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Effect of drip irrigation on growth and yield of onion (*Allium cepa* L.)

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Abstract

Drip irrigation is one of the essential, advanced and innovative irrigation methods over surface irrigation. In view of this, an experiment was conducted to study the efficiency of drip irrigation system over surface irrigation in onion during *Rabi* 2013-14 and 2014-15 and *Kharif* 2014 and 2015. The results revealed that drip irrigation system performed superior over surface irrigation system in terms of superior plant morphology, yield and quality of bulb. Drip irrigation recorded maximum plant height (66.37 cm & 61.88), number of leaves (9.23 & 8.00) and neck thickness (1.62 cm & 1.30 cm) in both *Rabi* and *Kharif* seasons. The bulb equatorial and polar diameter, higher gross yield as well as marketable yield obtained in drip irrigation system. In drip, gross yield and marketable yield increased 18.16% and 24.49%, respectively over surface irrigation method and better water use efficiency and also saved 29.36% and 27.12% water during *Rabi* and *Kharif* seasons, respectively.

Keywords: onion, drip irrigation, surface, yield, water use efficiency

Introduction

India is the second largest producer of onion next to China. Maharashtra state is the leading producing state in India. Onion is cultivated in three distinct seasons namely *Kharif*, late *Kharif* and *Rabi*. The soil moisture affect the quality of bulb and yield which is greatly influenced by the irrigation system. Onion is a shallow rooted crop needs light but frequent irrigation either by flood, sprinkler, or drip. The productivity of onion in India is 17.33 ton ha^{-1} which is low compared to world average. Managing the amount of applied irrigation water is critical to achieve optimum yield and quality. Most of the onion grown in India is under surface irrigation, which is relatively inexpensive, but inefficient in the amount of water use. Irrigation through drip is a new technique to increase agricultural production and to enhancing the efficiency of water use (Kusçu *et al*. 2009; Shock 2013; Enciso *et al*. 2015). Drip irrigation lends itself to automation, more so than either surface or sprinkler irrigation. Keeping this in mind, an experiment was planned on onion to study the feasibility of onion cultivation under drip irrigation.

Materials and methods

A field trial was conducted during *Rabi*, 2013-14 and 2014-15 and *Kharif* 2014 and 2015 under "All India Network Research Project on Onion and Garlic" programme to study the feasibility of onion under drip irrigation system over surface irrigation on variety *Agrifound Light Red* for *Rabi* and *Agrifound Dark Red* for *Kharif* at the research farm of National Horticultural Research and Development Foundation, Nashik, Maharashtra. During experimental period meteorological data has given in Fig. 1. Soil of the experimental area was deep heavy clay with pH (7.60), organic carbon (0.75 mg g^{-1}), available N (374.0 kg ha^{-1}), available P (49. 05 kg ha^{-1}), available K (414.4 kg ha^{-1}), water holding capacity (62.8%), field capacity (38.9%) and permanent wilting point (24.6%). The 55-60 days aged seedlings were transplanted in the month of December for *Rabi* and for *Kharif* 45-50 days old seedlings were transplanted in August.

The drip irrigation system was arranged in broad based furrow (BBF) system at spacing of 10 × 15 cm in both drip and surface irrigation systems (farmers practice). BBF of 1.20 m top width with 0.45 m furrow maintaining 15 cm height, each BBF consists of two drip laterals (16 mm size) with inbuilt emitters. The distance between two inbuilt emitters was 50 cm and the discharge rate is 4 L/hr. The BBF system was prepared with a BBF former mounted behind a tractor. Single bed size was kept as 45.0 m x 1.2 m in 6 replications and laid down in RBD design. The width of each bed and furrow was 1.2 and 0.45 m, respectively; thus the width of one unit of BBF was 1.65 m simultaneously the crop raised under surface irrigation method was arranged in flat bed system in three rows, single bed size was 5.0 x 2.0 m, single row contains 7 beds.

