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Effect of Drip Irrigation and Fertilizer Application on Quality and Water Use Efficiency of Brinjal (*Solanum melongena* L.)

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Abstract

Combination of 100% crop ET with 100% RDF recorded significantly highest fruit size and fruit yield. There was no significant difference between ascorbic acid content among various drip irrigation levels. The furrow irrigation recorded maximum ascorbic acid content. The water application and distribution efficiencies were higher in all the drip irrigation treatments as compared to furrow irrigation treatment. Combination of 60% ET and 100% RDF recorded maximum water use efficiency.

Key words : Drip irrigation, Furrow irrigation, Fruit weight, Size of fruit, Water use efficiency.

Irrigation water may be applied to brinjal by flooding on the field surface, by applying it beneath the soil surface, by spraying it under a pressure or by applying it in drops. The quantity of water applied by various systems and the different doses of fertilizer application influenced on the plant growth, yield and quality of brinjal. Hence an attempt was made to study the effect of drip irrigation and fertilizer application on quality and water use efficiency of brinjal crop.

Methods

The experiment was conducted during 2006 and the experiment was laid out using split plot statistical design with a total of eight treatments comprising five main treatments (irrigation levels) and three sub-treatments (fertilizer levels) and the treatments were replicated thrice to reduce diversity in observation and errors in readings. The treatment details are given as follows. Main treatments : I_1—Water application through drip at 60% crop ET, I_2—Water application through drip at 80% crop ET, I_3—Water application through drip at 100% crop ET, I_4—Water application through drip at 120% crop ET, I_5—Control treatment (conventional furrow method of irrigation). Sub-treatments : F_1—50% of the recommended dose of fertilizer (RDF), F_2—75% of the recommended dose of fertilizer (RDF), F_3—100% of the recommended dose of fertilizer (RDF).

The experiment was laid out on an area of 32 × 25 m, in black soil having uniformity in topography and physical properties. Treatmental plot size was 0.9 × 10 m consisting of 44 plants per plot. A space of 1.0 m between treatments and 1.0 m between replication was kept as buffer to avoid the border effect.

The five fruits selected randomly from each treatment were weighed and average fruit weight was worked out and expressed in grams per treatment. The average size of five fruit was expressed in terms of volume of fruits (cm^3) and was calculated by water volume displacement method.

Ascorbic Acid

Ascorbic acid content of fruit in each treatment was estimated by using the following formula.

$$\text{Ascorbic acid (mg/100 gm)} = \frac{\text{Ascorbic acid (mg) content in standard}}{\text{ml of aliquat}} \times \frac{V_2}{V_1} \times \frac{\text{Total sample volume (ml)}}{\text{Wt. of sample (g)}} \times 100$$

Table 1. Effects of irrigation and fertilizer application on size, average weight and ascorbic acid content of fruits.

Treatments	Size of fruits (ml)				Av wt of fruits (g)			
	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
I_1	8.567	10.733	11.767	10.356	126.723	129.073	133.997	129.931
I_2	16.000	17.733	17.567	17.100	146.903	149.197	152.427	149.509
I_3	19.067	21.667	22.900	21.211	155.603	167.830	167.517	163.650
I_4	13.967	15.000	16.167	15.044	137.603	141.693	144.683	141.327
I_5	8.800	8.263	9.003	8.689	112.460	116.480	121.283	116.741
Mean	13.280	14.679	15.481	14.480	135.859	140.855	143.981	140.232
		SE ±	CD at 5%		SE ±	CD at 5%		
Between two irrigation means		0.172	0.561		0.962	3.137		
Between two fertilizer means		0.105	0.309		0.485	1.430		
Between two fertilizer means at the same irrigation		0.235	0.691		1.084	3.197		
Between two irrigation means at the same or different		0.257	0.758		1.307	3.857		

Table 1. Continued.

Treatments	Ascorbic acid (mg/100 g)			
	F_1	F_2	F_3	Mean
I_1	5.560	6.103	6.597	6.087
I_2	4.637	7.030	7.000	6.222
I_3	5.410	6.673	5.750	5.944
I_4	6.217	6.137	6.7993	6.382
I_5	6.100	6.933	6.733	6.589
Mean	5.585	6.575	6.575	6.245
	SE ±		CD at 5%	
Between two irrigation means	0.177		0.579	
Between two fertilizer means	0.152		0.448	
Between two fertilizer means at the same irrigation	0.340		1.003	
Between two irrigation means at the same or different	0.329		0.972	

Where, V_1 = Concentration of Ascorbic acid content in working standard, V_2 = Titer value.
Ascorbic acid content of five fruits was then averaged and expressed in mg/100 g.

Irrigation Efficiencies

Various irrigation efficiencies given below were worked out.

Drip Irrigation. The application efficiency of drip irrigation was computed using equation given by Nakayama and Bucks (1).

Furrow Method. The application efficiency of furrow method of irrigation was computed using the following equation.

$$Ea = \frac{W_s}{W_f} \times 100$$

Where, Ea = Application efficiency (%), W_s = Water

Table 2. Application and distribution efficiency of different treatments.

Treatments	Application efficiency (%)	Distribution efficiency (%)
I_1	94.45	96.50
I_2	94.68	96.80
I_3	93.80	96.76
I_4	93.60	95.98
I_5	80.60	90.52

stored in the root zone of crop (liters), W_f = Water delivered to the field at the field supply channel (liters).

