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Influence of micro-irrigation methods on growth, yield and storage of *rabi* onion

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ABSTRACT

An experiment was conducted to study the effect of various irrigation methods, *i.e.* drip, mini sprinkler, big sprinkler and surface irrigation on the growth, yield and storage of onion cv. N-2-4-1. The highest yield was recorded in drip irrigation (47.47 t/ha) followed by big sprinkler (31.21 t/ha). The lowest yield was recorded in surface irrigation (22.79 t/ha). The plant height, percentage of big size bulbs, equatorial and polar diameter of bulbs was higher in drip irrigation method. The water use efficiency was higher in drip irrigation (770 kg per ha-cm) than micro sprinkler (344.6 kg per ha-cm), big sprinkler (386.5 kg per ha-cm) and surface irrigation (252.5 kg per ha-cm). The highest B: C ratio (1.98) was also found in drip irrigation. The storage losses after 3 and 6 months of storage were lowest in drip and surface irrigation.

Key words: Onion, irrigation, drip, sprinkler, yield, storage.

INTRODUCTION

Onion is an important commercial vegetable crop. It is grown predominantly in *rabi* (winter) season. The productivity of onion in our country is lower than many other onion-producing countries (Pandey *et al.*, 7). The low productivity of onion could be attributed to low inheritance potential of short day onion varieties predominately grown in our country, higher disease incidence, shortage of timely inputs particularly water, *etc.* (Lawande, 6). Irrigation is one of the most crucial input for onion. The shortage of irrigation at bulb development, which usually coincides with summer season, affects the yield drastically. In last few decades, emphasis has been given in enhancing the productivity of irrigation water. Onion is mostly grown as irrigated crop in our country and surface irrigation is commonly used. The productivity of water in surface irrigation is low due to higher percolation, distribution and evaporation losses. The modern systems of irrigation such as drip, sprinkler ensures higher water use efficiency. Several research workers reported that through micro-irrigation, higher crop yields can be obtained along with considerable saving in irrigation water (Sezen *et al.*, 10; Kumar *et al.*, 5). The results of micro-irrigation are though rewarding in fruit crops as also effective in widely spaced vegetable crops. There has always been apprehension about suitability of drip for closely-spaced vegetables, while sprinklers are used for variety of crops. Thus, a study was conducted to study the efficacy of micro-irrigations methods, *viz.*, drip and micro-sprinkler, big sprinkler *vis-à-vis* surface irrigation.

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MATERIALS AND METHODS

The experiment was conducted during winter (*rabi*) season of 2004-05 and 2005-06 at Research Farm of National Research Centre for Onion and Garlic, Rajgurunagar (Pune). The temperature range of Rajgurunagar is 5.5-42.0°C with annual average rainfall of 669 mm. The soil was clay loam in texture and had pH of 7.53. There were four irrigation methods, *i.e.* drip, big sprinkler and micro-sprinkler and surface irrigation taken for the study which were laid-out in randomized block design with six replications. Six-week-old onion seedlings of onion cv. N-2-4-1 were transplanted every year in December at a spacing of 15 cm x 10 cm distance. For drip irrigation the seedling were transplanted in 60 m long, 15 cm high broad based furrows of 120 cm top width with 45 cm furrow. Two drip laterals of 16 mm diameter having inline dripper at 50 cm distance and 4 l per h water discharge were fixed in each broad based furrow. In micro-sprinkler, 20 mm size lateral with sprinklers at 6 m distance and 135 l per h discharge were used. In big sprinkler 63 mm aluminium pipes with sprinklers at 12 m distance and 1050 l per h discharge were used. The drip and micro-sprinkler were operated on alternate days based on daily pan evaporation. While big sprinkler were operated at 7 day intervals. The drip system was operated at 1.0 kg/cm^2 while micro-sprinkler and big sprinkler were operated at 1.5 and 2.5 kg/cm^2 pressure, respectively.

Surface irrigation was given when cumulative pan evaporation reaches 50 mm at 7 cm depth of soil by using replogal flume meter (Clemmens *et al.*, 3). The recommended doses of fertilizer, *i.e.* 150 kg nitrogen, 50 kg phosphorus and 80 kg potassium per hectare were applied through Sampurna® (19% N, 19% P, 19% K), urea (46 % N) and murate of potash (60 % K). The half dose of nitrogen and full doses of phosphorus and potash were applied as basal and remaining 50 % of nitrogen (75 kg/ha) was divided in 7 equal doses and applied at weekly interval through fertigation or broadcasting starting from two weeks after transplanting. The recommended plant protection measures were taken as and when required. The irrigation was stopped at 15 days before harvesting. The observations on plant morphological characters, yield and yield contributing characters and marketable bulb yield (A, B and C grade bulbs) were recorded and quantity of water applied was also worked out. The well-cured bulbs were kept in bottom-ventilated storage structure from May to November each year to study the various types of storage losses. The data were statistically analyzed according to the methods suggested by Panse and Sukhatme (8).

