

# Assessment of Yield and Fruit Quality of Cucumber (*Cucumis sativus*) under Deficit Irrigation in the Agro-Ecological Tropical Zone

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**Abstract:** This study was carried out to determine the growth and yield performance of cucumber to deficit irrigation. The research was carried out in a screen house on the Teaching and Research Farm of Agricultural Engineering Department, Federal University of Technology, Akure, Nigeria. The experiment was a complete block design which comprised of four treatments and four replicates. The treatments were: T1, T2, T3 and T4 irrigated at 100 % ET, 80 % ET, 60 % ET and 40 % ET respectively using drip irrigation. Soil and agronomic parameters were determined and results were subjected to statistical analysis. The result showed that T1 (100 %) had the highest plant height and the highest number of leaves of 107 cm and 15 respectively, T2 (80 %) produced the highest cucumber fruit yield of 1059.3 kg/ha with average length and average diameter of 18.33 cm and 5.87 cm respectively while T4 (40 %) produced the lowest yield of 85.2 kg/ha with an average fruit length and diameter of 8.4 cm and 2.86 cm respectively. Thus, with 80 % water application, cucumber can produce the highest fruit yield and water use efficiency.

**Keywords:** Deficit irrigation, Cucumber, Evapotranspiration, Agronomic parameters.

## 1. Introduction

Cucumbers are vegetables grown all around the world. According to [1], it is one of the most widely cultivated in the world. Its cultivation is also becoming common in most part of Nigeria, probably due to its high nutritional and medicinal values according to [2]. Cucumbers are warm season plants that grow best between 18° to 24 °C. However, the plants do not tolerate prolonged exposure to temperatures below 13 ° or above 32 °C. Cucumber, because of its shallow fibrous root system is sensitive to water stress, which results to yield losses. However, high water application produced higher cucumber fruit yield [3], although, [4, 5] reported contrary that cucumber produced lower fruit yields under excess water application. Also, cucumber fruit parameters depend on irrigation water quantities [6]. Water use in agriculture is often highly inefficient with only a fraction of the water diverted for agriculture effectively used for plant growth, with the rest drained or lost via evapotranspiration. Deficit irrigation is a strategy, which allows crop to sustain some degree of water deficit during certain stages of crops or the whole season without a significant reduction in yield [7]. The idea of scheduling irrigation intervals according to crop water needs minimizes the chances of under or over watering of the cucumber plant. The typical purpose of irrigation is to favorably maintain the water status of plants. Few decades to come, irrigated crop production will be affected significantly with water scarcity, there is therefore a pressing need to improve the irrigation water efficiency under insufficient water supply conditions [3]. Screen house cultivation for agricultural product has been proven to provide favorable

condition for crop production which enables plant growth till their harvest [8]. Therefore, this study was carried out to determine the effects of different drip irrigation water quantities on the cucumber plant, fruit yield, fruit quality (fruit length, diameter, weight) and irrigation water use efficiency (IWUE) of cucumber in a tropical climatic region.

## 2. Materials and Method

### 2.1. Description of Experimental Site

The field experiment was carried out between May-August, 2018 at the Department of Agricultural and Environmental Engineering, Teaching and Research Farm, Federal University of Technology, Akure, Southwestern, Nigeria. The Research farm lies on latitude 7° 16' North of the equator and longitude 5° 13' East of the Greenwich meridian. Also, it lies in the rain forest zone with a mean annual rainfall between 1300-1600 mm and an average temperature of 27 °C. The relative humidity ranges between 85 and 100 % during the rainy season (April to October) and less than 60 % during the dry season (November to March). The experiment was conducted in a screen house (to make it purely irrigation-fed) because the experiment was carried out in the rainy months. A screen house made of wooden frames and covered with transparent plastic roof of dimensions 2 m long, 2.4 m wide and 2.2 m high was used for this experiment. There was no controlled environment in the screen house. Plastic containers (45 cm diameter and 60 cm high) filled with soil were used for planting of cucumber. The soil was sandy clay loam of (64.8 % sand, 23.2 % and 12.0 % clay) with 15 % field capacity, 1.47 g/cm<sup>3</sup> bulk density and pH of 5.5.

