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EFFECT OF DIFFERENT LATERAL, DRIPPER SPACING AND DRIPPER DISCHARGE RATES ON YIELD AND WUE OF ONION GROWN ON CLAY SOILS

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ABSTRACT

A field experiment with 20 treatment combinations consisting of three levels of lateral spacing (L_1: 80 cm, L_2: 120 cm, L_3: 160 cm), three dripper spacing (D_1: 80 cm, D_2: 120 cm, D_3: 160 cm) and two discharge rates (R_1: 4 lph and R_2: 8 lph) along with two controls *i.e.,* minisprinkler (MS) and surface control (S) methods of irrigation was conducted using onion as test crop during *rabi* seasons of 2006-07 and 2007-08 in FRBD with four replications at Soil and Water Management Farm, Navsari Agricultural University, Navsari. The results revealed that closer lateral and dripper spacings gave significantly higher bulb yield of onion as compared to wider spacings. Among the three methods of irrigation, MS had an edge over drip and drip over surface method of irrigation. However, bulb yield recorded under best drip treatment was 29 and 47 per cent more than MS and surface method of irrigation, respectively. The closer lateral spacing resulted in higher WUE (79.88 kg/ha-mm) than wider lateral spacing (56-90 kg/ha-mm). Among the irrigation methods, maximum WUE of 79.85 kg/ha-mm was obtained with MS irrigation and that of minimum with surface method of irrigation (43.04 kg/ha-mm). Within the drip treatments, 80 x 80 cm configuration of drip layout was ranked first by recording higher yield (32.8 t/ha). The corresponding values for minisprinkler method were 25.43 t/ha and for surface method of irrigation 22.38 t/ha.

INTRODUCTION

In India, onion is grown over an area of 5.08 lakh hectares producing about 60.3 lakh tones of bulb with an average productivity of 11.9 t/ha (Anon, 2002). It is the second most widely used vegetable in the country. Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Madhya Pradesh, Tamil Nadu, Uttar Pradesh, Rajasthan and Haryana are the major producing states for onion accounting nearly 90 per cent of the total area in the country. In Gujarat, Saurashtra region contribute larger portion of onion production. In South Gujarat, onion is grown during *rabi* season and productivity of onion is comparable with state average inspite of clay soils under paddy cultivation. So, there is a scope for increasing onion productivity through following appropriate land configuration and modern methods of irrigation *viz.*, drip and sprinkler. Further, it has already been established that onion is agroclimatically suitable crop during *rabi* seasons of South Gujarat (Patel, 2004). For mitigating the adverse effects of deteriorated soil physical conditions due to puddling in *kharif* paddy, appropriate land configuration has already been recommended (Dhodke, 2006). Onion is very sensitive to moisture stress because of its shallow root system which is restricted to top 8 cm and the roots penetration seldom exceeds 15 cm soil depth (Bose and Som, 1986) and it readily respond to frequent and light irrigations. These advantages of micro irrigation system are capable of resolving the excess and deficit water conditions being created in conventional method of irrigation (Tiwari, 2006). Similarly, the results of experiments conducted on use of mini-sprinkler at NAU were promising and recorded 42, 20 and 20 per cent water saving, increase the yield of onion and fertilizer saving, respectively, over surface method of irrigation (Anon, 2005). While designing drip irrigation system due consideration is required to be given to hydrological properties which affect the water transmission pattern. Lower ranges of diffusivity, sorptivity, penetrability and unsaturated hydraulic conductivity at field capacity of South Gujarat heavy black clay soils facilitate wider lateral and emitter spacing with higher discharge rates. By optimizing the numbers of lateral and emitter in designing drip system, investment on the system can be lowered down as it cost 70 per cent of the system. Another facet of the fluctuating market and demand conditions, farmers can easily switch over to another crop with minimum alterations in existing system. However, in South Gujarat, the information pertaining to this aspects is scanty and hence, present studies was conducted to find out appropriate lateral spacing, dripper spacing and dripper discharge for onion grown on clay soil and to work out the economics.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* seasons of 2006-07 and 2007-08 on Soil and Water Management Research Farm, Navsari Agricultural University, Navsari (Gujarat). The soil of the experimental field was clay in texture, low in available N (235 kg/ha), medium in available P (39 kg/ha) and fairly rich in available K (459 kg/ha). In all 20 treatment combinations consisting of three levels of lateral spacing (L_1: 80 cm, L_2: 120

