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Determination of Optimal Irrigation Scheduling and Water Productivity for Wheat (*Triticum aestivum* L.) at Abaya District of West Guji Zone, Southern Ethiopia

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Abstract

Changing climate conditions and declining water resources demand appropriate approaches to improve crop yield and water use efficiency through a reduced and more reliable water supply. This study was conducted to evaluate the response of wheat crop to irrigation regime (when and how much) and to identify water productivity of wheat under optimal irrigation regime. Field experiments were conducted in two consecutive years during 2023 and 2024 irrigation season. The experiment was carried out in RCBD with three replications, randomly assigned to the experimental plots with treatments. Five available soil moisture depletion levels (60% ASMDL, 80% ASMDL, 100% ASMDL (FAO recommended ASMDL), 120% ASMDL and 140% ASMDL) were used as treatment. The results obtained of two years of research showed that different of levels of soil moisture available had a significant effect ($P < 0.05$) on spike length, thousand kernel weight, grain yield and water productivity of wheat crop. However, different soil moisture depletion levels showed no significant difference on plant height and on number of tiller per plant. The highest number of spike length (7.608 g), thousand kernel weight (40.98 cm), grain yield (21.69 t/ha) and water productivity on wheat grain yield (5.640 kg/m³) were recorded at 80%ASMDL. On the other hand the minimum spike length, thousand kernel weight, grain yield and water productivity of wheat crop were recorded at 140 per cent ASMDL. Hence, based on the findings of the current experiment, it is recommended that using 80%ASMDL every five day irrigation application under furrow irrigation system for wheat crop to be grown in areas around Abaya district and similar agro-ecology with similar soil types as best options to increase yield and water use efficiency.

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Introduction

Water is the main production inputs in agriculture to maintain the development of irrigation agriculture [6]. One of the major issues facing the world today is the scarcity of freshwater resources, particularly for irrigated agriculture, which is the main consumer of freshwater. The improvement of irrigation technologies and practices was identified as an important major way to reduce water scarcity [8]. Irrigation in Ethiopia is considered as a basic strategy to alleviate poverty and hence food

security by transforming the rain-fed agricultural system into the combined rain-fed and irrigation agricultural system which is believed to be the most prominent way of sustainable development in the country [11]. Changing climate conditions and declining water resources demand appropriate approaches to improve crop yield and water use efficiency through a reduced and more reliable water supply.

There is significant possibility for improving the water use efficiency through adequate irrigation schedules [18].

Irrigation scheduling is the technique of applying water on a timely and accurate basis to the crop, and is the key to conserving water and improving irrigation performance and sustainability of irrigated agriculture [7]. The aim of irrigation scheduling is to keep soil moisture within a desired range, usually between field capacity (full point) and a predetermined refill point for optimal growth.

Wheat (*Triticum aestivum* L.), the target crop in this study, is one of the most substantial food crops in the world [14]. Wheat is one of the most important cereal crops in terms of production and consumption in Ethiopia. Through an intensive commitment from the Ethiopian government, significant steps have been made, including increasing cultivation in irrigable lowlands and increasing productivity in rain-dependent agricultural ecosystems [15]. However, this expansion into arid and semiarid lowlands has worried water resources, leading to heightened competition and disputes among water users, where water resources are already limited [5]. Limited access to water resources, particularly in arid and semi-arid regions, remains a substantial obstruction [13].

Irrigation scheduling practices in Ethiopia are very poor, and it has been a major challenge for the sustainability of the scheme [4]. Traditional irrigation practices are used in the study area to grow crops in various areas. Traditional irrigation practice is highly characterized by various problems, uncertainties and ambiguities in irrigation planning with unskilled labour, lack of sustainable and reliable water resources management strategy (irrigation schedule) and thus, over-irrigation and under-irrigation are common phenomena [5]. Accordingly, it is important to determine the actual need for crop water and the right time for water application (irrigation schedule) for effective use of the available water resource. This study was therefore carried out to determine the optimum irrigation schedule based on the level of depletion of soil moisture in the study area for wheat crop.

