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Yield and quality of summer onion seeds as influenced by vernalization and boron application

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Abstract

The experiment was conducted at the Horticultural Farm, Bangladesh Agricultural University, Mymensingh during the period from October, 2018 to April, 2019. The present study was aimed at determining the effect of vernalization and doses of boron on seed yield and quality of summer onion. There were three vernalization treatments viz., no vernalization (control), vernalization at 10˚C for 25 days and vernalization at10˚C for 40 days and four boron treatment viz., 0 kg ha^{-1}, 1 kg ha^{-1}, 2 kg ha^{-1} and 3 kg ha^{-1}. The two-factor experiment was laid out in the Randomized Complete Block Design with three replications. The results of the experiment showed that the vernalization had significant and positive influence on all the parameters studied. Boron had also significant effects on all the parameters. Interaction between vernalization and boron was significant on all the yield and yield contributing parameters. The highest seed yield (191.01 kg ha^{-1}) was obtained from vernalization at 10˚C for 40 days and lowest (137.88 kg/ha) from control. The highest seed yield (255.38kgha^{-1}) was obtained from 3 kg ha^{-1} boron and lowest (83.48 kg ha^{-1}) from control. When combined effect was considered the highest seed yield (293.36 kgha^{-1}) was obtained from vernalization at 10˚C for 40 days with 3 kg ha^{-1} boron. The lowest value (69.50 kg/ha) was recorded in the control treatment.

Key words: Onion, vernalization, bulb, micro-nutrient, yield

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Introduction

Onion (*Allium cepa* L.) is one of the most important winter spice crops grown during *Rabi* season in Bangladesh. It belongs to the family Alliaceae. The center of origin of the crops is west China and the desert lying east of the Caspian Sea (Jones and Mann, 1996). It is used in the preparation of almost all food of our daily diet. The crop is primarily consumed for their unique flavor or for their ability to enhance the flavor of other foods (Randle, 2000). So, it is called the queen of the kitchen (Selvaraj, 1976). Recently it is known that onion reduces the blood sugar by 25 percent as a diabetic drug in Arabian Folk medicine (Vohra *et al.*, 1974; Mossa, 1985; Yawalkar, 1985). In Bangladesh two types of onion variety such as winter and summer are cultivated and produced annually 17 lakh tones from the total area of 1.74 lakh hectares against its demand of 22 lakh tones (BBS, 2018). Summer onion is mainly grown in the summer season in Bangladesh. On the other hand, the productivity of the onion crop in the country is very low (5.36 t ha^{-1}) against the world's productivity, being (17.45 t ha^{-1}) (FAO, 2015).The total production of onion seed in Bangladesh is about 150 tons/year but the requirement is more than 900 tons (BBS, 2016). With the gradual increase of population, the demand of onion in Bangladesh is increasing day by day. So to meet the demand of Bangladesh has to import onion from India, China, Pakistan every year (Hossain and Islam, 2006). The unavailability of good quality onion seeds is partly responsible for low yield in Bangladesh (Bokshi *et al*., 1989). Due to limitation of land and climate, introduction and cultivation of high yielding exotic varieties is not possible in Bangladesh. The only possible way to increase the per hectare yield of onion is through manipulating existing method of cultivation such as planting geometry, fertilization, irrigation and other cultural management practices. Quality seed yield of onion depends on genotype, locality, season and method of seed production (Brewster, 1994). In Bangladesh 150 metric tons of onion seed were produced against an annual requirement of 300 metric tons (Rahim *et al.*, 1993). Small amounts of seeds are produced in some districts like Faridpur, Natore and Rajshahi. There is a large gap prevailing in the country to meet up the requirements of onion seed. Vernalization is a technique to initiate flowering in onion. Proper vernalization temperature of mother bulb stimulate early flowering and produces a heavier yield of seed (Jones and Mann, 1963). During the month of April and May, Nor'wester is a regular incidence in Bangladesh that affects the flower and flowering stalk to a great extent. Early flowering leading to early harvesting before the commencement of Nor'wester could save the onion seed crop. Hence, vernalization of mother bulbs might be a measure to ensure early flowering resulting in the production of early seed crop. On the other hand, fertility status of Bangladesh soils has been declining. Nutrient management is a critical component for successful onion production. Fertilizer application is one of the most important program to achieve higher and sustainable bulb yields of onion in Bangladesh. Boron is one of the important micro-nutrients having different function in plants. It is one of the most widely applied micro-elements though required in small quantity. Because of it is being short in soil, may hamper crop yield to a great extent. In the absence of boron, proper development of meristematic tissues of plant does not take place. Boron is necessary for cell division, nitrogen and carbohydrate metabolism, salt absorption and water relation in plant. It is also required in the translocation of sugars, starches, nitrogen and phosphorus and synthesis of amino acids and proteins (Tisdale *et al*., 1984). The piece of research work was undertaken to find out the optimum vernalization temperature and effective dose of boron to achieve the best possible yield of local onion cv. BARI Piaz-3 seed production under the existing agro-climatic conditions of Bangladesh.

