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Paclobutrazol and Bulb Size Effect on Onion Seed Production

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ABSTRACT

Field experimentation was done at Bangladesh Agricultural University, Mymensingh during, 2005-2006 to evaluate doses of paclobutrazol (PBZ) and bulb size of onion for their effect on growth and seed production of onion. Onion variety "Taherpuri" with three-bulb sizes viz., small, medium and large was used. Doses of PBZ were 20, 40, 80 ppm and no PBZ was used as control. A two-factor experiment was laid out in a randomized complete block design with three replications. PBZ application significantly reduced plant height, number of tillers per bulb, number of leaves per plant and length of scape. Number of flowers, umbels per bulb, umbel diameter, 1000-seed weight and seed yield were not influenced by PBZ concentrations used. Plant height, number of leaves per plant, length of scape, effective fruits per umbel, percentage of fruit set and seed yield were positively influenced by bulb size of onion. Variable interactive effects of PBZ dose and bulb size for different traits were recorded.

Key Words: Bulb size; Onion; Paclobutrazol; Yield and yield attributes

INTRODUCTION

Onion (*Allium cepa* L.) is a major bulbous vegetable of global importance. Out of 15 vegetables listed by the Food and Agricultural Organization (FAO), onion falls second only to tomato in term of total annual world production. Onion is cultivated almost throughout Bangladesh and amongst all spices, ranks first in terms of production and second with respect to acreage. A total requirement of 4,80,000 tons has been estimated annually in the country against the production volume of 2,72,000 tons with a shortage of 2,08,000 tons per year (BBS, 2004). Onion is used as an ingredient in many dishes using by both poor and rich. Domestic production is insufficient to meet local demand, so imports are necessary. The seed yield of onion is very low (370 to 500 kg ha^{-1}) as compared to the yield (1000 to 1200 kg ha^{-1}) of some other countries of the word (HRDP, 1995; Brewster, 1994). Onion production might be increased by increasing growing area with good variety and changing existing management practices. But the main constraint in increasing growing areas is the un-availability of sufficient seed during growing season.

Onion seed is produced by growing onion bulbs. Presently there are no professional onion seed producers in Bangladesh. Peoples are not also much interested in producing onion seed due to extra care for it. Through improved seed production technology both the yield and quality can be improved, which can fetch higher prices in the market. Significant differences were observed in seed yields since it depended on genotype, locality, season as well as, methods of production (Brewster, 1994). Bulb size generally plays an important role in seed production. Bulb size influences the plant growth yield as well as, the splitting of bulb (Baloch *et al.,* 1998). The larger the mother bulb, the greater the seed yield per plant. Planting of bulbs of suitable size increases the yield of onion (Singh & Sachan, 1998, Abedin *et al.,* 1999 & Khokhar *et al.*, 2001).

Paclobutrazol (PBZ) is a triazole derivate and inhibits gibberellin (GA) biosynthesis and abscisic acid (ABA) catabolism. In addition, PBZ induces various plant responses such as shoot growth reduction (Terri & Millie, 2000; Sebastian *et al.,* 2002), enhances chlorophyll synthesis (Sebastian *et al.,* 2002), delays leaf senescence (Davis & Curry, 1991), improves water use by reducing transpiration rate (Ritchie *et al.,* 1991; Sankhla *et al.,* 1992; Eliasson *et al.,* 1994) and increases assimilate partitioning from leaves to roots (Balamani & Poovaiah, 1985; Davis & Curry, 1991; Bandara & Tanino, 1995). Additionally, paclobutrazol has been shown to promote earlier flowering and increase the number of flowers in some plants (Banko & Bir, 1999; Burnett *et al.,* 2000).

Paclobutrazol was evaluated for maximizing growth and flowering and ultimately to increase onion seed yield. Studying the role of paclobutrazol and bulb size in growth and seed yield of onion was another vital objective of present investigations.

