row spacing of 100 cm x 50 cm. Weeding was done manually by hoe and hand pulling. Three plants were sampled from each plot containing six stands. Data were collected on the following: Number of days to emergence, Vine length at 2, 4, and 6 weeks after planting (WAP), Number of leaves at 2, 4, and 6 WAP, Leaf area at 2, 4, and 6 WAP, Number of days from emergence to flower initiation, Number of days to 50% flowering, Number of days to first fruit formation, Number of days to first harvest, Number of days to subsequent harvesting periods and Fruit yield per plant, per plot, and hectare. Data collected were subjected to analysis of variance (ANOVA) with Genstat edition. The treatment means were separated using Lethe ast Significant Difference (LSD).

Results and Discussion

Results

Soil and Meteorological Data

The soil for the experimental sites was classified as sandy Loam (Table 1). The soils were low in organic matter (2.60%) but high in phosphorus (9.45 Cmol/kg). Soil nitrogen was high (0.12%). The soils were generally acidic with a pH of 5.40. Total rainfall during the growing period was 734.30mm (Table 2). The monthly average rainfall from February to June during the cropping season was 146.86mm. The mean monthly sunshine duration was 5.6hr/day. The mean minimum and maximum Relative humidities were 23.34% and 33.8%, respectively. The monthly average temperature of the growing period was 28.63^{o}C.

Organic manure analysis

The results in Table 3 showed the proximate composition and mineral composition of cow dung respectively. The proximate composition of cow dung suggested high percentage composition of crude protein which can be released and made available for plant growth and development. The mineral composition of cow dung showed that cow dung contains a high percentage of nitrogen which is necessary for proper and adequate growth and development of crops. Both the proximate and mineral composition of cow dung has shown that cow dung contains elements that would be beneficial to plants' growth.

Number of leaves

The number of leaves for the five cucumber varieties at 2, 4, and 6WAP were shown in Table 3. The difference between the treatment means was significant at ($p<0.05$). At 2WAP, CU999 had the highest number of leaves (4.20) whereas the local variety produced the least number of leaves (2.60). At 4WAP, CU986 produced the highest number of leaves (16.20) while the local variety produced the lowest number of leaves (4.40). CU986 produced the highest number of leaves (28.20) while the local variety produced the lowest number of leaves 6 weeks after planting.

Vine length

The vine length of the five cucumber varieties at 2, 4, and 6 WAP are shown in Table 4. The difference between the treatment means was significant at ($p<0.05$). At 2WAP, the Smart variety had the highest vine length (10.40cm) which was significantly different from the vine length of the local variety (0.90cm). At 4WAP, CU999 produced the highest vine length of 76.50cm while the local variety had the lowest vine length (6.20cm). At 6WAP, CU999 produced the highest vine length (125.90cm) while the local variety had the lowest vine length.

Leaf area

The leaf area of the five cucumber varieties at 2, 4, and 6WAP are shown in Table 5. The difference between the treatment means was significant at ($p<0.05$). At 2WAP, CU999 produced the highest leaf area (65.10cm^2) whereas the local variety produced the lowest leaf area of 24.20cm^2. The smart variety produced the highest leaf area (218.00cm^2) while the local variety produced the least leaf area (83.70cm^2) at 4 WAP. At 6WAP, CU999 produced the highest leaf area (258.10cm^2) while the local variety produced the lowest leaf area (182.00cm^2).

Phenology of cucumber varieties in Umudike

The number of days to emergence, flower initiation, emergence to 50% flowering, and emergence to fruit formation of five cucumber varieties are shown in Table 6. There was a significant difference between the treatment means ($p<0.05$). CU986 and CU999 varieties had the lowest number of days to emergence (4.00) while Smart and local varieties had the highest number of days to emergence (5.25). CU986 had the lowest number of days to flower initiation (27.50) while the local variety had the highest number of days to flower initiation (32.50). CU999 attained 50% flowering on the 28.50 days after planting while the local variety had the highest number of days to 50% flowering (34.25). CU999 had the lowest number of days to fruit formation (29.50) while the local variety had the highest number of days to fruit formation (50.00).

