

Evaluating Water Productivity of Onion under Deficit Irrigation using Drip Irrigation System for Small Holder Farmers

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ABSTRACT

Irrigation water has been identified as one of the unusual inputs, which can severely restrict agricultural production and productivity unless it is carefully well-preserved and managed. It is a wide-ranging practice using every drop of water for crop production through suitable irrigation practices. Hence, a field experiment was conducted at Bekoji Negesso area for three consecutive years, 2020-2022 to evaluate the effect of deficit irrigation on yield and water productivity of onion (*Allium cepa* L.) under drip irrigation for small holder farmers during dry season. Drip irrigation with two treatments viz., 75% ETc and 50% ETc irrigation levels and full irrigation (control) were done. At an operating pressure head of 1.5 m, the average emitter flow rate was 0.43 liter/hr. Drip irrigation with 100% ETc gave the highest yield 34.31 t/ha as compared to 75% ETc and 50% ETc. Water productivity 10.13 kg/m³ were found highest at 75% ETc. The amount of water saved at 75% ETc and 50% ETc were 25 and 50 % respectively. And this would be sufficient to irrigate 0.33 to 1.00 ha of additional area of onion crop. The amount of water saved from 75% ETc could compensate the decrease in crop yield on additional 0.33 ha by using the 25% of saved water. Therefore, the study suggests farmers having limited amount of water for irrigation can adopt 75% ETc of drip irrigation.

Keywords: Drip irrigation; Deficit irrigation; Water productivity; Bulb yield.

Introduction

Irrigation management should be shifted from emphasizing production per unit area to maximizing production per unit of water consumed due to insufficient water supply for irrigation than the expectation in present and future (Feres and Soriano, 2007). Drip irrigation is a sort of micro irrigation system that allows water to drip slowly to the roots of plants from above the soil surface or buried below the surface, potentially saving water and nutrients. The idea is to get water into the root zone quickly and reduce evaporation. A drip irrigation system can be more efficient than other types of irrigation systems, such as surface irrigation or sprinkler irrigation, depending on how effectively it is designed, installed, maintained and operated (Shaik, 2021).

Drip irrigation also a water management technique that makes it possible to produce in the dry season, to increase and intensify agricultural production against food shortage and malnutrition (Yaakov *et al.*, 2014). This system is an effective tool to achieve the combined goals of sustainable water use, food security and poverty mitigation in the developing world (Wanvoeke *et al.*, 2015).

A well designed drip irrigation perform and can be suitable in smallholder farming system and rural communities' use since it doesn't recommend much effort for maintenance. It can be used to grow vegetables, livestock water drink and seed crops cultivation which can improve rural family livelihood and nutrition especially women and children (Millogo *et al.*, 2021). The practice of DI application up to 20% saved 45 to 108 mm depth of water from the gross onion irrigation water requirement (Enchalew *et al.*, 2016).

Improving water productivity is a vital strategy for addressing future water scarcity. Irrigation is a wide-ranging practice using every drop of water for crop production through suitable practices. Farmers in the dry region having

limited amount of water for irrigation, should adopt drip method with combination of deficit irrigation rather than practice of basin irrigation methods (Sujeewa *et al.*, 2020). The amount of water saved at 100, 80 and 60 % ETc under drip method was 29.4, 43.5 and 57.6% respectively over furrow method and this would be sufficient to irrigate 0.42 to 1.36 hectare of additional area of onion crop in which this earns better economic returns as compared to that of furrow irrigation method (Teferi, 2015).

According to Teferi, (2015), Onion irrigated at 100% ETc with drip method registered 32.8% of increase in yield over furrow method of irrigation. However, irrigation water productivity was found highest (7.60 kg m⁻³) with drip irrigation at 60% ETc. Maximum yield could be obtained with the achievement of the entire crop water requirements. Similarly, Tagar *et al.*, (2012) reported that drip irrigation method saved 56.4% water and gave 22% more yield as compared to that of furrow irrigation method. Halvorson *et al.*, (2008) obtained higher fresh onion yields, irrigation water productivity and economic returns with sub surface drip irrigation system compared to furrow irrigation systems. The experiment is accomplished with the aim to evaluate the effect of deficit irrigation on yield and water productivity of Onion (*Allium cepa* L.) under drip irrigation for small holder farmers.

