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Effects of spacing and age of seedling on the growth and yield of summer onion

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Abstract: An experiment was conducted at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh, during the period from February, 2006 to June, 2006 to study the effect of plant spacing and age of seedling on the growth and yield of summer onion. There were three levels of plant spacing viz. 20 x 20 cm, 20 x 15 cm and 20x10 cm and four levels of age of seedling viz. 35 days 40, days 45 days and 50 days. The experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. The plant spacing showed significant effects on most of the parameters studied. Wider spacing gave the highest diameter and weight of bulb; but the closer spacing produced highest yield of bulbs (9.40t/ha). The age of seedling also significantly influenced the growth, yield components and yield of bulb. The highest bulb yield (8.85t/ha) was produced by 50 days old seedlings and the lowest (4.13t/ha) was in 35 days old seedlings. The combined effect of plant spacing and age of seedling demonstrated a significant variation in fresh weight of bulb (ranging from 6.58 to 28.58 g) and yield (ranging from 1.61 to 13.43 t/ha). The highest yield (13.43t/ha) was found in the treatment combination of 20 x 10 cm plant spacing with 50 days old seedlings.
Key words: Spacing, age, seedling, growth, yield, onion.

Introduction

Onion (*Allium cepa* L.) belonging to the family Alliaceae is widely used as most important crop among the vegetables and spices. There are more than 500 species under the genus Allium, of these most of them are bulbous plants. It has been cultivated for 5000 years or more and does not exist as wild species (Brewster, 1994) of the 15 vegetable and spice crops listed by FAO. The leading onion producing countries of the world are China, India, Turkey, Japan, Spain, Egypt and USA (FAO, 1998). Among the spice crops grown in Bangladesh, onion ranks top (272230 mt) in respect of production and second (51857.44 ha) in respect of area (BBS, 2004). The average yield of onion in Bangladesh is very low (4.07 t/ha) as compared to the world average yield (17.46 t/ha) (FAO, 2003). On an average, the total annual requirement of onion in Bangladesh stands at 500 thousand metric tones whereas, the total production is only 127 thousand metric tones and thereby, there is a shortage of 373 thousand metric tones per annum. To meet this shortage, Bangladesh has to import onion from India every year at the cost of its hard earned foreign currency (Hussain and Islam, 1994). Onion in Bangladesh is cultivated only in the winter season. So, it is difficult to meet the demand of onion by growing only in the winter season. It is possible to meet the shortage with cultivation of onion in summer season. Farmers can also earn more money through the cultivation of summer onion. Formerly, onion was not cultivated commercially in the summer season in Bangladesh. Recently, some researchers have been conducted by Spices Research Centre of BARI for introduction of some summer onion lines. By this time, two summer onion varieties viz. BARI Pieaz 2 and 3 have been released for growing in Kharif season as its genetic potentiality proved to be suitable for the climatic condition of Bangladesh. Onion production is greatly influenced by agronomic practices such as, planting time, planting density, age of seedling, condition of seedling, judicious fertilization, etc. Specially, spacing and age of seedling are very important for growth and production of summer onion. Plant spacing affects the growth, size of bulb, yield as well as the quality of the produce (Badaruddin and Haque, 1977). Age of seedling is an important factor that influences the higher bulb yield. Proper age of seedling can produce better yield of bulb (Singh and Chaure, 1999). The present research work was undertaken to investigate the effect of plant spacing and age of seedling on the performance of yield and quality of summer onion.

