Journal of Spices and Aromatic Crops
Volume 17 (3) : 230–234 (2008)

Indian Society for Spices

Effect of micro irrigation practices on growth and yield of garlic (*Allium sativum* L.) var. G. 41

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Received 25 July 2007; Revised 28 February 2008; Accepted 15 April 2008

Abstract

An experiment was conducted at Pune (Maharashtra) to study the feasibility of micro irrigation on growth, yield and yield contributing characters of garlic (*Allium sativum*) under Western Maharashtra conditions. Both drip and sprinkler irrigation systems improved growth, yield and yield contributing parameters of garlic. Among the different irrigation methods and levels tested, drip irrigation at 100% PE recorded the highest marketable bulb yield of garlic followed by sprinkler irrigation at 100% PE. The study indicated that in the best treatment compared to surface method of irrigation, a saving of 37.9% irrigation water in drip and 36.4% in sprinkler system can be achieved.

Keywords : *Allium sativum*, drip irrigation, garlic, sprinkler irrigation, yield.

Introduction

Though India is second largest producer of garlic (*Allium sativum* L.) in the world, the average marketable bulb yield is low compared to other garlic producing countries. Among the various reasons, shortage of irrigation water at critical growth stages is an important factor in reducing the yield. In garlic, flood irrigation is widely practiced in India, which results in inefficient use of irrigation water due to losses in deep percolation, distribution and evaporation. Micro irrigation ensures higher water use efficiency and hence trials were laid out to study the efficacy of two micro irrigation methods namely, drip and sprinkler vis-a-vis surface irrigation on growth and yield of garlic.

Materials and methods

The trial was carried out during *rabi* season of 2000–03 in a randomized block design with garlic variety G.41 at National Research Centre for Onion and Garlic Farm at Rajgurunagar, Pune. The treatments comprised of drip and sprinkler irrigation at 50%, 75%, 100% PE along with surface irrigation up to 7 cm depth at 50% mm CPE as control. The cloves of garlic were dibbled at 10 cm x 15 cm spacing on broad based furrow (BBF) of 120 cm top width with 45 cm furrow maintaining 15 cm height. Each BBF consisted of two drip laterals (16 mm size) with in-built emitters. The distance between two in-built emitters was 50 cm and the discharge flow rate was 4 1 h^{-1}. The micro sprinkler with 135 1 h^{-1} discharge was placed at 6 m distance. The drip and sprinkler irrigation was given on alternate days based on daily pan evaporation rate. The operating pressure for given drip system was 1 kg cm^{-2} and for rotary micro sprinkler was

1.5 kg cm^{-2}. In control, the surface irrigation was given when CPE reached 50% at 7 cm depth of soil by using replogal flume meter. A fertilizer dose of 50 kg N ha^{-1} (as urea) was applied as a basal dose and remaining 50% nitrogen dose (50 kg ha^{-1}) was divided in seven equal doses and applied at weekly intervals through irrigation (drip fertigation) after dibbling and continued up to 70 days after planting. In case of sprinkler and surface irrigation, the remaining 50% of nitrogen was applied twice through broadcasting. Phosphorus @ 50 kg ha^{-1} and potassium @ 50 kg ha^{-1} were applied as single super phosphate and muriate of potash as basal dressing at the time of BBF formation. The recommended plant protection measures were adopted as and when required. Irrigation was stopped 15 days before harvesting in all treatments. The bulbs were harvested at full maturity stage. After proper curing and neck cutting, observations on morphological and bulb characters, and yield and contributing characters were recorded. Grading (A Grade: 30 mm and above, B Grade: 15–25 mm and C Grade: 10–15 mm) of bulbs was done after sorting of bulbs. The water budget was also worked out. The collected data were statistically analysed according to the method suggested by Panse & Sukhatme (1995).

