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Effects of Mulching and Amount of Water on Yield and Yield Components of Tomato under Drip Irrigation at Adola Rede District, Southern Ethiopia

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Abstract
Water has been recognized as one of the scarcest inputs, which can severely avoid agricultural production and productivity unless it is carefully conserved and managed. This study has investigated the effects of mulching and amount of water on yield and yield components of tomato (*Solanum Lycopersicum* L.) under drip irrigation at Adola rede District, Southern Ethiopia. The treatments of the study involved combination of three drip irrigation levels (100, 75, and 50% of crop water requirement, ETc) and three mulches (No mulch, white polyethylene sheet, and wheat straw). The yield and yield components in the mulched treatment with excessive stages of irrigation have been considerably higher in compared to these in the unmulched treatments. The yield of tomatoes increased with the growing quantity of irrigation water in mulched treatments. The highest marketable fruit yield for each mulch (35478kg ha^{-1} for white mulch and 28831kg ha^{-1} for straw mulch) was obtained when 75% of the crop water requirement used to be applied. With 100% water application, the white plastic mulched treatment produced a decrease marketable fruit yield than the straw-mulched treatment. The best water productivity of (12.915kg m^{-3}) was received with 75% water application under white plastic mulch, But statistically non-significant with straw mulch under 75% crop water requirement application. The highest net benefit of 563475.7ETB ha^{-1} was recorded from white plastic mulch with 75% ETc and followed by 484454.7ETB ha^{-1} with Straw mulch with 75% ETc. The lowest net advantage 285477.3ETB ha^{-1} was acquired from no mulch with 50% ETc. The lowest net benefit to cost ratio was gained under treatment straw mulch with 75% ETc (15.04) and followed by no mulch with 100% ETc (14.32). This end result showed that wheat straw mulch with 75% ETc is economically feasible for tomato production in the Adola area of the Guji zone.
Keywords: Crop Water Requirement, Tomato, Drip, Mulching, Water Levels, Marketable Fruit Yield
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1. INTRODUCTION

Agriculture is the primary water-consuming area worldwide, which accounts for 70 percentage of all water withdrawn from aquifers, streams, and lakes [7]. The world expansion of irrigated areas to feed the ever-increasing population and the restricted availability of irrigation water are not balanced in different components of the world. Rivers, lakes, groundwater, and different streams are dried due to unbalance between the inflow and outflow of water in the hydrologic cycle of that particular area. In arid and semi-arid areas the place moisture stress is the predominant venture for crop production, the spatial and temporal versions aggravate the problem.

Mulching practices have stated values on improving water use efficiency (WUE). [8] Stated that both plastic and straw mulches increased the water use efficiency by means of 79% and 58%, respectively, in contrast to bare soil. Based on six years of experiments on rice plants in China, [23] found that the crop water use efficiency was improved with the by 70 to 80% and irrigation water use efficiency by 274% when the crop used to be raised under the plastic film mulch conditions compared to the normal planting. Alongside the viable advantages of soil water conservation, higher yield, and greater water use efficiency, mulching additionally controls weed infestation [10], improves soil texture [13], improves aeration, modify soil temperature [15], checking surface sealing and crusting of soil through defending the topsoil surface from raindrop splashes [3], reducing nutrient losses and enlarge the infiltration charge [9], and make bigger sediment deposition through improving roughness of soil surface [6].

Drip irrigation is an irrigation method that permits exactly managed utility of water and fertilizer by allowing water to drip slowly close to the plant roots through a network of valves, pipes, tubing, and emitters [18]. According to [11], drip irrigation is one of latest of the systems and is becoming more and more famous in areas with water scarcity and salt problems. Water from the source passes through plastic pipes, constituting the essential and laterals, into emitters located to furnish each plant with the calculated water requirement at the same delivery rate. Pressure head losses are encountered in stresses which result in uneven distribution of the discharges from the emitters. [12] Reiterated that the most broadly commonplace hydraulic overall performance indices for assessing the drip irrigation device are emitter discharge, emitter flow value variation, uniformity coefficient, and emission uniformity.

