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# Evaluation of Irrigation water Levels with Integrated nutrient management on the Growth and Yield of tomato (*Solanumlycopersicum* L.) under Furrow Irrigation in OdaBultum district, Oromia Region, Ethiopia

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## ABSTRACT

*The objective of agricultural production is to provide enough food to meet the requirements of population in good quality that will not harm health of human beings. Furrow irrigation systems dominate crop production, resulting in low water and crop production levels Poor irrigation water management practices further compromise the sustainability of crop production, leading to crop failures, water disputes, and reduced household incomes. The aim of the experiment is to evaluate the effect of irrigation levels and integrated fertilizer application, and the economic advantage of tomato fruit production in OdaBultumDistrict.A split-plot design with three replication was used.Three irrigation levels (50%ETc, 75%ETc and 100%ETc) and four fertilizer rate applicationFull vermi-compost (FVC), full inorganic fertilizer (FIf), half vermi-compost with half inorganic fertilizer (HVC+HIF) and zero(0) fertilizer were used.Both physical and chemical soil sample was taken and analyzed. Ten year climate data of Badessa meteorology station. Except plant height most parameters of tomato fruit was significant different (P>0.05) level between treatments in 2023 season. There were also significant different between treatmentat all parameters during2024 season.The highest marketable and total yield was obtained on full vermi compost combined with 75% crop evapotranspiration (ETc). Except plant height most parameters, No of branch per plant, No of fruit per plant, marketable yield, unmarketable yield and total yield per ton per hector have significant different (P>0.05) levels. The highest tomato fruit yield was obtained on full vermi-compost combined with 75% crop evapotranspiration application.*

***Keywords:*** *Integrated nutrient, Irrigation level, Tomato, Vermin-compost.*

## 1. INTRODUCTION

Tomato is the most popular vegetable growing at different parts of the world, but it is sensitive to soil water deficit [32]. Therefore, use of suitable irrigation systems and maintaining optimum soil moisture conditions are crucial to get a higher return and water productivity for tomato production in open field conditions. Tomato yield and water productivity were significantly affected due to soil moisture deficit at 50% field capacity (FC) compared to 100% FC[27]. Marketable fruit yield of tomatoes decreased by 53–83% and water use efficiency by 17% under 50% of full irrigation supply and rain fed conditions, respectively [9]. The objective of agricultural production is to provide enough food to meet the requirements of population in good quality that will not harm health of human beings. For this purpose, it requires the development and application of new inputs and technologies. New agricultural technologies, including agrochemicals (fertilizers, pesticides, etc.) and intercropping, are being randomly used to improve the success of modern agriculture [10]. Some of these technologies are causing our soils to become ill, environmental pollution, increased pest resistance in weeds, insects, and pathogens, and toxic residue in our food [22]. Food production in many parts of Ethiopia is challenged by inadequate and unreliable supply of water.

The fact that the country's water use in general and agricultural water in particular is inefficient increases the water demand in all water use sectors[4]. Although modern irrigation development has short history in the country, the development trend of its undesirable consequences, such as soil salinity, sodicity and groundwater rise is becoming areas of concern [5]. When water is a limiting factor for agricultural production, irrigation with water deficit index provides greater economic return than total irrigation[33]. Deficit irrigation management is possible when crop production function is estimated. When properly applied, the technique shows great potential to increase water use efficiency, especially in areas of low water availability [19]. The deficit irrigation could be used for tomato without reduction in yield and also with increase in fruit quality parameters, such as the content of sugar and antioxidants moieties[13;12].

Small-scale irrigation initiatives are crucial for poverty reduction, food security, and enhancing rural livelihoods in Ethiopia [3]. However, the scarcity of available water resources poses a significant challenge to irrigated agriculture in many regions, including Ethiopia[7] (Belay, *et al*. 2019). Climate change further exacerbates water scarcity issues, leading to droughts, moisture stress, and inadequate water management practices that strain water resources and hinder crop productivity [28]. Insufficient water availability for irrigation results in low crop yields, conflicts over water allocation, and challenges in sustaining agricultural productivity [15]. Currently, irrigated agriculture take place under water scarcity and insufficient water supply for irrigation due to low crop productivity [18]. Enhancing Water Productivity (WP) and water savings are a major challenge for sustainable crop production in irrigated agriculture [20]. In the context of Ethiopia, traditional irrigation systems dominate crop production, resulting in low water and crop productivity levels [29]. Poor irrigation water management practices further compromise the sustainability of crop production, leading to crop failures, water disputes, and reduced household incomes. To address these challenges, innovative water-saving technologies and efficient irrigation strategies are essential for enhancing water productivity and ensuring sustainable crop production [2.

