Effect Of Spacing And Fertilizer On The Growth And Yield Of Onion

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Abstract: The experiment was conducted at the On-Farm Research Division (OFRD), Agricultural Research Station, Bangladesh Agricultural Research Institute (BARI) Daulatpur, Khulna to study the effects of spacing and fertilizer on the growth and yield of onion. Three spacing viz. 10 × 10 cm, 15 ×10 cm and 15 × 15 cm with three fertilizer combinations viz. soil test based fertilizer dose (STB); integrated plant nutrient system (IPNS) based fertilizer dose and farmers' practice were studied on the growth and yield of onion. The two factor experiment was laid out in a randomized complete block design (RCBD) with three replications. The size of unit plot was 1.5 × 1.2 m. The results demonstrated that plant spacing had significant effects on growth, yield components and yield of onion. Different fertilizers exhibited significant variation in respect of individual bulb weight, bulb diameter and yield. The maximum bulb weight and yield were recorded in IPNS based fertilizer dose while the combined effect of fertilizer and plant spacing had significant effect on growth and yield of onion. The highest yield was obtained from the spacing of 15 × 10 cm coupled with IPNS based fertilizer dose and the lowest yield was found in 15 × 15 cm spacing with farmers' practice.

Index Terms: Spacing, Fertilizer, Onion, STB, IPNS, Yield, RCBD

1 INTRODUCTION

Onion (*Allium cepa*) is an important bulb crop, belonging to the family Alliaceae. It is one of the most important and popular spice crops in Bangladesh as well as in the world. The crop was originated somewhere between western China and deserts lying east of the Caspian Sea (Jones and Mann, 1963). Onion ranks first among spices in respect of production and area in Bangladesh (BBS, 2010). The total area under onion cultivation is 290501 acres and its production is about 872081 metric tons (BBS, 2010). The yield of onion is very low (3.94 t/ha) in our country compared to the world average yield (17.00 t/ha), and it remained fairly static for the last five years (FAO, 2000). This production of onion cannot fulfill our national demand. In the year of 2010, the authorized import was about 73587 ton costing 18589651 US dollar (BBS, 2010). Onion production is greatly influenced by agronomic practices (Mondal *et al*. 1986). Manuring of soil is very important and proper manuring can play a vital role in increasing its yield. A good soil should have an organic matter content of more than 3%. But in Bangladesh, soils of most regions contain the organic matter of less than 1%. It is believed that the decline productivity of Bangladesh soils is the result of depletion of organic matter caused by high cropping intensity (SRDI, 2005). Animal manure supplies all major nutrients (N, P, K, Ca, Mg, S) necessary for plant growth, as well as micronutrients (trace elements), hence it acts as a mixed fertilizer. The use of proper agronomic practice has an undoubted contribution in increasing crop yield. The optimum level of any agronomic practice like plant spacing, plant population, planting date, harvesting time can bring desired results. The optimum use of spacing or plant population has dual advantages. It also avoids strong competition between plants for growth factor such as water, nutrient and light. Conversely, optimum plant population enables efficient use of available crop land without wastage (Zubelidia and Gases, 1977). Successful bulb production in onion depends on the plant spacing. Spacing influences the plant growth, size of bulbs, yields as well as the quality of the onion bulb (Badruddin and Haque, 1977). But very little work has so far been done in respect of spacing and organic-inorganic fertilizer combination under the agro-climatic condition of Khulna, Bangladesh. Therefore, the present investigation has been carried out with the following objectives:

(i). to select the suitable spacing for onion production

(ii). to find out the appropriate fertilizer for onion production.

2 CITATION

[1] Rizk (1997) worked on an experiment to investigate the effects of plant density (2 or 3 lines/ridge) and NPK fertilizers (4 rates and 2 method of application) on the productivity of onions. Lower planting densities resulted in higher number of leaves/plant, higher fresh and dry weight; higher leaf areas, higher average bulb weights and higher uptake of N. Total bulb yield and yield of marketable bulbs were the highest with dense planting. Increasing the NPK rate increased all vegetative growth parameters measured and increased the yield of bulbs.