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MATERIALS AND METHODS

Site description. The study was conducted at the Crop Botany Research field, Bangladesh Agricultural University, Mymensingh during, 2005 to 2006. Experimental soil was well-drained silty loam, medium high land with pH of 6.4 and 0.84% organic matter. The soil belongs to the old Brahmaputra flood plain Alluvial Tract under AEZ 9 (UNDP, 1988).

Experimental details. A completely randomized block factorial experiment with three replications was conducted using onion cultivar Therpuri. Net plot size was 1 m×1 m. Three bulb sizes as large, medium and small, with average bulb weights of 12, 8 and 5 g, respectively were planted. Solutions of paclobutrazol with three concentrations of 20, 40 and 80 ppm were prepared according to label specifications from the concentrated solution (250 g L^{-1}) and onion bulbs of three sizes was soaked over-night. Bulbs were soaked in distilled water at equivalent volumes as control.

Crop husbandry. Field was cultivated thrice each followed by leveling. Well-decomposed cowdung (10 ton ha^{-1}) was applied 3 days before sowing of onion bulb. Onion bulbs were planted on 25 November, 2005 in 20 cm apart rows maintaining plant to plant distance of 10 cm. Bulbs were set upright and at a depth of 2.5 cm at 50 bulbs per plot. Nitrogen, phosphorus and potassium were applied using urea, triple super phosphate (TSP) and muriate of potash (MP) at 350, 500 and 150 kg ha^{-1}, respectively. All TSP and half urea and potash were applied as basal dose, while the remaining urea and potash were applied in two equal splits (at 40 & 60 days after planting). The crop was kept weed free by manual hoeing. All other agronomic practices like irrigation, mulching, earthing-up, plant protection measure and staking were kept normal and uniform for all the treatments during the entire growth period.

Measurements. The data on plant height and number of leaves was recorded from 5 selected plants at 30, 40, 50, 60 and 70 days after sowing and averaged. Number of tillers per plant was counted at the maximum vegetative growth stage of the onion plants. The data regarding length of scape, scape diameter, number of umbels per plant, diameter of umbel, number of flowers per umbel, number of effective fruits per umbel, percentage of seeded fruits, weight of seeds per plant, seed yield per plot, seed yield per hectare, 1000-seed weight were recorded from 5 randomly selected plants from each plot and then averaged. The seed heads or umbels were harvested, when the seeds became mature. The umbels were considered to be ready for harvest, when about 15-20% of the fruit had black seed exposed. Mature umbels from the stalk were harvested from 9 to 25 April, 2006 in the morning to prevent shattering loss of seeds. Harvested umbels were sun-dried, threshed manually and the seed yield per plant was recorded and converted into kg ha^{-1}.

Data were analyzed using the statistical package program MSTAT-C developed by Russel (1986). Analysis of variance technique was employed to the test overall significance of the data. The difference between pair of mean was performed by least significant difference test (at P=0.05) and also Duncan's multiple range test was used to compare the differences among treatment means.

RESULTS AND DISCUSSION

Regardless of paclobutrazol (PBZ) concentration and bulb size, the plant height increased gradually up to 60 days after planting (DAP) and after that no further increases were observed (Table I). Increase in PBZ concentration reduced significant plant height throughout the growth period, which may be explained by blockage of biosynthesis of active gibberellin GA (Zeevaart *et al.,* 1993). Morphological response to paclobutrazol is the reduction in internode length and this effect has been observed in herbaceous plants (Quinlan, 1981). Tekalign (2005), reported significant reduction in potato plant height in response to PBZ. The larger bulb produced the tallest plant followed by medium-sized bulb, while the shortest plant was obtained from smaller bulbs (Table I) and is confirmatory to the findings of Khan *et al.* (2005). The combined effect of PBZ and bulb sizes on plant height was also significant. Large-sized bulb without PBZ produced significantly tallest plant at each sampling date, while significantly shortest plant was recorded in the plants grown from small-sized bulb with PBZ 80 ppm concentrations at all sampling dates.

