Original paper

Growth, Phenology and Yield of Two Cucumber (*Cucumis sativus* L.) Varieties as Influenced by Spacing

Abstract

The increasing population in Nigeria has resulted in a high demand for food including cucumber (*Cucumis sativus* L.). Some of cucumber production constraints include limited high yielding varieties and appropriate spacing. Therefore, two field trials were conducted to determine growth and yield of two cucumber varieties in 2019, at the research farm of Federal University of Agriculture Abeokuta (7°15¹N and 3°25¹E). The experimental design was Randomized Complete Block Design (RCBD) in a split plot arrangement and replicated three times. The factors: varieties (CU 999 and Monalisa), and spacing (75 × 25 cm, 75 × 50 cm, 75 × 75 cm) were allocated to the main plot and sub plot respectively. Data were collected on plant height, number of leaves per plant, days to 50% flowering, days to fruit set, fruit girth, fruit length, fruit weight, number of fruits per plant and yield. Data collected were subjected to analysis of variance and means of significant treatments were separated using Least Significant Difference ($p<0.05$). Monalisa produced significantly ($p<0.05$) longer vines than CU 999 in the early season while no significant differences were observed in the late season. The results of the experiment showed that increase in plant density brought about increase in fruit yield. Variety CU 999 at spacing of 75 x 25 cm is recommended for high yield of cucumber.

Keywords: Cucumber, Variety, Spacing, Growth, Yield

Introduction

Cucumber (Cucumis sativus L.) is one of Nigeria's most popular fruits and vegetables. It is the world's fourth most farmed vegetable and is often regarded as one of the healthiest foods available (Natural News, 2014). It belongs to the Cucurbitaceae family and is one of the most popular members. Cucumber is native to South Asia, although it currently grows on nearly every continent. Cucumbers come in a variety of shapes and sizes, and they're sold all over the world (Nonneck, 1989; Wells, 2016). They are vine crops that are cultivated on the ground, on poles, or on anchored trellises to suspend fruit (Nonneck, 1989; Wells, 2016). Cucumber fruit is high in vitamins A, C, K, B6, potassium, dietary fiber, pantothenic acid, magnesium, and phosphorus, as well as dietary fiber, pantothenic acid, magnesium, and phosphorus (Olaniyi *et al.,* 2009).

Cucumber cultivation is growing increasingly popular in a large area of Nigeria, according to Nweke *et al*. (2013), possibly due to its strong nutritional and medicinal benefits, as well as its use as a component ingredient in pharmaceuticals (Kumar *et al.,* 2010).

Plant spacing is one of the most essential elements in crop production, according to (Nnoke, 2001), since proper crop spacing makes optimal use of resources by limiting competition among plants with similar cultural requirements. More *et al*. (1990) investigated the influence of plant spacing on cucumber yield in a protected environment and found that a plant spacing of 60 cm 60 cm produced the maximum yield when compared to 60 cm 30 cm or 90 cm 60 cm spacing. According to Jacques *et al.* (2002), increasing plant density from 2 to 10 plants per m2 increased yield per plant but decreased productivity per unit area, whereas decreasing plant density increased yield per unit area. (Nerson, 2005) conducted an experiment to determine the effect of plant population on cucumber yield and fruit quality, and found that plant population had a substantial impact on cucumber yield attributes and fruit output. He found that as plant density increased, reproductive yield (kg/plant) decreased. The highest plant density resulted in the largest fruit output.
(Premalatha *et al*., 2006) investigated the influence of spatial arrangement on three cucumber types grown in a controlled environment, finding that close spacing resulted in a high total and marketable yield per unit area. Plant height, branches per plant, stem diameter, leaf area, fruits per plant, and yield per plant all rose dramatically with increasing plant spacing, according to an experiment done by Lacob *et al*. in 2009. (Nweke *et al.,* 2013) investigated the impact of plant spacing on cucumber growth and yield in a protected environment and found that the closest plant spacing (50 cm x 30 cm) produced the most fruits, marketable fruits, and weight of fruits when compared to the 50 cm x 40 cm spacing. This research was therefore done to determine the appropriate spacing for increased productivity to meet the consumers' demand.

