Influence of Drip Irrigation Frequency and Volume of Water Application on the Growth Parameters of Tomato (*Lycopersicon esculentum Mill*)

Oke, A. M., Jaiyeoba, K. F. and Ojediran, J. O.

***Abstract*— Tomato is an important fruit vegetable in Southwestern Nigeria. However, there is limitation to its production during the dry season, due to water shortage. This work studied the effects of drip irrigation on the development of tomato growth parameters (leaves and branches) prior to its fruiting with respect to irrigation frequency and volume of water applied. A Randomized Complete Block Design (RCBD) experiment was set up with irrigation frequency and depth as the main and sub-plot. Three frequencies (7, 5 and 3 days; designated as F1, F2 and F3) and three depths (100, 75 and 50% of crop Evapotranspiration; designated as D1, D2 and D3, respectively) were used. Growth parameters (number of branches (NoB), and leaves (NoL)) were taken and recorded on weekly basis via visual counting. Analysis of Variance (ANOVA) was conducted to determine the relationship between the irrigation frequency and the volume of water on the number of leaves and branches. The mean was separated using Fisher's Least Significant Difference (LSD) at 95% confidence level (P<0.05). Results of this study show that the soil's physical condition was not affected by the irrigation treatments, leaves and branches. The study hence recommends that tomato can be grown in Ogbomoso with half crop evapotranspiration without damage to the soil – physical properties and with a god vegetative growth.**

***Index Terms*— Drip irrigation, Tomato, Growth parameters, Irrigation frequency and Volume of water.**

I. INTRODUCTION

Tomato (Lycopersicon esculentum Mill) is one of the most widely grown vegetables in the world. The health benefits found in this vegetable crop makes it to be more popular among other vegetable crops. It can be consumed fresh, cooked or processed into various products and is composed mainly of water (approximately 90%), soluble and insoluble solids (5-7%), citric and other organic acids, vitamins and minerals [1]. The daily water requirement for tomato in different growing systems varies from 0.89 to 2.31 L plant – 1 day – 1 [2]. In order to optimize the available water application to the root zone of the crop for vegetative growth and the yield of tomato, drip irrigation method is adopted in this study [3]. Drip irrigation applied with 75% of crop evapotranspiration (ETc) was the optimum amount of irrigation for a humid tropical environment to maximize tomato growth and its yield [4]. It was revealed by [5] that the water quality significantly affected both the yield and water use efficiency (WUE) on tomato in their field of study. Generally, the yield of any crop has to do with the growth parameters of such plant such as the number of leaves and branches, plant height and stem girth to support the flowering and fruiting of tomato.

The increasing food demand and decreasing water allocation suggest that the agricultural sector has to increase agricultural water productivity for producing more food with less water [6]. According to [7], it was reported in his research that water resources are limited and restrict crop production in the newly reclaimed lands because of current intensive agricultural production. He further stated that agriculture in Egypt relies heavily on irrigation. It was also reported by [8] that agricultural sector consumes more than 84% of available water resources.

Water supply is a major constraint to crop production in terms of growth, and the yield. Efficient use of irrigation water is becoming increasingly important, and alternative water application methods such as drip and sprinkler irrigation, may contribute substantially toward making the best use of water for agriculture and improving irrigation efficiency especially under cereal crop production [9] and [10].

It was found according to [11] in their study that, water application positively influenced tomato productivity. The supplementary irrigation increased 284% of the marketable yield, and this value reached 578 and 1327% with the 50 and 100% maximum crop evapotranspiration replenished [11].

The aim of this research work is to study the influence of drip irrigation and amount of water application on the growth parameters of tomato at South-Western Nigeria. Moreover to determine the growth pattern of tomato under the respective drip irrigation frequencies and volume of

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Oke, A. M., *Agricultural Engineering Department, Faculty of Engineering, Adeleke University, Ede, Osun State, Nigeria Mobile No: +234-8033963063*
Jaiyeoba, K. F., *Agricultural Engineering Department, Faculty of Engineering, Adeleke University, Ede, Osun State, Nigeria, Mobile No: +234-8033841417*
Ojediran, J. O., *Agricultural Engineering Department, Faculty of Engineering and Technology, Ladoke Akintola University of Technology Ogbomoso, Oyo State, Nigeria,Mobile No: +234-8033883032*

water applications.

