# Variable Irrigation Scheduling Effects on Growth Parameters of *Celosia Argentea* in Humid Tropical Environment

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**ABSTRACT**

This work experimentally determines crop water requirements as well as effects of varying irrigation schedules on growth parameters of C*elosia Argentea*. Irrigation treatments of refilling the soil back to 100%fc, 75%fc and 50%fc were applied to predominant three soil samples from different locations within the South Western part of Nigeria having the same sandy loam textural class. Irrigation application was based on daily maximum crop evapotranspiration. Leaf Area, Number of Leaves, Plant Height and Stem Girth were measured twice a week. Cummulative irrigation treatments of 100%fc, 75%fc, and 50%fc amounted to 749, 583, and 454mm depth of water at 6 weeks after planting (WAP) with a yield of 11.8, 8.9, and 8.6 Kg per $5m^2$ respectively. Statistical results of crop growth parameters and yields indicated that significant differences existed at P>0.05 when 50%fc treatment was compared to 75%fc and/or 100%fc treatments. Biomass yield (edible weight) showed significant differences across the three treatments and also falls within the recommended range of 8 – 14 Kg per $5m^2$ for optimal propagation of Celosia Argentea in West Africa. However, for biomass yield at 6WAP; treatment of 100%fc was significantly different from 75%fc and likewise, treatment of 75%fc was significantly different from 50%fc for the three soil samples. Results also indicated that bulk weight (edible weight plus root weight) appeared best under treatment at 100%fc when compared with the other two treatments. It was thus concluded that if irrigation scheduling is aimed at maximizing Celosia yields per unit of irrigated area, 100%fc treatment is recommended. But if scheduling is to maximize yield per depth of water applied, preference should be given to 75%fc treatment for propagation of C*elosia Argentea*.

**Keywords:** Irrigation scheduling, *celosia argentea*, growth parameters, biomass yield.

## 1. INTRODUCTION

The recent technological progress in precision agriculture in humid areas is already being used to increase farm production thereby making irrigation economically feasible (DeJonge and Kaleita, 2006). If there is proper irrigation management i.e., schedule irrigation timing and amounts based on accurate crop water use, irrigation has a positive effect on yield provided planted crops are not stressed before water application. Historically, irrigation was designed in the humid areas to supplement rainfall. Therefore in humid environments, irrigation scheduling is a prime target for neglect as a result of adequacy of rainfall amounts; hence irrigation applications could be postponed until when needed (Thomas et al., 2004). Howbeit, precipitation, which is the main factor responsible for the high variation in availability of water, and crop irrigation requirements, is unpredictable (Rodrigues et al., 2001). In countries with large rainfall amounts over a period of years and within the same year, temporal variation in storm frequency do not always coincide with crop needs at critical periods. Hence, scheduling of irrigation remains one of the critical needs for efficient water management in crop production in humid areas (Thomas et al., 2004). For irrigated agriculture, irrigation scheduling was defined by Rodrigues et al. (2001) as strategies that minimize the water demand with acceptable impacts on yields while in a simplified form Shae et al. (1999) defined it as deciding when to irrigate and how much water to apply.

There exists a relationship between crop water requirement and yield (Al-Jamal et al., 1999; Rockstrom, 2001). The relationship between the total quantity of water applied and the yield of a specific crop is a complicated one which Upton (1996) agrees may vary in frequency and intensity. Problems associated with the sequential nature of irrigation water inputs, stem from the fact that crop-yield response depend on the timing and adequacy of individual water application. Those applied at critical growth stages have greater impact than those at other times (Upton, 1996; Michael, 1998). Thus, to attain stable crop yields with unpredictable storm frequency variability, irrigation scheduling is often necessary. Several types of irrigation scheduling methods have been documented (Steele et al. 1996; Werner, 1996). In the works of Shae et al. (1999), improved irrigation scheduling technique was compared with the commonly used water balance technique. The improved techniques included the use of infrared canopy temperature sensing, soil moisture sensing, and a crop growth model to estimate soil moisture content for scheduling irrigations.