Materials and Methods

Description of the study area

The field experiment was conducted at Bekoji located in Arsi zone, South East of Ethiopia during the dry season of 2020, 2021 and 2022 geographically, it is situated at 7° 33' N latitude and 39° 25' E longitude and its elevation is 2780 m.a.s.l respectively. The long-term average annual rainfall of the experimental site is 1098 mm and 62% of rain is falls between the months of June and October and the mean maximum and minimum temperature are 19 °C and 6.8°C respectively.

Experimental design procedure and field layout

The experimental treatments include drip line and two water levels, viz., 75% ETc, 50% ETc and control irrigation application. The experiment was laid out in randomized complete block design with three replications. The seedlings of Bombay Red onion were transplanted to farmer plots. Vigorous, strong and healthy seedlings were bought from Awash Melkassa seed growers. The experimental field was ploughed, leveled and made ready for planting. The experimental field will be divided into nine plots and each plot size was (2.8 m × 5 m) area to accommodate four double drip line and planting rows Figure 1. Each row accommodated about 50 plants. The distance between blocks, plots, rows and plants were 1.5 m, 1.0 m, 0.20 m and 0.10 respectively. The treatment combination is as shown in Table 1.

Table 1. Treatment combination

Lateral line	Water Level		
	100% ETc	75% ETc	50% ETc
Every crop row	T ₁	T ₂	T ₃

Irrigation scheduling was done based on control treatment (100% ETC). The other treatment receive lower amount of water based on water level percentage. The control treatment of drip irrigation was irrigated based on the allowable moisture depletion level in the effective root depth that aims to refill the soil moisture to field capacity.

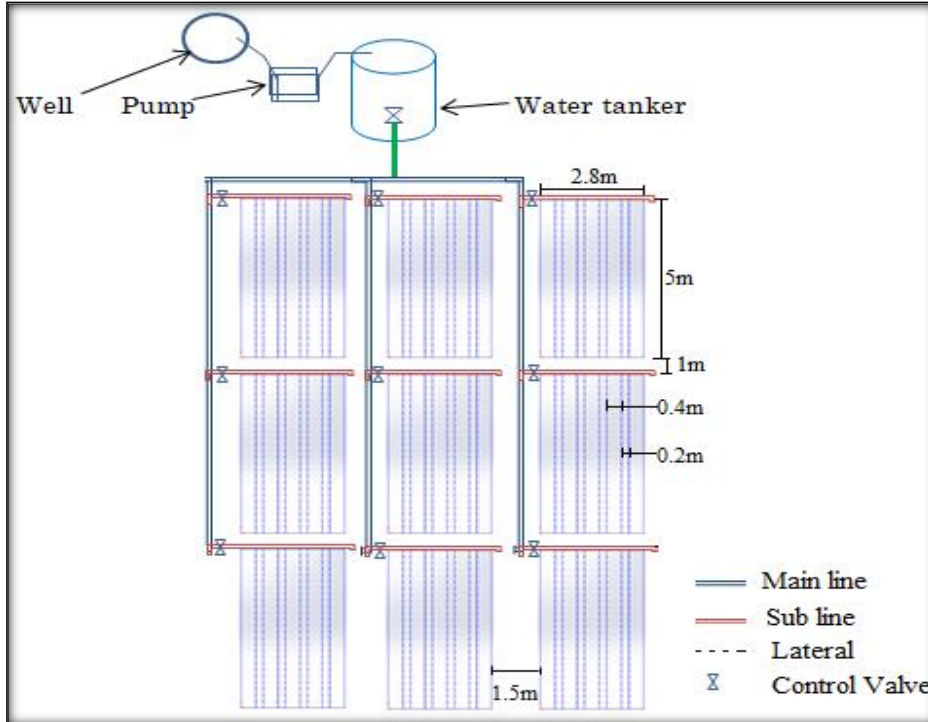


Figure 1. Field layout of the experiment

Soil sampling and analysis

The soil samples were taken from 0 – 60cm in 20 cm interval. The sub-samples were mixed thoroughly, dried at room temperature, ground and sieved through a 2 mm screen for analysis of physico-chemical properties.

