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# Amelioration of Onion Seed Production via Bulb Size and Growth Active Substances

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## ABSTRACT

Two field experiments were carried out during the two successive growth seasons of 2008/2009 and 2009/2010 at a private farm in Quesna ( EL-Menofyia, governorate, Egypt) to study the effect of two bulb sizes, i.e. large (>6.0-< 8.0 cm, diameter) and medium size (>4.0-<6.0 cm, diameter) as well as spraying with three growth active substances, i.e. yeast (3 g/L), chitosan (5cm/L) and boric acid (300 ppm) in addition to tap water as a control on the productivity of onion seed yield. The obtained results indicated that planting onion bulbs for seed production, it is favorable to use bigger bulbs (>6-<8 cm diameter) to obtain the significant vigorous plant growth (plant height, average number of tillers and leaves, fresh and dry weight of whole plant and its different organs). The higher quality of stalks and umbels, i.e. the higher stalk length which carried more number and diameter of stalks as well as bigger diameter and flowers of umbel all of these parameters gained with using bigger mother bulbs for onion seed production. The weight of onion seeds recorded its significant superiority when large mother bulbs (6-8 cm diameter) were grown compared to that obtained by growing medium mother bulbs. Foliar spray of onion plants by yeast at 3 g /L. or chitosan at 5 cm/L. (three sprays with 15- day intervals) gave the significant plant vigor characteristic. Whereas, the application of yeast recorded the best values of stalk height, number and diameter, as well as the average number of flowers / umbel and umbel diameter. The obtained data showed that the 3 active substances caused an increase in germination percentages if compared to the control treatments.

***Key words:*** Onion, bulb size, yeast, chitosan, boric acid and seed yield.

## Introduction

Presently, Egypt is ranked as the eighth in the world in dry onion planted area (43 x 103 ha) and production (1.302 x 103 ton). The total planted area in Egypt for onion seed production is 2752 fed. Produced 742 tons which equal 270 kg/fed. according to statement of the Egyptian Ministry of Agricultural (2007). Through increase and improve of seeds production technology both the yield and quality can be improved, which can obtain higher prices in the market. Peoples are not also much interested in producing onion seeds due to extra care for it. 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 whereas; 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 seeds yield per plant and planting of bulbs of suitable size increases the yield of onion (Abedin *et al*.,1999 ; Khokhar *et al.,* 2001).

Plant growth stimulants, i.e., yeast, chitosan and boric acid used to regulate growth and reproduction have been used successfully to increase seed yield in onion. Many investigators reported that, spraying plants with yeast improved plant growth, yield and quality of many vegetable crops ( Tartoura, 2001; Mahmoud, 2004; El-Desuki and El-Gereadly, 2006)., Moghazy (2009), found that the application of yeast extract obtained the best results from growth parameters, fruit and seed productivity and improving fruit quality of squash cv. Eskandrani.

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Chitosan has been used in seed, leaf, fruit and vegetable coating (Devlieghere *et al*., 2004), as fertilizer and in controlled agrochemical release (Sukwattanasinitt *et al.,* 2001), to increase plant product (Nwe *et al.,* 2004; Walker *et al.,* 2004). Recently, Abdel-Mawgoud *et al.,* (2010), reported that chitosan application on strawberry improved plant height, number of leaves, fresh and dry weights of the leaves and yield components (number and weight).

Boron is actively involved in pollen germination, fruit set and seed formation, it is required for flowering and seed set (Helal *et al.,* 2005). Moreover, the recent investigation on broad bean plant showed that foliar spray with boron at 250 or 500 ppm were simulative for vegetative growth characters, green pod and seed yield, also number of pods / plant as well as pod setting percentage (Abd El-Fattah, 1997).

This study aimed to studying the role of bulb size and some plant growth stimulants on growth of onion plant and its seed yield.