Materials and Methods

***Experimental site*:** The present research work was conducted at the Horticultural Farm, Bangladesh Agricultural University, Mymensingh during the period from October 2018 to April 2019. The experimental area is located at 24°46'N latitude and 90°24'E longitude. The elevation of the area is approximately 19 m from average sea level.

***Soil and climate*:** The field was a medium high land and above inundation level and texturally silty loam with a pH value 6.8. The selected area was well drained and had good irrigation facilities. Experimental area was sub-tropical, characterized by heavy rainfall during the month of April to September and scanty rainfall during October to March (Anon, 1999).

***Experimental material*:** The bulbs of cv. BARI Piaz-3 were used in this study. These bulbs were collected from Spices Research Sub-Center Bangladesh Agricultural Research Institute, Lalmonirhat, Rangpur. The distance maintained between the rows was 25 cm and between the plants was 20 cm and each unit plot accommodated 20 plants.

***Experimental treatments*:**

Treatments: The experiment had two factors. The levels of each factor were

Factor A: Vernalization

i. No vernalization, ii. Vernalization at 10˚C for 25 days, iii. Vernalization at 10˚C for 40 days

Factor B: Boron

i. 0 kg of boron ha^{-1}, ii. 1kg of boron ha^{-1}, iii. 2 kg of boron ha^{-1}, iv. 3 kg of boron ha^{-1}

***Design and layout of the experiment*:** The two-factor experiment consisting of twelve treatment combinations was laid out in the Randomized Complete Block Design (RCBD) with three replications. Thus in total 36 unit plots were obtained. The total area of this experiment was divided into three blocks and each blocks contained twelve plots. The treatment combinations were randomly placed to unit plots in each blocks. The size of each unit plot was 1m × 1m. The distance between the blocks was 50 cm and between the plots was 50 cm.

***Vernalization of mother bulbs*:** Selected bulbs of the same size were put in white cotton cloth bags. Bulbs were then vernalized separately in a refrigerator calibrated at 10˚C for 25 and 40 days.

***Land preparation*:** Land of the experiment field was opened on 06 October, 2018 with a disc plough drawn by a power tiller. The soil was then allowed to dry up. Each ploughing was followed by laddering to break clods into small pieces. Weeds and stubbles were removed and the land was finally leveled by laddering. Thus it was prepared to a good tilth.

***Manure and fertilizer application*:** The crop was fertilized @ 10 tones well decomposed cowdung, 350 kg/ha urea, 480 Kg/ha TSP, 156 kg/ha MoP, 100 kg/ha Gypsum, 25 kg/ha $ZnSO_4$and Boron as per treatment. The total amount of cowdung was applied just after opening of the land. Total amount of urea, TSP, MoP, gypsum and $ZnSO_4$ were applied and thoroughly mixed with soil during the final land preparation, borax was used as the source of boron and applied during final land preparation.

***Planting of bulbs in the experimental plot*:** Bulbs were taken out for the refrigerator four hours prior to planting and then kept under ceiling fan for surface drying. The bulbs were planted on 8 November, 2018. They were set at upright position (Novak, 1983) and planted at a depth of 2.5 cm. The distance maintained between the rows was 25 cm and between the plants was 20 cm.