Before transplanting of seedlings organic manures *i.e.* vermicompost @10 t ha^{-1} along with *Tricoderma viride* 5 kg ha^{-1}mixed with *Azotobacter* 10 kg ha^{-1} applied in soil in both BBF and flat beds. The recommended dose of chemical fertilizers NPKS was 100:50:50:30 kg ha^{-1}. Fifty percent of N and 100% P, K and S applied at basal remaining 50% N applied in two splits at 30 & 45 days after transplanting in flood irrigation flat bed system. Whereas, in drip

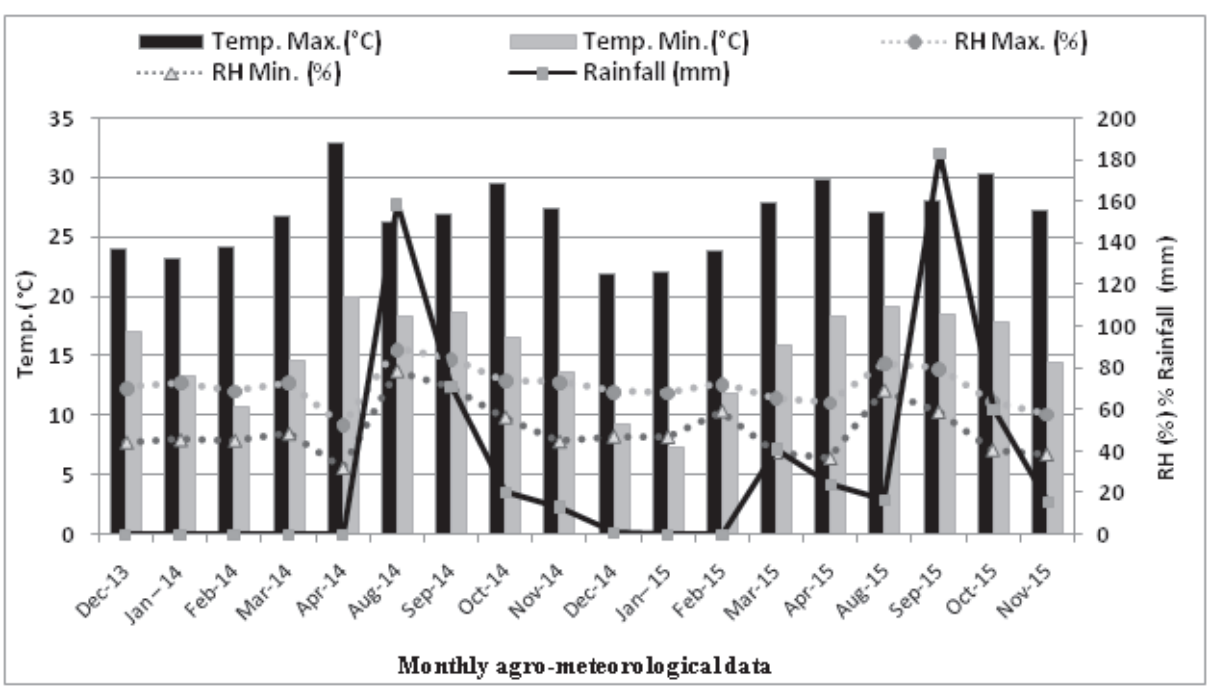

Fig. 1. Agro-meteorological data during crop growing period

system fertigation was done with drip tank in 7 splits with 7 days intervals per day 2-3 hr. First irrigation was operated immediately after transplanting and light irrigation was done three days after transplanting for better and uniform initial establishment of crop. Recommended crop production and protection practices were followed as and when required to get good healthy crop. Following critical precautions were taken while conducting the experiment *viz.* irrigation interval followed uniformly; the operating pressure of drip system was 1.0 -1.5 kg cm^{-2}. In both the systems, irrigation was stopped at 15-20 days before crop harvesting. The bulbs were harvested at full maturity stage. After proper curing and neck cutting, the observations on yield and yield contributing characters and marketable bulb yield, percent of A (>6.5 cm), B (4.5- 6.5 cm) and C (< 4.5 cm) grade bulbs on weight basis separately recorded and quantity of water applied was also measured.

Results and discussion

The results revealed that all growth and yield parameters of onion are significantly influenced by irrigation methods. The highest plant height *i.e.* 66.37 cm and 61.88 cm was recorded in drip irrigation raised bed system during *Rabi* and *Kharif* seasons, respectively, where as in surface irrigation flat bed system plant height was 65.00 cm and 51.52 cm. Number of leaves and neck thickness were also higher in drip irrigation method in both *Rabi* (9.23/ plant and 1.62 cm) and *Kharif* (8.0/ plant and 1.30 cm) seasons (Table 1) that indicated that in drip irrigation raised bed system plant receive favourable conditions for enlargement of root system thereby plant growth and vigour is high. The results are in line with the results of Bhonde *et al*. (2003); Kumar *et al.* (2007) and Bangali *et al*. (2012) for plant growth. Drip provided require amount of water to the crop in small amounts delivered at frequent intervals as needed by the plant, and water losses to evaporation are less than with surface irrigation and also water is delivered at or below ground level, so that wetting of the foliage is not a problem. The drip irrigation affected the size of onion bulb, highest bulb equatorial (6.15 cm & 5.15 cm) as well as polar bulb diameter (5.15 cm & 3.35 cm) were recorded in drip irrigation and the lowest bulb diameter were recorded from the surface irrigation during *Rabi* and *Kharif*, respectively. Frequent amount of soil moisture application leads to large

