



Effect of Breeding on the Growth and Yield of *Cucumis sativus* (L.)

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Authors' contributions

This work was carried out in collaboration between all authors. Author CVI designed the study and wrote the protocol. All authors wrote the first draft of the manuscript. All authors managed the analyses of the study and the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Hybridization was carried out on two varieties of cucumber namely: Darina cultivar and Local Slicing variety to raise F1 to investigate the effect of hybridization on the growth and yield of the cucumber as shown in parental plants compared with the F1 hybrid. This was done using standard methods. Randomised Complete Block Design was used with three replications. Data were collected on the germination percentage (%), number of days to 50% germination, number of days to 50% flowering, number of days to 100% maturity, vine length, number of fresh fruit/plant and weight of fresh fruit/plant. Results were analysed using ANOVA. Results showed that the parental and the F1 hybrid plants differed in the growth and yield parameters. The F1 hybrid had the lowest number of days to 100% maturity (47.33 ± 2.51) and the highest vine length (113.00 ± 1.00) when compared to the parental plants. The highest number of fruits (5.67 ± 0.58) was also recorded for the F1 hybrid. Results of this study revealed that the F1 hybrid combined the characteristics of the Darina cucumber and the Local Slicing cucumber and also had improved characters. This can be seen in

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the growth parameters values of the F1 hybrid which are at the intermediate between those of the parents. Also, the highest vine length and the highest number of fruits/plant shown by the F1 hybrid. The obtained data thus indicated that breeding could significantly enhance growth and yield in cucumber plant production.

Keywords: Breeding; growth and yield; Cucumis sativus (Darina hybrid and Local Slicing variety).

1. INTRODUCTION

Cucumber (*Cucumis sativus*) is one of the major vegetable crops worldwide. It belongs to the Cucurbitaceae family. Cucumber is a creeping vine that roots in the ground and grows on other supporting frames, wrapping around ribbing with thin, spiralling tendrils [1]. Cucumber fruits are roughly cylindrical, elongated, with tapered ends, and may be as large as 60 cm long and 10 cm in diameter. *C. sativus* most likely originated in India (south foot of the Himalayas), or possibly Burma, where the plant is extremely variable both in vegetation and fruit characters [2]. It has been in cultivation for at least 3000 years. From India, the plant spread quickly to China, and it was reportedly much appreciated by the ancient Greeks and Romans [3]. Cucumber is the fourth most important vegetable crop after tomato, cabbage, and onion [4]. Although its calorie and nutritional value are very low but it is a primary source of vitamins and minerals in the human diet [5]. In addition to its delicious taste, it has high medicinal value. It is well known for natural diuretic and thus can serve as an active drug for secreting and promoting the flow of urine. Due to a high content of potassium (50-80 mg/100 g), cucumber can highly be useful for both high and low blood pressures [6]. Compared with many crops, cucumber reaches harvest stage rapidly and is mainly eaten in the unripe green form. Cucumbers are botanically categorized as berries, which are available in many different sizes, shapes and colours. The most popular variety is the long smooth salad cucumber; having a dark-green skin, an enclosed seed and developing from a flower. Botanically cucumbers are classified as accessory fruits. Much like tomatoes and squash they are often also perceived, prepared and eaten as vegetables [7]. Cucumber is an excellent source of dietary fibre that massage in the teeth and gums. Digestive disorders, such as heartburn, gastritis, and even ulcers, can be cured by the daily consumption of fresh cucumber juice. The high water content and dietary fibre in cucumber are very useful in driving away the toxins from the digestive system and hence aid digestion. Daily consumption of cucumber can be regarded as a remedy for

chronic constipation. Cucumber is an excellent source of silica which is known to help promotes joint health by strengthening the connective tissues [8]. When mixed with carrot juice, they can relieve gout and arthritis pain by lowering the uric acid levels. This veggie contains a hormone needed by the cells of the pancreas for producing insulin. It has been found that some compounds called sterols in cucumber may help reduce cholesterol levels [9].