Tomato (*Lycopersicumesculentum*) is an essential component of human diet. It contains micro- nutrients, vitamins and certain phytochemicals which contribute significantly to human diet [1]. It has been strongly advocated by relevant global agencies that, consumption of approximately 400g of fresh produce per day has a prophylactic capacity to stem the tide of certain maladies in humans such as carcinoma, diabetes and cardiovascular diseases [6]. Despite its veritable contribution to human diet, the quality of fresh produce consumption has been greatly challenged by the excessive application of chemical fertilizers and pesticides[25]. In this context, the application of organic agricultural production is crucial because they not only can promote plant growth and yield but also can increase product quality. Organic agriculture is a production system that sustains the health of soils, ecosystems and people [26]. In organic production, instead of chemical fertilizers with many adverse effects, organic manures were applied, in there; vermi-compost has high porosity, drainage, water holding capacity, and microbial activity. Vermi-compost is produced by biodegradation of organic material such as farm wastes, kitchen wastes, market wastes etc., through interactions between earthworms and microorganisms [17].

The amount of water applied to crop, along with other production factors, allows changes in growth. Such quantitative analysis is based on the assessment of data from sequential collections, in order to describe changes in the production of dry matter depending on time, by calculating growth rates. In addition, it allows identifying plant traits linked to environmental conditions, as well as yield potential under optimal growth conditions.

The average productivity of tomato in Ethiopia is around 10 ton $ha^{-1}$. This is very low as compared to the world average productivity of 17.3ton $ha^{-1}$ [11]. Vermi-compost contains an average of 1.5% - 2.2% N, 1.8% - 2.2% P and 1.0% - 1.5% K. The organic carbon ranges from 9.15 to 17.98 and contains micronutrients like Sodium (Na), Calcium (Ca), Zinc (Zn), Sulphur (S), Magnesium (Mg), Iron (Fe) and growth hormones auxins, gibberlins, cytokinins .Vermi-compost is reported to affect positively to growth and productivity of plants and several studies had examined the effects of vermi-compost on numbers of plants such as cereals, legumes, vegetables, ornamental and flowering plants, and field crops [23].

Available nutrients in vermi-compost such as nitrate, exchangeable phosphorus, potassium, calcium and magnesium as well as natural plant growth regulation that supplied and stimulate plant growth [16]. However, the application of vermin-compost in Hararghe is not much and their effect on plant growth requires further research under irrigation condition. Therefore, optimizing irrigation water and organic and inorganic fertilizer application levels and adopting their best integrated use as a management tool for tomatoes production could be very important in situations where water is scarce and mineral fertilizer is coasty. Therefore, the main objectives of the present study wasto evaluate theeffect of irrigation levels andintegrated fertilizer and optimize irrigation water levels on the growth andyield of tomato under furrow irrigation, as well as determine partial economic analysis advantage of theexperimental treatments.

## 2. MATERIALS AND METHODS

### 2.1. Description of study Areas

The study was carried out for two years of irrigation potential areas in.OdaBultumDistrictWest HarargheZone. The District is located at 8º 91' 00"N latitude and 40º77'21"E.The annual rain fall is 900 mm-1100 mm). It has a mean maximum and mean minimum temperature of 28°C and 25°C; respectively. The district is characterized red sandy loam in color .OdaBultum district is found in West Hararghe zone of Oromia region with mean annual rainfall of 1120 mm and the annual temperature ranges from 15-28 degree Celsius. The soil type of the district is characterized by black clay loam and clay soil type.

