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Determination of Optimal Soil Moisture Depletion Level for Groundnut at Amibara, Middle Awash, Ethiopia

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Abstract: **The experiment was conducted to evaluate the response of Groundnut to different allowable soil moisture depletion level. From the three consecutive years combined data analyses, the effect of different allowable soil moisture depletion level on the yield of groundnut and other yield components was not significantly different. However, there was a statistically significance difference on crop water productivity. Among the five treatments SMD3 which is 50% allowable soil moisture depletion level gave the highest mean unshelled yield. Whereas, SMD4 which is 60% allowable soil moisture depletion level gave the lowest unshelled yield. 30% allowable soil moisture depletion level gave the highest crop water productivity. Even if the different allowable soil moisture depletion level didn't show a significant difference on yield of Groundnut, 50% allowable soil moisture depletion level gave relatively the highest yield and optimum crop water productivity.**

Keywords: **Soil moisture depletion; unshelled yield; Groundnut; crop water productivity.**

1. INTRODUCTION

Irrigation scheduling and accurate estimation of crop water requirement is important for developing best management practices for irrigated areas (Ali et al., 2011). There is considerable scope for improving water use efficiency of crops by proper irrigation scheduling which governed by crop evapotranspiration (Tyagi et al, 2000). Recently with the development and expansion of modern irrigation infrastructure in the country, improvement of irrigation water management is very important to address the on-farm water management. Irrigation water will be improved by applying the crop water need at the right time. The important principles of water management in relation to crop production has been determined for different crops, but it needs verification for site specific condition through adaptive research (Doorenbos and Kassam, 1979).

Study of soil moisture contents and soil moisture depletion level could be suitable for proper irrigation scheduling. Therefore, it needs to determine the optimal allowable soil moisture depletion level of the target crop for the desired areas. Hence, this research was aims to evaluate the responses of Groundnut to different allowable soil moisture depletion level for Amibara areas.

2. MATERIALS AND METHODS

2.1 Description of study area

The study was conducted at Werer Agricultural Research Center, Amibara Middle Awash, Ethiopia, located at 9°16'N latitude and 40°9'E longitude, with a mean altitude of 750m m.a.s.l. The soil at the experimental site was Vertisol with bulk density of 1.17 g/cm^3. The field capacity and permanent wilting point on a mass basis were 46 and 30.4%, respectively. The climate of the area is characterized as semi-arid with bi-modal low and erratic rainfall pattern, with annual average of 590 mm. The mean temperature varies from 26.7 to 40.8°C.

2.2 Soil and water content

Soil moisture content of the field was measured by gravimetric methods up to maximum rooting depth of the crop. Gravimetric water content was converted into volumetric content using the bulk density of each layer and then accumulated across depths to calculate the water stored within the soil.

2.3 Experimental Design

Treatments included five levels of soil moisture depletion. The experimental treatments have been design in randomized complete block design (RCBD) with three replications, in which the soil moisture depletion levels (SMDL) was randomly assigned to the experimental plots. The FAO recommended allowable soil moisture depletion level for Groundnut was 50% (Allen et al., 1998). Depending on the FAO recommended allowable soil moisture depletion level the other treatment settings were calculated (Table 1).

Table 1: Treatment settings and descriptions

Treatment	Description	Allowable depletion
SMD1	60% ASMDL	30%
SMD2	80% ASMDL	40%
SMD3	100%ASMDL*	50%
SMD4	120% ASMDL	60%
SMD5	140% ASMDL	70%

*ASMD is available soil moisture depletion level according to FAO (33)

2.4 Management practices and experimental procedures

The experiment has been done for three consecutive years in 2016, 2017 and 2018. Groundnut variety of Werer-962 was sown during the first week of July for each experimental year. A row spacing of 60 cm and 10 cm between plants were used. The experimental plot size used for each treatment was 3.6 m by 10 m sown in eight ridges with one side plants. Furrow irrigation method was used, and the applied water was measured using Parshall flumes. The amount of water applied to the crop root zone is based on the soil moisture depletion level at each growth stage. Irrigation scheduling was done based on their soil moisture depletion levels of each treatments. The soil moisture level was monitored using the gravimetric soil moisture content determination methods.