cm -nd L_3: 180 cm), three dripper spacing (D_1: 80 cm, D_2: 120 cm and D_3: 180 cm) and two discharge rates (lph: liter per hour) (R_1: 4 lph and R_2: 8 lph) along with two controls *i.e.*, mini sprinkler (MS) and surface control (S) methods of irrigation were evaluated in FRBD with four replications. One month old seedling of onion variety *Pilli-patti* was transplanted on 2nd January and 17th December during 2006-07 and 2007-08, respectively. Two common surface irrigations of 60 mm depth *i.e.*, first at the time of transplanting and second 10 days after transplanting were given for establishment of crop. In drip method of irrigation, irrigation was scheduled at 0.8 PEF. The scheduling of irrigation for mini-sprinkler was scheduled at 0.8 IW/CPE and depth of application was 50 mm, while it was scheduled at 1.0 IW/CPE and 60 mm depth for surface irrigated control plots. Recommended fertilizer dose *i.e.*, 125:50:50 NPK kg/ha was applied to all the plots. In drip and sprinkler irrigated plots N and K were applied through fertigation. The crop was harvested on 21nd April and 12th April during 2006-07 and 2007-08, respectively. The yield data were analysed statistically for meaningful interpretation of the results (Panse and Sukhatme, 1967).

RESULTS AND DISCUSSION

During first year, the fresh bulb yield of onion was affected significantly due to individual effects of L and D as well as interactive effect of DxR (Table 1). The results revealed that with increase in lateral spacing, bulb yield was found to decrease significantly and the lateral placed at 80 cm recorded significantly higher yield (25.17 t/ha) as compared to L_2 (20.56 t/ha) and L_3 (18.40 t/ha). Similarly, this was also true for dripper spacing as D_1 (24.0 t/ha) showed superiority over D_2 (21.60 t/ha) and D_3 (18.49 t/ha). With respect to combined effect of DR, combinations of D_1R_1 (25.82 t/ha) and D_2R_2 (23.87 t/ha) were found significantly better than rest of the treatments. All these treatments were also comparable with two control *i.e.*, surface and minisprinkler. The control with MS irrigation recorded bulb yield of 24.90 t/ha which is comparable with

Table 1: Effect of different treatments on fresh bulb yield of onion (t/ha) of onion (FRBD analysis)I:2006-07

Treat.	D1			D2			D3			OverallMean
	R1	R2	Mean	R1	R2	Mean	R1	R2	Mean	
L1	31.60	25.28	28.44	22.14	29.27	25.70	20.17	22.57	21.37	25.17
L2	25.81	22.63	24.22	16.78	22.56	19.67	17.85	17.76	17.80	20.56
L3	20.06	18.89	19.48	19.07	19.79	19.43	15.21	17.37	16.29	18.40
Mean	25.82	22.27	24.05	19.33	23.87	21.60	17.74	19.23	18.49	25.17
MS	24.90	S	21.30			R1	20.97	R2	21.79	
Source	L	D	R	L x D	L x R	D x R	LDR	D-MS-S		MS-S
SEm ±	0.692	0.692	0.565	1.199	0.978	0.978	1.695	1.179		1.622
CD at 5%	1.99	1.99	NS	NS	NS	2.65	NS	NS		NS
CV%	14									

II: 2007-08

Treat.	D1			D2			D3			OverallMean
	R1	R2	Mean	R1	R2	Mean	R1	R2	Mean	
L1	34.01	30.75	32.38	28.16	30.09	29.12	23.44	23.68	23.56	28.35
L2	28.08	28.05	28.06	22.04	24.12	23.08	21.37	23.04	22.20	24.45
L3	21.03	23.85	22.44	18.35	20.00	19.17	17.19	17.96	17.58	19.73
Mean	27.71	27.55	27.63	22.85	24.73	23.79	20.67	21.56	21.11	24.18
MS	25.96		S	23.41		R1	23.74	R2	24.61	
Source	L	D	R	L x D	L x R	D x R	LDR	D-MS-S		MS-S
SEm ±	0.749	0.749	0.611	1.295	1.057	1.057	1.832	1.055		1.452
CD at 5%	2.15	2.15	NS	Ns	NS	NS	NS	NS		NS
CV%	10									