The objectives for irrigation scheduling may be of a different nature, ranging from technical (including yield), to economic and environmental aims, although they usually are combined. The selection of a particular objective for irrigation scheduling depends on specific needs in each situation, but the following strategies by Martin et al. (1990) may be applied. The first strategy consists of maximizing yields per unit of irrigated surface. To obtain this yield optimization, crop evapotranspiration demand must be satisfied. The second objective is to maximize yield per unit of water applied. This requires adoption of strategic irrigations, the water being applied during the critical periods of the crop cycle, when the effects of water stress could strongly affect yields. This optimization strategy is justified when water is the limiting resource and when its cost is high. Another objective is the economic optimization by maximizing benefits in the farm productions. This approach takes into account each of the farm's limitations and may be achieved when there are no marginal benefits, that is, when the cost of the last unit of water applied is equal to the benefit produced. Hence, water application losses must be minimized and one approach according to Tolk and Howell (2001) was to schedule irrigation timing and amounts based on accurate predictions of crop water use.

According to Mark et al. (2002), world population is expected to reach 7.8 billion by 2005 and this was expected to put greater pressure on world food security, especially in developing countries where more than 80% of the population increase is expected to occur. Subsequently, more water will be withdrawn to satisfy domestic needs leading to a situation of chronic water supply. Rosegrant et al. (2002) showed that improved access to irrigation with proper water management contributes to rapid socioeconomic growth, food security, increased crop yield, improved farming and farm income. Irrigation has helped boost agricultural yields and outputs, stabilize food production and prices with resultant increased demand for irrigation water to meet food production requirements.

Harvesting of *Celosia Argentea* usually starts 4-6 weeks after planting (WAP) and yield in Nigeria ranges between 8 – 14 kg per 5m$^2$ i.e. 16 – 28 t/ha. Celosia is tolerant to a wide range of soil conditions, although a high level of organic material in the soil is required for the production of optimum yields. Due to its sensitivity to drought conditions frequent irrigation is needed. A crop spacing of 12 cm between and within rows as well as seed rate of about 3-4 per stand is recommended (Tindall, 1985). Hence, the objectives of this study were to experimentally determine the crop water requirement of *Celosia Argentea* and to statistically determine effect of variable irrigation scheduling on growth parameters of *Celosia Argentea* in humid tropical environment.

## 2. MATERIALS AND METHODS

Data used to determine irrigation management system was obtained from IITA (International Institute of Tropical Agriculture) weather station, Ibadan. Six years climatic data files of Ibadan obtained span year 2000 to 2005 inclusive. These data files were imputed into CROPWAT 4 Windows Programme to calculate reference crop evapotranspiration. The programme contains a CROPWAT version in Visual Basic to operate in the Windows environment and developed with the assistance of the International Irrigation and Development Institute (IIDS) of the University of Southampton, UK.

The percentage composition of each soil types was determined by mechanical sieve analysis using British Standard set of sieves. Agricultural and Environmental engineering experimental (AEEE) farm soil proportions were, sand (74%), silt (14.6%) and clay (9.4%). For Faculty of Agriculture Practical (FAP) farm, 72.2% sand, 11.4% silt and 16.4% clay. Soil composition in University Teaching and Research (UTR) farm soil sample were 70.5% sand, 15.4% silt and 14.1% clay. Soil samples were characterized as sandy loam texture when the % sand and % clay of the soil samples were inputted into an interactive Soil Moisture Triangle of the National Water and Climate Center Irrigation water management model – ‘Soil Water Characteristics’ National Resources Conservation Service (NRCS). The NRCS model gave the following average soil characteristics values for Sandy Loam soil; Field Capacity - 21%, Permanent Wilting Point -9%, and Moisture at Saturation - 42.6%.

Moisture regimes applied were based on actual crop evapotranspiration computed from equation four. The plots were irrigated at 3 days interval based on available soil water depletions as a result of actual crop evapotranspiration. The plots were refilled back to 100%, 75% and 50% field capacity (fc) respectively. Soil moisture was measured and monitored on a daily basis by gravimetric sampling using Infrared moisture meter so that soil moisture depletions will not reach the critical soil moisture content given as 13%. Based on available information from local vegetable farmers during the growing season, the crop is usually irrigated at 3-day intervals until the vegetables were harvested. Hence, cumulative soil moisture depletions for the 3-day intervals were determined before irrigation treatments of refilling back to 100%, 75% and 50% fc were applied. Available moisture, readily available moisture and critical moisture content ($\theta c$), which indicate when to irrigate were determined according to James (1993);

$$\text{AW} = Drz \times (fc - Pwp) / 100 \qquad (1)$$

Aw = Available water (mm)
$D_{rz}$ = Depth of root zone (mm)
fc = Field capacity in percent by volume
Pwp = Permanent witting point in percent by volume
Given that; Drz = 150 mm; fc = 21% and, Pwp = 9%.
Therefore; Aw = 18 mm per root zone depth.
Maximum Allowable Deficiency (MAD) is used to estimate the amount of water that can be used without adversely affecting the plant and is given as:

$$\text{MAD} = RAW / AW \qquad (2)$$

Where RAW is readily available water and MAD for most vegetable crops is 0.65 (James, 1993). Therefore; RAW = 11.7 mm.

$$\theta c = fc - (100 RAW) / Drz \qquad (3)$$

$\theta c$, critical soil water content below which to irrigate and is 13%.