Materials and Methods

The experiment was conducted at the Teaching and Research Farm of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, in the forest-savanna – transition agro-ecological zone ($7^{\circ}15^{1}$N and $3^{\circ}25^{1}$E, altitude 144 m above the sea level). The rainfall distribution pattern for Abeokuta is bimodal, having the first mode between

June and July and the second mode in September. The annual rainfall ranges from 1145 to 1270 mm. The experiment was conducted in two trials each in 2019.

Soil samples collected from experimental sites were subjected to routine laboratory analysis before planting.

The treatments were arranged as a split plot fitted into a Randomized Complete Block Design with three replications using sub plot size of 2 m × 2 m. The treatment consisted of two cucumber varieties (CU 999 and Monalisa) and plant spacing (75 × 25, 75 × 50, 75 × 75) cm.

Primary vine length was measured with a meter rule from the soil surface to the tip of the stem of the five tagged plants in the middle row at 3, 4 and 5 WAS. Number of leaves on the sample plants were counted at 3, 4 and 5 WAS. The number of flowers were observed on 50% of cucumber stands in each plot was recorded as days to 50% flowering, this same procedure was used for days to fruiting. Weight of fruit was done using a top scale to weigh the fruits harvested from each net plot. Number of fruits harvested from the sample plants was counted at each harvest. Fruit girth was done using a veneer caliper while fruit length was done with a meter ruler.

Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA). Means of significant treatment was separated using Least Significant Difference (LSD) at a 5% level of probability.

Results

The soil texture of the experimental location was sandy loam. The pH of the soil was slightly acidic. The pH was (6.8) in both trials of 2019. The nitrogen content of the soil was medium (between 0.16 % and 0.19 %). Low nitrogen content is < 0.15 %, medium is between 0.15 % to 0.20 % and high is > 0.20 %. The organic matter content of the soil was low (Table 1).

Significant ($P \leq 0.05$) varietal difference existed in primary vine length of the cucumber varieties at 3, 4 and 5 WAS in the early season of 2019 while no difference was observed in the late season (Table 2). Monalisa variety had longer vines compared to CU 999. Spacing significantly ($P \leq 0.05$) influenced primary vine length at 3, 4 and WAS in the early season of 2019 and no such difference was observed in the late season. Plants in plots with spacing of 75 cm × 75 cm had longer vines.

Significant difference was observed on number of leaves of the varieties at 3, 4 and 5 WAS in the early season of 2019 (Table 3). Monalisa variety produced plants with higher number of leaves compared to CU 999. Spacing significantly ($P \leq 0.05$) affected number of leaves at 3 and 4 WAS in the early and late season while at 4 and 5 WAS, significant differences were observed only in the early season. Cucumber plants in plots with spacing of 75 cm × 75 cm producing plants with higher number of leaves.

Variety had significant ($P \leq 0.05$) effect on days to 50 % flowering and days to fruit set of cucumber in the early and late season of 2019 (Table 4). Variety CU 999 flowered earlier than Monalisa. Effect of spacing on days to 50 % flowering and days to fruit set was significant ($P \leq 0.05$) in both seasons of 2019. Plants spaced at 75 cm × 75 cm flowered earlier than those spaced at 75 cm × 25 cm and 75 cm × 50 cm

Variety significantly ($P \leq 0.05$) influenced fruit girth in both seasons of 2019. CU 999 produced fruits with larger girth compared to Monalisa variety (Table 5). Spacing significantly ($P \leq 0.05$) influenced fruit girth in the late season and no significant difference was observed in the early season. Plants spaced at 75 cm × 50 cm produced larger fruits while plants spaced at 75 cm × 75 cm had the smallest fruit girth. There was significant ($P \leq 0.05$) interaction between variety and spacing on fruit girth in both seasons.

Varietal influence was observed on fruit length in both seasons of 2019 (Table 5). Variety CU 999 produced significantly ($P \leq 0.05$) longer fruits than Monalisa. Spacing significantly ($P \leq 0.05$) influenced fruit length in the late season but no significant difference was observed in the early season. Plants spaced at 75 cm × 50 cm in the late produced longer fruits.

Variety significantly ($P \leq 0.05$) influenced fruit weight/plant in both seasons with CU 999 producing heavier cucumber fruits than Monalisa in both seasons (Table 5). Spacing had Significant ($P \leq 0.05$) effect in both seasons. Plant in plots spaced at 75 cm × 25 cm produced fruits with higher weight.

