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Effect of Plant Spacing on the Growth and Yield of Different Varieties of Onion

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Abstract: The experiment was undertaken to determine the effect of spacing on onion cultivation of different varieties. Different spacings were taken 20x10 cm, 15x10 cm, 10x10 cm, 15x7.5 cm, 10x7.5 cm and 7.5x7.5 cm. Three varieties viz BARI Piaz–1, Taherpuri and Faridpur Bhati were used for study. Significantly wider spacing produced higher size of plant height, leaf length and number of leaves. Bulb length, diameter and weight also the same trend in wider spacing. The weight of individual bulb of onion (23.52 g) was increased with the widest spacing (20x10 cm). On the contrary, yield ha^{-1} was the highest (16.65 t ha^{-1}) at the closest spacing (7.5x7.5 cm) and the lowest (10.05 t ha^{-1}) was at widest spacing (20x10 cm). But in closer spacing, bulb size was so small that was not suitable for the choice of consumer. On the other hand wider spacing produced the highest percentage (24.34%) multiplier bulbs that was not better for storing and consumers demand. So, in respect of economic point of view 15x10 cm spacing recommended in onion cultivation. It was found BARI Piaz-1 performed better in respect of yield and other parameters.

Key words: Optimum spacing, varieties, growth and yield economically viable

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important spice and vegetable crops grown in Bangladesh. Onion stands first among the spice crops in the country, both in area and production. The average productivity of onion in Bangladesh is very low (4.28 t ha^{-1}) compared to the world average productivity (15 t ha^{-1}) (Leaflet-2000)). The reason behind such low yield may possibly due to practice of unimproved method of production generally followed by the farmers. Bangladesh requires about 450 thousand metric tons of onion bulbs per annum for fulfill her demand. Whereas, Bangladesh produces about 150 thousand metric tons of onion (Leaflet-2000). Rest of onion imported by hard earned foreign currency in every year. So, we have to cultivate onion through proper management. The yield of onion is influenced by a number of environmental factors including the cultural practices. The information on the effect of spacing on the growth and yield of onion is scanty. Proper spacing ensures optimum plant growth through adequate utilization of moisture, light, spacing and nutrients (Zubeldia and Gases, 1977). Planting of onion at optimum density gives the best economic return (Rashid and Rashid, 1976). Badaruddin and Haque (1977), Hoque *et al.* (1979), Gupta and Gaffer (1980), reported yield increased with the plant density up to a certain limit. Hoque *et al.* (1979) and Kumar *et al.* (1998) obtained the highest yield with a spacing of 20x10 cm, Gupta and Gaffer (1980) at 15x10 cm, Islam (1988) at 10x9 cm, Badaruddin and Haque (1977) at 10x30 cm and Rashid and Rashid (1976) at 20x10 cm in a single row system. On the other hand Rashid and Rashid (1976) also got the highest yield at 10x10 cm in a multiple row system. Singh and Jain (1972) observed that Patna Red onion planted at 10x30 cm spacing gave the highest yield ha^{-1} than those of 20x10 and 30x30 cm although wider spacing gave bigger and heavy bulbs. Considering the above facts, this piece of research work was carried out to find out the optimum spacing to achieve the optimum growth and economically viable yield of onion bulbs for cultivation.

MATERIALS AND METHODS

The experiment was conducted at Spices Research Sub-centre, BARI, Magrua during the years of 1996/97, 1997/98 and 1998/99. Three varieties viz., BARI Piaz-1, Taherpuri and Faridpur Bhati were used in the study. The unit plots size was 3x2.5 m during every year. Six plant spacing such as 20x10, 10x10, 15x10, 15x7.5, 10x7.5 and 7.5x7.5 cm were included in this experiment. The experiment was laid out in factorial randomized complete block design (RCBD) with three replications. Manures and fertilizers were applied at same doses and methods for each treatment, 50 days old seedlings were used for each treatment. Other cultural practices such as gap filling, irrigation, weeding and pest management were done as and when required. After being matured bulbs were also harvested at same day for each treatment. The bulbs were kept on the open floor to cure for three days. After curing

and chopping of tops bulbs were weighed. The observation were made on the following parameters: plant height, leaf length, number of leaves per plant, bulb length, diameter of bulbs, types of multiplier bulbs, bulb weight and yield of bulbs. All data for parameters were collected from ten randomly selected plants of each unit plot. Data were analyzed statistically. The differences among means were evaluated by least significant difference test.