Distribution Efficiency. The distribution efficiency of drip irrigation system was computed by using following equation

$$E_d = 100\left(1 - \frac{\overline{\Delta q}}{\overline{q}}\right)$$

Where, E_d=Distribution efficiency, $\overline{q}$ = Mean emitter flow rate (liters), $\overline{\Delta q}$ =Average absolute deviation of all emitter flow from the average emitter flow (liters).

The distribution efficiency of furrow irrigation method was calculated by following equation.

$$E_d = 100\left(1.0 - \frac{\overline{y}}{\overline{d}}\right)$$

Where, E_d = Distribution efficiency (%), $\overline{y}$ = Average numerical deviation from d (cm), $\overline{d}$ = Average depth of water stored during irrigation (cm).

Water Use Efficiency

The water use efficiency is the production per unit cm of water applied. The water use efficiency for each treatment was computed using the following equation

$$Eu = \frac{Y}{WR}$$

Where, Eu = Water use efficiency (t/ha-cm), Y = Crop yield (t/ha), WR = Water requirement (cm).

Results and Discussion

The results on size of fruits, average fruit weight and ascorbic acid content in response to various drip irrigation levels and different fertilizer levels are given in Table 1. It is observed that the highest fruit size (21.21 ml) and fruit weight (163.65 g) was observed in the treatment irrigated with 100% crop ET followed by 80, 120 and 60% crop ET respectively. The least fruit size and average weight of the fruit was observed in furrow irrigation which was significantly less than other treatments except 60% crop ET.

Among different fertilizer levels, the treatment that received 100% RDF recorded the highest fruit size (15.48 ml) and fruit weight (143.98 g) followed by 75% RDF and 50% RDF respectively.

Interaction effects were found significant in both size of the fruits and average weight of the fruits. Combination of 100% crop ET with 100% RDF recorded significantly highest fruit size (22.90 ml) followed by 100% crop ET with 75% RDF and 50% RDF (21.66 and 19.06 ml, respectively). Significant differences were observed among fertilizer levels with respect to average fruit weight. Combined application of 100% crop ET (I_3) with 75% RDF recorded maximum average fruit weight (167.83 g) which is at par with 100% crop ET with 100% RDF (167.51 g). Significantly lowest size of the fruit (8.263 ml) was recorded in furrow irrigation at 75% RDF and lowest average weight of fruit (112.46 g) recorded in furrow irrigation with 50% RDF.

There is no significant difference between ascorbic acid content among drip irrigation levels. The furrow irrigation recorded maximum ascorbic acid content and it was on par with other drip irrigation levels

Table 3. Effects of irrigation and fertilizer application on water use efficiency of brinjal (t/ha-cm).

Treatments	F_1	F_2	F_3	Mean
I_1	7.543	7.753	7.870	7.722
I_2	5.965	6.087	6.396	6.150
I_3	5.530	5.060	5.650	5.413
I_4	4.035	4.296	4.165	4.166
I_5	2.087	2.073	2.273	2.144
Mean	5.032	5.054	5.271	5.119
SE ±	CD at 5%			
0.106	0.346	Between two irrigation means		
0.056	0.165	Between two fertilizer means		
0.125	0.368	Between two fertilizer means at the same irrigation		
0.147	0.434	Between two irrigation means at the same or different		

except 100% crop ET. Ascorbic acid content differed significantly with regard to different levels of fertilizer. The plant receiving 100% RDF and 75% RDF recorded same ascorbic acid content (6.57 mg/100 g) and a significant difference was observed in plants receiving treatment, 50% RDF with 80% crop ET (I_2).

The better performance of plants in terms of size of fruits and average weight of fruit may be attributed to the frequent and consistent application of water in the vicinity of the roots which provides a good soil moisture regime in the crop root zone throughout the life period of crop. These results are in agreement with the earlier findings of Gorantiwar et al. (2) in bhendi and Deolankar and Firke (3) in chilli.

With regard to irrigation efficiency it is observed that the application efficiency (Table 2) ranged from 93.60 to 94.68% for drip irrigation treatments and it was 80.60% for furrow irrigation. The application and distribution efficiencies were higher in all the drip irrigation treatments, I_1, I_2, I_3 and I_4 as compared to furrow irrigation treatment, I_5. The above findings of application and distribution efficiency under the present study agree with the earlier findings of Nakayama and Bucks (1). The higher application efficiency in drip irrigation as compared to furrow irrigation system may be due to the reason that in drip irrigation water is applied as required by plant, thus the percolation losses will be zero below the crop root zone and the surface runoff losses are very negligible. The higher distribution efficiency values in case of drip irrigation are due to the efficient conveyance system using conduits which results in minimum conveyance losses unlike in furrow irrigation where water is conveyed through porous soil media.

The interactions between the irrigation and fertilizer levels were significant. Combination of 60% crop ET (I_1) with 100% RDF (F_3) recorded maximum water use efficiency (7.87 t/ha-cm) which is on par with 75% RDF and 50% RDF (7.75 t/ha-cm and 7.54 t/ha-cm respectively). Significantly lowest water use efficiency was observed in furrow irrigation (2.27 t/ha-cm) with 75 per cent RDF (F_3).

The higher value of water use efficiency for drip irrigation treatments over furrow irrigation are due to the fact that drip irrigation consumes considerably lesser amount of water than furrow irrigation and provides favorable conditions for plant. These results are in line with Mane et al. (4) and Gorantiwar et al. (2) in bhendi.

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