## Material and Methods

Two field experiments were carried out during the two successive growth seasons of 2008/2009 and 2009/2010 at a private farm in the Quesna, ( EL-Menofyia, Governorate, Egypt) to study the effect of two bulb sizes, i.e. large (>6.0 cm, diameter) and medium (4-6 cm, diameter) and spraying with three growth active substances ,i.e. yeast (3 g,/L), chitosan (5cm,/ L), boric acid (300 ppm) in addition to tap water as a control on the productivity of onion seed yield. Some physical and chemical properties of the experimental soil in 2008/2009 and 2009/2010 are shown in Table (1). Yeast spraying solution was prepared by mixing 3 g, yeast to 2 spoons of sugar for a period 24 h. Chitosan (2-Amino-2-deoxy-beta-D-glucosasmine) solution was prepared by dissolving 5 cm/L of Chito–Care ®.

Onion bulbs cv. Giza 20 were planted on 15 $^{th}$ of October in two successive seasons on one side of ridge (5 m long and 60 cm width) at a distance of 40 cm, between bulbs. The sub plot area was 9 $m^2$ (contained on 3 ridges).

A split-plot design with three replicates was used in the two seasons. Main plots contained 2 bulb sizes which were distributed randomly while the plant growth substances were arranged randomly within the sub-plots. The growth active substances were sprayed 3 times, starting 45 days after planting with 15 day intervals. The normal cultural practices were used for the onion seed production, i.e. irrigation, fertilization, weeds, diseases and pest control, were followed according to the recommendation of the Egyptian Ministry of Agriculture.

**Table 1:** Physical and chemical properties of experimental soil in 2008/2009 and 2009/2010 seasons.

| **2008/2009** | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analysis of the experimental soil** | | | | | | **Chemical analysis:** | | | | | | | | | | | |
| Texture | Clay% | Silt | Sand | EC ($dSm^{-1}$) 1 : 5 | pH 1 : 2.5 | Cations meq/L | | | | | Anions meq/L | | | | | | |
| | (%) | | | | | Ca | Mg | Na | Kt | Ka | $CO_3$ | $SO_4$ | CL | $HCO_3$ | $NH_4$ + $NO_3$ | P |
| | | | | | | | | | | ppm | | | | | ppm | | |
| Clay | 47.2 | 38 | 14.8 | 0.3 | 7.63 | 1.00 | 0.5 | 1.3 | 0.3 | 384.1 | - | 4.02 | 1.6 | 1.00 | 46.2 | 24.5 | |
| **2009/2010** | | | | | | | | | | | | | | | | | |
| Clay | 49.1 | 38 | 12.9 | 0.7 | 7.29 | 3.0 | 0.8 | 1.5 | 0.32 | 378.8 | - | 3.1 | 1.0 | 2.0 | 47.5 | 25.6 | |

*Recorded data:*

*- Vegetative growth:*

At 90 days five plants from each experimental plot were taken randomly for recording plant length, number of tillers per plant, number of leave per plant, fresh and dry weight of whole plant.

- *Flowering measurements:*

At 120 days five plants from each plot were chosen randomly for recording the data of stalk length number of stalk, number of flowers per umbel, stalk diameter and umbel diameter.

- *Seeds yield:*

Onion umbels were harvested (210 days after planting) before most of the umbel exposed their black seeds and 20-30 % capsule were splitted. Umbels were harvested in the morning to prevent shattering of seed. Data were recorded on seed weight per umbels, seeds weight per plant and seed yield per fed.

- *Seed quality:*

Onion seeds were stored at room temperature for four months after harvesting, then the weight of 1000, seed germination percentage and rate index (GRI) were recorded .The germination percentage and the rate index of seeds were calculated according to the following equations;

$$\text{- Germination \%} = \frac{\text{Number of the germination seed}}{\text{Initial number of seed}} * 100$$

$$\text{- Germination rate index (GRI)} = \frac{a_1b_1 + a_2b_2 + a_3b_3 + a_xb_x}{\text{The sum number of germination seeds}}$$

a = number of the germinated seeds at certain day from the beginning of germination.
b = the day of recording germination seeds (Scotte *et al*., 1984).

