Assessment of Yield and Yield Components of Cucumber (*CucumisSativus*L.) in Southeastern Nigeria

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Abstract
Seven varieties of Cucumis sativus L. were assessed for yield and yield components in a randomized complete block design with three replicates, at the Research Farm of the Michael Okpara University of Agriculture, Umudike (longitude $07^0$33E, latitude $05^0$29N, Altitude 122m) in 2014 and 2015. In each year, the experiment consisted of 18 plots, each measuring 0.6 x 1.5m^2, with a distance 0.75m and 1m separating plots and blocks. Seeds were planted at a spacing of 0.30m by 0.75m.Analysis of variance showed that the varieties were significantly different (P<0.05) in vine length, number of vines plant^{-1}, number of leaves plant^{-1}, fruit length, fruit girth, fruit weight, number of fruit plant^{-1} and fruit yield ha^{-1}. All the yield components (vegetative and reproductive characters) with the exception of vine and fruit lengthshad positive and highly significant (P < 0.01) coefficients of correlation with fruit yield ha^{-1} in both years. The varieties Regal and Market more with highest vegetative and reproductive characters performance, which translated into highest fruit yield hectare^{-1} could be released to farmers in Southeastern Nigeria for increased production of cucumber.

Keywords: *Cucumber, assessment, yield and yield components, Umudike.*

Introduction:
Cucumber (*Cucumis sativus* L.) is an important vegetable crop in the Cucurbitacea family that has been cultivated by man for over 3,000 years (Adetula and Denton, 2003; Okonmah, 2011). It originated in Northern India and is widely distributed throughout the world (Remison, 2005). Cucurbits are composed of 118 genera and 825 species. Economically, it ranks fourth after tomatoes, cabbage and onion in Asia (Eifediyi and Remison, 2010), and second after tomatoes in Western Europe (Phu, 1997). Cucumber is one of the most important market vegetables in the world (Williams *et al* 1997). However, the production of the fruit in Nigeria is very low due to limited use. They are produced mainly in the Northern states of Nigeria (Adetula and Denton, 2003).Cucumber requires a warm climate. In cold countries it can be grown only in greenhouses or in open field if there are hot summer days. The optimum day temperature is 30^0C, and optimum night temperature is 18-21^0C. Minimum temperature is 15^0C for efficient development. Sensitivity to day light affects the yield of cucumber by defining the sex characters and also type of growth. For example, short day length promotes vegetative growth and female flower production. Cucumber needs a plentiful amount of water but water logging is not good for its growth. Low humidity causes loss of water because of its large leaf areas. Also high humidity promotes the formation of downy mildew which is a fungus that first appears as tiny tan or bright prinks speckles on the leaves. The soil should be fertile, well drained with a pH of 6.0-7.0.

