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EFFECT OF DIFFERENT INTERVALS OF IRRIGATION ON GROWTH AND YIELD OF GARLIC

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A study was conducted to evaluate the growth and yield of garlic with 7, 14 and 21 day intervals of irrigation and without any irrigation. The result of the study indicated that crops grown under irrigated conditions of any interval duration produced better performances regarding growth and yield of garlic over non-irrigated crops. The 7-day interval of irrigation significantly increased the vegetative growth of garlic while the 14-day interval of irrigation produced significant increases of yield and harvest index.

Key words: Garlic, Irrigation, Growth, Yield.

Introduction

Garlic (*Allium sativum* L.) is well known as a spice and medicinal herb. It can be grown almost throughout Bangladesh during the winter season. During the winter season the average rainfall in Bangladesh is limited to only 110 mm which is distributed unevenly [1]. Sufficient soil moisture is essential for the growth and development of garlic [2].

Irrigation is an important factor for successful crop production. It influences better utilization of all other production factors. Most of the world's garlic crop is grown under irrigation [3]. Irrigation scheduling or duration of irrigation interval is unidentified in Bangladesh. Since garlic is normally a crop of a drier season, it needs supplemental soil moisture for its successful production. Four irrigations with 50 mm of water at 20-day intervals produced the highest yield in onion [4]. Donnari [5] observed that a 20-day interval of irrigation resulted in higher yield for garlic but storage diseases of garlic increased as the number of irrigations of the crop increased[6]. One irrigation at around 30-days after planting (DAP) was found to be best for potato cultivation [7]. The growth and yield of cabbage increased with irrigation at an interval of 10 days [8]. Frequent irrigations at -20 kPa soil water potential increased yield of radish [9]. Similar growth of okra was produced at different rates of irrigation (40-100% of Pan evaporation, Epan) but irrigation equal to 60% Epan produced the highest yield of okra [10]. Yield of tomato and okra was found to increase when frequent irrigation at the rate of 30 mm water, (at E_o=30 mm) with straw mulch was applied [11].

In order to achieve the best garlic yields, duration of interval of irrigation needs to be identified. Very little information is available for irrigation scheduling of garlic. Therefore, the present study was carried out with a cultivar of garlic locally grown in Bangladesh at different intervals of irrigation in Bangladesh Agricultural University soil. The main objective of the study was to determine the optimum interval of irrigation for garlic.

Materials and Methods

The experiment was conducted on a sandy loam soil at Bangladesh Agricultural University, Mymensingh during November 1989 to March 1990. The growth environment of the experimental site is presented in Table 1 [12]. A cultivar of garlic grown locally in Bangladesh was used in the experiment.

TABLE 1. METEOROLOGICAL DATA OF 1989-90 OF THE EXPERIMENTAL SITE (MONTHLY AVERAGE).

Months	Air temperature°C		RH	Sun shine	Soil temperature
	Max.	Min.	(%)	(hr./day)	at 20 cm depth °C
Nov.	29.09	17.10	79.80	8.29	24.1
Dec.	25.38	11.36	76.55	7.62	19.1
Jan.	25.65	12.27	78.61	6.19	20.4
Feb.	26.84	20.67	74.89	6.36	21.35
March	28.12	17.50	75.16	6.00	24.4

There were four treatments in the study consisting of four different intervals of irrigation schedules *viz.* no irrigation (control, I_o) irrigation at 7-day interval (I_7), at 14-day interval (I_{14}) and at 21-day interval (I_{21}) respectively. Irrigation was done by watering can at the rate of 400 m^3/ha [13]. The unit plot was 2m x 2m in size in which the cloves were planted at a spacing of 20 cm x 10 cm on the Ist November 1989. The plots were laid out in a randomized complete block design with 4 replications. Cowdung and triple superphosphate (TSP) were applied @ 10 ton/ha and 148 kg/ha, respectively as basal doses during the land preparation. Urea and muriate of potash @ 173 kg and 148 kg/ha, respectively were applied 20 and 45 days after planting (DAP) as top dressing in two equal installments. Intercultural operations were done as and when required. Irrigation was started from 40 DAP at 7,14 and 21 day intervals, respectively. Observations on growth parameters were made at three different stages of growth (40, 80 and 120 DAP, respectively). Ten plants from each plot were randomly selected for recording observations. Data were recorded on

plant height, length of pseudostem, pseudostem diameter, leaf and roots number per plant at 40, 80 and 120 DAP, respectively. Data on leaf length, leaf breadth, leaf area per plant, fresh weight of leaf per plant, dry weight of leaf per plant and specific leaf area were recorded only at 120 DAP. The size of bulb, size of cloves, number of cloves per bulb, individual weight of bulb (g) and yield (ton/ha) were recorded after final harvest. The variances of each parameter were statistically analysed and the treatment means were compared by Duncan's New Multiple Range Test (DMRT).