Bulk density was determined from undisturbed soil samples which were collected from three depths (0-20 cm, 21-40 cm and 41- 60 cm), oven dried for 24 h at 105°C and weighed for determination of dry weight given by (Hillel, 2004).

$$\rho_b = \frac{W_d}{V_T} \quad (1)$$

Where: - W_d - Weight of dry soil (gm) and V_T - Total sample volume (cm^3).

Crop water requirements

The reference evapotranspiration (ET_o) was estimated using the FAO Penman-Monteith equation using long term Bekoji meteorological data that taken from National Meteorological Agency with the help of CROPWAT 8.0 model. The crop water requirements (ET_c) over the growing season were determined by multiplying the ET_o values with the onion crop coefficients (K_c) given by (Allen *et al.*, 1998) as 0.53, 0.79, 1.05 and 0.88 for the initial, development, mid and late growth stages respectively.

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

Total available water was computed from the moisture content at field capacity and permanent wilting point using the following equation as indicated by (Allen *et al.*, 1998).

$$TAW = (FC - PWP) \times BD \times Dz \quad (3)$$

where, TAW is the total available water in the root zone (mm), FC and PWP are moisture content at field capacity and permanent wilting point (%) on weight basis respectively and Dz is the root zone depth of onion at times of each irrigation.

Irrigation water application

Full irrigation application was calculated as the net depth of irrigation required to recharge soil moisture to field capacity. The percentages of wetted area were determined using Keller and Bliesner (1990) method.

For the experimental test, volume of irrigation water application (m^3) to each plot was computed by the following equation (Allen *et al.*, 1998).

$$V = A \times (w.a) \times dg \quad (4)$$

Where: - A – plot area (m^2), w.a. - wetting area (0.8) and dg - gross irrigation depth (m).

The gross irrigation requirement, IR_g was computed by adopting field application efficiency, E_a of 90% for drip irrigation method (Allen *et al.*, 1998).

$$IR_g = \frac{IR_n}{E_a} \quad (5)$$

Whenever there is rainfall between irrigation, the IR_n could be obtained from,

$$IR_n = ET_c - P_{eff} \quad (6)$$

Where, P_{eff} is effective rainfall (mm).

Emitters uniformity determination

The hydraulic characteristics of emitters that were determined include emitter flow rate, emitter flow variation, uniformity coefficient, coefficient of variation and emission uniformity.

Emitter flow rate, q - average emitter flow rate was measured from randomly selected emitter along middle laterals from each plot using catch cans and volumes of flow measured over a time period (Ali, 2010).

$$q = \frac{v}{\Delta t} \quad (7)$$

Where: - q - Single emitter discharge (liter/hour); v - Volume of water collected from emitter, (liters) and Δt - Time duration (hour).

Emission Uniformity, EU - a measure of the uniformity for all emitter emissions along drip irrigation lateral line given by (Kruse, 1978)

$$EU = 100 \left(\frac{q_{min}}{q_a} \right) \quad (8)$$

Where: - E_u - Emission uniformity (%), q_{min} - Minimum emitter flow rate (l/h) and q_a - Average discharge rate of all observed emitters (l/hr).

Emitter flow variation, q_{var} - It is calculated as follows (Wu, 1983).

$$q_{var} = \left(\frac{q_{max} - q_{min}}{q_{max}} \right) \quad (9)$$

Where: - q_{max} - Maximum emitter flow rate (l/h), and q_{min} - Minimum emitter flow rate (l/h).

Coefficient of variation, CV - It is used to identify the relative variability among the treatments (Wu, 1983).

$$CV = \frac{s}{q_a} \quad (10)$$

Where: - s - Standard deviation of emitter flow rates (l/h) and q_a - Average emitter flow rate (l/h).

