J. Bangladesh Agril. Univ. 1(1): 7–12, 2003 ISSN 1810-3030

Effects of set size and growth regulators on growth and yield of onion

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Abstract

The experiment was conducted to evaluate the effects of three sizes of sets viz., small (2.25g), medium (5.5g) and large (9.00g), and five growth regulators, namely IAA (200 ppm), GA_3 (100 ppm), NAA (200 ppm), CCC (500 ppm) and a control on the growth and yield of onion cv. Taherpuri. Large bulb produced the highest bulb yield (12.86t/ha) by increasing plant height, number of leaves per plant, bulb diameter and mean bulb weight. Smaller bulb produced higher proportion of single bulbs (62.53%) than larger ones. The growth regulators significantly increased the bulb yield compared with control treatment. Application of IAA at 200 ppm gave the best results on all the parameters except plant height. The highest bulb yield was recorded as 12.57t/ha from the plants sprayed with IAA at 200 ppm. The interaction effect of bulb size and growth regulators was not significant. The combined treatment of large bulb × IAA gave rise to the highest bulb yield (14.23t/ha). The highest gross income (TK. 3,13,060/ha) and net return (TK. 1,67,445/ha) were obtained from the treatment combination of large bulb × IAA and large bulb × NAA. But the highest benefit cost ratio (2.52) was found in the treatment combination of small bulb × NAA. The effects of growth regulators were found in order of IAA>GA_3>NAA>CCC.

Key words: Onion, IAA, GA_3, NAA, Cycocel, Growth and Yield

Introduction

Onion (*Allium cepa* L.) is one of the most important bulb and spice crops in Bangladesh as well as in the world. Among the spices grown in Bangladesh, onion ranks first in respect of production and second in respect of area. The average yield of onion was only 3.73 tonnes per hectare in the year 2000-2001 (BBS, 2001). There are three distinct methods for the planting of onion in our country, namely set planting, direct seed sowing and seedling transplanting. Among them, the bulb planting method is suitable for early production of onion. The size of seed bulbs plays an important role in increasing the yield of onion grown from sets. It influences the plant growth and splitting of bulb (Shalaby *et al.*, 1991), and also increases the yield of onion (Dumitrescu and Radoi, 1984; Shalaby *et al.*, 1991). Plant growth regulators like IAA, GA_3 and NAA at various concentrations showed remarkable effects on bulb production of onion (Salah and Abd, 1989; Deore and Bharud, 1991). Information on the interaction effects of bulb size and growth regulators are not available in Bangladesh. Considering the above facts, the present study was undertaken to determine the optimum bulb size and best growth regulators for maximizing the bulb yield of onion.

Materials and Methods

The experiment was conducted at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh during the period from October 2001 to January 2002. A local cultiver of onion cv. Taherpuri was used in this experiment. Different bulb sizes viz., small (2.25g), medium (5.5g) and large (9.00g) and different growth regulators namely IAA (200 ppm), GA_3 (100 ppm), NAA (200 ppm), CCC (500 ppm) and a control were used. The experiment consisting of 15 treatment combinations was laid out in a split-plot design with three replications. Bulb size was assigned to the main plots and the growth regulators to the sub-plots. The size of each unit plot was 2 m × 1 m. Well decomposed cowdung, urea, triple superphosphate (TSP) and muriate of potash (MP) at the rate of 10 tons, 200, 125 and 180 kg per hectare, respectively were well mixed with the soil. The whole quantity of well-decomposed cowdung was applied to the plot soil just after opening the land. The entire quantity of TSP, MP and one third of urea were applied to the plot during final land preparation. The rest of the urea was applied as top dressing in two installments after 30 and 60 days of planting. Each top dressing was followed by light irrigation with the help of watering can. Mother bulbs of all sizes were planted in the experimental plots on 26 October 2001. Fifty mother bulbs were planted in each unit plot and the desired concentrations of growth regulators were sprayed to the plants after 30 and 37 days of planting the bulbs. The solutions were sprayed as foliar spray with the help of hand sprayer. Weeding, mulching and irrigations were done as and when necessary. Some of the plants were attacked by mole crickets, which were controlled mechanically. A few plants were infected by purple leaf blotch disease, and it was controlled by spraying Ridomil-MZ @ 2 g/l of water (Mondal, 1991). Bolting was discouraged by pinching off the flower stalks soon after their appearance. The crop was harvested on 30 January 2002 when the plants attained maturity by showing drying out most of the leaves and weakening of necks. Data were recorded on different parameters from ten randomly selected plants of each unit plot and were statistically analysed.

