RESEARCH ARTICLE

Effect of mulch levels and irrigation deficit on onion (*Allium cepa L.*) yield and water productivity

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In water-scarce locations like the Rift Valley, increasing the water productivity of irrigated vegetation through agricultural water management is a critical choice. As a result, a subject study was carried out at Gewane Agricultural TVET College to assess the effects of deficit irrigation and straw mulching on onion yield, productivity, and water productivity (*Allium cepa L*). In three replications, the experiment was put out in a randomized complete block design with a factorial arrangement of three levels of irrigation (a hundred, eighty, and sixty percent of and others) and four ranges of straw mulch (0, 3, 6, and 9 ton wheat straw per ha). The Crop Wat model output revealed that the highest seasonal water need of onion was 422.5 mm at 100% ETc, while the lowest was 253.5 mm at 60% ETc. The analysis of variance revealed that there was a statistically significant ($p<0.05$) difference in growth parameters, and yield parameters were shockingly large ($p<0.01$) when the interaction results of deficit irrigation and straw mulch ranges were used. The highest marketable bulb yield (33.47 t/ha) was obtained from an experimental plot treated with a combination of 100 percent and 6 t/ha straw mulch, while the lowest (21.10 t/ha) was obtained from plots treated with 60 percent and no mulch treatment. The interaction results of deficit irrigation and straw mulching levels inspired enormously vast water productivity ($p<0.01$); the highest (10.22 kg/m^3) and lowest (6.11 kg/m^3) were recorded from plots treated with 60 percent ETc and 9 t/ha straw mulch, and 100 percent and many others and no mulch treatments, respectively. According to a partial budget analysis, the most economically advantageous combination for small-scale farmers with reduced production costs and better net benefits was the application of 80% ETc and 6 t/ha straw mulch. As a result, irrigating with 8% with 6 t/ha straw mulch would be recommended for onion production in the study region in terms of marketable bulb yield and water profitable productivity.

Key Words: *Deficit irrigation; Evapotranspiration; Marketable yield; Straw mulching*

INTRODUCTION

The onion (*Allium cepa L.*) is the most widely farmed species of the genus Allium, and it belongs to the Alliaceae family [1]. It is a monocotyledonous, cross-pollinated plant that ranks second in total vegetable vegetative production after tomato [2]. The total onion production in the globe is 742.51 million tons, with China producing 205.08 million tons and India producing 205.08 million tons. United States of America of the United States, 133.72 million tons Egypt has 33.21 million lots. Pakistan 17.01 million heaps, Iran 19.23 million heaps, Turkey 19.00 million tons, Brazil 15.56 million heaps, Russia 15.36 million heaps, and Republic of Korea 14.12 million heaps [3]. Water scarcity is a global issue due to the ever-increasing global population and the demand for additional water delivery through the industrial, municipal, and agricultural sectors, all of which put a strain on renewable water resources. The growing demand for water from the residential and industrial sectors is anticipated to diminish irrigation water availability.

The rift valley region is semi-arid, with limited water resources and a growing demand for water, which, along with high evapotranspiration rates, limits crop output and productivity. As a result, new options for making effective and efficient use of existing water resources must be investigated [4]. There may be a growing interest in irrigating using specific deficit irrigation stages to increase water productivity. Mulching is another agronomic technique for preserving soil moisture and lowering evaporation rates. Crop yield is expected to improve as a result of a combination of managed deficit watering and mulching. Mulching with straw, according to Zhang , et al. [5], reduced soil evaporation, improved water infiltration, and conserved soil moisture. Furthermore, straw mulching reduced irrigation water use by 30% and improved water efficiency [5]. This could be accomplished by using better cultural and water management techniques. By utilizing increased green use of soil moisture, straw mulch not only conserves soil moisture, but also raises soil warmth, reduces weed problems, and simulates better crop yields [6]. Although deficit irrigation and straw mulch have been shown to save scarce water, no research has been done in Ethiopia to employ floor irrigation in conjunction with surface covering for exclusive weather and crop under moisture shortage. As a result, this study was required in light of the current poor productivity and water scarcity.

Objectives

- To investigate the effect of deficit irrigation and straw mulch levels on growth, yield and yield components of onion.
- To evaluate the effect of deficit irrigation and straw mulch levels on water productivity and economic importance of onion.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted at the Gewane Agricultural TVET College experimental site all through 2018/19 (September to March). Gewane is located in the Afar region, approximately 350 kilometers east of Addis Ababa. The middle is located at 90° 16 'N and four hundred ninety-one "E, and at an altitude of 740 m.a.s.l.

Treatment and experimental design

Three levels of irrigation (100, 80, and 60% ETc.) and four levels of straw mulch are used in the treatments (0, 3, 6, and 9 tons of wheat straw according per ha). The experimental design evolved into a factorial, yielding twelve treatments. The irrigation water implemented in accordance with the computed crop water requirement with the resources of the CROPWAT application program is 100 percent of irrigation. The eighty percent and so on irrigation depths and the sixty percent ET irrigation depths, respectively, represented eighty percent and sixty percent of the overall irrigation requirement (Table 1).

