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HortFlora Research Spectrum, 3(3): 274-277 (September 2014) ISSN : 2250-2823

DRIP IRRIGATION SCHEDULING IN OKRA [*Abelmoschus esculentus* (L.) Moench]

A. Abdul Haris[1*], Sunil Kumar[2*], A. K. Singh[3] and K. Rajan[4]

[1]*ICAR Research Complex for Eastern Region, ICAR Parisar,P.O.B.V.College, Patna-800014, Bihar, India.*

[2]*Department of Horticulture, North Eastern Hill University, Tura Campus, Chandmari-794 0002, West Garo Hills District, Meghalaya*

[3]*Divison of SWCE, CSSRI Regional Station, Lucknow*

[4]*Centre Soil and Water Conservation Research and Training Institute, Research Centre, Udhagamandalam, Tamil Nadu*

**E-mail: abdulharis123@rediff.com; sunu159@yahoo.co.in*

ABSTRACT : A field experiment on drip irrigation scheduling in okra was undertaken for two consecutive years (2002-04) at ICAR Research Complex for Eastern Region, Patna. The experiment was conducted in split-split plot design with irrigation water equivalent to 100, 80 and 60% ET (Evapo transpiration) in main plots and water as per daily, alternate days and once in three days schedule in sub-plots, two varieties Arka Abhay and Arka Anamika in sub-sub plots. Observations regarding plant height (cm), internodal length (cm), average fruit weight, yield (q/ha) and water use efficiency (q/ha^{-cm}) was undertaken. Irrigation at 80% ET gave significantly higher yield during both the years. The first year schedules were not significantly different though daily application recorded higher yield, but significant difference among the schedules were observed during second year and daily irrigation gave significantly higher yield than once in two days and three days schedules. Maximum water use efficiency was recorded at 60% ET treatment during both the years. Maximum plant height and average fruit weight was associated with cultivar Arka Abhay, while Arka Anamika registered minimum internodal length. Between two varieties tested Arka Abhay proved best in terms of yield than Arka Anamika during two consecutive year of experimentation.

Keywords : *Drip irrigation, evapo-transpiration, water use efficiency, okra.*

Okra [*Abelmoschus esculentus* (L.) Moench] is an important vegetable of tropics and sub-tropics which is widely grown in India for its mature, tender, green fruits which are used for culinary purpose. Okra is a good source of vitamins A, B and small amount of C. Okra has a high acceptability in Indian market and fetches high price. Okra is grown extensively as a pure culture as well as mixed crop during kharif and zaid seasons (April-June) due to its high adaptability over a wide range of environmental conditions.

Drip irrigation, a boon to today's era of high-tech agriculture, needs to be exploited to its fullest extent. The system has proved its superiority over other conventional methods of irrigation, especially in fruit and vegetable crops owing to precise and direct application of water in the root zone. Kataria and Michael (11) reported that under daily conditions crop yield of tomato increased 47.4% in drip irrigation over furrow irrigation. It is necessary for the vegetable crops grower to know how much water and when it should be applied to a particular crop for enhancing its productivity and can fetch good amount by increasing its marketability. Since, drip irrigation saves 30-40% fertilizer/chemical with enhanced quality of produce and yield as compared to surface irrigation and also helpful in reducing labour cost, salt concentration in the root zone and disease incidence. Al-Harbi *et al.* (1) observed that high-frequency water management by drip irrigation minimizes soil as a storage reservoir for water, provides at least dailyrequirements of water to a portion of the root zone of each plant, and maintains a high soil metric potential in the rhizosphere to reduce plant water stress.The use of drip in combination with plant residues and chicken manure can increase the okra yield and water use efficiency reported by Kedar *et al.*(9).

Therefore, an effort was made laid out keeping all these in view to study the water requirement and irrigation scheduling in okra with the objective to find out the optimum schedule of irrigation for maximum okra yield and water use efficiency.