RESULTS AND DISCUSSION

The results revealed that there was significant difference in the growth and yield of onion under different irrigation methods. The plant height was significantly higher (58.78 cm) in drip irrigation than surface and sprinkler irrigation. But there was no difference in the number of leaves per plant. The total yield was significantly higher in drip irrigation (47.47 t/ha) than other methods. The lowest yield was recorded in surface irrigation (22.79 t/ha). Higher yield in drip irrigation may be attributed to higher plant stand and better plant growth, which enable higher accumulation of photosynthates. The higher percentage of big size (60 mm or more) bulbs was recorded in drip irrigation, which was 36.03 per cent while it was between 10 to 20 per cent in other treatments. The medium size (50-60 mm) bulbs were between 40 and 50 percent in all the treatment and they were statistically similar. However, the percentage of smaller bulbs (35-50 mm) was significantly low (8.75 %) in drip irrigation than other methods (Table 2). The higher percentage of A and B grade bulbs in drip irrigation is directly correlated to the higher yield. Because of higher percentage of bigger bulbs, the yield in drip irrigation was higher. The higher yield and the big size bulbs in drip irrigation may be due to constant moisture regime, better availability of applied nutrients and porous soil conditions. It is a well known fact that drip irrigation ensures better moisture, aeration in the root zone and the fluctuation in soil moisture is less (Sankar *et al.*, 9; Tiwari *et al.*, 11). The percentage of twin bulbs (double bulbs) and bolters was almost similar in all the treatments. Probably these are more influenced by the quality of seed, genotype and the temperature conditions than the soil moisture regime.

There was no difference in the total soluble solids in the bulbs produced under different irrigation systems. The reason may be that the total soluble solids are more influenced by the genotype than the cultural practices. The equatorial and polar diameter of bulbs

Table 1. Effect of irrigation systems on growth and yield of onion cv. N-2-4-1.

Treatment	Plant height (cm)			No. of leaves/plant			Yield (t/ha)			Marketable yield (t/ha)		
	2005	2006	Av.	2005	2006	Av.	2005	2006	Av.	2005	2006	Av.
Surface irrigation	54.73	52.10	53.42	7.5	8.22	7.86	20.29	25.28	22.79	19.23	24.82	22.03
Drip irrigation	59.3	58.25	58.78	9.15	8.71	8.93	41.17	53.77	47.47	38.37	51.32	44.85
Sprinkler (big) irrigation	55.3	55.17	55.24	8.38	7.60	7.99	31.62	30.80	31.21	28.57	24.16	26.37
Sprinkler (micro) irrigation	55.08	53.16	54.12	8.4	7.68	8.04	23.77	25.71	24.74	22.69	23.05	22.87
$CD_{0.05}$	3.09	3.79	4.70	1.26	NS	NS	6.64	7.33	6.83	6.62	6.53	6.36

Table 2. Effect of irrigation systems on different grades of bulbs in onion.

Treatment	Per cent bulb grade								
	A (>60 mm dia.)			B (50-60 mm dia.)			C (35 to 50 mm dia.)		
	2005	2006	Av.	2005	2006	Av.	2005	2006	Av.
Surface irrigation	11.97	6.12	9.05	47.48	51.98	49.73	34.05	40.11	37.08
Drip irrigation	37.86	34.19	36.03	46.88	53.2	50.04	9.45	8.05	8.75
Sprinkler (big) irrigation	16.38	15.24	15.81	47.45	44.99	46.22	26.43	20.2	22.32
Sprinkler (micro) irrigation	15.57	12.1	13.84	44.22	44.19	44.21	26.4	44.35	35.38
$CD_{0.05}$	6.97	5.01	7.38	21.3	NS	NS	17.48	7.80	12.64

was higher in drip irrigation system than others. The neck thickness of the bulbs was statistically similar under all the treatments (Table 3). The higher equatorial and polar diameter of bulbs in drip irrigation was also reported by Balasubrahmanyam *et al.* (1).

The total water applied in different irrigation methods was lowest (62.52 ha/cm) in drip system followed by micro-sprinkler (72.86 ha/cm). While it was highest in surface irrigation (87.5 ha/cm). There was around 30 per cent water saving in drip irrigation system as compared to surface system while it was between 7 and 16 per cent in sprinkler irrigation systems. The highest water use efficiency was recorded in drip irrigation system, which was 770 kg per ha-cm of water (Table 3). The higher water saving, water productivity of water in drip irrigation system is due to the reduction of various types of water losses during irrigation. These are resemblance with the past findings (Gethe *et al.*, 4). The benefit: cost ratio was highest in drip irrigation (1.98) followed by big sprinkler (1.50) while it was lowest in surface irrigation. The higher benefit: cost ratio in drip irrigation suggests that despite higher initial cost of the system; the drip irrigation is more profitable than sprinklers and surface irrigation (Table 4).