Results and Discussion

Bulb size caused significant variations on plant height, number of leaves per plant, splitting of bulbs, bulb diameter, mean bulb weight and bulb yield. The results revealed that during the growth period the height and number of leaves gradually increased with the advancement of time reaching the peak at 60 DAP and thereafter it began to decrease due to the senescence and drying out of the tip of the leaves. The plant height and number of leaves increased with the increase in mother bulb size (Table 1). In all cases, the highest plant height (39.41cm) was obtained from the large bulb at 60 DAP, and the lowest (34.35cm) from the small bulb. The highest number of leaves per plant (12.29) was obtained from large bulb and the lowest (8.93) from the small bulb at 60 DAP. These might be due to the fact that large bulb containing more food materials, supplied adequate available plant nutrients for proper vegetative growth of onion plants, which ultimately influenced the plant height. The plant height and number of leaves per plant were influenced by different growth regulators. The first effect was considered from 40 DAP due to first application of the growth regulators at 30 DAP. Plant height also increased in all the plants sprayed with growth regulators compared with those of the control treatment. However, applying NAA at 200 ppm caused the highest plant height (38.92cm) and the lowest was found (33.49cm) in control at 60 DAP. At 60 DAP, the higher number of leaves (11.28) was obtained from the treatment of IAA as foliar spray, and the lowest (9.32) in control treatment (Table 2). At 60 DAP, result showed that the highest plant height (42.27cm) was observed from the treatment combination of large bulb × NAA and the lowest plant height (31.58cm) was obtained from the small bulb with control. The highest number of leaves per plant (13.00) was obtained from the treatment combination of large bulb × IAA at 200 ppm while the lowest leaf number per plant (8.13) was given by the treatment combination of small bulb × control at 60 DAP. Splitting of bulbs gradually and significantly increased with the increase in bulb size (Table 1). It was observed that small bulb produced the highest number of single bulbs (62.53%), and the lowest number of single bulbs (32.00%) was obtained from large bulb. On the contrary, the highest number of split bulbs (68.00%) were produced by the plants grown from large bulb and the lowest number of split bulbs (37.47%) was given by those grown from small bulb (Table 1). The larger bulbs accelerated the plant growth along with tillering, which resulted in more splitting of bulbs. Similar findings were reported by some previous workers (Rabinowitch, 1979; Natlob and El-Haber, 1983; Yamashita *et al.*, 1986). Shalaby *et al.* (1991) reported that the percentage of single bulb was the highest and the percentage of internal and external doubling were least from small sets.

Table 1. Main effects of bulb size on the growth and yield of onion

Treatments	Plant height at 60 DAP (cm)	Leaf number/ plant at 60 DAP	Splitting of bulbs (%)		Bulb diameter (cm)	Mean bulb weight (g)	Bulb yield	
			Single bulb	Split bulb			Kg/plot	t/ha
Small	34.35 c	8.93 c	62.53 a	37.47 c	4.25 b	33.87 b	2.01 c	10.07 c
Medium	35.37 b	10.30 b	54.20 b	45.80 b	4.36 b	35.39 b	2.22 b	11.08 b
Large	39.41 a	12.29 a	32.00 c	68.00 a	4.80 a	42.73 a	2.57 a	12.86 a

Means bearing the same letter(s) in a column do not differ significantly at the 5 % level of probability.
DAP: Days after planting

Growth regulators also significantly influenced splitting and diameter of bulb and the yield of onion per plot as well as per hectare (Table 2). Control treatment gave the highest percentage of single bulbs (57.89%) which was statistically similar with those treated with NAA (50.22%) and CCC (52.00%), while IAA gave lower percentage single bulbs (40.89%). On the other hand, IAA produced the highest percentage of split bulbs (59.11%) which was statistically similar with GA_3 (53.11%) and the lowest split bulbs (42.11%) was obtained from control treatment. Application of IAA increased more vegetative growth and more accumulation of food that resulted in large bulbs which ultimately produced more split bulbs. Among the treatment combinations, the highest splitting of bulbs (75.00%) was recorded from the treatment combination of large bulb × IAA at 200 ppm whereas; the lowest (27.67%) was obtained from small bulb × control. The highest single bulbs (72.33%) were obtained from the treatment of small bulb × control, while the lowest (25.00%) was found from large bulb × IAA at 200 ppm (Table 3). The above results indicated that the larger bulb in combination with IAA caused more tillering which resulted in the highest splitting of bulbs. The variations in diameter of bulb caused by bulb size were found statistically significant. The highest diameter of bulb (4.80cm) was recorded in the plants grown from large bulb whereas, the lowest diameter of bulb (4.25cm) was observed in those grown from small bulb which was statistically identical with that of the plants grown from medium bulb (Table 1).

