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Research Paper :

Effect of different drip irrigation levels on growth and yield of bitter gourd (*Momordica chanrantia.* L) in semi arid conditions of Karnataka

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ABSTRACT

A field experiment was carried out to study the effect of different drip irrigation levels on growth and yield of bitter gourd in 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 data revealed that 100 per cent ET level with drip irrigation produced superior values for plant height, number of branches, days taken for initiation of male and female flowers, number of fruits per plant, average fruit weight, fruit length, fruit girth and yield per hectare. The yield and yield parameters on either side of 100 per cent ET level and with furrow irrigation showed a decreasing pattern.

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Key words : Bitter gourd, Drip irrigation, Water requirement, Semi arid region

The sources of irrigation water are limited and the demand for agricultural produces is increasing. Therefore, it is necessary to adopt efficient use of water through micro irrigation systems like drip which saves 27 to 42 per cent of water. The micro irrigation area has been increasing steadily. Micro irrigation helps to conserve irrigation water and increase water use efficiency by reducing soil evaporation and drainage losses. It also helps to maintain soil moisture conditions that are favourable to crop growth. Thus micro irrigation can help to sustain the productivity of the land. The dry land ecosystems in the semi arid tracts are blessed with rich natural resources required for crop production except the water. In these areas micro irrigation technology is rapidly expanding not only because of its water economy but also due to higher biological returns. Among the different crops vegetables have been found to be highly responsive to micro irrigation. Bitter gourd (*Momordica chanrantia* L.) crop is grown on a sizeable area owing to its food and medicinal importance. It is a member of the Cucurbitaceous family. It is widely grown in China and India and throughout Southeast Asia. The present investigation was, therefore, undertaken to find out the optimum drip irrigation levels for bitter gourd in order to economize the use of water and to enhance the productivity under the semi arid tract of Raichur.

METHODOLOGY

A field experiment was conducted 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 soil was black sandy loam with a pH of 7.39 having normal EC (0.26 dSm^{-1}) and low in organic carbon (0.32 %), medium in available N (296.12 kg ha^{-1}), medium in available P_2O_5 (39.47 kg ha^{-1}) and low in available K_2O (48.36 kg ha^{-1}). The Bitter gourd variety Coimbatore long was grown with all the recommended practices. The irrigations were given as per the treatment. The daily water requirement for drip irrigation was computed using data from USDA Class-A open pan evaporimeter. The water requirements of bitter gourd crop per day per plant under drip irrigation were computed using the following equation.

$$Q = \frac{A \times B \times C \times D}{E}$$

where,

Q = Quantity of water required lpd.
A = Gross area per plant (m^2)
B = Amount of area covered with foliage fraction
C = Crop co-efficient, fraction
E = Efficiency of drip irrigation system (%)

$$D = K_p \times E_{pan}$$

where,
K_p = pan co-efficient
E_{pan} = Evaporation from Class-A open pan mm

The amount of water to be delivered through furrow irrigation method was computed using the following equation.

$$d = \frac{M_{fc} - M_{bi}}{100} \times A_s \times d_s$$

where,
d =Net amount of water to be applied during irrigation (cm)
M_{fc} = Moisture content at field capacity (%)
M_{bi} = Moisture content before irrigation (%)
A_s = Bulk density of soil (g/cc)
d_s = Effective root zone depth (cm)

Quantity of water (litres) required per plant is given by

$$Q = d \times A \times B$$

where,
Q=Quantity of water required per plant (litre)
d=Net amount of water to be applied during an irrigation (cm)
A = Gross area per plant (cm^2)
B = Extent of area covered by foliage, fraction.

The observations on growth parameters like plant height, number of branches, days taken for initiation of male and female flowers, number of fruits per plant, average fruit weight, fruit length, fruit girth and yield per hectare were recorded.

RESULTS AND DISCUSSION

The capacity of unit quantity of water to irrigate a crop is an important factor for any irrigation system. Table 1, presents the capacity of one m^3 of water to irrigate bitter gourd crop during its growth period. It can be seen from the table that, with increase in the level of irrigation, the amount of water applied also showed an increasing trend, whereas the irrigation capacity was found on a decreasing pattern. It was also observed that, the irrigation capacity was lowest (1.60×10^{-4} ha/m^3) for furrow irrigation. The highest irrigation capacity of 4.77×10^{-4} ha/m^3 was obtained for the treatment water application at 60 per cent ET. These results are in agreement with the earlier findings of Bafna *et al.* (1993).