MATERIALS AND METHODS

A field experiment on drip irrigation scheduling in okra was undertaken for two consecutive years (2002-04) at ICAR Research Complex for Eastern Region, Patna. The okra varieties *viz.* Arka Abhay and Arka Anamika were directly sown in the main field

Received : 04-08-2014 *Accepted : 03-09-2014*

during first week of March at the spacing of 60x60cm. The experiment was laid out in split-split plot design with three replications. The treatments as the main plot factors were irrigation level at 100% (I_1), 80% (I_2) and 60% (I_3) ET (Evapo-transpiration), the sub-plot factors were scheduling at daily (S_1), once in two days (S_2) and once in three days (S_3) and the sub-sub-plot factors were varieties *viz.* ArkaAbhay (V_1) and ArkaAnamika (V_2). The drip irrigation systems were consisted of 2lph capacity with online drippers. One lateral for one row of crop with one dripper per plant was adopted in each plot. Each sub-plot consisted of ten rows and ninety plants. The daily irrigation was applied in drip treatments at 1kg/cm^2 pressure. The daily pan evaporation was used to compute the daily water requirement of the crop through drip systems. The effective rainfall was computed by considering the pan evaporation and precipitation received during irrigation intervals. Okra were harvested several times and data were added to estimate the fruit yield and water use efficiency during experimentation and analyzed using statistical methods as suggested by Panse and Sukhatme (14).

RESULTS AND DISCUSSION

Effect of irrigation scheduling on plant height

The data presented in Table 1 indicated that there were significant differences inplant height withirrigation at100, 80 and 60% ET, but no significant difference among the daily, once in two days and once in three days irrigation scheduling was noticed during first year of experimentation. Maximum plant height (105.85 cm) was observed at 80% evapo-transpiration as compared to 100 and 60% ET. Between two varieties tested, Arka Abhay showed maximum plant height (107.89 cm) than Arka Anamika (103.81 cm). However, significant difference in plant height at 100, 80 and 60% ET with daily, once in two days and once in three days irrigation scheduling was noticed during second year experimentation. Maximum plant height (114.31 cm) was associated at 80% evapo-transpiration than 100 and 60%. In the irrigation scheduling, irrigation at once in two days showed maximum plant height (123.14 cm) than daily and once in three days. Between two varieties tested, Arka Abhay showed maximum plant height (119.61 cm) than Arka Anamika (109.00 cm). Significant better performance in plant height and average fruit weight of okra may be due to drip irrigation which kept the soil near field capacity throughout the growth period in the active root zone, resulting in low soil suction which facilitated better waterand nutrient uptake by the plant and excellent soil-water-atmosphere relationship with higher oxygen concentration in the root zone.Similar observations were also reported in tomato by Raina *et al.* (15). Sujatha and Haris (17) also reported that ferti-drip and drip irrigation in arecanut increased number of feeder roots four fold and two fold respectively compared to basin irrigation indicating increased root activity.

Effect of irrigation scheduling on internodal length

No significant difference among irrigation at 100, 80 and 60% ET observed during first year. In second year also, there was no significant difference among irrigation at 100, 80 and 60% ET with daily, once in two

Table 1 : Effect of drip irrigation scheduling on plant height, internodal length and averagefruit weight of okra

Treatments	Plant Height (cm)		Internodal Length (cm)		Average Fruit Weight (g)	
	1st year	2nd year	1st year	2nd year	1st year	2nd year
Main plots						
100% ET	96.94	106.47	7.59	7.58	9.54	12.76
80% ET	105.85	114.31	7.84	7.77	11.65	14.95
60% ET	102.33	121.42	7.50	7.51	9.96	12.46
CD (P = 0.05)	6.78	7.22	NS	NS	0.28	NS
Sub-Plots						
Daily	102.90	109.67	7.45	7.43	10.16	12.90
2 days	101.28	123.14	7.08	7.78	10.06	13.41
3 days	102.33	109.39	7.62	7.66	10.92	13.79
CD (P = 0.05)	NS	6.38	0.29	NS	0.41	NS
Sub-Sub Plot						
V_1	104.26	116.94	7.92	7.86	10.77	13.48
V_2	100.09	111.18	7.38	7.39	9.99	13.30
CD (P = 0.05)	2.98	5.00	0.31	0.32	0.50	NS

days and once inthree days irrigation scheduling in internodal length of okra. Between two varieties tested, Arka Anamika showed minimum internodal length (7.88 cm, 7.39cm) than Arka Abhay.

Effect of irrigation scheduling on average fruit weight

Irrigation at 100, 80 and 60% ET with daily, once in two days and once in three days irrigation scheduling showed significant difference in average fruit weight of okra (Table 1). Maximum fruit weightwas observed under 80% ET (11.65g) with once in three days irrigation scheduling (10.92g). Between two varieties tested,ArkaAbhay showed higher fruit weight (10.77g) than Arka Anamika (9.99g). In second year, Irrigation at 100, 80 and 60% ET with daily, once in two days and once in three days irrigation scheduling did not show significant difference in average fruit weight of okra.