Regardless of treatments (both bulb sizes & PBZ concentrations) number of leaves increased up to 60 DAP and then declined (Table II). PBZ treated plants produced significantly less number of leaves compared to control. This reduction was highest, when the concentration of PBZ was maximum (80 ppm). However, number of leaves did not differ significantly in the plants treated with 20 and 40 ppm PBZ except one or two sampling dates. PBZ induces various leaf morphological modifications on plant species, growth stage, rate and method of application (Sebastian *et al.,* 2002; Yeshitela *et al.,* 2004). Larger-sized bulbs produced the highest number of leaves, while the small-sizes bulb produced the least number of leaves. The increase in the number of leaves is directly related to the number of tillers. The more the number of tillers the more were the leaves and *vice versa* (Singh & Sachan, 1999; Hussain *et al.,* 2001).The combined effect of PBZ concentration and bulb sizes on number of leaves per plant was significant. The larger mother bulb without PBZ application produced the maximum number of leaves per plant. On the other hand small-sized bulb with 80 ppm PBZ produced the least number of leaves.

Application of PBZ decreased the number of tillers per plants however, differences amongst in the in the number of tillers per plant due to different concentration of PBZ were not statistically significant (Table IIIa). Highest number of tillers per plant was observed from larger and medium sized bulbs, while lowest number of tillers per plant was recorded from smaller bulbs. More tillers from larger bulbs may be

Table I. Changes in plant height of onion as influenced by bulb sizes and Paclobutrazol concentrations

Treatment	Plant height (cm)					
	Days after planting					
	20	30	40	50	60	70
Bulb size						
Large (L)	30.32 a	34.25 a	38.70 a	47.56 a	53.69 a	48.07 a
Medium (M)	26.20 b	30.03 b	36.07 b	44.71 b	48.59 b	45.01 b
Small (S)	23.88 c	28.19 c	34.28 c	36.93 c	41.63 c	37.34 c
LSD at 5%	2.206	1.567	0.909	0.684	1.274	0.512
PBZ Concentration						
0 ppm	29.09 a	34.63 a	38.25 a	43.89 a	52.95 a	47.99 a
20 ppm	27.76 ab	30.59 b	34.20 b	40.95 b	45.31 b	43.44 b
40 ppm	26.23 b	27.25 c	32.50 c	38.86 c	43.03 c	39.07 c
80 ppm	25.45 b	27.14 c	31.78 c	35.63 d	41.54 d	36.72 d
LSD at 5%	2.547	1.809	1.049	0.790	1.471	0.459
Bulb size x PBZ concentration						
L X 0 ppm	30.92 a	35.26 a	39.81 a	46.33 a	55.45 a	49.38 a
L X 20 ppm	28.83 ab	33.98 b	36.72 b	42.76 b	49.27 b	44.58 b
L X 40 ppm	27.30 b	31.83 bc	36.07 b	41.29 b	48.77 b	43.42 b
L X 80 ppm	25.24 bc	30.92 cd	34.20 c	39.15 c	47.15 b	39.90 c
M X0 ppm	26.46 b	33.93 b	36..97 b	43.55 b	49.84 b	43.13 b
M X20 ppm	23.97 c	27.50 d	33.93 c	39.74 c	47.60 b	41.01 bc
M X40 ppm	22.01 d	26.93 d	32.77 cd	38.94 c	40.54 cd	36.30 d
M X80 ppm	21.38 cd	25.76 d	30.26 de	36.59 d	40.37 cd	35.58 d
S X 0 ppm	24.90 bc	28.71 d	33.96 c	37.80 cd	42.47 c	39.47 c
S X 20 ppm	22.48 d	25.30 d	30.95 de	36.35 d	39.07 cd	35.72 d
S X 40 ppm	20.15 d	23.99 d	28.66 e	35.65 d	39.77 cd	35.50 d
S X 80 ppm	19.73 d	22.75 d	25.54 f	32.13 e	37.15 d	32.67 e
LSD at 5%	2.412	2.133	1.817	1.368	2.548	1.024