Materials and methods

Description of the Study Area

The study was conducted for two consecutive years in 2023 to 2024 during the irrigation season at Abaya district of west Guji Zone, Oromia regional state, Ethiopia. The district is found at a distance of 110 km from Bule hora, the zonal capital city and 385 km from

Finfinne in south west side. The study area lies between 6°10'0" to 6°40'0" N and 37°50'0" to 38°20'0" E longitude with average elevation of 1577 m a.s.l. The area is characterized by bi-modal rainfall pattern with a mean annual rainfall of 1167.4 mm with maximum rainfall on month of April, May, September and October (Table 1). The climate of the study area is described the maximum and minimum air temperature of 10.3 and 24.7°C respectively.

Experimental design and treatment combinations

The experiment was designed as a single factor experiment in randomized complete block design (RCBD) with three replications. The experiment were included five levels of soil moisture depletion depending on FAO soil moisture depletion level. The five level of ASMDL were (60% ASMDL, 80% ASMDL, 100% ASMDL (FAO recommended ASMDL), 120% ASMDL and 140% ASMDL) (Table 2). The recommended allowable soil moisture depletion level for wheat crop was 55 % and the other treatments allowable soil moisture depletion levels were calculated based on this value. The treatments were assigned randomly to the experimental plots.

Wheat Agronomy

Wheat (*Triticum aestivum* L.) king bird variety was used as test crop on experimental plot size of 3.6 m wide and 5.25 m long. The distances between plots and between replications were 1m and 1.5m, respectively. A row spacing of 0.6m between furrow, 0.4m between ridge and 0.2m between plant rows was used. Wheat was fertilized with the recommended rate of 121kg/ha NPS at planting and 100kg/ha Urea was applied half during planting as basal application while the remaining half dose was applied at tillering stage. All other agronomic practices were kept normal and uniform for all the treatments.

Soil moisture determination

Soil moisture content of the field was measured by gravimetric at every 15cm to maximum rooting depth of the crop by oven drying the soil samples at 105 °C for 24 hr. until the change in weight is constant. Then, the gravimetric water content was converted to volumetric water content by multiplying with the soil bulk density and root depth of the crop to get available field/current moisture at the time of irrigation using the following equation.

$$\theta_{dw} = \frac{w_{ws} - w_{ds}}{w_{ds}} \times 100 \quad (1)$$

Where w_{ws} = weight of wet soil (g), θ_{dw} = water content expressed on weight basis in (%) and w_{ds} = weight of dry soil (g)

Determination of irrigation requirement and irrigation scheduling

Determination of crop water requirement

There were no well-established weather stations in Abaya district of west Guji zone. For that reason, CLIMWAT was used to generate the required climatic data. CLIMWAT is a climatic database to be used in combination with the computer program CROPWAT and provides long-term monthly mean values of seven climatic parameters, namely daily maximum and minimum temperatures, relative humidity, wind speed, sunshine hours, solar radiation, monthly effective rainfall and reference evapotranspiration calculated with the Penman-Monteith method [12]. Latitude, longitude and altitude were directly measured at the sites using Geographic Positioning System and used to access meteorological parameters from CLIMWAT. Minimum and maximum temperatures, relative humidity, wind speed, sunshine hours and solar radiation of each individual experimental site were used to calculate reference evapotranspiration (ET_o). Reference Evapotranspiration (ET_o) was estimated by the CROPWAT software version 8.0 using the FAO Penman-Monteith approach [2].

The crop coefficient was collected from FAO Irrigation and Drainage Paper 56 for Pepper given by [2] as 0.3 for the initial stage, $0.3 < K_c < 1.05$ for the crop developmental stage, 1.15 for the mid-season stage and 0.65 K_c for the late season stage. For seasonal crop water requirements, ET_c was estimated by multiplying the long-term ET_o value with the established K_c value (Eq. 2).

$$ET_c = ET_o * K_c \quad (2)$$

Where, ET_c = Crop evapotranspiration (mm/day), K_c = crop coefficient, and ET_o = reference crop evapotranspiration (mm/day).