Fruit yield

The fruit yield of the five cucumber varieties accessed per plant (kg), per plot (kg), and hectare (tons/ha) are shown in Table 7. There were significant differences between the treatment means ($p<0.05$). CU999 had the highest fruit yield per plant (0.60kg) while the local variety had the lowest fruit yield per plant (0.20kg). The highest fruit yield per plot was recorded by CU999 (3.40kg) while the lowest fruit yield per plot was recorded by the local variety (1.50kg). The highest fruit yield per hectare was recorded by CU999 (8.50 tons/ha) while the lowest fruit yield per hectare was recorded by the local variety 3.70 tons/ha).

Pearson Correlation Matrix of Growth and Yield characteristics of cucumber evaluated in Umudike

A highly significant and positive correlation was observed between vine length and number of leaves at 6WAP (r = 0.771**) (Table 8). Leaf area had a positive correlation with number of laves at 6WAP (r = 0.398) and positive significant correlation with vine length (r = 0.541*) at 6WAP. Fruit yield per plant (kg) had a highly significant and positive correlation with the number of leaves at 6WAP (r = 0.629**) and leaf area at 6WAP (r = 0.634**). A highly significant and positive correlation was observed between fruit yield per plot (kg) and number of leaves at 6WAP (r = 0.629**) and fruit yield per plant (r = 1.000**). Fruit yield per hectare (tons/ha) had a highly significant and positive correlation with number of leaves at 6WAP (r = 0.629**).

Discussion

The results on the agronomic characteristics of this study showed that there were significant differences in the growth characteristics of cucumber. The results of the emergence parameters showed that the improved cultivars emerged earlier than the local variety. The local variety had the highest number of days from planting to emergence. The improved cultivars also showed high pathogenesis in growth and yield characteristics. Furthermore, the improved cultivar CU999 showed the highest performance in all parameters measured compared to CU986, Smart, market more, and local variety. The differential growth and yield characteristics of cucumber have been relisted by researchers in different parts of the world (Chinatu *et al*., 2017; Umeh and Okoye, 2021). The differences in vegetative and yield characteristics can be attributed to the genetic composition of the varieties used. The CU999 variety may have been quicker in adapting to the environment than other varieties or the vegetative characters of the CU999 variety may have been more active than the other varieties, and therefore have a strong source-to-sink relationship which resulted in high yield experienced in the varieties. The result of the emergence of the cultivars showed that the improved cultivars have a higher emergence rate than the local cultivar. This agrees with the findings by Umeh and Okoye, (2021) who reported that improved cultivars emerged earlier than local cultivars. The results of the number of leaves, vine length, and leaf area showed that the CU999 variety performed better in terms of number of leaves, vine length, and leaf area than other varieties. This agreed with the findings by Mary *et al*., (2022) who opined that CU999 had the highest values for vine length as compared to other improved varieties evaluated. Umeh and Okoye (2021) also agreed that the CU999 variety produced more leaves, vine length, and leaf area than other improved and local varieties. The results of flower initiation showed that CU986 initiated flowers earlier than other varieties. This was not in line with the findings of Umeh and Okoye, (2021) who observed that CU999 initiated flower earlier before CU986 and other varieties we studied. At 50% flowering, the results showed that CU999 attained 50% flowering earlier than other cultivars. This is in agreement with the findings of Umeh and Okoye (2021) who opined that CU999 flowered earlier and attained a 50% flowering rate earlier than other varieties observed. Also, CU999 has an earlier number of days to fruit formation than other cultivars. This did not agree with the findings of Maqsood *et al*. (2004) who observed that the market had earlier fruit formation than other cultivars observed. It is also evident that CU999 produced more flowers than other cultivars. This may be a result of its genetic makeup which is evident in its ability to produce more fruits than others. This was not in line with the findings of Umeh and Okoye (2021) who opined that CU100 produced more flowers than CU999 and other cultivars observed. The results of fruit yield per plant, per plot, and per hectare showed that the CU999 variety had the highest fruit yield per plant, per plot, and per hectare than other varieties observed. This may be a result of its superior genetic makeup. This is in contrast with the findings of Umeh and Okoye (2021) who thought that CU100 produced the highest number of fruits per plant than other cultivars observed. However, Mary *et al*. (2022) agreed that CU999 produced more fruits than other cultivars observed. Resende and De (1999) ascertained that about the number of fruit per plant, improved cultivars showed the best performance by producing more fruits per plant as compared to other local varieties evaluated. The results of the correlation analysis showed that there was a significant and positive association between the growth and yield characteristics of the five cucumber varieties planted under the Umudike condition. The result showed that a highly significant and positive correlation was observed between growth and yield characteristics. This was in line with the findings of Shweta *et al*. (2018) who observed that yield per hectare had a significant positive association with fruit yield per plant and the number of marketable fruits per plant. Fruit yield per plant (kg) had a highly significant and positive correlation with number of leaves, vine length, and leaf area. This agreed with the findings of Iftekhar *et al*. (2022) who reported that fruit yield per plant exhibited a positive and significant correlation with the vine length as well as other growth characteristics. Momeni and Ghaffarinegad (2010), also reported that components such as plant height, number of leaves, photosynthetic area, number of flowers, and number of pickling fruit showed that they are positively correlated with fruit yield.