## 2.2. Experimental Design

The experimental plot of 1.5 m by 1.8 m, a completely randomized block design which comprised of four treatments and four replicates. The treatments were different varying water application of T1 (100 %), T2 (80 %), T3 (60 %) and T4 (40 %) all based on the field capacity. Drip irrigation system was solely used for the experiment and was installed in the screen house before transplanting of cucumber seedlings. Cucumber seeds (variety: Darina) were planted on 22nd of May, 2018 in the nursery where equal amount of water was applied to them manually. At 3 weeks after planting (WAP), healthy and viable seedlings were transplanted to the experimental plot.

## 2.3. Crop Evapotranspiration Determination

Soil moisture content was determined using gravimetric method from depths 0-30 cm during and after the experiment. The amount of water required by the cucumber crop was determined using the energy- balance equation below:

$$ET_o = I + P + \Delta S \pm D \pm R \quad (1)$$

Where:

$ET_o$  = Crop Evapotranspiration (mm),

I = Irrigation (mm)

P = Precipitation (mm)

$\Delta S$  = Change in soil moisture (mm)

D = Deep Percolation (mm)

R = Runoff (mm)

Precipitation (P), deep percolation (D) and runoff (R) were all assumed negligible since the experiment was carried out in a screen house without interaction of rainfall. Also,  $\Delta S$  has no contribution to the plant ET, it was assumed the same throughout the experiment. T1 (100 %) received 506.62 mm, T2 (80 %) received 405.30 mm, Treatment T3 (60 %) received 303.97 mm and T4 (40 %) received 202.65 mm. Irrigation water application was strictly controlled by applying the exact amount to each of the treatments in the interval of 2 days.

## 2.4. Agronomic Measurements

In each of the treatments, the cucumber plants were vertically staked independently using rope. Also, management practices such as manual weeding and pest control were done throughout the entire research. Before harvest some agronomic parameters were determined on a weekly basis. These parameters were the number of leaves determined by physical counting and plant height was determined using a metre rule. At 14 WAP the fruits were harvested and the parameters determined per treatments were: number of fruits, fruit diameter and fruit length, fruit yield. Also, irrigation water use efficiency (IWUE) was determined.

## 2.5. Data Analysis

Statistical analysis used was Anova and Regression of multiple analysis and comparison among the treatment was

achieved by using Microsoft Excel 16.00 (Microsoft Inc, USA), software package for windows.

## 3. Results and Discussions

### 3.1. Effects of Varying Water Application to growth of Cucumber Plant

#### 3.1.1. Plant Height

Effects of different water applied on the heights of cucumber plants observed in each of the treatments as shown in Figure 1 showed that the cucumber plants had equal heights from 3-5 WAP, thereafter T1 started showing slight increase in height than the other treatments at 6 WAP. Moreover, T1 had the highest increase in height weekly as it reached an average height of 107 cm at the 13 WAP, while the other treatments T2, T3 and T4 at 13 WAP had average plants heights of 90 cm, 65 cm and 39 cm respectively. Likewise, [9, 10] reported the highest cucumber plants heights of 142.5cm and 119.2cm respectively at 100 % water application. Statistical analysis indicated there was a statistical significant difference between the average plant heights in all the treatments at  $P < 0.05$ . The result of cucumber plant height in relation to water applied indicates that soil water supply is directly proportional with plant height growth [11].

#### 3.1.2. Number of Leaves

Effects of different water application to the number of leaves in cucumber plants in each of the treatments are shown in Figure 2. It could be observed that there was insignificant difference in the number of leaves in the treatments between 3-5 WAP. T1 had highest average number of leaves of 15 at 10 WAP compared to the other treatments, until the number of leaves began to decrease to an average of 9 leaves at 13 WAP. Likewise, T2 had an average number of leaves of 14 initially but decreased to an average of 12. This decrease in the average number of leaves was evident in all the treatments. These findings were similar to that of [12, 13] where they reported the highest average number of leaves in 100% treatment at 10 WAP to be 15 and at 12 WAP to be 14 respectively. In addition, statistical analysis indicated that there was significance difference between the treatments at  $P < 0.05$ .