Means having the common letter (s) within a column do not differ significantly at 5% level of significance by DMRT

Table II. Changes in number of leaves of onion as influenced by bulb sizes and paclobutrazol concentrations

Treatment	Number of leaves per plant					
	Days after planting					
	20	30	40	50	60	70
Bulb size						
Large (L)	16.87 a	17.68 a	18.42 a	20.22 a	22.91 a	19.64 a
Medium (M)	14.77 b	16.03 b	17.08 b	19.55 ab	21.30 b	18.09 b
Small (S)	12.89 c	15.67 b	17.27 b	18.82 b	20.93 b	16.59 c
LSD at 5%	0.805	0.483	0.551	1.050	0.890	0.912
PBZ Concentration						
0 ppm	15.78 a	16.72 a	18.69 a	20.71 a	22.75 a	20.12 a
20 ppm	14.31 b	15.73 b	17.38 b	19.83 a	21.16 b	18.03 b
40 ppm	14.03 c	15.79 b	16.09 c	18.84 ab	20.54 b	17.74 b
80 ppm	13.91 c	14.09 c	15.80 c	17.74 b	18.30 c	15.53 c
LSD at 5%	0.930	0.558	0.636	1.212	1.027	1.054
Bulb size x PBZ concentration.						
L X 0 ppm	17.49 a	18.50 a	19.34 a	22.35 a	23.26 a	20.96 a
L X 20 ppm	16.07 b	17.27 b	18.93 ab	19.64 b	22.21 ab	19.37 ab
L X 40 ppm	14.97 bc	15.90 bc	17.47 b	18.38 b	20.32 b	17.93 b
L X 80 ppm	14.93 bc	15.07 bc	16.93 b	18.01 b	19.33 bc	16.31 bc
M X0 ppm	15.07 b	16.47 b	17.67 b	19.78 b	21.47 ab	18.60 ab
M X20 ppm	14.72 bc	15.40 bc	17.03 b	17.93 bc	20.27 b	17.47 b
M X40 ppm	14.60 bc	15.07 bc	16.07 bc	17.87 bc	19.60 bc	17.03 bc
M X80 ppm	13.20 c	14.07 c	15.33 c	16.60 c	18.67 c	15.62 c
S X 0 ppm	14.78 bc	15.20 bc	17.07 b	17.98 bc	20.72 b	17.02 bc
S X 20 ppm	12.65 d	14.53 cd	16.03 bc	17.93 b	19.10 bc	15.27 c
S X 40 ppm	12.54 d	13.40 d	14.73 cd	15.26 c	17.16 cd	14.62 cd
S X 80 ppm	11.59 e	12.53 d	13.33 d	14.12 cd	15.18 d	13.67 d
LSD at 5%	1.610	0.966	1.101	2.1	1.779	1.824

Means having the common letter (s) within a column do not differ significantly at 5% level of significance by DMRT

attributed to more shoot primordia in large size bulb as compared to small size bulb. A significant interaction between PBZ concentrations and bulb sizes was observed for the number of tillers per plant. Large-sized bulb and no PBZ application showed more number of tillers and smaller-size bulbs with maximum concentrations of PBZ produced fewer tillers compared to others.

