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Effect of Alternate Furrow Irrigation with Different Irrigation Intervals on Tomato (*Lycopersicon E.*) Yield and Water Use Efficiency

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Abstract: Experiment was conducted at Eastern Ethiopia of Harari Regional State of Erer Woldiya district, on farmers' field for two years. The purpose of this study was to evaluate the effect of AFI and EFI with different irrigation intervals on growth component, yield and water use efficiency of tomato for two years 2018 and 2019. Accordingly plant height and NFPP were significantly ($P<0.05$) influenced by (IMs), whereas (IIs) had highly significant ($P<0.01$) effect on plant height and NFPP at both planting season. Total tomato yield was significantly influenced ($P<0.05$) by furrow IMs, but application frequency had highly significant ($p<0.01$). Water saved from treatment combination of AFI with 4, 6 and 8 days water IIs were 16%, 44% and 58% of total volume of irrigation water applied. Whereas water saved from EFI with 6 and 8 days of application was 33.3% and 50% respectively. AFI with 4 day water application shows little yield reduction as 4.97%, as compared with no stressed treatment; EFI with the same water application frequency). But AFI with 4 day II was saves 16% water from gross water applied for no stressed treatment EFI with 4 day. Treatment with 6 day II of AFI and, EFI were indicated that significant yield reduction as 15.74% and 14.61% respectively. But total amount of gross volume of irrigation water saved as 44 and 33.3% for AFI and EFI of the same II treatment. Crop water productivity (CWUE, IWUE and EWP) were highly significantly ($P<0.01$) influenced by both IMs and IIs. The result clearly confirms that, AFI had beneficial advantage over EFI on water saving and, the same consequent is happened for irrigation interval i.e. increasing interval from 4 day followed by 6 to 8 days increases water use efficiency of crop. Hence the result indicates that interaction effect of both factors (IMs and IIs) could save significant amount of irrigation water.

Keywords: Irrigation Methods, Irrigation Intervals, Tomato, Growth, Yield Parameters, Water Productivity

1. Introduction

Agriculture is the largest freshwater user on the planet, consuming more than two thirds of total withdrawals [1]. In many parts of the world, irrigation water has been over-exploited and over-used, and freshwater shortage is becoming critical in the arid and semiarid areas of the world [2, 3]. About 93% of the available fresh water resources are currently utilized in the agricultural sector [4]. The increasing population has resulted in demand for more food and fiber, which is met through increasing irrigated agriculture. It is critical therefore that management and utilization of available water resources is improved at all scales; from catchment, to irrigated district, to farm and field scale.

Traditional surface irrigation methods (basin, border and furrow) are widely used to irrigate crops. Those are however inefficient irrigation methods and considered one of the main causes of waterlogging and salinization [5]. The reason why small holders farmers practiced traditional, ones are affordability and capacity on the use of modern, high-tech and efficient micro irrigation methods (drip, bubbler, sprinkler etc.) which are advocated worldwide. Though those modern and efficient irrigations are available in developing countries like Ethiopia these methods have not yet been widely adopted by farming communities.

Therefore need more efficient irrigation methods that are economical, easy to install and operate, and which are readily acceptable to the farming communities are mandatory for this reason, introducing every furrow irrigation method (EFI) to be transformed into alternate furrow irrigation (AFI) then it might be readily accepted by farmers. However, before introducing and advocating this method to local farmers for adoption, the method needs to be evaluated under soil and climatic conditions for representative areas being targeted. According to different finding AFI method is basically the same as EFI, except that instead of irrigating every furrow, irrigation water is applied to alternate furrows, while the in-between furrows remain dry [6]. This means each ridge receives water from only one side, and the side receiving irrigation water could be changed with each irrigation if the field is set up to facilitate this change. Irrigating just one side of the ridge means there is significant potential to save irrigation water compared to EFI, with some yield reduction [7]. Moreover, [8, 9] reported (AFI) is considered to be one of the most effective tools to minimize water application and irrigation costs and produce a higher crop yield. The AFI method is a way to save irrigation water, improve irrigation efficiency, and increase corn yield.