Table 1. Effect of drip irrigation and surface irrigation systems on plant growth, yield and quality of onion cv. *Agrifound Light Red* for *Rabi* 2013-14 and 2014-15, and *Agrifound Dark Red* for *Kharif* season 2014 and 2015

Growth and yield parameters	*Rabi*			*Kharif*		
	Drip	Surface	CD (P<0.05)	Drip	Surface	CD (P<0.05)
Plant height (cm)	66.37	65.00	1.16	61.88	51.52	5.92
Number of Leaf $plant^{-1}$	9.23	8.18	0.93	8.00	6.77	0.96
Neck thickness (cm)	1.62	1.04	0.39	1.30	0.95	0.05
Bolting (%)	0.56	2.22	0.22	0	0	0
Doubles (%)	2.28	6.34	0.70	0	0.47	0.077
Bulb equatorial diameter (cm)	6.15	5.36	0.33	5.15	4.66	0.26
Bulb polar diameter (cm)	4.64	4.13	0.017	3.35	2.99	N.S.
Gross yield (t ha^{-1})	33.93	29.86	1.71	23.30	20.39	1.22
Marketable yield (t ha^{-1})	31.96	26.07	2.95	20.03	16.93	0.75
A grade bulb (%)	63.07	53.68	1.72	28.96	15.98	3.39
B grade bulb (%)	24.82	22.46	2.40	36.28	34.16	1.21
C grade bulb (%)	12.11	23.86	6.32	34.76	49.86	2.29

photosynthesis area resulted highest plant height and large number of leaves leads to large bulb diameter and yield. The highest total bulb yield (33.93 & 23.30 t ha^{-1}) and marketable yield (31.96 & 20.03 t ha^{-1}) were recorded in drip irrigation system in both *Rabi* and *Kharif* seasons, whereas as in flood irrigation lowest gross yield (29.86 & 23.30 t ha^{-1}) as well as marketable yield (26.07 & 16.93 t ha^{-1}) were recorded. The gross yield and marketable yield increased 18.16% and 24.49%, respectively over surface irrigation. Drip irrigation with fertigation of NPK nutrients with regular intervals enables better plant growth caused higher photosynthesis levels and higher carbohydrates accumulation in sink region. It is evidenced from the results presented in this study is inclusive and similar with previous researchers (Balasubramanyan *et al*. 2001; Quadir *et al*. 2005; Tripathi *et al*. 2010; Bangali *et al*. 2012). The results further revealed that drip irrigation provided lower bolting (0.56%) and doubles (2.28%) as compared with surface system and it was observed that during *Kharif* season bolting did not record in any treatments because the average minimum temperature is above 17ºC is not favourable to initiate bolting, however doubles were recorded (Table 2).

Nashik comes under shadow of a southwest monsoon; hence the erratic summer monsoon experienced by this region sets in last part of June and extends till the 2nd week of October. The mean average rainfall varied from 548.0 mm to 862.0 mm during 2013 to 2015. Rainfall was coincided with bulb initiation and bulb development phases, due to heavy rain fall during *Kharif* season poor bulb development was observed. This is the reason and other climatic reasons during *Kharif* season 36.32% yield decreased as compared with *Rabi*, however by adopting drip irrigation system in *Kharif* season considerable yield was increased over surface irrigation method because drip irrigation raised bed system up to some extent remove excess water and avoid water logging due to slow and steady runoff water as compared with surface flat bed system where crop was affected. Over all during *Kharif* season in drip irrigation, the gross yield and marketable yield increased 14.27% and 18.30%, respectively. It is evidenced from the results, properly designed and managed drip irrigation raised bed has many advantages over surface irrigation including: elimination of surface runoff, high uniformity of water distribution, high water usage efficiency, flexibility in fertilization, prevention of weed growth and plant disease during rainy season. The results further revealed that highest 'A' grade (>6.0 cm) bulb (63.07%), 'B' grade (4.0-6.0 cm) bulb (24.82%) and lower 'C' grade (<4.0 cm) bulb (12.10%) were recorded in drip irrigation system during *Rabi* season and in *Kharif* also higher 'A' grade bulb (28.97%), 'B' grade bulb (36.28%) and lower 'C' grade bulb (34.76%) recorded in drip irrigation system (Table 3). Drip irrigation ensures optimum growth, better bulbing and early maturity of crops by assuring optimum soil moisture, water, air and nutrients throughout the crop growing period resulting uniform bulb obtained is directly correlated to the highest bulb size and productivity, whereas in surface irrigation yield decreased due to deep percolation and water is lost beyond the active absorption zone of the root system as an onion is shallow rooted crop. These results are in line with the results of Hanson & May (2005) and Tripathi *et al*. (2010).