### 3.2. Effects of varying water application on cucumber fruit yield

Effects of varying water application on the average marketable fruit yield of cucumber in each of the treatments is as shown in Figure 3. The highest marketable cucumber yield of 1059.3 kg/ha was obtained in T2 while the lowest yield of 85.2 kg/ha was recorded in T4. The total yield of all treatment was 1974.0 kg/ha. This was similar to the findings of [7], where they reported 80 % irrigation deficit as the most effective that produce good marketable cucumber yield compared to 100 %. In addition, [14] reported that 85 % irrigation deficit produced the highest yield. However, [3, 7, 15] reported the highest cucumber yield at 100 % full irrigation.

### 3.3. Effects of varying water application on cucumber fruit physical quality

Effects of varied water applied on cucumber fruit physical quality including average fruit weight, average fruit length and average fruit diameter is shown in Table 1. T2 produced the highest average fruit weight of 399.13 g while the lowest weight value of 48.15 g was T4. This is in contrary to the findings of [14, 3], they reported the highest and lowest

average fruit weight at 100 % and 85 % irrigation regime respectively. Also, T2 had the highest average fruit length of 18.33 cm while the lowest value of 8.4 cm was found to be T4. However, [3] reported the highest average fruit length of 15.95 cm at 100 % while [14] reported the highest value of 26.55 cm at 65 %. Moreover, the highest fruit diameter of

5.87 cm was found with T2 while the lowest value of 2.86 cm was found with T4. Relatively lower results were reported by [14, 3] where their highest fruit diameter were 2.79 cm and 3.81 cm respectively.