As far the storage losses in different irrigation systems are concerned, the total storage losses after three months of storage were lowest in drip irrigation (13.38%) and surface irrigation (13.59 %). While higher losses were found in micro-sprinkler irrigation (22.58%) and big sprinkler irrigation (32.25%) systems (Table 5). Similarly, these losses were 32.72 and 36.18 % in drip and surface irrigation, respectively in comparison to 46.18 % in micro-sprinkler and 57.73 % in big sprinkler after 6 months of storage (Tables 5 & 6; Fig. 1). Among the various types of losses the physiological weight losses (PLW), sprouting and black mould were statistically similar in all the treatments baring few in the first or second year. However, the rotting losses were significantly higher in both types of sprinklers than drip and surface irrigation (Tables 5 & 6). The higher

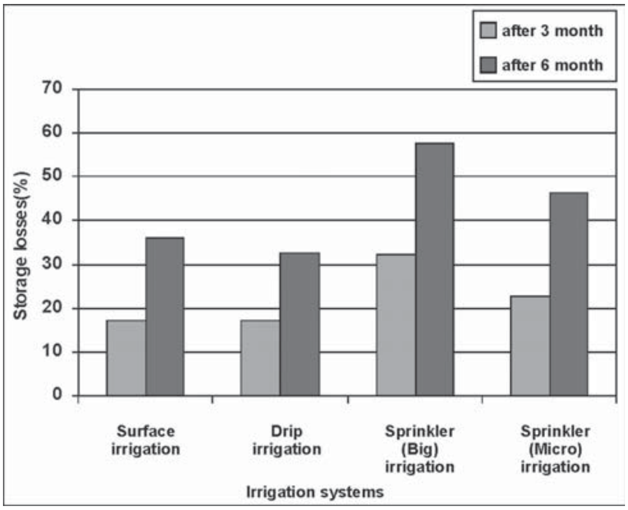

Fig. 1. Total storage losses in onion produced in different irrigation systems.

Table 3. Effect of irrigation systems on bulbs characters and total soluble solids in onion.

Treatment	Total soluble solids (°Brix)			Equatorial dia. of bulb (cm)			Polar dia. of bulb (cm)			Neck thickness of bulbs (cm)		
	2005	2006	Av.	2005	2006	Av.	2005	2006	Av.	2005	2006	Av.
Surface irrigation	12.75	13.1	12.93	5.62	5.42	5.52	3.87	3.94	3.91	0.55	0.68	0.63
Drip irrigation	12.38	13.3	12.84	5.45	5.97	5.71	3.99	4.53	4.26	0.33	0.82	0.58
Sprinkler (big) irrigation	13.05	12.6	12.83	5.17	5.41	5.29	3.75	4.07	3.91	0.52	0.72	0.62
Sprinkler (micro) irrigation	13.25	13.6	13.43	4.74	5.20	4.97	3.98	3.94	3.96	0.39	0.69	0.54
$CD_{0.05}$	NS	NS	NS	0.42	NS	0.26	NS	0.41	0.19	NS	NS	NS

Table 4. Effect of irrigation systems on water use efficiency in onion.

Treatment	Water applied (ha/cm)			Water saving (%) over surface			Water use efficiency (kg/ha-cm)			B:C ratio		
	2005	2006	Av.	2005	2006	Av.	2005	2006	Av.	2005	2006	Av.
Surface irrigation	91.0	84.0	87.5	-	-	-	202.9	302.1	252.5	0.99	1.24	1.11
Drip irrigation	67.2	57.87	62.52	26.15	31.11	28.63	612.6	921.2	770.9	1.72	2.24	1.98
Sprinkler (big) irrigation	84.3	77.58	75.94	7.36	7.64	7.50	375.1	397.0	386.5	1.52	1.48	1.50
Sprinkler (micro) irrigation	79.93	65.79	72.86	12.16	21.68	16.92	297.4	391.7	344.6	1.10	1.19	1.14

Table 5. Various types of losses in onion produced under different irrigation systems after three month of storage.