Table 2. Benefits of drip irrigation system over surface irrigation system during *Rabi* and *Kharif* seasons at Nasik region of Maharashtra

Parameters	*Rabi*	*Kharif*
Gross yield (%)	13.64	14.27
Marketable yield (%)	22.61	18.30
A grade bulb (%)	17.49	81.24
B grade bulb (%)	10.51	5.94
C grade bulb (- %)*	49.84	30.29
Water saving (%)	29.36	27.12
Water use efficiency (%)	60.87	56.79

*Per cent decreased over surface irrigation

The benefits of drip irrigation system over surface irrigation are illustrated in Table 4, that applied water in drip system is very lower in

two seasons as compare with surface irrigation system. The 60.29 ha cm^{-1} and 55.65 ha cm^{-1} quantity of water was applied in drip system during *Rabi* and *Kharif*, respectively where as in flood system 85.35 ha cm^{-1} and 76.35 ha cm^{-1}, respectively. Thus, the drip system could save 29.36% and 27.12% water during *Rabi* and *Kharif*, respectively. The primary reasons attributed for the water savings include irrigation of a smaller portion of the soil volume, decreased surface evaporation, reduced irrigation runoff from the drip field and controlled deep percolation losses below the crop root zone, which enables higher water use efficiency in drip irrigation raised bed system, which was 562.79 kg ha^{-1} mm for *Rabi* and 418.69 kg ha^{-1} mm for *Kharif* (Fig. 2). The results were similar in line with results of Halim & Ener (2001) and Nagaz *et al*. (2012). Based on water consumption of crop calculated that during *Rabi* season 1000 lit of water is utilized for production of 5.62 kg and 3.49 kg of onion in drip and surface irrigation, respectively. Whereas in *Kharif* season 1000 litre of water by drip produces 4.18 kg, while in surface it is 2.67 kg, therefore drip irrigation system well suited for shallow rooted onion. The Cost: Benefits ratio also high in drip (1:2.69) while in surface irrigation it is 1: 1.68. The Cost: Benefits ratio in drip suggests that despite higher initial cost of the drip system, the drip irrigation is more profitable than the surface irrigation.

Based on the obtained results of *Rabi and Kharif* seasons of the effect of drip irrigation on yield, yield components and morphological characteristics of onion, as well as water use efficiency and water saving it concluded that drip irrigation is highly significant effect on all studied parameters. To achieve a high production potential of onion, adopting drip irrigation should be maintained during the both *Rabi* and *Kharif* seasons.