Effect of irrigation scheduling on yield

The data (Table 2) indicated that during first year, yield (q/ha) registered in treatment with irrigation at 80% ET irrespective of irrigationscheduling. Significantly higher yield was noticed at 80% ET treatment (105.74q/ha) followed by 60% ET treatment (93.16q/ha). Daily irrigation recorded higher yield (100.56q/ha), though not significant. Between the two varieties tested, Arka Abhay recorded significantly higher yield (101.75q/ha) than Arka Anamika (88.66q/ha). In second year, significant higher yield (166.42 q/ha) was observed with irrigation at 80% ET. These findings corroborate with the results as irrigation at 80% ET responded for better yield and marketability in cabbage (Haris *et al.*, 6) and tomato (Haris and Kumar, 7). In the irrigation scheduling, daily irrigation recorded significantly higher yield (162.53t/ha) as compared to other schedules. Between two varieties, cultivar Arka Abhay (162.47 q/ha) performed better than Arka Anamika (156.61 q/ha).

The possibility of increased yield of okramay be due to the increased photosynthesis, maximum individual fruit weight, the production of more number of functional leaves resultingthe formation of highest photosynthates, less disease incidence and minimal physiological disorder. The increased yield under drip irrigation might have resulted due to better water utilization (Manfrinato, 13), higher uptake of nutrients (Bafna *et al.,* 2), irrigation interval (Gvozden *et al.,* 5) and excellent soil-water-air relationship with higher oxygen concentration in the root zone (Gornat *et al.,* 4). These findings corroborate with the result that drip irrigation scheduled with irrigation level 79% ET resulted maximum yield of tomato and increased yield up to 27% (Dalvi *et al.,* 3) Malik and Kumar (12) also observed maximum green pod yield of pea (*Pisum sativum* L.) when irrigations through drip were applied at 75% of pan evaporation.

Effect of irrigation scheduling on water use efficiency

Maximum water use efficiency was obtained under irrigation at 60 % ET (4.83q/ha^{-cm}) and daily irrigation gave better water use efficiency (3.99q/ha^{-cm}) than once in two days and once in three days irrigation scheduling. In second year, water use efficiency was significantly higher at 60% ET (5.79 q/ha^{-cm}) than 80 and 100% ET of water replenishment.

Table 2 : Effect of drip irrigation scheduling on plant height, internodal length and average fruit weight of okra.

Treatments	Yield (q/ha)		WUE (q/ha^{-cm})	
	1st year	2nd year	1st year	2nd year
Main plots				
100% ET	86.71	151.76	2.69	3.28
80% ET	105.74	166.42	3.94	4.51
60% ET	93.16	160.44	4.83	5.79
CD (P = 0.05)	12.34	6.06	0.53	1.05
Sub-Plots				
Daily	100.56	162.53	3.99	4.64
2 days	92.66	153.30	3.72	4.39
3 days	92.39	160.18	3.75	4.55
CD (P = 0.05)	NS	2.40	0.46	NS
Sub-Sub Plot				
V_1	101.75	162.47	4.15	4.63
V_2	88.66	156.61	3.49	4.42
CD (P = 0.05)	6.10	2.50	0.31	0.28

There was no significant difference among the irrigation scheduling. Similar results were observed as the water use efficiency was highest in drip irrigation at 60% ET with 74.33% water saving in broccoli (Kashyap *et al.,* 10). Between two varieties tested, Arka Abhay (4.15q/ha^{-cm}, 4.63q/ha^{-cm}) showed better water use efficiency than Arka Anamika during two consecutive year of experimentation.The higher water use efficiency might be due to the lower rate of water loss through evaporation from soil surface under drip irrigation. Hao *et al.* (8) and Sezen *et al.* (16) observed that irrigation frequency significantly increased the water use efficiency (WUE) and irrigation water use efficiency (IWUE). The increased water use efficiency under drip irrigation because of drip system provides precise and measured quantity of water to individual plant. The saving of water combined with higher yield under drip irrigation is the reason for increased water use efficiency.

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Citation : Haris A. A., Kumar S., Singh A.K. and Rajan K. (2014). Drip irrigation scheduling in okra [*Abelmoschus esculentus* (L.) Moench.]. *HortFlora Res. Spectrum,* **3**(3) : 274-277.