CROPWAT 4 Windows was used to estimate daily reference crop evapotranspiration (table 1.0). The demand for water during the plants growing season varies from one growth stage to another and from crop to crop. Values of potential evapotranspiration ($ET_0$) estimated were adjusted for actual crop ET. Table 2 shows CROPWAT 4 Windows tables for ET.

$$ET = Kc \times ETo \qquad (4)$$

ET = evapotranspiration for specific crop (mm/day); $ET_O$ = potential ET or reference crop ET (mm/day); $K_C$ = crop coefficient.

Table 1: Climate and $ET_o$ data

Country: Nigeria Altitude: 228 meter(s) above M.S.L. Latitude: $7.26^0$ N

| Date | MaxTemp ($^0$C) | MinTemp ($^0$C) | Humidity (%) | WindSpd. (km/h) | Sunshine (Hours) | Solar Rad. (MJ/m$^2$/d) | ETo (mm/d) |
|---|---|---|---|---|---|---|---|
| 18/11/05 | 32.3 | 24.0 | 72.0 | 2.3 | 6.8 | 12.8 | 3.8 |
| 24/11/05 | 32.5 | 22.0 | 68.8 | 1.7 | 6.5 | 14.3 | 3.7 |
| 1/12/05 | 32.5 | 22.8 | 53.3 | 1.7 | 7.9 | 13.5 | 3.8 |
| 8/12/05 | 32.8 | 21.3 | 61.8 | 1.8 | 8.9 | 14.7 | 4.0 |
| 14/12/05 | 33.2 | 23.5 | 65.0 | 2.0 | 9.1 | 13.4 | 4.2 |
| 17/12/05 | 32.3 | 23.5 | 67.0 | 1.5 | 7.2 | 12.8 | 3.7 |
| 20/12/05 | 32.8 | 23.5 | 63.5 | 1.8 | 7.4 | 13.2 | 3.8 |
| 22/12/05 | 33.0 | 22.0 | 61.8 | 2.4 | 7.2 | 14.9 | 3.9 |
| 25/12/05 | 32.8 | 21.8 | 60.3 | 2.1 | 9.0 | 15.3 | 4.1 |
| Average | 32.7 | 22.7 | 63.7 | 1.9 | 7.8 | 12.5 | 3.9 |

Table 2: Crop Water and Irrigation Requirements Report

Crop No 1: Small Vegetables

Planting date: 11/11/2005

| Date | Eto | Planted Area (%) | Crop Kc | CWR ($ET_{cr}$) | Total Rain | Effect. Rain | Irr. Req |
|---|---|---|---|---|---|---|---|
| | --(mm/day)-- | | ------------------------------ | | (mm/day) | ------------------------ | |
| 18/11/05 | 3.80 | 100 | 0.45 | 1.71 | 0.00 | 0.00 | 1.71 |
| 24/11/05 | 3.66 | 100 | 0.75 | 2.75 | 0.00 | 0.00 | 2.75 |
| 1/12/05 | 3.81 | 100 | 0.75 | 2.86 | 0.00 | 0.00 | 2.86 |
| 8/12/05 | 3.99 | 100 | 1.15 | 4.59 | 0.00 | 0.00 | 4.59 |
| 14/12/05 | 4.21 | 100 | 1.15 | 4.84 | 0.00 | 0.00 | 4.84 |
| 17/12/05 | 3.68 | 100 | 1.15 | 4.23 | 0.00 | 0.00 | 4.23 |
| 20/12/05 | 3.78 | 100 | 0.90 | 3.40 | 0.00 | 0.00 | 3.40 |
| 22/12/05 | 3.85 | 100 | 0.90 | 3.47 | 0.00 | 0.00 | 3.47 |
| 25/12/05 | 4.09 | 100 | 0.60 | 2.45 | 0.00 | 0.00 | 2.45 |

Measured agronomic parameters were analyzed using LSD values at $Pr<0.05$. ANOVA test provides a level of significance. (Ostle and Malone, 1988).