### 2.2. Experimental Design and Treatments

The experiments were arranged in a split plot design. A treatment combination of three irrigation levels 50%, 75%, and 100%ETc taken as whole plots and four fertilizer levels (full fertilizer, half fertilizer with half vermi-compost, full vermicomposting and zero fertilizer) as sub plot was used

According to [24] recommended vermi-compost rate (7.5ton $ha^{-1}$) and recommended inorganic fertilizer rate were used for two consecutive years of 2023 and 2024 season. Totally 12 treatments and three replications of each treatment combination was used. Irrigation levels were randomly assigned to the main plots, whereas the vermi-compost and inorganic fertilizer rate was randomly arranged in the subplots. The space between plots and block was 1m for each, respectively. Malka salsa tomato variety was used as a test crop. The seedlings was raised on nursery and transplanted to the experimental field within one month. The experimental land was ploughed twice using by local farmers and prepared for planting using manpower.The spacing between plants and rows was 40cm and 100cm, respectively. Watering was applied through surface irrigation by three-inch parshal flumes. The treatments were applied to tomato plants just after seedlings have been established in the experimental plots.All the agronomic activities including weeding, cultivation, staking, disease and insect pest control, will be carried out for all the experimental plots equally as per the recommendations.The seed was sown on nursery and stay there for one month until land preparation for transplanting and management as well as supervised until germination and transplanted. Tomato seedlings was transplanted into the field after one month.

*Table 1: Treatment arrangement*

| | Total Area=324.5m² | | | | Plot area= 2m*3m = 6m² | | | Space b/n block & plot=1m² | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | 100% | | | | 50% | | | | 75% | | | |
| | Half F+C | Full Comp | zero fertilizer | Full fertilizer | Half F+C | Full fertilizer | zero fertilizer | Full Comp | Full fertilizer | Half F+C | Full Comp | zero fertilizer |
| II | 50% | | | | 75% | | | | 100% | | | |
| | zero fertilizer | Half F+C | Full Comp | Full fertilizer | Full Comp | Half F+C | zero fertilizer | Full fertilizer | Half F+C | zero fertilizer | Full Comp | Full fertilizer |
| III | 100% | | | | 50% | | | | 75% | | | |
| | zero fertilizer | Full fertilizer | Full Comp | Half F+C | zero fertilizer | Half F+C | Full fertilizer | Full Comp | Half F+C | Full Comp | Full fertilizer | zero fertilizer |

1. Number of fruits per plant -At the time of each picking fruits will be counted in each cultivar of tags plants.
2. Average fruits weight (g) -In each cultivars five tomato fruits was measured with the help of electric balance and the calculate average.
3. Individual yield ( per plant)-weighting individual obtained from one randomly selected plant
4. Yield (ton $ha^{-1}$) -Yield of tomato fruits in tons will be calculated through the following formula

$$Y\left(\frac{ton}{ha}\right) = \frac{Yieldper\ plot(Kg) * 1000}{Plot\ Area(m2) * 10000}$$

### 2.3.2. Soil Sampling and Analysis.

A composite of disturbed soil sample was taken using Augur for the determination of selected soil physical and chemical properties which include soil texture, organic matter, pH, EC, total N, exchangeable Ca, available P, and available K. Organic matter content of the soil will be estimated from the organic carbon content determined using the Walkley and Black methodFor determination of available soil nutrients, soil samples will be taken from 0-20 and 20-40 cm composite depth was analyzed.

**Soil physical properties:** such asFC**,** PWP,Bd,soil texture, were taken once before commencing the treatment; soil moisture content every required days (may adjusted based on gravimetric method soil sample taken) after commencing the treatments taken at a depth of 0-20cmand 20-40cm.

**Soil chemical properties:** such asPH, CEC, organic carbon, available P & K, total Nwas determined from composite soil samples taken at two layers 0-30 cm before treatment application and at harvest analyzed with standard laboratory procedures**.**

**Partial budget analysis**

The economic analysis was done using a partial budget analysis, based on the procedures described by CIMMYT procedure. For this analysis, the variable cost of fertilizer (31.5EtB) $kg^{-1}$) and labor (150 ETB person $day^{-1}$) were considered at the time of planting and during other operations. The price of the tomato marketable fruit yield (25EtB $kg^{-1}$) was also taken into account. The return was calculated as total gross return minus the total variable cost. Net benefits and costs that varied between treatments were used to calculate the marginal rate of return on invested capital as we transitioned from a less costly to a costlier treatment. To draw farmers' recommendations from the marginal analysis in this study, a 100% return on investments was used as a reasonable minimum acceptable rate of return.

**Method of Data analysis and management.**

All agronomic and soil data collected were properly managed using the Excel computer software. The collected data were subjected to the ANOVA using R- software for statistical analysis.The differences among means for all traits were tested for significance at5% levels according to [31].