There exist three main varieties of cucumber; slicing, pickling and burpless. Within these varieties, several different cultivars have emerged. Many cultivars of cucumber exist with varying shapes, skin colours and carotene content [10]. Cucumber cultivars have distinctive characteristics/ traits which make them suitable for a particular environment or condition in terms of tolerances to drought, disease resistance, early maturing and yield [11]. Production of cucumber in Nigeria is mostly done in the northern part of the country. There was a general belief that cucumber can only be grown in the north. However, cucumber cultivation in the south-eastern Nigeria has been found to be achievable under moderate rainfall [12]. The slicing cucumber referred to as "regular" is the most common field-grown type, it ranges in size from 6 to 9 inches, and its dark-green skin is usually waxed to prevent moisture loss. The English cucumber, which may be called seedless, European, burpless, or hothouse (which is where it is commercially grown), grows to between 1 and 2 feet in length. Slimmer and smooth-skinned, the pickling cucumber is small and thick with bumpy, light-green, unwaxed skin [13].

However, there is a hybrid cucumber produced in U.S.A. called Darina hybrid cucumber; having beautiful dark green color fruits with white thorns measuring 20 – 23 cm. It is a high yielding variety 30t/acre that matures early 45 - 50 days and is resistant to cucumber vein yellowing virus and scab disease and intermittent resistance to cucumber mosaic virus and powdery mildew unlike the other varieties.

Improvement in crop production demands good quality crops; having good taste, early maturity, increased yield, insect/pest resistant, more nutrients and that can meet the immediate needs of man in terms of food and raw materials [14,15]. Considerable efforts have been made by breeders to improve the yield of several crops such as tomato, okra etc [16,17]. Incorporation of these characteristics from Darina cucumber to local slicing variety is highly imperative. Hence, this research aimed at hybridizing Darina cucumber and the Local Slicing cucumber to produce a hybrid that might combine the qualities of the two varieties to meet the popular demands of the society. Such a hybrid of the two varieties is likely to be of better quality and demand than either of the two parents. Accordingly, the problem and focus of the researchers is to crossbreed the Darina cucumber and the Local Slicing cucumber and compare the growth and yield parameters of the hybrid and the parental plants.

2. MATERIALS AND METHODS

2.1 Study Area

The experiment was conducted at the teaching and research farm of the Department of Botany, Nnamdi Azikiwe University Awka, Anambra State (6° 12N', 7° 04E') during the 2016-2017 cropping seasons to determine the effect of breeding on the growth and yield of *C. sativus*. Awka is located in the tropical rain forest zone of Nigeria with average temperatures, annual rainfall and relative humidity of 29°C, 2700 mm and 87% respectively.

2.2 Design of the Study

The experiment was laid out in a Randomized Complete Block Design replicated three times.

2.3 Collection and Identification of Plant Materials

The Darina hybrid cucumber seeds and the local slicing seeds were purchased from Kaduna State, Nigeria from an Agricultural market. The Darina cucumber hybrid seeds were produced by the Seminis Company located in the United States of America. The seeds were authenticated at the Department of Botany Nnamdi Azikiwe University.

2.4 Experimental Design and Materials

The materials include; seeds of Darina hybrid cucumber and local slicing cucumber (*C. sativus*), 20 buckets, loamy soil, measuring tape, organic liquid fertilizer, Petri dishes, plastic and wooden stakes, weighing scale and aluminium foil.

2.4.1 Planting procedure

The Darina hybrid cucumber seeds and local slicing seeds were put through a viability test. This was done by, soaking some seeds in a beaker containing distilled water for approximately 5 minutes; the water was then stirred and allowed to settle. The seeds that floated on the surface of the water were discarded, while those that settled to the bottom of the beaker were selected. A total of 20 buckets were used, each bucket contained 5kg of a mixture of loamy and sandy soil with 76.80% sand, 10.20% clay and 6.00% silt. The soil is acidic with PH of 5.9. 10 of the buckets were labelled Darina hybrid cucumbers, and the other 10 were labelled Local Slicing cucumbers. The seeds of each was planted accordingly (5 seeds in each bucket). At different stages, the seedlings were pruned to 2 seedlings per bucket. The buckets were perforated to allow free movement of water.

2.4.2 Crossbreeding

Flowering of the Darina hybrid cucumber started at 3 weeks, while that of the Local Slicing started at 4 weeks. It was at this stage that the crossing was done. Artificial crossing was adopted. This involves the removal of the anthers with a pair of forceps, from the Darina hybrid cucumber plant, thus, using it as a female plant before it dehisces and covering the emasculated flower with aluminium foil to avoid natural crossing by insects. This was followed by the collection and transference of ripe pollen grains from the Local Slicing cucumber (male plant) to the stigma of the emasculated plant (Darina cucumber plant). This pollination process was followed by fertilization and subsequent production of fruits (the F1 hybrid). This procedure is as outlined by [14]. The seeds of the parental plants and the F1 hybrid collected from the 2016 cropping season were planted and used to assess growth and yield during the 2017 cropping season.