RESULTS AND DISCUSSION

Effect of variety: Significant effect was found among the varieties for all parameters studied (Table 1). Highest yield (16.74 t ha^{-1}) was obtained from the variety of BARI Piaz-1. It is identical to the yield (14.99 t ha^{-1}) of Taherpuri. The lowest yield (8.86 t ha^{-1}) was produced by the variety Faridpur Bhati. Identical performance was recorded in respect of plant height, leaf length, leaf number, bulb length, bulb diameter, bulb weight and percentage of multiplier bulbs. No significant different was found between the variety BARI Piaz-1 and Thaherpuri.

Effect of plant spacing: Different spacing maintained in onion transplanting significantly affected the plant height, length of leaf, number of leaf, bulb length, bulb diameter, multiplier bulb and also yield ha^{-1} (Table 2). Closer spacing 7.5x7.5 cm produced significantly highest yield (16.65 t ha^{-1}) followed by the yield (15.82 t ha^{-1}) of spacing 10x7.5 cm. The lowest yield (10.05 t ha^{-1}) was obtained from the wider spacing 20x10 cm. The highest multiplier bulbs (24.34%) were recorded from the wider spacing 20x10 cm followed by the spacing 15x10 cm (20.11%).The lowest percentage of multiplier bulbs (14.38%) were recorded from the closer spacing 7.5x7.5 cm. 12.42 and 12.97 t ha^{-1} yield were obtained from the spacing of 15x10 and 15x7.5 cm, respectively. Significantly the highest plant height (40.46 cm) was observed from the spacing 20x10 cm followed by the spacing 15x10 cm (38.08 cm). The shortest plant height (27.07 cm) was observed from the spacing 7.5x7.5 cm. The heaviest bulb (23.52 g) was produced by the spacing 20x10 cm followed by the spacing 15x10 cm (22.42 g) and the lowest spacing 7.5x7.5 cm (11.13 g). The biggest bulb (4.44 cm of diameter, 4.47 of bulb length) was obtained from the spacing 20x10 cm followed by the spacing 15 x 10 cm (4.33 cm of diameter, 4.21 cm of bulb length) and the lowest by the spacing 7.5 x 7.5 cm (3.11 cm of diameter, 3.01 cm of bulb length). Leaf length and leaf number ranged from 24.03 – 35.82 and 6.45-8.43 cm, respectively but significantly the tallest leaf length (35.82 cm) and the highest numbers of leaves (8.43) were obtained by the 20x10 cm. The lowest (24.03 cm, 6.45) was produced by the spacing 7.5x7.5 cm. Estimated required numbers of seedlings ha^{-1} for spacing 20x10, 10x10, 15x10, 15x7.5, 10x7.5 and 7.5x7.5 cm were 480000; 928000; 582000; 836000; 1276000 and 1628000 respectively (Table- 4). It is clear from the results closer spacing needs about 2-3 times more seedlings compare to others for onion cultivation and closer spacing produced small size of bulbs, which were not suitable for marketing. The favorable effect of closer spacing in promoting the bulb yield might be due to the fact that closer spacing produced more number of bulbs per unit area. Wider spacing produced higher percentage of multiplier bulbs, which also are not suitable for marketing. Yield (12.42 t ha^{-1}) obtained from the spacing 15x10 cm was higher than the yield (10.05 t ha^{-1}) of wider spacing 20x10 cm. The yield difference between 20x10 and 15x10 cm is statistically significant. But the yield difference between the spacing 15x10 (12.42 t ha^{-1}) and 15x7.5 cm (12.97 t ha^{-1}) is not statistically significant. Bulb size and bulb weight decreased with the decrease in spacing (Table 2 and 3). This result is in agreement with the findings of Singh and Jain (1972). From the results considering all things the optimum plant spacing is 15x10 cm for onion bulb production in the view of economic condition. Similar results were also reported by Gupta and Gaffer (1980), Bhan (1966), Das and Dhyani (1956), Patel and Chauhan (1958), Pagare (1961), Purewal and Dargan (1962), Dastane and Joshi (1964), Arora *et al.* (1966) and Rao *et al.* (1967).

