Determination of Optimal Irrigation Scheduling for Groundnut at Werer, 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.

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 Ethiopia, 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 Werer areas.

Materials and Methods

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 740 masl. 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. The long term mean monthly climatic data are illustrated in Figure 1. Total monthly rainfall during cropping season is also described in Table 1.

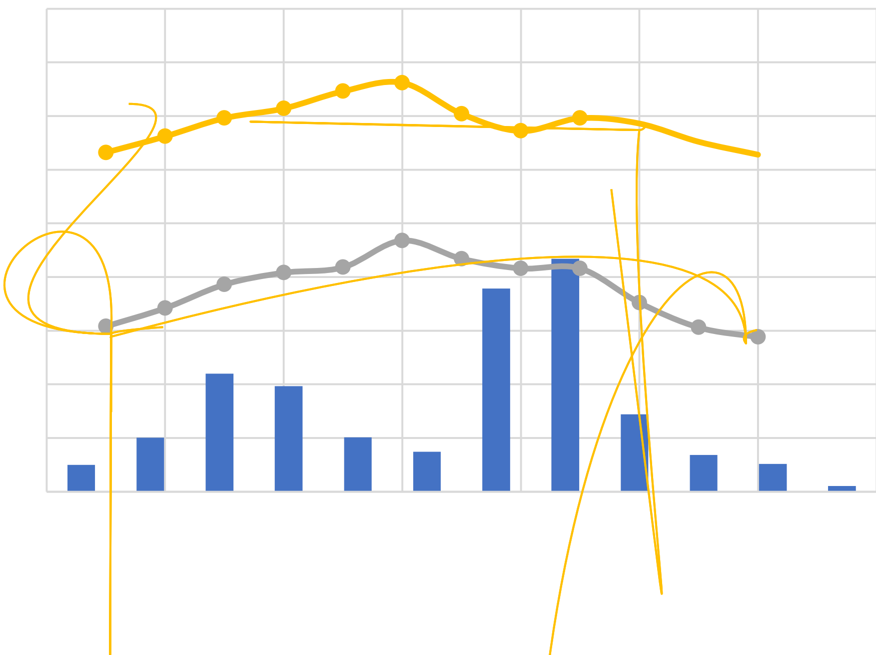

Figure 1. Long-term (1965 – 2019) mean monthly climatic data of the study area

Table 1. Total monthly rainfall of the study area during cropping season

Month	Rainfall (mm) during cropping season		
	2016	2017	2018
July	315.8	213.7	0
August	265.8	193.2	482.8
September	88.8	92	75.1
October	0	0	25.6
November	0	0	59.8
Total	670.4	498.9	642.8

Source: Werer Agricultural Research Center Agro-Meteorological Observatory Station.

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.

Experimental Design

Treatments included five levels of soil moisture depletion. The experimental treatments have been designed 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 2: Treatment settings and descriptions

Treatment	Allowable depletion
SMD1	30%
SMD2	40%
SMD3	50%*
SMD4	60%
SMD5	70%

*Allowable depletion level according to FAO (33)

Management practices and experimental procedures

The experiment has been done for three consecutive years from 2016-2018. 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 3-inch 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.

Data collection

Yield and yield components data such as; number of branches per plant, number of pods per plant, hundred seed weight and thousand seed weight were collected manually from the inside of six ridges from each experimental plot.

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 using the following equation (Zwart & Bastiaanssen, 2004).

CWP = (Y/ET)

Where,

CWP is crop water productivity (kg/m^3),

Y is crop yield (kg/ha) and

ET is the seasonal crop water consumption by evapotranspiration (m^3/ha).

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).

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.

Thousand seed weight

Thousand seed weight of groundnut was significantly influenced by the different level of allowable soil moisture depletion (Table 3). The highest weight (429.78 gram) was obtained from 30% allowable soil moisture depletion level followed by 50% allowable soil moisture depletion which is (399.38 gram).

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 3. effect of soil moisture depletion level on Groundnut yield and its components

Treatment	Number of branches per plant	Number of pods per plant	Hundred seed weight (gram)	Thousand seed weight (gram)	Yield (kg/ha)	CWP (kg/m³)
SMD1	6.26	27.51	42.37	429.78[a]	3025	0.45[a]
SMD2	6.30	28.84	40.80	381.99[b]	3150	0.36[b]
SMD3	6.54	29.69	45.15	399.38[ab]	3164	0.29[c]
SMD4	6.93	30.53	43.65	381.85[b]	2820	0.24[dc]
SMD5	6.53	29.67	41.97	386.34[b]	3077	0.23[d]
CV (%)	*14.30*	*23.64*	*12.58*	*9.65*	*16.66*	*20.09*
LSD (0.05)	*NS*	*NS*	*NS*	*36.52*	*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.

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).

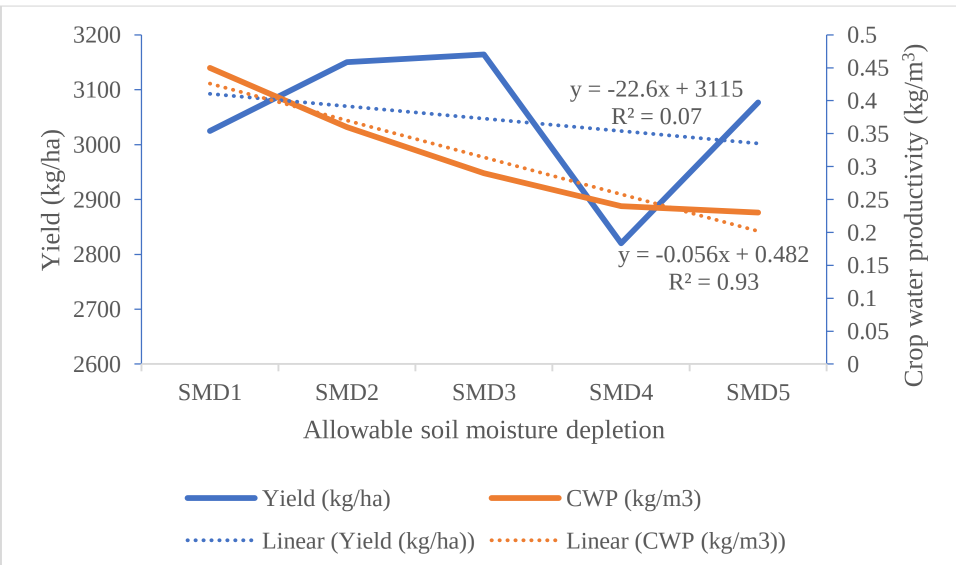

Figure 2. Relationship between yield, crop water productivity and allowable soil moisture depletion level.

The r-square value for the regression estimate for crop water productivity (R^2 ~ 0.93) is substantially higher than that for the regression estimate of yield (R^2 ~ 0.07) and reflects the greater scatter in the plotted points for yield compared to Crop Water Productivity.

Conclusion

Major findings revealed that the allowable soil moisture depletion level bmc l show a significant difference on yield of Groundnut. However, crop water productivity has been significantly affected by different allowable soil moisture depletion level. C cl gd f c bgdc cl jjm jc mgj k mg c bc jc gml jc c j bgbl 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, economic analysis should be included for further recommendation.

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