Results and discussion

Growth, yield and yield contributing characters of garlic were influenced significantly by different methods and levels of micro irrigation practiced (Table 1). Drip irrigation at 100% PE recorded the highest plant height (62.7 cm) followed by sprinkler irrigation at 100% PE (58.6 cm). Plant height is an important yield attribute in garlic and any practice to alter the plant height would influence the bulb yield as reported by Vincent (1980) in onion. Plant height has a direct correlation with bulb yield. In the present experiment, the increased plant height in micro irrigated plots might be due to better availability of moisture during entire crop growth period which favoured the growth attributes.

Table 1. Effect of micro irrigation practices on growth characters of garlic var. G. 41

Treatment	Plant height (cm)				No. of leaves				Neck thickness (cm)			
	2000–01	2001–02	2002–03	Pooled	2000–01	2001–02	2002–03	Pooled	2000–01	2001–02	2002–03	Pooled
Drip fertigation												
50% PE	60.4	53.1	48.2	53.9	9.1	9.5	9.97	9.5	0.39	0.65	0.43	0.49
75% PE	75.7	61.7	47.6	61.7	10.3	9.7	9.97	10.0	0.56	0.72	0.47	0.58
100%PE	79.3	63.4	45.3	62.7	11.1	10.1	10.1	10.4	0.60	0.74	0.50	0.61
Sprinkler irrigation												
50% PE	51.2	51.0	46.4	49.5	8.2	9.4	10.5	9.4	0.47	0.61	0.45	0.51
75% PE	66.8	56.8	44.6	56.1	9.98	10.3	10.6	10.3	0.50	0.75	0.54	0.60
100% PE	69.5	60.5	45.7	58.6	10.7	10.0	10.4	10.4	0.86	0.73	0.59	0.73
Surface irrigation at 50 mm CPE	71.0	61.3	46.9	59.7	10.5	9.9	10.5	10.3	0.63	0.76	0.64	0.68
SEm	1.12	1.47	1.34	1.24	0.05	0.04	0.05	0.05	0.07	0.02	0.03	0.08
CD (P=0.05)	3.49	4.32	NS	3.84	0.11	0.10	0.11	0.11	0.16	NS	0.07	0.18

In case of number of leaves, both systems of irrigation (drip irrigation at 100% PE and sprinkler irrigation at 100% PE) recorded the highest number of leaves. A crop should produce sufficient number of leaves to harness light energy and synthesize adequate photoassimilates for biomass production. The increased growth attributes might be due to adequate availability and supply of water and nutrients in proportion, which ultimately resulted in triggering the production of plant growth hormones namely Indole Acetic Acid (IAA) which helped in maintaining a higher number of leaves throughout the cropping period. With respect to neck thickness, the highest bulb neck thickness of 0.73 cm was noticed in sprinkler irrigation at 100% PE followed by surface irrigated plot (0.68 cm) and the lowest neck thickness of 0.49 cm was observed in drip irrigation at 50% PE. The thin neck of garlic bulb is favourable attribute for longer storage life.

The polar and equatorial diameter of bulbs and marketable yield were significantly improved in drip and sprinkler irrigated plots compared to surface irrigated ones (Table 2). In micro irrigation system, water is applied at a low rate for a longer period at frequent intervals near the plant root zone through lower pressure delivery system. It increased the availability of nutrients near the root zone with reduction in leaching losses. More nutrient availability especially nitrogen near the root zone might have increased the translocation of photosynthates to storage organ of bulb resulting in increased diameter and weight of bulb. Similar results were also obtained by Patel *et al.* (1996).

The highest marketable bulb yield (13.2 t ha^{-1}) was obtained in drip irrigation at 100% PE followed by sprinkler irrigation at 100% PE (12.3 t ha^{-1}). This confirms the earlier findings of Patel *et al.* (1996) who also recorded higher marketable bulb yield of garlic under drip irrigation system. Carrijio *et al.* (1982) reported that higher marketable bulb yield of garlic was noticed in higher pan evaporation factor. In the present experiment, the increased yield in drip irrigation