Gap filling: Rotten and un-sprout bulbs of the experimental plots were replaced by healthy ones of the same treatment from the border within seven days of planting.

***Weeding*:** Weeding was done several times to keep the plots free from weed when required and breaking the crust of the soil for easy aeration and to conserve soil moisture.

***Control of insect pests and diseases*:** At the emergence stage, the crop was attacked by cutworm (*Agrotis ipsilon* R.) and field cricket (*Brachytrype*ten *sportosus* L.). The insects were controlled mechanically. Purple blotch disease caused by *Alternaria porii*was found in many plants in the experimental field at later stages of crop growth. The diseases was controlled initially by spraying Bordeaux mixture and later by spraying 2% Rovral at 7 days interval.

***Staking*:** Staking was provided in each plant using Dhaincha (*Sesbania reticulate*) sticks to keep the flowering stalk (scape) erect and to protect them from the damage caused by strong wind and hail storm.

***Harvesting*:** Matured seed umbels were harvested in several installments when 10-20% of the capsules were splited and exposed their black seeds (Pandey *et al*., 1992). Umbels were harvested with a small portion of flowering stalk in the morning to prevent shattering of seed.

***Post-harvest operation*:** Harvested umbels were dried in open sunlight on brown paper for 4-5 days. Threshing was done manually seed were cleaned and were dried again until they reached safe moisture content (Brewster, 1994). Seeds were then kept in polythene bag, which were kept in refrigerator at 8±10˚C.

Germination test: Germination percentage of onion seed was recorded in the Postgraduate Laboratory of the Department of Horticulture, BAU, Mymensingh at ambient room temperature immediately after drying seeds with 3 replications. For each treatment 200 seeds were taken for each replication. It was performed following TP (top of paper) method and in sterile petridish (90 mm diameter). In each petridish 50 seeds were placed on three-tissue paper saturated with water.

Data collection: Data were recorded on the following parameters from the sample plants during the course of experiment. Data were collected from selected plants in each unit plot. To avoid border effect with the highest precision six plants were selected randomly from each plot out of 30 discarding the outer two rows and outer plants of the middle lines.

Results and Discussion

Effect of vernalization: Vernalization caused significant ($P \leq 0.05$) effect on the growth as well as yield and quality of summer onion (Table 1). Vernalization at 45 DAP, the tallest plant (47.72 cm) was obtained from the bulbs that were vernalized at 10˚C for 40 days (V_2) period to planting and the shortest plant (45.80 cm) was found in control. A similar finding was reported by Mollah *et. al.* (2015).

Table 1. Effect of vernalization on yield and yield contributing characters.

Duration of vernalization	Plant height (cm)	No. of umbels/ plant	No. of buds/ umbel	Percent flowering	No. of fruits/ umbel^{-1}	No. of seeds/ umbel	Weight of seeds/ umbel (g)	1000 seed weight (g)	Seed yield (kg/ha)	Percent germination
V_0	45.80	5.10	215.01	76.99	68.96	145.89	0.86	2.30	137.88	74.90
V_1	46.07	5.64	222.20	81.31	75.21	181.11	0.89	2.46	168.07	77.38
V_2	47.72	6.71	236.85	86.00	81.65	273.06	0.92	2.63	191.01	81.57
LSD ($P \leq 0.05$)	0.26	0.15	1.83	0.67	0.81	1.29	0.04	0.09	14.40	0.62

V_0, V_1 and V_2 indicate vernalization at 10º C for 0, 25 and 40 days, respectively.