Tomato (Lycopersicon esculentum Mill.) is one of the most frequent plants belonging to the nightshade family, Solanaceae. The fruit is ate up in various ways, consisting of raw, as an ingredient in many dishes, sauces, and drinks. Tomatoes are rich in Vitamins A and B, and iron. Moreover, tomatoes are wealthy sources of lycopene, which is a very powerful antioxidant and helps stop the development of many varieties of most cancers [25]. Tomato plant life are sensitive to water stress and exhibit an excessive correlation between evapotranspiration and crop yield [14].

Farmers in the study area produce vegetation particularly Tomato one time per dry season by using traditional furrow irrigation technique for their consumption and market sales. But due to the shortage of irrigation water, its production and land productiveness is reduced and there is struggle amongst irrigators. The most important reasons for the shortage of water are an inefficient use of irrigation water as an end result of excessive percolation loss, runoff loss, and excessive evaporation loss which is caused due to over-irrigation resulting in low water use efficiency. Shortage of capital and new technologies are the major constraints in region to put into effect and use modern irrigation strategies (especially, drip irrigation method) with water loss minimizing methods.

Numerous kinds of lookup have been carried out to consider the overall performance of drip irrigation below mulching practices in Ethiopia [20, 22]. However, no work has been performed to find out about the combined impact of mulching and amount of water on yield and water use efficiency of tomatoes in the study area. Therefore, the goal of this study was to investigate the mixed results of mulching and the amount of water on yield and water use efficiency of tomato (*Solanum Lycopersicum* L.) under drip irrigation.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

The experiment was conducted at Adola rede District of Guji zone, Oromia Regional State in the 2019 and 2020/21 during off season from December to March. Adola rede District is one of the most important tomato-producing areas of the region. Adola rede District is located between 5°44'10”- 6°12'38” northing latitudes and 38°45'10”- 39°12'37” easting longitudes and at an altitude of 1500-2000 meters above sea level. The long-term (thirty years) mean annual rainfall of the study area was 1126.0 mm with a maximum and minimum temperature of 21.4°C to 28.5°C and 9.9°C to 15.0°C respectively.

2.2. Climatic Characteristics

The average monthly climatic data of the study area (Maximum and minimal temperature, relative humidity, wind speed, and sunshine hours) were collected from the close to meteorological station. The potential evapotranspiration (ETO) was estimated using CROPWAT software.

Table 1. *Long-term (2004-2018) monthly climatic data of the experimental area.*

Month	T_{min} (°C)	T_{max} (°C)	RH (%)	Wind speed (m/s)	Sunshine hour (hr)	ETo (mm/day)
January	9.5	29.5	49.1	0.4	7.9	3.17
February	11.0	30.4	47.1	0.5	7.6	3.4
March	13.7	30.0	52.1	0.4	7.0	3.6
April	15.5	27.5	61.4	0.3	5.6	3.36
May	16.2	25.8	73.0	0.3	5.1	3.18
June	14.4	24.0	71.1	6.2	3.3	2.63
July	14.0	22.9	71.1	0.5	2.3	2.34
August	13.9	24.0	72.9	0.4	3.8	2.74
September	14.1	26.0	70.5	0.4	4.8	3.08
October	14.2	25.5	73.6	0.5	4.3	2.9
November	12.4	26.2	68.5	0.5	6.5	3.12
December	10.4	27.0	59.4	0.3	7.6	3.08
Average	13.3	26.6	64.2	0.9	5.5	3.05

Source: National meteorological station, (Tmin= Minimum temperature, Tmax= Maximum temperature, RH= Relative humidity, ETO = Reference Evapotranspiration)