Uniformity Coefficients, UC - It is often described in terms of the coefficient of variation defined as the ratio of the standard deviation to the mean (ASAE, 1985).

$$UC = \left(1 - \frac{s_q}{q_a} \right) * 100 \quad (11)$$

Where: - UC - Uniformity coefficient (%), s_q - Average absolute deviation of emitters flow from the average emitter flow (l/h) and q_a - Average emitter flow rate (l/h).

Crop data collection

The crop data was collected from the middle rows in order to avoid border effects. The yield and yield component data were collected randomly from five plants. The plants carefully picked randomly from middle two double rows by avoiding one plant from starting and ending of four middle rows. Harvesting was done manually by uprooting the onion bulbs. After harvesting, roots are trimmed and the bulb leaves cut away using sickle and bulbs of each plot was collected separately and tagged properly. Finally, yield and yield component data were collected.

Plant height: was measured from soil surface to the top of the longest mature leaf.

Leaf height: was measured from the start of leaf nod to the top of the longest mature leaf.

Number of leaf per plant: was counted by using hands. Mean plant height, leaf height and leaf number of each experimental unit were calculated from average of collected five samples.

Bulb diameter: Five samples of onion bulbs tagged were taken randomly from harvesting area of each plot. Then equatorial diameter (mm) of onion bulbs was measured using a digital caliper.

Bulb yield: The mean of weights of the bulb for each onion bulb taken randomly from plot. Finally, the bulb yield obtained from the sample area was converted to ton per hectare as illustrated in equation below.

$$\text{Bulb yield} \left(\frac{t}{ha} \right) = \frac{\text{Bulb yield} \left(\frac{kg}{plot} \right) * 10}{\text{Net harvested area of plot} (m^2)} \quad (12)$$

The onion bulb yield was collected and weighed from the central rows of each plot; this is to avoid border effects. The harvested yield was graded into marketable and non-marketable categories of onion bulb according to the size. Onion bulbs with less than 2cm diameter were categorized under non-marketable (Lemma and Shimeles, 2003).

Marketable yield (kg/ha): is healthy and non-diseased average to large sized Bombay Red onion bulbs were recorded from central two harvestable double rows.

Unmarketable onion (kg/ha): is split, decayed, diseased and under sized bulbs.

Total bulb yield (kg/ha): is the sum of marketable and unmarketable bulb yields.

Water productivity

Crop water productivity (WP) simply refers to the ration of output (yield) to water input during production. Crop water productivity was estimated as the ratio of onion bulb yield to the total irrigation depth applied to during the season (Araya *et al.*, 2011).

$$Wp = \frac{Y}{W} \quad (13)$$

Where: - Y - Onion bulb yield (kg/ha) and W - Irrigation depth applied during the season (m³/ha).

Water saving with deficit irrigation as compared with full irrigation was calculated according to (Jemal and Mukerem 2017) as:

$$Ws(\%) = \frac{TWUFI - TWUDI}{TWUFI} * 100 \quad (14)$$

Where: - WS - Water saved due to deficit irrigation, TWUFI - Total water using full irrigation (mm) and TWUDI - Total water using deficit irrigation (mm).

Percent of yield increase/decrease in deficit irrigation (%) as compared to full irrigation was calculated using the following equation (Jemal and Mukerem, 2017),

$$YI/D(\%) = \frac{YFI - YDI}{YFI} * 100 \quad (15)$$

Where: - YI/D - Percent of yield increase or decrease due to deficit irrigation, YFI - Yield in (kg/ha) obtained from full irrigation and YI/D - Yield in (kg/ha) obtained from deficit irrigation.

Statistical analysis

All necessary data collected were managed properly using SAS computer package version 8.2. When the treatments effect was found significant mean difference was tested using LSD test at 5% probability level.

Results and Discussions

Soil of the experimental site

The soil physical characteristics of the experimental site are presented in Table 2. An average soil layer of the study site is characterized as clay in texture over 60 cm soil depths. The bulk density is 1.05 g/cm³ over the effective root zone of onion crop.

