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CROP GROWTH AND FRUITING CHARACTERISTICS OF BRINJAL AS INFLUENCED BY GRAVITY DRIP IRRIGATION

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SUMMARY

The results of experiment on low cost gravity drip irrigation in winter brinjal crop (cv. Muktakeshi) revealed that maximum plant height, leaves and flowers were recorded with surface irrigation and 100% ET_o / ET_c treatments. Drip irrigated plant became stunted and leaf numbers and flowers per plant decreased with water supply at lower replenishment of ET_c. Branching of plant was more under drip-irrigated crop. Higher moisture supply widened flower to fruit ratio (1: 5.4 - 5.6). Reduced water supply by 80 and 60% ET_c caused early flowering and improved flower to fruiting ratio, but reduced the flower number and fruit size. The maximum fruit yield (162.8 – 176.8 q ha^{-1}) was obtained with increased water supply but reduced water supply did not hamper yield significantly. Drip irrigation with fertigation was noticed superior in fruit yield over surface method of water supply. Drip irrigation saved 37 - 49% water over surface irrigation.

***Key words*: Crop growth, drip irrigation, *Solanum nigrum,* water use efficiency, yield.**

INTRODUCTION

Water is fast becoming an economically scarce resource in many parts of India especially in arid and semi arid areas. Over the last two decades drip irrigation has been becoming popular in water scarce areas replacing the traditional irrigation management for high value crops like vegetables and orchard crops. Drip irrigation with its ability of small, frequent irrigation has created interest because of decreased water requirement and increased production. Same levels of production can be achieved with less water through drip irrigation by checking wasteful infiltration beyond root zone and evaporation from soil surface (Batta 2000). Field level application efficiency of surface irrigation is 40 to 50%, which can be enhanced to the tune of 70 to 90 % under drip system (Westrap *et al.* 2004). Yield increase of 10 -112% has been registered in drip irrigation depending upon crop type (Yadav *et al.* 1993). Thus drip irrigation may allow more crops per unit water. Besides, high irrigation frequency under drip (1 – 2 day intervals) prevented cyclic water stress as compared to low frequency surface irrigation (Wanjura *et al.* 2002). In spite of the advantages of drip system higher installation cost is a barrier for its wide adoption by the small and marginal farmers in eastern India. To overcome this hurdle a gravity type low cost drip system i.e. over head drum method, was studied for growing vegetables in small land holdings during post rainy season. The study was carried out to assess the productivity and water use efficiency of brinjal.

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MATERIALS AND METHODS

The field experiment was carried out on low cost gravity drip irrigation system at Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya, West Bengal (23^0 N latitude and 89^0 E longitude with 9.75 m MSL) during 1999 – 2001 to study the crop growth and fruiting behaviour of winter brinjal under different irrigation scheduling against surface irrigation method. The soil of the experimental site was newly developed alluvial and sandy loam in texture (Typic Fluvaquent) having medium soil fertility status with soil pH 6.8 and organic carbon 0.55%, nitrogen 0.59%, available P_2O_5 30 kg ha^{-1} and available K_2O 145 kg ha^{-1}. The ground water table fluctuation in the experiment site varied from 2.1 to 3.8 m from the ground surface during both the cropping seasons. The hydro-physical properties of the crops, root zone soil profile (0-90 cm) are as sandy loam in texture with bulk density 1.46 g cc^{-1} and soil water retained at 0.01 MPa 0.36 m^3 m^{-3} and unsaturated hydraulic conductivity at 0.01 MPa 0.38 mm day^{-1}. Brinjal seedlings (cv. Muktakeshi) were raised in nursery and planted in the middle of October at the age of 30 days. The plants were planted at 70 cm apart in rows and between rows in plot of 8.4 x 2.8 m and were supplied with nutrients N:P:K @120:60:100 kg ha^{-1}. The half dose of nitrogen, full dose of phosphate and potash were applied in soil at the time of planting and rest nitrogen was applied as liquid in the splits at 15 days interval. Four drip water supply levels on the replenishment basis of ET_0 and ET_c: I_1 - 100% ET_0, I_2 – 100% ET_c, I_3 – 80% ET_c, I_4 - 60% ET_c were tested against I_5 - surface irrigation ψ_m = – 0.04 MPa at 20 cm soil depth). Surface irrigation with 33 mm was given 4 and 6 times for two cropping seasons. Drip irrigation was started just after plant establishment. The gravity drip irrigation was provided from overhead reservoir of 200 lit. capacity placed on four-legged bamboo platform at an elevation of 3 m from the ground surface. Water was lifted to the tank by hand pump and the filling time was 30 minutes. Water delivered from the tank by gravity through HDP lateral of 12 mm ID. On-line pressure compensating button type dripper was used with discharge rate 1.2 lit $hour^{-1}$ at 0.35 atm. operational pressure. The alternate day irrigation frequency was maintained for all treatments. The drip running time (DRT) was calculated based on drippers discharge and plot area wise water allotment based on ET_{crop} as