Obtained data were subjected to the analysis of variance procedure and treatments means were compared to the L.S.D. test according (Gomze and Gomz 1984).

**Results and Discussion**

**A - Plant growth characteristics:**

Table (2) shows the bulb sizes of onion significantly affected plant growth characters, during both experimental seasons. These findings were true for all plant growth characters except that of dry weight of neck in the second season. The taller onion plant that carried the higher number of leaves as well as the heaviest fresh and dry weight of whole plant and its different organs, all of them were as associated with plants which grown using the bigger onion bulbs. These results were completely similar in the two seasons. The increase in fresh and dry weight of whole plant when using large bulbs over than that of using medium one amounted to 42.7 and 44.0%, respectively, in the first season and 54.2 and 50.5% in the 2 second season for the same respective.

It could be concluded that planting onion for seed production, it is favorable to use bigger bulbs to obtain the vigorous plant growth (plant height, average number of tiller and leaves, fresh and dry weight of whole plant). These findings are in good accordance with that reported by other workers (Hussain *et al.,* 2001; Khan *et al.* 2005 and Ashrafuzzaman, *et al.,* 2009). All of them showed that the better plant growth criteria of onion were associated with using bigger mother bulb for planting.

The response of onion plants to yeast, boric acid and chitosan as compared to those non treated plants during the two experimental seasons of 2008/2009 and 2009/2010 are presented in Tables (2).

Generally application of the three materials of plant growth substances resulted significantly in more vigor plant growth compared to the control (no treated) plants. in both seasons . The foliar application of yeast gained the most vigorous plant growth expressed by height as plant, average number of tillers and leaves, fresh and dry weight of whole plant and, followed in descending order, but with no significant differences, with plants sprayed by chitosan.

**Table 2:** Effect of bulb sizes and some growth promoter substances on plant growth characters of onion plant during 2008/2009 and 2009/2010 seasons.