The number of umbels/plant and the number of buds/umbel were significant ($P \leq 0.05$) due to vernalized at 10˚C for 40 days (maximum number of umbels plant^{-1}and number of bud's umbel^{-1} were 6.72 and 236.85 respectively). At harvested day (60 DAP), the highest percent flowering value was 86.00 at 10˚C for 40 days of vernalization and the lowest (76.99) in control condition. The maximum number of fruits/umbel (81.65) and number of seeds/umbel (273.06) was obtained at 10˚C for 40 days of vernalization and the minimum (number of fruits/umbel 68.96 and number of seeds/umbel 145.89) in control (Table 1). Like others yield components of onion weight of seeds/umbel,1000 seed weight and seed yield increased linearly as the days of vernalization was raised. The highest weight of seed/umbel (0.92g) and the highest 1000 seeds weight (2.63g) were recorded at 10˚C for 40 days of vernalization. Vernalized at 10˚C for 40 days gave the highest seed yield (191.01 kg/ha) followed by vernalization at 10˚C for 25 days (168.07 kg/ha) and the lowest (137.88kg/has) in control condition. Muktadir (2000) stated that the highest seed yield (755.50 kg/ha) obtained from the bulb vernalized at 12°C. Similar observations have been documented by Aguiar (1984); Arguelles *et al.* (1986); Yazawa (1989); Farooque and Fordham (1992); Diaz and Leon (1994) and Meer and Bennekom (1998) who found the highest seed yield of onion when mother bulbs were stored at 12°C for 2-4 months. The highest percent germination (81.57) was found in 10˚C for 40 days of vernalization and the lowest (74.90) in control condition (Table 1).

Effect of Boron: The yield and quality of summer onion was significantly($P \leq 0.05$) influenced by different doses of boron (Table 2). The highest plant height (48.53 cm) was recorded in 3 Kg/ha boron and the lowest plant height (44.42cm) in 0 kg/ha boron. Similar findings also reported by Begum *et. al.* (2015) and Abedin *et al.* (2012). Khatemenla *et.al.* (2018) also reported that the maximum plant height (57.47 cm) was recorded in treatment combination (Zn 25 kg ha-1 + B 5 kg ha-1) and the minimum (39.57 cm) under control. The maximum number of umbels/plant (7.15), maximum number of buds/umbel (275.22), highest percent flowering at 60 DAP (94.39), maximum number of fruits/umbel (93.46) were obtained in 3 kg/ha boron and the minimum number of umbels/plant (4.10), minimum number of buds/umbel (178.00), minimum number of fruits/umbel (56.20), the lowest percent flowering (67.74) at 60 DAP found in control treatment of boron. Treatment with 3 kg/ha of boron produced maximum number of seeds/umbel, highest number of weight of seeds/umbel and highest number of 1000 seed weight as 278.54, 1.04g, 2.81g respectively. In control condition, all the parameters of above showed lowest value (Table 2). Seed yield of onion and percent germination at harvested days showed highly significant($P\leq0.05$) due to different doses of boron. The highest seed yield (255.38 kg/ha) and highest percent germination (94.48) was recorded in 3 kg/ha boron. This might be due to the optimum and efficient use of boron as micro nutrient. The lowest seed yield (83.48 kg/ha) and lowest percent germination (55.80) found in 0 kg/ha boron.

Table 2. Effect of Boron on yield and yield contributing characters.

Doses of Boron	Plant height (cm)	No. of umbels/ plant	No. of buds/ umbel	Percent flowering	No. of fruits/ umbel^{-1}	No. of seeds/ umbel	Weight of seeds/ umbel(g)	1000 seed weight (g)	Seed yield (Kg/ha)	Percent germination
B_0	44.42	4.10	178.00	67.74	56.20	112.06	0.72	2.03	83.48	55.80
B_1	45.97	5.51	197.18	77.72	69.46	187.69	0.83	2.32	130.10	75.94
B_2	47.19	6.50	248.33	85.90	81.97	221.80	0.97	2.70	193.65	85.60
B_3	48.53	7.15	275.22	94.39	93.46	278.54	1.04	2.81	255.38	94.48
LSD ($P\leq0.05$)	0.30	0.17	2.12	0.77	0.94	1.49	0.04	0.10	16.62	0.71