Eastern part of Ethiopia (Harari Region), ranked as the last among region in terms of surface and ground water potential due to the topography and hydro-geological condition, [10]. The source of water for domestic and agricultural use especially for irrigation vegetable production during dry season is groundwater, which is availed by constructing traditionally hand-dug wells. Farmers fit their wells with pressurized engine pumps (centrifugal pump) exploit the water for irrigating their farm. Even though irrigation practice virtuous, they don’t have knowledge about irrigation management or water productivity. Farmers consider only water is applied to maximize crop yield (maximizing production per unit of land). So to resolve this ineffective irrigation practice and, to enhance best water saving, as compared to this situation they have to adopt optimum water productivity methods through practicing and promoting water-use efficiency and productivity techniques to optimize yield and cost incurred, like alternate and interval of irrigation as alternative irrigation to achieve on-farm water management and to get better yield with this scarce resource and minimize other variable cost. Generally this experiment aimed to evaluate the effect of AFI and EFI with different irrigation intervals on yield and water use efficiency.

2. Materials and Methods

The study was conducted in Harari Regional State of Erer Woldiya district in Erer Dodota kebele. Representative site was selected purposively based on availability resource required and willingness the farmer to brought the experimental land, as well as access for field monitoring and follow up. Accordingly the sites was situated at 42°11' 00" to 42°15' 30" and 9°15' 22" to 9°19' 35" East latitude and North longitude respectively. The site receives a mean annual rainfall of 400 mm. It has erratic and uneven in distribution, with mean minimum and maximum temperatures of 25°C and 35°C, respectively. The major soil types which occur in lowlands of the Erer Woldiya districts are Luvisols (Sandy soil) 90% and nitisols (clay) 10% [11]. The soil in the experimental site Erer dodota, being sandy loam.

2.1. Treatments and Experimental Design

The experiment has two factors, factorial design arranged in randomized complete block design (RCBD) with three replications. The treatments considered for the experiment were namely two furrow irrigation methods AFI (Alternative furrow irrigation and EFI (every furrow irrigation) and three irrigation interval or days (4, 6, and 8, interval for successive /next irrigation), hence there are six treatment combinations (Table 1).

Table 1. *Treatment description.*

S. №	Treatment	Treatment Combination
1	AFI_8	Alternative Furrow Irrigation (AFI) with 8 II
2	AFI_6	Alternative Furrow Irrigation (AFI) with 6 II
3	AFI_4	Alternative Furrow Irrigation (AFI) with 4 II
4	EFI_8	Every Furrow Irrigation (EFI) with 8 II
5	EFI_6	Every Furrow Irrigation (EFI) with 6 II
6	EFI_4	Every Furrow Irrigation (EFI) with 4 II

Note: II = Irrigation interval/day.

The experiment was conducted on individual plot size of 3.5 m x 5 m (15 m^2) with 18 number of such plot. The spacing between the blocks and plots were kept as 2 m and 1 m respectively. Each plot had 5 furrows and 4 planting ridges (rows) with 0.8 m and 0.3 m furrow and between plants spacing respectively. A test crop tomato (*Melka shola variety)* seed of (cultivar: *OPV*) was used which, was adapted in study area with a purity test of 98%, and having germination percentage of 85% collected from Fedis Agricultural Research Center (FARC) of Horticulture Department. Five weeks after germination seedlings were transplanted on experimental plots.

A common recommended fertilizer rate was applied manually in the experimental plots. All plots received the same amounts of fertilizer consisted of 150 kg ha^{-1} of urea and 100 kg ha^{-1} of P_2O_5 (DAP). The irrigation water used in the study was obtained from a well. Crop water requirements was estimated using the CROPWAT computer software program using and climatic, soil and crop data as input.

2.2. Soil Texture and Water Holding Analysis

Soil samples from the experimental plots were taken to analyze bulk density, texture, moisture content at filed capacity and permanent wilting point from the field at three points along the diagonal of the experimental plot at two depth 0-20 cm and 20-40 cm.