III: Pooled

Treat.	D1			D2			D3			Mean (L)
	R1	R2	Mean	R1	R2	Mean	R1	R2	Mean	
L1	32.80	28.02	30.41	25.15	29.68	27.41	21.81	23.12	22.47	26.76
L2	26.94	25.34	26.14	19.41	23.34	21.37	19.61	20.40	20.00	22.51
L3	20.55	21.37	20.96	18.71	19.90	19.30	16.20	17.67	16.93	19.06
Mean	26.76	24.91	25.84	21.09	24.30	22.70	19.20	20.40	19.80	22.78
MS	25.43	S	22.38			R1	22.35	R2	23.20	
Source	L	D	R	L D	LR	DR	LDR	D-MS-S	MS-S	
SEm ±	0.462	0.462	0.378	2.260	0.654	0.654	1.133	0.791	1.089	
CD at 5%	1.31	1.31	NS	2.26	NS	1.85	NS	NS		NS
Source	YL	YD	YR	YL D	YLR	YDR	YLDR	YD-MS-S		YMS-S
SEm ±	0.654	0.654	0.534	0.925	1.602	1.333	0.925	1.119		1.541
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS		NS
CV%	12									

MS: Minisprinkler S: Surface

Table 2: Water use efficiency under different treatments (Mean of two years)

Methods of irrigation	Pooled Bulb yield (t/ha)	Water applied (mm)	WUE (kg/ha-mm)
L1	26.76	335	79.88
L2	22.51	335	67.19
L3	19.06	335	56.90
D1	25.84	335	77.13
D2	22.7	335	67.76
D3	19.8	335	59.10
R1	22.35	335	66.72
R2	23.2	335	69.25
Drip mean	22.40	335	67.97
MS	25.43	335	75.91
Surface	22.38	520	43.04

Table 3: Effect of different treatments on onion bulb yield (t/ha) (RBD analysis)

SN	Treatments	2006-07	2007-08	Pooled
T_1	L1D1R1	31.60	34.01	32.80
T_2	L1D1R2	25.28	30.75	28.02
T_3	L1D2R1	22.14	28.16	25.15
T_4	L1D2R2	29.27	30.09	29.68
T_5	L1D3R1	20.18	23.44	21.81
T_6	L1D3R2	22.57	23.68	23.12
T_7	L2D1R1	25.81	28.08	26.95
T_8	L2D1R2	22.63	28.05	25.34
T_9	L2D2R1	16.78	22.04	19.41
T_{10}	L2D2R2	22.56	24.12	23.34
T_{11}	L2D3R1	17.85	21.37	19.61
T_{12}	L2D3R2	17.76	23.04	20.40
T_{13}	L3D1R1	20.06	21.03	20.55
T_{14}	L3D1R2	18.89	23.85	21.37
T_{15}	L3D2R1	19.06	18.35	18.71
T_{16}	L3D2R2	19.80	20.00	19.90
T_{17}	L3D3R1	15.21	17.19	16.20
T_{18}	L3D3R2	17.37	17.96	17.67
T_{19}	MS	24.91	25.96	25.43
T_{20}	Surface	21.35	23.41	22.38
	Source			
	SEm ±	1.62	1.45	1.09
	CD at 5%	4.65	4.16	3.07 Y =CD: 0.97
	CV%	13	10	12