Conclusion

This study sought to determine the best-yielding cucumber variety among the five varieties investigated in the study area. The findings of the study have been able to establish that the cucumber variety - CU999 performed better than other varieties. From the study, it could be inferred that all the improved varieties performed better than the local variety. More so, cow dung readily supports cucumber production and can be efficiently used to amend poor soils for optimum productivity. Furthermore, as observed, the high productivity of cucumber resulting from the planting of improved varieties correlates to high income that could

be generated by farmers. Finally, given the many improved varieties available, studies with other improved varieties of cucumber are necessary. Further studies are very essential as they will enable the identification of the variety with the highest-yielding characteristics and best suited for the study area.

The following are the recommendations supporting this study based on the findings:

1. Farmers in Umudike should plant more of CU999 to enjoy better performance of the crop and for higher yield.
2. Other improved varieties like CU986, Smart, and Market should be an alternative where CU999 is not available.
3. Cow dung is recommended for use as soil amendment material in Umudike and its environs where other sources of plant nutrients are unavailable.
4. Further research should be conducted with other improved cucumber varieties for better inference in the study area.

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Table 1: Soil physicochemical properties of the study site

Soil Properties	
Sand (%)	72.60
Silt (%)	10.00
Clay (%)	17.40
Textural class	Sandy loam
pH	5.40
Organic carbon (%)	1.50
Organic matter (%)	2.60
Total nitrogen (%)	0.12
Calcium (cmol/kg)	2.72
Magnesium (cmol/kg)	0.36
Potassium (cmol/kg)	0.28
Sodium (cmol/kg)	0.40
Available phosphorus (cmol/kg)	9.45
Exchangeable acidity (cmol/kg)	1.48
ECEC (cmol/kg)	5.24

Table 2: Agro-meteorological data for Umudike from January to June 2022

Months	**No of days of rainfall (mm)**	**Total rainfall (mm)**	**MAX RH (%)**	**MIN RH (%)**	**Sunshine duration (hr/day)**	**Wind speed (km/day)**	**Mean Temperature (º C)**
January	4	42.8	33.0	21.1	8.9	3.4	29.70
February	0	0	36.1	23.2	6.9	2.6	29.30
March	4	46	35.3	24.9	7.1	2.2	29.50
April	13	175.9	34.9	24.7	6.8	2.3	28.60
May	14	319.9	31.4	21.8	4.1	1.8	27.80
June	14	192.2	31.3	22.1	3.1	2.2	26.90

