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Effects of Irrigation Frequency and Manure on Growth Parameters, Crop Coefficient and Yield of Okro (Abelmoscus Esculeutus)

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Abstract
It is essential to maintain readily available water in the soil if crops are to make satisfactory growth and give optimum yield. This work studied the response of Okro to the application of different regimes of irrigation water (W1, W2 and W3) in order to determine its growth performance and yield. Twenty seven (27) bucket of the volumetric capacity of 10litres each, Okro was planted in each bucket equal treatment of animal and organic fertilizer was applied in the ratio 6:1 while response to plant height observed were 13 cm, 10.8 cm and 15 cm, also, stem diameter observed were 0.06 mm, 0.12 mm, and 0.17 mm.The effects of irrigation frequency, average plant height (cm), average number of leaves; average Stem (diameter, mm) and yield (g) were studied. W1 gave 13, 4, 0.06, 11.4; W2: 10.8, 6, 0.12, 18.1; W3: 15, 7, 0.17, 23.3. Plants under W3 recorded the highest plant height and it also produced the highest number of leaves at 7 stem diameter (0.17mm) and consequently the highest mean yield. The study showed that with readily available nutrients present in soil, the most desirable frequency of irrigation gives an optimum crop yield as nutrients is easily taken up by plants. It is recommended that a standard model green house be constructed to study various crop coefficients and consumptive use for this zone.
Keywords: irrigation frequency, growth parameters, crop coefficient, yield, Okro

1. INTRODUCTION

Irrigation can basically be described as the economic and sustainable application of water for optimum production of crops. An efficient irrigation method is that which best suit local conditions such as soil characteristic of crop diversity, topographic condition, soil moisture flow and aquifer recharge.

Irrigation can be broadly classified into; surface irrigation, overhead irrigation and sub-surface irrigation methods. Each of these methods can be manipulate according to the desired result and level of water application depending on the type of crops and method of planting. Irrigation also has a few other uses in crop production, which include protecting plant against frost (Snyder and Melo-Abrcu, 2005), suppressing weed growing in grain fields and helping in preventing soil consolidation (William *et al*, 2007).

Different irrigation application methods which includes pot, bucket etc have been investigated to determine their effects in crop growth. Pot or bucket irrigation can be used to grow vegetable like tomatoes, okro, pepper and cucumber. It also helps to maintain post-season production of vegetable as far as the conditions of planting are suitably provided and monitored. This study focus on varying the amount of water required for the production of crop using different irrigation techniques using 10 litres bucket drilled at sufficient point at the bottom for the collection.

2. MATERIALS AND METHODS

The study was conducted under an open side roof structure situated at Agricultural Engineering Departmental research farm of Ladoke Akintola University of Technology, Ogbomoso, Nigeria. The experimental site lies between longitude 425'E and latitude 815'N.

2.1 Experimental procedure

Twenty seven (27) bucket of volumetric capacity of 10 litres each, each bucket was drill at the diameter of 8.5mm at the bottom at twelve equidistance points to allow water for drainage at each water application period.

2.2 Soil preparation

Each bucket was filled with 10.9kg of 10mm sieved soil (loamy soil) to enhance adequate soil plant optimum interaction. The soil was saturated with water and was covered with polythene bags. The saturated soil in the bucket covered with polythene bags was allowed to drain for three days to attain field capacity before planting. The bucket was placed on 50cm concrete platform to facilitate optimum drainage.

2.3 Climatological data

Table 1 shows the climatological data from NIHORT Ibadan Meteorological station which was adapted for Ogbomosho from 2004-2009. The data include; Temperature (maximum and minimum), Sunshine hours, Evaporation and Relative Humidity.

Table 1: Summary of climatic data

Monthly mean From 2004-2009	No of days	Temperature (^{0}c) Max	Min	Sunshine Hours	Relative Humidity	Evaporation
January	31	34	21	5.7	75	3.2
February	28	35	21	4.0	72	4.1
March	31	36	24	4.8	80	4.0
April	30	33	23	5.0	82	3.6
May	31	33	23	5.2	82	2.5
June	30	31	23	5.1	85	3.1
July	31	30	24	3.7	87	2.5
August	31	29	22	2.6	87	1.8
September	30	29	24	3.3	88	2.3
October	31	32	23	4.4	86	2.1
November	30	33	23	5.2	70	2.3
December	31	33	21	6.2	77	2.5

Source: NIHORT Ibadan.

2.4 Determination of moisture content

Soil moisture content was taken using spatula and dried to constant moisture with the aid of an oven at 105 C. Soil samples were collected into five can which was earlier weighed with a weighing balance. Soil moisture content can be determined by using granumetric method;

$$\text{Moisture content} = \frac{\text{Weight of wet soil - weight of dry soil}}{\text{Weight of dry soil}}$$

2.5 Determination of irrigation water requirement

Irrigation water requirement can be determine by multiplying monthly evapotranspiration (ETo) and crop use co-efficient.

Irrigation water requirement = ETo * Kc

where, ETo = Evapotranspiration.

Kc = Crop use Co-efficient.

