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Effects of planting dates on growth and yield of winter onion

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Abstract

The experiment was carried out to examine the effect of planting dates on growth and yield of winter onion at USDA-ARS Allium Field Laboratory, Horticulture Farm, Bangladesh Agricultural University, Mymensingh during the period from September, 2015 to April, 2016. This study was conducted to find out the suitable date in which growth and yield of onion will maximum. The experiment consisted of three planting dates: 16th September, 18th October, 17th November 2015 and three onion varieties: BARI Piaj 1, BARI Piaj 4 and Taherpuri. The experiment was laid out in the randomized complete block design with three replications. Different dates of planting showed highly significant influence on the growth and yield of onion. September 16 planting gave the highest yield of bulbs (8.95 t/ha) while November 17 planting gave the lowest yield (6.58 t/ha). Variety also has a significant influence on the yield on onion. The highest yield were obtained from the variety BARI Piaj-4 (8.51 t/ha) and the lowest one from BARI Piaj-1 (6.67 t/ha). The combined effect of planting dates and varieties on the growth and yield of onion was statistically significant. The highest bulb yield (9.51 t/ha) was obtained from the combination of BARI Piaj-4 and September 16 planting, and the lowest yield (5.45 t/ha) was recorded from the combination of BARI Piaj 1 and November 17 planting.

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Introduction

Onion (*Allium cepa* L.) is the most common member of the family Alliaceae and the widely grown herbaceous biennial cool season spice crops with cross pollinated and monocotyledonous behavior having diploid chromosome number (2n = 16). Onion is different from the other edible species of Alliums for its single bulb and is usually propagated by true botanical seed. In Bangladesh onion is cultivated mainly as winter crop. Usually, it is sown in October to November. Harvesting is mostly done in the months from February to March. Onions prefer a sunny position with a rich but light soil. Onion is used as delicious vegetables in many countries including Bangladesh, and in the tropics. It is the second important crop among the vegetables after tomato (Pathak, 1994). Various types of spice crops are produced in the country. Among the spice crops which are grown in Bangladesh onion ranks first in respect of production and area (BBS, 2013). Onion is grown in all over the Bangladesh. In Bangladesh onion occupied an area of 1.26 lakh hectares with a total production of 13.4 lakh tons (BBS, 2013). But this production of onion is not sufficient to meet up the demand of our huge population. On an average, the total annual requirement of onion in Bangladesh is about 16,50,000 metric tons but production is 13,40,000 metric tons (Anonymous, 2012), which is very poor compared to that of other leading onion producing countries of the world such as Austria (92 t/ha), Korea Republic (58.01 t/ha), Japan (50.01 t/ha), USA (44.49 t/ha) and Germany (39.59 t/ha) (FAO, I999). To meet the demand Bangladesh has to import onion from India and Pakistan every year at the cost of earned foreign currency (Rahim *et al.*, 2013). There are three methods of onion production in Bangladesh viz., direct seed sowing, seedling transplanting and bulb planting. Though bulb plantation is expensive as whole bulb is used but here the crop can be harvested earlier than other methods. Due to limitation of land in Bangladesh, it is very hard to expand the cultivable land area under onion cultivation. The production of onion largely depends on planting date and the use of seeds, fertilizers, irrigation, pesticide etc. Among these planting date plays very crucial role to get height yield.

The Government of Bangladesh has, therefore, provided priority to the agriculture sector to increase the production of onion by giving subsidy to the farmers and inputs support such as seeds, fertilizer, irrigation, pesticide etc. to achieve self-sufficiency of agricultural crops including onion production. The planting dates of onion for bulb production vary from place to place. Planting date is very important for growth and production. Very earlier planting may face dry condition and late planting may form high rainfall. Early planting gives the longest growth cycle. However, different cultivars vary in sensitiveness to growing environment particularly temperature and photoperiod (Mondal and Siddique, 1981). Onion production is greatly influenced by agronomic practices. Therefore, emphasis must be given to increase per yield of onion adopting improved methods. Adjusting planting date is very important because of the short winter season of Bangladesh. Early harvesting and off season marketing can compensate for the high cost involved in this method of onion production (Mondal and Alain, 2003). The available information on the effect of planting dates on the growth and yield of onion grown from seedling under Bangladesh condition is not conclusive. Considering above facts, the present study was undertaken with the following aims: to study the performance of three winter varieties of onion in respect of growth and yield; and to find out the appropriate date of planting and suitable variety for the winter season.