Results and Discussions

Effect of different intervals of irrigation on various stages of growth of garlic is presented in Table 2. Variations in the recorded parameters such as plant height, length of pseudostem, pseudostem diameter, number of leaf and number of root per plant were not significant till 40 DAP in all the treatments (Table 2). The above parameters except the root number were significantly influenced by 7-day interval of irrigation both at 80 and 120 DAP, respectively (Table 2).

The plant heights were significantly different both in 80 and 120 DAP. The tallest plants were obtained at 80 DAP (57.4 cm) and at 120 DAP (74.7 cm), respectively, when the plants were irrigated at 7-day intervals. Shortest plants (59.1 cm) were obtained where no irrigation was applied. Plant heights obtained by 14 and 21-days intervals of irrigation at 120 DAP were similar (Table 2).

Length of pseudostem in all the treatments were similar upto 40 DAP. Seven-day interval of irrigation produced the longest pseudostem at 80 DAP (20.6 cm) and at 120 DAP (27.45 cm), respectively (Table 2). The shortest pseudostem (19.88 cm) were produced by the untreated plants. Pseudostem diameters were not influenced by different intervals of irrigation at either 40 DAP or at 80 DAP (Table 2). Seven day interval of irrigation produced significantly higher pseudostem diameter (1.01 cm) only at 120 DAP. The smallest diameter (0.73 cm) was found in the plants where no irrigation was applied (Table 2).

Leaf number per plant were not influenced by different intervals of irrigation treatments at 40 DAP. The 7-day interval of irrigation produced the highest leaf number both at 40 DAP (8.08) and at 120 DAP (8.2). Leaf number obtained by 7-day and 14-day intervals of irrigation were similar at 120 DAP (Table 2).

Number of roots was similar at 40 DAP in all the treatments. The 14 and 21-day intervals of irrigation produced the highest root number at both 80 and 120 DAP (Table 2).

Some features of leaf morphological characters such as leaf length, leaf breadth, leaf area, leaf fresh weight, leaf dry weight and specific leaf area were measured at different intervals of irrigation at 120 DAP (Table 3). The 7-day interval of irrigation produced significantly higher length of leaf than the control and the 21-day interval irrigated plants. Leaf length of 7-day and 14-day intervals irrigated plants were similar (Table 3). On the other hand, 14-day interval of irrigation produced significant increase in leaf width than the other treated plants. Leaf area, fresh and dry weights of leaf were higher in 7-day intervals irrigated plants than the other treated and untreated plants. The 14-day interval irrigated plants required minimum specific leaf area (18.8 cm^2) to produce 1 (g) dry matter of leaf of garlic (Table 3). It means that the plants of this treatment attained high relative leaf thickness than the others.

Plant height, length of pseudostem, pseudostem diameter, leaf number, root number, leaf length, leaf width, leaf area etc. have little genetic variability in a progeny but are regulated by environmental variables. Thus the variability observed in the above characters was the result of change in microclimatic conditions imposed by different intervals of irrigation. Soil moisture availability due to the shortest intervals of irrigation

TABLE 2. EFFECT OF DIFFERENT INTERVALS OF IRRIGATION ON GROWTH OF GARLIC AT DIFFERENT STAGES OF GROWTH.

Days after planting	Intervals of irrigation	Growth components: Plant height (cm)	Length of pseudostem (cm)	Pseudostem diameter (cm)	Leaf number per plant	Root number per plant
40	I_0	27.75	7.55	0.490	4.93	33.23
	I_7	29.25	7.93	0.480	4.99	32.90
	I_{14}	28.75	7.70	0.515	5.05	35.93
	I_{21}	28.75	7.83	0.483	5.30	33.70
80	I_0	48.6d	14.98c	0.50	6.68b	50.84b
	I_7	57.4a	20.65a	0.653	8.08a	55.20b
	I_{14}	53.6b	18.30ab	0.763	6.96b	62.95a
	I_{21}	51.4c	17.65b	0.730	6.80b	65.63a
120	I_0	59.1c	19.88c	0.73c	6.75b	59.60b
	I_7	74.7a	79.45a	1.01a	8.0a	62.63b
	I_{14}	66.7b	24.2b	0.87b	6.87b	70.45a
	I_{21}	65.27b	22.68b	0.84bc	6.65b	75.88a

The figure in the same column marked with different letters are statistically different at the 5% level by DMRT.

