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EVALUATION OF IRRIGATION REGIME ON TOMATO IN MAREKO WOREDA, GURAGE ZONE, ETHIOPIA

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Abstract *- Irrigation scheduling is critical technique to quantifying water required by plants and improving irrigation efficiency. This study was carried out for two years (2016 and 2018) in Mareko Woreda, Gurage Zone, Ethiopia. The objective of this study was to determine irrigation scheduling and water productivity under different water depletion levels. The method used was field experiment in randomized complete block design (RCBD) four treatments with three replications. The treatments were (125% MAD, 100% MAD, and 75% of MAD and farmer practice). The combined yield results showed that non-marketable yield, marketable yield and total yield were insignificantly affected by different irrigation scheduling. As the result indicated that, there was no significant yield reduction when maximizing and minimizing irrigation intervals. Maximum and minimum water productivity were obtained from 100% MAD (4.9 kg/m^3) and 125% MAD (4 kg/m^3), respectively. It is concluded that to obtain better yield and WP with minimize number of irrigation and labour cost, it is better to use 100% MAD.*

Key Words: ETc, Irrigation Regime, Tomato, MAD, Water productivity

1. INTRODUCTION

Improving irrigation management is a crucial part of developing sustainable agricultural practices. Currently, agriculture accounts for over 70% of the world's water withdrawal [1]. Irrigation scheduling is a critical management input to crop production in all, particularly in arid and semi-arid regions that practice irrigation. Thus, the purpose of optimum irrigation scheduling is to ensure an adequate supply of soil moisture to minimize plant water stress during critical growth stages [2]. Irrigation scheduling involves deciding when and how much water to apply to a field. Good scheduling will apply water at the right time and in the right quantity in order to optimize production and minimize adverse environmental impacts. Successful irrigation depends upon understanding and utilizing scheduling principles to develop a management plan, and then on efficiently implementing the plan [3].

Tomatoes are an important global vegetable crop and require a high water potential for optimal vegetative and reproductive development [4].

Tomato is one of the most important vegetables because of its special nutritive value, and is the world's largest vegetable crop next to potato and sweet potato. Irrigation scheduling requires frequent measurements or continuous estimation of soil water depletion. Martin [5] stated that irrigation scheduling assists in the development of irrigation systems for different crops under different soil and climatic conditions. To achieve better control and management of irrigation water in tomato production, irrigation schedules should be applied based on crop water requirements [6]. The objective of this study is to evaluation effects of irrigation regime on tomato in Mareko Woreda which allow achieving optimum crop yield of tomato.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

The study was conducted at Mareko Woreda in Gurage Zone, SNNPR, Ethiopia. The area was geographical located at Latitude of 08°01'53"N, Longitude of 38°27'23" and an altitude ranges 1820m -1836m m.a.s.l.

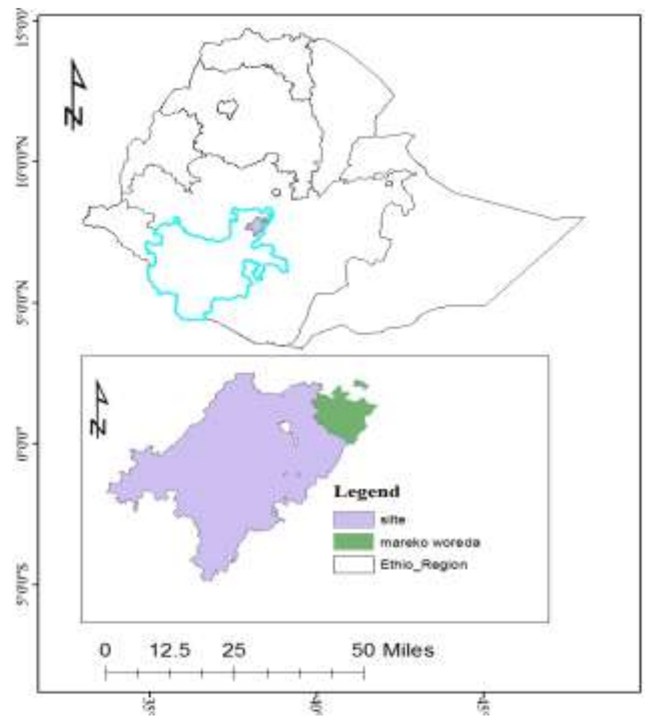

Figure: 2.1: Map of study area

2.2. Experimental Design

The experimental treatment (125%MAD, 100%MAD, 75% of MAD and farmer practice) were arranged in randomized complete block design with three replications made a total of 12 experimental plots. Each plot had 16 m^2 (4 m x 4 m) areas. The space between plots and blocks were 1.5 m and 2 m, respectively. The space between tomato plants and rows kept at 40 cm and 70 cm respectively. Fertilizer rate used was 300kg/ha NPS and 200kg/ha urea.

2.3. Soil Data

The composite soil sample was collected from experimental field to determine physical and chemical properties (soil moisture, texture, Bulk density, FC and PWP and pH). Bulk density was calculated using:

$$BD = \frac{\text{Weight of dry soil(gm)}}{\text{Volume of the same soil}(cm^3)} \qquad 2.1$$

The water content of the soil at field capacity and permanent wilting point were determined in the laboratory by using a pressure plate apparatus. The pressure plate was adjusted to 0.33bar to determine field capacity and 15bar to determine permanent wilting point to a saturated soil sample. Total available Water (TAW) in the root zone was computed as the difference in moisture content between FC and PWP [6]. It is computed as follows:

$$TAW = \frac{(FC-PWP)*Dr}{100} * BD \qquad 2.2$$

Where: TAW = total available water (cm), FC = Water content at filed capacity (%).