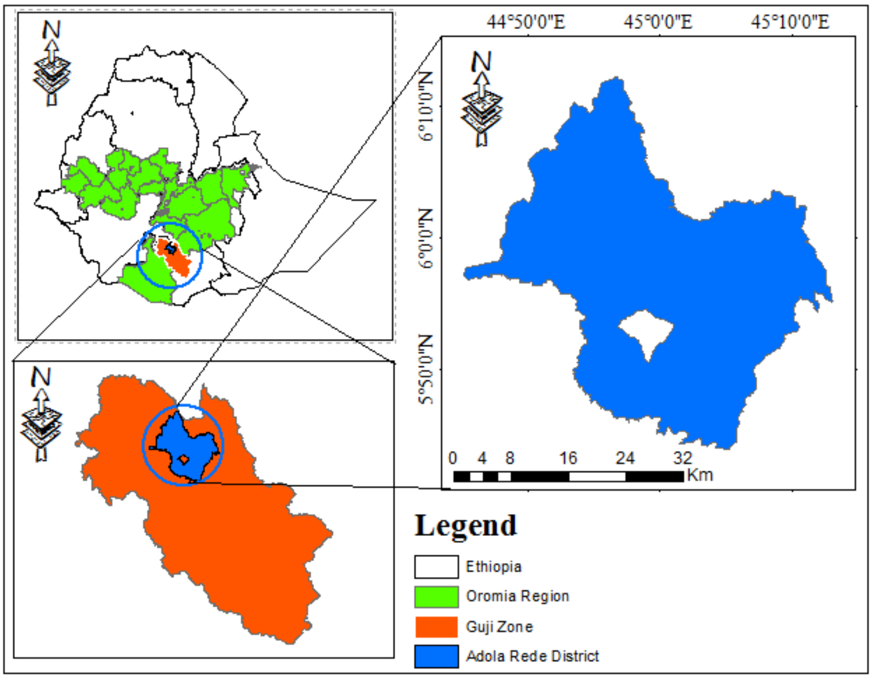

Figure 1. *Map of the study area.*

2.3. Soil Sampling

To characterize the soil of the experimental field, a representative composite soil sample was taken using an auger from the entire experimental field earlier to planting at two depths, 0-30 cm, and 30-60cm. These samples have been randomly collected from eight different locations of the experimental field in a zigzag manner and combined to form a representative sample. From these samples, chosen soil chemical parameters (pH, total N, available P, OC, OM, and EC) and physical parameters (Texture, Bulk density, FC, and PWP) have been analyzed following well known methods at the Engineering Corporation of Oromia. The core sample volume was known and the oven-dry weight was computed, and the soil bulk density was determined by dividing the soil dry mass by means of the volume of the core sample using the following equation.

$$Pb = Ws/Vc \quad (1)$$

where: - Pb is soil bulk-density (g/cm^3), Ws is mass of dry soil (g) and Vc is the extent of soil in the core (cm^3).

2.4. Experimental Design and Area Management

The experiment has conducted with three level of irrigation applications, full irrigation (100% ETc), ¾ irrigation (75% ETc), and half irrigation (50% ETc), and three mulching materials No Mulch (NM), Straw Mulch (SM), and white Plastic Mulch (WPM) (Figure 2). Control irrigation was the quantity of irrigation water utilized following the computed crop water requirement with the aid of the CROPWAT program without mulch. The treatments were organized in Randomized Complete Block Design (RCBD) in factorial preparations with three replications and a total of 9 treatments. The experimental plot was plowed using oxen, leveled, and made equipped through dividing the subject into 27 plots for transplanting. The experiment was carried out on a plot size of 3 m x 2 m (6 m^2) with 27 such plots. The spacing between adjacent plots and between replications were 1 m and 1.5 m respectively. The spacing between plants and rows was 40 cm and 75 cm, respectively, with a total of 4 rows per plot. A row consists of 5 vegetation and a total of 20 plants per plot. The net harvesting place of a plot was 2 m by means of 1.5 m (3 m^2). More seedlings than those required for transplanting have been raised so that vigorous, strong, and healthy ones have been selected. The seedlings were transplanted to field plots five weeks after germination on the first week of January 2020 and 2021. Transplanting used to be carried out late in the afternoon to decrease the chance of poor establishment. The treatment was randomly applied to the area of each of the blocks (replications) and every treatment was assigned to the blocks. Tomato (Lycopersicon esculentum Mill.) seedling variety galila was used as a test crop. A commonly recommended fertilizer rate at the study area was applied manually in the experimental plots. All plots were received the same amounts of fertilizer consisting of 150 kg ha^{-1} of urea and 242kg ha^{-1} of NPS. The irrigation water used in the study was harvested from the rooftop.