Materials and Methods

The experiment was conducted in the field of USDA Allium project and laboratory of the Fruit Tree Improvement Project (FTIP) at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh during the period from February to June, 2006 to study the effect of plant spacing and age of seedling on the growth and yield of summer onion. The experiment was conducted to study the growth, yield and storage of onion cv. BARI Pieaz-2 as influenced by different spacing and age of seedling. The spacing 20 x 20 cm (S_1), 20 x 15 cm (S_2), 20 x 10 cm (S_3) and age of seedling were 35 days (A_1), 40 days (A_2), 45 days (A_3) and 50 days (A_4). The two factor experiment having 12 different treatment combinations was laidout in a Randomized Complete Block Design (RCBD) with 3 replications. The size of each unit plot was 1 m x 1 m, the space between two plots was 30 cm and that between blocks was 50 cm. Data were recorded from the sample plants during the course of experiment. Five plants were selected randomly from each plot in such a way that the border effect was avoided for the highest precision. For this, the outer two rows and the outer plants of the inner rows were avoided.

The height and number of leaves of the 5 selected sample plants from each plot was measured after 15 days of transplanting and then at 15 days interval up to 60 days of transplanting. After harvesting fresh foliage of five selected plants was weighed in gram and their average was taken as fresh weight of foliage per plant. The percentage of bulb dry matter content was calculated by the following formula.

$$\% \text{ Dry matter content of bulb} = \frac{\text{Constant dry weight of bulb}}{\text{Fresh weight of bulb}} \times 100$$

The collected data on various parameters under study were analyzed to find out the statistical significance of the experimental results. The means of all the treatments were calculated and analyses of variance for all the characters

were performed by F test. The significance of the difference among the means was evaluated by Least Significant Difference Test (LSD).

Results and Discussion

Effects of plant spacing on growth and yield of summer onion: The growth, yield and yield contributing characters viz. plant height, number of leaves, bulb diameter, bulb weight, dry weights of foliage & bulb and yield of onion were significantly influenced by plant spacing. The highest plant height (36.90 cm) was found when spacing was 20 x 15 cm followed by the plants grown at 20 x 10 cm (33.78 cm) and the lowest (31.82 cm) when spacing (20 x 20 cm). The increased plant height at closer spacing was due to more competition for air and light. But the plant height was not significantly affected at 60 days after planting. The number of leaves per plant counted at different days after planting was significantly influenced due to variation in plant spacing. The number of leaves per plant was the highest (5.35) when the plants were grown at 20 x 20 cm spacing followed by the number of leaves per plant at 20 x 15 cm (5.33) and 10 x 10 cm spacing produced the lowest number of leaves per plant (4.60). The increased number of leaves at wider spacing was probably due to less inter plant competition for water, nutrients and light.

Significant variation was observed among the spacing treatments in respect of fresh weight of foliage per plant at harvest. The fresh weight of foliage per plant was the highest (6.62 g) at 20 x 20 cm spacing followed by 20 x 15 cm (5.47 g) and the lowest (4.36 g) was at 20 x 10 cm plant spacing. The increased fresh foliage weight per plant was higher at wider spacing due to favorable condition availed by the plants for vegetative growth. Dry matter weight of foliage was significantly affected by the different plant spacing. The highest dry matter weight of foliage (9.25%) was obtained from the plants grown at 20 x 15 cm spacing and the lowest (6.19%) was given by 20 x 10 cm spacing. The diameter of bulb was the highest (4.73 cm) at the widest spacing of 20 x 20 cm followed by the plants grown at 20 x 15 cm (3.00 cm) and the lowest bulb diameter (2.93 cm) was obtained from 20 x 10 cm spacing. The plants with wider spacing received more nutrients under less inter plant competition resulting increased number of leaves which ultimately promoted the growth of bulbs. The results presented in Table 2 showed that the effects due to variation among the spacing were significant regarding weight of bulb per plant. The highest (22.57 g) weight of individual bulb was obtained from the spacing of 20 x 20 cm. The plant spacing of 20 x 10 cm gave the lowest weight (14.79 g) of bulb per plant. Wider spacing accommodated less number of plants which received adequate nutrients, moisture and light which helped to increase the fresh weight of bulb per plant. There was significant effect of spacing on the dry matter content of bulb. The highest dry matter content (7.24%) was found at 20 x 10 cm spacing followed by the spacing of 20 x 20 cm (4.92%) and the lowest dry matter content (4.74%) was obtained from 20 x 15 cm plant spacing. The yields of onion bulb per plot were significantly influenced by the treatments of different spacing. The highest yield (0.96 kg/plot) was observed at the spacing of 20 x 10 cm and the lowest yield (0.40 kg/plot) was found at the spacing of 20 x 20 cm. The yields of onion bulb per plot were increased with increase in number of plants per unit area. The yields of onion bulb per hectare were differed significantly by the treatments of different spacing. The yield of bulbs produced at the spacing of 20 x 10 cm was recorded as the highest (09.40 t/ha) while the lowest (3.90 t/ha) was found at 20 x 20 cm spacing. As the number of plants per unit area was increased with the decrease in plant spacing, the yields of onion bulb per hectare were increased.