Irrigation scheduling

The total available water (TAW), stored in a unit volume of soil was estimated by taking the difference between

the water content at field capacity (FC) and at permanent wilting point (PWP) using [2] (Eq. 3).

$$TAW = \frac{(FC - PWP)}{100} * BD * DZ \quad (3)$$

Where:- TAW=Total available Water (%), FC and PWP in % on weight basis, BD= Bulk density of the soil ($gm\ cm^{-3}$) and DZ= maximum effective root zone depth (mm) Readily Available Water (RAW): is the amount of water that crops can extract from the root zone without experiencing any water stress. The RAW was computed from the expression in (Eq. 4)

$$RAW = TAW * p \quad (4)$$

Where:- RAW is the readily available water or net irrigation depth, IR_n (mm), p is allowable permissible soil moisture depletion fraction and TAW is total available water in the root depth (mm).

Whenever there is rainfall between irrigation, the IR_n was calculated based on [2] as follows

$$IR_n = ET_c - P_e \quad (5)$$

Where, IR_n =Net irrigation requirement (mm), ET_c = crop evapotranspiration (mm) and P_e = effective rainfall (mm) which is part of the rainfall that enters into the soil and makes available for crop production. The effective rainfall (p_e) was estimated using the method given by [2] as.

$$P_e = 0.6 * RF - 10/3 \text{ for } RF \text{ month } \leq 70 \text{ mm or}$$

$$P_e = 0.8 * RF - 24/3 \text{ for } RF \text{ month } > 70 \text{ mm} \quad (6)$$

Where, P_e (mm) = effective rainfall and P (mm) = actual monthly rainfall. The gross irrigation requirements account for losses of water incurred during conveyance and application to the field. This is expressed in terms of efficiencies when calculating project gross irrigation requirements from net irrigation requirements. Daily gross irrigation was estimated using the following equation [2]:

$$IR_g = \frac{ET_c}{E_a} \quad (7)$$

Where, IR_g = gross irrigation requirement (mm), ET_c = crop evapotranspiration (mm/day)/net irrigation water requirement and E_a = irrigation efficiency

Irrigation interval, f , was estimated using the following (Eq. 8).

$$f = \frac{IRn}{ET_c} \quad (8)$$

Where, f is irrigation interval (day), IRn = Net irrigation requirement (mm) and ET_c is mean daily crop water requirement (mm day⁻¹)

Irrigation water application

Irrigation water applied to each experimental plot was measured using a standard (3-inch) Parshall flume and installed 10 m away from the first plot of the first block. Calculated gross irrigation was finally applied to each experimental plot based on the treatment proportion. The volume of water applied for every treatment was determined from plot area and depth of gross irrigation requirement. The time required to irrigate each treatment was calculated from the ratio of the volume of applied water to the discharge-head relation of the 3-inch Parshall flume. The time required to deliver the desired depth of water into each furrow was calculated using an equation below.

$$T = \frac{A \cdot d}{6 \cdot q} \quad (9)$$

Where, T = Application time (min), A = Area to be irrigate (m²), d = gross irrigation depth of water to be applied (cm) q = Flow rate of Discharge (l/s)

Water productivity

Water productivity was estimated as a ratio of grain yield of wheat to total water consumption through the growing season and it was calculated using the following equation [3].

$$WUE = \frac{\text{Wheat grain yield} \left(\frac{kg}{ha} \right)}{\text{Seasonal crop water consumed} \left(\frac{m^3}{ha} \right)} \quad (10)$$

Data collection

Plant height: Plant height (cm) was computed for five randomly selected plants using measuring tape from the ground level up to the tip of the spike in the experimental plot at physiological maturity.

Number of tiller per plant: number of effective tillers was also estimated by counting plants that have spikes in the Center of the plots during physiological maturity.

Spike length: average length of 5 randomly selected spikes of the main tiller measured during physiological maturity in cm from base to tip.

Thousand Kernel Weight (TKW): Kernel weight in a gram was determined from randomly taken sample of thousand seeds per plot after threshing and cleaning.

Grain yield (t ha⁻¹): Weight of grains recovered from harvested wheat plants in the net plot areas after sun-drying threshing and cleaning converted into t/ha.

Data Analysis

All necessary data collected were managed properly using the Genstat software 18th edition. When the treatment effect was found significant, the mean separation was tested using least significant difference (LSD) at 5% probability level.