Materials and methods

Description of the experimental site

The texture of the soil of the experimental area was silty loam belonging to the Old Brahmaputra Flood Plain Alluvial Tract under AEZ-9 (UNDP, 1988). The selected area was a medium high land having soil pH 6.3. Before land preparation, it was well drained with good irrigation facilities. The experimental site is located at 24°N latitude and 91°E longitude having an altitude of 8.3m. The experimental site was under sub-tropical climatic zone which is characterized by heavy rainfall, high humidity, high temperature and relatively during Kharif season (April to September) and scanty rainfall, high temperature and short day period during Rabi season (October to March).

Treatments of the experiment

The present experiment included two factors which were as follows: Factor A: Three planting dates: 16September, 2015: 1st sowing and 21 November, 2015: 1st transplanting, 18 October, 2015: 2nd sowing and 18 December, 2015: 2nd transplanting and 17 November, 2015: 3rd sowing and 17 January, 2016: 3rd transplanting, Factor B: Varieties: It included three winter onion varieties: V_1 = BARI Piaj 1, V_2 = BARI Piaj 4 and V_3 = Local variety, Taherpuri.

Table 1. Effect of planting dates on plant height and number of leaves/plant of winter onion at maximum growth stage (75 DAT).

Planting dates	Plant height (cm)	Number of leaves/plant
16th September 2015	42.40	5.79
18th October 2015	39.18	4.67
17th November 2015	33.00	3.71
$LSD_{0.05}$	0.760	0.197
$LSD_{0.01}$	1.05	0.272
Level of significance	**	**

** = Significant at 1% level of probability.

Design and layout of the experiment

The field experiment consisted of 27 treatment combinations and was laid out in Randomized Complete Block Design (RCBD) with three replications. The treatment combinations were randomly placed to unit plots of each block. The plot size was 1 m x 1 m. The distance between the blocks was 50 cm and between the plots was 50 cm.

Crop husbandry

The selected land of the experimental plot was opened on 1st September 2015, with the help of power tiller and then left for sun drying. After 12 days it was then prepared by several ploughings and cross ploughings followed by-laddering.

The following doses of manures and fertilizers were applied in the experimental plots. Well decomposed cowdung 10 ton/ha, Urea 200 kg/ha, Muriate of Potash 148 kg/ha and Triple Super phosphate 90 kg/ha. The whole amount of well decomposed cowdung was applied to the plots and mixed with the soil just after opening the land.

Table 2. Effect of planting dates on yield and yield contributing characters of winter onion.

Planting date	Total weight/plant (g)	Bulb fresh weight (g)	Fresh wt. of leaf (g)	Bulb length (cm)	Bulb diameter (cm)	Leaf length (cm)	Bulb dry weight (g)	Leaf dry weight (g)	Bulb yield/plot (kg)/m²	Bulb yield (t/ha)
16th September 2015	62.15	40.37	22.18	6.12	4.38	47.37	4.42	2.46	0.90	8.95
18th October 2015	53.22	35.48	12.59	5.57	4.04	38.74	3.67	2.09	0.73	7.34
17thNovember 2015	29.56	23.70	6.89	4.76	3.57	34.26	2.93	1.76	0.66	6.58
$LSD_{0.05}$	1.68	1.43	0.865	0.291	0.109	0.413	0.234	0.055	0.032	0.232
$LSD_{0.01}$	2.32	1.97	1.19	0.401	0.151	0.569	0.323	0.075	0.044	0.320
Level of significance	**	**	**	**	**	**	**	**	**	**

The entire quantity of TSP, MP and one third of Urea was applied to the plot during final land preparation. The rest amount of the Urea was applied as top dressing in two installments after 25 and 50 days of planting. Each top dressing was followed by light irrigation with the help of a water cane and it was done carefully.

The seedling was raised in several beds. Border crop was also planted around the experimental plot in the same date for the replacement of damage seedlings by healthy seedlings of the same age. Uprooting of seedlings was done carefully to avoid any mechanical injury to the seedlings.

