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Cotton Crop Performance and Economics under Drip Irrigation at Various Water Application Levels

* Jignesh. A. Shah

* Student, Department of Civil Engineering, Shantilal Shah Engineering College, Bhavnagar

ABSTRACT

The field experiments were conducted for consecutive two years to assess the crop performance and economics of drip irrigation system for cotton (H-8) variety. Total sixteen treatments having Three water application levels were L1 (IW/CPE=0.4), L2 (IW/CPE=0.6) and L3 (IW/CPE=0.8) and five-crop growth stages S1-vegitative stage(46 to 90days after sowing), S2-flowering stage(91 to 135days) S3-boll development stage(136 to 180days) ,S4-boll maturity stage(181 to 210days), S-whole season stage(46 to 210days) and one control (stress free) water application level L4 (IW/CPE=1.0) Were considered. The highest yield was 2075kg/ha, 2535kg/ha, and 2305 kg/ha respectively in the First year, Second year and pooled results were obtained under drip when irrigation at IW/CEP = 1.0 during first three stages and at IW/CEP = 0.4 during stage-4. The highest water use efficiency of 3.47kg/ha.mm, 4.21kg/ha.mm and 3.847kg/ha.mm ha respectively in the First year, Second year and pooled results were attained under drip when irrigated at IW/CPE of 0.4 continuously throughout the season. In case of excess water supply and deficit water conditions, the drip was not that profitable.

Keywords : Drip Irrigation, Cotton Crop Yield, Water Consumption, Water Use Efficiency

I. INTODUCTION

Saurashtra and Kutch region of the state has a total geographical area of 11mha of which 4.36mha area is under cultivation. The average annual rainfall of this region is 300mm to 700mm. The rainfall pattern of the region is both scanty and erratic and cause frequent draughts and famines. Crop yields under irrigated agriculture are several folds higher than rain fed dry farming system. Investments for irrigation are usually of top priority in all countries of aired and semiarid regions like India. The cotton is highly remunerative crop because of higher yield due to Favorable soil and climatic conditions in the Saurashtra region of Gujarat. However water scarcity is the main constraint in its adoption for large scale. Deficit irrigation through water use efficient irrigation method like drip is one of the major ways to increase the cotton acreage and water use efficiency. Before implementing deficit irrigation programmed, it is necessary to know crop yield responses to water applications.

II. MATERIAL AND METHODOLOGY

Field experiment: The experiment was carried out at Junagadh Agricultural University campus farm, Junagadh, Gujatat, India to assess the cotton crop performance under drip irrigation system with various water application (stress) levels at different crop growth stages/periods. Cotton crop H-8 variety was sown at a spacing of 0.45m x 1.22m. the seed rate was 4.0kg/ha. The crop was fertilized using urea in three installments during growing season as per agronomic recommendations for this region

Fig1. Study area (junagadh)

Table-1 Description of the treatments on cotton crop

		Irrigation Method : Drip	
S. N.	Treatment	Water application	
		at IW/ CEP of	During considered growth period (Days after sowing)
1	DL_1S_1	0.4	46 to 90
2	DL_1S_2	0.4	91 to 135
3	DL_1S_3	0.4	136 to 180
4	DL_1S_4	0.4	181 to 210
5	DL_1S	0.4	46 to 210
6	DL_2S_1	0.6	46 to 90
7	DL_2S_2	0.6	91 to 135
8	DL_2S_3	0.6	136 to 180
9	DL_2S_4	0.6	181 to 210
10	DL_2S	0.6	46 to 210
11	DL_3S_1	0.8	46 to 90
12	DL_3S_2	0.8	91 to 135
13	DL_3S_3	0.8	136 to 180
14	DL_3S_4	0.8	181 to 210
15	DL_3S	0.8	46 to 210
16	DL_4S (control)	1.0	46 to 210

Three water application levels L1 (IW/CPE=0.4), L2 (IW/CPE=0.6) and L3 (IW/CPE=0.8) and five-crop growth stages S1-vegitative stage(46 to 90days after sowing), S2-flowering stage(91 to 135days) S3-boll development stage(136 to 180days) ,S4-boll maturity stage(181 to 210days), S-whole season stage(46 to 210days) were considered and one control treatment (stress free , IW/CEP = 1.0) was kept throughout the growing period. Total 16-treatment was replicated four times. The water meter was used to measure the volume of water applications. For the drip irrigation system drip line of 16mm was fitted at 0.9m distances so that one drip line can serve two rows of the crops. The operating pressure was 1kg/cm^2. The length of the drip line was varied to match the plot Size of the replication.

Economics: The economics of cotton cultivation includes the total cost and total return per unit area. The total cost of cultivation was computed using the following expression:

TCC = FCC + VCC + FCI + VCI

Where, TCC is the total cost of cotton cultivation (Rs. / ha / season). FCC is the fixed cost of cultivation (Rs. / ha / season) included cost of plowing, sowing, thinning, dressing. VCC is the variable cost of cultivation (Rs. / ha / season) included the cost of hand weeding and harvestings. FCI is the fixed cost of irrigation (Rs. / ha / season). VCI is the variable cost of irrigation (Rs. / ha / season) included the cost of labor and electricity for pumping, conveyance and applications.