Interaction effect of variety and spacing: The interaction effect of variety and spacing had influenced significantly on the parameters (Table 3). Significantly the highest plant height (45.46 cm) was obtained from the variety BARI Piaz-1 with 20x10 cm. The shortest plant height (22.47 cm) was obtained from the variety Faridpur Bhati with spacing 7.5x7.5 cm. Plant height 42.32 cm as produced by the variety Taherpuri with 20x10 cm which is statistically different between BARI Piaz-1 and Taherpuri. The heaviest bulb (27.61 g) was produced by the variety BARI Piaz-1 with spacing of 20x10 cm and the lowest (8.78 g) was produced by the variety Faridpur Bhati with the spacing 7.5x7.5 cm. The highest yield (20.23 t ha^{-1}) was recorded from the variety BARI Piaz –1 with spacing 7.5x7.5 cm and the lowest (6.39 t ha^{-1}) from the variety Faridpur Bhati with spacing 20x10 cm.

Economics: The economics of onion is influenced by the plant spacing shown in Table 4. For transplanting of seedlings, intercultural operations, controls of pests and diseases, harvesting and post harvest processing, closer spacing needs more cost of production compared to wider

Table 1: Effect of variety on growth and yield of onion

Variety	Plant height (cm)	Leaf length (cm)	No. of leaf	Bulb length (cm)	Bulb diameter (cm)	Multiplier bulbs (%)	Bulb weight (g)	Yield (t ha^{-1})
BARI Piaz-1	38.84	34.28	8.07	4.51	4.34	13.43	20.84	16.74
Taherpuri	36.20	32.13	7.81	4.31	4.47	17.52	18.44	14.99
Faridpur Bhati	28.73	25.56	6.23	3.01	3.03	23.39	14.25	8.86
LSD (0.05)	5.11	5.69	0.98	1.13	0.96	3.64	3.23	2.33
CV (%)	10.31	12.94	9.33	20.13	17.00	13.98	12.66	12.03

Table 2: Effect of plant spacing on growth and yield of onion

Spacing (cm)	Plant height (cm)	Leaf length (cm)	No. of leaf	Bulb length (cm)	Bulb diameter (cm)	Multiplier bulbs (%)	Bulb weight (g)	Yield (t ha^{-1})
20x10	40.46	35.82	8.43	4.47	4.44	24.34	23.52	10.05
10x10	35.92	31.97	7.42	3.94	3.99	17.01	17.91	13.28
15x10	38.08	33.87	7.87	4.21	4.33	20.11	22.42	12.42
15x7.5	36.70	32.47	7.13	4.11	4.16	17.22	18.76	12.97
10x7.5	29.19	25.86	6.90	3.33	3.52	16.51	12.82	15.82
7.5x7.5	27.07	24.03	5.45	3.01	3.11	14.38	11.13	16.65
LSD (0.05)	4.31	4.80	0.83	0.96	0.81	3.07	2.73	1.97
CV (%)	10.31	12.94	9.33	20.13	17.00	13.98	12.66	12.03