$$ET_0 = E_p \times K_p \quad .....1)$$

$$ET_c = ET_0 \times K_c \quad ....2)$$

$$\text{Water requirement/plot} = \text{Plot area} \times ET_c \times K_r \quad ....3)$$

where, E_p = open pan evaporation (mm day^{-1}), K_p = pan co-efficient (0.8), K_c = crop co-efficient (0.5, 1.1 & 0.75), K_r = ground reduction factor or wetted area fraction (0.3 & 0.4). Discharge variation (CV) of drippers was noted up to 10 - 15 %. Crop received 19.6 mm and 11.0 mm rainfall for two cropping seasons respectively**.** The climate was per humid subtropical-temperature ranges 27.9 to 23.2^0 C and 15.3 to 8.2^0 C from November to March. The underground water table fluctuation was 1.5 to 3.5 m during winter months in upland topo-sequence.

The observation on crop growth - plant height, leaf production, branching, flowering, yield attributes and yield were recorded.

RESULTS AND DISCUSSION

Different levels of drip irrigation significantly influenced the plant growth parameters and fruiting behaviour of winter brinjal (Table 1). Maximum plant height was attained under surface and drip irrigation with 100% ET_0 / ET_c but stunted plant growth was observed when water volume was decreased under treatments 80% ET_c and 60 % ET_c. Under surface irrigation branches per plant was less by 18.9 – 42.9% but plant gave the highest number of leaves as compared to drip irrigation. Branches and leaves of the plant were reduced by 16.6 - 26.0% under 60 and 80% ET_c drip irrigation treatments. Flowering of brinjal plant was very much influenced by the volume of water applied. The highest numbers of flower per plant (48.4) was recorded in surface irrigation which was 15.8 – 68.0% more but flower to fruit ratio (1: 5.8) was widened as a result of increased flower abortion under cyclic stress in surface irrigation. The drip-irrigated plants had small numbers of flower but high fruiting chances (1: 3.6 – 5.4) were created with continuous water supply. Fruit size was

Table 1. Growth parameters and fruiting behaviour as influenced by drip irrigation (average of two years)

Irrigation schedule	Plant height (cm)	Branches plant^{-1}	Leaves plant^{-1}	Flowers plant^{-1}	Fruits plant^{-1}	Flower: fruit	Fruit size (g)	Plant yield (g)
100% ET_0	69.9	27.1	177	34.1	8.7	5.6	98.4	864
100% ET_c	68.9	25.6	164	41.8	7.7	5.4	102.5	797
80% ET_c	64.6	25.3	156	28.8	7.2	4.0	98.7	717
60% ET_c	61.1	22.6	131	30.5	7.7	3.9	87.5	696
Surface *	69.7	19.0	188	48.4	8.3	5.8	97.9	855
LSD (P=0.05)	3.45	2.85	19.4	7.35	0.52	-	5.02	69.03

*ψ_m = – 0.04 MPa (at 20 cm soil depth), IW = 3.3 cm

significantly influenced by drip irrigation regimes. The highest fruit size was achieved under 100% ET_c which was at par with surface irrigation and the lowest size was recorded with decreased water supply at 60% ET_c. Plant yield was similarly influenced by drip and surface irrigation regime.

The variation in brinjal fruit production was significant at different dates of harvests under drip and surface irrigation regimes in both the cropping seasons (Table 2). Early date of harvest (17/1) of 2000 cropping season revealed that lower soil moisture regime created by 60 and 80% ET_c drip irrigations gave higher (35.6 – 55.3%) fruit production than 100% ET_0 / ET_c, which might be attributed to soil moisture stress caused by less (60 / 80%) replenishment of ETc triggered early fruiting (Jaafar *et al*. 1994 & Raina *et al*. 1999). Surface irrigation was much ahead in fruit production as compared to drip

Table 2. Fruiting capacity of brinjal as influenced by drip irrigation over whole harvesting period (January – March)

