Agriculture, Forestry and Fisheries
2023; 12(3): 57-63
http://www.sciencepublishinggroup.com/j/aff
doi: 10.11648/j.aff.20231203.11
ISSN: 2328-563X (Print); ISSN: 2328-5648 (Online)

Effects of Different Irrigation Levels and Fertilizer Rates on Yield, Yield Components and Water Productivity of Onion at Adami Tulu Agricultural Research Center

Anbese Ambomsa*, Dulo Husen, Zelalem Shelemew, Ayub Jalde

Oromia Agricultural Research Institute, Adami Tulu Agricultural Research Center, Batu, Ethiopia

Email address:
anbeseambomsa@gmail.com (Anbese Ambomsa)
*Corresponding author

To cite this article:
Anbese Ambomsa, Dulo Husen, Zelalem Shelemew, Ayub Jalde. Effects of Different Irrigation Levels and Fertilizer Rates on Yield, Yield Components and Water Productivity of Onion at Adami Tulu Agricultural Research Center. *Agriculture, Forestry and Fisheries*. Vol. 12, No. 3, 2023, pp. 57-63. doi: 10.11648/j.aff.20231203.11

Received: February 10, 2023; **Accepted**: April 23, 2023; **Published**: May 18, 2023

Abstract: Today's agriculture sector faces a complex series of challenges to cope with the demands for sustainable management and production, which entails an increase in food production to ensure food security while using less water per unit of output and reducing nitrogen (N) fertilizer losses through leaching. The experiment was conducted at Adami Tulu Agricultural Research Center on-station to study the effect of different irrigation levels and N-fertilizer rates on plant height, bulb yield, bulb diameter, and bulb height and water productivity of onion. The treatments of the experiment had factorial combinations of three levels of watering and four N-fertilizer amounts. Results indicated that the highest plant height (53.07 cm), bulb height (6.13 cm), bulb diameter (6.21 cm), marketable bulb yield (241.39 qt/ha) and total bulb yield (252.89 qt/ha) were obtained from full irrigation and fully N-fertilized compared to the deficit conditions. The highest water productivity was recorded from 60% ETc irrigation level and 150 Kg/ha N-fertilizer application rate, but the reduction in water productivity with 80% ETc and 150 Kg/ha N-fertilizer application rate was not significant. Hence, if water is not limiting factor, 100% ETc irrigation level and 150 Kg/ha N-fertilizer could be suggested to apply. But if water becomes 232 limiting factor, 80% ETc irrigation level with 150 Kg/ha N-fertilizer would be more appropriate for growing onion in the study area. Therefore these can be used as one package of onion production technology and all growers better to apply.

Keywords: Irrigation Level, N-fertilizer Rate, Onion, Bulb Yield, Water Productivity

1. Introduction

Worldwide, fresh water availability for irrigation is decreasing because of increasing competition from urban and industrial development, degrading irrigation infra-structure and water quality [1]. Today's agriculture sector faces a complex series of challenges to cope with the demands for sustainable management and production, which entails an increase in food production to ensure food security while using less water per unit of output and reducing nitrogen (N) fertilizer losses through leaching.

Onion (Allium cepa L.) is a popular crop that is grown and sold in many places around the world [2]. It can grow in many different weather conditions in Ethiopia. Onion is very important in Ethiopia because people eat it often and it can be sold in the country and to other places. It is the most important vegetable in the allium family for making money [3]. But onions grow less and are less productive than what is normal worldwide because of various living and non-living causes. Among which inappropriate and uneconomical uses of soil macronutrients are the most important ones [4].

Farmers need to find better ways to grow crops, so they don't waste water and fertilizer. This will help them keep producing food for a long time. [5]. The increase in agricultural production in the world, including that in arid and semiarid areas, has been achieved through application of modern agricultural technologies, comprising a combination of irrigation and heavy doses of fertilizer [6].

