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Growth, Yield and Water Economy in Egg Plant (*Solanum melongena* L.) as Influenced by Drip Irrigation and Biofertilizers

K.V. Jadav*, H.M. Mehta and L.V. Lakkad
Department of Agronomy, Gujarat Agricultural University, Anand Campus, Anand 388 110, India

Abstract : Growth parameters, yield attributes, total fruit yield and water-use efficiency (WUE) increased significantly with irrigation scheduling through drip at 0.8 CPE compared to check basin system. Drip irrigation at 0.8 CPE resulted in 28.4% saving in water, 12.3% higher total fruit yield and two fold higher WUE over check basin irrigation system. Fertilizer application of 100 kg N ha^{-1} through urea, 1.43 t ha^{-1} dry azolla (equivalent to 50 kg N ha^{-1}) and inoculation with *Azotobacter* ABA-1, were found significantly superior to their lower levels in respect of growth parameters, yield attributes, total fruit yield and WUE of egg plant.

Key words : Egg plant, growth parameters, fruit yield, water-use efficiency, nitrogen, biofertilizer, irrigation.

Egg plant (*Solanum melongena* L.) is a long duration vegetable crop which requires high amount of irrigation water and nutrients. Although, irrigation and fertilizers are cost prohibitive inputs, yet play a vital role in maintaining high yield levels and stability of crop production. Better water-use efficiency (WUE) can be achieved through proper method of irrigation. No work has been done on comparative evaluation of methods of irrigation along with nitrogen management of egg plant crop in Gujarat. Thus, the present investigation was undertaken to quantify the effect of drip system in conjunction with biofertilizers on growth and yield of egg plant.

Materials and Methods

An experiment was conducted at the College Agronomy Farm, Gujarat Agricultural University, Anand, during *rabi* seasons of 1989-90 and 1990-91. The soil, well drained sandy loam with 7.5 pH, was low in nitrogen (0.036%), medium in available phosphorus (18 kg P ha^{-1}) and medium in potassium (207 kg K ha^{-1}). The moisture content (w/w) at 1/3 and -15 bar tension of the top layer (0-15 cm) was 17.0 and 5.0%, respectively. There were 36 treatment combinations consisting of three levels of nitrogen (0, 50 and 100 kg N ha^{-1}, through urea), two levels of dry azolla (0 and 1.43 t ha^{-1}, equivalent to 50 kg N ha^{-1}) and two levels of inoculation (with and without *Azotobacter* ABA-1) as sub-plots in split plot design with four replications. In drip system, lateral pipe lines were laid out parallel to plot length in alternate row at 180 cm distance and were extended on one side with sub lateral pipe lines. The drippers of 2 L h^{-1} capacity were fitted in between two plants on lateral lines, at a distance of 120 cm. The system was operated at a pressure of 2 kg cm^{-2} on every third day. The healthy and uniform seedlings of egg plant Cv. Doli-5 were transplanted on November 11 in 1989 and October 25 in 1990 at inter and intra row spacing of 90 and 60 cm, respectively. A basal dose of 21.5 kg P ha^{-1} and 41.5 kg K ha^{-1} was applied to all the plots before planting of seedlings. Two irrigations of 50 mm depth (at transplanting and 5 days after transplanting) by surface flooding method were given to all the plots.

Results and Discussion

Drip irrigation at 0.8 CPE significantly increased leaf area index (LAI) from 6.3 to 13.8% and plant dry weight from 9.6 to 12.8% over check basin irrigation during both the years (Table 1). Application of 100 kg N ha^{-1} significantly increased the LAI (1.02 to 1.94) and DM $plant^{-1}$ (153 to 225 g) over control (no nitrogen) during both the years (Table 1).

* Main Dry Farming Research Station, Gujarat Agricultural University, Targhadia 360 003 (Rajkot), Gujarat, India

Application of dry azolla (equivalent to 50 kg N ha^{-1}) significantly increased LAI and dry matter from 1.47 to 1.66 and 179.8 to 199.3 g plant^{-1}, respectively, over no azolla. Similarly, inoculation with *Azotobacter* ABA-1 was significantly superior to uninoculation in respect of all the growth parameters during both the years. The LAI increased from 1.50 to 1.62 and dry matter from 186.9 to 197.3 g plant^{-1}.