Source: National Root Crops Research Institute (NRCRI) Meteorological Station, Umudike, Abia State

Table 3: Proximate composition of cow dung on dry matter basis (DMB) and Mineral Composition of cow dung

Proximate Nutrients	**Content (%)**	**Mineral Nutrients**	**Content (%)**
MC	9.85	P	0.39
DM	90.16	K	0.20
ASH	8.28	Na	0.27
CP	17.88	N	2.86
CF	15.41	Ca	0.75
FAT	3.30	Mg	0.64
CHO	45.29		

Table 4: Number of leaves of five cucumber varieties at 2, 4, and 6 weeks after planting in Umudike

Treatment	No 2WAP	of 4WAP	Leaves at 6WAP
CU986	4.00	16.20	26.60
CU999	4.20	12.90	28.20
Smart	4.10	15.10	27.90
Market More	4.00	14.80	25.90
Local Variety	1.60	4.40	17.60
MEAN	3.60	12.70	25.20
$LSD_{(0.05)}$	0.45	3.11	4.80
CV (%)	1.80	7.90	2.60

Table 5: Vine length of five cucumber varieties at 2, 4, and 6 weeks after planting in Umudike

Treatment	Vine 2WAP	Length 4WAP	(cm) at 6WAP
CU986	9.30	66.70	107.50
CU999	9.80	76.50	125.90
Smart	10.40	55.50	100.70
Market More	10.30	47.10	91.00
Local Variety	0.90	6.20	33.10
MEAN	8.10	50.40	91.60
$LSD_{(0.05)}$	1.82	19.13	16.23
CV (%)	7.60	4.10	4.80

Table 6: Leaf area of five cucumber varieties at 2, 4, and 6 weeks after planting in Umudike

Treatment	Leaf 2WAP	Area 4WAP	(cm^2) at 6WAP
CU986	59.20	170.00	183.40
CU999	65.10	200.00	258.10
Smart	58.30	218.10	205.30
Market More	57.60	208.70	216.00
Local Variety	24.20	83.70	182.00
MEAN	52.90	176.10	209.00
$LSD_{(0.05)}$	12.02	40.63	34.92
CV (%)	4.60	2.60	3.10

Table 7: Phenology of cucumber varieties in Umudike

Treatments	No of days to emergence	No of days to flower initiation	No of days to 50% flowering	No of days to fruit formation
CU986	4.00	27.50	28.75	30.50
CU999	4.00	28.00	28.50	29.50
Smart	4.00	28.00	30.50	31.50
Market More	4.00	28.00	29.25	42.75
Local Variety	5.25	32.50	34.25	50.00
MEAN	4.25	29.15	29.90	36.85
$LSD_{(0.05)}$	0.35	1.46	0.88	1.41
CV (%)	2.4	1.5	0.7	2.0

Table 8: Fruit yield of five cucumber varieties in Umudike

Treatments	Yield/plant(kg)	Yield/plot (kg)	Yield/hectare (tons/ha)
CU986	0.40	2.50	6.20
CU999	0.60	3.40	8.50
Smart	0.40	2.30	5.80
Market More	0.30	2.00	5.10
Local Variety	0.20	1.50	3.70
MEAN	0.40	2.30	5.90
$LSD_{(0.05)}$	0.02	0.14	0.35
CV (%)	1.90	1.90	1.90

Table 9: Pearson correlation matrix of Growth and Yield characteristics of cucumber evaluated in Umudike

Plant traits	1	2	3	4	5	6
1). No. of leaves at 6 WAP	-					
2). Vine length at 6 WAP	0.771**	-				
3). Leaf area at 6 WAP	0.398	0.541*	-			
4). Fruit yield per plant (kg)	0.629**	0.859**	0.634**	-		
5). Fruit yield per plot (kg)	0.629**	0.859**	0.634**	0.914**	-	
6). Fruit yield per hectare (t/ha)	0.629**	0.859**	0.634**	0.914**	1.000**	-

**** Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed)***