| Treatments | | **First season** | | | | |
|---|---|---|---|---|---|---|
| Bulb size | Growth active substances | Plant height (cm) | No. tillers/ plant | No. leaves/ plant | Fresh wt. Whole plant (g) | Dry wt./Whole plant (g) |
| Medium 4–6(cm) | Control | 89.33 | 4.33 | 34.67 | 379.43 | 35.40 |
| | Yeast | 97.33 | 5.33 | 49.67 | 528.18 | 49.71 |
| | Boric acid | 90.33 | 4.67 | 38.67 | 399.69 | 37.07 |
| | Chitosan | 97.00 | 5.33 | 47.67 | 479.13 | 45.03 |
| Mean | | 93.50 | 4.92 | 42.42 | 446.61 | 41.81 |
| Large 6-8 (cm) | Control | 95.00 | 5.67 | 49.00 | 549.33 | 52.27 |
| | Yeast | 108.67 | 7.33 | 68.33 | 767.99 | 72.75 |
| | Boric acid | 96.67 | 6.00 | 56.00 | 650.65 | 61.90 |
| | Chitosan | 106.00 | 7.00 | 66.00 | 721.80 | 70.98 |
| Mean | | 101.58 | 6.50 | 59.83 | 672.44 | 64.48 |
| Averages | Control | 92.17 | 5.00 | 41.83 | 464.38 | 43.84 |
| | Yeast | 103.00 | 6.33 | 59.00 | 648.09 | 61.23 |
| | Boric acid | 93.50 | 5.33 | 47.33 | 525.17 | 49.49 |
| | Chitosan | 101.50 | 6.17 | 56.83 | 600.47 | 58.01 |
| L.S.D at 5% level | Bulb size | 2.18 | 0.95 | 5.02 | 59.56 | 7.79 |
| | Substances | 4.18 | 0.67 | 5.44 | 47.06 | 5.13 |
| | Interaction | N.S. | N.S. | N.S. | N.S. | N.S. |
| | | **Second season** | | | | |
| Medium 4–6(cm) | Control | 80.00 | 4.00 | 34.00 | 371.14 | 34.28 |
| | Yeast | 97.67 | 5.33 | 49.67 | 537.37 | 50.01 |
| | Boric acid | 89.00 | 5.00 | 40.67 | 422.93 | 39.53 |
| | Chitosan | 97.00 | 5.67 | 48.67 | 515.93 | 50.61 |
| Mean | | 90.92 | 5.00 | 43.25 | 461.84 | 43.61 |
| Large 6-8 (cm) | Control | 88.33 | 5.33 | 48.33 | 518.71 | 47.28 |
| | Yeast | 106.00 | 7.33 | 69.67 | 772.10 | 73.49 |
| | Boric acid | 94.00 | 6.00 | 54.00 | 644.03 | 59.94 |
| | Chitosan | 105.00 | 6.33 | 67.67 | 726.41 | 68.19 |
| Mean | | 98.33 | 6.25 | 59.92 | 665.31 | 62.23 |
| Averages | Control | 84.17 | 4.67 | 41.17 | 444.93 | 40.78 |
| | Yeast | 101.83 | 6.33 | 59.67 | 654.73 | 61.75 |
| | Boric acid | 91.50 | 5.50 | 47.33 | 533.48 | 49.74 |
| | Chitosan | 101.00 | 6.00 | 58.17 | 621.17 | 59.40 |
| L.S.D at 5% level | Bulb size | 4.98 | 1.08 | 8.72 | 89.37 | 11.68 |
| | Substances | 4.31 | 0.82 | 7.04 | 69.06 | 7.47 |
| | Interaction | N.S. | N.S. | N.S. | N.S. | N.S. |

Yeast enhancement of growth may be due to its high content of some essential bio stimulates, i.e. carbohydrate, protein, growth promoters (GA, IAA, and cytokines), and vitamins (B1) as well as some major elements (N, P and K) which in turn cause stimulation of cell division and enlargement, protein and carbohydrate synthesis as well as chlorophyll formation (Ali, 2006; Balbaa *et al.*, 2007; Maghazy, 2009). Many other workers support the obtained results, such as Amer (2004) on common bean, Mahmoud (2004) on potato, El-Dusuki and El-Gereadly (2006) on pea plant and El-Tohamy *et al.*, (2008) on eggplant.

Chitosan increased plant growth as a result of stimulation of immunity of plants (Nwe *et al.,* 2004) against microorganisms (Pospieszny *et al.*, 1991) and to stimulation of root, shoot, leaves and Photosynthesis rate (Khan *et al.*, 2002 and Gornik *et al.*, 2008). The results of Chibu and Shibayama (2001), Ohta *et al.,* (2001) and Abdel-Mawgoud *et al.*, (2010) support data for that obtained herein.

The interaction effect between the two factors (sizes of bulb and foliar spraying by some growth substances) on growth criteria of onion plants was not statistically significant in the two seasons of 2008/2009 and 2009/2010 as presented in Tables (2 and 3). This might be attributed to that each of the two factors act independently.

**B- Stalk and Umbel characteristics:**

Plants grown from the large bulb size gained the better stalk and umbel characters, i.e. stalk length, number and diameter as well as number of flowers / umbel and diameter of umbel compared with plants grown from the medium bulb diameter. These findings were true in both the two experiments. Many investigators have studied the behavior of stalks and umbel of onion and reported that there was a positive correlation within using large mother onion bulbs and the characteristics of stalk and umbel (Khan *et al.,* 2005; Ashrafuzzaman *et al.,* 2009).

The effect of some plant growth active such as yeast, chitosan and boric acid on the characteristics of stalks and/or umbel of onion mother bulbs is presented in Table (3).