Cucumber can germinate in 3 days if temperatures are at optimum levels. Crop physiologists have established that high yields in crop production by adapted cultivars can largely be explained by increased solar interception achieved by larger and longer living canopies (Ayoola and Adeniran, 2006).It is necessary to increase the production in order to supplement the high intake of carbohydrate, especially in the Southeastern Nigeria, where there are sparse and over dependence of its supply for salad vegetables and fruit on major suppliers from the north, resulting to relative higher price because of transportation cost and spoilage production of the fruit. Soft and succulent, the vegetable crop is cherished by man and eaten in salads or sliced into stew in tropical regions. And its juices are often recommended as sources of silicon to improve the health and complexion of the skin (Duke, 1997). It is also a good source of vitamin A, C, K, B_6, potassium, pantothenic acids, magnesium, phosphorus, copper and manganese (Vimala *et al.*, 1999). With the help of ascorbic acid contained in cucumber help to reduce irritation and swollen skin (Okonmah, 2011).In spite of the increasing relevance of cucumber in Nigeria, low yields are obtained in farmers' fields because of declining soil fertility due to continuous cropping and disregard for soil amendment materials.Lower yields are more common in Southern parts where the crop is usually put to more use. The significance of yield may be qualified by factors such as fruit quality, fruit size, or price development at the market determined by season. Fruit exceeding a certain size are of no value, and nowadays, consumers demand good fruit shape and quality (Than, 1996). The fruit could be fried and steamed, grilled, battered or eaten raw. Fruits are preserved by pickling, or drying and grinding into powder. They are used to make stews and even salads and sauces. Cucumber is high in fiber and rich in vitamins and minerals, including Potassium and vitamin C. The young leaves are also used as a salad or as a cooked vegetable particularly in some Asian countries. Cucumber leaves are sometimes dried and ground into powder for storage. The seed are often used as edible oil in Asia. Cucumber seed are often used in place of dried peas, beans in rice dishes and soups. In Nigeria, the seeds are eaten as diet; cooked immature fruits are used to treat dysentery in children in indo-china. Yellow curry-cucumber (dosakayi) is used widely in a variety of curry, and stew preparations in South India with added buttermilk and yoghurt. Leaves and immature fruits have long been used in indo-china, Africa where their mixture is applied as a spurge, moisturize skin, induce sweating, prevent scurvy and treat urinary disorders. Its juice is often recommended as source of silicon to improve the health and complexion of the skin (Duke, 1997).The ascorbic acid contained in cucumber helps to reduce irritation and swollen skin (Okonmah, 2011). Cucumber peel is a good source of dietary fiber that helps reduce constipation, and offer some protection against colon cancers by eliminating toxic compounds from the gut. Cucumber leaves and seed-cake are sometimes used as cattle feed, and the leafy tops are grazed by stock and game.

Cucumbers are harvested before they are fully matures, unless required for seed, and picking usually begins about $1^{1/2}$ - 2 months after sowing and thereafter as the need arises. Mature fruits should be firm and green. Yield is approximately 5-7t/ha (Remison, 2005). Fresh cucumber can be transported quite easily in bulk and kept for a few days without much loss of quality (Makinde *et al.*, 2007). In view of the importance of cucumber to southerners, the objectives of this research work include to determine cucumber varieties that are best suited for Umudike environment, and to determine the relationship between fruit yield and yield components

Materials and Methods:

The experiments were conducted at Michael Okpara University of Agriculture Umudike in 2015 and 2016 cropping seasons. Umudike lies within longitude $07^0$33E and latitude $05^0$29N, with an

altitude of 122m above sea level, (National Root Crop Research Institute, Umudike, and Meteorological station). Seven varieties of *Cucumis sativus* (treatments) used included; Belt apha, Point set, Market more, Regal, Unbeit, Zeina and Ashley. These varieties were obtained from the National Biotechnology Centre, Ibadan, Nigeria. The experiments were laid out in a randomized complete block design with 3 replications. Each experiment consisted of 27 plots, each measuring 0.6 x 1.5m^2, with a distance 0.75m and 1m separating plot and blocks. Spacing of 0.30m by 0.75m was used. Planting was done in May. Weed control was done manually at two and four weeks after planting. Poultry dropping was applied two weeks before planting to improve nutrient content of the soil. Harvesting was done manually using knife to cut fruits from plant. The experiment lasted from May to July. Data were collected on vine length, number of vines $plant^{1}$, number of leaves $plant^{1}$, fruit length, fruit girth, fruit weight, number of fruit $plant^{-1}$ and fruit yield ha^{-1}, and subjected to statistical analysis as described by Gomez and Gomez (1984), using Genstat 4th edition. In each year relationship between yield and yield components were determined through correlation analysis.

RESULT AND DISCUSSION: The physical and chemical characteristics of the soil of the experimental site were taken before planting. The physico-chemical characteristics were analyzed and the result given on Table 4.1. The soil of the experimental site was about 73.5and 72.20% sand, 15.2 and 16.70% silt and 12.00 and 11.20% clay in 2015 and 2016 respectively. It was low in nitrogen (0.1%), phosphate level was 10.90mg/kg, with 0.10cmol/kg of potassium in 2015. In 2016, nitrogen content was 0.25%, phosphate level was 11.40mg/kg, with 0.21cmol/kg of potassium. Slight appreciation in soil nutrient composition is attributable to the organic manure that was applied in 2015. In 2015, its organic matter content was 1.94%, which was low for the cultivation of cucumber as reported by Food and Agricultural Organization (FAO, 2008). The soil was also acidic with pH in H_20 of 5.6. The soil textural class was sandy loam. The soil was analyzed at National Root Crop Research Institute Umudike, Soil Science Laboratory.

