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Response of Garlic (*Allium sativum* L.) cv. G-282 to Different Irrigation Levels under Drip Irrigation System

Rajesh Gupta[1*], K. P. Mishra[2] and M. K. Hardaha[3]

[1]Scientist, KVK, College of Horticulture, Mandsaur – 458001(M.P.)

[2]Associate Professor, Soil & Water Engineering, Faculty of Agricultural Engineering, MGCGVV, Chitrakoot, Satna – 485334 (M.P.)

[3]Professor, Department of Soil & Water Engineering, College of Agricultural Engineering, JNKVV, Jabalpur – 482004, (M.P.)

*Corresponding Author E-mail: rajgupta171@gmail.com

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ABSTRACT

The field experiments were conducted during the two consecutive rabi seasons 2014-15 and 2015-16 to study the influence of drip irrigation on plant growth and yield parameters of garlic (cv. G-282) in agro-climatic conditions of Malwa plateau of Madhya Pradesh. The experiment was laid out in a factorial randomized block design with nine treatment combinations consisting of three irrigation levels and three fertilizer levels having three replications and one control plot treatment of flood irrigation in border strip. Three irrigation levels (treatments) were 60% CPE, 80% CPE and 100% CPE. The maximum percentage of water saving over control treatment was observed in treatment 100% CPE (64%) followed by 80% CPE (52%) and 60% CPE (40%). The irrigation levels significantly affected (P<0.05) the plant height, marketable bulb yield and gross bulb yield of garlic. However, the neck thickness was not affected by irrigation levels. Highest plant height (72.82 cm), neck thickness (0.80 cm), marketable bulb yield (114.85 q/ha) and gross bulb yield (126.24 q/ha) was recorded in treatment 100% CPE.

Key words: *Drip Irrigation, Plant height, Neck thickness, Marketable bulb yield, Gross bulb yield*

INTRODUCTION

India has become one of the biggest exporters of garlic worldwide. Garlic (*Allium sativum* L.) belongs to the family Alliaceae. It is used as a spice or condiment throughout India and also an important foreign exchange earner for India and grown in large quantities in the states of Madhya Pradesh, Gujarat, Orissa, Rajasthan, Karnataka, Tamil Nadu, Maharashtra and Bihar. Madhya Pradesh is leader state in the production of seed spices and the largest producer of garlic in India and occupies the area of over 81.17 thousand ha with a production of 424.50 thousand MT[7].

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Garlic is a very shallow-rooted bulb crops and very sensitive to moisture stress conditions particularly during bulb initiation and development. Frequent irrigation is, therefore, necessary for better bulb development. 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. The drip irrigation technology is the key intervention in water and fertilizer saving which enhanced the crop productivity. Reduced evaporative losses and high irrigation uniformity of surface drip system often results in high irrigation application efficiencies[10]. Energy requirements and costs may be less for low-pressure drip irrigation systems than for high-pressure systems such as impact sprinklers. This system applies water slowly, almost matching with the consumptive use by the plant, to keep the soil moisture within the desired range of available moisture to plant growth and minimizes the water losses in the conventional irrigation methods such as percolation, runoff and evaporation. The area between the crop row is not irrigated therefore more area of land can be irrigated with the same amount of water. Thus, water saving and production per unit of water is very high in drip irrigation. Drip irrigation is making a positive impression on sustainable agriculture in India. Studies conducted on irrigation methods at Directorate of Onion and Garlic Research, ICAR, Pune revealed that the drip irrigation at 100 percent CPE (cumulative pan evaporation) recorded the highest marketable bulb yield in garlic crop with 30-40 percent water saving in comparison with surface irrigation[9].

Although various researches have been conducted on drip irrigation in various parts of India but such types of research have not been reported for Malwa region of Madhya Pradesh. Malwa region is a geographic sub-division situated in the north-west of Madhya Pradesh in India. In Malwa region of Madhya Pradesh, garlic is considered as one of the major rabi crop especially in Mandsaur district and most of the garlic growers practiced flood irrigation which resulted in less productivity. Therefore, this study was conducted to standardize the irrigation scheduling for garlic crop under drip irrigation in agro-climatic conditions of Malwa region of Madhya Pradesh.