PWP = Water content at permanent willing point (%) and Dr = effective depth of root zone (cm) and BD = bulk density (g/cm^3)

$$RAW = MAD = TAW*p \qquad 2.3$$

Where, p =40% allowable soil moisture depletion without stress determined for tomato in all stages. Amount of irrigation applied in each irrigation event were measuring using partial flume. The irrigation water had applied using furrow irrigation system with the application efficiency of 60%. The infiltration rate of the soil in the experimental field was determined using double ring infiltrometer method before the staring of the experiment.

2.4. Determination of Crop Water Requirement

Determination of water required (CWR) to compensate the amount of water lost through evapotranspiration (ET_c), requires climatic and crop input data. Crop water reqiurment or ET_c over the growing season was calculated from reference evapotranspiration (ET_o) and crop coefficient (K_c) for that stage:

$$ET_c = ET_o * K_c \qquad 2.4$$

Where, ET_c= crop water requirement (mm), k_c = crop coefficient, ET_o = reference evapotranspairation (mm)

2.5. Climatic Data

Maximum and minimum temperature (°C), humidity (%), wind speed (km/day) and sunshine (hours) and Rainfall (mm) of the experimental site was from New locClim1.10 model. The reference evapotranspiration (ET_o) of each month were computed by using CropWat 8.0 model.

2.6. Irrigation Water Management

The net irrigation requirement was calculated using the CROPWAT computer program based on Allen at [6] as follows:

$$IRn = ETc - Pe \qquad 2.5$$

Where, IR_n = net irrigation requirement (mm), ET_c in mm and Pe = effective rainfall (mm) which is part of the rainfall that enters into the soil and makes available for crop production.

Gross irrigation requirement was calculated by:

$$IR_g = \frac{IRn}{Ea} \qquad 2.6$$

Where IR_g = gross irrigation, IR_n = net irrigation,

Ea = application efficiency

$$\text{Irrigation interval (days)} = \frac{IRn}{ETc} \qquad 2.7$$

The irrigation water had applied using furrow irrigation system. Amount of irrigation water applied in each irrigation event were measured by partial flume. The time required to deliver the desired depth of water into each plot was calculated as:

$$T = \frac{A*dg}{6Q} \qquad 2.8$$

Where: T = time in minute, dg = gross irrigation depth in cm, A = area of plot (m^2), Q= flow rate in l/s

2.7. Data Collection and Analysis

The field data such as marketable and non- marketable yield weight were taken from each plot. The harvested yield was grouped based on its quality for market according to the size and degree of damage [7].

Data was analyzed using SAS 9.0 statistical soft ware based on randomized complete block design. Least Significant Difference (LSD at P = 5%) was employed to identify different level of deficit irrigation that were significantly different from other treatments.

3. RESULT AND DISCUSSION

3.1. Soil Result

Based on soil textural classification of USDA, the experimental field soil was clay loam soil. The soil bulk density, FC and PWP were 1.03g/cm^3, 35.74% and 17.8 %, respectively. This bulk density value was lower than the critical threshold level (1—1.4gm/m^3) for any texture soil class [8]. In general, these values are suitable for crop root growth.

Table1. Soil analyzed Results

Soil parameters	Result
Sand (%)	20.33
Clay (%)	35.84
Silt (%)	43.93
Textural class	Clay loam
Bulk density (gm/cm3)	1.03
Field capacity (%)	35.74
Permanent wilting point (%)	17.8

3.2. Response of Tomato Yield to Irrigation Scheduling

The combined yield results showed that non-marketable yield, marketable yield and total yield were insignificantly affected by varying irrigation scheduling intervals. Statically there was no yield difference among the treatments, But the result shows that applying at 100 % MAD gives relatively better yield. The maximum and minimum water productivity were obtained from 100% MAD (4.9 kg/m^3) and 125% MAD (4 kg/m^3), respectively.

Table 2. Combined Tomato Yield Results

Trts	Non MY t/ha	MY t/ha	TY t/ha	WP kg/m^3
125%MAD	4.36	12.4	16.76	4
100% MAD	5.82	14.9	20.73	4.9
75 % of MAD	3.9	15.2	19.11	4.5
Fp	5.44	13.65	19.09	4.5
CV (%)	50	117	80	-
LSD (5%)	Ns	Ns	Ns	-

Note: MAD=Management Allowed Depletion, MY= marketable yield, nonMY= marketable yield, TY= total yield, WP= water productivity

4. CONCLUSION AND RECOMMENDATION

The combined yield results showed that non-marketable yield, marketable yield and total yield were insignificantly affected by varying irrigation scheduling interval. However, there were insignificant yield difference among the treatments; there were minimum yield was obtained from 125% of MAD. Maximum and minimum water productivity were obtained from 100% MAD (4.9 kg/m^3) and 125% MAD (4 kg/m^3), respectively. It is concluded that in addition to obtaining better yield and water productivity, to minimize number of irrigation and labour cost, it is better to use 100% MAD.

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