Water budget technique of determining when to irrigate is given thus:

$$\theta_i = \theta_{i-1} - 100(ET - Pe) / Drz \qquad (5)$$

$\theta_i$ , $\theta_{i-1}$ = soil water content (% by volume) at the end of day i and i-1 respectively;
ET = daily crop evapotranspiration (mm/day);
Pe= effective rainfall (mm) and,
D = Depth of root zone (mm).

Cumulative irrigation depths of 223, 194, 142, 266, 202, 145, 260, 187 and 167 mm were applied to the plots $A_1$, $A_2$, $A_3$, $B_1$, $B_2$, $B_3$, $C_1$, $C_2$ and $C_3$ respectively. $A_1$, $B_1$, $C_1$ were irrigated back to 100%fc, while $A_2$, $B_2$ and $C_2$ were irrigated back to 75%fc and $A_3$, $B_3$ and $C_3$ were irrigated back to 50%fc. Symbols A, B, and C are respectively soil samples from UTR, AEEE, and FAP farms. Measurements of agronomic parameters commenced on the $10^{th}$ day after planting (DAP) and were done weekly for 6 consecutive weeks and the results presented in tabular form. 5 plants were analyzed in each plot per treatment. Recommended irrigation treatments according to Doorembos and Kassam (1979) are as follows; one "wet treatment" or treatment with no water deficit over the total growing period, this is typical of refilling back to 100%fc. One "dry treatment" or treatment with considerable water deficit throughout the total growing period, this is typical of refilling back to 50%fc and may be of significant interest as it is observed that yield response to water deficit of different crops is of major importance in production planning. One or more "mixed treatments" with water deficit during selected individual growth periods only and is representative of refilling back to 75%fc that is 15.75%, hence water deficit will occur as soon as 2.75% (15.75% - 13%) moisture is depleted. Refilling back to 100%, 75%, and 50%fc amounted to 749, 583, and 454 mm depth of water respectively.

*Celosia Argentea* seeds were planted and thinned to an average of four plants per stand at a spacing of 12 cm x 12 cm. Experimental plot for the experimentation was 5.5 m x 8 m and this was divided into blocks, each of area 1.5 m x 2 m. Three irrigation treatments were replicated three times in a randomized block design and a spacing of 0.5 m was left between two replicates. Experimentation was conducted during dry seasons (October to December) of 2005 and 2006 respectively. The plots were first irrigated on the $8^{th}$ DAP when some plants had started sprouting. During the growth stages of 47 days cumulative irrigation depths were determined. Soil moisture content readings were taken every 3 days throughout the growth period. Agronomic parameters such as plant height were measured from the soil surface (base of plant) to the tip of the terminal bud. The number of leaves was determined by counting the individual leaves on the stem of the vegetable while the stem diameter was measured using a vernier caliper. Leaf area was measured empirically using Length x Width of a single blade x 0.75 (Saxena and Singh 1965). Stands of vegetables were harvested fresh and weighed on a digital scale.

## 3. RESULTS AND DISCUSSION

Effect of different irrigation scheduling treatments on crop growth parameters and yield was presented in tables 3–7. Tables 3 through 6 showed that plant height, stem girth, number of leaves, and leaf area which are collectively termed growth parameters of Celosia increased from 2 to 6 WAP across all treatments. Crop growth parameters from UTR farm, AEEE farm and FAP farm (Tables 3-6) showed that irrigation treatment of refilling back to 50%fc was significantly different from treatment of refilling back to 75%fc and/or 100%fc at 6WAP. The exception was UTR farm (Table 4), which showed no significant difference across all the treatments at 6WAP.

Table 3: Effects of Varying Irrigation Schedules on Plant Height

| Location | UTR Farm | | | | | AEEE Farm | | | | | FAP Farm | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | Weeks After Planting | | | | | Weeks After Planting | | | | | Weeks After Planting | | | | |
| %FC | 2 | 3 | 4 | 5 | 6 | 2 | 3 | 4 | 5 | 6 | 2 | 3 | 4 | 5 | 6 |
| 100 | 4.74a | 13.62a | 26.96a | 44.62a | 61.56a | 4.56a | 21.80a | 30.86a | 36.46a | 59.84a | 5.30a | 8.54a | 20.52a | 26.30a | 42.58a |
| 75 | 2.70b | 11.32b | 28.96a | 39.44b | 58.86a | 7.40b | 17.15b | 24.86b | 34.06a | 45.50c | 6.32 b | 9.20a | 19.42ab | 25.78a | 43.84a |
| 50 | 1.64c | 5.08c | 24.12b | 27.10c | 47.04b | 9.14c | 17.58b | 25.44b | 35.42a | 49.90b | 5.84ab | 9.00a | 18.38 b | 22.80b | 32.68b |
| LSD 0.05 | 0.18 | 0.99 | 2.31 | 3.63 | 4.82 | 1.00 | 1.65 | 2.05 | 6.82 | 4.38 | 0.56 | 1.00 | 1.18 | 2.39 | 3.50 |