Irrespective of concentrations, PBZ significantly reduced length of scape as compared to control (Table IIIa). Reduced GA synthesis in response to PBZ treatment might have resulted in a reduced cell proliferation leading to a reduction in stem elongation. Haughan *et al.* (1989) reported that the 2 R configuration of PBZ greatly retarded cell proliferation in celery. PBZ effectively suppressed growth in a wide range of plant species and treated plants tended to be darker and more compact in appearance (Kamoutsis *et al.,* 1999; Terri & Millie, 2000; Sebastian *et al.,* 2002). Bulb sizes had significant positive influence on the length of scape. Data revealed that length of scape increased with the increase in of bulb size. The longest of scape was observed in large sized bulb, while shortest scape was recorded in the plants grown from small-sized bulb (Table IIIa), which is in conformity with the findings of Farag and Koriem (1996). The combined effect of PBZ and bulb size was also significant in respect of length of scape. Large-sized bulb without application of PBZ produced tallest scape, while shortest scape was recorded in small-sized bulb those received 80 ppm PBZ.

PBZ application significantly reduced the diameter of scape (Table IIIa). However, there were no significant differences amongst different concentration of PBZ used. The highest scape diameter was recorded in plants having larger and medium-sized bulbs, while this value was the lowest in the smaller-sized bulb. The range between the scape diameters was 1.27-157 cm. The combined effect of PBZ and bulb sizes on scape diameter was not significant for large and medium sized bulbs (Table IIIa). However, scape diameter was significantly reduced in case of smaller sized bulb.

The number of umbels per bulb is very important in seed yield. Data (Table IIIa) revealed that application of PBZ had significant effect on the number of umbels per bulb. PBZ treated plant significantly decreased the number of umbels per bulb as compared to control, while amongst the concentrations, these differences were statistically insignificant. This result can be explained by decreased number of tillers by PBZ over control, which resulted in a smaller number of umbels per bulb. Like other parameters, number of umbels was higher in larger-sized and medium-sized bulb, while it was lowest in the plants having small-sized bulb (Table IIIa). These results are in agreement with findings of Singh and Sachan (1998) who found that umbels per bulb decreased with the decrease of bulb size.

PBZ had no significant effect on umbel diameter. However, largest sized bulb produced the highest umbel diameter followed by the medium size, while the smallest

Table IIIa. Effects of bulb size and paclobutrazol concentrations on the yield and yield contributing characters of onion

Treatment	Tillers per plant	Length of scape (cm)	Diameter of scape (cm)	Umbels per bulb	Umbel diameter (cm)	Flowers per umbel
Bulb size						
Large (L)	3.83 a	70.49 a	1.57 a	4.17 a	5.47 a	177.42 a
Medium (M)	3.22 b	64.74 b	1.55 a	3.38 b	4.38 b	169.17 b
Small (S)	2.36 c	59.28 c	1.27 b	2.29 c	3.61 c	135.67 c
LSD at 5%	0.475	3.110	0.097	0.348	0.297	4.708
PBZ Concentration						
0 ppm	3.77 a	67.98 a	1.77 a	3.87 a	5.85 a	177.67 a
20 ppm	3.37 b	64.29 b	1.35 b	3.31 b	5.03 b	167.56 b
40 ppm	3.18 b	62.71 b	1.36 b	3.18 b	4.85 b	148.00 c
80 ppm	3.12 b	61.38 b	1.30 b	2.76 c	4.79 b	149.78 c
LSD at 5%	0.348	3.592	0.112	0.402	0.343	5.436
Bulb size x PBZ concentration						
L X 0 ppm	4.06 a	73.07 a	1.64 a	4.77 a	5.59 a	209.67 a
L X 20 ppm	3.97 a	70.20 ab	1.56 a	4.13 a	5.47 a	185.33 b
L X 40 ppm	3.75 a	65.87 b	1.53 a	4.02 ab	5.15 b	140.33 e
L X 80 ppm	3.71 a	62.82 bc	1.45 a	3.75 b	5.02 b	174.33 c
M X 0 ppm	3.27 b	66.20 b	1.59 a	3.63 b	5.10 a	187.33 b
M X20 ppm	3.19 b	61.87 bc	1.52 a	3.52 b	4.73 b	172.00 c
M X40 ppm	3.13 b	62.67 bc	1.51 a	3.50 b	4.33 c	165.67 c
M X80 ppm	3.09 b	59.23 bc	1.45 a	2.87 c	3.93 d	151.67 d
S X 0 ppm	2.68 c	60.13 c	1.32 b	3.20 bc	4.28 c	136.00 e
S X 20 ppm	2.57 c	57.67 c	1.30 b	2.27 d	3.90 d	151.67 d
S X 40 ppm	2.56 c	54.07 cd	1.25 c	2.03 d	3.10 e	143.67 de
S X 80 ppm	2.53 c	49.07 d	1.10 c	1.67 e	3.17 e	135.33 e
LSD at 5%	0.425	6.220	0.193	0.696	0.593	9.415