TABLE 1
Description of treatments

Treatment No.	Treatment label	Description
T-1	DI100M0t	100% of ETc, No mulch
T-2	DI100M3t	100% of ETc, 3 t/ha straw mulch

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T-3	DI100M6t	100% of ETc, 6 t/ha straw mulch
T-4	DI100M9t	100% of ETc, 9 t/ha straw mulch
T-5	DI80M0	80% of ETc, No mulch
T-6	DI80M3t	80% of ETc, 3 t/ha straw mulch
T-7	DI80M6t	80% of ETc, 6 t/ha straw mulch
T-8	DI80M9t	80% of ETc, 9 t/ha straw mulch
T-9	DI60M0	60% of ETc, No mulch
T-10	DI60M3t	60% of ETc, 3 t/ha straw mulch
T-11	DI60M6t	60% of ETc, 6 t/ha straw mulch
T-12	DI60M9t	60% of ETc, 9 t/ha straw mulch

Note: T=treatments, ETc=Crop evapotranspiration, DI=deficit irrigation, M=straw mulch levels.

In three replications, the experiment was set up as a Randomized Whole Block Design (RWBD). After establishing order, the mulching procedure was carried out. Each experimental plot had a plot length of 5.4 m × 5 m to comprise 8 furrows of five m duration, with a spacing of 60 cm between ridges, and the middle six furrows were regarded the online plot from which the facts series was obtained. To cast off, the space between plots and replications is increased to 1.6 m and 3.6 m, respectively, affecting lateral sub-floor water motion. The distance between plants and rows is increased to 10 cm and 30 cm, respectively (Figure 1).

Yield parameters data collection

At harvest, the mean bulb weight (g) was calculated from ten randomly selected bulbs. Six bulbs each weighing 200 g were randomly taken from every plot and chopped into small 1-2 cm cubes, mixed very well, and two sub-samples each weighing 200 g were weighed. The precise weight of each sub-pattern changed is determined and recorded as fresh weight. A consistent dry count was obtained by placing each subsample in a paper bag and placing it in an oven until a consistent dry count was obtained. Sub-pattern was then straight away weighed and recorded as dry and counted yield.

The TSS was determined at harvesting time from ten randomly selected bulbs using Waskar, et al. [7] methods. The TSS is determined with the aid of a hand refract meter (ATAGO TC-1E) with various 0 to 320 Brix and resolutions of zero. 20 Brix by putting 1 to two drops of clean juice on the prism, washed with distilled water.

The lengths of ten randomly decided on bulbs according to plot had been measured from the lowest to the pinnacle using calipers and the suggested price had been computed.

Bulb diameter (cm)

The mean length of the bulb at harvest was calculated by measuring the diameters of ten randomly chosen bulbs in each plot with a caliper [8].

Marketable bulb yield (t/ha)

Bulbs which can be freed from mechanical, disease, and insect pest damage, are uniform in coloration, and range from medium to large in size (20-a hundred and sixty g) were taken into consideration as marketable yield. The weight of such bulbs, obtained from the net plot location of every plot, was measured in kilograms by the use of scaled balance and expressed as a ton consistent with a hectare [8].

Total bulb yield (t/ha)

The total onion yield was calculated by combining marketable and unmarketable bulb yields.

Productivity of crop water

Water productiveness was estimated as a ratio of marketable yield to total ETc. during the growing low season and was calculated using the following equation [9].

Yield response factor

The relationship between evapotranspiration deficit [1-(ETa/ETm)] and yield despair [1-(Ya/Ym)] is constant. The slope of this linear courting is called the yield response thing or crop response component (Ky) [10]. The Ky is defined as the lower yield in step with the unit decrease in ET.

Statistics analysis

The accumulated information was statistically analyzed appropriately for RCBD using the Statistical Analysis Device (SAS) model 9.0 statistical bundles and the method of widespread linear version (SAS, 2002) for the variance analysis. It suggests that comparisons have been completed using the Least Giant Distinction (LSD), while treatments display significant distinction to compare differences amongst treatments. Correlation (Pearson) evaluation was also used to see the association of onion growth parameters, yield element, yield and water productiveness.

RESULTS

Effect of deficit irrigation and straw mulch levels on onion yield

<u>Neck and bulb diameter:</u> Statistical evaluation revealed that deficit irrigation and straw mulching levels had a highly significant ($P<0.01$) influence on bulb neck diameter. The interaction effect of the two elements additionally had a tremendous ($p<0.01$). Onion bulb diameter was converted into a measurement to assess the quality of onions produced (Table 2).