Plant to plant distance was 10 cm and row to row distance was 15 cm. The seedlings were always kept under careful observation. Necessary intercultural operations were done throughout the cropping season for better growth and development of the plants.

The crop was harvested when 75% of the tops had fallen over (Shalaby *et al.*, 1991).

Table 3. Effect of varieties on plant height and number of leaves/plant of winter onion at maximum growth stage (75 DAT).

Variety	Plant height (cm)	Number of leaves/plant
BARI Piaj 1	34.67	4.39
BARI Piaj 4	41.62	5.12
Taherpuri	38.28	4.66
$LSD_{0.05}$	0.760	0.197
$LSD_{0.01}$	1.05	0.272
Level of significance	**	**

The crop of different plantings was harvested on 10th March 2016, 1st April 2016 and 29th April 2016. Before 7 days of each harvest, when the plants attained maturity by showing drying up of leaves and weakening of necks, the crop was bended at the soil level by hands and kept as such up to harvest to fasten maturity (Faruq, 2001).

The onion was lifted with the help of niri. Care was taken so that no bulb was injured during lifting.

The bulbs were dried in shade for one day with tops uncut and in the following day tops were separated with knife keeping 2 cm neck. Curing of bulbs was done in a room at ambient temperature for 5 days.

Table 4. Effect of varieties on yield and yield contributing characters of winter onion.

Variety	Total weight/plant (g)	Bulb fresh weight (g)	Fresh wt. of leaf (g)	Bulb length (cm)	Bulb diameter (cm)	Leaf length (cm)	Bulb dry weight (g)	Leaf dry weight (g)	Bulb yield/plot (kg)/m²	Bulb yield (t/ha)
BARI Piaj 1	35.19	23.33	11.11	4.58	3.48	35.30	2.45	1.86	0.67	6.67
BARI Piaj 4	57.52	41.56	15.70	6.46	4.46	43.41	4.46	2.34	0.85	8.51
Taherpuri	52.22	34.67	14.85	5.40	4.05	41.67	4.11	2.11	0.77	7.70
$LSD_{0.05}$	1.68	1.43	0.865	0.291	0.109	0.413	0.234	0.055	0.032	0.232
$LSD_{0.01}$	2.32	1.97	1.19	0.401	0.151	0.569	0.323	0.075	0.044	0.320
Level of significance	**	**	**	**	**	**	**	**	**	**

Data collection

Data on the following parameters were recorded from the plants during experiment such as Plant height, Number of leaves per plant, Total fresh weight of plant, Fresh weight of leaves, Fresh weight of bulb per plant, Diameter of bulb, Length of bulb, Length of leaves, Dry weight of leaves, Dry weight of bulb per plant and Yield of onion bulb.

Data analysis

The collected data on various parameters under study were statistically analyzed using MSTAT package program.

The means for all treatments were calculated and analyses of variance of all the characters were performed by F-test. The significance of difference between the pairs of treatment means separated by LSD test at 5% and 1% levels of probability (Gomez and Gomez, 1984).

Results and discussions

Effects of planting dates on the growth and yield of winter onion

All the growth and yield characters of winter onion showed significant difference among different planting dates.

Table 5. Combined effect of planting dates and varieties on plant height and number of leaves/plant of winter onion at maximum growth stage (75 DAT).

Variety × Planting date	Plant height (cm)	Number of leaves/plant
BARI Piaj 1× September 16 planting	38.51	5.09
BARI Piaj 1 × October 18 planting	35.77	4.60
BARI Piaj 1 × November 17 planting	29.73	3.48
BARI Piaj 4 × September 16 planting	45.02	6.69
BARI Piaj 4 × October 18 planting	43.88	4.73
BARI Piaj 4 × November 17 planting	35.97	3.95
Taherpuri × September 16 planting	43.66	5.59
Taherpuri × October 18 planting	37.89	4.69
Taherpuri × November 17 planting	33.30	3.71
$LSD_{0.05}$	1.32	0.342
$LSD_{0.01}$	1.81	0.471
Level of significance	**	**

Plant height is one of the important growth contributing characters for onion. Plant height of onion was measured at 15 days interval up to 75 DAT. It was observed that plant height was increased gradually with the advancement of time. During the period of growth, plant height increased gradually and reached to peak at 75 DAT. Seedlings transplanted on 21st November, 2015 produced the maximum (42.40 cm) plant height while seedlings transplanted on 17th January, 2016 produced minimum (33.00 cm) plant height which is similar to the findings of Badaruddin and Haque (1977). After 75 DAT plant height was gradually decreased due to drying of leaf tip. The similar result was in the findings of Mondal and Islam (1987).