Table 4.1: Physico-chemical characteristics of the experimental site before planting.

Soil Attributes	Amount		Method of analysis
Physical characteristics	**2015**	**2016**	
Sand %	73.5	72.20%	Hydrometer (Jackson, 1962)
Silt %	15.2	16.70	Hydrometer (Jackson, 1962)
Clay %	12.0	11.20	Hydrometer (Jackson, 1962)
Texture class	Sandy loam	Sandy loam	
Chemical characteristics			
PH in H_2o	5.60	5.95	pH meter
Available P (mg/k)	10.90	11.4	Flame photometric (Kjedahl, 1983)
Total N (%)	0.1	0.25	Kjeldahl method (1983)
Organic Matter	1.8	2.90	Walkley-Black method (1947)
Calcium (Cmol/kg)	2.85	3.20	A. A. S (Kjeldahl, 1983)
Magnesium (Cmol/kg)	1.47	2.00	A. A. S (Kjeldahl, 1983)
Potassium (Cmol/kg)	0.1	0.21	Oxidation method (Kjedahl, 1983)
Exchangeable acid (Cmol/kg)	1.6	1.40	
ECEC (cmol/kg)	6.55	6.79	
Base saturation %	75.85	76.95	

Source: National Root Crops Research Institute, Umudike, Abia State, Nigeria.

Application of NPK (20:10:10) improved the Nitrogen, Potassium and Phosphorus level of the soil. The rise in Organic matter, total Nitrogen and available phosphorus in 2016 was due to the residual effects of application of poultry droppings because organic manure unlike inorganic fertilizers releases their nutrients slowly.

Table 2: Agro-meteorological data of the experimental site in 2015 and 2016

Month	Rainfall (mm)		Temperature (^{0}C)		Relative Humidity (%)	
	Amount	No of days	Maxi	Mini	06S00hours	1500hours
2015						
April	61.7	4.0	33.4	23.8	78	58
May	246.2	15.0	32.7	23.4	81	63
June	346.2	21.0	29.8	23.5	87	76
July	129.2	18.0	27.3	22.4	88	81
August	366.2	19.0	29.0	24.0	87	80
September	276.0	23.0	29.0	23.0	87	78
October	380.2	12.0	31.0	24.0	84	74
November	49.7	06.0	33.0	24.0	80	60
December	0.0	0.0	29.5	22.9	35	34
Total	1855.4	118	274.7	211	707	604
Mean	206.2	13.1	30.5	23.4	78.5	67.1
2016						
April	78.7	6	32.2	23.5	79	66
May	249.2	16	31.9	23.4	81	69
June	281.8	12	30.5	24.2	81	74
July	114.9	14	30.0	24.0	86	79
August	444.2	20	29.6	23.3	85	78
September	405.3	22	29.8	22.9	85	79
October	165.1	12	31.0	23.6	82	71
November	147.4	11	31.6	23.5	81	66
December	0.0	0	32.7	21.8	65	47
Total	1886.6	113	279.3	210.2	725	629
Mean	209.6	12.6	31.0	23.4	80.6	69.9

Source: National Root Crops Research Institute, Umudike, Abia State, Nigeria.

Table 2 showed the Agro-meteorological data of the experimental site in 2015 and 2016 from April to December. The mean maximum temperatures were 30.5 and 31^{0}C, while mean rainfall (amount) were 206.2 and 209.6 for 2015 and 2016 respectively. These weather conditions were good enough for production of cucumber (Adetula and Denton, 2003).