The average pH value of the experimental site through the analyzed soil profile is 5.77. According to Olani and Fikre (2010), onion can grow best in soils with pH range of 6.0 to 8.0. The total available water which is the amount of water that a crop can theoretically extract from its root zone is about 145 mm over 1 m soil depths.

Table 2. Average soil physical properties of experimental site

Depth (cm)	Bulk density (g/cc)	FC (%) (V/V)	PWP (%) (V/V)	TAW (mm/m)	pH	OC (%)	OM (%)	Texture			Class
								% Sand	% Silt	% Clay	
0 – 20	0.95	37.60	23.60	140.00	5.8	2.44	4.20	20	30	50	Clay
21– 40	1.07	39.10	23.90	152.00	5.8	2.29	3.95	18	28	54	Clay
41 – 60	1.14	37.90	23.60	143.00	5.7	2.05	3.54	20	28	52	Clay
Aver.	1.05	38.20	23.70	145.00	5.77	2.26	3.89	19.33	28.7	52	Clay

Irrigation Water Requirement of Onion

Crop water requirement of onion was determined based on the seasonal water application depth and vary according to irrigation water levels. Application efficiency (E_a) used for drip irrigation was 90%. The highest and minimum seasonal crop water requirement obtained was 359 mm and 180 mm at 100% E_{Tc} and 55% E_{Tc} respectively Table 3. The result of full irrigation (100 % E_{Tc}) agreed with (Teferi, 2015) report on onion which was 396.9 mm used for drip irrigation at farmer field.

Table 3. Seasonal net irrigation water depth applied for each treatment

Treatments	d_{net} (mm)	E_a	d_{gross} (mm)
100% E_{Tc}	359	0.9	399.30
75% E_{Tc}	270	0.9	299.48
50% E_{Tc}	180	0.9	199.65

Emitter flow rate

An emitter flow rate was affected by the number tested at a time using the catch can test method. At an operating pressure head of 1.5 m, the average emitter flow rate was 0.43 liter/hr while mean maximum and mean minimum values were 0.45 and 0.40 liter/hr respectively Table 4. The mean coefficient of variation obtained was 4.85 %.

Table 4. Average, maximum and minimum emitter flow rates as affected by the number of plots tested at a time using catch cans

Parameter	Average Number of emitters on the plots tested at a time									
	P ₁	P ₂	P ₃	P ₄	P ₅	P ₆	P ₇	P ₈	P ₉	Aver
Average emitter flow	0.39	0.42	0.39	0.38	0.44	0.45	0.43	0.45	0.51	0.43

rate (liter/hr)

Maximum emitter

0.40 0.42 0.42 0.40 0.44 0.48 0.47 0.46 0.53 0.45

Flow rate (liter/hr)

Minimum emitter

0.39 0.42 0.37 0.35 0.43 0.38 0.34 0.43 0.49 0.40

flow rate (liter/hr)