Table 1. Effect of spacing on plant height and number of leaves/plant of summer onion

	Plant height (cm) at				Number of leaves /plant at			
	15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT
S_1(20 x 20cm)	17.25	23.41	31.45	31.82	3.40	4.53	5.27	5.35
S_2(20 x 15cm)	17.58	23.78	32.95	36.90	3.58	4.58	5.18	5.33
S_3(20 x 10cm)	15.10	22.10	31.19	33.78	2.72	3.59	4.32	4.60
LSD at 1%	-	-	-	-	0.272	0.397	0.710	0.678
Level of significance	NS	NS	NS	NS	**	**	**	**

** Significant at 1% level of probability; NS = Non significant

Table 2. Effect of spacing on yield and yield contributing characters of summer onion

	Fresh foliage wt. (g/plant)	Dry wt of foliage (%)	Bulb Dia. (cm)	Fresh Bulb wt (g)	Bulb dry wt. (%)	Bulb yield/ plot (kg)	Yield of bulb (t/ ha)
S_1(20 x 20cm)	6.62	8.89	4.73	22.57	4.92	0.40	3.90
S_2(20 x 15cm)	5.47	9.25	3.00	16.14	4.74	0.56	5.55
S_3(20 x 10cm)	4.36	6.19	2.93	14.79	7.24	0.96	9.40
LSD at 1%	1.513	2.549	0.519	1.024	1.128	0.136	1.347

Effect of age of seedling on the growth and yield of summer onion: Table 3 showed there was a significant difference in plant height among the various ages of seedling recorded at 15, 30, 45 and 60 DAP (Days after planting). The plant height was significantly influenced due to the variation in age of seedling. The highest plant height (43.74 cm) was obtained from the plants when they were transplanted at 50 days old followed by the plants at 40 days old seedlings (36.70 cm) and the lowest (25.99 cm) was recorded when plants were grown with 45 days old seedlings. An increased number of leaves indicates good growth and development of onion crop and is directly related to the yield of bulb. The more leaves, the more photosynthetic area and thereby higher yield. The number of leaves per plant counted at different days was significantly influenced due to variation in age of seedling. The number of leaves per plant was the highest (6.21) when the plants were transplanted at 50 days old and the lowest number of leaves per plant (4.08) when the plants were transplanted with 35 days old seedlings.