Variety significantly ($P \leq 0.05$) influenced number of fruits in both seasons with CU 999 producing more cucumber fruits than Monalisa in both seasons (Table 5). Significant ($P \leq 0.05$) difference was also observed on spacing in both seasons. Plant in plots spaced at 75 cm × 25 cm produced more fruits.

Varietal influence was observed on fruit yield (t/ha) in both seasons of 2019. Yield of CU 999 was higher compared to Monalisa (Table 5). Spacing significantly ($P \leq 0.05$) influenced yield (t/ha) in both seasons of 2019. In both seasons, plots spaced at 75 cm × 25 cm had higher yield.

Discussion

During the experiment, there were substantial differences in primary vine length and number of leaves per plant of cucumber; these disparities in growth rate indices are generally linked to their genetic make-up, according to Ibrahim *et al.,* (2002). This was in line with the findings of Sajjan *et al.* (2002), who found that genetic variables improved plant height, leaf area, and pod output.

Differential yield features were found in the CU 999 variety. Monalisa had a much lower number of fruits per plant, weight of fruits per plant, and total yield per hectare. Different cucumber researchers from around the world have reported on these differences in cucumber growth and production. The genetic composition of the types employed can be blamed for the discrepancies in vegetative and yield characteristics. The CU 999 type may have adapted to the surroundings more quickly than Monalisa. The CU 999 variety's vegetative features may have been more active, resulting in a robust source-to-sink interaction that led in the variety's high yields (Cavatorta *et al.,* 2007). This was in line with Staub and Bacher's (2004) findings, which claimed that cucumber yield is influenced by genetic and environmental factors, and so varies depending on growing season and locale.

One of the most significant aspects of agricultural productivity is plant spacing. The highest plant density yielded the highest fruit production in this study. This contradicted the findings of Serquen *et al*. (1997), who found that increasing plant spacing increased the number of fruits per plant, fruit length, and fruit weight per plant, but lowering plant spacing increased the plant height and number of leaves. Streck *et al.,* (2014) found that cassava ultimate leaf size and lateral shoot growth rose when planting density reduced, corroborating these findings. Plant density has a significant impact on plant development, growth, and marketable output of many vegetable crops, according to Kosson and Dobrzanska (2002). In their investigation of the influence of varied plant spacing on the output and quality of cucumbers in a greenhouse, Echevarra and Castro (2002) discovered that closer plant spacing resulted in a significantly lower fruit yield per plant.

The increased fruit weight in closer plants could be attributable to greater assimilate use and increased assimilate allocation to the economic section. Choudhari and More (2002), Echevarria and Castro (2002), Motscenbocker and Arancibia (2002), Peil and Lopez (2002), Khalid and Elwan (2011), Zhang *et al.* (2011), and Sharma *et al.* (2011) all reported similar results. Plants with a wider spacing of 75 cm x 75 cm performed better in the majority of the plant growth factors tested. The higher population density, which resulted in improved weed suppression through canopy shade, better water utilization as a result of less evaporation, and better radiant energy utilization, could be ascribed to the higher yield obtained at a tight spacing of 75 cm x 25 cm. Reduced weed competition, more oxygen, and improved water circulation in the soil were all factors that contributed to increased okra development, according to Udensis *et al.*, 2018. The low yield produced at 75 cm x 75 cm spacing could be ascribed to the cucumber vines' inability to smother weeds due to a lack of plants and ample room for weeds to thrive. Because of the large amount of area available, the crop and weeds had to compete for nutrients, light, water, carbon dioxide, and space, giving the weeds a resource utilization edge over the crop.

Plant spacing of 75 x 25 cm was determined to be the best for better output, which was in line with Dhillon *et al.* (2017), who discovered that the best spacing for optimum cucumber yield was 70 cm x 30 cm. Quian (2000) also discovered that the closer the plant spacing, the higher the output. Jacques *et al.* (2002) also found that when plant density grew from four to ten plants per meter square, the number of fruit declined. However, the results of the trial contradict those of Paulo *et al.* (2003), who found that higher plant spacing yielded the maximum yield.

Conclusions

From the study, it was established that variety CU 999 is higher yielding than Monalisa and the optimum growth and high fruit yield in cucumber is dependent on crop spacing in the field.