Soil texture, organic matter and pH measurement: The particle size distribution in the soil profile was done using hydrometric method following the procedure outlined in

[12]. For this purpose disturbed soil samples from the 3 locations on the experimental field was collected from a depth of 0-20 cm and 20-40 cm with the help of soil auger and composite samples were prepared. Organic carbon (%) was determined by potassium dichromate wet combustion producer [13] Organic matter was obtained by multiplying organic carbon by conversion factor of 1.724. The pH of the soil in experimental site was determined by calibrated AD-8000 model (EC, TDS, pH meter) was measuring instrument by preparing soil water solution of 1:2.5 ratio (soil to water) following procedures or guide line given by manufacturer.

Determining of FC, PWP moisture content and bulk density: Field capacity (FC), permanent wilting point (PWP) and bulk density (ρ_b) of the soil in the study area was determined from particle size result by using SPAW-version 6.2.0.75 software. After getting soil moisture values, water availability to crops from the soil was calculated. The total available water (TAW) in root zone is then be computed as the difference in moisture contents between field capacity (FC) and permanent wilting (PWP) as follows [14].

Crop water and irrigation water requirement: Crop coefficient (Kc) for initial, development, mid and late stages, root depth, allowable depletion level was determined from CROPWAT data base and FAO tables [14]. Meteorological data was collected from nearest station as Erer automatic meteorological station which was situated in Babile district. The station was established in since 2015. Even though the station was high precision there was no long-term data records, and no other optional station. Therefore available data of 4 year was used to determine reference evapotranspiration (ETo).

Table 2. *Average monthly climatic data of Erer Automatic recording meteorological station and reference evapotranspiration.*

Month	Minimum Temp (°C)	Maximum Temp (°C)	R. H (%)	Wind (km day^{-1})	Sunshine (hr)	Ra. (MJ m^{-2}day^{-1})	ETo. (mm day^{-1})
January	7.0	32.1	51	111	8.5	20	3.75
February	14.5	32.5	68	104	8.2	20.8	4.12
March	15.4	33.6	63	112	7.0	20.1	4.37
April	16.1	33.5	76	104	14.5	31.9	6.14
May	18.7	29.9	85	92	15.4	32.5	6.04
June	18.2	29.7	89	95	16.1	32.8	5.98
July	16.8	29.8	97	92	18.7	36.8	6.55
August	13.7	30.9	87	78	18.2	37.0	6.56
September	11.0	32.0	78	86	16.8	35.1	6.17
October	7.5	30.6	63	104	13.7	29.2	4.99
November	13.0	23.9	49	95	11.0	23.7	4.07
December	12.8	23.5	52	138	7.5	18.2	3.58
Average	13.7	30.2	72	101	13	28.2	5.19

RH= Relative humidity; Ra. =Radiation; ETo = Reference Evapotranspiration.

Water application and discharge measurement: Water source obtained from manual hand dug well pumped by using diesel fuel pump for irrigated vegetable production. The discharge was measured at pump delivery tube before reaching the field and it was directly measured at outlet. Smaller supply channels that were feed the furrows for furrow irrigation system and through careful opening and closure of channel banks, the water was supplied into furrows and the flow was measured by parshall flume in the field. Irrigation water was conveyed to the plots through a circular orifice and its quantity was calculated using the equation of immersed orifice as follows [15].

$$Q = 0.61\times 0.334 * A\sqrt{h} \quad (1)$$

where: Q = Quantity of irrigation water in l sec^{-1}, A = Area of the orifice in cm^2 and h = Effective water head over the orifice center in m.

Crop water use efficiency (CWUE) in kg m^{-3}: It is the ratio of crop yield (Y) to the amount of water required (WR) by the crop in the process of evapo-transpiration is formulated as:

$$CWUE = \frac{Y}{WR} \quad (2)$$

Irrigation water use efficiency (IWUE) in kg m^{-3}: It is the ratio of crop yield (Y) to the total amount of water (TW) used in the field determined as:

$$IWUE = \frac{Y}{TW} \quad (3)$$

Economical water productivity in (Birr m^{-3}): it is relates the economic benefits per unit of water used and calculated by:

$$WP = \frac{\text{Yield in cash in (value)}}{\text{Total water consumed in } (m^3)} \quad (4)$$

where; Wp is the economic water productivity in birr m^{-3}, out-put is the product of marketable yield and market price in birr, and water consumed in m^3.

Water saving was calculated by the following way [16]

$$\text{Water saved (\%)} = \frac{\text{Water used in Every FI - Water used AFI}}{\text{Water used in EFI}} \quad (5)$$

2.3. Data Analysis

All measured variables was subjected to analysis of variance appropriate for RCBD. Significant mean separation will be compared using least significant difference (LSD) and Duncan's Multiple Range Test (DMRT) by *Genstat* 15th version software was used for analysis of variance.

3. Result and Discussion

3.1. Soil Physical Properties of Experimental Field

Laboratory analysis result indicated that particle size distribution the study area was found as sand clay loam` throughout the depths of 0-20 cm and 20-40 cm. The average soil bulk density of 0-40 cm soil depth was 1.6 g cm^{-3}. Average available soil moisture content for the top (0-40 cm) soil depths was observed as 15.8% in volume percent and representative value of total available water (TAW) of 142.6 mm m^{-1} was obtained by considering the average of 0 - 40 cm soil depth. The average OM of the soil was found as 1.2%. Representative value of the soil pH at 1:2.5 soil to water was 6.5. Field level infiltration test indicated that basic infiltration rate of the experimental area soil was 24 mm hr^{-1} (Table 3).

Table 3. *Physical properties of experimental soil.*

Averaged values of 0-20 and 20-40 cm depth of soil						
			Particle size distribution			
			Sand (%)	**Silt (%)**	**Clay (%)**	**Textural class**
			65	**25**	**10**	**Sandy clay loam**
BD (gcm^{-3})	**FC (Vol. %)**	**PWP (Vol. %)**	**TAW (mm m^{-1})**	**OM (%)**	**pH**	**Infiltration rate (mm hr^{-1})**
1.6	24.5	14.3	142.6	1.2	6.5	24.0

Note: FC =Field capacity volume base: PWP = Permanent wilting point volume base: BD = bulk density; TAW = Total available water: OM = Organic matter: pH = power of Hydrogen.

3.2. Gross Irrigation Water Applied for Each Growth Stages of Treatments

All treatments were conducted according to the initially planned framework and followed the required amount of gross water applied for each stages. Comparison of two irrigation methods (IMs); alternating furrow irrigation (AFI) and every furrow irrigation (EFI) under three irrigation intervals (IIs): (4, 6 and 8 day) as described in Table 4.

From practical point of view for alternate furrow irrigation (AFI) method, water applied only two or three furrow at each successive irrigation event if the plot have five irrigation furrow o, so water saved from these irrigation method was greater than EFI for each event throughout growth season, even though, the yield obtained was less than full or every furrow irrigated once per predetermined irrigation interval.

Table 4. *Water applied per growth stage and water saved from each treatments.*

Treatments	Irrigation water in (mm) per each growth stage				I_{gross} (mm)	Water saved in (%)
	Initial	Development	Mid	Late		
AFI with 8 day	33.1	45.3	64.6	49.9	321.6	58
AFI with 6 day	44.2	60.4	86.2	66.5	428.8	44
AFI with 4 day	66.3	90.6	129.3	99.8	643.2	16
EFI with 8 day	39.5	53.9	76.9	59.4	382.8	50
EFI with 6 day	52.6	71.9	102.6	79.2	510.4	33
EFI with 4 day	78.9	107.8	153.9	118.8	765.7	0
Total	314.6	429.8	613.6	473.6	3052.5	

3.3. Effect of IMs and IIs on Growth Yield Components and Water Productivity

Effect of IMs and IIs on plant height: ANOVA shows that plant height at harvest maturity was significantly ($P<0.05$) influenced by irrigation methods, and IIs had highly significantly ($P<0.01$) effect during both planting seasons The highest mean plant height of both planting seasons 72.9 cm and 76.8 cm was recorded by EFI and every 4 day II respectively. Whereas the lowest mean plant height was observed at every 8 day water application interval as 64.2 cm in second year planting season which was not significant different from 6 day irrigation frequency (Table 5).

Effect of IMs and IIs on number of fruit per plant (NFPP): Number of fruit per plant was counted at fruit set stage or one week after flower drop of the crop. Statistical analysis indicates that NFPP was highly significantly ($p<0.01$) affected by IIs. But IMs had significant ($p<0.05$) effect on NFPP recorded during both planting seasons. The highest mean NFPP owned by EFI as 86.3 was observed in both planting season, whereas 96.9 and 91.8 NFPP was produced by every 4 day water application interval in first and second planting season respectively. The lowest mean NFPP produced as 70.9 and 63.4 were recorded by ever 8 day IIs as shown in Table 5. The result agreed with [20] reported that FI treatments gave the highest yield, plant diameter and number of leaves of tomato crop when compared with other treatments. In contrast of this study results, [21] reported that different irrigation levels did not significantly affect mean leaf number and plant diameter.

Effect of IMs and IIs on tomato yield: Analysis of variance indicated that total yield was significantly ($P<0.05$) influenced by furrow IMs in both planting season, whereas, IIs had highly significant (p<0.01) effect on yield. The highest mean total yield was recorded by EFI as 33.2 and 37.2 t ha^{-1} in respective planting season, while the lowest mean total yield of 31.5 t ha^{-1} was recorded by AFI, during first year (Table 5). Accordingly the result under different water application frequency lied in between 39.6 t ha^{-1} and 24.8 t ha^{-1} in increasing order from every 4 to 8 days II respectively.

Effect of IMs and IIs on water productivity and yield reduction: The result indicated that water saved from treatment combination of AFI with 4, 6 and 8 days water application were 16%, 44% and 58% of total volume of irrigation water applied. Whereas EFI with 6 and 8 day application obtained 33.3% and 50% respectively.

Table 5. *Effect of IMs and IIs on growth and yield components of tomato.*

Treatment		Two year data of crop growth and yield component					
		2017/18			2018/19		
		PH	NFPP	TY	PH	NFPP	TY
Irrigation method (IMs)	EFI	72.9	86.3	33.3	70.7	83.4	37.2
	AFI	70.0	80.8	31.5	67.5	73.6	34.9
	LSD	2.2	4.9	1.4	3.0	5.9	2.0
Irrigation intervals (IIs)	4 day	77.0^a	96.9^a	39.6^a	76.5^a	91.8^a	39.2^a
	6 day	70.6^b	82.6^b	33.1^b	66.4^b	80.3^b	35.3^b
	8 day	66.7^c	70.9^c	24.5^c	64.2^b	63.4^c	33.7^b
	LSD	2.7	6.0	1.7	3.7	7.3	2.5

PH-Plant height (cm): NFPP- Number of fruit per plant in (No.): TY-Total yield in (ton ha^{-1}) and, Note: mean followed by the same letter in the columns are not significantly different.

Table 6. *Average water saved and relative yield reduction of season.*

Treatments	I_{gross} (m^3)	Water saved (m^3)	Water saved (%)	Yield (kg ha^{-1})	Yield reduced (kg ha^{-1})	Yield reduced (%)
AFI with 8 day	3215.8	4440.9	58.0	27341.5	2006.5	32.3
AFI with 6 day	4287.7	3369.0	44.0	34040.0	6358.4	15.7
AFI with 4 day	6431.6	1225.1	16.0	38391.9	13056.9	4.9
EFI with 4 day	7656.7	0.0	0.0	40398.4	0.0	0.0
EFI with 6 day	5104.4	2552.3	33.3	34498.1	5900.3	14.6
EFI with 8 day	3828.3	3828.4	50.0	30625.8	9772.6	24.2

EFI with 4 day water application produced maximum yield because this treatment received maximum amount of water of all treatment, as a result no yield reduction observe or it used as control for comparison purpose. Whereas AFI with 4 day II shows little yield reduction which was indicated as 4.97%, as compared with no stressed (EFI with the same II). But AFI with 4 day II was saves 16% water from gross water applied when compared with no stressed treatment EFI with 4 day (Table 6).

Similarly treatment with 6 day II of AFI and, EFI were indicated that significant yield reduction as 15.7% and 14.6% respectively. But total gross volume of irrigation water saved as 44 and 33.3% for AFI and EFI of the same II treatment (Table 6). Hence water saved from AFI and EFI with 6 day II could irrigate more or additional cultivation land at water limited or scarce environment. Accordingly [25] concluded that water saved through improved irrigation systems could allow for an expansion of cultivation land and increase crop production in water limited area. Farmers' decisions are often driven by maximizing their return and rarely by environmental concerns; if they pursue efforts to save water, do they often use it to expand their irrigated areas or shift to higher value crops, rather than losing water allocation.

Table 7. *Effect of furrow IMs and IIs on physical water productivity.*

Treatment		Two year data of crop water productivity					
		2017/18			2018/19		
		CWUE	IWUE	EWP	CWUE	IWUE	EWP
Irrigation methods (IMs)	EFI	10.3	6.2	49.7	7.9	4.8	38.3
	AFI	11.6	6.9	55.5	8.9	5.3	42.6
	LSD	0.59	0.36	2.87	0.42	0.25	1.99
Irrigation intervals (IIs)	Every 4	9.4^b	5.6^b	45.2^b	6.2^c	3.7^c	29.9^c
	Every 6	11.8^a	7.1^a	56.8^a	8.4^b	5.1^b	40.3^b
	Every 8	11.6^a	6.9^a	55.7^a	10.7^a	6.4^a	51.1^a
	LSD	0.73	0.44	3.51	0.51	0.31	2.45

(CWUE) = Crop water use efficiency in kg m^{-3}: IWUE = Irrigation water use efficiency in kg m^{-3}: EWP = Economic water productivity in Birr m^{-3}.

Crop water use efficiency (CWUE): Statistical analysis (ANOVA) indicated that CWUE was highly significantly (P<0.01) influenced by both IMs and IIs. The highest of 11.6 kg m^{-3} and the lowest 7.9 kg m^{-3} was produced by AFI and EFI respectively from both planting season. Whereas CWUE, application frequency, was significantly increases when irrigation days or intervals decreased. Hence the result shows that, the highest CWUE 11.9 kg m^{-3} was obtained from 6 day water application intervals followed by 8 day as 11.6 kg m^{-3}, but statistically had not significant difference, and the lowest 9.4 kg m^{-3} was recorded at 4 day water application interval correspondingly (Table 7) in first year planting. Similarly the highest and lowest mean value 10.7 and 6.2 kg m^{-3} CWUE was recorded in second year respectively. It is also evident that, at each irrigation methods, the CWUE increased with increasing water application day i.e. 4 to 8 day.

Effect of furrow IMs and IIs on Irrigation water use efficiency (IWUE): The analysis of variance, showed that IWUE was highly significantly (P<0.01) influenced by both furrow IMs and IIs. The result revealed that IWUE was significantly increased from 4.8 to 6.9 kg m^{-3}, of EFI and AFI respectively that EFI method irrigation), both cropping season. Similarly the highest mean IWUE of 7.1 kg m^{-3} and the lowest as 3.7 kg m^{-3} was recorded by 6 day 4 day water application interval respectively during both planting season (Table 7). This result was agreed with [27]; report on wheat, the result reveals that WUE values was improved under AFI as compared with the EFI method. [17] For field grown potato showed that compared with FI (full irrigation), PRD (partial root drying) treatment saved 30% of water and increased water use efficiency. Moreover [28] reported that both AFI_7 and AFI_{14} achieved high WUE of maize was obtained as compared with EFI.

Effect of furrow IMs and IIs on Economic water productivity (EWP): The analysis of variance revealed that economic water productivity was highly significantly (P<0.01) influenced by both IMs and IIs. The result indicates that mean maximum economic water productivity value for AFI obtained as 55.5 ETB m^{-3}, which had significant different from EFI and the mean minimum EWP was recorded by EFI as 38.4 ETB m^{-3} for both planting season (Table 7). Accordingly, EWP was significantly influenced by different irrigation interval, the result showed that maximum value 56.8 ETB m^{-3} by every 6 day crop water application which was not significantly different from 8 day and the lowest by 4 day irrigation interval was recorded during first year cropping season. Whereas the second year data indicates that maximum EWP was obtained from 8 day II as 51.1 ETB m^{-3} followed by 6 day and the lowest as 29.9 ETB m^{-3} as described in the (Table 7). This result reveals that, economic water productivity depends on the ratio of yield obtained in cash to the amount and frequency of water applied in volume (m^{-3}) basis. Hence every 8 day irrigation interval had least water application frequency and similarly the yield was relatively lower when compared with 6 and 4 day water application interval, this resulted in superior economic water productivity.

