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A CASE STUDY

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Studies on irrigation efficiencies with different drip systems and their economic analysis for bitter gourd (*Momordica chanrantia* L.)

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ABSTRACT
A field experiment was carried out to study the irrigation efficiencies with different drip systems and their economic analysis for bitter gourd under semi arid conditions of Raichur during *Rabi*/summer 2009-10. The different drip irrigation levels included T_1 - 60 % ET, T_2 - 80 % ET, T_3 - 100% ET, T_4 - 120 % ET and T_5 – furrow irrigation (control). The results of the study indicated that 80 and 100 per cent ET level with drip irrigation exhibited superior values for different irrigation efficiencies when compared to other drip irrigation levels and furrow irrigation. All the drip irrigation treatments recorded higher benefit: cost ratio (2.64 to 3.86) except 60 per cent ET level (0.94) as compared with furrow irrigation (2.13).

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Key words : Bitter gourd, Drip irrigation, Irrigation efficiency, Economic studies

INTRODUCTION

Drip irrigation is gaining importance in the world, especially in areas with limited and expensive water supplies, since it allows limited resources to be utilized more judiciously. Drip irrigation is the method of slow and frequent application of water approximately equal to the consumptive needs of the plants. Filtered water is distributed under low pressure by means of emitters on or in the soil. In drip irrigation, low discharge of water is applied more frequently close to the plant through suitably spaced drippers. In that case, part of the soil in the vicinity of plant roots is wetted and kept close to field capacity. Physically these systems are adoptable to wide range of soil topography and crops. This method not only ensures highest economy in water utility, reduced evaporation and seepage losses, but also provides ideal moisture regimes for high yields in many crops.

Bitter gourd (*Momordica chanrantia* L.) is a member of the Cucurbitaceous family. It is widely grown in China and India and throughout Southeast Asia. The widely spaced crops and vegetables have been found to be feasible for their economic and biological returns considering high initial costs incurred in drip irrigation systems. Also the irrigation efficiency factors need to be verified while choosing a suitable drip irrigation system.

MATERIALS AND METHODS

A field experiment was carried out at Main Agricultural Research Station, Raichur during *Rabi*/ summer 2009-10. The experiment was laid out in a randomized block design with 5 treatments (T_1 - 60 % ET, T_2 - 80 % ET, T_3 - 100 ET, T_4 - 120 % ET, T_5 - Control treatment) and 4 replications. The climate of the site is typical semi arid environment with an average rainfall of 722 mm per anum. The soils are black sandy loam representing a major soil type of the region. The application efficiency, distribution efficiency and water use efficiency for drip and furrow irrigation were computed and

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compared. (Nakayama and Bucks, 1986).

The application efficiency of drip irrigation was computed using the equation given by Nakayama and Bucks (1986), and the equation is expressed as follows.

$$e_a = \frac{e \times qmin \times T}{V} \times 100$$

where,

e_a = Application efficiency, per cent
e = Total number of emitters
q_{min} = Minimum emitters flow rate, lph.
T = Total irrigation time, hr
V = Total volume of water applied, L

The application efficiency of furrow irrigation was computed using the following equation

$$e_a = \frac{Ws}{Wf} \times 100$$

where,

e_a = Application efficiency (%)
W_s = Water stored in root zone of crop, L
W_f = Water delivered to the field.

The distribution efficiency of drip irrigation was computed using the equation given by Nakayama and Bucks (1986).

$$e_d = 100 \times \left[1 - \frac{\overline{\Delta q}}{\overline{q}}\right]$$

where,

e_d = distribution efficiency, per cent
q = Mean emitter flow rate, L
?q = Average absolute deviation of all emitter flow from the average emitter flow, L.

For furrow irrigation method the equation used to calculate the distribution efficiency is as follows (Michel, 1982).

where,

$$e_d = 100\left[1 - \frac{\overline{y}}{\overline{d}}\right]$$

e_d = Distribution efficiency (%)
y = Average numerical deviation from d, cm
d = Average depth of water stored, cm.

The field water use efficiency of each treatment was computed using the following formula

$$ed = \frac{y}{WR}$$

where

e_u = Field water use efficiency, kg/m^3
Y = Crop yield, kg
WR = Total amount of water used in the field, m^3

Economics of drip irrigation and furrow irrigation method was worked out to compute the net returns and the benefit-cost ratio. For this purpose, the life period of polyvinyl chloride (PVC) items was considered as ten years and that of the submersible pump set was taken as fifteen years. One ha area, under each treatment was considered for comparison. The fixed cost, operation cost and total cost were worked out. These parameters were used to compute net returns and work out B-C ratio.

Further, an attempt was made to calculate additional benefits that can be obtained, if the water needed to raise 1 ha of bitter gourd crop through furrow irrigation is used through drip irrigation, assuming that the land is not a constraint and the crop response to other inputs remains constant. The important parameters verified to work out the projected additional returns from saved water in drip irrigation were water saved over furrow, yield, net returns, additional yield with saved water, total yield, yield increase over furrow, increase in net returns with saved water and projected net returns. These parameters were worked out as per the standard procedures.

RESULTS AND ANALYSIS

The present studies indicated that 80 and 100 per cent ET level with drip irrigation exhibited superior values for different irrigation efficiencies when compared to other drip irrigation levels and furrow irrigation.

The irrigation efficiency factors are very important in deciding the efficiency of drip systems and status of availability of water to plants. In the current studies the application and distribution efficiencies were higher in drip irrigation treatments than that of furrow irrigation with maximum value in case of 60 per cent ET treatment. These findings are in agreement with the earlier findings of Chowde Gouda and Jangandi (1995). The higher application efficiency in drip irrigation as compared to furrow irrigation system was due to the fact that, in drip irrigation water will be applied as per plant water requirement and percolation losses below the crop root zone and the surface runoff losses are very less, which results in higher application efficiency.

