

Response of Onion Crop to Foliar Application by Amino Acids, Yeast extract and Boron in Upper Egypt



Abdel-Rahim, G.H.¹; A.A. Gamie²; M.S.S. Al-Bassuny¹ and M.A.A. Abd Allah¹

¹Vegetable Sciences, Azhar University, (Assiut Branch).

²Vegetable Sciences, Shandweel Agric. Res. Station ARC.

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Abstract

Two field experiments were investigated in two successive seasons of 2016/2017 and 2017/2018 in sand loam soil of private farm in El-Usayrat village El-Monshaa City, Sohag Governorate, Egypt, to study the response of onion plants (cultivar Giza 6 mohassan) to foliar application of amino acids (1gm/l) from a compound contains 23.68% Free amino acids), yeast extract (5gm yeast/l) and boron (5 cm/l) from compound contains 15% boron). Results showed that onion plant significantly affected by foliar application of bio-fertilizers (amino acid & yeast) and boron. Foliar application of yeast extract + boron gave the maximum vegetative growth of onion plant including plant height and neck diameter. While, bulb yields was affected by foliar application of amino acid + boron. Results concluded that foliar application by amino acid + boron (T5) increased total yield by (52.24% & 50.15%), marketable yield by (65.13% & 63.54) and yield quality compared to control treatment in both seasons. Foliar application of (T5) tended to reduce culls yield, double bulbs (%) and bolting bulbs (%) in comparison to the control (T1) in the 1st and 2nd seasons, respectively. Storage period indicated that the minimum values of weight losses of onion (%) were obtained from application of boron (T4) after 60, 120 and 180 days from storing in both seasons. Nutrient concentration in onion bulbs reveal that (N, P and K concentration) strongly responded to the foliar application of T5, while, boron concentration of onion bulbs responded to foliar application of boron (T4).

Keywords: onion, amino acids, boron, vegetative growth, nutrient concentration.

1. Introduction

Onion (*Allium cepa*, L.) is biennial crop. Onion is considered one of the principal field crops grown in Egypt. Moreover, beside its importance for local consumption, it has great potentiality as export commodity to some European and Arabic markets. