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Response of Irrigation Scheduling on Tomato *(Lycopersicon esculentum)* under Micro Irrigation System

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ABSTRACT
The present study was conducted at Agriculture researchfarm, IFTM University, Moradabad in Rabi season (October - March 2018). The experimental results revealed that maximum production of 640.64 q/h has been obtained under the treatment T3 (3 hr water applied in time interval of threeday) whereas minimum achieved under treatment T5 (control) i.e.468.28 quintal/hectare. Highest fruit weight was also recorded in T3 treatment as 15.50 kg/plant and lowest 10.80 kg/plant was obtained under T5 treatment. Highest water use efficiency (WUE) and benefit-cost ratio (BCR) also achieved under the T3 as 3.45 q/ha-cm and 3.67, respectively.
Key Words: *Drip irrigation method, Scheduling, Water use efficiency, Yield*

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INTRODUCTION
Tomato (*Solanum lycopersicum*) is one of the most important vegetable crop in the world.Water is increasingly becoming a scarce resource and the areas requiring irrigation are very extensive and encompass portions of every continent of the word. An earlier estimate made by [5] for average irrigation water utilization showed that farm distribution losses constitute 15% of irrigation water; while field application system losses constitute 25%, irrigation system losses 15% and the water effectively used by crops constitutes only about 45%. These statistics are of utmost importance if we know that the amount of water present in the universe is about 1520 million cubic kilometers, out of which 97% is ocean water, 2% is frozen arctic waters and only 1% water is present in lakes, rivers and underground water, which is portable water for direct use to humans. Many scientists previously done lots of work related to application of drip irrigation method to show its impact on various parameters; growth, weight and height etc. responsible for high crop production of tomato crop [1-7, 9-12]. They all have suggested that drip irrigation method has provided high yield and maximum water use efficiency and studied the relationship between irrigation amount, yield and quality.

MATERIAL AND METHODS
Location of experimental site
The experiment was carried out at IFTM University, Moradabad (U.P.). The research farm is geographically situated at 28°21´ to 28°16´ N latitude and78°4´ to 79° E longitudes at an altitude of193.23 m above the mean sea level. The present research has been conducted for the year, 2017-2018 crop duration on tomato from October to March in Rabi season.

Layout of drip irrigation system

The experimental setup consists of screen filter, main, sub mains, laterals, drippers and other accessories required for drip irrigation and fitted in the experimental plot of 0.006 ha land. Drippers having flow rate, 1.46 liter/ hour (lph) were fitted on the laterals at a spacing of 70 cm and the end plug fixed on each lateral of the plot to control the flow rate of all taps. Switching was allowed through small valves placed in the beginning of each treatment.

Table 1:Detail of experimental treatments

Treatment	Irrigation Scheduling
T1	1 hr in one day interval
T2	2 hr in two day interval
T3	3 hr in three day interval
T4	4 hr in four day interval
T5	Control

Experimental details

The experimental details for the test plots are given in Table 2.

Table 2: design of experimental details

Description	Unit	Details
Crop		Tomato
Variety	-	Hybrid NS-524
Botanical Name	-	*Lycopersiconesculentum*
Duration of crop	-	150-180 days
Plantation time	-	October
Temperature	-	25-30^{o}c
Net irrigation Area	Ha	0.006
Row to Row Spacing	Mtr	0.70
Plant to Plant Spacing	Mtr	0.50
Total No. of Plants	No	192
Emitter Per Plant	No	1
Emitter Discharge	LPH	1.46
Water Source		Tube well
Water Source Depth	Mtr	30

Crop

'Hybrid NS-524' variety of commercial tomato (*Lycopersicon esculentum Mill.*)has been selected for conducting trial and details of crop specification are given in Table 2. The selected crop was planted in the month of January and harvested in March.

Soil

Soil samples were collected from the different location of the field by physical properties was judged as sandy soil. Thedetailed physical properties of the soils are given in Table 3.

Table 3: Soil physical characteristics of experiment

Soil Depth (cm)	Size distribution of soil			Texture	Saturated Point (%)	F.C.	W.P.	EC
	Corse Sand	Fine Sand	Clay Silt	Class		(%)	(%)	(dSm^{-1})
0-20	43.7	48.76	2.85	Sandy	20	10	5.4	0.32
20-40	55.6	39.55	3.6	Sandy	18	12.4	6	0.29
40-60	40.6	9.42	3.5	Sandy	21	12.5	4	0.45

Weather Information

The meteorological data (average temp, humidity, sunshine duration, wind velocity, rainfall, and evaporation) of year 2016 were collected from the website (www.accuweather.com).The

minimum temperature occasionally falls below 1°C during winter in December and January were 16 °C. The mean annual rainfall is 904 mm.

Water Use Efficiency

Water use efficiency (WUE) is the yield that can be produced from a given quantity of water. It was worked out *by* using the following formula and expressed as (kg ha^{-1} cm^{-1}).

Field water use efficiency of each treatment was computed using the following equation:

$$\text{WUE} = \frac{\text{Yield of crop}(\text{kg ha}^{-1})}{\text{Total water used (cm)}}$$

$$\text{WUE} = \frac{\text{Y}}{\text{WR}}$$

Where,

Y = Weight of marketable produce of the crop (kg/ha)

WR=Depth of water used (cm)

Economical Analysis

The expenditure incurred from field preparation to harvest was worked out and expressed as Rs/ha. The green tomato yield was computed per hectare and the total income was worked out based on the prevailed minimum market rate of Rs. 5.0/Kg. The cost of drip system for one hectare was worked out based on current market rates. The life of the drip system was assumed to be 5 years.

Benefit-cost ratio (BCR):

The benefit cost ratio (BCR) was worked out by using the formula :.

$$\text{BCR} = \frac{\text{Grossreturn (Rs. ha}^{-1})}{\text{Totalcostofcultivation (Rs. ha}^{-1})}$$

Statistical Analysis

Statistical analysis of the data was performed using a completely RBD (Randomized box design) with three replications. The Data on various parameters studied during the course of investigation were statistically analysed, applying the technique of analysis of variance suggested by Panse and Sukhatme [8]. The treatment differences that were not significant were denoted by "NS".

RESULTS

Yield and Yield related Parameters

The physical characteristics of tomato crop recorded after every picking from the field and the average yield is expressed under various treatments are given in Table 4.

Table 4: Effect of different treatments on fruit weight of tomato (gm), plant height (cm), fruit yield (q/ha), water use efficiency (t/ha-cm), net return (Rs/ha and benefit-cost ratio (BCR) of tomato crop.

Treatments	Plant height (cm)	Fruit weight (gm)	Yield (q/ha)	Water depth (cm)	Water use efficiency (q/ha-cm)	Fruit weight (kg/plant)	Benefit-Cost Ratio
T1	16.26	46.77	515.86	18.54	2.78	11.40	2.97
T2	16.26	43.57	526.03	18.54	2.83	12.90	3.06
T3	17.33	48.77	640.64	18.54	3.45	15.50	3.67
T4	16.76	45.23	484.25	18.54	2.61	14.50	2. 81
T5	15.99	41.67	468.28	18.54	2.52	10.80	2.73

Table 5: Effect of irrigation scheduling on yield parameters of tomato

Treatments	Avg. plant height (cm)	Avg. fruit weight (gm)	Yield (q/ha)
T1	16.16	46.77	515.86
T2	16.26	43.57	526.03
T3	17.33	48.77	640.64
T4	16.76	45.23	484.25
T5	15.99	41.67	468.28
CD	0.496	5.09	45.031
SE(m)	0.150	2.733	13.597
SE(d)	0.212	3. 865	19.229
C.V.	1.569	10.473	4.469

Note: p=0.05 means significant at 5 % level, p=0.01 means significant at 1 % level

From Table 5, it is clear that maximum average yield of tomato has been recorded under the treatment T3 (when irrigation is done for three hour time interval in three days during whole crop period) while minimum was recorded when irrigation was applied every day for one hour interval (T1 treatment). From table 5it is also evident that, better growth and yield related parameters like average plant height (17.33 cm), average fruit weight (48.77gm), Yield (640.64 q/ha), Net return (233020Rs/ha), Water use efficiency (3.45 q/ha-cm)and Benefit- cost ratio (3.67) were also observed in treatment T3.The maximum yield was obtained from the treatment of (T3) i.e.644.8 (q/ha).
Thus, it can be concluded that treatment T3 ensured better growth and yield related parameters as compared to other treatments. T3 was able to save enough amount of water and supported the sustainable crop production..

The data on the economics of drip irrigation for tomato in one hectare are presented in gave Table 6.

Table 6: Cost Economics from per hectare of land under various treatments

S. No.	Description	T1	T2	T3	T4	T5
1	Fixed cost (Rs)	90000	90000	90000	90000	90000
	Life (Years)	5	5	5	5	5
	Annual cost (Rs) (a)	18000	18000	18000	18000	18000
	Interest @ 8% (Rs) (b)	7200	7200	7200	7200	7200
	Repair and maintenance (Rs) (c)	600	600	600	600	600
	Total Cost (Rs) (A=a+b+c)	25800	25800	25800	25800	25800
2	Cost of cultivation, (Rs/ha) (B)	61000	60050	61500	60500	60000
3	Seasonal total cost (Rs)(C= A+B)	86800	85850	87300	86300	85800
4	Maximum production (q/ha)	515.86	526.03	640.64	484.25	468.28
5	Selling price (Rs/q)	500	500	500	500	500
6	Income from produce (Rs) (D)	257930	263015	320320	242125	234140
7	Total Net seasonal benefit (Rs) E = (D – C)	171130	177165	233020	155825	148340
8	Benefit – Cost ratioF=(D/C)	2.97	3.06	3.67	2.81	2.73

From table 6, it can be concluded that treatment T3 in which three hours water is supplied to the root zone of the crop in every three days during whole crop grown period recorded the maximum net return. From this study we can conclude that, there is saving of more water from the treatment T3 and it also achieved best results such as maximum production, maximum net benefit by utilizing less amount of irrigation water which was the main aim of conducting present trial and these findings can serve as a benchmark in water deficit zones of the country to fulfill the food demands of rapidly growing population because of shrinkage of cultivation land and water resources.
The life of drip system varies from 5 to 10 years based on quality and maintenance of drip system. Hence a normal life of drip system of 6 years was considered for computation. The fixed cost towards installation of drip system was worked out to be Rs. 90000/ ha taking into the prevailing rate. For maximum highest seasonal net income was recorded in treatment T3. The Benefit – Cost Ratio (BCR) values worked for various treatments show that highest BCR was recorded with the treatment T3 (3.67) treatment. The lowest BCR was recorded under the treatment T5 (2.73).

CONCLUSION

From the present study, it can be concluded that modern irrigation system (drip) should be used for planning and management of available water resource by reducing water losses in large extent.Indian agriculture today faces the challenge of scarcity of irrigation resources and reduced water use efficiencies of various crops. In lieu of the above stated points it can be concluded that drip irrigation helps in obtaining higher yield and profit as well as it saves a lot of water.

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