The application of yeast recorded the best values of stalk length, number/plant, diameter, as well as the average number of flowers/umbel and umbel diameter followed in descending order by the foliar application by chitosan (Table 3).

Moreover, the statistical analysis of the obtained data revealed that the differences between yeast and chitosan were not great enough to reach the 5 % level.

The pronounced effect of yeast and chitosan in enhancing the growth of stalks and umbel of onion plant could be attributed to their influences on plant growth characters (Table 2 and 3).

The pronounced effect of yeast and chitosan in enhancing the growth of stalks and umbel of onion plant could be attributed to their influences on plant growth characters (Table 2 and 3).

Generally, the obtained results concerning the effect of chitosan on flowering of onion are in good accordance with those of Ohta *et al.,* (1999).

The interaction effect between mother bulb sizes and foliar application of some growth substances were not significant in the two seasons except diameter of stalk in two seasons and length of stalk in the second season. In other words each factor of the interaction acts independently.

**C - Onion seed yield and viability:**

The weight of onion seeds recorded significantly superiority values when large mother bulbs were used compared to medium ones for seed production. Whereas, the statistical analysis of the obtained data revealed that the differences within the two sizes of mother onion bulbs recorded a significant value at 5% level. In other words, grown large mother onion bulbs caused increases over that used medium one. These results were true in both the two seasons for all seed weight criteria (weight of seeds/umbel, weight of seeds/mother onion bulb, weight of seeds/fed and weight of 1000 seeds) (Table 4). This superiority amounted to 25.5% in the first season, and 27.4% in the second season for the yield of seeds as kg/fed.

Many workers such as Khan *et al*., (2005); Mosleh UD-Deen (2008), and Ashrafuzzaman *et al*., (2009) reported that the large mother bulb produced greater seed yield than the small one.

Regarding to the germination percentages and rate index, the obtained date reveals that the sizes of mother onion bulbs had on significant effect on both Characters in the two seasons. El-Aweil and Ghobasli, (1999) reported that there were no significant effect for bulb sizes on germination, but Farag and Koriem, (1996) showed that the largest bulb size gave the lowest percentage of seed germination compared to the other bulb size. Moreover Gamie *et al.,* (1996) indicated that medium bulbs gave the highest percentage of seed germination.

Generally, that plants which treated with the yeast, chitosan or boric acid resulted in more seed weight over that untreated (control) plants (Table 4). Moreover, the foliar spraying with yeast extract resulted in the heaviest seed weight, followed by chitosan application with no significant difference between them. This might be attributed to that application of yeast or chitosan resulted in the tallest stalks which attracted the honey flies to visit the umbel flowers consequently the seeds set increased. In addition both yeast and chitosan stimulated the plant growth, stalk and umbel characters (Tables 2, 3).

The foliar spraying by yeast caused an increase in yield of onion seeds as kg. /fed. amounted to 45.3% and 52.5% in the 1 first and the 2 seasons respectively compared to control treatment.

The onion plants which received yeast extract or chitosan gained onion seeds which had the highest germination percentage with no significant different between them. Many other investigations repotted similar results (Amer, 2004; El-Desuki and El-Gereadly, 2006 on common bean; El-Tohamy *et al.,* 2008 on eggplant).

The interaction within sizes of onion mother bulb and the supplied some active substances as foliar application had no significant effects on weights of onion seeds as well as the values of germination percentage and GRI during the two experimental seasons. It means that each factor of the interaction act independently.