<u>Length of the bulb:</u> The interaction effect of deficiency irrigation and straw mulching ranges had a widespread (p 0.05) effect on the bulb period of onion, according to statistical analysis of yield additives. The longest (4.28 cm) onion bulb duration was obtained from experimental plots treated with 80% and many others and nine t/ha straw mulching, and it had a non-full-size distinction with the combinations of one hundred percent and many others with 3, 6 and 9 t/ha straw mulching, 80% and many others with six and nine t/ha, and 60% and many others with three and nine t/ha straw mulching. The shortest (2.98 cm) came from plots treated with 60 percent and so on, and no mulch had a wide range of differences with 80 percent, ETc., and no mulch. That shows that larger onion sizes can be created when the applied water is top-rated and the moisture

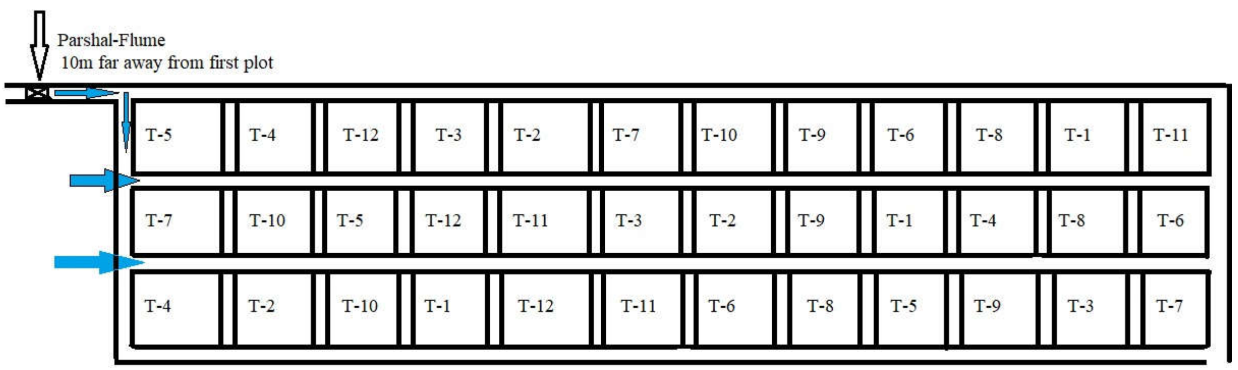

Figure 1) *Field layout of the experiment*

TABLE 2

Effects of deficit irrigation and straw mulching levels on neck diameter, bulb diameter and bulb length of onion

Deficit Irrigation	Neck diameter (cm)				Bulb diameter (cm)			
	Straw mulching levels (t/ha)							
	0	3	6	9	0	3	6	9
100% ETc	1.68^{cde}	1.80^{bc}	2.36^{a}	2.48^{a}	5.07^{g}	5.52^{def}	6.38^{a}	5.73^{cd}
80% ETc	1.48^{ef}	1.70^{cde}	1.97^{b}	1.88^{cb}	4.66^{h}	5.32^{efg}	6.20^{ab}	5.94^{bc}
60% ETc	1.25^{f}	1.50^{def}	1.74^{bcd}	1.82^{cb}	4.16^{i}	5.00^{gh}	5.17^{fg}	5.70^{cde}
LSD (5%)	0.26				0.4			
CV (%)	8.61				4.33			

Note: Different letters in a column indicate significant statistical differences; The probability level is 95% confidence. LSD (0.05)=Least Significant Difference at 5% level; CV (%)=Coefficient of variation.

TABLE 3

Effects of deficit irrigation and straw mulching levels on bulb length and average bulb weight of onion

Deficit Irrigation	Bulb length (cm)				Average bulb weight (g)			
	Straw mulching levels (t/ha)							
	0	3	6	9	0	3	6	9
100% ETc	3.54^{d}	4.06^{ab}	4.20^{ab}	4.03^{ab}	85.89^{ef}	90.09^{d}	106.69^{a}	97.11^{bc}
80% ETc	3.20^{e}	3.77^{cd}	4.08^{ab}	4.28^{a}	81.79^{gh}	87.92^{de}	98.68^{b}	97.77^{cb}
60% ETc	2.98^{e}	4.03^{ab}	4.00^{cb}	4.26^{a}	78.91^{h}	83.51^{fg}	84.42^{fg}	95.25^{c}
LSD (5%)	0.25				2.95			
CV (%)	3.85				1.92			

Note: Different letters in a column indicate significant statistical differences; probability level is 95% confidence. LSD (0.05)=Least Significant Difference at 5% level; CV (%)=Coefficient of variation.

pressure has a negative impact on the onion size (Table 3).

The average weight of a bulb: The interaction effect of deficit irrigation and straw mulching levels significantly (p 0.01) affected the average bulb weight of onion, with a coefficient of determination of 0.97, indicating a direct relationship between deficit irrigation and straw mulching levels and the common bulb weight, according to a statistical analysis of yield additives. The treatment that received the best supply of water (100 percent and so on) and six t/ha of straw mulch produced the best average bulb weight of 106.69 g, while those that received the least amount of water (60 percent and so on) and no mulch treatments produced a minimum common bulb weight of 78.91 g.

Soluble solids total: The effect of deficiency watering and straw mulching levels on the total soluble solids (TSS) of the onion was widespread (p 0.05). However, the total solids of the onion did not differ much when the deficit irrigation and straw mulching levels were combined in application. This will most likely be owing to the difficulty of assimilation and accumulating in bulbs under pressure (Table 4).