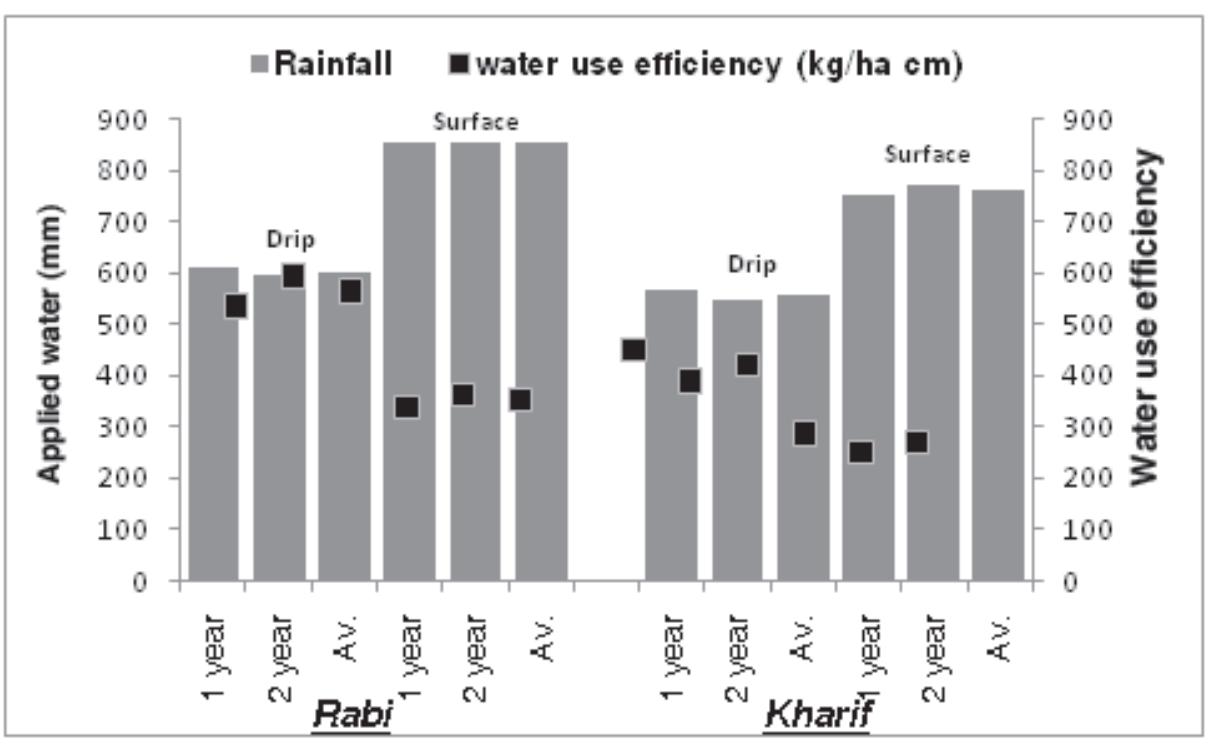

Fig. 2. Effect of drip irrigation and surface irrigation systems on water consumption and water use efficiency of onion cv. *Agrifound Light Red* for *Rabi* 2013-14 and 2014-15, and *Agrifound Dark Red* for *Kharif* season 2014 and 2015

References

Bagali A N, Patil H B, Guled M B & Patil R V 2012 Effect of scheduling of drip irrigation on growth, yield and water use efficiency of onion (*Allium cepa* L.). Karnataka J. Agri. Sci. 25: 116–119.

Balasubrahmanyam V R, Dhakae A V & Moitra P 2001 Microirrigation and Fertigation in onion. In: Proc. Int. Conf. Micro and Sprinkler irrigation Systems, Jalgaon, Maharashtra.

Bhonde S R, Singh N B & Singh D K 2003 Studies on the effect of drip irrigation in onion bulb crop. NHRDF Newsletter 23: 1–3.

Enciso J, Jifon J, Anciso J & Ribera L 2015 Productivity of Onions Using Subsurface Drip Irrigation versus Furrow Irrigation Systems with an Internet Based Irrigation Scheduling Program. Int. J. Agron. Article ID 178180, Available online at http:// dx.doi.org/10.1155/2015/178180.

Halim O A & Ener M 2001. A study on irrigation scheduling of onion (*Allium cepa* L.). Turkey J. Biol. Sci. 1: 735–736.

Hanson B R, May D M 2004 Response of processing and fresh market onions to drip irrigation. Acta Hort. 664: 399–405.

Kumar S, Imtiyaz M, Kumar A & Singh R 2007 Response of onion to different levels of irrigation water. Agric. Water Mgnt. 89: 161–166.

Kusçu H, Çetin B & Turhan A 2009 Yield and economic return of drip irrigated vegetable production in Turkey. New Zealand J. Crop Hort. Sci. 37: 51–59.

Nagaz K M, Masmoudi M & BenMechlia N 2012 Effects of deficit drip-irrigation scheduling regimes with saline water on pepper yield, water productivity and soil salinity under arid conditions of Tunisia. J. Agri. Environ. Int. Dev. 106: 85–103.

Quadir M, Boulton A, Ekman J, Hickey M & Hoogers R 2005 Influence of drip irrigation on onion yield and quality. IREC Farmers Newslett. 170: 29–31.

Shock C C 2013 Drip Irrigation: An Introduction. Oregon State University Extension publication. EM 8782. Available online at http:// ir.library. oregonstate.edu/ xmlui/ bitstream/handle/1957/ 20206/em8782-e.

Tripathi P C, Sankar V & Lawande K E 2010 Influence of micro irrigation methods on growth, yield and storage of *Rabi* onion. Indian J. Hort. 67: 61–65.