MATERIALS AND METHODS

The field experiments were carried out during the two consecutive rabi seasons 2014-15 and 2015-16 to study the influence of drip irrigation on plant growth and yield parameters of garlic (cv. G-282) at farmer's field in Dhariyakhedi village of Mandsaur district of Madhya Pradesh. The area lies between the parallels of 23°45'50" and 25°2'55" north latitudes and between the meridians of 74°42'30" and 75°50'20" east longitudes with an average elevation of 436 meters. The area is characterized by sub-tropical climate having a mean temperature range of minimum 5^0C and maximum 44^0C in winter and summer, respectively with average annual rainfall of 786.6 mm. The soil of the experimental site is clayey with 45 cm depth. The various physico-chemical properties of soil were analyzed before the start of experiment. The experiment was laid out with nine treatment combinations consisting of three irrigation levels and three fertilizer levels having three replications and one control plot treatment of flood irrigation in border strip. Three irrigation levels (treatments) were 60% CPE, 80% CPE and 100% CPE.

The total plot size of experimental site was 35 m X 25 m with individual plot area of 15 m X 1.2 m. The garlic cloves were dibbled at 15 cm X 10 cm spacing on broad bed furrow (BBF) of 120 cm top width with 45 cm furrow maintaining 15 cm height. Each BBF having two drip laterals with in-built emitters with 50 cm spacing between two consecutive emitters at a discharge rate of 4.1 lph. The uniformity coefficient was calculated as 96.80% at pressure of 1.0 kg/cm^2. Irrigation water was applied according to daily crop evapotranspiration. In this study, a fixed irrigation interval of three days was adopted and amount of water applied was estimated based on previous two days' evapotranspiration. The irrigation was stopped 15 days before harvesting in all treatments. The meteorological data like rainfall, minimum and maximum temperature, relative humidity, wind speed and sunshine hours, during crop growth period were collected from automatic weather station of College of Horticulture, Mandsaur located at nearby experimental site. The observation on plant height, neck thickness, gross bulb yield and marketable bulb yield of garlic were recorded using standard procedures. The experiment was laid out in factorial randomized block design (FRBD) with three replications as suggested by Gomez and Gomez[4].

RESULTS AND DISCUSSION

The total amount of water applied in different irrigation treatments for both the experimental years is presented in Table 1. The irrigation water applied in treatment 100% CPE was maximum (343.39 mm) followed by 80% CPE (274.71 mm) and 60% CPE (206.03 mm) in first year of experiment (2014-15), similarly, it was maximum in 100% CPE (348.80 mm) followed by 80% CPE (279.04 mm) and 60% CPE (209.28 mm) in second year of experiment (2015-16). However, maximum amount of irrigation water was applied as 572.31 mm and 581.33 mm in control treatment i.e., border strip method of flood irrigation during the first year and second year of experiment respectively. The maximum percentage of water saving over control treatment was observed in treatment 100% CPE (64%) followed by 80% CPE (52%) and 60% CPE (40%). The present findings are supported by Patel *et al*[8]., Mohammad and Zuraiqi[6], Sankar *et al*[9]., and Chala and Quraishi[2].

Table 1: Total amount of water applied in different irrigation treatments

Irrigation levels	Irrigation water (mm)			Water saving (%)
	2014-15	2015-16	Average	
60% CPE	206.03	209.28	207.65	64.00
80% CPE	274.71	279.04	276.87	52.00
100% CPE	343.39	348.80	346.09	40.00
Control	572.31	581.33	576.82	-

The results revealed that plant height was significantly affected by different irrigation treatments (Table 2). The plant height was significantly higher (72.82 cm) in 100% CPE followed by 80% CPE (72 cm), control (70.50 cm) and least in 60% CPE (68.95 cm) as depicted in Fig 1. The increased plant height in drip irrigated treatments might be due to better availability of moisture and nutrients near root zone during entire crop growth period which favoured the growth attributes. Similar results were obtained by Sankar *et al*[9]., and Mahadeen[5]. The neck thickness was unaffected by irrigation levels (Table 2), however drip irrigated treatments gave higher neck thickness as compared to control. The highest neck thickness was recorded in 100% CPE (0.80 cm) followed by 80% CPE (0.76 cm) and least in control (0.70 cm) as depicted in Fig 2.

Table 2: Plant height and neck thickness of garlic as influenced by different irrigation levels

Parameter	Year	60% CPE	80% CPE	100% CPE	Control	CD (0.05)
Plant height (cm)	2014-15	68.72	71.90	72.69	70.35	0.11
	2015-16	69.18	72.10	72.04	70.65	0.12
	Pooled	68.95	72.00	72.82	70.50	S
Neck thickness (cm)	2014-15	0.69	0.76	0.79	0.64	0.01
	2015-16	0.71	0.77	0.81	0.66	0.02
	Pooled	0.70	0.76	0.80	0.65	NS
S - Significant, NS - Non Significant						