Bulb yield that can be sold: The interaction impact of deficit watering *via* straw mulching levels had a very large (P 0.01) effect on the marketable yield, according to the analysis of variance and so on. The highest marketable yield of onion (33.47 t/ha) was obtained with a combination of 100% and many other irrigation methods, as well as six t/ha of straw mulch, which was not statistically significant with 80% and so on. The lowest commercial yield (21.10 t/ha) came from treatment, which received 60%, and so on, but no mulch. Marketable bulb production improves by 11 percent, 26 percent, and 14 percent over non-mulch treatment as the extent of straw mulch increases from 3, 6, and 9 t/ha, irrespective of growing irrigation stages, for example, at 80 percent. The rise in the production of growth measures, enabling faster synthesis and delivery of photosynthetic supply to descent, is likely the reason for marketable onion bulbs at better watering stages. Furthermore, according to Singh and Singh (2018), an increase in irrigation regimes and the use of residue mulching increases onion bulb production (t/ha) significantly. Total bulb output: The interaction impact of deficit watering and straw mulching degrees resulted in a significant (P.01) variation in overall onion production, according to the analysis of variance (Table 5).

Deficit irrigation and straw mulch's effects on water productivity: The analysis of variance revealed that the interaction between deficit irrigation and straw mulching degrees significantly ($p<0.05$) influenced Water Productiveness (WP), with deficit irrigation and straw mulching stages having a particularly high ($p<0.01$) impact on onion WP. The application of 60 percent and many other deficit irrigation and 9 t/ha straw mulch produced the maximum WP (10.22 kg/m^3). It is, however, not particularly noteworthy from the application of 60 percent and so on, as well as six t/ha straw mulch. In comparison to the other deficit irrigation ranges, the experimental plot managed with 60% and so on produced quality WP (9.34 kg/m^3).

The maximum WP (8.93 kg/m^3) was obtained with a straw mulching range of 6 t/ha. The lowest irrigation WP (6.11 kg/m^3) came from the application of a hundred percent, ETc., and did not include mulch because the difference between a hundred percent, ETc., and three t/ha straw mulch application was insignificant (Table 6).

There is a positive relationship between growth, yield, and yield additives: Table 7 shows the computed values of the correlation coefficient (r) between growth, yield, and yield additives. The correlation coefficient values revealed that there was a link between the crop factors and the value and course of affiliation. As a result, all growth parameters, such as days to maturity (r=0.73), plant peak (r=0.77), leaf period (r=0; 69), range of leaves consistent with plant (r=0.88), and leaf diameter (r=0; 66), had a strong (p 0.01) link with marketable bulb production. Furthermore, yield parameters such as neck diameter (r=0.79), bulb diameter (r=0.84), bulb duration (r=0.59), common bulb weight (r=0.9), total soluble solids (r=0.48), bulb dry matter content (r=0.74), and general bulb yield (r=1) had a positively robust and incredibly large (p 0.01) correlation with marketable bulb yield. This suggests that applying deficit watering and straw mulching to onions boosted bulb production by positively altering key yield components. Furthermore, bulb dry matter content (r=0.74), bulb length (r=0.66), plant height (r=0.66), number of leaves per plant (r=0.69), and average bulb weight (r=0.84) all demonstrated a positive and highly significant link. The fact that the yield parameters have a positive and significant connection suggests that the ultimate yield is directly influenced by their values. Except for water productivity, all growth and yield indices were positively and strongly associated.

Effects of deficit irrigation and straw mulching levels on yield response factor: Table 8 shows the response of onion yield to water supply as measured by the yield response factor (Ky). The Ky values ranged from 0.35 to 1.5, with the maximum being achieved with 80 percent ETc and no mulch and the lowest being achieved with 80 percent ETc and 6 t/ha of straw mulching. The yield response factor varies based on the crop variety and deficit condition, according

TABLE 4

Effect of deficit irrigation and straw mulching levels on total soluble solids and bulb dry matter of onion

Treatment	Parameters	
Deficit Irrigation	**Total Soluble Solids (o brix)**	**Bulb dry matter (g)**
100% ETc	13.15^{a}	15.37^{a}
80% ETc	12.17^{b}	15.05^{a}
60% ETc	11.61^{b}	13.82^{b}
LSD (5%)	0.86	0.76
Straw Mulching Levels (t/ha)		
0	11.37^{b}	13.35^{b}
3	12.26^{ab}	14.94^{a}
6	12.98^{a}	15.66^{a}
9	12.62^{a}	15.02^{a}
LSD (5%)	1	0.87
CV (%)	3.02	6.05

Note: Different letters in a column indicate significant statistical differences; probability level is 95% confidence. LSD (0.05)=Least Significant Difference at 5% level; CV (%)=Coefficient of variation.

TABLE 5

Effects of deficit irrigation and straw mulching levels on marketable bulb yield and total bulb yield of onion

Deficit Irrigation	Marketable bulb yield (t/ha)				Total bulb yield (t/ha)			
	Straw mulching levels (t/ha)							
	0	3	6	9	0	3	6	9
100% ETc	25.80^{cd}	26.77^{c}	33.47^{a}	29.64^{b}	27.08^{cd}	28.41^{c}	34.71^{a}	30.72^{b}
80% ETc	23.36^{e}	26.37^{cd}	31.57^{ab}	27.19^{c}	24.46^{e}	27.23^{c}	32.52^{b}	28.11^{c}
60% ETc	21.10^{f}	23.23^{e}	24.53^{de}	25.90^{cd}	21.99^{f}	24.47^{e}	25.33^{de}	26.90^{cd}
LSD (5%)	1.94				1.88			
CV (%)	4.32				4.02			

Note: Different letters in a column indicate significant statistical differences; probability level is 95% confidence. LSD (0.05)=Least Significant Difference at 5% level; CV (%)=Coefficient of variation.