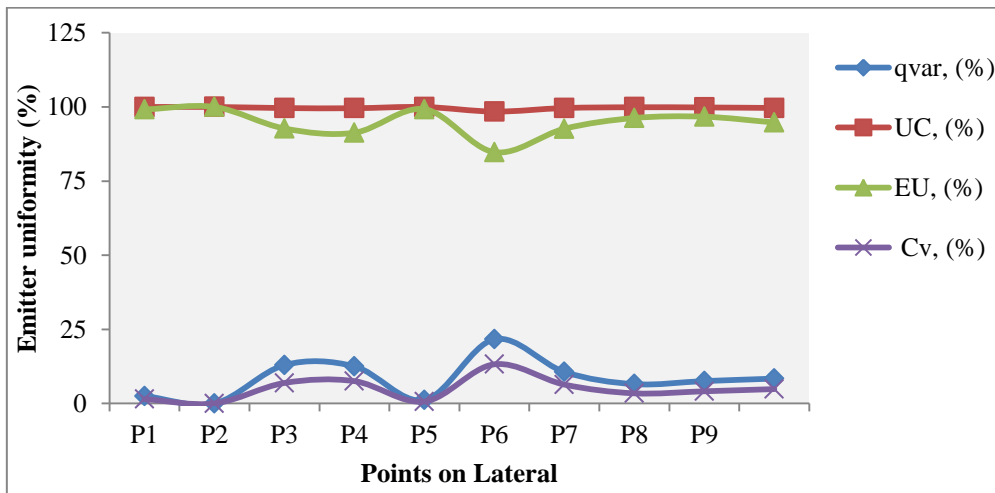


Figure 2. Uniformity parameter distribution

Emitter flow rate variation, uniformity coefficient and emission uniformity

The average emitter flow rate variation along laterals on all experimental plots was 8.38% as shown in Table 5. This result closely agreed with the finding of (Firissa, 2018) which stated that, in drip systems the average emitter flow variation in discharge rate of individual emitters in a plot should not exceed 20%. ASAE, (1986) also stated that, emitter flow rate variation <10% was classified as desirable.

The average uniformity coefficient was 99.66% while the mean of the emission uniformity was 94.76%, signifying uniform distribution of water throughout the system. This result was supported by ASABE standards EP 458, (1999) which stated that a drip system with both emission uniformity and uniformity coefficient of 90 % or greater was classified as excellent.

Table 5. Emitter flow rate variation, uniformity coefficient, emission uniformity and application efficiency as affected by the number of treatments tested at a time using catch cans

Parameter	Average Number of emitters on the plots tested at a time									
	P ₁	P ₂	P ₃	P ₄	P ₅	P ₆	P ₇	P ₈	P ₉	Aver.
Emitter flow rate Variation (%)	2.50	0.05	12.94	12.50	1.14	21.65	10.64	6.52	7.55	8.39

Uniformity	99.98	100.00	99.62	99.57	99.99	98.44	99.63	99.90	99.83	99.66
Coefficient (%)										
Emission	99.15	100.00	92.73	91.30	99.24	84.76	92.65	96.27	96.71	94.76
Uniformity (%)										
Coefficient of	1.47	0.00	6.92	7.53	0.66	13.21	6.37	3.42	4.11	4.85
Variation, Cv (%)										

Effect of water level on yield and yield components of onion



Figure 3. Growth of onion at development stage

Plant height and Bulb diameter

Growth parameter of onion shows significance ($P \leq 0.05$) difference due to effects of irrigation water level Table 6. The highest mean value of yield and yield components of onion was recorded under full irrigation application (100% ETC). As deficit irrigation application increase the mean value of yield and yield components decrease and also increasing irrigation water level, plant and leaf height was also increased (Beniam, 2019).

ROP (2016) and David *et al.*, (2016) found that, the largest mean diameter (5.95) was from 100% ETC Table 6 which received maximum amount of water (399.3mm), while 50% ETC with the smallest diameter (5.02) receive the minimum amount of water (199.65mm). This result indicated that bulb diameter varied proportionally with the quantity of irrigation water applied.

Table 6. Effect of water levels on onion yield and yield components

Drip with water level (DWL)	PH (cm)	LH (cm)	LN	BD (cm)	BH (cm)	BW (g)
100% ETC	53.13 ^a	45.67 ^a	10.67 ^a	5.95 ^a	5.31 ^a	89.75 ^a
75% ETC	44.93 ^b	35.07 ^b	10.33 ^a	5.65 ^a	5.12 ^{ab}	75.88 ^{ab}

50% ETc	31.87 ^c	30.73 ^b	8.67 ^b	5.02 ^b	4.77 ^b	59.21 ^b
S.Em±	1.05	1.11	0.30	0.15	0.11	4.93
CV	4.21	5.18	5.33	4.89	3.71	11.41
LSD (5 %)	4.13	4.36	1.19	0.61	0.43	19.39

Means with the same letter (s) in columns are not significantly different at $P \leq 0.05$, PH – Plant height, LH – Leaf height, LN – Leaf Number, BD – Bulb diameter, BH- Bulb height, BW – Bulb weight.