The higher application and distribution efficiencies in case of drip irrigation treatments was mainly due to the conveyance system using conduits which were responsible for minimum conveyance losses unlike in furrow irrigation. Normally in case of furrow irrigation the water is conveyed in field through soil media leading to sizeable conveyance losses. But in drip irrigation treatments water is discharged uniformly without much variations.

Among the drip irrigation levels higher water use efficiency was found in 80 per cent ET treatment indicating more efficient use of irrigation water closely followed by 100 per cent ET level. This may be due to higher water use efficiency recorded by both 80 and 100 per cent ET treatments which were 3.73 and 3.45 times more as compared to furrow irrigation (Table 1). The higher water use efficiency at 80 and 100 per cent ET level was mainly due to relatively lower degree of moisture stress created in the respective treatments. The above discussion suggests that higher bitter gourd yields could be achieved by adopting drip irrigation schedule at 80 and 100 per cent ET levels. The present investigations fall in line with that of the findings of Balasubramanyam *et al.* (2001).

Table 1: Effect of irrigation methods and different levels of irrigation on irrigation efficiencies

Treatments	Application efficiency (%)	Distribution efficiency (%)	Field water use efficiency (kg/m^3)
T_1: 60 % ET	93.75	97.10	4.36
T_2: 80 % ET	93.50	96.40	8.17
T_3: 100 % ET	93.20	96.10	7.55
T_4:120 % ET	92.75	95.70	4.91
T_5: Control	85.30	92.00	2.19

The yield per hectare is the ultimate factor which decides the superiority of any treatment in terms of not only its biological returns but also its economic returns. In the present investigations highest bitter gourd yield was produced by 100 per cent ET level followed by 80 per cent ET level which were at par. The yield levels achieved by 100 per cent ET level were higher by 65.40 per cent as compared to furrow irrigation and by 150 per cent compared to 60 per cent ET level. The trend clearly suggests the superiority of 100 per cent ET level when compared to all other drip and furrow irrigation treatments (Table 2). This advantage is not only in terms of superior yields but also in terms of water saved. These results are in agreement with the findings of Dalvi *et al.* (1999).

In the present study, it is evident from the results that the drip irrigation is financially viable at 100 per cent ET and 80 per cent ET levels as compared to other drip irrigation levels and furrow irrigation.

The initial cost of installing the drip irrigation system for vegetable crops is high but over a period of time the cost could be recovered and the benefits derived would be higher than furrow irrigation. Even during the first year itself the drip irrigation system at 100 per cent ET and 80 per cent ET level showed maximum net returns as compared to other drip irrigation treatments and furrow irrigation. The net returns in case of 100 per cent ET level was more by 87.60 per cent as compared with furrow irrigation. Similar trend was also exhibited in terms of benefit: cost ratio which was highest (3.86) in case of 100 per cent ET treatment. The results fall in line with the findings of Sivanappan (1996).

The water saved by different drip irrigation systems was maximum in case of 60 per cent ET level and minimum in case of 120 per cent ET level. But the additional yield with saved water was maximum by 80 per cent ET level

Table 2 : Economics of furrow and drip irrigation levels in bitter gourd crop

Treatments	Crop yield t/ha	Total returns Rs/ha	Total cost of cultivation Rs/ha	Net returns Rs/ha	Benefit cost ratio
T_1: 60 % ET	9.13	63910	32947.807	30962.19	0.94
T_2: 80 % ET	20.93	146510	32947.807	113562.19	3.45
T_3: 100 % ET	22.88	160160	32947.807	127212.19	3.86
T_4: 120 % ET	17.17	120190	32947.807	87242.19	2.64
T_5: Control	13.67	95690	30578.32	65111.68	2.13

Table 3 : Projected additional return from saved water in drip irrigation levels

Treatments	Water saved over furrow (%)	Yield (t/ha)	Net returns (Rs/ha)	Additional yield with saved water (tons)	Total yield (tons) (3+5)	Yield increase over furrow (tons)	Increase in net returns with saved water (Rs)	Projected net returns with drip irrigation from water used in furrow (Rs) (4+8)
1	2	3	4	5	6	7	8	9
T_1: 60 % ET	66.45	9.13	30,962.2	9.18	18.31	4.64	31312.2	62,274.4
T_2: 80 % ET	58.96	20.93	1,13,562.2	18.70	39.63	25.96	97952.2	2,11,514
T_3: 100 % ET	51.50	22.88	1,27,212.2	17.79	40.67	27.00	91582.2	2,18,794
T_4:120 % ET	44.00	17.17	87,242.2	11.44	28.61	14.94	47132.2	1,81,506
T_5: Control	-	13.67	65111.7	-	13.67	-	-	65111.68

followed by 100 per cent ET level. However, the total yield was found to be maximum in 100 per cent ET level and which was 1.97 times more than furrow irrigation (Table 3). Similar to these trends the maximum projected net returns with drip irrigation was found in case of 100 per cent ET level.

This finding suggests the superiority of 100 per cent ET level over other drip and furrow irrigation treatments. Thus it could be inferred that under sandy loam soils of semi arid track 100 per cent ET level of drip irrigation can be ideal for successful bitter gourd cultivation. The findings suggest that 80 and 100 per cent ET level of drip irrigation for bitter gourd could produce highest fruit yield with superior B-C ratio. Further these treatments could produce superior projected net returns with saved water when compared to traditional furrow irrigation method.

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