FCI = SCps + SCis + SC bc Where SCps is the seasonal cost of pumping system (Rs/ha/ season)

SCps= [PVPS x i x (1+ i) ^{m}]/[(A x s) {(1+ i) ^{m} − 1}] PVPS is the value of pumping unit. it included the purchase cost of pump, electric motor, m is the life of pumping unit and i is the prevailing rate of interest. Aisthe total area (ha) commanded by the pumping unit in a season,s is the number of season in year SCis= seasonal cost of irrigation system (Rs / ha /season)

SCis = [PVIS x i x (1 + i)^n / [{s} {(1 +i)^n − 1}], PVSI is the present value of the irrigation system (Rs./ ha), n is the life of the irrigation system. SCbc = seasonal cost of making bunds and channels for the irrigation (Rs / ha / season), is considered zero in drip. The GR (gross realization) Rs/ha was calculated from cotton yield at prevailing market price. The NT (net realization) NR=TCC- GR, Benefit cost ratio (BC) is obtained by BC= GR/TCC, considering the water saving in different irrigation treatments.

III-RESULTS AND DISCUSSION
A. Cotton yield:
The highest yield can be obtained under the treatment combination of DL1S4 (under drip irrigation, water application level of IW/CEP of 0.4 during stage-4). It was found that for the highest yield, the cotton should be irrigated at IW/CEP of 1.0 during first three stages and at IW/CEP of 0.4 during last stage by drip irrigation. The highest yield was 2075kg/ha, 2535kg/ha, and 2305 kg/ha respectively in the First year ,Second year and pooled results, which was 1.07, 1.04 and 1.06 times the yield obtained in control under drip irrigation. The lowest yield can be obtained under the treatment combination of DL1S (under drip irrigation, water application level of IW/CEP of 0.4 during stage-S) .the lowest yield was 1234kg/ha, 1479kg/ha, and 1356 kg/ha respectively in the First year, Second year and pooled results.

Table-2 Interaction effects of irrigation methods, water application levels and stages/growth periods for water application level on cotton yield.(kg/ha)

Year	M	W.L.	growth period of water application level					control
			S$_1$	S$_2$	S$_3$	S$_4$	S	
First year	D	L1	1757	1833	1862	2075	1234	1933
		L2	1891	1898	1975	2061	1625	
		L3	1931	1957	1978	2052	1801	
Second year	D	L1	2213	2196	2319	2535	1479	2432
		L2	2310	2321	2319	2469	2027	
		L3	2342	2343	2370	2411	2293	
Pooled	D	L1	1985	2015	2091	2305	1356	2183
		L2	2100	2109	2147	2265	1826	
		L3	2136	2150	2172	2231	2047	

M:Method , D: Drip , W.L.: Water level
Control : control under drip , Continues water application of IW/CPE of 1.0 throughout the season)

B- Water Use Efficiency:
Table-3: water use efficiency (kg/ha.mm) obtained under dif-

ferent combination of methods of irrigation, water application levels and stages of water application

Year	M	S	Stage of water stress level					Control
			S$_1$	S$_1$	S$_1$	S$_1$	S	
First year	D	L1	2.53	2.86	2.85	2.95	3.47	2.48
		L2	2.62	2.76	2.84	2.83	3.27	
		L3	2.57	2.67	2.68	2.72	2.82	
Second year	D	L1	3.37	3.42	3.55	3.68	4.21	3.19
		L2	3.34	3.40	3.36	3.46	4.15	
		L3	3.22	3.24	3.26	3.26	3.66	
Pooled	D	L1	2.94	3.14	3.20	3.31	3.84	2.83
		L2	2.97	3.08	3.10	3.14	3.71	
		L3	2.89	2.92	2.97	2.99	3.24	

M:Method , D: Drip , S: Stress level
Control :(DC: control under drip , Continues water application of IW/CPE of 1.0 throughout the season)

The highest water use efficiency of 3.47kg/ha.mm, 4.21kg/ha.mm and 3.847kg/ha.mm ha respectively in the First year, Second year and pooled results were attained under drip when irrigated at IW/CPE of 0.4 continuously throughout the season. It is seen that increasing the water application level fromL1toL3, it has decreased water use efficiency. The lowest water use efficiency 2.48 kg/ha.mm, 3.19 kg/ha.mm 2.83

kg/ha.mm respectively in the First year, Second year and pooled results under the control treatment of drip due to higher consumptive use.