Yield attributes and yield

Drip irrigation at 0.8 CPE increased total number of flowers plant^{-1} by 12.3% over check basin method during second year of study (Table 1). Similarly, 0.8 CPE resulted in higher percentage of conversion of flowers into fruits (15.5%) over check basin method. Application of 100 kg N ha^{-1} significantly increased number of flower plant^{-1} (124.3 to 170.4) over 50 kg N ha^{-1} and no nitrogen. Similarly, application of 100 kg N ha^{-1} significantly increased the percentage of flowers developed into fruits per plant (31.5 to 46.6.) over 50 kg N ha^{-1} and no nitrogen.

The total number of flowers plant^{-1} under the application of dry azolla also increased by 11.2% over no azolla. Similarly, the percentage of flowers developed into fruits plant^{-1} also increased by 16.5% with dry azolla as against no azolla application.

Inoculation of *Azotobacter* ABA-1 increased the total number of flowers plant^{-1} by 6.1% over uninoculation which was reflected into higher percentage of flowers developed into fruits plant^{-1} by 5.5% under inoculation treatment.

Drip irrigation at 0.8 CPE significantly increased the number (35.5%) and yield of fruit (41.6%) over check basin method of irrigation

Table 1. Effect of treatment on growth parameters and yield attributes of egg plant

Treatment	Total number of flowers plant^{-1} (1990–91)	Percentage of flowers developed into fruits plant^{-1} (1990–91)	Dry matter at 120 DAP (g plant^{-1})			LAI at 90 DAP		
			(1989–90)	(1990–91)	Mean	(1989–90)	(1990–91)	Mean
Irrigation								
Drip (0.8 CPE)	157.9	42.7	211.2	198.9	205.0	1.69	1.57	1.63
Drip (0.6 CPE)	141.0	38.1	192.4	181.0	186.7	1.62	1.52	1.57
Check basin (1.2 IW/CPE)	140.6	37.0	192.6	176.3	184.4	1.59	1.38	1.49
CD 5%	6.6	2.0	16.2	7.1		0.09	0.08	
Nitrogen (kg ha^{-1})								
0	124.3	31.5	157.5	149.6	153.6	1.05	0.99	1.02
50	144.8	39.6	202.8	192.5	197.6	1.84	1.61	1.73
100	170.4	46.6	235.8	214.2	225.0	2.00	1.88	1.94
CD%	3.3	0.8	3.3	2.4		0.02	0.03	
Dry azolla (t ha^{-1})								
0	138.7	36.3	186.6	173.1	179.8	1.55	1.38	1.47
1.43	154.3	42.2	210.8	187.8	199.3	1.72	1.60	1.66
CD 5%	2.7	0.6	2.6	2.0		0.02	0.02	
Azotobacter								
Uninoculation	142.1	38.2	192.4	181.3	186.9	1.57	1.43	1.50
Inoculation	150.9	40.3	205.0	189.6	197.3	1.69	1.55	1.62
CD 5%	2.7	0.6	2.6	2.0		0.02	0.02	
Interaction effects	NS*	NS	NS	NS		NS	NS	

* Not significant.

Table 2. Effect of treatment on yield attributes, WUE, and fruit yield of egg plant

Treatment	Number of fruits plant^{-1}			Fruit yield (kg ha^{-1})			WUE (kg fruit ha^{-1} mm^{-1})		
	1989-90	1990-91	Pooled	1989-90	1990-91	Pooled	1989-90	1990-91	Mean
Irrigation									
Drip (0.8 CPE)	72.1	69.8	70.0	27737	24914	26326	44.4	40.3	42.3
Drip (0.6 CPE)	53.1	53.6	53.3	19218	20139	19679	38.8	41.1	40.0
Check basin (1.2 IW/CPE)	51.5	51.7	51.6	18086	17947	18017	21.2	20.9	21.1
CD 5%	2.0	5.0	2.0	967	1738	1035	2.0	2.7	–
Nitrogen (kg ha^{-1})									
0	45.3	37.7	41.5	16759	12900	14830	27.0	20.9	24.0
50	58.3	56.8	57.5	22428	20542	21485	35.9	33.5	34.7
100	73.2	78.7	76.0	25864	29559	27712	41.5	47.9	44.7
CD 5%	2.2	1.8	1.4	905	751	608	1.4	1.2	–
Dry azolla (t ha^{-1})									
0	49.9	50.2	50.1	18940	18286	18613	30.5	29.7	30.1
1.43	67.9	65.2	66.6	24424	23714	24069	39.1	38.5	38.8
CD 5%	1.8	1.5	1.2	741	607	498	1.2	1.0	–
Azotobacter									
Uninoculation	56.1	54.7	55.4	20607	19907	20257	33.1	32.4	32.8
Inoculation	61.7	60.8	61.2	22757	22094	22426	36.5	35.8	36.2
CD5%	1.8	1.5	1.2	741	607	498	1.2	1.0	–