Significant variation was observed among the age of seedling treatments in respect of fresh weight of foliage per plant at harvest. The fresh weight of foliage per plant was the highest (8.36 g) when 50 days old seedlings were transplanted and the lowest (3.71 g) was with the 35 days old seedlings. The increased fresh foliage weight per plant was higher by transplanting older seedlings due to quicker establishment and favorable condition availed by the plants for vegetative growth. Dry matter content of foliage was significantly affected by the different ages of seedlings. The highest dry matter content of foliage (9.92%) was obtained from the plants grown with 35 days old seedlings and the lowest (6.49%) was given by 45 days old seedlings. The diameter of bulb was the highest (4.12 cm) with the transplanting of oldest seedling (50 days) followed by the plants transplanted with 45 days old seedling (3.26 cm), 3.76 cm when the age of seedling was 40 days and the lowest bulb diameter (3.08 cm) was obtained from 35 days old seedling. A significant variation in respect of fresh weight of bulb was recorded due to different ages of seedling. The highest fresh weight of individual bulb (24.53 g) was found by transplanting 50 days old seedling which was statistically different from those of other ages of seedling and the lowest individual bulb fresh weight (10.54 g) was recorded by 35 days old seedling. The increased fresh weight of bulb resulted by the 50 days old seedlings could also be explained by the fact that the older seedlings were less susceptible to transplantation shock. Dry matter content of onion bulb was significantly influenced by the age of seedlings. The highest dry matter content (7.60 %) of bulb was found by transplanting 50 days old seedling and the lowest dry matter content (4.61%) was obtained from 40 days old seedling. The yields of onion bulb per plot were significantly influenced by the treatments of different seedling ages. The highest yield (0.90 kg/plot) was obtained from planting 50 days old seedlings. The second highest yield of bulbs was found by planting 45 days old seedlings (0.75 kg/plot) followed by 40 days old seedling (0.49 kg/plot) and the lowest was found by 35 days old seedlings (0.42 kg/plot). The yields of onion bulb per hectare were differed significantly by the treatments of different seedling ages. The highest yield (8.85 t/ha) was obtained from planting 50 days old seedlings. The second highest yield of bulbs was recorded by planting 45 days old seedlings (7.35 t/ha) followed by 40 days old seedling (4.80 t/ha) and the lowest was observed by 35 days old seedlings (4.13 t/ha).

Table 3. Effect of seedling age on plant height and number of leaves/plant of summer onion

	Plant height (cm) at				Number of leaves /plant at			
	15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT
A_1	12.44	18.32	25.24	30.24	2.61	3.70	3.81	4.08
A_2	16.98	25.16	35.84	36.70	3.17	4.32	5.59	5.70
A_3	13.67	18.40	26.07	25.99	3.10	3.88	4.21	4.39
A_4	23.49	30.51	40.30	43.74	4.06	5.04	6.08	6.21
LSD at 1%	2.261	3.048	4.468	9.888	0.314	0.458	0.820	0.783

A_1 = 35 days old seedling; A_2 = 40 days old seedling; A_3 = 45 days old seedling; A_4 = 50 days old seedling

Table 4. Effect of seedling age on yield contributing characters and yield of summer onion

	Fresh foliage wt. (g/plant)	Dry wt of foliage (%)	Bulb Dia (cm)	Fresh Bulb wt. (g)	Bulb dry wt. (%)	Yield/plot (kg)	Yield of Bulb (t/ha)
A_1	3.71	9.92	3.08	10.54	4.78	0.42	4.13
A_2	5.56	6.78	3.76	20.44	4.61	0.75	7.35
A_3	4.31	6.49	3.26	15.82	5.53	0.49	4.80
A_4	8.36	9.24	4.12	24.53	7.60	0.90	8.85
LSD at 1%	1.747	2.943	0.599	1.183	1.302	0.157	1.555

A_1= 35 days old seedling; A_2 =40 days old seedling; A_3 = 45 days old seedling; A_4 = 50 days old seedling

Combined effects of spacing and age of seedling on growth and yield of summer onion:

Plant height: The plant height was significantly varied by the combined effect of plant spacing and age of seedling. The highest plant height (44.77 cm) was obtained from planting 50 days old seedling at spacing of 20 x 15 cm followed by 20 x 20 cm spacing with 50 days old seedling (44.57 cm) and the lowest plant height (19.87 cm) was produced when the age of seedling was 45 days at the spacing of 20 x 20 cm.