***Combined effect of vernalization and boron*:** The combined effect of vernalization and doses of boron had significant ($P\leq0.05$) effect on most of the parameters studied (Table 3). The highest value of plant height (50.00 cm) was obtained from vernalization at 10˚C for 40 days with 3 kg ha^{-1} boron and the lowest value of plant height (43.70 cm) was recorded from the bulbs having no vernalization and boron treatment. The maximum number of umbels/plant (8.51), maximum number of buds/umbel (289.11), highest percent flowering at 60 DAP (98.38), maximum number of fruits/umbel (99.46) were obtained in vernalization at 10˚C for 40 days with 3 kg ha^{-1} boron and minimum number of umbels/plant (3.86), minimum number of buds/umbel (168.39), minimum number of fruits/umbel (48.51), the lowest percent flowering (63.54) at 60 DAP found in control condition both for vernalization and boron. Relevant results were published by Behairy and Habbasha (1979), Msika *et al.* (1997) who observed earlier and higher flowering for vernalized bulb planting. High temperature (28-30˚C) during storage inhibits inflorescence initiation and prevents floral initiation. On the other hand, 8-12˚C storage temperatures were optimum for the occurrence of such events (Brewster, 1994). The maximum number of seeds/umbel (376.93), the highest value of weight of seeds/umbel (1.07) and 1000 seeds weight (3.01g) obtained from vernalization at 10˚C for 40 days with 3 kg ha^{-1} boron. The minimum number of seeds/umbel (89.50), the lowest value of weight of seeds/umbel (0.70g) and 1000 seeds weight (1.94g) found in control condition. The highest seed yield (293.36 kg ha^{-1}) was found in the plots which received 10˚C vernalization for40 days with 3 kg ha^{-1} boron while the lowest seed yield (69.50 kg ha^{-1}) was recorded in the plant that received no vernalization with 0 kg ha^{-1} boron. The highest percent germination (98.39) was found in the plots which received 10˚C vernalization for40 days with 3 kg ha^{-1} boron while the lowest percent germination (53.00) was recorded in the plant that received no vernalization with 0 kg ha^{-1} boron (Table 3).

Table 3. Combined effect of vernalization and boron on yield and yield contributing characters.

Treatments	Plant height (cm)	No. of umbels/ plant	No. of buds/ umbel	Percent flowering	No. of fruits/ umbel^{-1}	No. of seeds/ umbel	Weight of seeds/ umbel(g)	1000 seed weight (g)	Seed yield (Kg/ha)	Percent germination
V_0B_0	43.70	3.86	168.39	63.54	48.51	89.50	0.70	1.94	69.50	53.00
V_0B_1	45.52	5.18	189.88	75.42	63.95	126.92	0.81	2.16	113.00	73.85
V_0B_2	46.40	5.45	238.86	79.53	77.48	157.65	0.93	2.53	159.23	81.83
V_0B_3	47.59	6.10	262.91	89.49	85.92	209.47	1.01	2.58	209.80	90.94
V_1B_0	43.85	4.02	173.80	65.10	57.70	107.18	0.73	2.04	81.46	54.85
V_1B_1	45.59	5.48	194.29	78.15	66.80	169.56	0.83	2.31	129.06	75.62
V_1B_2	46.83	6.22	247.05	86.69	81.33	198.51	0.97	2.65	198.76	84.95
V_1B_3	48.02	6,84	273.66	95.30	95.01	249.21	1.05	2.85	263.00	94.11
V_2B_0	45.72	4.60	191.81	74.59	62.41	139.49	0.74	2.11	99.50	59.54
V_2B_1	46.82	5.87	207.39	79.58	77.64	266.60	0.85	2.49	148.23	78.33
V_2B_2	48.35	7.85	259.09	91.48	87.08	309.23	1.00	2.91	222.96	90.04
V_2B_3	50.00	8.51	289.11	98.38	99.46	376.93	1.07	3.01	293.36	98.39
LSD ($P \leq 0.05$)	0.51	0.29	3.67	1.34	1.62	2.58	2.58	0.18	28.79	1.24

V_0=Control, V_1 = 10˚C at 25 days, V_2 =10˚C at 40 days, B_0 = 0 kg of boron ha^{-1}, B_1 = 1 kg of boron ha^{-1}, B_2 = 2 kg of boron ha^{-1} and B_3 = 3 kg of boron ha^{-1}

The results of the present experiment revealed that effect of vernalization and doses of boron have positive effect on yield and quality of summer onion seed. From the above result and discussion combination of vernalization at 10˚C for 40 days with 3 kg ha^{-1} boron may be recommended for maximizing yield of seed.

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