Results and Discussion

Selected soil physical properties at the experimental site

In order to characterize soils of the study site, soil physical and chemical parameters were measured. Thus, according to the USDA soil textural classification, the percent particle size determination for the experimental site revealed that the soil textural class of surface and subsurface soil profile could be classified as clay and clay loam respectively (Table 3). The result of bulk density of the soil in the experimental field has a small variation with its depth. The soil of the study site has bulk density of 1.36 g/cm³ at top and 1.40 g/cm³ at sub surface layer of the soil profile with average bulk density of 1.39 g/cm³, which is below the critical threshold level 1.45 g/cm³, and it was suitable for crop root growth [10]. The average moisture content at field capacity of the experimental site soils were 33.0 % and at the permanent wilting point had 24.2 %. As indicated in Table 3 the total available water in 90 cm soil profile was 109.79 mm.

Selected soil chemical properties of the experiment field

The average pH value of the experimental site soil profile was revealed in slightly acidic range with average value of 6.07% (Table 4). The average Organic Carbon and Organic Matter content of the soil was an average value of 1.74% and 3.007% respectively over 90 cm

depth of soil profile. An average electrical conductivity (ECe) of an experimental soil is 0.137 ds/m. Generally, according to USDA soil classification, a soil with electrical conductivity of less than 2.0 dS/m at 25°C and pH less than 8.5 are classified as normal. Accordingly, the soils of the study area can be classified as normal soils.

Crop water requirement and Irrigation interval

Analysis of monthly reference evapotranspiration (ET_o) calculated from historical records showed that the maximum reference evapotranspiration (ET_o) of 4.38 mm/day was occur during late-stage which was in March month, and minimum ET_o occurs in December during initial growth stage. The seasonal crop water requirement was 17 mm for the initial stage, 81 mm, 191 mm and 64.5 mm for development, mid and late stages with a total of 353.5 mm water requirement though out the cropping season of wheat crop. The highest crop water requirement was observed during the mid-stage which is not corresponding to maximum reference evapotranspiration (Table 5).

The maximum total net irrigation application (323.2 mm) was recorded under treatment of 80% allowable soil moisture depletion level (ASMDL), while minimum total net irrigation application (321.1 mm) was under treatment of 140% allowable soil moisture depletion level (ASMDL).

The gross irrigation water applied in treatment 60% allowable soil moisture depletion level (ASMDL) was maximum (615.9 mm) which is followed by 80% ASMDL (535.3 mm) and the minimum gross water was applied at 140% ASMDL (535.3 mm) treatment of the experiment.

The average irrigation interval was 4, 5, 5, 6 and 7 days for irrigation treatment of 60% ASMDL, 80% ASMDL, 100% ASMDL, 120% ASMDL and 140% ASMDL respectively (Table 6). The irrigation application events or interval was shortest for 60% of ASMDL, but longest interval for 140% of ASMDL of wheat crop.

The result revealed that a decrease trend of wheat grain yield with increase of irrigation interval. Forth day's irrigation interval showed higher wheat grain yield compared to the other irrigation intervals. On the other hand irrigation interval of 7 days gave the lowest wheat grain yield. Similar findings have been reported by [16] for garlic crop.

Yield and yield-related effects

Plant height

The soil moisture depletion levels were not significantly affected the plant height of wheat crop. The statistical analysis of variance show that, there was no significant difference between treatment at ($p < 0.05$) level. Maximum plant height (62.95cm) was obtained from treatment received 80% of ASMDL and the minimum (60.38cm) was from 120% of ASMDL (Table 7).

Number of tiller per plant

The analysis of variance revealed that there is no a significant difference ($p < 0.05$) among treatments on number of tiller per plant (Table 7). The highest number of tiller per plant was obtained from irrigation application of 80% ASMDL, whereas, the minimum was obtained from 140% ASMDL. From the present study, as a moisture depletion level reduced the number of tiller per plant of the wheat crop increased but not statistically significant.

Spike length

The analysis of ANOVA indicates that, there was significant ($P < 0.05$) difference on the different treatment of available soil moisture depletion level (ASMDL) on spike length of wheat crop. The maximum spike length (7.608 cm) was obtained from treatments which received 80% ASMDL followed by 60% ASMDL (7.482 cm). However, there was no statistically significant different between treatment application of 60% ASMDL and 80% ASMDL regarding to spike length (Table 7). On the other hand the minimum spike length was recorded under treatment of 140 % ASMDL, which is statistically similar with treatment application of 120 % ASMDL.