2.5 Statistical Analysis and Data Collection

Data collected on growth include; the germination percentage (%), number of days to 50% germination, number of days to 50% flowering, number of days to 100% maturity and vine length. Data collected on yield include; number of fresh fruit/plant and weight of fresh fruit/plant of the Darina hybrid cucumber, local slicing cucumber and F1 hybrid. The data collected were analysed using Analysis of variance (ANOVA), while mean values were separated by the Duncan multiple range test.

3. RESULTS AND DISCUSSION

Results of the study are shown in Tables 1-2, Plates 1-4 and Fig. 1.

3.1 Growth Parameters of the Parental Plants and the F1 Hybrid

Result of the growth parameters of the parental plants and the F1 hybrid showed that the Local Slicing cucumber recorded the lowest germination percentage (28.67±6.43) and vine length (80.33±1.53) compared to the Darina hybrid cucumber and the F1 hybrid (Table 1) (Fig. 1). The Darina hybrid had the lowest number of days to 50% germination (2.67±0.58) and highest germination percentage (98.00±2.00) followed by the F1 hybrid (Table 1) (Fig. 1). The F1 hybrid had the highest vine length (113.00±1.00) compared to the parental plants (Table 1) (Fig. 1). The local slicing variety had the least performance in growth parameters. The findings showed a significant difference in the growth of the parental plant and the F1 hybrid (Table 1) (Fig. 1). The Local Slicing cucumber had the highest number of days to 50% flowering (38.00±1.73) and number of days to 100% maturity (68.00±2.00) (Table 1) (Fig. 1). The Darina hybrid cucumber had the highest

germination percentage (98.00±2.00) (Table 1) (Fig. 1). The F1 hybrid had the highest vine length (113.00±1.00) and its values for germination percentage (93.33±5.03), number of days to 50% germination (4.33±5.03) and number of days to 100% maturity (47.33±2.52) were at intermediate between that of the parental plants (Table 1) (Fig. 1). This agrees with [14] who reported that F1 generation combined the characteristics of both parents and also had additional genetic attributes. This is also in line with the report of [18] that hybrids are a mosaic of both parental plants. [19] also reported that in some cases hybrid plants grow more vigorously than their parental species, known as the phenomenon of heterosis or hybrid vigour. Again, variation in growth parameters of Cucumber varieties indicated that they have different responses to environmental conditions which might be attributed to their genetic makeup.

3.2 Yield Parameters of the Parental Plants and the F1 Hybrid

Result of the average yield parameters of the parental plants and the F1 hybrid showed that the Local Slicing cucumber had the lowest number of fruits/plant (2.33±0.58) compared to the Darina hybrid cucumber (4.33±0.58) and the F1 hybrid (5.67±0.58) (Table 2) (Fig. 1). The Darina hybrid cucumber had the highest weight of fruits/plant (1.51±0.51) compared to the Local Slicing cucumber (0.79±0.08) and F1 hybrid (0.58±0.06) (Table 2) (Fig. 1). The F1 hybrid had the highest yield (number of fruits/plant) (5.67±0.58) compared to the parental plants (Table 2) (Fig. 1). There was a significant difference in the yield parameters of the parental plants and the F1 hybrid ($p < 0.05$) (Table 2) (Fig. 1). The highest number of fruits/plant (5.67±0.58) showed by the F1 hybrid may be attributed to the highest vine length which led to an increase in the number of branches, allowing for an increase in the number of fruits/plant thus supporting

Table 1. Average growth parameters of the parental plants and F1 hybrid

Variety	Germination (%)	No. of days to 50% germination	No. of days to 50% flowering	No. of days to 100% maturity	Vine length (cm)
Darina hybrid	98.00±2.00 ^a	2.67±0.58 ^c	24.67±0.58 ^b	53.67±1.53 ^b	108.67±2.52 ^b
Local Slicing	28.67±6.43 ^b	6.33±0.58 ^a	38.00±1.73 ^a	68.00±2.00 ^a	80.33±1.53 ^c
F1 Hybrid	93.33±5.03 ^a	4.33±0.58 ^b	18.67±1.16 ^c	47.33±2.52 ^c	113.00±1.00 ^a
p-value	0.000	0.001	0.000	0.000	0.000