[2] Singh *et al*. (1996) reported that the effects of N (0, 60, 120 or 80 kg/ha) and S (0, 20, 40 or 80 kg/ha) on the growth of onion (cv. Pusa red) were investigated in Aga, India in 1991-93. The yield and plant N content significantly increased with increasing rate of N. Combined addition of NS significantly influenced yield. Amin *et al*. (1995) worked in sandy loam soil in Mymensing on onion cv. Taherpuri. They planted on 20 December and 20 January and gave 0, 25, 50 or

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100 kg N/ha. Yields were the highest from the planting of 20 December supplied with 100 kg N/ha. Individual bulb weight was also greater in the treatment.

[3] Coelo *et. al*. (1996) conducted an experiment under three irrigation regimes and five spacings as 8 or 10 cm between plants and rows 10-30 cm apart. They found the highest yield of commercial bulbs at 20 × 8 cm spacing. This spacing gave the highest proportion of larger bulbs and the highest average bulb weight.

[4] Singh (1995) conducted two trials at Ranchi with plant spacing, nitrogen rate and phosphorus rate to study the response of onion. He found that the closest spacing gave higher number of marketable bulbs and yields. He also reported that the widest spacing gave the greater sizes of bulb.

[5] Nasiruddin *et al*. (1993) conducted an experiment on the effect of potassium and sulphur on growth and yield of onion in Mymensingh, Bangladesh. They reported that application of both potassium and sulphur either individually or combined increased the plant height, leaf production ability of the plant, bulb diameter, bulb weight as well as the bulb yield.

[6] Rajas *et al*. (1993) investigated into the trial using four rates of sulphur (0, 40, 60 and 80 kg/ha), three plant spacings (10 × 15 cm, 15 × 15 cm and 20 × 15 cm) and irrigation at intervals of 5, 10 or 15 days. They stated that the highest yield (28.11 t/ha) was obtained with 80 kg S/ha, plant spacing of 10 × 15 cm and an irrigation interval of 5 days.

3 MATERIALS AND METHOD

3.1 Experimental location

The experiment was conducted to study the effects of fertilizer and plant spacing on the growth and yield of onion at the On-Farm Research Division (OFRD), Agricultural Research Station, Bangladesh Agricultural Research Institute (BARI) Daulatpur, Khulna.

3.2 Physical and chemical properties of soil

The experimental area was medium high land and the soil was sandy to clay loam. The nutrient status of the soil of the experimental plot was analyzed at SRDI, Daulutpur, Khulna prior to cultivation. Chemical characteristics of the soil of this experiment field are shown below

Constituents	N	P	K	S	Zn	B	pH	Salinity	OM
Amount	0.27%	46.65 ppm	0.35 me/100g	81.64 ppm	5.01 ppm	0.74 ppm	7.5	7.22 dS/m	4.81%

3.3 Climate

The experimental area was under the sub-tropical climate zone, which is characterized by heavy rainfall, high humidity, high temperature, and relatively long day during the kharif season and hardly rainfall, low humidity, low temperature and short day period during the rabi season. Details of the meteorological data during the experimental period are listed below. Monthly mean temperature, total rainfall, relative humidity and sunshine during crop period at the experimental site

Month	Temperature (°C)	Rainfall (mm)	Humidity (%)	Sunshine (hrs.)
December,2011	19.8	20 mm	83.58	5.18
January, 2012	19.35	12 mm	80.28	6.03
February,2012	22.37	10 mm	73.25	8.41
March, 2012	27.9	68.2 mm	76.23	8.36

Source: Bangladesh Agricultural Research Institute, OFRD, Daulatpur, Khulna.

3.4 Variety

BARI Piaz 1, a high yielding variety was considered for this study as a test material. Thirty five days old seedlings were collected from Spices Research Station, BARI, Magura. The variety produces plant of 50-60 cm tall with 10-12 leaves per plant. The average weight of individual bulb is 20-30g and the diameter is 3-4 cm. The bulbs are rhombic and highly pungent with pinkish red skin and most of the bulbs are single type, mature at 130-140 days, bulbs have long shelf life and the yield is about 12-16 t/ha.