The results of analysis of variance and correlation studies between yield and yield related components are presented on Tables 3, 4, 5, and 6. The vine length varied from 259.00 to 396.30cm and from 270.70 to 408.30cm in 2015 and 2016. Number of vines varied from 4.90 to 13.93 and from 5.33 to 15.00 in 2015 and 2016 respectively. Number of leaves plant^{-1} varied 158.33 to 339.83 and from 172.30 to 350.30 in 2015 and 2016 respectively. From Tables 3 and 4, the vegetative characters (vine length, number of vines and number of leaves plant^{-1}) were highly significant. This implied that the varieties were different from one another with respect to their vegetative character performance or growth attributes or pattern. The varieties Belt alpha,

Zeina and Ashley recorded the least vegetative character performance, while Regal and Market more had the highest vegetative characters performance. Fruitweight varied from 0.300 to 0.417 and from 0.293 to 0.430 in 2015 and 2016 respectively, while number of fruit plant^{-1} varied from 2.60 to 3.83 and from 2.63 to 4.00 in 2015 and 2016 respectively. Ashley and Belt alpha recorded lowest fruit weight and number plant^{-1}, while Regal and Market more recorded highest fruit weight and number plant^{-1} in both years. Fruit yield hectare^{-1}varied from 41178.00 to 62844.00kg and from 42111.30 to 63667.57kg (Tables 3 and 4) in 2015 and 2017 respectively. All the reproductive characters (fruit length, fruit girth, fruit weight, and number of fruits plant^{-1}) as well as fruit yield plant^{-1} significantly differed ($P< 0.05$) from one another. This also showed that the varieties used in this research work varied considerably from one another in vegetative characters reproductive characters performance and in fruit yield hectare^{-1}.

Table 3. Mean values of fruit yield and yield components of Seven *Cucumis sativus* varieties in 2015 at Umudike, Nigeria

Varieties	Characters							
	Vine length (cm)	Number of vines plant^{-1}	Number of leaves plant^{-1}	Fruit length (cm)	Fruit girth (cm)	Fruit weight (kg)	Number of fruits plant^{-1}	Fruit yield hectare^{-1} (kg)
Belt alpha	312.70	7.93	159.33	25.24	21.14	0.305	2.90	42741.00
Point set	259.00	11.60	281.00	23.34	21.05	0.343	3.70	56667.00
Market more	307.70	8.60	267.00	24.82	23.17	0.370	3.43	55941.00
Regal	327.00	13.93	339.83	24.01	21.47	0.417	3.83	62844.00
Unbeit	298.30	8.27	252.00	24.61	20.03	0.380	3.20	54519.00
Zeina	396.30	7.03	268.67	22.32	21.47	0.333	3.30	49341.00
Ashley	298.70	4.90	158.33	22.63	21.89	0.300	2.60	40178.00
LSD.0.005	37.60	2.489	6.530	1.896	1.026	0.0465	0.553	8047.700

Table 4. Mean values of fruit yield and yield components of Seven *Cucumis sativus* varieties in 2016 at Umudike, Nigeria

Varieties	Characters							
	Vine length (cm)	Number of vines plant^{-1}	Number of leaves plant^{-1}	Fruit length (cm)	Fruit girth (cm)	Fruit weight (kg)	Number of fruits plant^{-1}	Fruit yield hectare^{-1} (kg)
Belt alpha	321.00	9.00	173.70	25.86	22.14	0.307	2.83	43704.00
Point set	270.70	12.67	295.30	24.02	21.82	0.337	3.70	54881.10
Market more	319.30	9.67	280.70	25.48	23.73	0.387	3.55	59519.00
Regal	338.70	15.00	350.30	24.87	21.99	0.430	4.00	63667.57
Unbeit	310.00	9.33	264.30	25.29	20.67	0.377	3.17	53704.07
Zeina	408.30	8.00	282.30	23.08	21.03	0.313	3.33	47111.87
Ashley	308.30	5.33	172.30	23.28	21.38	0.293	2.63	42111.30
LSD.0.005	16.09	2.654	11.58	0.907	0.865	0.0562	0.637	8963.200

Table 5. Correlation matrix of mean values of yield and yield components of Seven varieties of *Cucumis sativus* in 2015