Thousand Kernel weight

The results of pooled mean from the two years showed that the use of different depletion levels had significant effect ($p \leq 0.05$) on thousand kernel weight of wheat crop.

The highest thousand kernel weight (40.98 g) was recorded under treatment of 80% ASMDL, but statistically similar with treatment of 60% ASMDL, 100% ASMDL and 120% ASMDL. The minimum thousand kernel weight was obtained from irrigation application of 140% ASMDL (Table 7).

Table.1 Long-term climatic data of the study area.

Month	Min Temp (°C)	Max Temp (°C)	Humidity (%)	Wind (m/s)	Sun hours	ETo (mm/day)	Rainfall (mm)
January	7.3	26.6	62	1.5	8.4	4.07	29
February	9.8	26.3	60	1.5	8	4.25	42
March	10.9	26.9	65	1.7	7.3	4.38	123
April	11.3	25.2	75	1.5	7.4	4.05	293
May	11.2	24.1	77	1.5	7.2	3.75	296
June	11.8	23.6	80	1.8	6.7	3.51	136
July	11.8	23.3	80	1.4	4.7	3.1	101
August	11.9	23.3	77	1.4	5	3.3	124
September	11.3	23.4	81	1	6	3.43	243
October	11.4	23.1	71	0.9	7.1	3.61	301
November	8.9	24.7	70	1.1	8.5	3.78	103
December	6.3	26.1	58	1.3	8.2	3.88	13
Average	10.3	24.7	71	1.4	7	3.76	1804

Table.2 Treatment setting for field experiment

Treatment	Description
ASMD1	60% ASMDL
ASMD2	80% ASMDL
ASMD3	100% ASMDL*(Control)
ASMD4	120% ASMDL
ASMD5	140% ASMDL

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

Table.3 Soil Physical properties of experimental site.

Soil depth (cm)	FC (%)	PWP (%)	BD (g/cm ³)	Textural status (%)			Textural Class	TAW (mm)
				Sand	Silt	Clay		
0-30	30.4	20.8	1.36	34	24	16	Clay	40.32
30-60	32.4	24.7	1.40	35	37	9	Clay loam	32.34
60-90	36.1	27.0	1.40	31	39	75	Clay loam	37.13
Total available water in 90 cm	33.0	24.2	1.39	33.3	33.3	33.3	Clay loam	109.79

Where: BD- bulk density, FC- field capacity, PWP- permanent wilting point, TAW- total available water

Table.4 Soil Chemical properties of experimental site.

Soil Depth (cm)	pH (H ₂ O)	EC (dS/m)	%OC	%OM
0-30	6.2	0.245	2.57	4.44
30-60	6.0	0.091	1.64	2.83
60-90	6.0	0.077	1.02	1.75
Average	6.07	0.137	1.74	3.007

Where: EC: Electrical conductivity, OC-Organic carbon and OM- organic matter

Table.5 Determination of crop water requirement of (ETc) for wheat

Growth stage	Growing Period	ETo (mm/day)	Kc	ETc (mm/day)	Effective rain (mm/season)	Stage CWR
Initial	20	3.88	0.4	1.55	0	17
Development	25	3.98	0.66	2.65	0	81
Mid	40	4.16	1.17	4.16	0.2	191
Late	25	4.38	0.75	3.23	28.1	64.5
Total					28.3	353.5