## 3. RESULTS AND DISCUSSION

*Table1: Soil physical and chemical properties of the experimental site*

| Sample code at depth of 20cm | Parameters | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PH-H2O 0-14 | Avail. P mg/kg | Avail. S mg/kg | CEC meq/100g soil | TN % | OC % | OM % | C/N Ratio |
| PS1 | 7.15 | 99.41 | 54.56 | 57.98 | 0.26 | 3.34 | 5.76 | 13.1 |
| AHHf 1 | 7.04 | 90.69 | 70.96 | 58.1 | 0.24 | 3.29 | 5.67 | 14 |
| AHZf 1 | 7.27 | 51.01 | 56.95 | 58.62 | 0.19 | 2.64 | 4.55 | 13.97 |
| AHFc 1 | 7.24 | 57.99 | 76.25 | 51.33 | 0.21 | 3.12 | 5.38 | 14.72 |
| AHFf 1 | 7.22 | 64.96 | 54.5 | 51.43 | 0.22 | 3.08 | 5.31 | 13.81 |
| PS2 | 7.24 | 143.23 | 100 | 59.84 | 0.28 | 3.86 | 6.65 | 13.59 |
| AHHf 2 | 7.26 | 107.69 | 42.18 | 57.99 | 0.28 | 3.17 | 5.47 | 11.24 |
| AHZf 2 | 7.26 | 107.7 | 85.4 | 54.26 | 0.25 | 3.56 | 6.14 | 14.3 |
| AHFc 2 | 7.21 | 137.99 | 63.22 | 58.82 | 0.27 | 3.73 | 6.43 | 13.81 |
| AHFf 2 | 7.22 | 102.96 | 60.33 | 60.5 | 0.27 | 3.41 | 5.88 | 12.82 |
| Physical Parameter | | | | | | | | |
| Sand% | 8 | Clay% | 58 | Silt% | 34 | Textural | Clay | |
| FC (%) | 40.1 | PWP (%) | 28 | Bd(cm/gm) | 1.24 | | | |

*Table 2: Individual Effect of Irrigation levels and integrated fertilizer rate on growth and fruit yield of tomato*

| TRT | Effect of Irrigation levels | | | | | | |
|---|---|---|---|---|---|---|---|
| | PH | NBPP | NFPP | AvFW | MY | UMY | TY |
| 100%ETc | 63.8a | 8.68a | 32.56a | 0.32a | 14.82a | 2.01 | 16.83 |
| 75%ETc | 64.22a | 9.19a | 32.56a | 0.33a | 16.05a | 1.83 | 17.88 |
| 50%ETc | 63.61a | 9.73a | 35.0 | 0.38a | 16.27a | 1.52 | 17.89 |
| Mean | 63.88 | 9.2 | 32.70 | 0.34 | 15.71 | 1.79 | 17.50 |
| CV | 3.1 | 27.3 | 32.5 | 28.5 | 27.3 | 32.3 | 30.5 |
| LSD | 1.60 | 2.01 | 8.52 | 0.25 | | | 4.27ns |
| | Effect of fertilizer levels | | | | | | |
| Fc | 63.66ab | 10.20a | 30.28a | 0.34a | 16.47a | 1.44b | 17.91a |
| Ff | 67.31a | 9.55a | 34.63a | 0.37a | 15.96a | 2.11a | 18.07a |
| H | 65.37a | 9.43a | 34.23a | 0.36a | 16.33a | 1.82ab | 18.15a |
| N | 59.18b | 7.62b | 31.67a | 0.33a | 14.08b | 1.79ab | 15.87b |
| Mean | | 9.20 | | | | | |
| CV (%) | 10.5 | 17.4 | 28.4 | 34.8 | 15.3 | 23 | 17.5 |
| LSD (5%) | 4.69 | 1.13 | 6.51 | 0.08 | 1.69 | 0.54 | 0.54 |