2.5 Data collection

The samples were taken manually from the inside of six ridges from each experimental plot. Yield and yield components data such as; number of branch per plant, number of pod per plant, hundred seed weight and thousand seed weight were collected. Based on the obtained unshelled yield of groundnut and the amount of irrigation water applied, the crop water productivity was calculated.

2.6. Crop water productivity

The Water productivity has been estimated as a ratio of unshelled yield to the total crop evapotranspiration (ETc) through the growing season and it has been calculated using the following equation (Zwart & Bastiaanssen, 2004).

$$CWP = (Y/ET)$$

Where, CWP is crop water productivity (kg/m³), Y is crop yield (kg/ha) and ET is the seasonal crop water consumption by evapotranspiration (m³/ha).

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2.7. Data Analyses

The collected data such as, yield, yield components and water productivity data were analyzed using statistical analysis software (SAS package) version 9. The Generalized Linear Model (GLM) procedure was applied for the analysis of variance. Mean comparisons were carried out to estimate the differences between treatments. Least significance difference (LSD) at 5% probability level was used to compare the differences among the treatments mean (Gomez and Gomez, 1984).

3. RESULTS AND DISCUSSION

The three consecutive years combined data analyses revealed that yield of groundnut and other yield components was not significantly affected by different allowable soil moisture depletion level. Except thousand seed weight and crop water productivity.

3.1. Unshelled yield of Groundnut

The three years combined analyses results of the experiment showed that the yields of groundnut were not significantly influenced by the different level of allowable soil moisture depletion (Table 2). The highest yield (3164 kg/ha) was obtained from the 50% allowable soil moisture depletion level followed by 40% allowable soil moisture depletion level (3150 kg/ha). The lowest yield (2820 kg/ha) was obtained from 60% allowable soil moisture depletion level.

Table 2: effect of soil moisture depletion level on Groundnut yield and its components

Treatment	Number of branch per plant	Number of pod per plant	Hundred seed weight (gram)	Thousand seed weight (gram)	Yield (kg/ha)	CWP (kg/m3)
SMD1	6.26	27.51	42.37	429.78a	3025	**0.45a**
SMD2	6.30	28.84	40.80	381.99b	3150	0.36b
SMD3	6.54	29.69	45.15	399.38ab	**3164**	0.29c
SMD4	6.93	30.53	43.65	381.85b	2820	0.24dc
SMD5	6.53	29.67	41.97	386.34b	3077	0.23d
CV (%)	*14.30*	*23.64*	*12.58*	*9.65*	*16.66*	*20.09*
LSD (0.05)	*NS*	*NS*	*NS*	*36.519*	*NS*	*0.06*

Means followed by different letters in a column differ significantly and those followed by same letter are not significantly different at $p<0.05$ level of significance. Bold font entries highlight the most significant results of interest.

3.2. Crop water productivity

The crop water productivity was significantly affected by different allowable soil moisture depletion level. The highest crop water productivity (0.45 kg/m^3) was observed at 30% allowable soil moisture depletion level followed by 40% allowable soil moisture depletion level (0.36 kg/m^3). The lowest crop water productivity (0.23 kg/m^3) was obtained from 70% allowable soil moisture depletion level. This study revealed that, as allowable soil moisture depletion level increases from 30% to 70%, the crop water productivity significantly decreased (Table 2).

4. CONCLUSION

Major findings revealed that the allowable soil moisture depletion level doesn't show a significant difference on yield of Groundnut. However, crop water productivity has been significantly affected by different allowable soil moisture depletion level. Even if the different allowable soil moisture depletion level didn't show a significant difference on yield of Groundnut, 50% allowable soil moisture depletion level gave relatively the highest yield and optimum crop water productivity. The findings are similar with FAO recommended allowable soil moisture depletion level for Groundnut. Therefore, for Amibara and other similar agroecological areas irrigating Groundnut at 50% allowable soil moisture depletion level will provide an optimum yield.

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