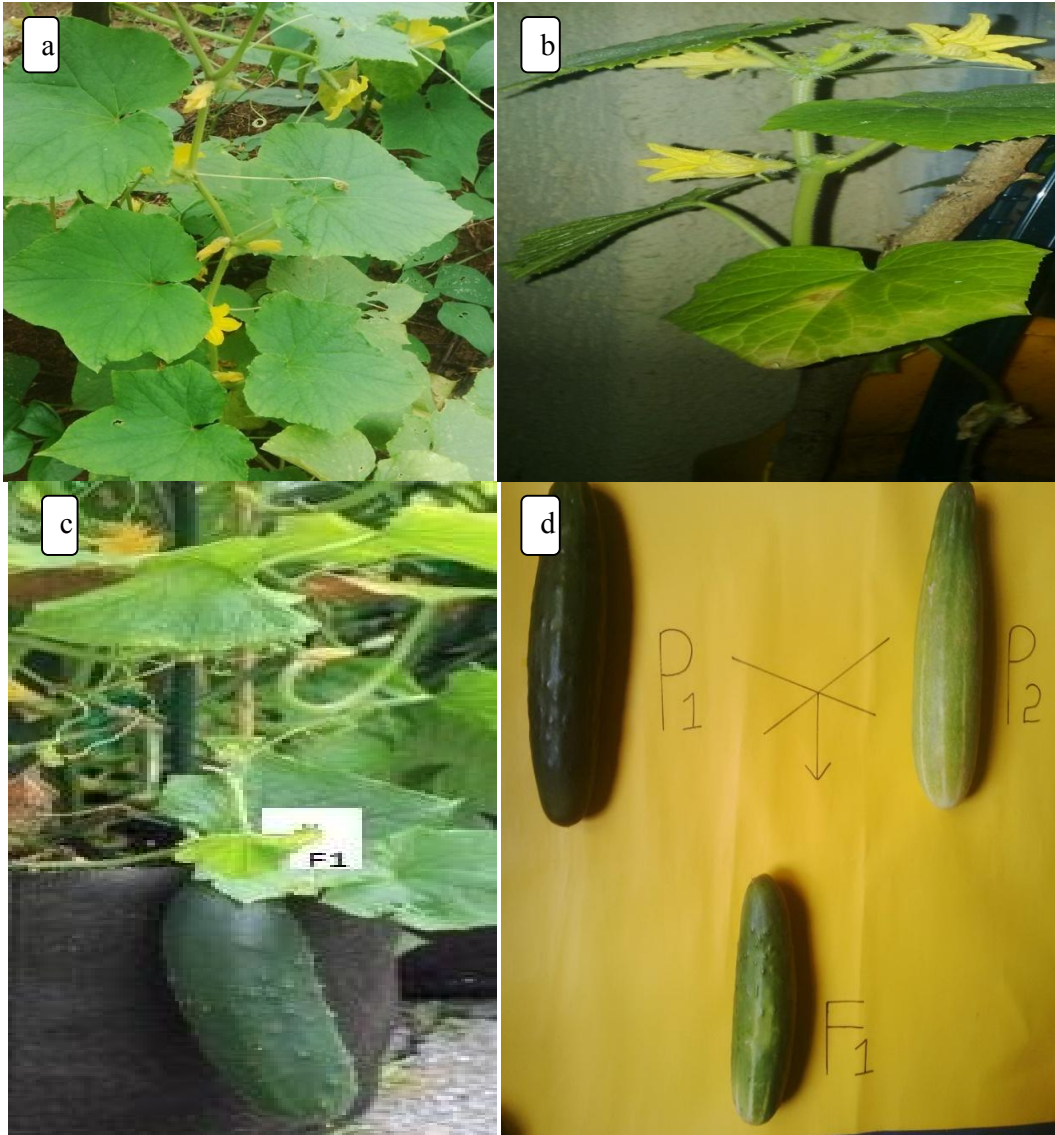
Results are in Mean ± Standard Deviation

Means with the same letter in a column are not significantly different, $p > 0.05$