1.1 Description of the Study Area

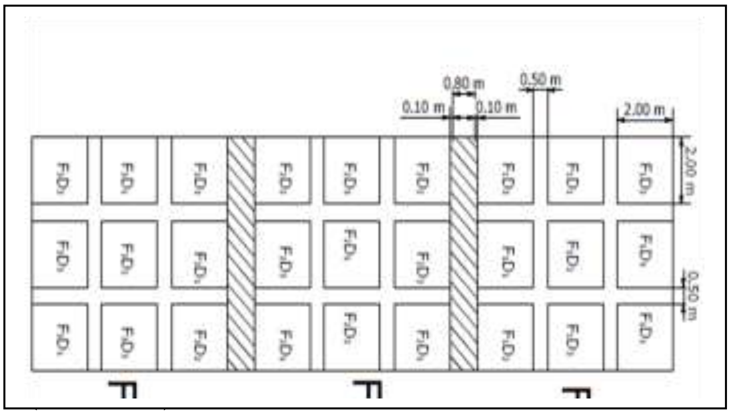
The study was conducted at the Research Field of Agricultural Engineering Department, Ladoke Akintola University of Technology, Ogbomoso. Ogbomoso lies between Latitudes 8° 08[1] and 8° 10[1]N of the Equator and Longitudes 4° 10[1] and 4°14[1] E of the Greenwich Meridian. The climatic condition of Ogbomoso is mostly influenced by the Northeast and Southwest trade winds with a maximum temperature of 33°C and a minimum temperature of 28°C [12]. The Northeast trade wind which is cold with drying effect (harmartan) normally starts from November to March while the southwest trade wind which is warm and very moist (rain bearing) blows between the months of April and October [12]. The relative humidity of this area is high all year round (about 74%) except in the month of December to February. This period relative humidity is low when because of dry wind which blows from the North [13]. The average annual rainfall is about 1000 mm and the soil type is sandy loam. The soil in the field used for the study had been fallowing for three years before the experiment.

II. EXPERIMENTAL WORKS AND MATERIALS

2.1 Experimental Design

This experiment was based on two factor; frequency and volume of water application. The [7 days (F1), 5 days (F2) and 3 days (F3)] durations (frequencies) were used. The frequency is the main plot while depth is the subplot. The depths of application were taken as 100%, 75% and 50% of the crop water use (ETc) [3]. The irrigation scheduling was determined as a function of ETc. The experimental design is a Randomized Complete Block Design (RCBD) with three replicates. It has main and sub-plots; main plot is 7 x 7.5 m while the sub-plot measure 4 m2 (fig. 1.0).

According to [3], each sub-plot contained 15 stands of tomato at 0.5 m spacing within row and 1 m between rows. The three main plots were separated from each other by a space of 1 m. Weeding of the plots was done manually at four (4) weeks interval. The first weeding was done four weeks after transplanting (WATP). Fertilizer application was done according to [14].



LEGEND

F_1 = 7 – day irrigation frequency
F_2 = 5 – day irrigation frequency
F_3 = 3 – day irrigation frequency
ETc = crop evapotranspiration
D_1 = volume of water application (100 % ETc)
D_2 = volume of water application (75 % ETc)
D_3 = volume of water application (50 % ETc)
F x D = interaction between the factors

2.2 Irrigation Scheduling

The volume of water application for the desired depth was determined by multiplying the depth by the crops area as:

$$a_v = d_i \times a_c \qquad 1$$

Where: a_v is the volume of application (m^3), d_i is the irrigation depth (m), a_c is the crop nutrient area (m^2). The drippers were calibrated to have a discharge $4\ l/h$. The time required for applying the desired volume was calculated using the relation:

$$t = \frac{a_v}{d} \qquad 2$$

Where:

t = time required (hr)

a_v = volume of application (m^3)

d = discharge (m^3/hr)

$$\rho_b = \frac{M_s}{V_t} \qquad 3$$

Where:

ρ_b = bulk density, (gcm^{-3})

M_s = mass of soil (g)

V_t = total soil volume (cm^3)

Plate 2.1: The growth stages of tomato field production

2.3 Statistical Analysis

The data collected on various parameters were subjected to analysis of variance (ANOVA). All the statistical analyses were done using Statistical Package for Social Science (SPSS v. 20). The means were separated using Least Significant Difference (LSD) at 5 % probability level.

III. RESULTS AND DISCUSSION

The effect of drip irrigation frequencies and water regimes on soil hydro-physical properties, growth and yield of tomato was investigated. The results were measured and discuss in this section.

3.1 Tomato Growth Parameters

Results of the growth parameters measured in this study include number branches and leaves.