The figures having the common letter (s) within a column do not differ significant at 5% level of significance by DMRT

Table IIIb. Effects of bulb size and paclobutrazol concentrations on the yield and yield contributing characters of onion

Treatment	Flowers per umbel	Effective fruits per umbel	%Effective fruits set	Seed weight gplant^{-1}	1000-seed weight (g)	Seed yield kgha^{-1}
Bulb size						
Large (L)	177.42 a	94.42 a	55.72 a	0.82 a	2.29 a	405.67 a
Medium (M)	169.17 b	80.92 b	50.22 b	0.59 b	2.16 b	328.92 b
Small (S)	135.67 c	55.25 c	44.89 c	0.36 c	1.70 c	188.74 c
LSD at 5%	4.708	3.408	2.135	0.027	0.089	11.739
PBZ Concentration						
0 ppm	177.67 a	81.00 a	51.75 a	0.64 a	2.33 a	341.33 a
20ppm	167.56 b	77.22 ab	50.74 ab	0.64 a	2.07 b	313.22 b
40 ppm	148.00 c	76.67 b	50.41 ab	0.57 b	1.94 c	282.90 c
80 ppm	149.78 c	72.56 c	48.21 b	0.52 c	1.84 c	240.31 d
LSD at 5%	5.436	3.935	2.465	0.031	0.102	13.555
Bulb size x PBZ concentration						
L X 0 ppm	209.67 a	102.00 a	59.43 a	0.83 b	2.49 a	469.33 a
L X 20 ppm	185.33 b	97.00 ab	55.40 ab	0.87 b	2.15 bc	419.67 b
L X 40 ppm	140.33 e	93.00 b	54.36 bc	0.80 b	2.33 ab	386.33 c
L X 80 ppm	174.33 c	85.67 c	53.70 bcd	0.98 a	2.17 bc	347.33 d
M X 0 ppm	187.33 b	78.67 c	50.42 cde	0.61 d	2.27 bc	328.67 d
M X 20 ppm	172.00 c	81.33 c	49.11 def	0.63 d	2.16 bc	312.00 d
M X 40 ppm	165.67 c	84.33 c	49.21 def	0.58 d	2.11 c	285.00 e
M X 80 ppm	151.67 d	79.33 c	52.15 bcd	0.83 d	2.11 c	230.00 f
S X 0 ppm	136.00 e	62.33 d	45.41 f	0.47 e	2.24 bc	226.00 f
S X 20 ppm	151.67 d	53.33 e	47.69 ef	0.42 e	1.91 d	208.00 f
S X 40 ppm	143.67 de	52.67 e	47.67 ef	0.32 f	1.39 e	177.37 g
S X 80 ppm	135.33 e	52.67 e	38.79 g	0.22 c	1.25 e	143.60 h
LSD at 5%	9.415	6.816	4.270	0.054	0.177	23.478

The figures having the common letter (s) within a column do not differ significant at 5% level of significance by DMRT

umbel was observed in the plants having smaller bulbs (Table IIIa). This agrees with reported values of Ambulker *et al.* (1995).