Fertilizer requirements may be affected by amount and frequency of irrigation water. On the other hand water use efficiency is highly dependent on plant nutrient and supply. Few research studies have been conducted in the area to characterize an appropriate irrigation level and fertilizer rate for onion, but the irrigation water management varies with soil-agro-climatic condition and with water availability and irrigation systems. Onion grown in different soil and crop management factors responded differently to the application of both deficit irrigation and N-fertilizer. Therefore, there is a continuous need to select both optimum N-fertilizer rate and irrigation level for onion crop in ever changing agro-pedo-climatic conditions. Therefore, the present investigation was proposed with an objectives of to evaluate the responses of onion yield, yield component and water productivity on different irrigation levels and N-fertilizer rates, to determine an optimum irrigation level and N-fertilizer rate and to determine partial budget analysis.

2. Materials and Methods

The experiment was conducted at Adami Tulu Agricultural Research Center on-station for two (2021 and 2022) consecutive years. The Centre is situated in the Central Rift Valley of Region of Ethiopia with 7° 51’ 40’’N and 38° 42’ 47’’E at an altitude of about 1651 meters above sea level. It is located at 167 km from Addis Ababa/Finfinne to South East of the country on the asphalt road to Hawassa.

The mean minimum and maximum monthly temperature were 14.3°C and 27.7°C respectively. The area has an average annual rainfall of 762 mm, which is erratic and uneven in distribution. And the soil texture of the area is sandy loam. It is a potential area for horticultural crops production with a wider diversity.

The treatments were consisted of factorial combination of three irrigation levels i.e. 100% ETC (D1), 80% ETC (D2) and 60% ETC (D3) and four N-fertilizer rates (150 Kg/ha, 130 Kg/ha, 110 Kg/ha and 90 Kg/ha). The experiment was arranged in a Split Block Design and replicated three times.

The experimental field was prepared by plowing with tractor driven implement and followed by harrowing, leveling and ridging manually. It has plots size of 3.6 m x 4 m and buffer zones with spacing of 1 m and 1.5 m were provided between the plots and blocks respectively. Onion (Bombe red variety) was used as trial crop and transplanted to the experimental field plots. Furrows spaced at 60 cm was used and transplanted at plant and row spacing of 10 cm and 20 cm, respectively. To ensure the plant establishment common irrigations were provided to all treatments before commencement of the differential irrigation. All treatments were irrigated at four days intervals at initial and development stages and five days intervals at mid and late season stages. All cultural practices other than variable factors were standard practices recommended for the area. NPS fertilizer was applied during transplanting in the same rate (200 Kg/ha) to all treatments and the N-fertilizer applied in split (half during transplanting and the half after 6 weeks). Weeding and inter-row cultivations were performed by hand hoeing when deemed necessary. Disease and pest management were made as per recommendation of agronomist at the research center.

2.1. Determination of Crop Water Requirement

Crop water requirement (ETc) is the depth of water needed to meet the water loss through evapotranspiration of a disease free crop growing in large fields under non-restricting soil conditions, including soil water and fertility and achieving full production potential under the given growing environment. ETc represents the water used by a crop for growth and cooling purposes. This water is extracted from the soil root zone by the root system and is therefore not available as stored water in the soil [7].

Crop water requirement (ETc) was calculated from climatic data by directly integrating the effect of crop characteristics into reference crop evapotranspiration. FAO Penman-Monteith method was used for determining reference crop evapotranspiration (ETo).

Experimentally determined ratio of ETc and ETo, called crop coefficients (Kc), was used to relate ETc to ETo by equation:

$$ETc = ETo \times Kc \tag{1}$$

where: ETc = crop evapotranspiration (mm/day), ETo = reference crop evapotranspiration (mm/day) and Kc = crop coefficient.

Irrigation Requirement (IR) was calculated by the following equation:

$$\text{IR} = \text{CWR} - \text{Effective rainfall} \tag{2}$$

where, IR in mm, CWR in mm and effective rainfall which is part of the rainfall that entered into the soil and made available for crop production in mm.

Irrigation schedule was worked out using Cropwat 8.0 software. In the model, one of the computation methods for the optimal irrigation scheduling for no yield reduction is the irrigation given at 100% readily available soil moisture depletion to refill the soil to its field capacity. The readily available water (RAW) was computed by the following formula:

$$RAW = \rho \times TAW \tag{3}$$

where RAW in mm, ρ is in fraction for allowable soil moisture depletion for no stress, and TAW is total available water in mm.