Table 2. Effect of micro irrigation practices on bulb grade in garlic var. G. 41

Treatment	A grade bulbs (%)				B grade bulbs (%)				C grade bulbs (%)			
	2000–01	2001–02	2002–03	Pooled	2000–01	2001–02	2002–03	Pooled	2000–01	2001–02	2002–03	Pooled
Drip fertigation												
50% PE	54.1	43.6	25.1	40.9	37.0	39.6	49.1	41.9	8.90	16.8	25.9	172.
75% PE	63.3	51.5	31.6	48.8	32.5	40.1	47.8	40.2	4.20	8.42	20.6	11.1
100%PE	65.7	57.2	37.5	53.5	30.9	35.3	51.1	39.1	3.4	7.70	22.9	11.3
Sprinkler irrigation												
50% PE	33.5	38.6	20.3	30.8	45.9	32.1	36.7	38.24	20.6	29.3	43.0	31.0
75% PE	46.8	40.9	32.1	39.9	43.2	37.5	40.4	10.0	21.3	27.5	27.5	19.6
100% PE	54.1	50.6	36.1	46.9	38.4	34.7	49.3	40.8	7.5	14.7	24.6	15.6
Surface irrigation at												
50 mm CPE	55.6	52.7	31.8	46.7	32.1	30.4	57.9	40.2	12.3	16.9	10.3	13.2
SEm	0.89	1.17	0.96	1.12	0.89	1.29	0.77	1.04	0.42	0.82	0.63	0.55
CD (P=0.05)	2.26	2.81	3.15	2.97	2.82	3.11	2.12	2.43	0.93	1.22	1.37	1.03

system was mostly due to the favourable effect of available soil moisture, uniform distribution of irrigation water during entire growth period and also uniform size of A and B grade bulbs. Another possible reason is, continuous availability of moisture enhanced the availability and uptake of nutrients throughout the cropping period which resulted in better growth and bulb development. In contrary, Pawar *et al.* (1998) opined that micro sprinkle method was suitable for irrigating close growing crops like garlic by closely spacing the micro sprinklers.

The grade-wise marketable bulb contribution (A grade and B grade bulbs) was also more in drip irrigation at 100% PE in comparison with flood irrigation (Table 3). The beneficial effect of yield characters vis-a-vis better water use efficiency through drip irrigation is attributed to the continuous supply of water in required quantity without flooding to cause hypoxia; therefore, the roots remain well aerated. Another possible reason is, drip fertigation improved the marketable bulb yield of garlic when compared to soil fertilization probably due to continuous and constant supply of fertilizers during growth and development period, as the fertilizers were applied in split doses.

The lower yield in surface irrigation method could be attributed to inefficient use of irrigation water, deep percolation and uneven distribution of irrigation water. Another possible reason is, the growth and yields were ultimately low in surface treatment due to stress condition as compared to micro irrigation system. The quantity of water applied for garlic crop was also worked out (Table 4). The minimum water was applied to drip irrigation at 50% PE (28.2 cm) and the maximum water applied to the surface irrigation method (78.73 cm). It is clear from the data that water could be saved to the extent of 37.9% in drip and 36.4% in sprinkler system. It was observed that double the area could be brought under drip and sprinkler irrigation with the quantity of water normally used for unit area under traditional flood irrigation method (Patel *et al*. 1996; Pawar *et al*. 1998).

Table 3. Effect of micro irrigation practices on yield and yield contributing characters of garlic var. G. 41

Treatment	Plant height (cm)				No. of leaves				Neck thickness (cm)			
	2000–01	2001–02	2002–03	Pooled	2000–01	2001–02	2002–03	Pooled	2000–01	2001–02	2002–03	Pooled
Drip fertigation												
50% PE	3.27	3.44	2.86	3.19	3.11	2.91	2.55	2.86	10.1	8.63	8.48	9.07
75% PE	3.80	4.30	3.42	3.87	3.67	3.41	3.10	3.39	13.5	13.2	9.12	11.9
100%PE	4.30	4.40	.3.95	4.22	3.50	3.72	3.67	3.63	14.8	14.5	10.4	13.2
Sprinkler irrigation												
50% PE	2.91	3.22	2.55	2.89	2.63	2.75	2.31	2.56	9.31	7.30	5.33	7.31
75% PE	3.22	3.77	3.20	3.40	3.24	3.10	2.89	3.08	11.4	10.7	8.98	10.4
100% PE	3.49	4.25	3.79	3.84	3.42	3.54	3.42	3.46	12.8	12.8	11.3	12.3
Surface irrigation at 50 mm CPE	3.14	4.30	3.81	3.75	3.26	3.65	3.38	3.43	11.9	13.0	9.96	11.6
SEm	0.05	0.03	0.04	0.05	0.02	0.02	0.01	0.02	0.18	0.22	0.31	0.27
CD (P=0.05)	0.08	0.05	0.09	0.07	0.05	0.05	0.04	0.05	0.43	0.37	0.59	0.56