Table.6 Irrigation interval of wheat under different optimum rates

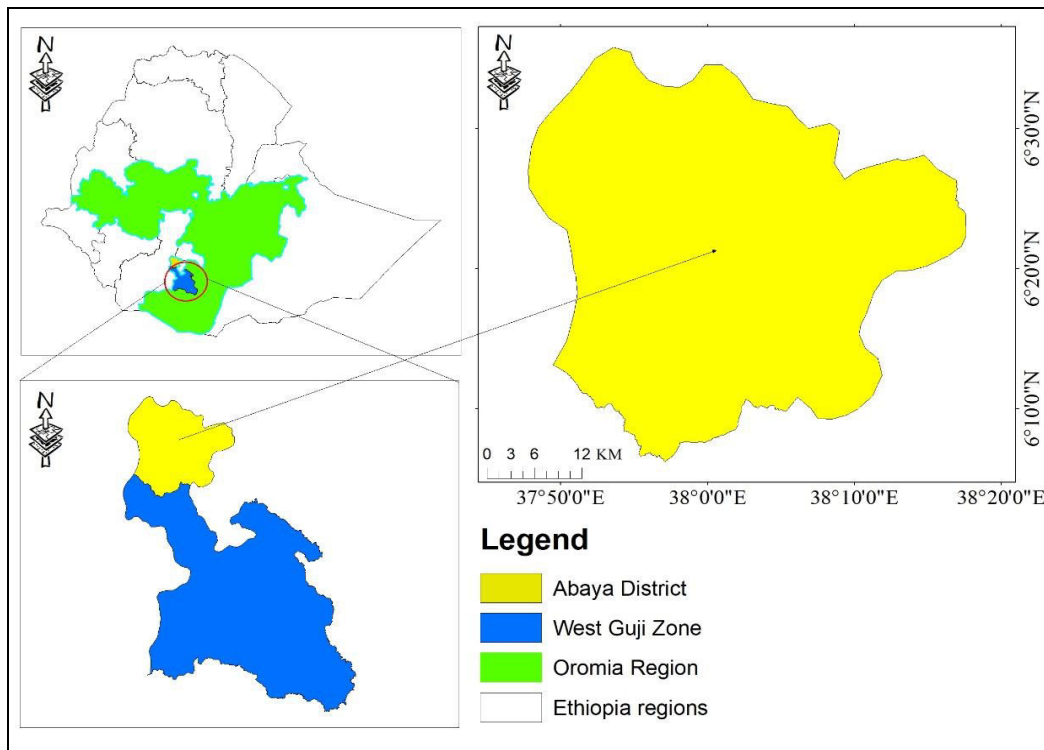
Treatments	Initial Stage		Development stage		Mid stage		Late stage		Total net Irrigation (mm)	Total gross Irrigation (mm)	Average Interval (days)
	NIR depth (mm)	Interval (days)	NIR depth (mm)	Interval (days)	NIR depth (mm)	Interval (days)	NIR depth (mm)	Interval (days)			
60% of ASMDL	7.4	4	7.84	3	9.4	4	11.58	4	323.2	615.9	4
80% of ASMDL	9.65	5	10.5	4	14.3	5	15.5	6	340.4	567.1	5
100% of ASMDL	10.6	6	13.3	4	14.6	4	16.6	6	330.2	550.2	5
120% of ASMDL	12	6	15.3	6	18.5	5	20.6	7	339.0	565.3	6
140% of ASMDL	13.5	8	17	7	21	5	24.6	9	321.1	535.3	7

Table.7 Analysed yield components, green cob yield and water productivity

Treatment	PH (cm)	NTPP	SL(cm)	TKW(g)	GY (t/ha)	WP (kg/m ³)
ASMD1	62.02	6.053	7.482 ^{ab}	40.32 ^{ab}	20.60 ^{ab}	5.356 ^{ab}
ASMD2	62.95	6.165	7.608 ^a	40.98 ^a	21.69 ^a	5.640 ^a
ASMD3	62.35	5.787	7.020 ^{bc}	39.38 ^{ab}	19.80 ^b	5.148 ^b
ASMD4	60.38	5.565	6.733 ^c	36.88 ^{ab}	17.36 ^c	4.515 ^c
ASMD5	61.13	5.522	6.637 ^c	35.32 ^b	15.71 ^d	4.084 ^d
LSD _{0.05}	NS	NS	*	*	**	**
CV (%)	3.5	28.5	6.6	11.1	5.1	5.1
Mean	61.77	5.82	7.10	38.58	19.03	4.95

Note: PH-plant height, NTPP-number of tiller per plant, SL-spike length, TKW-thousand kernel weight, GY-grain yield, WP- water productivity, Qt- ton, LSD = least significant difference, NS = non-significant * = significant at p = 0.05, ** = significant at p = 0.01 and CV (%) = Coefficient of variation, Means followed by the same letters in a column are not significantly different from each other at a 5% probability level.