(Table 2) due to favourable soil moisture status in root zone throughout the life span of the crop which led to better growth and distribution of roots. Better soil moisture condition may positively contribute for higher solubility and conductivity of nutrients which ultimately results into increased mass flow transport of nutrients (Tisdale and Nelson, 1975). This favourable effect was reflected through higher number of leaves as reflected in LAI (Table 1). Therefore, it synthesized higher amount of DM plant^{-1}. The well developed plant canopy produced higher number of flowers plant^{-1} which increased percentage of flowers developed into fruits plant^{-1} (Table 1). It was directly reflected by higher number of fruits plant^{-1} which consequently resulted in higher fruit yield. These findings are in accordance with the findings of Freeman *et al.* (1976), Padmakumari and Sivanappan (1978) and Mane *et al.* (1986). The reduction of fruit yield in surface method of irrigation (Check basin) might be due to non-maintenance of the continuity of uniform level of soil moisture status between two succesive irrigations. Sufficient moisture was available immediately after irrigation which continuously declined until next irrigation. This fluctuation in soil moisture status has been found to adversely influence the plant growth (Freeman *et al.*, 1976; Mane *et al.*, 1986).

Application of 100 kg N ha^{-1} significantly increased total number of flowers plant^{-1}, percentage of flowers developed into fruits plant^{-1} (Table 1) and total number of fruits plant^{-1} over 50 kg N ha^{-1} and no nitrogen (Table 2). The pooled data of two years indicated that the highest fruit yield of 27712 kg ha^{-1} was obtained from 100 kg N ha^{-1} which was higher by 29.0 and 86.9% over 50 kg N ha^{-1} and no nitrogen, respectively. Higher yield under this level had evidently resulted from more plant height, DM plant^{-1}, LAI and total number of fruits plant^{-1} recorded under 100 kg N ha^{-1}. These findings are in agreement with the findings of Umrani and Khot (1973) and Gupta and Rao (1984).

Total number of flowers plant^{-1} and percentage of flowers developed into fruits plant^{-1} were significantly higher under dry azolla application than no application (Table 1). Similarly, total number of fruits plant^{-1} and total fruit yield increased to 1.43 t ha^{-1}, where dry azolla was applied, over no application (Table 2). The mean increase in fruit yield was 29.3%. Higher fruit yield accrued under dry azolla application could be attributed to favourable effect of nitrogen provided through dry azolla, which also inhibited the root knot nematode population. These findings are in agreement with those of Subbiah *et al.* (1983) and Thakar *et al.* (1986).

Inoculation of seedlings with *Azotobacter* ABA-1 significantly increased total number of flowers plant^{-1}, percentage of flowers developed into fruits during the year 1990-91, while total number of fruits plant^{-1} and fruit yield increased over uninoculation during both the years (Table 2). The mean increase in total fruit yield over uninoculation was 10.7%. The increase in fruit yields might be attributed to the beneficial effect of *Azotobacter* ABA-1 culture on growth and yield attributes, which ultimately increased fruit yield. These findings are in accordance with those of Mehrotra and Lehri (1971).

WUE and water saving

Drip irrigation at 0.6 and 0.8 CPE recorded significantly higher WUE over check basin method of irrigation. However, the differences in WUE between both the levels of drip irrigation remained statistically at par during both the years (Table 2). The WUE was 44.4 and 40.3 kg fruit ha^{-1} mm^{-1} in 0.8 CPE while 21.2 and 20.9 kg fruit ha^{-1} mm^{-1} in check basin irrigation during 1989-90 and 1990-91, respectively. Drip irrigation at 0.8 and 0.6 CPE recorded 27.9 and 44.5% saving in water during the year 1989-90 and 28.9 and 45.1% in 1990-91, respectively, over check basin irrigation. These results are in accordance with the findings reported by Mane *et al.* (1986).

The WUE was maximum with 100 kg N ha^{-1} during both the years. This was mainly due to favourable effect of nitrogen on crop growth and higher fruit yield which was reflected in higher WUE. These results are in accordance with the findings of Yadav and Batra (1991).

Application of dry azolla and *Azotobacter* ABA-1 recorded significantly higher WUE over treatment without biofertilizer during both years. The increase in WUE could be ascribed to more efficient use of water and increased fruit yield of egg plant.

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