Table 3: Interaction effect of variety and spacing on growth and yield of onion

Variety x Spacing (cm)	Plant height (cm)	Leaf length (cm)	No. of leaf	Bulb length (cm)	Bulb diameter (cm)	Multiplier bulbs (%)	Bulb weight (g)	Yield (t ha^{-1})
BARI Piaz-1-20x10	45.46	40.07	9.23	5.39	4.89	18.32	27.61	12.65
BARI Piaz-1-10x10	40.36	35.78	8.13	4.58	4.39	12.18	20.97	16.61
BARI Piaz-1-15x10	42.80	37.91	8.63	4.89	4.77	14.56	26.32	15.63
BARI Piaz-1-15x7.5	41.23	36.12	7.81	4.78	4.58	12.96	22.03	16.24
BARI Piaz-1-10x7.5	32.80	28.93	7.56	3.87	3.87	12.43	15.05	19.09
BARI Piaz-1-7.5x7.5	30.40	26.86	7.07	3.54	3.54	10.15	13.07	20.23
Taherpuri-20x10	42.32	37.51	8.93	4.87	5.03	23.58	24.40	11.11
Taherpuri-10x10	37.56	33.47	7.86	4.09	4.53	16.40	18.54	14.64
Taherpuri-15x10	39.81	35.44	8.34	4.37	4.91	19.40	23.27	13.72
Taherpuri-15x7.5	38.39	34.12	7.55	4.30	4.71	16.68	19.47	14.28
Taherpuri-10x7.5	30.54	27.07	7.31	3.47	3.98	15.99	13.30	17.67
Taherpuri-7.5x7.5	28.35	25.19	6.84	3.16	3.41	13.07	11.55	18.52
Faridpur Bhati -20x10	33.59	29.88	7.12	3.71	3.41	3.13	18.55	6.39
Faridpur Bhati -10x10	29.83	26.67	6.27	3.16	3.06	22.46	14.23	8.58
Faridpur Bhati -15x10	31.63	28.26	6.65	3.37	3.32	26.36	17.68	7.92
Faridpur Bhati -15x7.5	30.47	27.18	6.02	3.29	3.19	22.02	14.80	8.40
Faridpur Bhati -10x7.5	24.24	21.66	5.83	2.66	2.70	21.12	10.11	10.71
Faridpur Bhati -7.5x7.5	22.47	19.71	5.45	2.43	2.47	17.24	8.78	11.21
LSD (0.05)	5.91	6.58	1.14	1.32	1.10	4.21	3.73	2.70
CV (%)	10.31	12.94	9.33	20.13	17.00	13.98	12.66	12.03

Table 4: Effect of plant spacing on cost and return analysis of onion

Plant spacing (cm)	No. of seedlings ha^{-1}	Bulb yield t ha^{-1}	Gross return (Tk. ha^{-1})	Cost of production (Tk. ha^{-1})	Net return (Tk. ha^{-1})	Benefit-cost- ratio
20x10	480000	10.05	80400	40950	39450	1.96
10x10	928000	13.28	106240	61460	44790	1.73
15x10	582000	12.42	99360	45650	53710	2.17
15x7.5	836000	12.97	103760	55350	48410	1.87
10x7.5	1276000	15.82	94920	65200	29720	1.45
7.5x7.5	1628000	16.65	99900	69560	30250	1.43

Market value: Onion seedlings - Tk. 20.00/1000 seedlings
Price of bulb -- Tk 8.00 kg^{-1} for the spacing of 20x10 cm, 10x10cm and 15x10 cm
Tk.600 kg^{-1} for the spacing of 10x7.5 cm and 7.5x7.5 cm

spacing. The highest net return (Tk. 53,710.00 t ha^{-1}) and the highest benefit cost ratio (2.17) was obtained from the plant spacing of 15x10 cm followed by the spacing 15x7.5 cm (Tk. 48410.00 ha^{-1} and 1.87) and the lowest (Tk. 30250.00 ha^{-1} and 1.43) from the plant spacing of 7.5x7.5 cm.

It can be concluded from the study that the widest spacing of 20x10 cm produced significantly the highest plant height, leaf length, number of leaf, bulb length and diameter, multiplier bulb and yield per plant. These values of this characters were found to be decreased with the decreasing of plant spacing and ultimately the significantly the lowest value of their growth parameters were recorded in the closest spacing of 7.5x7.5 cm. The plant grown under wider spacing received more nutrients, light and moisture around each plant surrounding

compared to plants of closer spacing, which is probably the cause of better performance and yield of individual onion in wider spacing. The total yield ha^{-1}, when evaluated, it was evident onion grown in maximum density i.e. with the closest spacing resulted the best performance producing 16.65 t ha^{-1} yield compared to the yield of 10.05 t ha^{-1} produced in the widest spacing. The maximum yield of onion in the closest spacing was due to presence of more number of plants resulting in total the highest yield. But the size of bulb in closest spacing was so small that they were not suitable for marketing due to consumer's choice. Except this per unit value of onion received from closer spacing was low. On the other hand the highest net return and BCR obtained from the spacing 15x10 cm.

The results of the study revealed the BARI Piaz-1 performed better in respect of yield and other parameters and the closer spacing 7.5x7.5 cm performed better in respect of yield but from the economic point of view the plant spacing 15x10 cm suggested for onion cultivation.

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