Treatment	Fresh fruit yield (q ha^{-1}) at different dates of harvest				
2000	**17/1**	**27/1**	**7/2**	**14/2**	**28/2**
100% ET_0	8.1	25.1	67.5	41.6	74.8
100% ET_c	5.9	19.9	74.3	49.7	56.5
80% ET_c	13.2	22.1	58.6	51.8	58.6
60% ET_c	11.0	31.0	65.9	48.9	52.2
Surface	14.4	38.7	93.0	82.9	49.7
LSD (P=0.05)	3.7	8.2	14.1	17.4	22.8
2001	**21/2**	**27/2**	**6/3**	**14/3**	**23/3**
100% ET_0	7.0	25.9	45.9	19.7	18.9
100% ET_c	7.2	20.0	43.3	16.6	17.8
80% ET_c	10.6	20.4	30.6	15.0	11.0
60% ET_c	14.0	22.1	36.1	15.7	8.9
Surface	6.8	16.1	31.4	16.6	8.9
LSD (P=0.05)	4.3	3.9	7.5	1.7	5.1

irrigation with 100% ET_0 / ET_c recorded at earlier fruit plucking dates but at later stages drip irrigated crop recorded higher (5.0 – 50.5%) yields than that of surface. Important factor was that soil application of plant nutrient failed to register any impact on crop growth and fruit production under drip irrigation system. Similar yield trend was noted by Singh *et al.* (1990).

In the 2nd crop season, the fruit yielding capacity of brinjal under drip irrigation was low due to bad performance of cultivated variety but interesting to note that nitrogen fertigation significantly increased the fruit yield by 9.8 – 58.9% over surface irrigated crop. Crops under surface irrigation were always lagged behind the drip-irrigated crop in terms of fruit productions at different dates of harvest in the 2nd cropping season. There was a less distinction in fruit production due to variation in replenishment rate of evapotranspiration. Under drip irrigation fruit production declined at lower space at later plucking dates than surface irrigation. Mean fruit yield over two crop seasons revealed that there was no remarkable yield differences between surface and drip irrigation at 100% ET_0. Fruit yield was marginally reduced by 7.0 - 12.6% at drip irrigation with 80 and 60% ET_c over 100% ET_c.

Daily water requirement in brinjal increased with age and increased atmospheric evaporative demand (Table 3). At early drip operation period daily 412 ml of water was required per plant for 100% replenishment of potential pan evaporation and it increased to 998 ml at later growth period. Over the whole cropping period surface method of irrigation required higher amount of water (194.5 mm) followed by drip irrigation at 100% ET_0 (165.7 mm). Under 80 and 60% ET_c drip irrigation treatments total water supply was reduced to the tune of 109.0 and 89.1 mm respectively. Drip irrigation regimes recorded higher degree of water use efficiency (WUE) values over surface method of irrigation (Table 4). Drip irrigation at 60% ET_C gave the highest WUE value of 1.62 q ha^{-1} mm^{-1} followed by 80% ET_c. Surface irrigation recorded the mean WUE value of 1.06 over two-crop seasons. WUE drastically reduced in the 2nd crop season due to low yield of variety and high water use but trend followed the 1st cropping season.

Results reveal that the crop growth and reproductive development of brinjal are very much influenced by drip irrigation schedules and surface method of irrigation. Drip irrigation on the basis of crop evapotranspiration (ET_c) replenishment up to 80 % may be advocated to brinjal crop with minor yield sacrifice but it saved 37 – 49% irrigation water.

Table 3. Details of drip irrigation scheduling under gravity drip system in brinjal.

Treatments	Daily drip irrigation per plant						Relative water water use (%)
	December		January		February		
	DRT (min)	Volume (ml)	DRT (min)	Volume (ml)	DRT (min)	Volume (ml)	
I_1=100% ET_o	23	461	37	738	40	963	84
I_2=100% ET_c	16	322	26	520	32	849	63
I_3= 80% ET_c	13	257	21	412	25	663	49
I_4= 60% ET_c	10	194	16	325	19	472	37
I_5= Surface	-	-	-	-	-	-	100

No. of irrigation - 4, 6 for 1st & 2nd year; volume - 780 lit / plot (23.5 m^2).
DRT- drip running time,

Table 4. Brinjal fruit yield and water use efficiency as influenced by drip irrigation.

Irrigation schedule	Water use (mm)			Fruit yield (q ha^{-1})			Water use efficiency (q ha^{-1} mm^{-1})		
	99-00	00-01	Mean	99-00	00-01	Mean	99-00	00-01	Mean
100% ET_0	140.0	191.4	165.7	226.8	126.8	176.8	1.62	0.66	1.14
100% ET_c	112.4	148.0	130.2	220.8	104.9	162.8	1.96	0.70	1.33
80% ET_c	99.1	119.0	109.0	204.2	98.6	151.4	2.06	0.83	1.44
60% ET_c	89.4	88.8	89.1	201.2	87.9	144.5	2.26	0.99	1.62
Surface	149.1	240.0	194.5	269.3	79.8	174.5	1.80	0.33	1.06
LSD (P=0.5)	-	-	-	22.8	14.3	-	-	-	-

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