Table 2. *Details of treatment combination.*

TR	Descriptions
T_1	Without mulch with 100% ETc
T_2	Without mulch with 75% ETc
T_3	Without mulch with 50% ETc
T_4	White plastic mulch with 100% ETc
T_5	White plastic mulch with 75% ETc
T_6	White plastic mulch with 50% ETc
T_7	Straw mulch with 100% ETc
T_8	Straw mulch with 75% ETc
T_9	Straw mulch with 50% ETc

TR= treatment

2.5. Crop Water Requirement

Crop water requirements were estimated with the CROPWAT software program using climatic, soil, and crop data as input. In this experiment, the reference evapotranspiration (ETo) and crop water requirement (ETc) had been estimated from 15 years of (2004-2018) climatic information collected from the National Meteorological Agency of Adola Station. Based on FAO CROPWAT output, crop water requirement (ETc) of tomato vegetation was determined as 380 mm for growing periods of a hundred thirty five days at full irrigation level (100% ETc). Accordingly, for treatment of three-fourths (75% ETc) and a half (50% ETc), crop irrigation water requirements had been deduced as 285 mm and 199 mm, respectively.

2.6. Drip Irrigation System Installation

The drip irrigation devices were used for making use of irrigation water. The drip device consists of Polyvinyl Chloride major lines, sub-main, and laterals. The plots had been leveled manually to create uniform plots within the given treatment. The drip laterals have been set up in such a way that the spacing between rows is equal to that between the lateral and the spacing between vegetation is equal to emitters' spacing. There have been 27 plots laid out in 2 m length, 4 laterals per plot. Hence, every plot consisted of four drip lateral lines; each lateral has a 2 m size with 5 emitters so that every emitter drops water to a single plant. The water from the source used to be collected in a water tanker of 1000 liters capacity, which was placed at a peak of 2m above the floor to furnish the required irrigation water to the experimental field. The water distribution system part (mainline) have been laid and connected to the water container and to the sub-main pipe which is linked to individual drip lines. The drip lines (laterals) of 16mm diameter were unrolled and laid along the crop rows and every lateral served one row of the crop. At the end of the laterals, the sub-main pipe and main strains have been closed with stop cups to avoid direct soil contact and as a consequence prevent clogging.

Figure 2. *Pictures of No Mulch (NM), Straw Mulch (SM), and white plastic Mulch (WPM) of treatment.*

2.7. Application of Mulches

The mulching rate of 5 ton/ha wheat straw and white plastic mulch with 30 microns thickness were applied. White Plastic mulches had been utilized earlier than transplanting tomato seedlings with the aid of making small holes at the preferred intra-row spacing and the seedlings had been transplanted. However, straw mulches were applied right away after the transplanting of seedlings. Transparent plastic mulch was chosen because it presents more yields than black plastic mulch and it is characterized with the aid of the incidence of greater soil temperature that it lets in early germination and increases water use efficiency than black plastic mulch [16].

2.8. Water Productivity
Crop water productivity (WP) fundamentally refers to the output (for example, crop yield or economic return) regarding water input all through production. This potential the output might also be expressed either as physical production in kilograms per unit area or economic return in dollars per area. The water input is the amount of water utilized to the cropped area per season. In this study crop water productivity was estimated as the ratio of tomato yield to net irrigation depth applied to every treatment plot. It is expressed as:

$$WUE(\text{Kg}/m^3) = \frac{\text{Marketable grain yield}\left(\frac{\text{kg}}{\text{ha}}\right)}{\text{Seasonal net amount of water}\left(\frac{m^3}{\text{ha}}\right)} \quad (2)$$

where WUE is water use efficiency.

2.9. Data Collection
Related growth, yield, and yield elements (plant height, number of fruits per plant, Marketable fruit yield, Unmarketable fruit yield, and Total fruit yield) data have been collected. The agronomic records was collected from the middle rows to avoid border effects.

(1) Plant height (cm): The mean height of the plant was taken from the ground level to the tip of the uppermost phase of 9 randomly selected plants at the first harvest and final harvest.
(2) Marketable fruit yield (kg ha^{-1}): Recorded by means of weighing all harvests of marketable fruits from the two middle rows of each plot and calculated to kilogram per hectare.
(3) Unmarketable fruit yield (kg ha-1): Recorded through weighing all harvests of unmarketable fruits from the two middle rows of every plot and calculated to kilogram per hectare considering the cause for un-marketability.
(4) Total Fruit yield (kg ha-1): Recorded by using weighing all harvests of marketable and unmarketable fruits from the two center rows of each plot and calculated to kilogram per hectare.