Table 4 . Effect of micro irrigation practices on water use efficiency of garlic var. G. 41

Treatment	Water applied (cm)				Water saving (%)				Water use efficiency (kg ha cm^{-1})			
	2000-01	2001-02	2002-03	Pooled	2000-01	2001-02	2002-03	Pooled	2000-01	2001-02	2002-03	Pooled
Drip fertigation												
50% PE	23.5	22.9	38.3	28.2	72.0	70.3	48.9	63.7	431.1	376.9	221.4	343.1
75% PE	35.4	34.3	46.2	38.6	58.0	55.6	38.4	50.7	374.3	384.8	197.4	318.8
100%PE	47.2	45.7	53.3	48.7	44.0	40.7	28.9	37.9	313.1	317.3	192.7	274.4
Sprinkler irrigation												
50% PE	24.9	24.3	35.6	28.3	70.0	68.4	52.5	63.6	318.0	300.4	149.7	256.0
75% PE	37.4	36.5	42.9	38.9	55.0	52.6	42.8	50.1	304.0	293.2	317.3	304.8
100% PE	49.8	48.6	51.6	50.0	41.0	36.9	31.2	36.4	257.4	263.4	226.0	248.9
Surface irrigation at 50 mm CPE	84.0	77.0	75.0	78.7	-	-	-	63.7	140.0	168.8	126.6	145.1

The highest water use efficiency was observed in drip irrigation system (Table 4). Among the levels of irrigation evaluated, drip irrigation system at 50% PE recorded the highest water use efficiency (343.1 kg ha^{-1} cm^{-1}) but there was a marked reduction in yield at minimum water applied per either through drip or sprinkle irrigation. This in accordance with earlier findings of Saman (2002) in onion who also obtained higher water use efficiency in raised beds with drip irrigation method.

It can be concluded that micro irrigation practices significantly improved growth, yield and water use efficiency of closely spaced crop of garlic (G. 41 variety) under Western Maharashtra conditions. Among the various methods of irrigation, drip irrigation at 100% PE was superior in terms of improved growth characters, higher marketable bulb yield and water use efficiency than surface irrigation method.

References

Carrijio O A, Olitta A F L, Miami K & Menezes 1982 Effect of different water quantities on the productivity of two garlic cultivars under drip irrigation. Pesquisa Agropecuaria Brasileira 17: 783-780.

Patel B G, Khanpara V D, Malavia D D, Maraviya R B & Kaneria B B 1996 Economic feasibility of drip irrigation in garlic. Indian J. Agron. 45: 143-145.

Panse V G & Sukhatme P V 1995 Statistical Methods for Agricultural Workers, 2nd Edn. Indian Council of Agricultural Research, New Delhi.

Pawar C Y, Kadam U S, Gorantiwar S D & Pampattiwar S P 1998 Efficacy of the micro sprinkler irrigation method for garlic. J. Maharashtra. Agri. Univ. 23: 156-159.

Saman S 2002 Micro irrigation in onion cultivation. In: Souvenir of Consultative Meeting on Accelerated Production and Export of Onion and Garlic, New Delhi, 19-20 April 2002. National Horticultural Research and Development Foundation, Nashik.

Vincent S R 1980 Studies on the effect of different levels of N, P and K on C^3 onion. MSc (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.