*Mean values with same alphabet in same column are not significantly different at P<0.05* LSD (Least Significant Difference).

Table 4: Effects of Varying Irrigation Schedules on Stem Girth

| Location | UTR Farm | | | | | AEEE Farm | | | | | FAP Farm | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | Weeks After Planting | | | | | Weeks After Planting | | | | | Weeks After Planting | | | | |
| % FC | 2 | 3 | 4 | 5 | 6 | 2 | 3 | 4 | 5 | 6 | 2 | 3 | 4 | 5 | 6 |
| 100 | 0.18a | 0.44a | 0.51a | 0.68a | 0.80a | 0.22a | 0.51a | 0.52a | 0.71a | 0.80a | 0.19a | 0.34a | 0.43a | 0.55a | 0.67a |
| 75 | 0.17a | 0.44a | 0.51a | 0.70a | 0.78a | 0.23a | 0.37b | 0.65a | 0.57b | 0.65b | 0.21a | 0.32a | 0.44a | 0.47b | 0.67a |
| 50 | 0.08b | 0.22a | 0.46b | 0.68a | 0.82a | 0.25a | 0.44c | 0.44ba | 0.63b | 0.67b | 0.22ab | 0.31a | 0.40a | 0.42c | 0.61b |
| LSD 0.05 | 0.02 | 0.32 | 0.02 | 0.06 | 0.11 | 0.3 | 0.03 | 0.16 | 0.06 | 0.04 | 0.02 | 0.03 | 0.04 | 0.04 | 0.05 |

*Mean values with same alphabet in same column are not significantly different at P<0.05* LSD (Least Significant Difference).

Table 5: Effects of Varying Irrigation Schedules on Number of Leaves

| Location | UTR Farm | | | | | AEEE Farm | | | | | FAP Farm | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | Weeks After Planting | | | | | Weeks After Planting | | | | | Weeks After Planting | | | | |
| %FC | 2 | 3 | 4 | 5 | 6 | 2 | 3 | 4 | 5 | 6 | 2 | 3 | 4 | 5 | 6 |
| 100 | 5.40a | 8.80a | 12.20a | 16.40a | 24.40a | 6.00a | 9.40a | 11.00a | 17.00a | 22.40a | 5.60a | 9.00a | 11.00a | 13.00a | 18.60a |
| 75 | 5.80b | 9.40a | 11.40b | 15.80a | 22.20b | 5.20b | 8.20b | 10.80a | 14.80b | 16.80b | 6.20b | 8.20b | 10.20b | 11.20b | 20.00a |
| 50 | 4.00c | 6.00b | 9.0c | 12.00b | 17.80c | 6.60c | 7.80b | 10.20b | 14.00b | 18.60c | 6.40b | 7.80c | 10.20b | 10.60b | 14.00b |
| LSD0.05 | 0.26 | 0.77 | 0.45 | 1.15 | 1.14 | 0.37 | 0.48 | 0.43 | 1.17 | 0.88 | 0.33 | 0.35 | 0.23 | 0.63 | 1.4 |

*Mean values with same alphabet in same column are not significantly different at P<0.05* LSD (Least Significant Difference).