3.1.1 Number of Branches

Figures 2, 3 and 4 present the results of the number of branches on the tomato plants. Fig. 2 shows the number of branches on the tomato plants under frequency F_1. The figure shows that the treatment F_1D_2 has the highest number of branches from the beginning to the end while the treatment F_1D_3 produced the least number of branches. However, the three treatments have similar trend except that treatment F_1D_1 growth is almost constant from week one (1) until week eleven (11) where number of leaves was expected to start decreasing. The variation in the number of branches may be attributed to response of tomato to moisture. F_1D_2 has the highest available moisture in the soil while F_1D_3 has the least. This result shows that tomato plants perform best in this experiment at D_2 (75 % ETc). This implies that tomato may be grown at about 75 % of the ET without adverse effect on the growth of branches.

Figure 3 shows the number of branches under the frequency treatment F_2. Here again, the treatment F_2D_1 has the highest number of branches. However, at the beginning (week one), F_2D_2 have higher number of branches until week three (3) where F_2D_1 and F_2D_3 started to increase to the end. F_2D_1 has the highest available moisture in the soil while F_2D_2 has the least. It was observed that difference in the number of leaves for D_1 and D_2 is not significant. This implies again that tomato plant may be grown with lesser amount of water than the ETc for tomato. Similar trend was observed at F_3 as shown in Fig. 4. Generally, about 75 % deficit in ETc of tomato has no significant effect on the number of branches. However, at about 50 % ETc, the difference in the number of branches becomes significant.