2.10. Data Analysis and Economic Analysis
The collected data were statistically analyzed using Genstat 8^{th} Edition software for the variance analysis. The two years' data were subjected to combined analysis over years and least significant difference (LSD) at 5% probability level was carried out for means separation.

To verify the values and advantages associated with drip and mulch substances the partial budget approach as described through [4] was applied to the yield results. The net profits (NI) as calculated by using subtracting total variable cost (TVC) from Total Return (TR) as follows:

$$NI = TR - TVC \quad (3)$$

3. RESULTS AND DISCUSSION
3.1. Physical and Water Properties of the Soil at the Experiment Site
Laboratory analysis of particle size distribution indicated that the soil texture was clay. The average soil bulk density of 0-60cm soil depth was 1.38 g cm^{-3}. A representative value of TAW (102.7mm m^{-1}) was obtained by using considering the average of the upper 0 - 60 cm soil depth. Average available soil moisture content for the top (0-30 cm) and lower (30-60 cm) soil depths were observed as 116 mm and 130 mm respectively. The basic infiltration rate in this experiment was found to be 5 mm/hr, which is within the range of clay soil (1 to 5) mm/hr.

Table 3. *Physical and water properties of the soil at adola rede District, experimental site.*

Parameters	Results
Basic Infiltration rate (mm/hr)	5
Bulk density (gcm^{-3})	1.38
Field Capacity (%)	25.9
P.W.P (%)	16.6
Total Available Soil Water (TAW)(mm)	102.7
Sand%	50
clay%	28.75
Silt%	21.25
Soil textural class	Clay

3.2. Selected Chemical Properties of Experimental Site Prior to the Experiment
The representative value of the soil pH (1:2.5 soil to water) was 5.9. As laboratory result shows the electrical conductivity (EC) of the soil was 0.099 ds/m (Table 4). The weighted average organic matter content of the soil was about 3.69%. As cited in [19], the organic matter content of the soil is of medium class. The average value of total nitrogen were found about 0.32%.

Table 4. *Soil chemical characteristics of the experimental site.*

Parameters	Chemical analysis
pH (H_2O)	5.9
Total N (%)	0.32
Organic carbon (%)	2.14
Organic matter (%)	3.69
EC (ds/m)	0.099

3.3. Yields and Yield Components

3.3.1. Plant Height

The results of the study showed that the different levels of drip irrigation and plastic mulching were non-significantly influenced the plant height of tomatoes. Among the treatments, white plastic mulch with 75% ETc recorded maximum plant height (62.69 cm) and the minimum height (54.64 cm) was recorded in no mulch plot with 50% ETc (Table 4). This finding is in line with [24], who obtained faster crop development and earlier yields in cucumber with the application of plastic mulching.

3.3.2. The Number of Fruits per Plant

A maximum of 28.9 numbers of fruits per plant was obtained for the treatment of white plastic mulch with 75% ETc. The study revealed that the use of plastic mulch resulted in a maximum numbers of fruits per plant but, its effect was not statistically significant from straw mulching (Table 5). The minimum (17.13) number of fruits per plant was recorded at no mulch with 50% ETc. These results were in line with the findings of [5] who indicated that the treatment combination receiving drip irrigation at 80% Etc along with polythene mulch was recorded with the highest fruit yield per plant.

3.3.3. Marketable Fruit Yield

The end result of this study showed that the Combined impact of mulching and irrigation levels under drip exhibited a significant ($P<0.05$) influence on the marketable fruit yield. The highest marketable fruit yield (35478 Kg ha^{-1}) was obtained from the combined application of treatment received white plastic mulch with 75% ETc, whereas the lowest marketable fruit yield (17463 Kg ha^{-1}) used to be obtained from treatment received no mulch with 50% ETc. However, there was no significant difference observed in marketable fruit yield between white plastic mulch with 75% ETc and straw mulch with 75% ETc (Table 5). The increment of marketable fruit yield as irrigation levels raised is comparable to the [21] which indicated that yield reduction was related with an extend in soil moisture tension which when allowed continuing resulted in the loss of turgidity, cessation of growth and yield reduction. On different hand, a favorable environment for the growth of tomato plants maintained with the aid of the application of plastic mulch observed by plots treated with straw mulch than no mulch alongside with the improved irrigation levels might also have contributed to the production of the highest marketable yield. The current study is additionally in agreement with the results of [2] who pronounced that the highest marketable yield was received through black plastic mulch followed by straw mulch (56.43 tons/ha) in tomato crop.