TABLE 6

Water productivity and irrigation water saved of deficit irrigation and straw mulching levels of onion

Treatments	WP,	Water saved, %	Yield reduction, %	Additional area to be cultivated (ha) by saved	Additional yield (t/ha) that can be produced as result of
	kg/m^{3}			water	saved water
T – 1	6.11^{f}	0	22.9	0	0
T – 2	6.34^{e}	0	20.01	0	0
T – 3	7.92^{c}	0	0	0	0
T – 4	7.01^{d}	0	11.45	0	0
T – 5	6.91^{de}	20	30.2	0.2	6.994
T – 6	7.80^{c}	20	21.2	0.2	6.994
T – 7	9.34^{b}	20	5.67	0.2	6.994
T – 8	8.04^{c}	20	18.76	0.2	6.994
T – 9	8.32^{c}	40	36.95	0.4	13.388
T – 10	9.16^{b}	40	30.6	0.4	13.388
T – 11	9.68^{ab}	40	26.69	0.4	13.388
T – 12	10.22^{a}	40	22.62	0.4	13.388
LSD(0.05)	0.59				
CV (%)	4.33				

Note: Different letters in a column indicate significant statistical differences; probability level is 95% confidence. LSD (0.05)=Least Significant Difference at 5% level; CV (%)=Coefficient of variation.

TABLE 7

Pearson's correlation coefficient (r) of growth and yield parameters of onions as influenced by deficit irrigation and straw mulching levels

	Dtm	Phgt	LLgth	NoLplt	Ldmtr	Nedmr	AvBW	Blgth	Bdtr	TSS	BDM	MYld	Tyld	WP
Dtm	1	0.91**	0.85**	0.85**	0.80**	0.89**	0.77**	0.71**	0.77**	0.45*	0.58**	0.73**	0.73**	0.01ns
Phgt		1	0.88**	0.89**	0.87**	0.87**	0.87**	0.78**	0.87**	0.46*	0.66**	0.77**	0.77**	0.10ns
LLgth			1	0.83**	0.81**	0.75**	0.77**	0.72**	0.77**	0.51**	0.58**	0.69**	0.68**	0.11ns
NoLplt				1	0.82**	0.89**	0.86**	0.68**	0.86**	0.38*	0.68**	0.88**	0.87**	0.04ns
Ldmtr					1	0.79**	0.73**	0.76**	0.81**	0.47**	0.53**	0.66**	0.65**	0.18ns

Nedmr	1	0.77**	0.58**	0.77**	0.47*	0.57**	0.79**	0.79**	-0.10ns
AvBW		1	0.72**	0.87**	0.45*	0.74**	0.90**	0.90**	0.10ns
Blgth			1	0.78**	0.28ns	0.66**	0.58**	0.58**	0.33*
Bdtr				1	0.45*	0.74**	0.84**	0.83**	0.11ns
TSS					1	0.42**	0.48**	0.49**	-0.09ns
BDM						1	0.74**	0.75**	-0.03ns
MYld Tyld							1	1.00**	-0.01ns
								1	-0.04ns
WP									1

Note: Dtm=Days to maturity (days), Phgt=Plant height (cm), LLgth=Leaf length (cm), NoLplt=Number of leaf per plant, Ldmtr=Leaf diameter (cm), Nedmr=Neck diameter (cm), AvBW=Average bulb weight (g), Blgth=Bulb length (cm), Bdtr=bulb diameter (cm), TSS=Total Soluble Solids (obrix), BDM=bulb dry matter (%), MYld=Marketable bulb yield (t/ha), Tyld=Total bulb yield (t/ha), WP=water productivity.* significant, ** highly significant.

TABLE 8

Effects of deficit irrigation and straw mulching levels on yield response factor of onion

Treatments	Yield (kg/ha)	ETa (mm)	ETa ETm	Ya Ym	1 − ETa ETm	Ya Ym	Ky=Ym ETa (1−ETm)
T-1	25803.3	422.5	1	0.77	0	0.23	-
T-2	26770.7	422.5	1	0.8	0	0.20	-
T-3	33466.7	422.5	1	1	0	0.00	-
T-4	29635.7	422.5	1	0.89	0	0.11	-
T-5	23358.9	338	0.8	0.7	0.2	0.30	1.5
T-6	26373.3	338	0.8	0.79	0.2	0.21	1.06
T-7	31106.7	338	0.8	0.93	0.2	0.07	0.35
T-8	27186.7	338	0.8	0.81	0.2	0.19	0.94
T-9	21100.1	253.5	0.6	0.63	0.4	0.37	0.92
T-10	23225.6	253.5	0.6	0.69	0.4	0.31	0.77
T-11	24533.3	253.5	0.6	0.73	0.4	0.27	0.67
T-12	25896.7	253.5	0.6	0.77	0.4	0.23	0.57

Note: T=Treatment, DI=deficit irrigation, SML=straw mulching levels, ETa=actualevapotranspiration, ETm=maximum evapotranspiration, Ya=actual yield, Ym=maximum yield.

to several studies. The off-seasonal Ky of onion was reported to be 1.28 [11], while the limit was 1.1 [12].