## 3.1. Plant Height, No, Branch and Fruit per Plant

*Table 3: Effect of interaction of irrigation levels and integrated fertilizer on tomato yield and yield components in 2023/24*

| | 2023 | | | | 2024 | |
|---|---|---|---|---|---|---|
| TRT | PH(cm) | NB/Pl | NFPP | PH | NB/Pl | NF/Pl |
| 75+Fc | 68.1 | 9.1$^{a}$ | 50.8$^{bc}$ | 68.5$^{ab}$ | 11.5$^{ab}$ | 21.8$^{ab}$ |
| 75+Ff | 67.3 | 8.6$^{ab}$ | 59.7$^{ab}$ | 67.9$^{ab}$ | 12.5$^{a}$ | 20.1$^{ab}$ |
| 75+H | 66.5 | 7.6$^{abc}$ | 48.8$^{bc}$ | 67.3$^{ab}$ | 10.2$^{abcd}$ | 22.4$^{ab}$ |
| 100+Ff | 65.5 | 8.1$^{ab}$ | 47.4$^{c}$ | 72.3$^{a}$ | 11.6$^{ab}$ | 24.8$^{a}$ |
| 100+Fc | 65.0 | 7.5$^{abc}$ | 41.2$^{e}$ | 66.0$^{bc}$ | 12.6$^{a}$ | 17.9$^{ab}$ |
| 50+Ff | 64.3 | 7.11$^{bc}$ | 43.9$^{d}$ | 65.9$^{abc}$ | 10.57$^{abc}$ | 22.5$^{ab}$ |
| 100+N | 63.5 | 6.0$^{c}$ | 45.2$^{a}$ | 63.7$^{abcd}$ | 7.9$^{cd}$ | 17.1$^{ab}$ |
| 100+H | 62.1 | 7.6$^{abc}$ | 48.6$^{bc}$ | 67.7$^{ab}$ | 10.3$^{abcd}$ | 20.4$^{ab}$ |
| 75+N | 61.9 | 8.3$^{ab}$ | 40.5$^{g}$ | 62.5$^{bcd}$ | 8.17$^{bcd}$ | 15.9$^{b}$ |
| 50+N | 61.8 | 8.1$^{ab}$ | 41.8$^{a}$ | 56.2$^{d}$ | 7.0$^{d}$ | 16.7$^{ab}$ |
| 50+H | 59.1 | 7.6$^{abc}$ | 39.1$^{f}$ | 57.7$^{cd}$ | 11.9$^{a}$ | 18.4$^{ab}$ |
| 50+Fc | 57.5 | 8.4$^{ab}$ | 47.5$^{c}$ | 60.0$^{bcd}$ | 12.9$^{a}$ | 22.6$^{ab}$ |
| Mean | 53.6 | 7.8 | 45.4 | 64.7 | 10.6 | 20.1 |
| cv% | 10.6 | 15 | 29.3 | 9 | 18.9 | 24.7 |
| LSD (5%) | NS(11) | 2.1 | 1.9 | 10.1 | 3.5 | 8.6 |

There is no significance between treatments on plant height during 2023 season, but, the highest numerical value was obtained on full vermicomposting (FVC) with 75%ETc followed by full fertilizer (Ff) application with 75%ETc irrigation level and the lowest plant height is recorded on full fertilizer rate with 50%ETc irrigation application level. During 2024 season, there were a significant level between treatments at (P<0.05) with the highest 72.2 cm plant height is recorded on full fertilizer (Ff)with 100%ETc followed by 68.2 cm on full vermi-compost (FVC) with 75%ETc application. The lowest plant height was recorded on full vermicomposting with 50%ETc in 2023 and on zero fertilizer with 50%ETc in 2024 irrigation season. The highest No of branch per plant was recorded on full vermicomposting with 75%ETc irrigation water application followed by full fertilizer with 75%ETc.The lowest was recorded onzero fertilizer with 50%ETc during 2023 irrigation season. According to the result shown, there were wassignificances at (P<0.05) levels on number of fruit per plant between treatments in both 2023/24 irrigation season (Table 1).

## Marketable, Unmarketable and Total Yield

*Table 4: Effect of interaction of irrigation levels and integrated fertilizer on tomato yield during 2023/24 season*