Marketable, total bulb yield and water productivity

Marketable and total bulb yield of onion were significantly ($P \leq 0.05$) affected by irrigation levels Table 7. The highest marketable bulb yield of onion 26.94 t/ha was obtained from full irrigation (100 % ETc). Whereas, the lower marketable bulb yield of 14.03 t/ha was recorded with 50 % ETc of water level. According to Tsegaye *et al.*, (2016) higher marketable bulbs of onion at higher water levels might be due to the increase in the formation of growth parameters causing faster synthesis and transportation of photosynthesis from source to sinks.

The total bulb yield was a significant difference ($P \leq 0.05$) between irrigation levels. The total bulb yield was highest in the control treatment (34.31 t/ha) and statistically significant difference ($P \leq 0.05$) from the other treatments. The least total bulb yield (19.93 t/ha) was recorded from treatment receiving 50% ETc.

The total bulb yield of onion was also increased with increasing in water level up to 100% ETc. This result clearly indicates that an increased photosynthetic area in response to moisture availability had substantially contributed to increase onion productivity. According to Teferi (2015), onion irrigated at 100% ETc with drip method registered 32.8% of increase in yield over furrow method of irrigation.

Table 7. Effect of water levels on onion bulb yield and water productivity

Drip with water level (DWL)	MY (t ha ⁻¹)	UMY(t ha ⁻¹)	TY (t ha ⁻¹)	WP (kg m ⁻³)
100% ETc	26.94 ^a	7.36 ^a	34.31 ^a	8.59 ^b
75% ETc	23.27 ^b	7.08 ^{ab}	30.35 ^b	10.13 ^a
50% ETc	14.03 ^c	5.90 ^b	19.93 ^c	9.98 ^a
S.Em±	0.61	0.31	0.87	0.35
CV	4.93	7.99	5.40	6.38
LSD (5 %)	2.39	1.23	3.45	1.38

Means with the same letter (s) in columns are not significantly different at $P \leq 0.05$, My – Marketable yield, UMY – Un-marketable yield, TY – Total yield, WP – Water productivity.

It is observed that water productivity was not significantly ($P \geq 0.05$) affected due to the irrigation level application Table 7. The highest water productivity 10.13 kg/m³ was obtained at 75 % ETc. These results are in accordance

with Wondatir *et al.* (2013) who concluded that drip laying in every rows improve crop water utilization efficiency.

Opportunity cost

Table 8. Relative yield reduction of onion and water saved (WS) due to deficit irrigation

Treatment	TBY (t/ha)	Igross (m ³ /ha)	YL (t/ha)	WS (m ³ /ha)	WS (%)	YL (%)	AA. Irrig. by WS (ha)	YG from AA (t)	YG -YL (t)
100% ETc	34.31	399.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
75% ETc	30.35	299.48	3.96	99.82	25.00	11.54	0.33	10.02	6.06
50% ETc	19.93	199.65	14.38	199.65	50.00	41.91	1.00	19.93	5.55

TBY= total bulb yield, WS= saved water, AA irrig. =additional area irrigated due to saved water, YG= yield gain by additional irrigated area and YL =yield loss due to deficit irrigation.

The opportunity cost of deficit irrigation water express the amount of saved water in terms of extra land to be irrigated and its compensated yield. Hence, it has been observed that amount of water saved from 75% ETc (25%) could compensate the decrease in crop yield in relation to plot receiving full and more stressed irrigation water which amounted to be 6.06 ton more bulb yield on additional 0.33 ha by using the 25% of saved water Table 8. As shown in Table 8 the highest water productivity was obtained with treatment receiving 75% ETc of irrigation water.