The experiment's findings revealed that deficit watering and straw mulch level treatments had an impact on onion yield. When Ky>1, the crop reaction to water deficit could be very sensitive, with proportional larger yield reductions; Ky 1, the crop is more tolerant of water deficit and recovers partially from strain, showing much less than proportional yield discounts with reduced water use; Ky=1, the yield discount is directly proportional to decreased water use; Ky=1, the yield discount is directly proportional to decreased water use; Ky=1, the yield discount is directly proportional to decreased water use; Ky=1, the yield discount is directly proportional to decreased water use [12]. In comparison to the alternate deficit irrigation and straw mulch ranges, applying 80 percent ETc. and without utilizing mulch resulted in a reported reduced yield (Ky=1.5%).

DISCUSSION

The treatment of 100% ETc in combination with 6 t/ha straw mulch resulted in the largest onion bulb diameter of 6.38 cm and had no discernible difference from the application of 80% ETc and 6 t/ha straw mulch. This is likely due to the fact that a sufficient amount of soil moisture results in a greater photosynthetic area (plant height and a large variety of leaves), resulting in a giant bulb diameter. According to Ayas, et al. [13], 60 percent of irrigation applications transformed the smallest bulb length (4.16 cm) into a record, and many others did not use mulch treatment.

This result was consistent with a study conducted by, which found that the bulb diameter had improved considerably with increasing irrigation input levels. According to Mubarak and Hamdan (2018)'s fashion analysis, bulb diameter was linearly related to irrigation levels (as a percentage of and so on), with R2 values of 0.998 and 0.994 at the 1% level, respectively, below mulch and no-mulch. Regardless of the dirt cowl device utilized, the maximum diameter was recorded at 100 percent and so on, and the lowest cost was recorded at 60 percent and so on, with an incredible lower of around 40%. The results suggested that the lower irrigation intensity may have lowered transpiration, photosynthesis, and assimilate available for crop growth, prompting the supply of undersized bulbs. This finding is similar to that of de Santa Olalla, et al. [14], who found smaller bulbs in somewhat water-stressed onion flora. Furthermore, Neeraja, et al. [15] claimed that a higher level of irrigation (1.2 IW: CPE) terminated most bulb lifetimes.

Weight loss was dramatically reduced in trendy areas when irrigation was limited, which is likely due to water restrictions. This implies that the crop was reacting to the lack of water, and that as the amount of water applied increased, so did the average weight of onion bulbs. The increase in bulb weight as the irrigation and straw mulch stages progress could be due to the development of larger blooms with a wider variety of leaves, resulting in increased assimilate synthesis and movement from supply to sinks [6], observed a similar finding, stating that the Total Soluble Solids (TSS) of onion increased with the increase in irrigation from 0.50 to at least 1.10 of capability evaporation. This finding is also in line with Patel and Rajput (2013), who discovered that the TSS of onion fluctuates depending on the irrigation degree version at different growth stages Igbadun , et al. [16]. The maximum TSS (13.0 brix) was reported from application of 6 t/ha straw mulching and did not alter much with any of the mulch degrees, except without mulch. The lowest TSS rate changed from recorded to no mulch treatment, with no discernible difference when compared to 3 t/straw mulch. While experimenting with peanut production, Khan, et al. [17] also emphasized the positive impact of soil surface control through mulching.

According to [14], the dry count number yield in drip irrigation equipment is unaffected by the volume of water intake (with volumes ranging from 603.1 to 772.0 mm). The maximum TSS (13.0 brix) was reported from application of 6 t/ha straw mulching and did not alter much with any of the mulch degrees, except without mulch. The lowest TSS rate changed from recorded to no mulch treatment, with no discernible difference when compared to 3t/straw mulch. While experimenting with peanut production, [17] also emphasized the positive impact of soil surface control through mulching.

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772.0 mm). The experimental plots that were not treated with mulch had the lowest value (13.35 g).

The experimental plots received a better marketable bulb output of 31.57 t/ha after being treated with 8% percent and so on, as well as six t/ha of straw mulching. However, in comparison to 100% and so with 6t/ha straw mulch, this treatment saved 20% (84.5%), and the yield reduction due to water deficit was 5.67 percent (1.90 t/ha) (Table 4), with 20% (84.5%) saved water, 0.2 ha of land could be irrigated, yielding 6.69 t/ha of marketable bulb yield (Table 4). That's more than the highest marketable yield (33.47 t/ha) obtained with a 100% mulch application and so on with the same degree of mulch. As a result, irrigation is an alternate option for improving productivity per unit of water implemented in locations where water is precious and land is scarce. This is most likely due to the favorable conditions for onion plant growth created by the use of the most effective straw mulch in conjunction with increased irrigation levels, which may have also contributed to the maximum commercial yield being produced.