The main effect of planting dates on the plant height of winter onion at different days have presented in Table 1. Number of leaves per plant was recorded at the interval of 15 days up to 75 DAT and observed that it increased gradually in respect of date. In the first planting (16th September, 2015) maximum number of leaves per plant (5.79) was obtained and lowest (3.71) was found in 17th November 2015 planting.

Table 6. Combined effect of planting dates and varieties on yield and yield contributing characters of winter onion.

Variety × Planting date	Total weighplant (g)	Bulb weight (g)	Fresh wt. of leaf (g)	Bulb length (cm)	Bulb diameter (cm)	Leaf length (cm)	Bulb dry weight (g)	Leaf dry weight (g)	Bulb yield/plot (kg)/m²	Bulb yield (t/ha)
V_1P_1	42.89	30.44	18.22	4.77	3.88	40.45	2.93	2.04	0.81	8.14
V_1P_2	42.67	22.44	11.11	4.49	3.35	34.22	2.92	1.88	0.64	6.41
V_1P_3	20.00	17.11	4.00	4.48	3.20	31.22	1.52	1.66	0.55	5.46
V_2P_1	75.33	49.11	24.44	7.25	4.91	52.11	5.31	2.85	0.95	9.51
V_2P_2	61.44	47.56	13.78	6.87	4.43	41.00	4.05	2.27	0.80	8.05
V_2P_3	35.78	28.00	8.89	5.27	4.05	37.11	4.01	1.89	0.80	7.97
V_3P_1	68.22	41.55	23.89	6.33	4.36	49.55	5.01	2.49	0.92	9.21
V_3P_2	55.56	36.45	12.89	5.34	4.33	41.00	4.04	2.11	0.76	7.57
V_3P_3	32.89	26.00	7.78	4.54	3.46	34.44	3.27	1.74	0.63	6.31
$LSD_{0.05}$	2.91	2.47	1.50	0.505	0.190	0.716	0.406	0.095	0.055	0.402
$LSD_{0.01}$	4.01	3.41	2.06	0.695	0.261	0.986	0.559	0.131	0.075	0.554
Level of significance	**	**	**	**	**	**	**	**	**	**

** = Significant at 1% level of probability, V_1P_1 = BARI Piaj 1 × September 16 planting, V_1P_2 = BARI Piaj 1 × October 18 planting, V_1P_3 = BARI Piaj 1 × November 17 planting, V_2P_1 = BARI Piaj 4 × September 16 planting, V_2P_2 = BARI Piaj 4 ×October 18 planting, V_2P_3 = BARI Piaj 4 × November 17 planting, V_3P_1 = Taherpuri × September 16 planting, V_3P_2 = Taherpuri × October 18 planting,V_3P_3 = Taherpuri × November 17 planting.