3.3.4. Unmarketable Fruit Yield

The evaluation of variance confirmed that the combination treatment of mulching and water amount resulted statically non-significant ($P<0.05$) impact on unmarketable fruit yield (Table 5). The highest unmarketable fruit yield (34060 Kg ha-1) was recorded from plants grown under White plastic mulch with 75% ETc followed by the treatment that received Straw mulch with 75% ETc. The highest unmarketable fruit yield was recorded from the plot that received plastic mulch followed via straw mulch under increased water application levels. The lowest unmarketable tomato fruit yield was recorded under treatment no mulch with 50% ETc.

Table 5. *Effect of drip Irrigation level and plastic mulching techniques on yield attributes and fruit yield of tomato.*

Treatment Combination	**Plant Height (cm)**	**Number of fruits per plant**	**Unmarketable fruit yield (Kg ha^{-1})**	**Marketable fruit yield (Kg ha^{-1})**	**Total Fruit yield (Kg ha^{-1})**
T1; Without mulch with 100% ETc	60.39^{ns}	20.77^{bc}	2554^{ns}	24570^{bc}	27124^{b}
T2; Without mulch with 75% ETc	58.88^{ns}	25.37^{ab}	2071^{ns}	19291^{bc}	25861^{b}
T3; Without mulch with 50% ETc	55.64^{ns}	17.13^{c}	1974^{ns}	17463^{c}	19755^{b}
T4; White plastic mulch with 100% ETc	61.51^{ns}	23.13^{abc}	2727^{ns}	22772^{bc}	25500^{b}
T5; White plastic mulch with 75% ETc	62.69^{ns}	28.90^{a}	3406^{ns}	35478^{a}	38883^{a}
T6; White plastic mulch with 50% ETc	59.89^{ns}	24.00^{ab}	2512^{ns}	24538^{bc}	26512^{b}
T7; Straw mulch with 100% ETc	59.96^{ns}	19.18^{bc}	2001^{ns}	23349^{bc}	21292^{b}
T8; Straw mulch with 75% ETc	57.26^{ns}	19.67^{bc}	3361^{ns}	28831^{ab}	30902^{ab}
T9; Straw mulch with 50% ETc	61.05^{ns}	23.13^{abc}	2292^{ns}	22474^{bc}	25835^{b}
$LSD_{0.05}$	6.92	6.01	1488.98	9607.1	9952.20
CV (%)	9.9	23.0	49	33.9	31.8
Mean	59.7	22.4	2544.3	24307.1	26851.4

*Means followed by different letters in a column differ significantly and those followed by the same letter are not significantly different at $p < 0.05$ level of significance, ns = non-significant at 5% probability level, LSD (%) = Least significant Difference at 5% of significance and CV (%) = Coefficient of variation

3.3.5. Total Fruit Yield

Analysis of variance confirmed that the total fruit yield of tomatoes was statistically ($P<0.05$) influenced with interaction effect of water amount and mulching techniques. Accordingly, the maximum total yield (38883 Kg ha^{-1}) was got from the treatment that acquired white plastic mulch with 75% ETc, followed by treatment Straw mulch with 75% ETc (30902 Kg ha-1). The minimal total fruit yields (19750 Kg ha-1) have been recorded at the treatment of no mulch with 50% ETc. For each deficit irrigation level, highest total yield was received from plots treated with plastic mulch which was followed by plots received straw mulch than treatments that received no mulch (Table 5). Accordingly, for each mulching technique, total fruit yield lowered with an increase in the irrigation deficit level. The universal trend from this result revealed that the yield of tomatoes increased with high depth of water provide and lowered with low depth of water applied different mulching techniques.