As soil moisture stress diminishes, the trend for mean marketable yield suggests that it will increase dramatically. This will be due to the variation in irrigation water depth carried out. The increase in marketable yield as the number of irrigation levels improved is similar to Habtie Honelign, [18] previous paintings, which showed that yield reduction was linked to an increase in soil moisture tension, which, if left unchecked, resulted in turgidity loss, growth cessation, and yield discount [19]. Also obtained a maximum commercial yield of onion bulbs by using water depths corresponding to 100 percent and others, as opposed to 75% and others, and acting irrigation control with magnificence a pan and without the use of mulch. According to current findings, [16] said that with managed deficit watering; onion bulb yield has reduced substantially [20]. Found similar results, confirming that increased water productivity is closely linked to the irrigation practice of regulated deficit irrigation and has an immediate influence on marketable bulb yield. This is because reducing the amount of water sprayed will result in a decreased crop yield. Furthermore, the increase in marketable bulb output due to the use of straw and irrigation water could be linked to increased vegetative growth and assimilates production. The increase in leaf area index, bulb diameter, and average bulb weight is linked to this.

The increase in onion total bulb output is most likely due to the huge size of the onion bulb caused by excessive watering. This is because it promotes mobile elongation, above-floor vegetative growth, and gives the leaves a dark green hue, all of which are important for increased assimilate production and partition, which supports onion bulb growth. The higher performance on vegetative growth like plant peak, wide variety of leaves, and leaf period, which increase the photosynthetic capacity of the plant, which in turn can enhance bulb weight and contribute to the increase in overall bulb yield, could be attributed to the increased overall bulb yield by applying full (no deficit) irrigation. The overall bulb yields improved as the irrigation stage was increased from 60 percent and many others to 100 percent and so on.

Larger water productivity was achieved with higher deficit irrigation treatments. This finding agrees with Samson and Ketema (2007), who found that deficit irrigation increased onion water productivity. WP was significantly higher for straw mulching levels at every irrigation tier, according to the imply values of WP. For example, application of 60% and so on with 0, 3, 6, and 9 t/ha straw mulching proved an increasing price of WP that was eight 0.32, 9.16, 9.68 and 10.22 kg/m^3, respectively, and additionally, the identical for the other deficit stages. If enough water is applied for the duration of the crop cycle, the crop will now not absolutely broaden, resulting in low yield and better water productiveness. And crop yield and water productivity may be improved if a vast quantity of water is introduced. Also, because the irrigation depth and straw mulching degree fluctuate, the yield and water production also vary. This finding is in line with Mubarak and Hamdan (2018), who found that even at full irrigation, WP was considerably higher for mulched treatments than for non-mulched treatments (100 percent). This suggests that by cultivating the irrigated regions with the saved water, any yield loss due to deficit irrigation might be compensated for. In this situation, the crop water need below (100 percent, ETc.) was around 422.5 mm, and below 60 percent, ETc., was about 253.5 mm on average. The water saved, which amounts to about 169 mm (422.5-253.5=169 mm), can be utilized to irrigate 0.4 ha of onion grown land or a similar crop, resulting in a 13.388 t/ha increase in yield. The final result concurred with Patel and Rajput (2013), who stated that using 40% DI during the developing off-season, water savings of roughly 272 mm could be used to irrigate an additional half-hectare of cropped land. Metwally (2011) found that plant top and bulb diameter had a huge and extensive link with bulb production in a similar study. According to Abd El-Hady , et al. [21,22], there is a significant and high-quality relationship between bulb diameter and bulb yield.

CONCLUSION

The application of eighty percent and so on and six t/ha straw mulching (T-7) treatment produced the most economically appealing aggregate for small-scale farmers, with a cheap cost of production and improved net advantages. Over manipulative treatment (a hundred percent and so on without mulch), experimental plots treated with a hundred percent, ETc., and eighty percent and so on with the same degree of straw mulch (6 t/ha) had an overall gain of 32279.42 birr (19%) and 21530.26 birr (14%), respectively. However, application of 100%, ETc., and six t/ha straw mulch (T-three) becomes profitable with higher value and maximum online advantage for resource complete producers (traders), and can be supported as a second-exceptional choice. Therefore, from the above outcomes, we have concluded that the deficit irrigation and straw mulch degrees exerted sizable effective consequences on the growth, yield, and crop water productivities of the onion crop. Mulching with 3 and 6 t/ha gave a yield increase of about 3.633 and 22.9% as compared to the non-mulched treatment under better irrigation (a hundred percent and so forth). With the aid of application, a greater bulb yield reduction of 30.6 and 36.95% was achieved, with the aid of which many others without mulch treatments. Deficit irrigation with straw mulch levels gave better water productivity as compared to non-mulched conditions. The water productiveness was discovered to be the best (10.22 kg/m^3) in 60% ETc. with the nine-t/ha straw mulched treatment. However, a higher yield discount (22.62%) was acquired similar to this treatment. Therefore, in terms of marketable bulb yield, water productiveness, and economic significance, irrigating with 8% percent and so forth with 6 t/ha straw mulch can be advised for the production of onions. As a result of the foregoing findings, we have determined that the deficit irrigation and straw mulch degrees had significant effects on onion crop growth, yield, and crop water productivity. Mulching with 3 and 6 t/ha increased yield by around 3.633 and 22.9 percent, respectively, when compared to the non-mulched treatment with better watering (a hundred percent and so forth). With the use of application, a bigger bulb production reduction of 30.6 and 36.95 percent was achieved, and many others without mulch solutions were able to benefit as well. In comparison to non-mulched settings, deficit irrigation with low straw mulch levels resulted in higher water productivity. With the nine-t/ha straw mulched treatment, the water productiveness was found to be the best (10.22 kg/m^3) in 60 percent ETc. Similar to this treatment, however, a greater yield discount (22.62 percent) was obtained. As a result, irrigating with 8% percent and so forth with 6 t/ha straw mulch can be recommended for onion production in terms of marketable bulb yield, water productiveness, and economic significance.