Table 2. Main effects of Growth regulators on the growth and yield of onion

Treatments	Plant height at 60 DAP (cm)	Leaf number/ plant at 60 DAP	Splitting of bulbs (%)		Bulb diameter (cm)	Mean bulb weight (g)	Bulb yield	
			Single bulb	Split bulb			Kg/plot	t/ha
Control	33.49 e	9.32 c	57.89 a	42.11 c	4.17 c	32.41 b	1.79 d	8.96 d
IAA (200 ppm)	36.39 c	11.28 a	40.89 c	59.11 a	4.77 a	39.79 a	2.51 a	12.57 a
GA_3 (100 ppm)	37.66 b	11.03 ab	46.89 bc	53.11 ab	4.57 ab	38.89 a	2.44 ab	12.19 ab
NAA (200 ppm)	38.92 a	10.64 ab	50.22 ab	49.78 bc	4.49 b	38.28 a	2.32 bc	11.62 bc
CCC (500 ppm)	35.42 d	10.24 b	52.00 ab	48.00 bc	4.36 bc	37.28 a	2.27 c	11.34 c

Means bearing the same letter(s) in a column do not differ significantly at the 5 % level of probability.
DAP: Days after planting

Table 3. **Combined effects of bulb size and growth regulators on growth and yield of onion grown from sets**

Treatment combinations	Plant height at 60 DAP (cm)	Leaf number/ Plant at 60 DAP	Splitting of bulbs (%)		Bulb diameter (cm)	Mean bulb weight (g)	Bulb yield	
			Single bulb	Split bulb			Kg/plot	t/ha
SH_0	31.58 k	8.13 f	72.33 a	27.67 g	3.89 e	28.67 c	1.56 g	7.82 g
SH_1	34.18 I	9.37 def	47.00 de	53.00 cd	4.64 a-d	36.32 b	2.26 de	11.31 de
SH_2	35.32 h	9.27 def	58.33 a-d	41.67 d-g	4.33 cde	35.40 b	2.16 de	10.82 de
SH_3	36.90 ef	8.97 ef	66.33 abc	33.67 efg	4.29 cde	35.10 b	2.05 ef	10.25 ef
SH_4	33.77 ij	8.90 ef	68.67 ab	31.33 fg	4.11 de	33.87 b	2.03 ef	10.14 ef
MH_0	32.97 j	9.03 ef	59.33 a-d	40.67 d-g	4.16 de	31.90 bc	1.83 f	9.14 f
MH_1	35.55 gh	11.47 abc	50.67 de	49.33 cd	4.57 bcd	37.30 b	2.43 bcd	12.17 bcd
MH_2	36.58 efg	10.93 bcd	52.67 cde	47.33 cde	4.49 bcd	36.43 b	2.40 cd	11.99 cd
MH_3	37.60 de	10.07 cde	53.00 cde	47.00 cde	4.30 cde	35.87 b	2.24 de	11.22 de
MH_4	34.13 I	10.00 cde	55.33 b-e	44.67 c-f	4.27 cde	35.47 b	2.18 de	10.88 de
LH_0	35.93 fgh	10.80 bcd	42.00 ef	58.00 bc	4.45 bcd	36.67 b	1.98 ef	9.92 ef
LH_1	39.45 c	13.00 a	25.00 g	75.00 a	5.11 a	45.77 a	2.84 a	14.23 a
LH_2	41.07 b	12.90 a	29.67 fg	70.33 ab	4.88 ab	44.83 a	2.75 a	13.77 a
LH_3	42.27 a	12.90 a	31.33 fg	68.67 ab	4.87 ab	43.88 a	2.68 ab	13.39 ab
LH_4	38:35 d	11.83 ab	32.00 fg	68.00 ab	4.71 abc	42.50 a	2.60 abc	12.98 abc

Means bearing the same letter(s) in a column do not differ significantly at the 5 % level of probability.
Bulb sizes: S: Small; M: Medium; L: Large
Growth regulators: H_0: Control; H_1: IAA (200 ppm); H_2: GA_3 (100 ppm); H_3: NAA (200 ppm); H_4: CCC (500 ppm)
DAP : Days after planting