3.3.6. Water Productivity

The Interaction Effect of irrigation levels with mulch kind on water productiveness of tomatoes under drip irrigation has confirmed a significant ($p<0.001$) effect on the water productivity of tomatoes (Table 6). Results indicated that the maximum water productiveness (12.915kg/m^3) was observed at white plastic mulch with 75% ETc which used to be statistically non-significant with white plastic mulch with 50% ETc (12.448 kg/m^3). The minimum water productivity (5.993 kg/m^3) was determined at white plastic mulch with 100% ETc (Table 6). Mulches with irrigation gave greater water productivity over-irrigation alone under all levels of irrigation. Mulches reduced the value of water loss through evaporation from the soil surface. So, the soil-water-plant relationship was better in low irrigation regimes than in excessive irrigation regimes which may assist produce greater yields and thereby greater water productivity. The lower water productivity might be attributed to higher irrigation water depth applied, a good deal of which was lost via soil deep percolation. The greater amount of irrigation water utility is associated with lower water productivity and the decrease amount of irrigation water quantity is associated with greater water use efficiency. The result agree with [1], who stated that a low irrigation regime decreased deep percolation and increased water use from the root zone.

Table 6. *Interaction effect of irrigation levels with mulch type on water productivity of tomato under Drip irrigation.*

Treatments	WP (kg/m^3)
T1; Without mulch with 100% ETc	6.466^{bc}
T2; Without mulch with 75% ETc	6.769^{bc}
T3; Without mulch with 50% ETc	9.191^{abc}
T4; White plastic mulch with 100% ETc	5.993^{c}
T5; White plastic mulch with 75% ETc	12.915^{a}
T6; White plastic mulch with 50% ETc	12.448^{a}
T7; Straw mulch with 100% ETc	$6.144b^{c}$
T8; Straw mulch with 75% ETc	10.116^{ab}
T9; Straw mulch with 50% ETc	11.828^{a}
$LSD_{0.05}$	3.615
CV (%)	34.1
Mean	9.10

3.4. Economic Comparison of Treatments

Data concerning economic comparison is presented in Table 7. Accordingly, the highest net benefit of 563475.7ETB ha^{-1} was recorded from white plastic mulch with 75% ETc and followed by 484454.7ETB ha^{-1} with Straw mulch with 75% ETc. The lowest net benefit 285477.3ETB ha^{-1} was obtained from no mulch with 50% ETc. The highest benefit to cost ratio was obtained under treatment straw mulch with 75% ETc (15.04) and followed by no mulch with 100% ETc (14.32). This result revealed that wheat straw mulch with 75% ETc is economically feasible for tomato production in adola area of the Guji zone.

3.5. Correlation of Tomato Yield, Yield Component, and Water Productivity

The calculated values of correlations coefficient (r) between yield, yield components, and water productivity are presented in Table 8. The number of fruits per plant was statistically no-significant ($p<0.01$) associate with all the studied parameters, but it shows a positive correlation. The highest Pearson correlation coefficient in the result provided a relationship between total fruit yield with marketable fruit yield (r =+0.92) followed by correlations between marketable fruit yield and water productivity (r =+0.80).

The correlation was showed that plant height, unmarketable fruit yield, marketable fruit yield, and water use efficiency were correlated positively with marketable fruit yield. Marketable fruit yield (kg ha^{-1}) positively and significantly associated with plant height (r = 0.48**), unmarketable fruit yield (r = 0.41**), total fruit yield (r = 0.58*) and water productivity (r = 0.99**). These results were in lined with findings of [17] who reported, WUE positively correlated with grain yield and yield components.

Table 7. *Economic analysis of marketable fruit yield of tomato under different treatments.*

Treatments	Marketable fruit yield (Kg ha^{-1})	Total Return (ETB /ha)	Total cost (ETB /ha)	Net Income (ETB /ha)	Benefit-cost ratio
T1; Without mulch with 100% ETc	24570	442260	30893.3	411366.7	14.32
T2; Without mulch with 75% ETc	19291	347238	29853.3	317384.7	11.63
T3; Without mulch with 50% ETc	17463	314334	29856.7	284477.3	10.53
T4; White plastic mulch with 100% ETc	22772	409896	75138.3	334757.7	5.46
T5; White plastic mulch with 75% ETc	35478	638604	75128.3	563475.7	8.50
T6; White plastic mulch with 50% ETc	24538	441684	75121.7	366562.3	5.88
T7; Straw mulch with 100% ETc	23349	420282	34513.3	385768.7	12.18
T8; Straw mulch with 75% ETc	28831	518958	34503.3	484454.7	15.04
T9; Straw mulch with 50% ETc	22474	404532	34506.7	370025.3	11.72

Note: - The price of tomato taken was 18 ETB Kg^{-1}, ETB = Ethiopian Birr and MRR = Marginal Rate of Return.