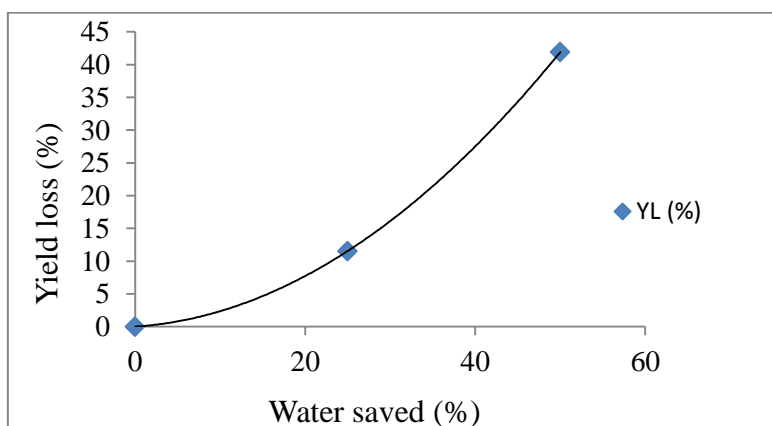


Figure 4. Optimum production of onion using water saving and yield reduction

Halvorson *et al.*, (2008) obtained about 15% higher fresh onion bulb yield under drip irrigation and used at least 57% less water than the furrow irrigation. Treatments receiving 50 % ETc during its growth stage was characterized by poor performance in all yield components. It is obvious that these treatments are already deficit irrigated and as a result yield reduction occurs by 41.91% Table 8. This result is in agreement with Temesgen *et al.*, (2018) treatments receiving 50 % ETc reduce bulb yield of onion by 30 – 45.4 %. Also according to Rop, (2016) onion yield from non-stressed treatments 100 % ETc which acted as control was highest at 34.4 ton/ha while the most stressed treatment 50 % ETc had the lowest yield of 18.9 ton/ha.

According to Ketema and Abraham, (2022) treatment receiving 75% ETc saves 25% irrigation water, but resulted in bulb yield reduction of 6.1 ton/ha. The water saved is adequate to expand more than 0.31 ha of land and produce additional 10.08 tons of onions. As yield penalty increase, the water saved increases more figure 4.

Economic Analysis

The production costs were computed by considering drip system cost, operation cost, labor cost for its installation and removal. Drip system with full irrigation system of marketable bulb yield gave the maximum net income of 324,919.41 ETBha⁻¹ Table 9. On the other hand, less net income of 134,885.46 ETBha⁻¹ was obtained from drip system with 50% ETc. The net benefit value to cost ratio for drip with 75% ETc is 1.3 and greater than the other treatments. This result revealed that drip system with 75% ETc gave high net income than the others. According to Ketema and Abraham, (2022) treatment receiving 75% ETc gave high net income.

Table 9. Effect of drip with irrigation level on cost of production and net return of onion

Treatments	TC (ETB/ha)	UMY (kg/ha)	AMY (kg/ha)	GB (ETB/ha)	NB (ETB/ha)	B/C (ETB/ha)
100%ETc	281,231	26,940	24,246	606,150	324,919.41	1.2
75%ETc	230,866	23,270	20,943	523,575	292,709.03	1.3
50%ETc	180,790	14,030	12,627	315,675	134,885.46	0.7

TC – Total cost, UMY – Un-adjustable Marketable Yield, AMY – Adjustable Marketable Yield, GB – Gross Benefit, NB – Net benefit, B/C – Benefit Cost ratio.

Conclusion and Recommendation

Analysis of drip irrigation uniformity test showed that there is no significant uniformity variation along and across emitters on the experimental plots. The mean of uniformity determination parameters are within the recommended range. The maximum onion bulb yield of (34.31 t/ha) were obtained at full irrigation application (100 % ETc) but consumes more irrigation water and highest water productivity (10.13 kg/m³) was obtained at 75% ETc. The amount of water saved from 75 % ETc could compensate the decrease in crop yield by using 25% of saved water. Deficit irrigation with drip method could be a best one for onion cultivation in water scarce area over surface irrigation method. In addition, considering the high water productivity (10.13 kg/m³) with water saving (25%), the application of water at 75% ETc could be suggested for the farmers. It was also observed that, the amount of saved water would be sufficient to irrigate additional area 0.33 ha of onion crop at 75% ETc using drip irrigation method.

Declarations

Source of Funding

The study has not received any funds from any organization.

Competing Interests Statement

The authors have declared no competing interests.

Consent for Publication

The authors declare that they consented to the publication of this study.

Authors' Contributions

All the authors took part in literature review, research and manuscript writing equally.

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