The highest diameter of bulb (4.77cm) was recorded in the plants grown from IAA which was statistically identical with that of GA_3 (4.57cm) and the lowest (4.17cm) at control (Table 2). The treatment combination of large bulb × IAA at 200 ppm produced the largest bulb diameter (5.11cm). The lowest diameter of bulb (3.89cm) was recorded from the treatment combination of small bulb × control treatment (Table 3). Bulb weight increased with the increase in bulb size. It was found that the weight of bulb ranged from 33.87 to 42.73g. The highest mean weight of bulb weight was (42.73g) in the plants grown from large bulb and the lowest (33.87g) was found in the plants grown from small bulb, which was statistically identical with that of medium bulbs (Table 1). The highest mean weight of bulb (39.79g) was obtained from the application of IAA followed by the treatment GA_3 (38.89g), NAA (38.28g) and CCC (37.28g). But there was not significant difference among these four treatments (Table 4). The lowest mean weight of bulb (32.41g) was recorded in the control treatment. It was found that the interaction effect of bulb size and growth regulators on mean weight of bulb was not significant. The mean bulb weight varied from 28.67 to 45.77g among the treatment combinations. The highest mean bulb weight (45.77g) was resulted from the treatment combination of large bulb × IAA at 200 ppm and the lowest (28.67g) by the treatment combination of small bulb × control treatment. The variations in bulb yield of onion per plot as well as per hectare were found statistically significant due to the use of different bulb sizes. Bulb yield increased with the increase in bulb size. The highest bulb yield per plot (2.57kg) was recorded in the plants grown from larger bulb. A similar trend was also found in case of yield per hectare where large bulb gave the highest yield of 12.86t/ha (Table 1). Larger bulb produced more healthy and vigorous plants, which in turn gave higher yield than smaller bulb (Natlob and El-Haber, 1983; Dumitrescu and Radoi, 1984; Yamashita *et al.*, 1986; Shalaby *et al.*, 1991). The highest yield of onion per plot (2.51kg) was recorded in IAA at 200 ppm which was statistically identical with that of GA_3 at 100 ppm (2.44kg) and the lowest (1.79kg) at control treatment. The single effect of different growth regulators on onion bulb yield was also significant. IAA at 200 ppm gave the highest (12.57t) and control treatment gave the lowest (8.96t) yield (Table 2). In all these treatments the highest onion bulb yield per plot (2.84kg) was produced by the treatment combination of large bulb × IAA followed by large bulb × GA_3 (2.75kg), large bulb × NAA (2.68kg) and large bulb × CCC (2.60kg) which did not statistically differ from one another.

Table 4. Cost and benefit analysis for onion due to bulb sizes and growth regulators used

Treatment combinations	Seed bulb requirement (t/ha)	Cost (Tk/ha)		Gross income TK./ha	Total cost of production (TK./ha)	Net return (TK./ha)	Benefit-cost ratio (BCR)
		seed	hormone				
SH_0	0.562	19670	-	172040	83001	89039	2.07
SH_1	0.562	19670	18900	248820	104989	143831	2.37
SH_2	0.562	19670	17500	238040	103443	134597	2.30
SH_3	0.562	19670	4860	225500	89475	136025	2.52
SH_4	0.562	19670	134000	223080	232176	-9096	0.96
MH_0	1.37	34250	-	201080	99111	101969	2.03
MH_1	1.37	34250	18900	267740	121100	146640	2.21
MH_2	1.37	34250	17500	263780	119554	14426	2.21
MH_3	1.37	34250	4860	246840	105587	141253	2.34
MH_4	1.37	34250	134000	239360	248286	-8926	0.96
LH_0	2.25	49500	-	218240	120658	97582	1.82
LH_1	2.25	49500	18900	313060	142648	160292	2.19
LH_2	2.25	49500	17500	302940	137786	165154	2.20
LH_3	2.25	49500	4860	294580	127135	167445	2.32
LH_4	2.25	49500	134000	285560	258334	27226	1.10

Bulb sizes: S: Small; M: Medium; L: Large,

Growth regulators: Growth regulators: H_0: Control; H_1: IAA (200 ppm) H_2: GA_3 (100 ppm); H_3: NAA (200 ppm); H_4: CCC (500ppm)

Price of seed bulb: Small size @ Tk 35/kg; Medium size @ Tk 25/kg; Large size @ Tk 22/kg

Price of growth regulator: IAA @ Tk 140/g; GA_3 @ Tk 250/g; NAA @ Tk 36/g; CCC @ Tk 400/g

Sale price of onion bulbs: Tk 22/kg

The lowest bulb yield per plot (1.56kg) was recorded in plants grown from small bulb without hormone treatment. Similar trend was also observed in case of yield per hectare. The highest yield per hectare (14.23t) was achieved from the treatment combination of large bulb × IAA (200 ppm), and the lowest yield (7.82t) was recorded from the treatment combination of small bulb × control treatment (Table 3). The interaction effect of bulb size and application of growth regulators on the yield and yield components of onion was not significant. Nevertheless, the combined effect of bulb size and growth regulator was significant (Table 3). The benefit cost ratio was found to be the highest (3.34) in the treatment combination of small bulb × NAA at (200 ppm), and the lowest (0.96) was recorded from the treatment combination of small bulb × CCC (500 ppm) (Table 4). The large bulb × IAA (200 ppm) gave the highest gross (Tk. 313060/ha) and large bulb × NAA (200 ppm) gave the highest net returns (Tk. 167445/ha). But the benefit cost ratio analysis, treatment showed the highest profitability (BCR=2.52) combinations from the treatment combination of small bulb × NAA (200 ppm).

Acknowledgement

The financial support of BAURES, Bangladesh Agricultural University, Mymensingh for conducting the experiment is gratefully acknowledged.

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