The total Available soil Water (TAW) was computed from the soil moisture content at field capacity (FC) and permanent wilting point (PWP) using the following expression:

$$TAW = \frac{FC-PWP}{100} \times (BD \times Dz) \tag{4}$$

where FC and PWP are soil moisture content at field capacity in % on weight basis, BD is the bulk density of the soil in gm/cm^3, and Dz is the maximum effective root zone depth in mm.

Soil bulk density was determined by taking undisturbed soil samples from an effective root zone at 15 cm interval using core sampler. The soil samples were oven dried for 24 hours at a temperature of 105°C. Then, bulk density (ρ_b) was determined as [8]:

$$\rho b = \frac{M_s}{V_b} \tag{5}$$

where ρ_b = Soil bulk density (g/cm^3), M_s = the mass of soil after oven dry (g) and V_b = bulk volume of soil (cm^3).

Considering the daily CWR and RAW the irrigation interval was computed from the expression:

$$Interval = \frac{RAW}{CWR} \tag{6}$$

where RAW in mm and CWR in mm/day

The gross irrigation requirement, IR_g, in a particular event was computed from the expression:

$$IR_g = \frac{CWR}{E_a} \tag{7}$$

where IR_g is in mm, CWR is crop water requirement (mm/day) and E_a is the irrigation water application efficiency in fraction.

2.2. Data Collection and Analysis

The sources of data for this research were both primary and secondary. Daily climatic data such as rainfall, maximum and minimum temperature, relative humidity, sunshine hours and wind speed were obtained from Hawassa branch National Meteorological Agency. These data were used to determine reference evapotranspiration (ETo) and effective rainfall by CROPWAT 8.0 software.

Representative soil samples were taken to investigate some properties of the soil like field capacity (FC), permanent wilting point (PWP), bulk density (ρ_b), organic matter (OM), texture, electrical conductivity (ECe) and PH of the study area. The soil samples were taken at 30 cm depth intervals within the effective root zone and used to determine the total available water content of the soil.

2.2.1. Agronomic Data

The height of five randomly taken plants were measured from the ground level to the tip of the longest matured leaf at 75 days after transplanting. Yield parameters data such as bulb height (bulb length), bulb diameter, and bulb weight were also recorded from the same plants and a means were reported. In order to assess the effect of treatments, the onion bulb yield was also collected from the middle row of each area and measured how much they weighed. The harvested yield was graded into marketable and un-marketable categories of onion bulb according to the size and degree of damage. Onion bulbs with less than 2 cm in diameter were categorized under non-marketable.

2.2.2. Water Productivity

Water productivity (WP) was determined by dividing the total onion bulb yield to the net amount of irrigation water applied to the crop as indicated by the following equation [9]:

$$WP = \frac{Y}{ETc} \tag{8}$$

where: WP is water productivity (Kg/m^3), Y is total bulb yield per unit area (Kg/ha), ETc is crop evapotranspiration (mm).

2.2.3. Water Saving

The water saved due to treatments as compared to control was calculated as follows:

$$W_s = \frac{W_c - W_t}{W_c} \times 100 \tag{9}$$

where: W_s is water saving (%), W_c is total water used in control treatment (m^3/ha) and W_t is total water used in treatment (m^3/ha).

2.2.4. Economic Analysis

The Partial budget analysis was done in order to evaluate the benefit obtained from different irrigation levels and N-fertilizer rate. Benefit-cost analysis was carried out to determine the economic feasibility. The cost of onion production includes expenses incurred in field preparation, cost of seeds, sowing, fertilizer, weeding, crop protection measures, irrigation water, and harvesting. The income from produce was estimated using prevailing average market prices at the time the crop was harvested (30 Birr/kg). The pricing level practiced in Awash River Basin of 1 Birr/238 m^3 was considered [10]. All costs and benefits were calculated on hectare basis in Ethiopian Birr (Birr/ha). The total cost of production, benefit-cost ratio, and irrigable land by using saved water, net return from saved water and net return from cultivation of onion over 1 ha were then estimated.