3.5 Land preparation

The land was first ploughed in the 12th December, 2011 with power tiller. After that the land was exposed to sunlight for five days. The ploughing was followed by laddering to obtain good tilth and this process was repeated until getting a loose soil. During land preparation weeds and stubbles were collected and removed from the field and the clods were broken. Seedlings were transplanted on 26th December, 2011.

3.6 Treatment and layout of the experiment

The experiment comprised three different plant spacings and three different fertilizers.

Factor A: Spacing
i. Close: 10 × 10 cm (S1)
ii. Medium: 15 × 10 cm (S2)
iii. Wide: 15 × 15 cm (S3)

Factor B: Fertilizer
F1- Soil test based fertilizer dose (N 30 kg/ha; P 18 kg/ha; K 30 kg/ha and S 5 kg/ha).
F2- IPNS ((N 7.5 P 0.5 Kg/ha) based fertilizer dose + cow dung 5 ton/ha.
F3- Farmers' practice (N 115 kg/ha; P 82 kg/ha and K 125 kg/ha).

3.7 Experimental design

The two factor experiment was laid out in a randomized completely block design (RCBD). The whole field was first divided into 3 blocks each containing 9 plots. In total there were 27 unit plots. The treatment combinations were assigned randomly in each unit plot so as to keep one treatment only in each block. The size of each unit plot was 1.5 × 1.2 m. The space left between plots and replication was 1 m.

3.8 Fertilizer application

During land preparation all the fertilizer except urea were applied according to the recommended experimental design as a basal dose. The selected 3 fertilizer combinations were

applied in the treatment of unit plots. Top dressing with urea was applied in two equal splits, at 20 and 50 days after transplanting.

3.9 Intercultural operation

Various kinds of intercultural operations were accomplished for better growth and development of the plants.

Gap filling: Gap filling was done using healthy plants as per requirement.

Weeding and mulching: Weeding and mulching were accomplished as and when required to keep the crop free from weeds and to conserve the soil moisture.

Irrigation: Irrigation was given by both watering can and hose pipe as and when needed. Seedlings were first irrigated just after transplanting and then they were irrigated whenever required to conserve the optimum moisture level to the soil. Plant protection: To avoid pest and fungal infection seedlings were sprayed with Antracol @ 0.2% after 1 month of sowing and sprayed with Rovral @ 0.2% and Tilt @ 0.2% after 45 days of transplanting. Harvesting: The crop was harvested on 23 rd March, 2012 when more than 75% of the tops had fallen over. The tops were removed by cutting off the pseudo-stem keeping 2.5 cm with the bulb.

3.10 Data collection

Data of the following parameters were recorded from the sample plants. Ten plants were selected randomly form each plot in such a way so that the border effect could be avoided. Plant population per square meter. The total number of plants in a square meter area were counted and recorded.

Bulb length (cm)

The length of bulb was measured with a centimeter scale from pseudo-stem to the bottom of the bulb taken from 10 randomly selected plants from each plot.

Bulb diameter (cm)

The diameter of bulb at harvest was measured at the middle portion of bulb taken from 10 randomly selected plants with slide calipers.

Individual bulb weight (g)

Ten plants were selected from each unit plot. The top was removed by cutting the pseudo-stem keeping only the 2.5 cm from the bulb (A- AS-Saqui, 1994). Ten bulbs were weighed by a simple balance and the average was taken.

Yield of onion (t/ha)

The yield of bulb per unit plot was converted into tons per hectare.