Table 2. Average yield parameters of the parental plants and F1 hybrid

Variety	No.of fruits/plant	Weight of fruits (kg)
Darina Cucumber	4.33±0.58 ^b	1.51±0.51 ^a
Local Slicing	2.33±0.58 ^c	0.79±0.08 ^b
F1 Hybrid	5.67±0.58 ^a	0.58±0.06 ^b
<i>p-value</i>	0.01	0.02

*Results are in Mean ± Standard Deviation
Means with the same letter in a column are not significantly different, p>0.05*



Plates 1-4(a-d). (a) The parental variety P₁ (Darina hybrid) (b) Parental variety P₂ (Local Slicing variety) (c) F₁ hybrid and (d) Fruits of parents compared with the fruit of the F₁ hybrid

heterosis. [20] reported that, hybrid breeding by taking advantage of heterosis brings about many superior properties to the F₁ hybrid. [21] pointed out that when the male pollen of a plant is

manually transferred, into the female stigma of another plant which may be of a different variety, species or even genera, a hybrid with improved characteristics is produced.

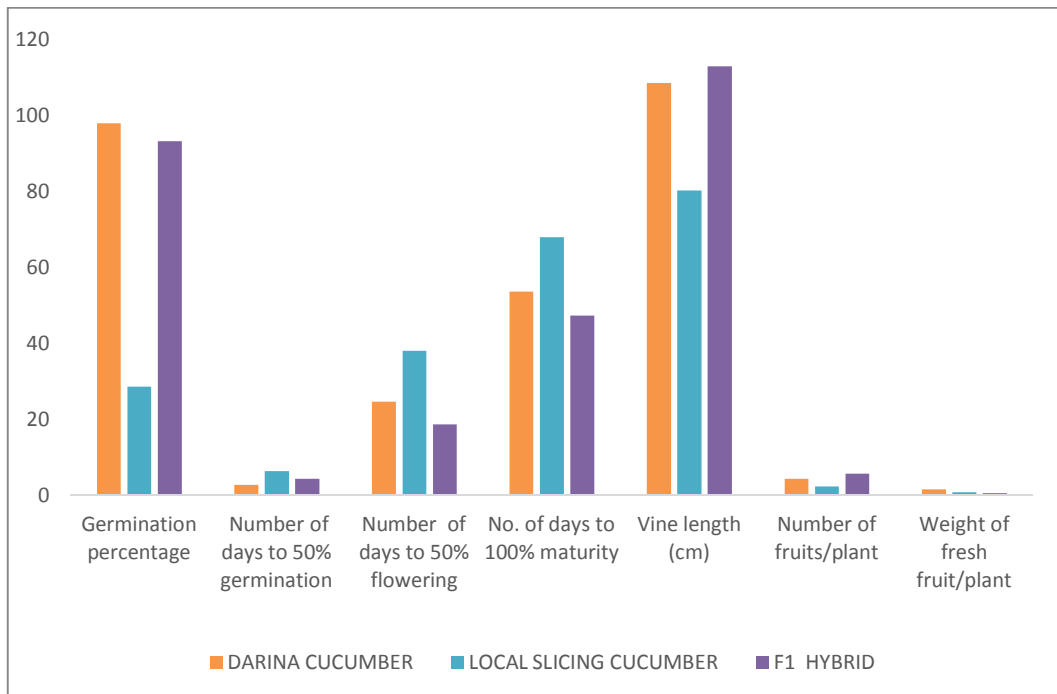


Fig. 1. Growth and yield of Darina, Local Slicing and the F1 hybrid of *Cucumis sativus*

Furthermore, the F1 hybrid combined the characters of both the Darina hybrid cucumber and Local Slicing cucumber; this can be seen in the growth parameters values of the F1 hybrid which are at intermediate between those of the parents (Table 1) (Fig. 1). However, the characters of the Darina cucumber dominated that of the slicing cucumber and this can be seen in the appearance of bumps on the skin of the F1 hybrid as in Darina cucumber (Plates 3 and 4).

4. CONCLUSION

Results of this study showed that the F1 hybrid combined the characteristics of the Darina cucumber and the Local Slicing cucumber and also had improved characters. This can be seen in the growth parameters values of the F1 hybrid which are at the intermediate between those of the parents. Also, the highest vine length and the highest number of fruits/plant shown by the F1 hybrid. The obtained data thus indicated that breeding could significantly enhance growth and yield in cucumber plant production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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