Figure.1 Map the study area



Grain yield

The analysis of variance revealed that different soil moisture depletion level influence grain yield of wheat at ($P < 0.01$). Maximum grain yield of 21.69 t/ha was obtained under treatment of 80% treatment. However, the highest grain yield obtained at 80% of ASMDL treatment was statistically similar with grain yield obtained when moisture depletion of 60% ASMDL was applied. The minimum grain yield of 15.71 t/ha was obtained when soil moisture depletion of 140% ASMDL was applied (Table 7). This result clearly indicated that the yield of wheat crop was increased as application water depth levels decreased with short irrigation interval. This finding result is in lined with the results reported by [9], which reported that maximum wheat yield and water use efficiency were obtained from 80% of available soil moisture depletion level. This was also in agreement with [16] findings in which the highest garlic crop yield was obtained from 80% of available soil moisture depletion level.

Water productivity

Water productivity result showed that, there was significance difference among the treatment at $P < 0.01$ level. The highest water productivity of wheat grain yield

(5.640 kg/m^3) was observed at 80% of ASMDL treatment, but statistically similar with treatment of 60% ASMDL. Dissimilar to this, the minimum water productivity of 4.084 kg/m^3 was recorded when wheat irrigated with treatment of 140% ASMDL (Table 7).

The study showed that irrigating wheat at 80% of ASMDL depletion from the soil improved water productivity by 8.7% than the 100% ASMDL (FAO recommended ASMDL) depleted from the soil treatment. Improving water productivity is an increasing concern through different irrigation practice to enhance yield of crop per irrigation water used.

Different studies on different crops revealed that water productivity improved based on different irrigation practice like determining the optimum soil moisture depletion level. The results obtained from this experiment showed irrigation application of 80% of ASMDL is better in grain yield of wheat and water productivity compare to FAO recommended and the other treatments. Therefore, 80% of ASMDL is the best application in order to improve water productivity of wheat crop production. This finding aligned with [17] who obtained similar results of water productivity and reported the highest value was recorded under 80% of ASMDL.

Conclusions and Recommendation

Changing climate conditions and declining water resources demand appropriate approaches to improve crop yield and water use efficiency through a reduced and more reliable water supply. Irrigation scheduling ensures that water is applied according to crop requirements and is consistently available to the plant. Based on this, the experiment was conducted to determine the optimal depletion level on wheat grain yield and water productivity. The experiment was designed as a single factor experiment in randomized complete block design (RCBD) with three replications. The experiment were included five levels of soil moisture depletion depending on FAO soil moisture depletion level. The five level of ASMDL were (60% ASMDL, 80% ASMDL, 100% ASMDL (FAO recommended ASMDL), 120% ASMDL and 140% ASMDL).

From the result obtained, there was a significant difference among treatments on grain yield and water productivity of wheat crop. Maximum wheat grain yield was obtained under irrigation application of 80% of ASMDL treatment. However, the highest wheat grain yield obtained at 80% of ASMDL treatment was statistically similar with wheat grain yield obtained when moisture depletion of 60% ASMDL was applied. On the other hand, minimum wheat grain yield was obtained when soil moisture depletion 140% of ASMDL applied.

The maximum water productivity of wheat crop yield was also observed at 80% of ASMDL treatment, but statistically non-significant different from irrigation application of 60% ASMDL treatment. Dissimilar to this, the minimum water productivity was recorded under treatment of irrigation application of 140% ASMDL. The study showed that irrigating wheat crop at 80% of ASMDL depletion from the soil improved water productivity by 8.7% than the 100% ASMDL (FAO recommended ASMDL) depleted from the soil treatment. The results obtained from this experiment showed irrigation application of 80% of ASMDL is better in grain yield of wheat and water productivity compare to FAO recommended and the other treatments.

Therefore, based on the findings of the current experiment, it is recommended to use 80% allowable soil moisture level with five day irrigation interval under furrow irrigation system for wheat crop production at Abaya district and similar agro-ecology with similar soil types.

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Declaration of Conflicting Interests

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