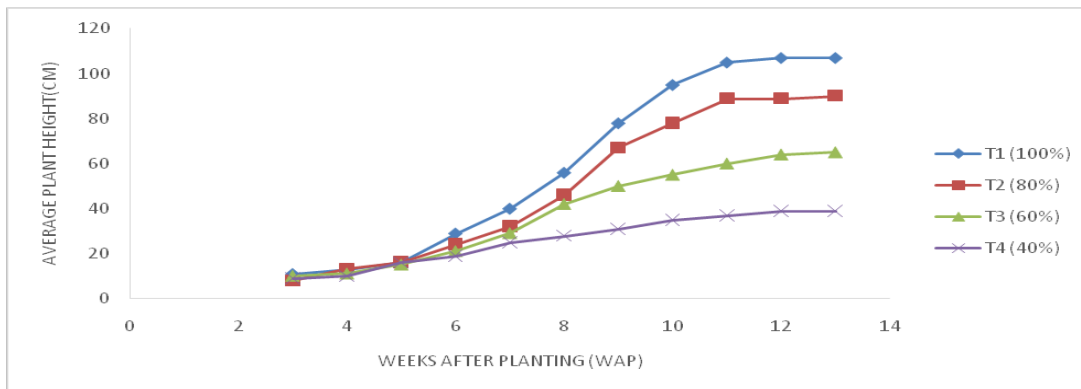


Figure 1. Average plant height against weeks after planting

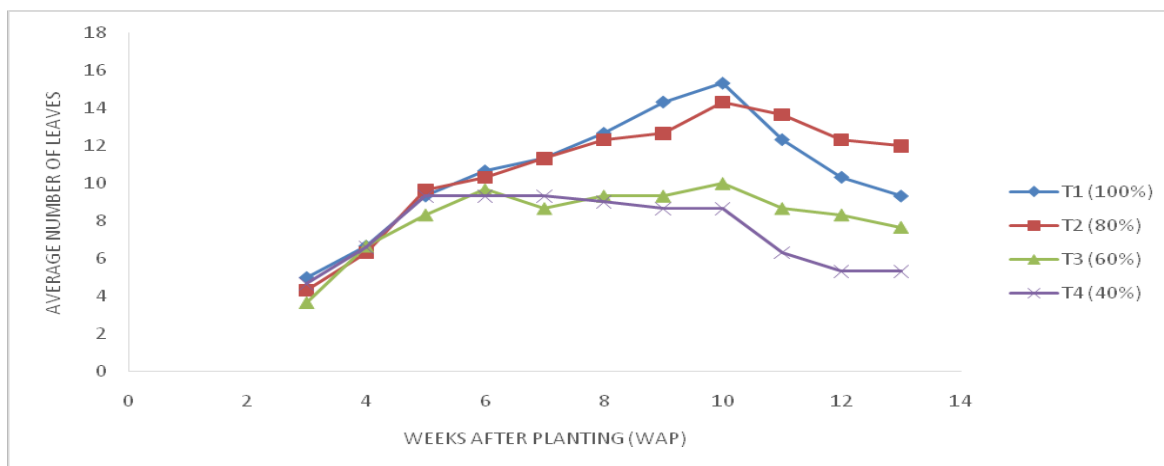


Figure 2. Average number of leaves against weeks after planting

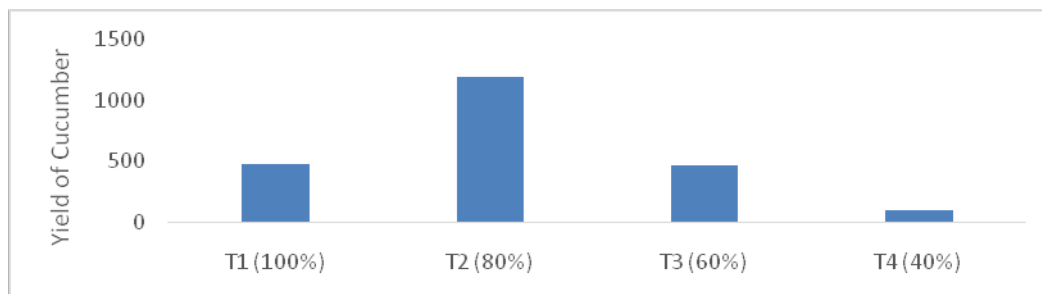


Figure 3. Yield of Cucumber per treatment

**Table1.** Effects of varied water applied on cucumber fruit physical quality

FRUIT QUALITY	TREATMENTS			
	T1	T2	T3	T4
*Fruit Weight (g)	157.90	399.13	93.92	48.15
*Fruit Length (cm)	14.83	18.33	11.66	8.4
*Fruit Diameter (cm)	4.21	5.87	3.76	2.86

\* - Average

**Table 2.** Water requirement and water use efficiency of cucumber under different water application

Treatment	IA (mm)	ER (mm)	ETc (mm)	Y (kg/ha)	WUE (kg/ha/mm)
T1	506.2	0	506.2	419.2	0.83
T2	405.2	0	405.3	1059.3	2.61
T3	304.0	0	304.0	410.3	1.35
T4	202.6	0	202.6	85.2	0.42

Irrigation Applied =IA, Effective Rainfall = ER, Total Crop water use = ETc, Yield = Y, Water use efficiency = WUE

### 3.4. Irrigation Water use efficiency

Table 2 shows the water requirement and water use efficiency of cucumber under different water application. T2 had the highest irrigation water use efficiency (IWUE) of 2.61 kg/ha/mm while the lowest value of 0.42 kg/ha/mm was recorded for T4. However, higher values of WUE of 61.9 kg/m<sup>3</sup> at 40% and 134.94 kg/ha/mm at 85% were recorded for [16,3] respectively. Also, lowest irrigated treatment T4 had the lowest WUE, this is similar to [17, 6, 3] where they reported the lowest irrigation WUE values for cucumber in the lowest irrigation conditions

### 4 Conclusion

Through the application of different rates of water for plant growth, it could be seen that the highest yield of cucumber fruits was 1059.3 kg/ha which was gotten from the 80 % treatment. While the least yield of 85.2 kg/ha was gotten from the least irrigated treatment which was the 40 % treatment. Therefore, in order to have a reduction in water application for cucumber fruit with a corresponding increase in growth, yield and fruit quality, 80 % of the gross irrigation requirement (GIR) is required, and also gave the highest water use efficiency.

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