**Table 3:** Effect of bulb size and some growth promoter substances on stalk and umbel characters of onion plant during two seasons 2008/2009 and 2009/2010.

| Treatments | | First season | | | | |
|---|---|---|---|---|---|---|
| | | Stalk | | | Umbel | |
| | | Length (cm) | No./ plant | Diameter (cm) | No. Flowers/plant | Diameter (cm) |
| Medium 4-6 (cm) | Control | 60.55 | 4.67 | 1.54 | 668.33 | 4.46 |
| | Yeast | 69.87 | 5.00 | 1.67 | 785.00 | 6.03 |
| | Boric acid | 60.67 | 4.33 | 1.50 | 715.00 | 4.92 |
| | Chitosan | 67.67 | 5.00 | 1.64 | 760.00 | 5.93 |
| Mean | | 64.69 | 4.75 | 1.59 | 732.08 | 5.34 |
| Large 6-8 (cm) | Control | 60.67 | 5.00 | 1.42 | 700.00 | 4.97 |
| | Yeast | 74.00 | 6.67 | 1.94 | 856.67 | 6.40 |
| | Boric acid | 62.90 | 5.67 | 1.71 | 770.00 | 5.37 |
| | Chitosan | 72.00 | 6.00 | 1.79 | 840.00 | 6.23 |
| Mean | | 67.39 | 5.83 | 1.72 | 791.67 | 5.74 |
| Averages | Control | 60.61 | 4.83 | 1.48 | 684.17 | 4.72 |
| | Yeast | 71.93 | 5.83 | 1.81 | 820.83 | 6.22 |
| | Boric acid | 61.78 | 5.00 | 1.60 | 742.50 | 5.14 |
| | Chitosan | 69.83 | 5.50 | 1.72 | 800.00 | 6.08 |
| L.S.D at 5 % level | Bulb size | 2.61 | 0.36 | 0.01 | 28.85 | 0.35 |
| | Substances | 3.24 | N.S. | 0.06 | 24.50 | 0.28 |
| | Interaction | N.S. | N.S. | 0.08 | N.S. | N.S. |
| | | **Second season** | | | | |
| Medium 4-6 (cm) | Control | 63.33 | 4.00 | 1.15 | 628.33 | 4.40 |
| | Yeast | 78.47 | 4.67 | 1.72 | 805.00 | 5.79 |
| | Boric acid | 70.95 | 4.33 | 1.37 | 709.00 | 5.01 |
| | Chitosan | 75.07 | 5.00 | 1.67 | 780.00 | 5.31 |
| Mean | | 71.95 | 4.50 | 1.48 | 730.58 | 5.13 |
| Large 6-8 (cm) | Control | 63.98 | 4.67 | 1.55 | 716.00 | 5.03 |
| | Yeast | 88.87 | 6.00 | 1.92 | 903.33 | 6.95 |
| | Boric acid | 75.33 | 5.00 | 1.57 | 774.00 | 5.68 |
| | Chitosan | 83.55 | 6.00 | 2.10 | 861.89 | 6.20 |
| Mean | | 77.94 | 5.42 | 1.79 | 813.80 | 5.97 |
| Averages | Control | 63.66 | 4.33 | 1.35 | 672.17 | 4.72 |
| | Yeast | 83.67 | 5.33 | 1.82 | 854.17 | 6.37 |
| | Boric acid | 73.14 | 4.67 | 1.47 | 741.50 | 5.35 |
| | Chitosan | 79.31 | 5.50 | 1.89 | 820.94 | 5.76 |
| L.S.D at 5 % level | Bulb size | 2.60 | N.S. | 0.03 | 11.23 | 0.35 |
| | Substances | 2.01 | 0.50 | 0.09 | 24.07 | 0.22 |
| | Interaction | 2.85 | N.S. | 0.13 | N.S. | N.S. |

**Table 4**: Effect of bulb sizes and some growth promoter substances on yield of onion seeds, weight of 1000 seeds, seed germination percentage and germination rate index during 2008/2009 and 2009/2010 seasons .