TABLE 3. EFFECT OF DIFFERENT INTERVALS OF IRRIGATION ON THE LEAF MORPHOLOGY OF GARLIC.

Intervals of irrigation	Leaf parameters: Length (cm)	Width (cm)	Area per plant (cm^2)	Fresh weight per plant (g)	Dry weight per plant (g)	Specific leaf area (cm^2/g)
I_0	23.8c	1.03c	21.5c	6.6c	1.12c	19.2bc
I_7	31.3a	1.19b	32.0b	9.6a	1.61a	20.16b
I_{14}	29.3a	1.30a	29.1ab	7.86b	1.54ab	18.8c
I_{21}	26.7b	1.14b	26.4b	7.26bc	1.25b	21.1a

The figures in the same column marked with different letters are statistically different at 5% level by DMRT.

encourages the plants to divert dry matter to the above ground vegetative parts instead of bulbs and roots [2].

The overall performances of plants obtained by different intervals of irrigation in garlic were evaluated in terms of biological yield, economic yield and HI (Table 4). The plants obtained by 14-day interval of irrigation produced higher biological yield, economic yield and HI than those of plants originated by I_0, I_7 and I_{21} intervals of irrigation (Table 4). The HI (0.61) in the plants obtained by 14-day interval of irrigation compared to I_0, I_7 and I_{21} intervals of irrigation was probably indicative of their higher efficiency of storing photosynthates into the bulbs [14].

Data on yield and yield components response at different intervals of irrigation have been shown in Table 5. The higher yield (5.33 ton/ha) was obtained in 14-day intervals irrigated plats. The lowest yield (2.88 ton/ha) of garlic was obtained in the plants where irrigation water was not applied (Table 5).

The size of bulb was significant and the largest size of bulb (length 3.08 cm and diameter 3.30 cm) was obtained in the plants where irrigation was applied at 14-day interval (Table 5). The size of bulbs obtained by I_0, I_7 and I_{21} intervals of irrigation was similar. Similar trends were found in the case of clove size (Table 5). The 14-day interval of irrigation resulted in a higher number of cloves (19.25) but this number was not significant compared with other treatments (Table 5).

TABLE 4. EFFECT OF DURATION OF INTERVAL OF IRRIGATION ON BIOLOGICAL YIELD, ECONOMIC YIELD AND HARVEST INDEX.

Treatments	Parameters		
	Biological yield (dry wt., g/m^2)	Economic yield (dry wt., g/m^2)	HI
I_0	125.6c	70.7d	0.56b
I_7	166.1b	81.4c	0.49c
I_{14}	225.4a	138.3a	0.61a
I_{21}	169.8b	98.4b	0.58a

The figure in the same column marked with different letters are statistically different at 5% level by DMRT.

TABLE 5. EFFECT OF DURATION OF INTERVAL OF IRRIGATION ON THE YIELD AND YIELD COMPONENTS OF GARLIC.

Treatments	Yield and yield components						
	Yield (ton/ha)	Size of bulbs (cm)		Size of cloves (cm)		Number of cloves/ bulbs	Weight of one bulb (g)
		Length	Diameter	Length	Diameter		
I_0	2.88	2.466	2.42b	2.01b	0.72b	15.0	6.53c
I_7	3.26c	2.51b	2.48b	2.02b	0.73b	18.75	6.98c
I_{14}	5.33a	3.08a	3.30a	2.44a	0.96a	19.25	11.18a
I_{21}	4.06b	2.54b	2.64b	2.05b	0.81ab	18.0	8.14b

The figure in the same column marked with different letters are statistically different at 5% level by DMRT.

The weight of individual bulb was significant and the highest weight (11.18 g) was obtained in the treatment of 14-day interval of irrigation (Table 5) which was followed by I_{21}, I_7 and I_0 treated plants.

The 14-day interval of irrigation treated plants resulted in higher yield (5.33 ton/ha) in garlic which was followed by I_{21}, I_7 and I_0 treated plants, respectively. However, yield obtained from I_0 and I_7 treated plants were not statistically different. The 14-day interval of irrigation probably maintains the proper soil moisture and soil temperature range for the development of bulbs [15]. It might also help the plants to distribute and accumulate dry matter to bulbs of garlic properly.

It could be concluded from the above results that the 14-day interval of irrigation starting from 40 DAP should be used for growing garlic in sandy loam soil in Bangladesh.

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