Treatment	PLW (%)			Rot (%)			Sprout (%)			Black mould (%)			Total (%)		
	2005	2006	Av.	2005	2006	Av.	2005	2006	Av.	2005	2006	Av.	2005	2006	Av.
Surface irrigation	10.81	7.89	9.35	6.03	4.33	5.18	3.12	1.29	2.21	0.75	0.98	0.87	20.71	13.59	17.15
Drip irrigation	8.46	7.22	7.84	3.96	5.28	4.62	2.37	0.1	1.24	0	0.78	0.39	14.79	13.38	17.09
Sprinkler (big) irrigation	7.79	14.38	11.09	16.07	22.35	19.21	1.83	2.07	1.95	0	0.73	0.36	25.69	38.81	32.25
Sprinkler (micro) irrigation	8.07	13.47	10.77	10.96	11.11	11.03	1.03	0.39	0.71	0	0.36	0.18	15.18	18.98	22.58
$CD_{0.05}$	1.22	3.59	2.41	5.77	3.74	4.76	NS	1.37	NS	-	0.21	0.17	3.05	4.38	3.63

Table 6. Various types of losses in onion produced under different irrigation systems after six month of storage.

Treatment	PLW (%)			Rot (%)			Sprout (%)			Black mould (%)			Total (%)		
	2005	2006	Av.	2005	2006	Av.	2005	2006	Av.	2005	2006	Av.	2005	2006	17.15
Surface irrigation	19.28	17.38	18.33	8.87	10.06	9.47	5.96	7.52	6.74	3.34	3.59	3.47	37.41	34.94	36.18
Drip irrigation	16.18	16.61	16.39	8.36	11.68	10.02	9.65	2.97	6.31	3.23	3.56	3.40	34.19	31.26	32.72
Sprinkler (big) irrigation	16.29	25.12	20.71	2.69	28.38	28.04	5.7	8.19	6.95	3.6	3.19	3.40	53.78	61.69	57.73
Sprinkler (micro) irrigation	15.49	21.27	18.38	18.01	19.77	18.89	7.42	5.3	6.36	2.95	2.06	2.51	43.87	48.40	46.18
$CD_{0.05}$	1.95	2.53	5.24	5.23	4.87	7.2	NS	4.31	2.16	NS	0.85	NS	4.88	10.53	8.76

storage losses in overhead irrigation have been reported earlier (Brice *et al.*, 2). The reason may be due to the fact that the overhead irrigation allows the entry of disease causing microorganisms in the later stage of bulb maturity.

REFERENCES

1. Balasubrahmanyam, V.R., Dhake, A.V. and Moitra, P. 2001. Micro-irrigation and fertigation in onion. **In:** *Proc. Int. Conf. Micro and Sprinkler irrigation Systems*, Jalgoan, Maharashtra.

2. Brice, J., Currah, L., Malins, A. and Bancroft, R. 1997. *Onion Storage in the Tropics: A Practical Guide to Methods of Storage and their Selection*. Chaltham, UK, Natural Resources Institute.

3. Clemmens, A.J, Wahl, T.L., Bos, M.G. and Replogle, J.A. 2001. *Water Management with Flumes and Weirs*. International Institute for Land Reclamation and Improvement. Wageningen, The Netherlands.

4. Gethe, R.M., Pawar, V.S., Sonawane, D.A. and Kadlag, A.D. 2006. Infuence of planting layouts, irrigation regimes and fertilizer levels and yield of onion under micro sprinkler. *J. Maharashtra Agric. Uni.* **31**: 272-74.

5. Kumar, S., Imtiyaz, M., Kumar, Aswani and Singh, R. 2007. Response of onion (*Allium cepa*) to different level of irrigation water. *Agric. Water Mgmt.* **89**: 161-66.

6. Lawande, K.E. 2005. Onion improvement- Present status and future thrust. **In:** *Souvenir of National Symposium on Current Trends in Onion, Garlic, Chillies and Seed Spices- Production, Marketing and Utilization*. Rajgurunagar, Pune.

7. Pandey, U.B., Singh, L. and Bhonde, S.R. 2004. *Onion Production in India*. Technical Bulletin No. 9 Revised 2nd edn. National Horticultural Research and Development Foundation, Nashik.

8. Panse, V.G. and Sukhatme V.G. 1995. *Statistical Methods for Agricultural Workers,* 2nd edn., ICAR, New Delhi.

9. Sankar, V., Qureshi, A.A., Tripathi, P.C. and Lawande, K.E. 2001. Micro irrigation studies in garlic. *South Indian Hort.* **49**: 379-81.

10. Sezen, S.M., Yazar, A. and Eker, S. 2006. Effect of drip irrigation regimes on yield and quality of field grown bell pepper. *Agric. Water Mgmt.* **81**: 115-31.

11. Tiwari, K.N., Singh, Ajai and Mal, P.K. 2003. Effect of drip irrigation on yield of cabbage (*Brassica oleracea* L. var. c*apitata*) under mulch and no mulch conditions. *Agric. Water Mgmt.* **58**: 19-28.

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