4. Discussion

4.1. Gross Irrigation Water Applied for Each Growth Stages of Treatments

Hence the result indicated that water saved from treatment combination of AFI with 4, 6 and 8 day IIs were found as 16%, 44% and 58% of total volume of irrigation water applied. Whereas water saved from EFI with every 6 and 8 application days were 33% and 50% respectively (Table 4). According to [17] comparative report of FI (full irrigation) with PRD (partial root drying) for field grown potato shows, PRD treatments were saves' 30% of water which increases water use efficiency of the crop.

4.2. Effect of IMs and IIs on Growth, Yield Components and Water Productivity

Effect of IMs and IIs on plant height: The result indicates furrow water application methods and intervals had signEPbO,DFT*JYfPoO,DFJJfJvPtOHFv*EHYYPhOfFv*H*JP O,EfY
signEPbO,DFT*JYfPoO,DFJJfJvPtOHFv*EHYYPhOfFv*H*JHFv*EH
Poto sFv*LHL*PiOHFH4YFY*JF2ffDEvPeO,JvFYLJJ4DDvFY

Hence the result indicates that interaction effect of factors (IMs and IIs) saves significant amount of water. Hence, it could increasing addition irrigable land and/or improve minimize operation or variable cost. The same idea reported by some authors, according to [29], water productivity, is considerably increased by using APRD (alternative partial root drying) on different crops. [30] Also reported that PRD significantly reduced yield by 24%, while WP (water productivity) increased by 52% compared with the FI (full irrigation).

5. Conclusion

Experiment was conducted at Eastern Ethiopia of Harari Regional State of Erer Woldiya district, on farm field for two years. The purpose of this study was to evaluate the effect of AFI and EFI with different irrigation intervals on growth component, yield and water use efficiency of tomato. Accordingly the parameters for experimentation include growth component: such as plant height and number fruit per plant and yield parameter total fruit yield and, water productivities.

Plant height at harvest maturity was significantly ($P<0.05$) influenced by IMs, but IIs had shown highly significantly ($P<0.01$) effect on plant height on both planting season. Statistical analysis indicates that NFPP was highly significantly ($p<0.01$) affected by IIs. But NFPP was significantly affected ($p<0.05$) by irrigation methods at both planting seasons. Total fruit yield was significantly influenced ($P<0.05$) by furrow irrigation methods in both planting season, but the effect of water application days were highly significant ($p<0.01$).

Generally crop water productivity (CWUE, IWUE and EWP) revealed that, alternate furrow irrigation had beneficial advantage over every furrow irrigation on water saving and the same consequent perceived for irrigation interval i.e. increasing irrigation interval from 4 day followed by 6 to 8 days increases water use efficiency of crop. Hence the result indicates that interaction effect of (IMs and IIs) save significant amount of water. Hence water saved from treatment combination of AFI with 4, 6 and 8 IIs were 16%, 44% and 58% of total gross volume of irrigation water applied respectively. While EFI with 6 and 8 application day obtained 33% and 50%. Therefore amount of saved water from each treatment have advantage of increasing addition land, time or labor productivity. AFI with 4 day II shows little yield reduction which was indicated as 4.9%, as compared with no stressed (EFI with the same II). Accordingly AFI and, EFI were shows significant yield reduction as 15.7% and 14.6% respectively. But total amount of gross volume of irrigation water saved as 44% and 33.3% for AFI and EFI of the same IIs treatment.

6. Recommendation

The finding approves that farmers can practice AFI with 4 day II, as first option, it was identified as negligible yield reduction of less than 5% as compared to every furrow irrigation with the same II. Another alternative EFI and AFI with 6 day IIs was observed as a second option, if they pursue efforts to save water, do farmers often use it to expand their irrigated areas or shift to higher value crops. Finally all possible efforts could be made to introduce the technologies to the farming community since the use of furrow irrigation method with best fit IIs to save or sustain irrigated agriculture for next generation.

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