the best treatment of drip irrigation. Almost similar trend of treatment effect on bulb yield of onion was observed during second year also. This was ultimately reflected in pooled analysis as well. In pooled analysis, individual effects of L and D as well as interactive effect of L x D and D x R were significant on bulb yield of onion. The bulb yield of 26.76, 22.51 and 19.06 t/ha recorded with L_1, L_2 and L_3, respectively, were differed significantly from each other (Table 1). This was true for dripper spacing. Among the combinations, L_1D_1 recorded significantly higher bulb yield (30.41 t/ha) as compared to rest of the combinations. With respect to DxR effect, a combination involving D_1 and R_1 showed superiority over rest of the combinations except D_1R_2 (24.91 t/ha) with which it was at par in pooled results (Table 1). This suggests that in clay soils, 8 lph dripper is good enough to give optimum wetting zone. The remaining first and second order interactions failed to reach the level of significance. Similarly, the difference between two controls and treatment mean were not conspicuous. In all the cases, the interactions between year and all the factors were absent. The higher yield of onion with closer lateral and dripper spacing might be due to better availability of moisture with closer spacing. Under closer lateral and dripper spacing due to better availability of moisture, the microbial activity might have increase that ultimately might have enhanced the bulb yield of onion. The yield advantage under drip irrigation over surface methods of irrigation was reported by Khalil Ajdari (2008) on sandy loam soil of Iran and Bhakare and Fatkal (2008) on sandy loam soil of Rahuri (Maharashtra). Gite (1999) from Rahuri reported superiority of drip over MS. Yanglen and Tumbare (2014) also reported higher curd yield under drip irrigated cauliflower crop grown on silty clay soils under Rahuri condition.

The data pertaining to the bulb yield, water applied and WUE are reported in Table 2. On an average, during both the years water applied in drip and minisprinkler methods of irrigation was around 335 mm as against 520 mm in surface method of irrigation. Similarly, the bulb yield was ranging from 26.76 t/ha with L_1 to 19.06 t/ha with L_3 treatment. Across the methods, the bulb yield did not vary much as it was around 23 to 25 t/ha. Almost similar bulb yield of onion were recorded under surface irrigation under cold desert conditions of Leh (Kanwar and Ishfaq, 2013). With respect of WUE, it was maximum with MS irrigation (75.91 kg/ha-mm). It was least with surface method of irrigation (43.04 kg/ha-mm). These data clearly indicate that water saving to the extent of 35 per cent can be achieved by adopting either drip or MS method of irrigation as compared to surface method of irrigation. In other words, one can harvest an equal bulb yield of onion as that of surface method with almost half the amount of irrigation water or one can almost double the area under onion crop with drip method of irrigation. The reasons for higher WUE with drip and MS are frequent application of irrigation directly in root zone by drip method and controlled application of irrigation water in MS improves the efficiency. Apart from these, the conveyance losses are almost nil under drip and MS methods of irrigation. Not only less irrigation water is required with drip and MS methods, but at the same time yield enhancement is also achieved because of the congenial conditions for better growth is maintained in root zone throughout the crop growth period. Similar increase in WUE with drip and MS methods of irrigation was also reported by Mane and Khade (1987), Gite (1999), Gole (2000) and Sarkar *et al.* (2008).

When statistical analysis was done using FRBD, the treatment mean *i.e.*, 18 treatments of drip irrigation were compared with surface and MS, the bulb yield of onion was almost similar. However, if the same yield data are processed individual treatment wise for drip, MS and surface control in RBD, then drip irrigation with 80 x 80 cm lateral and dripper spacing recorded around 33 t/ha bulb yield as against the 22 t/ha with surface and 25 t/ha with MS method of irrigation. These differences are conspicuous.

Within the drip treatment, 80 x 80 cm configuration of drip layout was ranked first by recording higher yield (32.8 t/ha). The corresponding values for MS were 25.43 t/ha, and that for surface control 22.38 t/ha. This economics empathetically establishes the fact that even adoptions of lateral spacing at 80 cm (cost intensive) give more bulb yield than conventional method of irrigation. This implies that an increase in bulb yield is so high that it counter balances the drip system cost. Not only this, but drip irrigation also saves the irrigation water to the extent of 35 per cent. If this saved water is used for irrigating an additional area under onion, the monetary benefits will be still higher. Another important aspect emerged from the results of present study is that adoption of appropriate drip layout is must otherwise farmers will have to face the yield as well as monetary losses.

For obtaining higher bulb yield under South Gujarat conditions, adoption of 80 cm lateral and dripper spacing was found more suitable than wider spacing of lateral as well as minisprinkler and surface methods of irrigation. The performance from bulb yield point of view, drip system laid at 120 cm lateral and 80 cm dripper spacing with 8 lph dripper is comparable with the MS and better than surface method of irrigation. So, the farmers already having drip system with 120 cm lateral spacing can also grow onion profitably.

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