Statistical analysis:

The collected data on various parameters were statistically analyzed. The mean for all the treatments were calculated and analysis of variance for the all the character were performed by F-test. The significance of the difference between the pairs of means was evaluated by Duncan's new Multiple Range Test (Gomez and Gomez, 1984)

4 FIGURES AND TABLES

This chapter comprises the presentation and discussion of the results obtained from the experiment. The growth and yield components such as plants per square meter, plant height, leaf number, bulb length, bulb diameter, bulb weight and finally yield of the bulbs influenced by spacing and fertilizer doses are presented in Table 1-3.

Table 1. *Yield and yield attributes of onion influenced by spacing*

Spacing	No. of plants /m^2	Bulb length (cm)	Bulb diameter (cm)	Bulb wt. (g)	Yield (t/ha)
S_1	98.00 a	3.27	2.61 c	14.13 b	12.57 a
S_2	60.50 b	3.05	3.47 b	23.07 a	14.11 a
S_3	43.33 c	3.02	3.91 a	23.41 a	10.00 b
CV (%)	4.03	11.12	9.66	21.02	15.98
Level of significance	*	NS	*	*	*

Means in a column followed by the same letter(s) or without letter(s) are not Significantly different at the 5% level by DMRT.
*Significant at 5% level of probability, NS- Non significant.
Note:
S_1- 10 X 10 cm
S_2- 15 X 10 cm
S_3-15 X 15 cm
Plot size -1.5 X 1.2 m

Table 2. *Yield and yield attributes of onion influenced by fertilizer*

Fertilizer dose	No. of Plants /m^2	Bulb length (cm)	Bulb diameter (cm)	Individual bulb wt. (g)	Yield (t/ha)
F_1	67.27	3.05	3.18 b	19.98 b	11.94 b
F_2	67.83	3.28	3.31 a	20.65 a	12.56 a
F_3	67.05	3.01	3.50 a	19.99 a	12.18 a
CV (%)	4.03	11.12	9.66	21.02	15.98
Level of significance	NS	NS	*	*	*

Means in a column followed by the same letter(s) or without letter(s) are not significantly different at the 5% level by DMRT.
*Significant at 5% level of probability, NS- Non significant.
Note:
F_1- Soil test based fertilizer dose ($N_{30}P_{18}K_{30}S_6$ kg/ha)
F_2- IPNS ($N_{7.5}P_{0.5}$ kg/ha) based fertilizer dose + cow dung 5 ton/ha.
F_3- Farmers' practice ($N_{115}P_{82}K_{125}$ kg/ha).

Table 3. *Combined effect of spacing and fertilizer on the yield and yield attributes of onion*

Treatments	No. of Plants /m²	Bulb length (cm)	Bulb diameter (cm)	Individual bulb wt. (g)	Yield (t/ha)
S_1F_1	97.38 a	3.25 ab	2.50 c	12.47 c	12.33 abc
S_1F_2	98.33 a	3.56 a	2.65 c	17.30 bc	13.72 ab
S_1F_3	97.61 a	3.00 ab	2.68 c	12.62 c	11.67 bc
S_2F_1	60.50 b	3.00 ab	3.43 b	23.27 ab	14.47 ab
S_2F_2	61.11 b	3.25 ab	3.68 ab	24.74 ab	15.17 a
S_2F_3	61.27 b	3.05 ab	3.30 b	22.23 ab	12.70 abc
S_3F_1	43.88 c	2.91 b	4.00 a	22.72 ab	10.13 c
S_3F_2	44.07 c	2.91 b	4.13 a	25.11 a	10.17 c
S_3F_3	42.22 c	2.95 b	3.60 ab	21.38 ab	9.70 c
CV (%)	4.03	11.12	9.66	21.02	15.98
Level of Significance	*	*	*	*	*

Means in a column followed by the same letter(s) or without letter(s) are not significantly different at the 5% level by DMRT.

*Significant at 5% level of probability, NS- Non significant.

Note:

S_1- 10 X 10 cm

S_2- 15 X 10 cm

S_3-15 X 15 cm

F_1- Soil test based fertilizer dose ($N_{30}P_{18}K_{30}S_6$ kg/ha)

F_2- IPNS ($N_{7.5}P_{0.5}$ kg/ha) based fertilizer dose + cow dung 5 ton/ha.