Table 1 : Water applied and irrigation capacity (duty) of 1m^3 of water for different treatments for the crop period

Treatments	Water applied in (litre/plant)	Water applied in (m^3/ha)	Irrigation capacity (ha/m^3)
T_1: 60 % ET	157.00	2093.44	4.77×10^{-4}
T_2: 80 % ET	192.03	2560.53	3.90×10^{-4}
T_3: 100 % ET	227.01	3026.95	3.30×10^{-4}
T_4:120 % ET	262.13	3495.24	2.86×10^{-4}
T_5: Control	468.00	6240.31	1.60×10^{-4}

The differences due to growth parameters were more striking in different drip irrigation methods as compared to furrow method. The crop condition under drip irrigation treatments had better growth in terms of higher plant height, more number of branches and optimum number of days in flower initiation of both male and female flowers as compared to furrow irrigation (Table 2). Better growth of plants led to higher yield in drip

Table 2 : Effect of irrigation methods and irrigation levels on plant height (cm), number of branches, days taken for initiation of male and female flowers at different intervals

Treatments	Plant height (cm) at harvest	Number of branches at harvest	Days taken for initiation of male flowers	Days taken for initiation of female flowers
T_1: 60 % ET	176.88	7.05	44.75	53.50
T_2: 80 % ET	197.50	8.80	46.75	56.50
T_3: 100 % ET	218.30	9.25	50.25	60.75
T_4:120 % ET	184.95	8.40	53.00	66.25
T_5: Control	180.13	8.10	47.25	60.75
S.E.±	7.79	0.2077	1.7187	2.5807
C.D. (P=0.05)	24.01	0.6402	5.2961	7.9522
Mean	191.55	8.32	48.40	59.55

irrigation at 100 per cent ET level followed by 80 per cent ET level. The optimum period at which the reproductive stage was achieved by 100 per cent and 80 per cent ET level drip irrigation in comparison to furrow and 60 per cent ET treatments was helpful in determining higher yields. The earliness of flowering in any crop is due to moisture stress prevailing in growth period. These results are in agreement with the findings of Antony *et al*. (2004).

The plant height and number of branches are the most important growth parameters which determine the canopy of plant. The canopy is directly related to productivity of crops. The moisture stress condition lead to poor cell elongation, low rate of photosynthesis and low carbohydrate assimilation resulting in poor plant growth. The bitter gourd plant height was more in 100 per cent ET level by 23.40 per cent as compared to 60 per cent ET and by 21.20 per cent compared to furrow irrigation. Thus in drip irrigation treatments, the treatment which received water at 100 per cent ET level exhibited better plant growth in terms of plant height and number of branches due to favourable moisture conditions. These results are in agreement with the findings of Tiwari *et al.* (1998).

The better growth and optimum days for flower initiation under drip irrigation could be achieved due to better soil moisture status which remained around field capacity during crop growth period. But in furrow irrigation and as well as 60 per cent ET irrigation level the plants faced moisture stress due to fall in moisture level below field capacity between irrigation cycles. However the number of days for flower initiation was at optimum level to produce highest crop yield when compared to furrow irrigation where the number of days for flower initiation was lowest owing to moisture stress condition. In case of 100 per cent ET level the number of flowers produced was higher leading to better fruit growth and yields.

The bitter gourd plants performed well in terms of yield and yield contributing factors under drip irrigation levels as compared to furrow irrigation. The better performance of plants in terms of number of fruits per plant, average fruit weight, fruit length and fruit girth were superior in 100 per cent ET level as compared to 60 per cent ET level and furrow irrigation which have performed poorly.

The number of fruits per plant were found to be more in 100 per cent ET level followed by 120 per cent ET level. Similar trends were noticed for other yield parameters like fruit weight and fruit length. But highest fruit girth was produced by 100 per cent ET level followed by 80 per cent level. The overall trend for all the growth parameters was found to be superior in case of 100 per cent ET level. This may be attributed to the frequent and consistent application of water in the vicinity of the roots which provided better soil moisture regime in the crop root zone throughout the crop growth period. The optimum period taken for flower initiation in 80 and 100 per cent drip irrigation treatments has contributed to higher yield. Similar results were observed in the works of Prabakar (2000).

The important component which decides the superiority of a crop production system is yield. Among all the drip irrigation treatments at 100 per cent ET level, superior yield in kg per plant were obtained which was found to be at par with 80 per cent ET level. The higher yield per plant could be due to better soil moisture regimes created by the said treatments. The best yields in terms of kg per plant could be achieved in case of 100 per cent ET level which was found to be higher by 35.80 per cent when compared to furrow irrigation treatment and by 59.50. per cent as compared to 60 per cent ET level (Table 3).

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

Table 3 : Effect of irrigation methods and irrigation levels on yield and yield parameters of bitter gourd

Treatments	No of fruits/plant	Average fruit weight (g)	Fruit length (cm)	Fruit girth (cm)	Yield/ha (t/ha)
T_1: 60 % ET	11.60	55.57	9.6	2.68	9.13
T_2: 80 % ET	16.25	69.98	13.4	3.46	20.93
T_3: 100 % ET	21.50	80.17	16.2	4.12	22.88
T_4:120 % ET	18.30	74.69	14.3	3.12	17.17
T_5: Control	14.45	59.58	11.2	2.84	13.67
S.E.±	0.56	1.79	0.64	0.14	0.68
C.D. (P=0.05)	1.74	5.51	1.99	0.44	2.14
Mean	16.42	68.0	12.94	3.24	16.75

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. 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 Bajracharya and Sharma (2005).

The general trend considering the different parameters tested suggests that 100 per cent ET level can be used to achieve higher yields of bitter gourd in sandy soils of semi arid tracts of northern Karnataka.

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