| Treatments | | First season | | | | | |
|---|---|---|---|---|---|---|---|
| | | Average weight | | | | Germination | |
| | | Umbel (g) | Plant (g) | Fed. ( kg.) | 1000 Seed (g) | % | rate index |
| Medium 4–6 (cm) | Control | 2.40 | 12.01 | 227.41 | 3.01 | 83.33 | 2.91 |
| | Yeast | 3.16 | 16.00 | 317.66 | 3.42 | 88.33 | 2.60 |
| | Boric acid | 3.14 | 13.93 | 278.53 | 3.07 | 87.33 | 2.86 |
| | Chitosan | 3.13 | 15.37 | 300.89 | 3.37 | 90.00 | 2.36 |
| Mean | | 2.96 | 14.33 | 281.21 | 3.22 | 87.25 | 2.69 |
| Large 6-8 (cm) | Control | 2.89 | 14.94 | 277.09 | 3.09 | 84.67 | 2.86 |
| | Yeast | 4.11 | 24.60 | 415.47 | 3.62 | 90.67 | 2.49 |
| | Boric acid | 3.55 | 19.03 | 330.39 | 3.28 | 88.33 | 2.85 |
| | Chitosan | 3.70 | 22.27 | 388.57 | 3.60 | 92.00 | 2.54 |
| Mean | | 3.56 | 20.21 | 352.88 | 3.40 | 88.92 | 2.69 |
| Averages | Control | 2.64 | 13.48 | 252.25 | 3.05 | 84.00 | 2.89 |
| | Yeast | 3.63 | 20.30 | 366.56 | 3.52 | 89.50 | 2.55 |
| | Boric acid | 3.35 | 16.48 | 304.46 | 3.18 | 87.83 | 2.86 |
| | Chitosan | 3.41 | 18.82 | 344.73 | 3.48 | 91.00 | 2.45 |
| L.S.D at 5% level | Bulb size | 0.06 | 0.56 | 21.20 | 0.07 | N.S. | N.S. |
| | Substances | 0.37 | 0.79 | 26.47 | 0.14 | 3.92 | 0.28 |
| | Interaction | N.S. | 1.12 | N.S. | N.S. | N.S. | N.S. |
| | | **Second season** | | | | | |
| Medium 4–6 (cm) | Control | 2.48 | 11.77 | 224.28 | 2.92 | 83.33 | 4.00 |
| | Yeast | 3.21 | 16.22 | 325.48 | 3.33 | 85.67 | 4.08 |
| | Boric acid | 3.24 | 14.43 | 273.65 | 3.20 | 84.00 | 3.93 |
| | Chitosan | 3.10 | 15.20 | 306.26 | 3.22 | 87.33 | 4.00 |
| Mean | | 3.01 | 14.41 | 282.42 | 3.17 | 85.08 | 4.00 |
| Large 6-8 (cm) | Control | 2.99 | 14.37 | 272.53 | 3.03 | 82.33 | 3.98 |
| | Yeast | 4.05 | 22.45 | 432.23 | 3.48 | 86.00 | 4.05 |
| | Boric acid | 3.41 | 18.24 | 337.02 | 3.30 | 83.33 | 4.08 |
| | Chitosan | 3.62 | 20.08 | 397.60 | 3.47 | 88.00 | 3.95 |
| Mean | | 3.52 | 18.79 | 359.85 | 3.32 | 84.92 | 4.02 |
| Averages | Control | 2.74 | 13.07 | 248.41 | 2.98 | 82.83 | 3.99 |
| | Yeast | 3.63 | 19.34 | 378.86 | 3.41 | 85.83 | 4.07 |
| | Boric acid | 3.32 | 16.34 | 305.34 | 3.25 | 83.67 | 4.01 |
| | Chitosan | 3.36 | 17.64 | 351.93 | 3.34 | 87.67 | 3.98 |
| L.S.D at 5% level | Bulb size | 0.28 | 1.82 | 36.49 | N.S. | N.S. | N.S. |
| | Substances | 0.24 | 1.08 | 23.15 | 0.15 | 2.94 | N.S. |
| | Interaction | N.S. | 1.53 | N.S. | N.S. | N.S. | N.S. |

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