F_3- Farmers' practice ($N_{115}P_{82}K_{125}$ kg/ha).

5 SUMMARIES AND CONCLUSION

Plant population per plot was significantly influenced by spacing treatment the highest plant populations (98) were recorded in S1 (10 × 10 cm) and the lowest (43.33) found in S3 (15×15 cm) where fertilizer had no significant effect on plant population per square meter. The combined effect of spacing and fertilizer dose on the number of plants was found statistically significant. The highest number of plants (98.33) recorded in S1 (10 × 10 cm) with F2 (IPNS based fertilizer dose + cow dung 5 ton/ha) and the lowest (42.22) recorded from S3 (15 × 15 cm) with F3 (N 115 P 82 K 125). The bulb length of the plant was also statistically non-significant in spacing and fertilizer but it was significantly influenced by the combined effect of spacing and fertilizer dose. The maximum bulb length (3.56cm) was observed from S1 (10 × 10 cm) with F1 (N 30 P 18 K 30 S6 kg/ha) and lowest (2.91 cm) recorded in S3 (15× 15 cm) with F2 (IPNS based fertilizer dose + cow dung 5 t/ha). Bulb diameter was significantly influenced by both spacing and fertilizer dose, the maximum bulb diameter (3.91 cm) was found in S3 (15 × 15 cm) and the lowest bulb diameter (2.61 cm) found in S1 (10 × 10 cm). For fertilizer dose maximum bulb diameter (3.5 cm) from F3 (N 115 P 82 K 125 kg/ha) and the minimum (3.18 cm) recorded in F1 (N 30 P 18 K 30 S6 kg/ha). Bulb diameter was significantly influenced by the interaction effect of spacing and fertilizer dose. The maximum bulb diameter (4.13 cm) was obtained from S3 (15 × 15 cm) with F2 (IPNS based fertilizer dose + cow dung 5 ton/ha) and the minimum bulb diameter (2.50 cm) recorded in S1 (10 × 10 cm) with F1 (N 30 P 18 K 30 S6 kg/ha). In bulb weight, the highest bulb weight (23.41 g) recorded in S3 (15× 15 cm) and followed by 23.07 g that was found from S2 (15 × 15 cm) and the lowest bulb weight (14.13 g) observed in S1 (10 × 10 cm) and it was significantly influenced by spacing. Fertilizer dose significantly influenced the individual weight of bulbs. The maximum bulb weight (20.65 g) was obtained from F2 (IPNS based fertilizer dose + cow dung 5 ton/ha) and the lowest (19.98 g) found in F1 (N 30 P 18 K 30 S6 kg/ha) and it also statistically significant in combined effect. The maximum bulb weight (25.11 g) was found in S3 (15 × 15 cm) with F2 (IPNS based fertilizer dose + cow dung 5 ton/ha) and lowest (12.47 g) observed in S1 (10 × 10 cm) with F1 (N 30 P 18 K 30 S6 kg/ha). The bulb yield was significantly influenced by plant spacing. The maximum yield (14.11 t/ha) was obtained from the closer spacing S2 (15 × 10 cm) and lowest yield (12.57 t/ha) recorded in S1 (10 × 10 cm) and it was also found significant in case of fertilizer dose, maximum yield (12.56 t/ha) was recorded in F2 (IPNS based fertilizer dose + cow dung 5t/ha) and the lowest yield (11.94 t/ha) found in F1 (N 30 P 18 K 30 S6 kg/ha). The maximum bulb weight (15.17 t/ha) found in S2 (15 × 10 cm) with F2 (IPNS + cow dung 5 t/ha) and lowest yield (9.70 t/ha) recorded in S3 (15 × 15 cm) with F3 (N 115 P 82 K 125) kg/ha due to the combined effect.The above result suggested that the most effective combination for high yield of onion was the spacing of S2 (15 × 10 cm) with fertilizer combination of F2 (IPNS based fertilizer dose + cow dung 5 t/ha).

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