2.3. Data Analysis

Data collected were analyzed using SAS 9.2 software. Whenever treatments effect were found significant, treatment means were compared using the least significant difference (LSD) method.

3. Results and Discussions

3.1. Soil Properties

Some selected soil physical and chemical properties of the experimental site by two soil depths interval were presented in table 1. Percent of particle size determination revealed that the soil texture of the study area is sandy loam. The mean bulk density of soil of the study area was 1.272 g/cm^3. The mean PH, EC and OC of soil of the study area were 7.8, 0.145 ds/m and 1.04% respectively. The moisture content at field capacity, permanent wilting point and total available water were 12.98%, 6.78% on and 78.80 mm/m respectively. The basic infiltration rate was about 4 cm/hr.

***Table 1.** Selected soil physical and chemical properties.*

Soil properties	Soil depth (cm)		Mean
	0-30	30-60	
Sand (%)	71	76	73.5
Silt (%)	15	11	13
Clay (%)	14	13	13.5
Textural class	Sandy loam	Sandy loam	Sandy loam
Bulk density (gcm^{-3})	1.271	1.272	1.272
PH-water (1:2.5)	7.9	7.7	7.8
EC (ds/m)	0.166	0.123	0.145
Organ C (%)	1.25	0.82	1.04
Total N (%)	0.166	0.073	0.120
FC (%)	14.1	11.85	12.98
PWP (%)	8.71	4.85	6.78
TAW (mm/m)	68.5069	89.04	78.864

3.2. Crop Water Requirement

The amount of irrigation water applied to treatments 100% ETc with 150 Kg/ha N-fertilizer, 100% ETc with 130 Kg/ha N-fertilizer, 100% ETc with 110 Kg/ha N-fertilizer and 100% ETc with 90 Kg/ha N-fertilizer was 596.45 mm and 477.16 mm gross irrigation were applied to 80% ETc with 150 Kg/ha N-fertilizer, 80% ETc with 130 Kg/ha N-fertilizer, 80% ETc with 110 Kg/ha N-fertilizer, and 80% ETc with 90 Kg/ha N-fertilizer and 357.87 mm was applied to 60% ETc with 150 Kg/ha N-fertilizer, 60% ETc with 130 Kg/ha N-fertilizer, 60% ETc with 110 Kg/ha N-fertilizer and 60% ETc with 90 Kg/ha N-fertilizer. [11] obtained 469 mm crop water requirement for onion. [12] also obtained irrigation requirement of 507.8 mm. The net and gross irrigation water applied in the entire growing period of the crop for all the treatments are shown in table 2. The common irrigation was applied two times from transplanting up to sixth days. Relatively 20% of water was saved under 80% ETc with 150 Kg/ha N-fertilizer, 80% ETc with 130 Kg/ha N-fertilizer, 80% ETc with 110 Kg/ha N-fertilizer and 80% ETc with 90 Kg/ha N-fertilizer and 40% of water was saved under 60% ETc with 150 Kg/ha N-fertilizer, 60% ETc with 130 Kg/ha N-fertilizer, 60% ETc with 110 Kg/ha N-fertilizer and 60% ETc with 90 Kg/ha N-fertilizer as compared to treatments irrigated with 100% ETc. The variation of net and gross irrigation requirement occurred between the treatments were due to deficit application.

***Table 2.** Crop and irrigation water requirement.*

Treatments	IRn (mm)	P_{ef} (mm)	CWR (mm)	IRg (mm)	Rws		
					mm	(m^3/ha)	(%)
100% ETc * 150	417.52	0	417.52	596.45	0	0	0
100% ETc * 130	417.52	0	417.52	596.45	0	0	0
100% ETc * 110	417.52	0	417.52	596.45	0	0	0
100% ETc * 90	417.52	0	417.52	596.45	0	0	0
80% ETc * 150	334.02	0	334.02	477.16	119.29	1192.9	20
80% ETc * 130	334.02	0	334.02	477.16	119.29	1192.9	20
80% ETc * 110	334.02	0	334.02	477.16	119.29	1192.9	20
80% ETc * 90	334.02	0	334.02	477.16	119.29	1192.9	20
60% ETc * 150	250.51	0	250.51	357.87	238.58	2385.8	40
60% ETc * 130	250.51	0	250.51	357.87	238.58	2385.8	40
60% ETc * 110	250.51	0	250.51	357.87	238.58	2385.8	40
60% ETc * 90	250.51	0	250.51	357.87	238.58	2385.8	40