| | 2023 | | | 2024 | | |
|---|---|---|---|---|---|---|
| TRT | MY | UMY | TY (kg/6m$^{-2}$) | MY | UMY | TY (kg/6m$^{-2}$) |
| 75+Fc | 20.3$^{a}$ | 2.76a | 22.94a | 18.5$^{ab}$ | 2.2$^{abc}$ | 20.7a |
| 75+Ff | 16.7$^{ab}$ | 2.13ab | 18.04ab | 17.2$^{abc}$ | 2.6$^{ab}$ | 19.8ab |
| 75+H | 11.3$^{bc}$ | 1.03bc | 16.94ab | 19.98$^{a}$ | 1.7$^{abc}$ | 21.6a |
| 100+Ff | 15.6$^{ab}$ | 1.97ab | 12.34b | 16.8$^{abc}$ | 3.1$^{a}$ | 19.9ab |
| 100+Fc | 12.0$^{b}$ | 1.39b | 15.67 b | 18.8$^{ab}$ | 2.7$^{ab}$ | 21.5a |
| 50+Ff | 12.5b | 1.93ab | 15.23 b | 13.7$^{bc}$ | 1.6$^{abc}$ | 15.3bc |
| 100+N | 9.2c | 1.23c | 14.67 b | 15.8$^{abc}$ | 0.9$^{bc}$ | 16.7bc |
| 100+H | 14.9b | 1.32b | 15.47 b | 16.9$^{abc}$ | 2.7$^{abc}$ | 19.6ab |
| 75+N | 13.b | 1.41b | 13.79 b | 15.3$^{abc}$ | 1.6$^{abc}$ | 16.9bc |
| 50+N | 11.5b | 1.36b | 15.97 b | 12.8$^{c}$ | 1.0$^{c}$ | 13.4c |
| 50+H | 13.1b | 1.01b | 13.41 b | 17.4$^{abc}$ | 2.2$^{abc}$ | 19.6ab |
| 50+Fc | 13.7b | 0.88b | 8.30c | 17.7$^{abc}$ | 2.1$^{ab}$ | 19.8ab |
| Mean | 13.46 | 1.6 | 15.05 | 16.7 | 1.98 | 18.7 |
| CV (%) | 28.6 | 28.6 | 28.6 | 20.5 | 41.9 | 21.9 |
| LSD (5%) | 3.1 | 0.4 | 3.5 | 6 | 1.9 | 7.1 |

The finding from the 2023 irrigation season indicate a significant difference in yield out comes based on the treatment methods applied. Specifically, in terms of marketable, unmarketable, and total yields. The data reveals that full vermicomposting (FVC) combined with 75% crop's evapotranspiration (ETc) resulted in the highest marketable yield of (33.8t ha$^{-1}$), unmarketable yield of (4.6tha$^{-1}$). This suggests that the combination of adequate water application and the nutrient rich properties of vermicomposting play a crucial role in optimizing crop yield conversely the lowest marketable yield waspaired with a reduced irrigation level of 50%ETc, Thus the importance of sufficient water supplyin achieving optimal agricultural production and productivity.

During 2024 irrigation experimental season, the result shows a significant different between treatment at (P<0.05) levels on marketable, unmarketable and total yield. The highestmarketabletomato fruit yield was recorded 33ton per hector on half inorganic fertilizer and half vermicomposting combined with 75% crop's evapotranspiration (ETc) followed by 31.3tha$^{-1}$ on full inorganic fertilizer combined with 100% crop's evapotranspiration, and the lowest marketable yield obtained 21.3ton per hectoronreduced irrigation water application of 50% ETc combined with none (zero) fertilizer application. These results could be affected by soil textural type and different available nutrients found in vermicomposting and in artificial fertilizer factors.Unmarketable tomato yield also obtained the highest yield 4.5ton per hector on full inorganic fertilizer combined with 100% crop evapotranspiration and the lowest was recorded 1.7ton per hector on zero fertilizer application combined with 100% crop evapotranspiration.The highest total tomato yield was obtained with 36 ton per hector on full inorganic fertilizer combined with 100% crop's evapotranspiration, and the lowest marketable yield obtained 22.3ton per hector on reduced irrigation water application of 50% ETc combined with none (zero) fertilizer application.

### 3.2. Interaction effect of irrigation level and integrated fertilizer rate on mean growth, yield component and yield of tomato

*Table 5: Effect of interactionofirrigation level and integrated fertilizer rate of two year combined data on tomato yield and yield components*