The rate of leaf growth was significantly higher in 1st planting (16th September, 2015) than other plantings (Table 1). The fresh weight of leaves was maximum (22.18 g) on September 16 planting and the lowest (6.89 g) from November 17 planting (Table 2). Bulb weight is very important yield contributing character of onion which varies due to effect of different planting dates. From the experiment, September 16 planting produced maximum (40.37 g) bulb weight and minimum (23.70 g) was obtained from November 17 planting. Maximum vegetative growths as well as large number of leaves were produced from September 16 planting. The maximum diameter of the bulb (4.38 cm) was found from earliest (September 16) planting, whereas the minimum diameter of bulb (3.57 cm) was observed in the late planting (November 17) planting. The maximum length of bulb (6.12 cm) was found from September 16 planting, whereas, the minimum length (4.76 cm) was obtained from November 17 planting. The maximum length of the leaves (47.37 cm) was found from earliest (September 16) planting, whereas the length of the leaves (34.26 cm) was observed in the late planting (November 17) planting. Large size of bulb was observed on September 16 planting due to favorable environmental conditions. Maximum dry weight of bulb (4.42 g) was found from September 16 planting and minimum dry weight of bulb (2.93 g) was observed from November 17 planting. Dry weight of leaves reduced gradually with delayed planting. Maximum dry weight of leaves (2.46 g) was found from September 16 planting and minimum dry weight of leaves (1.76 g) was observed from November 17 planting. The highest yield of onion per plot (0.90 kg/m^2) was obtained from planting in September 16 while a gradual decrease in yield was noticed in second (0.73 kg/m^2) was obtained from planting in October 18 and third planting (0.66 kg/m^2) respectively. So the experiment is revealed that September 16 gave the highest yield that of November 17 planting. The September 16 planting gave the significantly highest bulb yield 8.95 t/ha followed by 6.58 t/ha at November 17 and October 18 planting gave yield 7.34 t/ha (Table 2).

Effects of varieties on the growth and yield of winter onion

All the growth and yield characters of winter onion showed significant difference among different varieties. The maximum (41.62 cm) plant height was attained from the variety BARI Piaj 4 and minimum (34.67 cm) was observed from the variety BARI Piaj 1 (Table 3).The number of leaves per plant gradually increased with the increasing date after planting. The maximum number of leaves per plant (5.12) was obtained from the variety BARI Piaj 4 and minimum (4.39) from the variety BARI Piaj 1 (Table 3).The variety has influence on the growth and yield of winter onion. The highest (15.70 g) weight of leaves obtained from the variety BARI Piaj 4 and the lowest (11.11 g) was found in the variety BARI Piaj 1 (Table 4). The highest bulb weight obtained from the variety BARI Piaj 4 (41.56 g) while the lowest obtained from BARI Piaj 1 (23.33 g).BARI Piaj 4 gave the maximum diameter (4.46 cm) which produced more food materials, whereas the minimum (3.48 cm) from the variety BARI Piaj 1.The highest bulb length obtained from the variety BARI Piaj 4 (6.46 cm) while the lowest obtained from BARI Piaj 1 (4.58 cm).The highest leaves length obtained from the variety BARI Piaj 4 (43.41 cm) while the lowest obtained from BARI Piaj 1 (35.30 cm).The variety has an impact on the dry matter content of leaves. The maximum dry weight of leaves found from the variety BARI Piaj 4 (2.34 g) and the minimum from BARI Piaj 1 (1.86 g).The highest bulb dry weight obtained from the variety BARI Piaj 4 (4.46 g) while the lowest obtained from BARI Piaj 1 (2.45 g).This variation was occurred due to the variation of bulb per plant. The highest yield per plot obtained from the variety BARI Piaj 4 (0.85 kg/m^2) while the lowest obtained from BARI Piaj 1 (0.67 kg/m^2) and the variety Taherpuri gave (0.77 kg/m^2) yield per plot.The highest yield per hectare obtained from the variety BARI Piaj 4 (8.51 t/ha) while the lowest obtained from BARI Piaj 1 (6.67 t/ha) and the variety Taherpuri gave (7.70 t/ha) yield (Table 4).

Combined effects of planting dates and varieties on the yield and yield contributing characters of winter onion