The result showed that the different grade garlic bulbs viz., A-Grade (>25 mm), B-Grade (15-25 mm), C-Grade 10-15 mm), D-Grade (<10 mm) were significantly affected by different irrigation treatments. The A, B and C grade bulbs were considered under marketable yield and D grade bulbs considered under unmarketable category (Table 3). The pooled data clearly indicated that the 100% CPE gave the lowest percentage (9.13%) of unmarketable bulb yield and while control treatment gave the highest percentage (12.62%) of unmarketable bulb yield. This might be due to the fulfilment of crop nutrient and water requirement at various growth stages under different irrigation treatments. It is evident fact that drip irrigation ensures better aeration and moisture in the root zone[11]. These results are in accordance with Sankar *et al*[9]., in garlic and Enchalew *et al*[3]., in onion.

Table 3: Grade wise bulb yield of garlic as influenced by different irrigation levels

Treatment	Grade wise bulb yield (q/ha)				Market-able bulb yield (q/ha)	Gross bulb yield (q/ha)	Unmar-ketable Yield (%)
	Grade A	Grade B	Grade C	Grade D			
Year: 2014-15							
60% CPE	26.38	37.62	37.08	10.91	101.08	111.99	9.68
80% CPE	28.48	39.68	39.20	10.90	107.36	118.26	9.18
100% CPE	30.60	42.61	41.33	11.01	114.54	125.55	8.93
Control	17.68	26.03	26.62	10.02	70.33	80.34	12.47
Year: 2015-16							
60% CPE	26.92	38.04	37.55	11.33	102.51	113.84	10.06
80% CPE	28.66	40.20	40.05	11.53	108.91	120.43	9.54
100% CPE	30.71	42.82	41.63	11.78	115.15	126.93	9.32
Control	17.85	26.18	26.98	10.39	71.01	81.4	12.77
Pooled							
60% CPE	26.65	37.83	37.32	11.12	101.80	112.92	9.87
80% CPE	28.57	39.94	39.63	11.21	108.14	119.35	9.36
100% CPE	30.65	42.71	41.48	11.40	114.85	126.24	9.13
Control	17.77	26.11	26.80	10.21	70.67	80.87	12.62

The yield of garlic bulb was significantly affected by different irrigation levels (Table 4). Marketable bulb yield of garlic was found maximum in 100% CPE (114.85 q/ha) which was significantly higher over control (70.67 q/ha), 60% CPE (101.79 q/ha) and 80% CPE (108.14 q/ha) as depicted in Fig 3. Similarly, gross bulb yield of garlic was found maximum in 100% CPE (126.24 q/ha) which was significantly higher over control (80.87 q/ha), 60% CPE (112.92 q/ha) and 80% CPE (119.35 q/ha) as depicted in Fig 4. These results are in line with that of Patel *et al*[8]., and Ayars[1]. The maximum bulb yield was recorded in treatment 100% CPE may be due to the favourable effect of available soil moisture, uniform distribution of irrigation water and fertilizers in split doses during entire growth period of garlic. Also, drip irrigation treatment created better micro-climate as compared to flood irrigation because of prolonged duration of watering.

Table 4: Marketable bulb yield and gross bulb yield of garlic as influenced by different irrigation levels

Parameter	Year	60% CPE	80% CPE	100% CPE	Control	CD (0.05)
Marketable bulb yield (q/ha)	2014-15	101.08	107.37	114.54	70.33	2.61
	2015-16	102.51	108.91	115.15	71.01	2.25
	Pooled	101.79	108.14	114.85	70.67	S
Gross bulb yield (q/ha)	2014-15	111.99	118.27	125.55	80.34	1.94
	2015-16	113.84	120.43	126.93	81.40	1.84
	Pooled	112.92	119.35	126.24	80.87	S
S - Significant						