Number of leaves per plant: Number of leaves per plant was significantly influenced by the combined effect of plant spacing and the age of seedling. The number of leaves per plant was recorded to be the highest (6.40) in plants grown at 20 x 15 cm spacing with 50 days old seedling followed by 20 x 20 cm plant spacing with 50 days old seedling (6.20) whereas the lowest number (3.70) was found in plants grown at 20 x 10 cm spacing with 35 and 45 days old seedlings.

Fresh foliage weight per plant (g): The combined effect of spacing and age of seedlings was found to be significant on the fresh foliage weight. The highest fresh weight of foliage per plant (8.78 g) was observed at the spacing of 20 x 20 cm with 50 days old seedlings and the lowest (1.96 g) was recorded at the treatment combination of 20 x 10 cm spacing with 35 days old seedlings.

Table 5. Combined effect of spacing and seedling age on plant height and number of leaves/plant of summer onion

Treatment combination	Plant height (cm) at				Number of leaves /plant at			
	15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT
A_1S_1	13.53	18.23	24.40	25.73	2.80	4.07	4.20	4.33
A_1S_2	13.07	20.80	26.27	38.47	3.07	4.27	4.00	4.20
A_1S_3	10.73	15.93	25.07	26.53	1.97	2.77	3.23	3.70
A_2S_1	17.80	25.53	36.07	37.10	3.40	4.53	6.07	6.13
A_2S_2	18.20	26.60	35.53	34.63	3.67	4.67	5.80	6.00
A_2S_3	14.93	23.33	35.93	38.37	2.43	3.77	4.90	4.97
A_3S_1	15.27	20.53	27.33	19.87	3.20	4.47	4.73	4.73
A_3S_2	13.80	17.60	27.20	29.73	3.20	3.93	4.60	4.73
A_3S_3	11.93	17.07	23.67	28.36	2.90	3.23	3.30	3.70
A_4S_1	22.40	29.33	38.00	44.57	4.20	5.07	6.07	6.20
A_4S_2	25.27	30.13	42.80	44.77	4.40	5.47	6.33	6.40
A_4S_3	22.82	32.06	40.11	41.87	3.57	4.60	5.83	6.03
LSD at 1%	3.917	5.279	7.739	17.127	0.545	0.794	1.421	1.356

A_1=35 days old seedling; A_2=40 days old seedling; A_3=45 days old seedling; A_4=50 days old seedling, Spacing (S_1) = 20 x 20cm; Spacing (S_2) = 20 x 15cm; Spacing (S_3) = 20 x 10cm

Foliage dry matter content (%): Significant combined effect due to plant spacing and age of seedlings was observed on the dry matter content of foliage. The highest dry matter of foliage (12.46%) was recorded in plants grown at the spacing of 20 x 15 cm with 35 days old seedlings followed by 20 x 20 cm with 35 days old seedlings (12.41%) whereas the lowest (4.89%) was found in plants grown at 20 x 10 cm spacing with 35 days old seedlings.

Diameter of bulb (cm): Bulb diameter was significantly influenced by the combined effect of spacing and age of seedling. The highest bulb diameter (5.35 cm) was obtained due to the effect of 20 x 20 cm spacing with 50 days old seedlings followed by 20 x 20 cm spacing with 40 days old seedlings (4.89 cm) and the lowest bulb diameter (2.24 cm) was recorded from 20 x 10 cm spacing with 35 days old seedlings.

Fresh weight of bulb (g): The fresh weight of bulb was significantly influenced due to the combined effect of plant spacing and age of seedlings. The highest fresh weight of bulb (28.58 g) was recorded in plants grown at the spacing of 20 x 20 cm with 50 days old seedlings followed by (24.07 g) 20 x 10 cm spacing with 50 days old seedling while the lowest fresh weight of bulb per plant (6.58 g) was found in plants grown at the spacing of 20 x 10 cm with 35 days old seedlings.