Table 8. *Pearson's correlation coefficients (r) of tomato yields, yield component, and water use efficiency.*

	NFPP	PH	UMFY	MFY	TFY	WP
NFPP	1					
PH	0.160 ^{ns}	1				
UMFY	0.149 ^{ns}	0.482**	1			
MFY	0.102 ^{ns}	0.405**	0.414**	1		
TFY	0.084 ^{ns}	0.415**	0.491**	0.921**	1	
WP	0.098 ^{ns}	0.415**	0.376**	0.797**	0.765**	1

*. and **. = Correlation is significant at 5 and 1% level, *. NFPP =Number of fruits per plant, PH = Plant Height, UMFY =Unmarketable Fruit yield, MFY =Marketable Fruit yield, TFY =Total Fruit yield and WP =water productivity

4. CONCLUSION AND RECOMMENDATION

A study was performed at Adola rede District of Guji zone for two consecutive years in the 2018/2019 and 2020/2021 off-season of copping. This study aimed to evaluate the effect of mulching and the amount of water on the yield and yield components of tomatoes (*Solanum Lycopersicum* L.) under drip irrigation. The experiment has conducted with three levels of irrigation water application;- full irrigation (100% ETc), ¾ irrigation (75% ETc), half irrigation (50% ETc), and three mulching materials No Mulch (NM), Straw Mulch (SM), and white Plastic Mulch (WPM). The test crop of the experiment was tomato (*Solanum Lycopersicum* L.) variety galila. The experiment was organized in Randomized Complete Block Design (RCBD) with three replications. No mulch with 100% crop water requirement was used as a control for this experiment. The parameters for experimentation consist of yield and yield components: such as plant height, number of fruit per plant, marketable and unmarketable fruit yield, and total fruit yield. The results of this study indicated white plastic mulch with 75% ETc recorded maximum plant height (62.69 cm) and the minimum height (54.64 cm) was recorded in no mulch plot with 50% ETc. The study indicated that the use of plastic mulch resulted in a most number of fruits per plant but, its impact was not statistically significant to straw mulching. The highest marketable fruit yield (35478 Kg ha^{-1}) was obtained from the mixed application of treatment obtained white plastic mulch with 75% ETc whereas the lowest marketable fruit yield (17463 Kg ha^{-1}) was obtained from treatment received no mulch with 50% ETc. However, there was no wide difference observed in marketable fruit yield between white plastic mulch with 75% ETc and straw mulch with 75% ETc. The highest total fruit yield was received from a high depth of water utilized beneath plastic and straw mulch respectively and this was notably distinct from an enormously low depth of water applied treatments. The Interaction Effect of irrigation levels with mulch type underneath drip irrigation has shown a substantial ($p<0.001$) influence on the water productiveness of tomatoes. Results indicated that the maximum water productivity (12.915kg/m^3) used to be found at white plastic mulch with 75% ETc which was statistically non-significant with white plastic mulch with 50% ETc (12.448 kg/m^3). The minimum water productivity (5.993 kg/m^3) was observed at white plastic mulch with 100% ETc. Based on the partial budget analysis, the highest net benefit 563475.7ETB ha^{-1} was recorded from white plastic mulch with 75% ETc and followed by means of 484454.7ETB ha^{-1} with Straw mulch with 75% ETc.

In conclusion, the present study points out that wheat straw mulch with 75% ETc is economically more profitable than the other different mulch treatments at Adola rede District and similar areas.

Finally, we recommend that farmers can use wheat straw mulch with 75% ETc under drip irrigation, especially in drought-prone areas the place water is very scarce to produce tomato crops.

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