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Table I Physical and chemical properties of soil of the experimental sites

	Early	Late
Properties	Pre planting	Pre planting
pH	6.8	6.8
N (%)	0.18	0.19
Available P (mg/kg)	19.55	20.12
Org. C (%)	0.48	0.57
Org. M (%)	0.89	0.99
Ex. A (mEq/100g)	0.20	0.20
Na (cmol/kg)	0.28	0.32
k (cmol/kg)	0.40	0.43
Ca (cmol/kg)	0.30	0.32
Mg (cmol/kg)	0.38	0.39
Sand (%)	74.20	74.50
Clay (%)	7.20	6.10
Silt (%)	19.20	19.40
Textural Class	Sandy loam	Sandy loam

Table II Effect of Variety and Spacing on Primary Vine length of Cucumber at 3 - 5 Weeks after sowing

	3		4		5	
	Early	Late	Early	Late	Early	Late
Variety						
CU 999	28.12	23.31	176.43	75.94	357.63	128.27
Monalisa	32.23	24.14	222.25	66.11	440.81	115.45
LSD (P≤0.05)	1.118	NS	2.925	NS	14.001	NS
Spacing (cm)						
75 × 25	28.98	21.17	184.52	81.83	373.67	127.06
75 × 50	30.05	22.62	199	61.36	397.6	124.4
75 × 75	31.5	27.39	214.5	69.89	426.4	114.13
LSD (P≤0.05)	0.734	NS	1.92	NS	9.19	NS
V × S (P≤0.05)	NS	NS	NS	NS	NS	NS

Table III Effect of Variety and Spacing on Number of leaves of Cucumber at 3 - 5 Weeks after sowing

	3		4		5	
	Early	Late	Early	Late	Early	Late
Variety						
CU 999	11.66	8.42	21.57	15.06	39.36	19.76
Monalisa	13.48	10.76	24.9	12.71	47.79	15.61
LSD ($P \leq 0.05$)	0.182	NS	0.41	NS	0.615	NS
Spacing (cm)						
75 × 25	11.99	9.75	22.19	16.5	40.86	19.89
75 × 50	12.55	8.29	23.19	11.33	43.5	15.58
75 × 75	13.17	10.72	24.33	13.82	46.36	17.58
LSD ($P \leq 0.05$)	0.12	1.616	0.269	NS	0.403	NS
V × S ($P \leq 0.05$)	NS	NS	NS	NS	NS	NS

Table IV Effect of Variety and spacing on Days to 50 % flowering and Days to fruit set

	Days to 50 % flowering		Days to Fruit set	
	Early	Late	Early	Late
Variety				
CU 999	19.44	21.44	29.67	31.67
Monalisa	24.67	26.67	35.00	37.00
LSD (P≤0.05)	2.084	2.084	1.656	1.656
Spacing (cm)				
75 × 25	23.67	25.67	33.83	35.83
75 × 50	21.67	23.67	32.00	34.00
75 × 75	20.83	22.83	31.17	33.17
LSD (P≤0.05)	1.615	1.615	1.883	1.883
V × S (P≤0.05)	NS	NS	NS	NS

Table V Effect of Variety and spacing on fruit breadth, fruit length, Unit fruit weight, number of fruits and yield

	Fruit Girth		Fruit Length		Unit Fruit Weight		No of Fruits		Yield (t/ha)	
	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
Variety										
CU 999	56.27	56.55	24.94	25.92	3.85	5.91	10.28	19.25	9.63	14.79
Monalisa	47.32	52.39	19.19	22.79	1.30	1.93	5.39	7.35	3.25	4.81
LSD (P≤0.05)	1.153	2.055	4.235	1.550	1.596	1.971	2.426	5.879	3.99	4.929
Spacing (cm)										
75 × 25	51.63	50.07	21.89	24.29	3.52	7.14	10.92	20.47	8.80	17.85
75 × 50	52.37	57.31	22.15	26.46	3.11	2.26	9.00	9.45	7.78	5.64
75 × 75	51.39	56.03	22.16	22.31	1.10	2.36	3.58	9.98	2.75	5.91
LSD (P≤0.05)	NS	0.754	NS	0.448	1.574	0.533	3.907	1.318	3.935	1.332
V × S (P≤0.05)	4.856	0.907	NS	0.584	1.942	0.718	NS	2.018	4.854	1.794

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