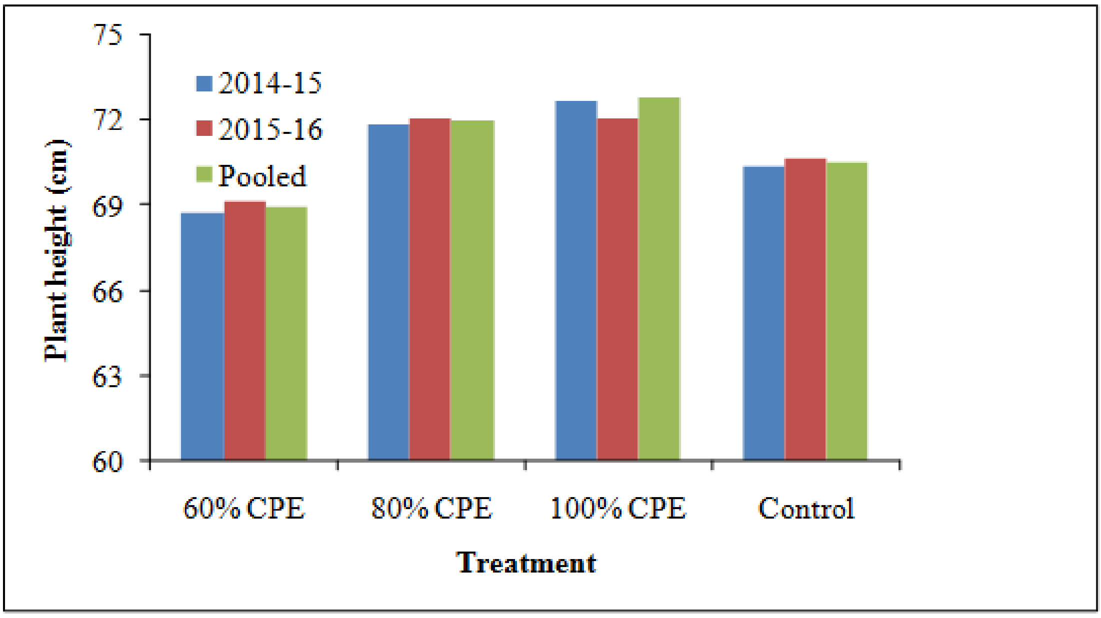

Fig. 1: Effect of irrigation levels on plant height of garlic

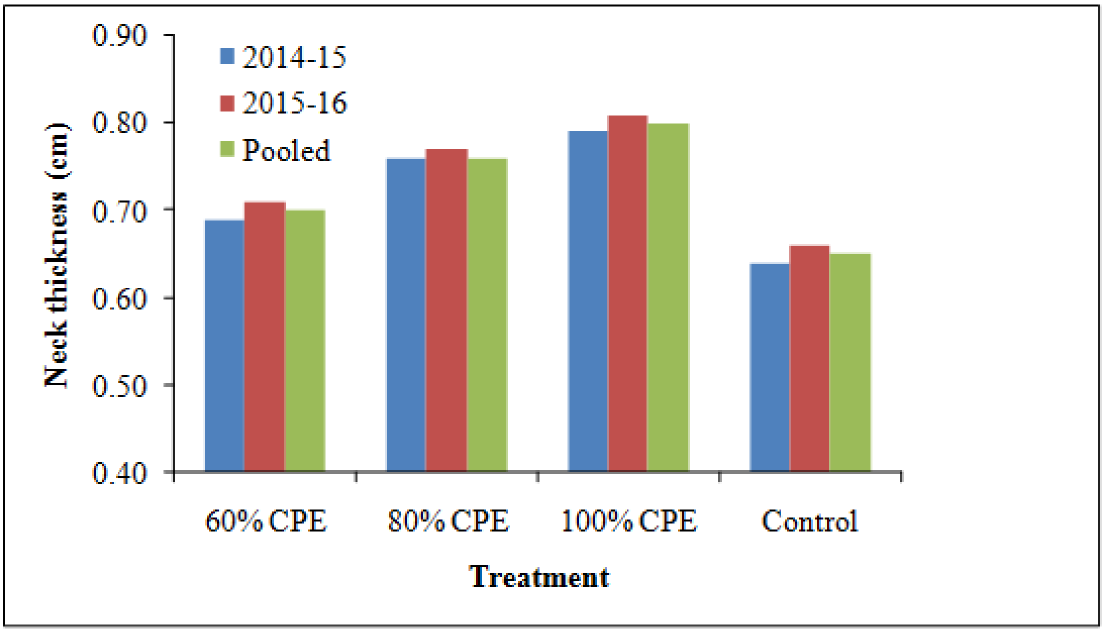

Fig. 2: Effect of irrigation levels on neck thickness of garlic

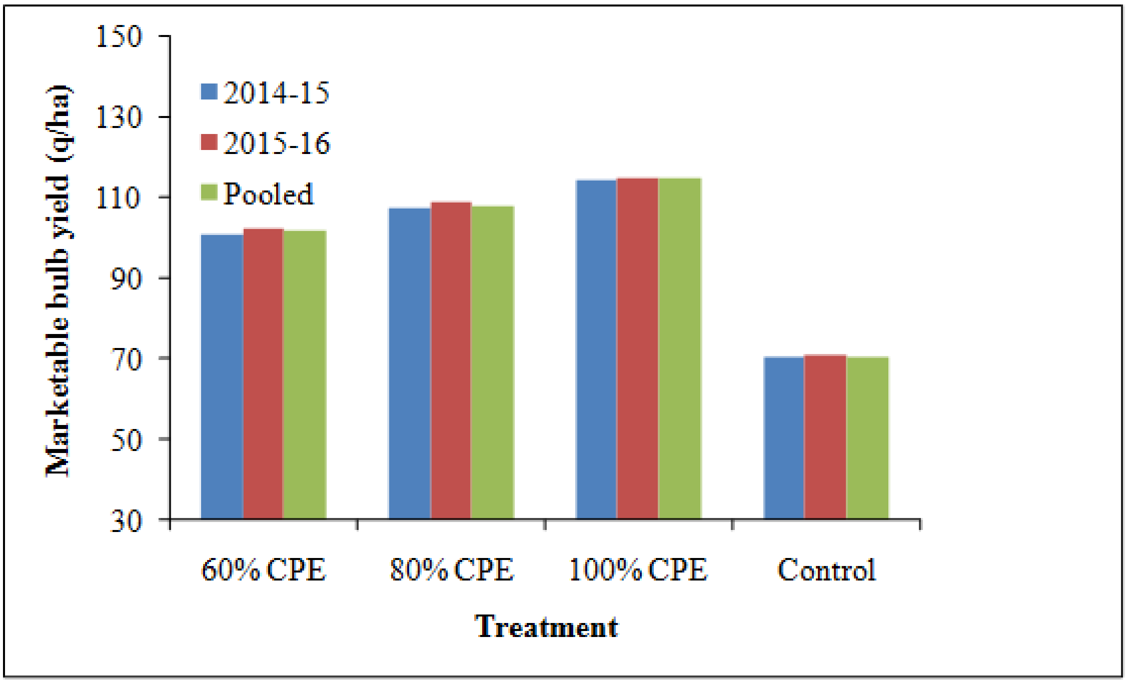

Fig. 3: Effect of irrigation levels on marketable bulb yield of garlic

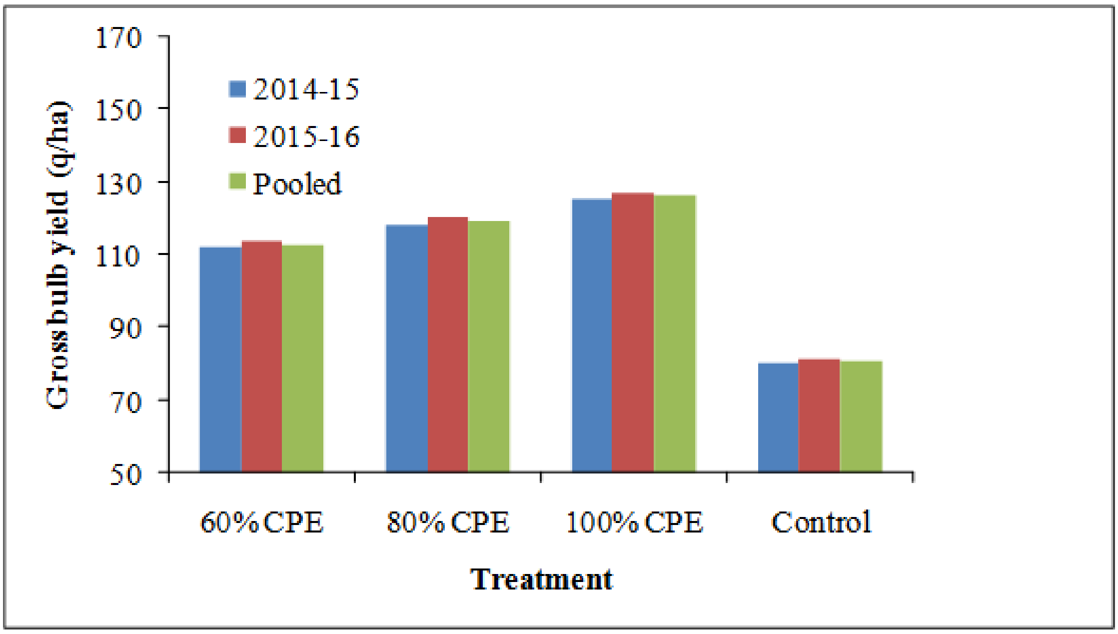

Fig. 4: Effect of irrigation levels on gross bulb yield of garlic

CONCLUSION

On the basis of results obtained in present study, it can be concluded that the 100% CPE (cumulative pan evaporation) with three days' irrigation interval was found best in order to get higher marketable and gross bulb yield for agro-climatic conditions of Malwa plateau of Madhya Pradesh.

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