Table 6: Effects of Varying Irrigation Schedules on Leaf Area

| Location Treatment | UTR Farm Weeks After Planting | | | | | AEEE Farm Weeks After Planting | | | | | FAP Farm Weeks After Planting | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| %FC | 2 | 3 | 4 | 5 | 6 | 2 | 3 | 4 | 5 | 6 | 2 | 3 | 4 | 5 | 6 |
| 100 | 7.52a | 24.49a | 17.41a | 33.73a | 50.18a | 12.41a | 26.60a | 21.15a | 41.59a | 51.59ab | 5.98a | 16.38a | 14.84a | 23.95a | 40.78a |
| 75 | 7.35a | 20.25b | 21.60b | 35.51a | 35.16b | 10.48b | 13.77b | 15.43b | 30.78b | 38.57a | 6.03a | 12.36b | 14.06a | 17.63b | 35.06a |
| 50 | 1.77b | 8.48c | 23.14bc | 47.73b | 61.16c | 8.60c | 25.43ac | 19.06ac | 34.92b | 60.52b | 7.66b | 12.27b | 14.41a | 20.41bc | 20.95b |
| LSD(0.05) | 0.51 | 3.17 | 2.15 | 5.39 | 8.96 | 1.21 | 3.01 | 2.65 | 5.14 | 17.83 | 0.91 | 1.36 | 1.78 | 3.09 | 6.54 |

*Mean values with same alphabet in same column are not significantly different at P<0.05* LSD (Least Significant Difference).

Results presented in table 7 showed that at 6WAP (harvest), mean bulk weight (BW) and edible weight (EW) of Celosia was highest under treatment at 100%fc for all soil samples. Thus, bulk weight (edible weight plus root weight) appeared to be best under treatment at 100%fc when compared with the other two treatments of 75%fc and 50%fc. This may be attributed to higher water content in the edible part of the vegetable crop and this submission agreed with the findings of Sorensen (2005). Effects of varying irrigation schedules on number of leaves and biomass yield (edible weight) were given utmost importance in Celosia Argentea propagation because it is considered a vegetable crop. It was shown in table 5 at 6WAP, treatment of 100%fc was significantly different from 75%fc; and likewise, 75%fc treatment was significantly different from 50%fc for the three farms under consideration.

Table 7: Effects of Varying Irrigation Schedules on Biomass Yield

| %FC | BW | EW | RW | BW | EW | RW | BW | EW | RW |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 38.89a | 29.67a | 9.22a | 41.89a | 28.44a | 13.44a | 22.78a | 17.33a | 5.44a |
| 75 | 35.44a | 25.11b | 10.33a | 20.22b | 14.44b | 5.78b | 22.44a | 16.78a | 6.11a |
| 50 | 36.00a | 20.78c | 12.89b | 24.56c | 16.11b | 8.44c | 15.33b | 11.11b | 4.22ab |
| LSD (0.05) | 6.15 | 4.06 | 2.50 | 3.02 | 2.19 | 1.29 | 5.02 | 3.93 | 1.27 |

*Mean values with same alphabet in same column are not significantly different at $P<0.05$*
*LSD-Least Significant Difference, BW-Bulk Weight, EW-Edible Weight, RW-Root Weight.*

Irrigation treatment of refilling back to 100%fc, 75%fc, and 50%fc, amounted to 749, 583 and 454 mm depth of water at 6WAP (harvest). These irrigation treatments respectively resulted to a yield of 11.8, 8.9 and 8.6 Kg per 5 $m^2$ at harvest. The yield for the three treatments was in agreement with the works of Tindall (1985) that gave a range of 8 – 14 Kg per 5 $m^2$ for Celosia Argentea when propagated under optimal condition of meeting crop evapotranspiration demand.

## 4. CONCLUSION

The resultant effects of varying irrigation schedules on crop growth parameters and crop yield when combined, showed that significant differences existed at P>0.05 when 50%fc treatment was compared to 75%fc and/or 100%fc treatments.

Biomass yield (edible weight) showed significant differences across the three treatments and also, the yield for all the treatments was within the recommended range of 8 – 14 Kg per 5 $m^2$ for optimal propagation of Celosia Argentea in West Africa. A difference of 2.9 Kg per 5 $m^2$ (11.8 – 8.9) was observed when 100%fc treatment was compared to 75%fc treatment. Also 0.3 Kg per 5 $m^2$ (8.9 – 8.6) differences was recorded when 75%fc and 50%fc treatments were compared.

Hence from the foregoing statistical analysis results, if irrigation scheduling is aimed at maximizing yields per unit of irrigated area, refilling back to 100%fc treatment is hereby recommended. Also, if the scheduling objective is to maximize yield per depth of water applied as a result of water been a limiting resource due to its cost of making it available to the planted crop to attain stable crop yields in humid tropical environment of south western Nigeria, preference should be given to treatment of refilling back to 75%fc as the yield also falls within the recommended range for optimum propagation of Celosia Argentea. This 75%fc treatment will help to remove more water from agriculture and also to reduce the challenge of water conservation for the teeming human population in West Africa.

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