The combined effect of planting dates and varieties of winter onion showed significant difference on all the growth, yield and yield contributing characters. The highest plant height (45.02 cm) was recorded from the treatment combination V_2P_1 (BARI Piaj 4 × September 16 planting) which is similar to the findings of Izquierdo *et al.* (1981) and the lowest (29.73 cm) was obtained from the combination V_1P_3 (BARI Piaj 1 × November 17 planting) (Table 5). The treatment combination V_2P_1 (BARI Piaj 4 × September 16 planting) produces maximum (6.69) number of leaves per plant while the minimum (3.48) was obtained from the combination V_1P_3 (BARI Piaj 1 × November 17 planting) (Table 5). The maximum fresh weight of leaves per plant (24.44 g) was obtained from the treatment combination of V_2P_1 (BARI Piaj 4 × September 16 planting) and the minimum fresh weight of leaves (4.00 g) per plant was found from the treatment combination of V_1P_3 (BARI Piaj 1 ×November 17 planting) (Table 6).From this experiment, it was observed that the treatment combination V_2P_1 (BARI Piaj 4 × September 16 planting) produces the largest bulb (4.91 cm) whereas, the treatment combination of(BARI Piaj 1 × November 17 planting).The plants need essential environment for development of bulb. It was observed from the experiment, the early planting was best bulb weight for prevailing the vegetative growth. Onion bulb swelling and growth are related with the production of more leaves. Higher production of leaves causes increased photosynthetic activities leading to more accumulation of photosynthetes that produces larger bulb in diameter and weight (Mohanty *et al.*, 1990). Badaruddin and Haque (1977) reported same result that produced heavier and larger sized bulbs resulting in the highest weight. Bulb length was affected by planting dates adversely. Arora (1967) under India condition in an experiment planted onion at several dates between late December to late February. He observed that bulb development was adversely affected by the late planting. North European cultivar growing in controlled environment at constant temperature showed the most rapid bulb growth indicating maturity at temperatures 25°C and 30°C. But less rapid blubbing in 20° C and 15°C temperatures reported by data of Butt (1968). Abdella (1968) also observed that the bulb development was significantly retarded when the maximum day temperature reached 40-45°C. Nes (1985) pointed out the significant reduction in bulb size with the delay in planting. The maximum dry weight of bulb (5.31 g) was obtained from the treatment combination of V_2P_1 (BARI Piaj 4 × September 16 planting)(Brewster, 1981 also reported similar result)Seedlings planted on September 16 produce the maximum foliage due to favorable climate condition. Early planting gave the higher yield of onion bulbs. The minimum dry weight of bulb (1.52 g) was found from the treatment combination of V_1P_3 (BARI Piaj 1 × November 17 planting). The maximum dry weight of leaves (2.85 g) was obtained from the treatment combination of V_2P_1 (BARI Piaj 4 × September 16 planting) Late planting caused the reduction on onion yield due to unfavorable condition. Late planting cannot get the long period for the proper development of the bulb and proper vegetative growth. This result was similar with the report by Maseo (1980) who reported the gradual reduction in yield of onion bulbs with delay planting. and the minimum dry weight of leaves (1.66 g) was found from the treatment combination of V_1P_3 (BARI Piaj 1 × November 17 planting). The highest yield of winter onion (9.51 t/ha) was recorded from the treatment combination V_2P_1 (BARI Piaj4 × September 16 planting). Deka *et al.* (1994), Resende *et al.* (1996) also conducted a similar experiment. September 16 planting produced the maximum foliage of plants and formation of bulbs due to availing long day temperature and enough moisture. The maximum photosynthesis occurred in foliage and early planting had a great contribution to yield and yield contributing characters. The yield of onion per plot as well as per hectare was highly influenced by the combine effect of planting dates and varieties and the lowest yield (5.46 t/ha) was obtained from the combination V_1P_3 (BARI Piaj 1 x November 17 planting). It might be due to higher diameter, higher bulb length, Number of bulb per plot (Table 6).

Conclusion

From the results of the study, it was observed that the yield and yield component of winter onion were positively influenced by the planting date. Early planting gave the highest yield than late planting. Adequate soil moisture, favorable environment might be the possible reasons for the larger bulb production and highest yield. So, September 16 planting was much better than the November 17 planting. BARI Piaj 4 was the best among three varieties used for the experiment. BARI Piaj 4 gave the highest yield. The treatment combination of BARI Piaj 4 and September 16 planting was found better than any other treatment combination.

The present research work was carried out at Mymensingh. Further studies are also needed to evaluate the effectiveness of the varieties and the planting dates other than those used in the experiment in different AEZ of Bangladesh.

Abbreviations

AEZ = Agro-Ecological Zone
BARI = Bangladesh Agricultural Research Institute
Cm = Centimeter
DAT = Days after Transplanting
FAO = Food and Agricultural Organization
g. = Gram
kg. = Kilogram
t/ha = Ton per hectare
USDA = United States Department of Agriculture
UNDP = United Nations Development Program
Viz. = Namely

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