IRn=net irrigation requirement, IRg=gross irrigation requirement, CWR=crop water requirement, P_{ef}=effective rainfall and Rws=relative water saved

3.3. Combined Effects of Irrigation Levels and N-Fertilizer Rates on Plant Height Yield, Yield Components and Water Productivity

As shown in the table 3, the combined effect of different irrigation levels and N-fertilizer rates showed significant effect on plant height. The highest plant height (53.07 cm) was observed from 100% ETc with 150 Kg/ha N-fertilizer treatment and statistically it was significantly different from all treatments except 100% ETc with 130 Kg/ha N-fertilizer and 80% ETc with 150 Kg/ha N-fertilizer treatments, while the shortest mean plant height (45.73 cm) was recorded under 60% ETc with 90 Kg/ha N-fertilizer and statistically different from all treatments except treatment 60% ETc with 110 Kg/ha N-fertilizer. The reason for the better performance of this growth parameter was due to the larger irrigation level and fertilizer rate may be attributed to optimum soil water-air-balance around plant root zone and easily availability of soil nutrients. The outcome of this study was in line with the findings of [13], which stated that soil water supply is directly proportional with plant height growth and nitrogen enhances and extends the plant vegetative growth [4].

***Table 3.** Combined effects of irrigation levels and N-fertilizer rates on plant height, yield, yield components and water productivity.*

Treatments	Plant height (cm)	Total bulb yield (qt/ha)	Marketable bulb yield (qt/ha)	bulb diameter (cm)	Bulb height (cm)	water productivity (Kg/m^3)
100% ETc * 150	53.07^{a}	252.89^{a}	241.39^{a}	6.21^{a}	6.13^{a}	4.24^{cd}
100% ETc * 130	51.53^{ab}	226.67^{bc}	217.74^{b}	5.91^{bc}	5.89^{a}	3.80^{de}
100% ETc * 110	50.40^{bc}	204.37^{de}	195.39^{dc}	5.78^{c}	5.55^{b}	3.43^{ef}
100% ETc * 90	49.53^{dc}	176.79^{cfgh}	172.46^{fe}	5.37^{de}	4.97^{de}	2.96^{f}
80% ETc * 150	52.60^{a}	240.48^{ab}	224.33^{ab}	6.14^{ab}	5.97^{a}	5.04^{ab}
80% ETc * 130	50.47^{bc}	220.28^{cd}	213.02^{bc}	5.85^{bc}	5.59^{b}	4.62^{bc}

Treatments	Plant height (cm)	Total bulb yield (qt/ha)	Marketable bulb yield (qt/ha)	bulb diameter (cm)	Bulb height (cm)	water productivity (Kg/m^3)
80% ETc * 110	48.93^{dc}	186.83^{efg}	184.92^{de}	5.41^{de}	5.23^{cd}	3.92^{de}
80% ETc * 90	48.80^{dc}	167.74^{ghi}	158.53^{fg}	5.31^{e}	4.94^{e}	3.52^{ef}
60% ETc * 150	49.40^{dc}	194.09^{fe}	186.31^{de}	5.65^{dc}	5.44^{bc}	5.42^{a}
60% ETc * 130	48.33^{de}	161.87^{hi}	152.69^{fg}	5.15^{ef}	4.91^{e}	4.52^{cb}
60% ETc * 110	46.80^{fe}	155.12^{i}	150.99^{g}	4.97^{f}	4.87^{e}	4.33^{cd}
60% ETc * 90	45.73^{f}	125.32^{j}	123.61^{h}	4.58^{g}	4.73^{e}	3.50^{ef}
LSD (0.05)	1.93	19.42	20.68	0.30	0.28	4.97
CV (%)	2.30	5.95	6.59	3.23	3.13	7.16

*Means followed by the same letter in a column per treatment factor are not significantly different from each other at a 5% probability level