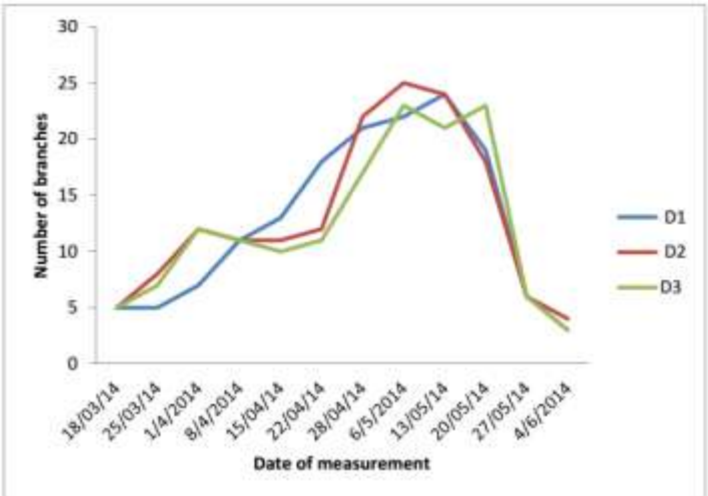


Figure 2: Effects of 7 – days irrigation frequency on number of branches

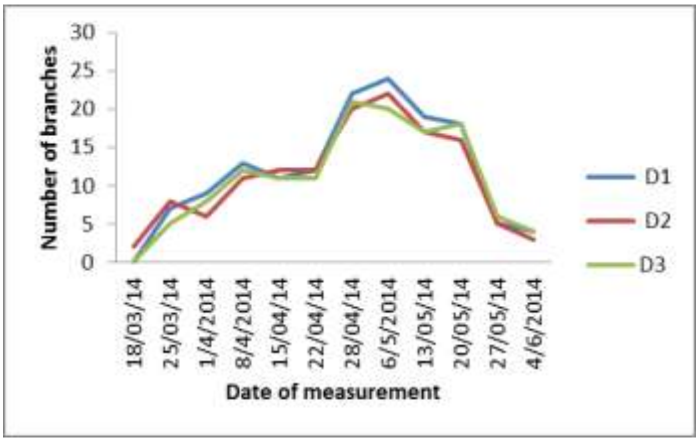


Figure 3: Effects of 5 – days irrigation frequency on number of branches

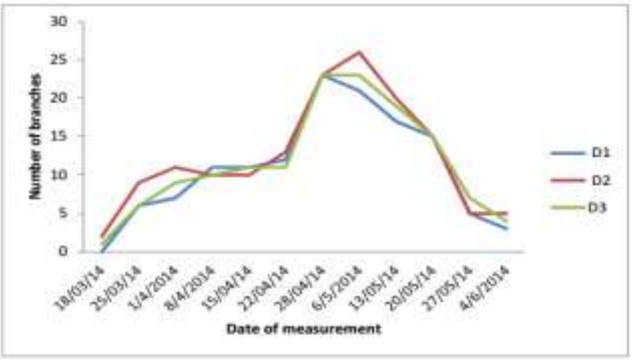


Figure 4: Effects of 3 – days irrigation frequency on number of branches

3.1.2 *Number of leaves*

Figures 5, 6 and 7 present the results of the number of leaves on the tomato plants. Fig. 5 shows the number of leaves on the tomato plants under frequency F_1. The figure showed that the treatment F_1D_1 has the highest number of leaves while the treatment F_1D_3 produced the least. The three treatments have similar trend under the frequency F_1. The variation in the number of leaves also may be attributed to response of tomato to moisture. F_1D_1 has the highest available moisture in the soil followed by F_1D_2 and F_1D_3. It was observed that the number of leaves increase as depth of water application decreases. From Fig. 5 and 6, it was observed at F_2 and F_3 that the highest number of leaves was obtained at D_3 and the least numbers was at D_1. However, similar trends were observed for frequencies F_2 and F_3 with all the three (3) depth of water applications (D_1, D_2 and D_3). At about 50% ET_C, there was a significant difference in the number of leaves at F_2 and the result shows that 75% ET_C is better for growing tomato. At F_3 the results obtained indicate that, there is no significant difference in the depth of water application from the beginning of the experiment to the end.

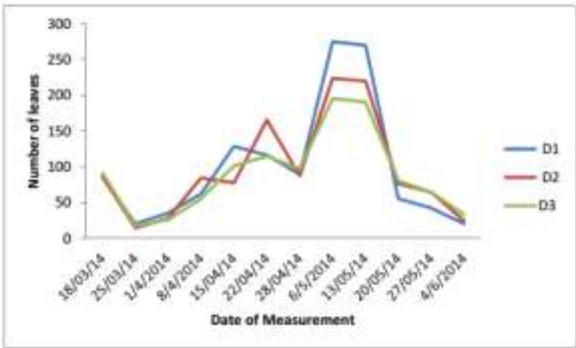


Figure 5: Effects of 7 – days irrigation frequency on number of leaves

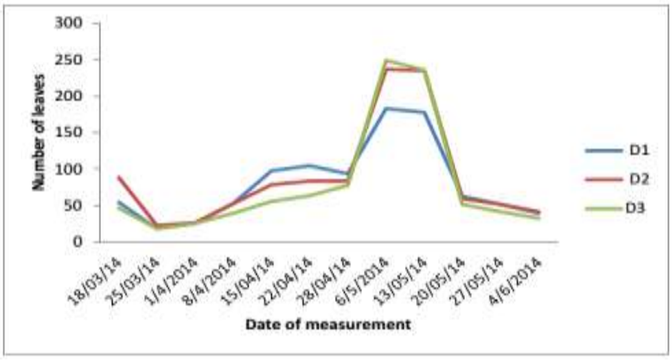


Figure 6: Effects of 5 – days irrigation frequency on number of leaves

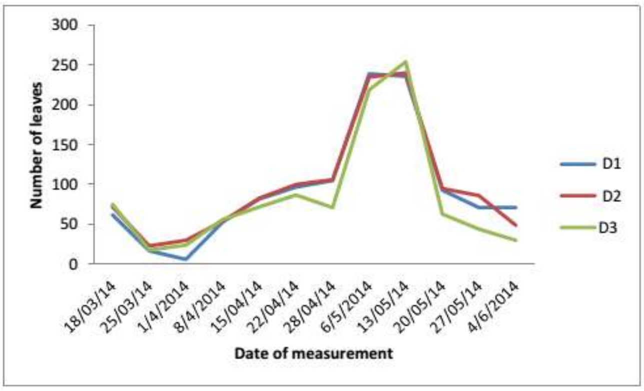


Figure 7: Effects of 3 – days irrigation frequency on number of leaves

IV. CONCLUSION AND RECOMMENDATIONS

A – two factor Randomized Complete Block Design (RCBD) was employed to study the effect of frequency and volume of water application on tomato (*Lycopersicon esculentum M.*) all round season production. The experiment made up of three (3) treatments and three (3) replicates giving rise to 27 plots; A plot size was 2 m by 2 m with a spacing; 0.5 m within row and 1 m between row. Frequency and amount of water application were considered to estimate the growth parameters and yield of tomato.

It was observed that drip irrigation frequencies with different water regimes have significant effects on the yield of tomato. According to [3], it can be concluded that all round season production of tomato with vegetative growth using drip irrigation could be ensured at 75 % ETc as the best method of irrigation for the production of tomato in the study area. It is therefore recommended that all-round season production through this approach should be encouraged among farmers. The use of other method of irrigation can be employed in a further study.

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