REFERENCES

1. Megersa GH. Onion (*Allium cepa L.*) yield improvement progress in Ethiopia: A review. Int J Agric Biol. 2017;6(5):265-271.
2. Berhanu MA, Berhanu GA. Constraints of onion (*Alluim cepa. var. cepa L.*) yield production and food preference to shallot (*Alluim cepa. var. aggregatum*) in the case of Bibugn Woreda, Amhara Regional State, Ethiopia. Constraints. 2014;32.
3. FAO (Food and Agricultural Organization) 2012. Major Food and Agricultural Commodities and Producers -Countries by Commodity. Food and Agriculture Organization of the United Nations.
4. Enchalew B, Gebre SL, Rabo M, et al. Effect of deficit irrigation on water productivity of onion (*Allium cepa L.*) under drip irrigation. J Irrig Drain Eng. 2016;5(172):2.
5. Zhang Q, Wang S, Li L, et al. Effects of mulching and sub-surface irrigation on vine growth, berry sugar content and water use of grapevines. Agric. Water Manag. 2014;143:1-8.
6. Biswas SK, Sarker PK, Islam AM, et al. Effect of irrigation on onion production. Pak J Biol Sci . 2003.
7. Waskar DP, Khedkar RM, Garande VK. Effect of post-harvest treatments on shelf life and quality of pomegranate in evaporative cool chamber and ambient conditions. J Food Sci Technol. 1999;36(2):114-117.
8. Dessalegn L, Aklilu S. 2003. Research results and experiences in onion dry bulb and seed production in Ethiopia. Vegetable crops improvement research, EARO, Melkassa Agricultural Research Centre. p39.
9. Zwart SJ, Bastiaanssen WG. Review of measured crop water productivity values for irrigated wheat, rice, cotton and maize. Agric Water Manag. 2004;69(2):115-133.

10. Kirda C, Çetin M, Dasgan Y, et al. Yield response of greenhouse grown tomato to partial root drying and conventional deficit irrigation. Agric Water Manag. 2004;69(3):191-201.

11. Kipkorir EC, Raes D, Massawe B. Seasonal water production functions and yield response factors for maize and onion in Perkerra, Kenya. Agric Water Manag. 2002;56(3):229-240.

12. Doorenbos J, Kassam AH. Yield response to water. Irrig Drain. 1979;33:257.

13. Ayas S, Demirtaş Ç. Deficit irrigation effects on onion (Allium cepa LET Grano 502) yield in unheated greenhouse condition. J Food Agric Environ. 2009;7(3/4):239-243.

14. de Santa Olalla FM, Domınguez-Padilla A, Lopez R. Production and quality of the onion crop (*Allium cepa L.*) cultivated under controlled deficit irrigation conditions in a semi-arid climate. Agric Water Manag. 2004;68(1):77-89.

15. Neeraja G, Reddy KM, Reddy IP, et al. Effect of irrigation and nitrogen on growth, yield and yield attributes of rabi onion (*Allium cepa L.*) in Andhra Pradesh. 1999.

16. Igbadun HE, Ramalan AA, Oiganji E. Effects of regulated deficit irrigation and mulch on yield, water use and crop water productivity of onion in Samaru, Nigeria. Agric Water Manag. 2012;109:162-169.

17. Khan AR, Rahman A, Singh RD. Influence of soil surface manipulation on soil temperature in relation to peanut production. J Nat Appl Sci. 2013;5(1):53-57.

18. Habtie Honelign, 2007. Comparison of different Irrigation Scheduling Methods for Tomato (*Lycopersicum esculentum L.*) Production in Libo kemkem Woreda South Gondar Zone. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

19. Carvalho DF, Ribeiro EC, Gomes DP. Marketable yield of onion under different irrigation depths, with and without mulch. Rev Bras de Eng. 2018;22:107-112.

20. Kloss S, Pushpalatha R, Kamoyo KJ, et al. Evaluation of crop models for simulating and optimizing deficit irrigation systems in arid and semi-arid countries under climate variability. Water Resour Manag. 2012 ;26(4):997-1014.

21. Abd El-Hady EM, Eldardiry I, Abou-El-Kheir MS, et al. Effect of deficit irrigation on yield and water productivity of onion (*Allium cepa L.*) under different lateral length. GARJAS. 2015;4(11):796-802.

22. Nagaz K, Masmoudi MM, Ben Mechlia N. Yield response of drip-irrigated onion under full and deficit irrigation with saline water in arid regions of Tunisia. Int Sch Res Notices. 2012.