3.3.1. Total Bulb Yield

As shown in the table 3, the combined effect of different irrigation levels and N-fertilizer rates showed significant effect on total bulb yield and the maximum total bulb yield (252.89 qt/ha) was obtained from 100% ETc with 150 Kg/ha N-fertilizer and it was statistically significantly different from all treatments except 80% ETc with 150 Kg/ha N-fertilizer. The smallest total bulb yield (125.32 qt/ha) was recorded from 60% ETc with 90 Kg/ha N-fertilizer. Generally, statistical analysis of the results showed significant increase in onion total bulb yield with increasing irrigation level and N-fertilizer rate. This might be due to combined effects of N-fertilizer and irrigation was contributed to plant growth and development and bulb formation. [14] reported that as irrigation level increase, significantly increase in bulb yield.

3.3.2. Marketable Bulb Yield

As shown in the table 3, the combined effect of different irrigation levels and N-fertilizer rates showed significant effect on marketable bulb yield and the maximum marketable bulb yield of (241.39 qt/ha) was obtained from 100% ETc with 150 Kg/ha N-fertilizer and it was statistically significantly different from all treatments except 80% ETc with 150 Kg/ha N-fertilizer. The lowest marketable bulb yield (123.61 qt/ha) was recorded from 60% ETc with 90 Kg/ha N-fertilizer and it was significantly different from all other treatments. The result showed that there was an increasing trend in bulb yield for an increase in irrigation level and N-fertilizer rate. The highest bulb yield obtained from higher irrigation level was due to the better performance of growth parameters. The highest level of irrigation and fertilizer rate ensures the optimum growth of the crop by assuring balanced water and nutrient supply. This result agreed with study result of [15] and [16]. [14] also reported that as irrigation level increase, significantly increase in bulb yield.

3.3.3. Bulb Diameter

As shown in table 3, the combined effect of different irrigation levels and N-fertilizer rates showed significant effect on bulb diameter and the largest bulb diameter (6.21 cm) was obtained from 100%ETc with 150 Kg/ha N-fertilizer which was significantly ($P<0.05$) different from all treatments except 80% ETc with 150 Kg/ha N-fertilizer, while the least bulb diameter (4.58 cm) was recorded under 60% ETc with 90 Kg/ha N-fertilizer which was significantly different ($P<0.05$) from all treatments. This means that when you water plants more, their bulbs get bigger. If you give crops enough water and nutrients through irrigation, they will grow the best. [17] and [18] indicated that bulb diameter has an increasing trend with the level of irrigation application. This result agrees with what was found in [3], where the use of 138 kg ha^{-1} N led to the biggest bulb diameter of 5.67 cm.

3.3.4. Bulb Height

The combined effect of different irrigation levels and N-fertilizer rates showed significant effect on bulb height and the tallest (6.13 cm) was gotten from 100% ETc with 150 Kg/ha N-fertilizer and significantly ($p<0.01$) different from all treatments except 100% ETc with 130 Kg/ha N-fertilizer and 80% ETc with 150 Kg/ha N-fertilizer, While the shortest bulb height (4.73 cm) was obtained from 60% ETc with 90 Kg/ha N-fertilizer and was not significantly different from 100% ETc with 90 Kg/ha N-fertilizer, 80% ETc with 90 Kg/ha N-fertilizer, 60% ETc with 130 Kg/ha N-fertilizer, 60% ETc with 110 Kg/ha N-fertilizer and 60% ETc with 90 Kg/ha N-fertilizer (table 3). This result agrees with the findings of [4], who found that bulb length increase with amount of N-fertilization.

3.3.5. Water Productivity

As shown in the table 3, the combined effect of different irrigation levels and N-fertilizer rates showed significant effect on water productivity and 60% ETc with 150 Kg/ha N-fertilizer gave the maximum water productivity (5.42 kg/m^3), but the reduction in water productivity with 80% ETc with 150 Kg/ha N-fertilizer was not significant. The reasons for maximum water productivity recorded from this treatment might be due to the smallest water and enough amount of N-fertilizer were applied. While the least water productivity (2.96 kg/m^3) was recorded from 100% ETc with 90 Kg/ha N-fertilizer. This might be due to the highest water was applied and smallest amount of N-fertilizer applied.