Paclobutrazol had no significant influence on number of flowers per umbel compared to control (Table IIIa). Foley and Keever (1991) reported that there was no impact of paclobutrazol on flowering time or flower number of carnations (*Dianthus caryophyllus* L.). Berberich *et al.* (2006) concluded that paclobutrazol did not increase the number of flowers. However, significant influence of

paclobutrazol in increasing number of flowers has been experimentally substantiated by De Baerdemaeker *et al.* (1994) and Singh *et al.* (1999). Larger bulbs produced maximum flowers per umbel that were lowest in small-sized bulbs. This result is in agreement with the findings of Rathore *et al.* (1975). The combined effect of PBZ and bulb size on number of flowers per umbel was also significant. Number of flowers per umbel was maximum in the large-sized bulb and PBZ non-treated and this number was least in the small-sized bulb with PBZ 80 ppm.

PBZ application did not influence the effective number of fruits per umbel. The number of effective fruits per umbel increased from 55.25 to 94.42 with the increase in bulb size. The superiority of large bulbs may be explained on the basis of higher initial food reserves in these (Table IIIb). Begum *et al.* (1998) and Muktadir (2001) also reported similar results. The combined effect of PBZ and bulb sizes on the effective fruits per umbel was also significant. The highest seeded fruits per umbel were recorded from combination of large-bulb size without PBZ application. The lowest effective fruits per umbel were recorded from the treatment combination of small-sized bulb with 80 ppm PBZ. The response was mainly due to bulb size differences.

There was no significant influence of PBZ application on percentage of effective fruit setting (Table IIIb). Percentage of effective fruit setting was the highest in the plants developing from large-sized mother bulbs. In contrast this value was the lowest in the plants having smaller mother bulb. The combined effect of PBZ and bulb size on the percentage of effective fruit setting was significant. Effective fruit setting was maximum in the large-sized bulb without PBZ application. Percentage of effective fruit setting was going down in small-sized bulb with higher concentrations of PBZ.

Different PBZ concentrations had no significant effect on the 1000-seed weight (Table IIIb). On the other hand, 1000-seed weight significantly increased with the increase in bulb size ranged from 1.70 to 2.29 g (Table IIIb). Several other authors (Singh & Sachan, 1998; Ali *et al.*, 1998) reported similar results. The combined effect of PBZ and bulb size on 1000-seed weight was significant. The highest 1000-seed weight was obtained from large sized bulb without PBZ application, while the lowest 1000-seed weight was recorded from small sized bulb with 80 ppm PBZ treated plants, which was statistically identical with small sized bulb with 40 ppm PBZ treated plants.

Increasing concentrations of PBZ had an inhibitory influence on seed yield (Table IIIb). Best seed-yields were obtained from plants grown from large bulbs as compared to medium and small sizes. A larger mother bulb having a larger food supply and water content than the other sizes-enabled the development of vigorous plants and production of higher seed yields (Levy *et al.,* 1981). Similar trends were observed for seed yield by other workers (Ambulker *et al.,* 1995; Abedin *et al.,* 1999; Muktadir *et al.,* 2001; Verma *et al.,* 1994 & Baloch *et al.,* 1998). The combined effect of PBZ and bulb sizes on seed yield per plant was significant. The highest seed weight per plant was obtained from large sized bulb without PBZ application and the lowest seed weight per plant was found from small sized bulb with 80 ppm PBZ treated plants. No clear trend was observed in seed yield due to combined influence of PBZ and bulb sizes.

Paclobutrazol was effective at reducing plant height, leaf numbers and length of scape, but did not increase flowering, fruit setting percentages and 1000-seed weight. Since onion plants can be grown in field, reducing growth is unnecessary if flowering in not increased. Therefore, the use of paclobutrazol would not be recommended for this production system. We also recommend further trials with changing PBZ application methods like foliar spray or drench application etc. The vegetative growth and seed production ability of the plants increased gradually with the increase in bulb size. However, the most important thing is the seed rate per hectare as well as, the production cost. Considering the cost, medium-sized bulb can be used as the differences in seed yield among large and medium sized mother bulb was not so big.

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