| TR | PH | NBPl | NFPl | MY | UMY | TY | TY(t/ha) |
|---|---|---|---|---|---|---|---|
| Fc+75 | 64.2abc | 9.84ab | 22.1b | 17.39a | 1.81ab | 19.2a | 32 |
| Fc+100 | 63.51abc | 10.41a | 34.0 ab | 16.64a | 1.98a | 18.44a | 30.7 |
| H+100 | 63.98abc | 9.3abc | 34.2ab | 16.6a | 2.4a | 18.3a | 30.5 |
| Ff+75 | 67.19 ab | 9.9ab | 36.58a | 16.48a | 2.3a | 18.71a | 31.2 |
| Ff+100 | 68.01a | 9.74ab | 24.2b | 16.31a | 2.2a | 18.51a | 30.9 |
| H+75 | 64.8abc | 8.9abc | 36.93a | 16.26a | 1.58ab | 17.69ab | 29.5 |
| H+50 | 67.32 ab | 10.19ab | 31.6ab | 16.12a | 1.85ab | 16.36ab | 27.3 |
| Fc+50 | 63.27abc | 10.36ab | 33.6ab | 15.39ab | 1.57ab | 18.21a | 30.3 |
| Ff+50 | 66.73abc | 9.03abc | 33.3ab | 15.1ab | 1.88ab | 16.98ab | 28.3 |
| N+100 | 60.0abc | 7.35c | 33.4ab | 14.88ab | 0.93b | 16.86ab | 28.1 |
| N+50 | 58.2c | 7.22c | 32.3ab | 14.5ab | 1.86ab | 16.32ab | 27.2 |
| N+75 | 59.3bc | 8.28bc | 29.3ab | 12.86b | 1.54ab | 14.39b | 24.0 |
| Mean | 63.88 | 9.2 | 32.7 | 15.71 | 1.79 | 17.5 | 29.17 |
| CV% | 9.1 | 16.6 | 35.2 | 8.8 | 19.4 | 6.2 | 6.2 |
| LSD | 2.85 | 2.68 | 12.25 | 3.12 | 1 | 3.34 | 3.4 |

The results of year combined analysis reveals that, there were a significant different among treatment ($P<0.05$). In terms of tomato growth parameter, plant height, No of branch per plant and fruit per plant were significant different between treatments, the same is true for fruit marketable, unmarketable and total yield was statistically significant different ($P<0.05$) level, That means the highest marketable and total 29t$ha^{-1}$ and 32t $ha^{-1}$respectivelyfruit yield of tomato wereobtainedon full vermicomposting (FVC) combined with 75% crop evapotranspiration (ETc) application. This result agree with[8]26.4t $ha^{-1}$). Additionally, thehighest (2.4t $ha^{-1}$) and lowest (0.93 t$ha^{-1}$) yield of unmarketable fruit were recorded from the combined application half of inorganic and vermicomposting with 100% crop evapotranspiration (ETc).

The result indicated that there was a consistent increase in yield affected by soil texture and irrigation water levelHowever, the yield increment was not consistent across all levels of the irrigation regime with application of recommended VC, full inorganic fertilizer and half of the two integrated application nutrients.

This indicates that the yield of tomato is mainly determined by the application of irrigation water. Therefore, the best combination of these two factors for this study area was found to be 75%ETc and full recommended (7.5t ha-1)vermi-compost. Similarly, various scholars reported the effect of irrigation water and nutrient on tomato yield. In vegetable crop production, nutrients, especially nitrogen and water management are related,The result also confirmed that the interaction of the irrigation amount and nitrogen rate was significant. Tomato plants are sensitive to water stress. Suboptimal application of nutrients and low soil fertility status, especially nitrogen and phosphorus, also adversely affect tomato yield.

### 3.3. Water Productivity

*Table 6: Irrigation water use efficiency and water productivity of tomato*

| TRT | Av yield data | Applied water | WUE | WP |
|---|---|---|---|---|
| N+100 | 28100.0 | 8500 | 3.31 | 3.3 |
| H+100 | 30500.0 | 8500 | 3.59 | 3.6 |
| Fc+100 | 30733.3 | 8500 | 3.62 | 3.6 |
| Ff+100 | 30850.0 | 8578 | 3.63 | 3.6 |
| N+75 | 23983.3 | 6434 | 3.75 | 3.7 |
| H+75 | 29483.3 | 6434 | 4.61 | 4.6 |
| Ff+75 | 31183.3 | 6434 | 4.87 | 4.9 |
| Fc+75 | 32000.0 | 6434 | 5.00 | 5.0 |
| N+50 | 27200.0 | 4389 | 6.33 | 6.3 |
| H+50 | 27266.7 | 4389 | 6.34 | 6.3 |
| Ff+50 | 28300.0 | 4389 | 6.58 | 6.6 |
| Fc+50 | 30350.0 | 4389 | 7.06 | 7.1 |