3.4. Partial Budget Analysis

As shown in table 4 the highest and lowest total cost of 147402 birr/ha and 129181 birr/ha were incurred for treatments 100% ETc with 150 Kg/ha N-fertilizer and 60% ETc with 90 Kg/ha N-fertilizer, respectively. The economic analysis also revealed that the highest net return was (504351 birr/ha) and lowest (204566 birr/ha) was obtained from 100% ETc with 150 Kg/ha N-fertilizer and 60% ETc with 90 Kg/ha

N-fertilizer. The highest benefit-cost ratio of about 4.42 was obtained from 100% ETc with 150 Kg/ha N-fertilizer and followed by 80% ETc with 150 Kg/ha N-fertilizer. Therefore, 100% ETc with 150 Kg/ha N-fertilizer and 80% ETc with 150 Kg/ha N-fertilizer could be considered to have an economic advantage over other.

The highest irrigable land with water that could be obtained from saved water (0.67 ha) was recorded from treatments irrigated with 60% ETc. The highest total return that could be obtained from saved water (3353.60 birr) was recorded from 60% ETc with 150 Kg/ha N-fertilizer application.

Table 4. *Partial budget analysis.*

Treatments	UMY (kg/ha)	AMY (kg/ha)	TC (birr/ha)	TR (birr/ha)	NR (birr/ha)	B/C	IL_{sw} (ha)	NR_{ws} (birr)
100% ETc * 150	241.39	217.25	147402	651753	504351	4.42	0	0
100% ETc * 130	217.74	195.97	147072	587898	440826	4.00	0	0
100% ETc * 110	195.39	175.85	146742	527553	380811	3.60	0	0
100% ETc * 90	172.46	155.21	146412	465642	319230	3.18	0	0
80% ETc * 150	224.33	201.90	138787	605691	466904	4.36	0.25	1514.25
80% ETc * 130	213.02	191.72	138457	575154	436697	4.15	0.25	1437.90
80% ETc * 110	184.92	166.43	138127	499284	361157	3.61	0.25	1248.23
80% ETc * 90	158.53	142.68	137797	428031	290234	3.11	0.25	1070.10
60% ETc * 150	186.31	167.68	130171	503037	372866	3.86	0.67	3353.60
60% ETc * 130	152.69	137.42	129841	412263	282422	3.18	0.67	2748.40
60% ETc * 110	150.99	135.89	129511	407673	278162	3.15	0.67	2717.80
60% ETc * 90	123.61	111.25	129181	333747	204566	2.58	0.67	2225.00

UMY = Unadjusted marketable yield, AMY = Adjusted marketable yield, Adjustment coefficient was 10%, TC = Total cost, TR = Total return, NR = net return, B/C = benefit-cost ratio, ILsw = irrigable land with saved water, NRsw = net return from saved water, Field price of water and onion bulb was 1 birr/238 m^3 [10] and 30 birr/kg, respectively.

4. Conclusion and Recommendation

In general the results indicated that the combined effect between irrigation levels and N-fertilizer application rates significantly affected plant height, yield and yield components and water productivity of onion. The highest plant height, bulb height, bulb diameter, marketable bulb yield and total bulb yield of (53.07 cm), (6.13 cm), (6.21 cm), (241.39 qt/ha) and (252.89 qt/ha) respectively were obtained from fully irrigated (100% ETc) and fully N-fertilized treatment compared to the deficit conditions. The highest water productivity was recorded from 60% ETc and 150 Kg/ha N-fertilizer application rate, but the reduction in water productivity with 80% ETc with 150 Kg/ha N-fertilizer was not significant.

Hence, if water is not limiting factor, 100% ETc with 150 Kg/ha N-fertilizer could be suggested to apply. But if water becomes limiting factor, 80% ETc with 150 Kg/ha N-fertilizer would be more appropriate for growing onion in the study area. And this technology should be further demonstrate and scaling up for end user.

References

[1] Molden, D. 2007. Water for nutrients, water for life: a comprehensive Assessment of water management in agriculture. International Water Management Institute, London.