Bulb dry matter content (%): The combined effect of plant spacing and age of seedlings on the dry matter content of bulbs was found to be significant. The highest dry matter content (9.47%) of bulb was found at the treatment combination of 20 x 10 cm plant spacing with 50 days old seedlings followed by 20 x 20 cm spacing with 50 days old seedlings (7.00%) and the lowest (3.54%) was found at the treatment combination of 20 x 20 cm plant spacing with 40 days old seedlings.

Yield of bulbs per plot (kg): The yield of bulbs was significantly influenced by the combined effect of plant spacing and age of seedlings. The highest yield of bulbs (1.36 kg/plot) was observed at the spacing of 20 x 10 cm with 50 days old seedlings. The lowest yield (0.16 kg/plot) was found in plants grown at 20 x 20 cm spacing with 35 days old seedlings.

Yield of bulbs per hectare (mt): The yield of bulbs was also significantly influenced by the combined effect of plant spacing and age of seedlings. The highest yield of bulbs (13.43t/ha) was observed at the spacing of 20 x 10 cm with 50 days old seedlings followed by 20 x 10 cm plant spacing with 45 days old seedlings (10.14 t/ha). The lowest yield (1.16 t/ha) was found in plants grown at 20 x 20 cm spacing with 35 days old seedlings.

Table 6. Combined effect of spacing and seedling age on yield contributing characters and yield of summer onion

Treatment combination	Fresh foliage wt. (g/plant)	Dry wt of foliage (%)	Bulb Dia. (cm)	Fresh Bulb wt.(g)	Bulb dry wt. (%)	Yield/ plot (kg)	Yield of bulbs (t/ha)
A_1S_1	6.74	12.41	4.37	18.11	4.16	0.16	1.61
A_1S_2	2.43	12.46	2.64	6.93	3.90	0.24	2.38
A_1S_3	1.96	4.89	2.24	6.58	6.28	0.86	8.40
A_2S_1	6.15	7.29	4.89	21.82	3.54	0.44	4.34
A_2S_2	6.44	7.80	3.01	21.97	3.77	0.77	7.56
A_2S_3	4.08	5.27	3.37	17.52	6.51	1.03	10.14
A_3S_1	4.80	6.78	4.32	21.78	4.97	0.38	3.71
A_3S_2	5.15	7.73	2.99	14.70	4.95	0.52	5.05
A_3S_3	2.97	4.96	2.49	10.98	6.68	0.58	5.64
A_4S_1	8.78	9.06	5.35	28.58	7.00	0.60	5.92
A_4S_2	7.84	9.02	3.37	20.95	6.32	0.73	7.21
A_4S_3	8.44	9.63	3.63	24.07	9.47	1.36	13.43
LSD at 1%	3.027	5.098	1.037	2.048	-	0.272	-

A_1=35 days old seedling; A_2=40 days old seedling; A_3=45 days old seedling; A_4=50 days old seedling, Spacing (S_1) = 20 x 20cm; Spacing (S_2) = 20 x 15cm; Spacing (S_3) = 20 x 10 cm

The plant spacing, age of seedlings and the treatment combinations showed significant effect on most of the growth parameters, yield components and yield of onion bulbs. The total yield of bulbs was increased with decreased in plant spacing. With the increase in age of seedling the diameter of bulb was increased. The total yield of bulbs was increased with the increase in seedling age. The combined effect of plant spacing and age of seedlings showed significant variation in case of all parameters except bulb diameter. The highest yields of bulb (1.36kg/plot and 13.43 t/ha) were found from the treatment combination of 20 x 10 cm spacing with 50 days old seedlings and the lowest (0.16kg/plot and 1.61 t/ha) were from the combination of 20 x 20 cm spacing with 35 days old seedlings. In the experiment, the closer spacing with older seedlings gave the highest yield of bulbs, but the size of bulbs was relatively smaller. Economic analysis of such bulbs was not investigated in the study. Such study may be conducted in future to investigate the economic feasibility of preservation of such bulbs under normal storage conditions.

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