C-Economics:
The data of benefit-cost under drip presented in Table- 4 shows that the lowest variable Cost of irrigation 3145 Rs./ha, total cost of cultivation 17592 Ra./ha, gross return 27128 Ra./ha, net return 9535 Ra./ha ,and benefit cost ratio of cotton cultivation 1.54 and drip system adoption 1.54 were found when irrigation was given at IW/CPE of 0.4 for entire season. The highest variable cost of irrigation and total cost of cultivation were found respectively as 6868 Ra./ha and 22968 Rs./ha when cotton was irrigated at IW/CPE of 1.0 throughout the season. The highest gross realization of 46100 Ra. /ha, net realization of 23555 Ra. /ha and benefit cost ratio of 2.05 of cotton cultivation was obtained by irrigation cotton at the IW/CPE of 1.0 for first 3 stage and then at IW/CPE of 0.4 in the last stage. However, while considering the values of water saving over water stress free treatment,

Table-4: Cost-benefits of cotton cultivation under different treatments of drip irrigation.

Treat-ment	Cost of Cultiv-ation (Rs/ha)	Fixed Cost of Irriga-tion (Rs./ha)	Variable Cost of Irrigation (Rs./ha)	Total Cost of Cultiv-ation (Rs/ ha)	Gross Return (Rs/ ha)	Net Return (Rs/ha)	Total net return with water saving value	Benefit cost ratio of cotton cultivation
DL$_1$S	8813	5634	3145	17592	27128	9535	18788	1.54
DL$_2$S	9752	5634	4383	19769	36521	16752	23688	1.85
DL$_3$S	10194	5634	5625	21453	40937	19483	21465	1.91
DL$_4$S	10465	5634	6868	22968	39699	20687	18668	1.90
DL$_4$S	10070	5634	6012	21716	42008	17983	18538	1.83
DL$_1$S	10301	5634	6297	22232	42728	19775	19462	1.89
DL$_2$S$_1$	10373	5634	6583	22590	40294	20138	18960	1.89
DL$_3$S$_1$	10129	5634	5713	21477	42186	18817	20412	1.88

DL$_1$S$_2$	10319	5634	6098	22051	43000	20135	20463	1.91
DL$_2$S$_2$	10400	5634	6483	22517	41814	20483	19581	1.91
DL$_1$S$_3$	10281	5634	5818	31734	41814	20081	21392	1.92
DL$_2$S$_3$	10394	5634	6168	22197	42945	20748	20848	1.93
DL$_3$S$_3$	10448	5634	6518	22601	43481	20881	19854	1.92
DL$_1$S$_4$	10710	5634	6201	22545	46100	23555	23542	2.05
DL$_2$S$_4$	10630	5634	6423	22688	45300	22613	21818	2.00
DL$_3$S$_4$	10563	5634	6646	22843	44629	21787	20318	1.95

the highest return of 23688 with highest benefit cost ratio 2.84 of drip adoption was achieved when irrigation cotton at IW/CPE of 0.6 throughout the season. The data of benefit-cost ratio shows that under highly deficit and fully water supply conditions, the drip system adoption is not economically de-

sirable.

IV.CONCLUSION

(a)The highest yield of 2305 kg/ha was attained under drip when cotton was irrigated at 1.0 IW/CEP ratio during the first 3 stages and at 0.4 ratio during the last stage.(b) The water use efficiency was found to be the maximum 3.84 kg/ha.mm under drip when irrigated at IW/CEP of 0.4 continuously for whole season(c) The highest benefit cost ratio of 2.05 for cotton cultivation under drip was obtained by irrigating cotton at IW/CPE of 1.0 for the first 3 stages and then at IW/CPE of 0.4 in the last stage.(d) The drip system adoption is not economically feasible for two extreme conditions i.e. highly water deficit and fully water supply conditions.

REFERENCES

[1] Kirda, C.P. et. al. (1999) Crop Yield Response to Deficit Irrigation, KluwerAcademic Publishers. London. [2] Hexem, R.W. and Heady, E.O. (1978). Water Production Functions for Irrigated Agriculture, IOWA State University Press, Ames,IOWA, USA.. [3] Stegman, E.C. et. al. (1980). Design and Operation of Farm Irrig.Systems, ASAE, Washigton. [4] USDA (1959). SCS National Engg. Handbook, Washigton, D.C. pp.8-1 to 8.15. [5] Wanjura, F.D., et al. (2002). Agic Water Manage, 55:217:237. [6] Bhatnagar, V.N.S. and Singh, A.K. (1974). Effect of date of sowing and levels of nitrogen on the yield of irrigated cotton in the Mewar Tract of Rajasthan. India J.Agron.,19(3):220-222 [7] Fry,K.E. (1983). Heat unit calculations in cotton crop and insect models. Advances in agricultural technology research service, USDA, No.AAT-W-23, IV: 23pp. [8] Guthrie,D.S. (1991).Cotton response to starter fertilizer placement and planting dates.Agron.J.83(5):836-839. [9] Jacson, B.S and Arkin, G.F. (1986). Quantifying cultivars differences in cotton .Field Crops Research., 14 (1) :75-86 [10] Kalisa,P.and Makram, E.A.(1988). Effect of sowing date on the yield of rain grown cotton in Burundi, Cairo, 33(2):881-889