Character	Vine length (cm)	Number of vines plant^{-1}	Number of leaves plant^{-1}	Fruit length (cm)	Fruit girth (cm)	Fruit weight (kg)	Number of fruits plant^{-1}	Fruit yield hectare^{-1} (kg)
Vine length (cm)	1.0000							
Number of vines plant^{-1}	-.0339	1.0000						
Number of leaves plant^{-1}	0.8722***	0.7536**	1.0000					
Fruit length (cm)	-.0167	0.3645*	-.0197	1.0000				
Fruit girth (cm)	0.0517	0.3309*	0.1776	0.5015**	1.0000			
Fruit weight (kg)	0.1927	0.7468***	0.7468***	0.4089*	0.3702*	1.0000		
Number of fruits plant^{-1}	0.1751	0.8854***	0.8168***	0.3164*	0.4126*	0.7575***	1.0000	
Fruit yield hectare^{-1} (kg)	0.0809	0.8381***	0.8722***	0.2758	0.3963*	0.9176***	0.9127***	1.0000

Table6. Correlation matrix of mean values of yield and yield components of Seven varieties of *Cucumis sativus* in 2016

Character	Vine length (cm)	Number of vines plant^{-1}	Number of leaves plant^{-1}	Fruit length (cm)	Fruit girth (cm)	Fruit weight (kg)	Number of fruits plant^{-1}	Fruit yield hectare^{-1} (kg)
Vine length (cm)	1.0000							
Number of vines plant^{-1}	-.1069	1.0000						
Number of leaves plant^{-1}	0.1823	0.7681***	1.0000					
Fruit length (cm)	-.2300	0.8743***	0.0245	1.0000				
Fruit girth (cm)	-0.1119	0.3238*	0.1735	0.5237**	1.0000			
Fruit weight (kg)	0.0386	0.7709***	0.7709***	0.5544**	0.4174*	1.0000		
Number of fruits plant^{-1}	0.1153	0.8743***	0.8743***	0.2354	0.3596*	0.7522***	1.0000	
Fruit yield hectare^{-1} (kg)	-.1051	0.7237***	0.7030***	0.2945	0.5121**	0.8651***	0.8297***	1.0000

*,** and ***Implies significant at 5%, 1% and 0.1% probability levels respectively.

From Tables 5 and 6, vegetative characters with the exception of vine length had significant association with reproductive characters except fruit girth and length, in both years. With the exception of vine length, all the vegetative characters had positive and very highly significant correlation coefficient with fruit yield plant^{-1}. This showed that the vegetative characters that influenced high reproductive characters performance, positively influenced fruit yield hectare^{-1}. Vegetative characters (plant height, number of leaves and number of lateral branches) according toOseni 2004, Ajibade and Morakinyo (2000) and Chinatu(2015) determine the amount of photosynthates available to plants for growth and fresh pod yield. Tenebe *et al.*, (1995) had reported that growth parameters (plant height, number of leaves and number of lateral branches) are strong yield parameters. Adeniji and Aremu (2007) reported that the proportion of the photosynthates allocated to the reproductive parts during flowering and fruit set go a long way to determine the reproductive characters performance, thereby influencing yield hectare^{-1} in fruit crops. This is because the higher the vegetative surfaces exposed for photosynthesis the higher the volume or proportion of photosynthates available to the cucumber crop for higher reproductive characters performance. These reproductive characters directly determine the level of fruit yield hectare^{-1}. This explains why Regal and Market more that recorded highest vegetative characters performance, also recorded highest vegetative characters performance which translated into higher fruit yield in cucumber. In the same vein, Belt alpha and Ashley which recorded lowest vegetative characters performance, had lowest reproductive characters performance which translated into lowest fruit yield hectare$^{-1.}$

Conclusion:

The seven varieties of cucumber used in the experiments performed well with the exception of Ashley and Belt alpha. Cucumber varieties that perform well vegetatively are likely to record high reproductive characters performance which could lead to high fruit yield. The varieties Regal and Market more which recorded highest vegetative and reproductive characters performance that translated into highest fruit yield hectare^{-1} could be released to farmers in Umudike for increase production of cucumber in Southeastern Nigeria.

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