2.6 Planting of Okro

Okro seed was planted on 20th July, 2010 at the rate of 10 seeds per bucket. Uniform amount of water was added to the bucket until germination and development of two leaves per plant.

2.7 Application of irrigation

Consequently, three watering regime at the rate of one litre per time of application was applied once (w1), twice (w2), and thrice (w3) per week.

2.8 Application of fertilizer and manure

7.5g of fertilizer and 1.5g of manure (poultry and cow dung) was applied on the 21st day as first application and subsequently at flowering stage.

Figure 1: Typical representation of 27 bucket of okro

2.9 Determination of Crop Co-efficient (Kc)

Crop Co-efficient (Kc) is obtained by linking the actual crop evapotranspiration (ETcrop) to reference crop evapotranspiration (ETo) as given in the equation;

$$Kc = \frac{ET\ crop}{ETo}$$

where ETcrop is the crop evapotranspiration and
ETo is the reference crop evapotranspiration

Method used for calculating ETo and ETp from meteorological parameter are:

i. Pan evaporation method (FAO, 1986)

$$ETo = Kp * Epan$$

where ETo is the reference crop evapotranspiration
Epan is the pan evaporation
Kp is the pan co-efficient

ii. Adjusted Blaney-Criddle (ABC) model for tropics (Fapohunda and Ude 1992).

$$ETp = \frac{(37.846-0.254RH)}{100} Kc*Kt*T*P$$

where ETp is pot evapotranspiration (mm/day);
T is the monthly mean temperature in degree;
Kt is 0.0173T-0.314 monthly temperature factor;
P is monthly % of daylight hours of the year and RH is Relative humidity.

2.10 Measurement of growth parameters

Growth parameter such as plant height was measured using graduated meter rule from the soil surface to the tip of the leaves of okro, while stem diameter was measured using vernier caliper and number of leaves was also counted.

3 RESULTS AND DISCUSSIONS

3.1 Reference crop evapotranspiration (ETo)

Table 2: ETo for irrigation water requirement from July to December, 2004 to 2009

Monthly mean From	No of Days	Mean Temp. Max ^{O}c	Sunshine Hours	% Sunshine
July	31	30	3.7	0.12
August	31	29	2.6	0.08
September	30	29	3.3	0.11
October	31	32	4.4	0.14
November	30	33	5.2	0.17
December	31	33	6.2	0.20

Bleney Criddle (Temperature Method) for ETo

$$ETo = P (0.46T + 8.13) \text{ (Michel, 1978)}$$

where P is percentage sunshine hour for the month
T is Temperature ^{o}C

Table 3: Effect of irrigation frequency on growth parameters

Irrigation frequency	Average plant height (cm)	Average number of leaves	Average stem diameter (mm)	yield (g)
W1	13	4	0.06	11.4
W2	10.8	6	0.12	18.1
W3	15	7	0.17	23.3

Table 4: Effect of irrigation frequency on okro growth and yield

Treatment	Average plant height (cm)	Average number of leaves	Average stem diameter (mm)	yield (g)
W1	13	5	0.08	19.9
W2	10.8	6	0.13	23.7
W3	15	7	0.16	25.6

Effect of irrigation frequency on growth and yield is presented in Tables 3 and 4. This trend is expected since plants need water for growth. Plants under w3 recorded the highest plant height and it also produced the highest number of leaves at 7 stem diameter (0.17mm) and consequently the highest mean yield. Generally, w3 produced plants with the best growth parameters. The yield recorded under w3 was such that other treatment could not compete economically with it. Irrigation frequency and treatment (fertilizer and manure) thrice per week was for all parameters.

3.2 Determination of irrigation water requirement

This is the calculation of crop used co-efficient (Kc), reference crop evapotranspiration (ETo), and Potential evapotranspiration (ETp).

$$Kc = \frac{ETcrop}{ETo}$$

Calculation of ETo = Kp * Epan

Calculation of ETcrop = $\frac{(57.846 - 0.254RH)}{100}$ Kc*Kt*T*P

Calculation of Kc: $Kc = \frac{Etcrop}{Eto}$

Table 5: Calculated Eto (mm/day), Etp (mm/month), Kc and IWR

Monthly mean 2009-2010	No of day	ETo. mm/day	ETp. mm/month	Kc	IWR mm/day
July	31	0.30	3.72	12.4	3.72
August	31	0.14	0.062	0.44	0.06
September	30	0.25	2.70	10.8	2.70
October	31	0.29	5.27	18.2	5.28
November	30	0.39	8.70	22.3	8.70
December	31	0.50	1.86	3.72	1.86

4. CONCLUSIONS

The study showed the effect of irrigation frequency on growth parameters, crop coefficient and yield of okro with the use of manure (poultry and cow dung) under an open roof structure situated at agricultural engineering departmental research farm. It is observed that with readily available nutrients present in soil, the most desirable frequency of irrigation gives optimum crop yield as nutrients is easily taken up by plants. It is recommended that this study be repeated in the dry season as it is believed that the humidity in the raining season has effect to the place of study. It is equally recommended that a standard model green house be constructed to study various crop co-efficient and consumptive used for this zone.

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