[2] Mubarak I., and Hamdan A., 2018. Onion crop response to different irrigation and N-fertilizer levels in dry Mediterranean region. - Adv. Hort. Sci., 32 (4): 495-501.

[3] Negasi T., Nigussie D., Kebede W., Lemma D. and Abuhay T. 2018. Influence of Nitrogen and Phosphorus Application on Bulb Yield and Yield Components of Onion (L.). The Open Agriculture Journal, 12 (1).

[4] Gosa Shura, Hussien Mohammed, and Ashenafi Haile, 2022. Improving onion productivity through optimum and economical use of soil macronutrients in Central Rift Valley of Ethiopia. Journal of Agriculture and Food Research, Volume 9.

[5] Shrestha, J., Subedi, S., Timsina, K., Subedi, S., Pandey, M., Shrestha, A., Shrestha, S. and Hossain, M. 2021. Sustainable intensification in agriculture: an approach for making agriculture greener and productive. Journal of Nepal Agri. Res. Council, 7, pp. 133-150.

[6] Janmohammadi, M., Pornour, N., Javanmard, A. and Sabaghnia, N., 2016. Effects of bio-organic, conventional and nanofertilizers on growth, yield and quality of potato in cold steppe. Bot. Lith, 22 (2), pp. 133-144.

[7] Ali, O. 2012. A computer program for calculating crop water requirements. Greener J Agri. Sci., 3 (2): 150–163.

[8] Arega M. and Tena A. 2012. Deficit Irrigation Application Using Center Pivot Sprinkler Irrigation for Onion Production. International Journal of Basic and Applied Sciences, 1 (2).

[9] Illiassou, N., Leonor, R. S. and Raúl, S. C. 2014. Water use efficiency and water productivity in the Spanish irrigation district "Río Adaja". International Journal of Agricultural Policy and Research, 2 (12): 484-491.

[10] Mekonen A., Gebremeskel T., Mengistu A., Fasil, E. and Melkamu, M. 2015. Irrigation water pricing in Awash River Basin of Ethiopia: Evaluation of its impact on scheme-level irrigation performances and willingness to pay. African Journal of Agricultural Research, 10 (6), pp. 554-565.

[11] Dirirsa G., Tilahun H. and Daniel B. 2015. Water Requirement and Crop Coefficient of Onion (Bombay Red) in the Central Rift Valley of Ethiopia. International Journal of Recent Research in Life Sciences (IJRRLS) Vol. 2, Issue 1, pp: (1-6).

[12] Miniebel F. 2021. Determination of Optimal Irrigation Scheduling for Onion (Allium cepa L.) at Assosa District, North West of Ethiopia. Int. J. Adv. Res. Biol. Sci. (2021). 8 (7): 103-109.

[13] El-Noemani, A., Aboamera, M., Aboellil, A. and Dewedar, O. 2009. Growth, yield, quality and water use efficiency of pea (Pisum sativum L.) plants as affected by evapotranspiration (ETo) and sprinkler height. J. Agric. Res., 34 (4): 1445-1466.

[14] Satyendra Kumar., M. Imtiyaz, Ashwani Kumar, and Rajbir Singh (2007). Response of onion (Allium cepa L.) to different levels of irrigation water. Agricultural water management 8 9 (2007) 161–166.

[15] Quadir, M., Boulton, A., Ekman, J., Hickey, M. and Hoogers, R. 2005. Influence of drip irrigation on onion yield and quality. IREC Farmers News lett. 170: 29-31.

[16] Bagali, A. N., Patil, H. B., Guled, M. B. and Patil, R. V. 2012. Effect of scheduling of drip irrigation on growth, yield and water use efficiency of onion (Allium cepa L.). Karnataka J Agric. Sci., 25 (1): 116-119.

[17] Ayas, S. and Demirtaş, Ç. 2009. Deficit irrigation effects on onion (Allium cepa LET Grano 502) yield in unheated greenhouse condition. J Food, Agri. and Envi., 7 (3/4): 239-243.

[18] Al-Moshileh, A. 2007. Effects of planting date and irrigation water level on onion (Allium cepa L.) production under central Saudi Arabian conditions. J Basic Appl. Sci, 8: 14-28.