### 3.4. Partial budget analysis

The highest marginal rate of return (MRR) was obtained on the application of full vermin compost combined with 75%ETc, followed by full inorganic fertilizer combined with 100%ETc (Table 8). Therefore, the application of 75% ETc recommended vermi-compost resulted in the highest net benefit as well as an acceptable (9116%) rate of return for the invested capital. The application of 75% ETc with recommended vermi compost also resulted in the highest MRR (9116%) with a reasonable net benefit (854625ETB) and could be an alternative setting if irrigation water is limited (Table 8)

*Table 7: Gross benefit, Variable cost, Net benefit and Marginal rate of return of treatments*

| TRT | Av yield data | Adjusted yield | Gross benefit | Var. cost | Net beft | %MRR |
|---|---|---|---|---|---|---|
| N+100 | 28100 | 25290 | 758700 | 0 | 758700 | 0 |
| N+50 | 27200 | 24480 | 734400 | 0 | 734400 | 0 |
| N+75 | 23983.3 | 21585 | 647550 | 0 | 647550 | 0 |
| Fc+75 | 32000 | 28800 | 864000 | 9375 | 854625 | 9116 |
| Fc+100 | 30733.3 | 27660 | 829800 | 9375 | 820425 | 8751.2 |
| H+100 | 30500 | 27450 | 823500 | 10103 | 813397 | 8051.1 |
| Ff+75 | 31183.3 | 28065 | 841950 | 12706.3 | 829243.8 | 6526.3 |
| Ff+100 | 30850 | 27765 | 832950 | 12706.3 | 820243.8 | 6455.4 |
| H+75 | 29483.3 | 26535 | 796050 | 10103 | 785947 | 7779.3 |
| H+50 | 27266.7 | 24540 | 736200 | 10103 | 726097 | 7186.9 |
| Fc+50 | 30350 | 27315 | 819450 | 9375 | 810075 | 8640.8 |
| Ff+50 | 28300 | 25470 | 764100 | 12706.3 | 751393.8 | 5913.6 |

*Price of vermi-compost 10EtB $kg^{-1}$ [14;21]*

The highest marginal rate of return (MRR) was obtained on the application of full vermi-compostcombined with 75%ETc followed by full inorganic fertilizer combined with 100%ETc(Table 5).Therefore, the application of 75% ETc with $ha^{-1}$ resulted in the highest net benefit as well as an acceptable rate of return (9.1) for the invested capital. The application of 75% ETc with 7.5t $ha^{-1}$ also resulted in the highest net benefit (854625EtB) with a reasonable marginal rate of return (9116%) and could be an alternative setting if irrigation water is limited (Table7)

## Conclusions and Recommendations

The result over the two years revealed that there were significant differences among treatments on most parameters except plant height on in the first year. This result obtained due to the application of vermi-compost and optimum irrigation water.

The significant differences also observed among the treatments on average fruit weight, marketable yield and unmarketable fruit yield due to the interaction effect of vermi-compost and optimum application of irrigation levels.

In tomato farming, the interplay between nutrient, particularly vermi-compost, and water management is crucial. The study found that both the irrigation level and integrated fertilizer application significantly impact tomato yield and water use efficiency (WUE).The highest results were obtained irrigation (75% ETc) level. However, in water-limited conditions, a reduced irrigation level (50% ETc) with a lower zero fertilizer application provided the highest WUE. Thus, optimum irrigation water application (75% ETc) combined with recommended vermi-compost application for both tomato production and soil fertility improvement in drought prone area of west Hararghe zone and similar agro-ecology. The application of recommended vermin-composting with 75%ETc recorded the highest on most parameters. The highest economic return was 854625 ET birr $ha^{-1}$ with acceptable marginal rate at 9116%.

**Recommendations**

Agricultural application of optimum irrigation water application and recommended vermin-compost is not only yield advantage also more than (3$tonha^{-1}$) other treatment.On the second, using full vermin-compost with 75%ETc irrigation level has (2.5$tha^{-1}$) yield advantage than other treatments.Thus, full vermin-compost combined with 75%ETc recommended as the first for the study area in yield advantage, water saving and economic benefits.The full vermin-compost (recommended) combined with 100%ETc is recommended as the second option in respect to higher tomato yield, economic benefit, and marginal rate of returns. Therefore, the recommended treatments will be used for the study area and similar agro-ecology.

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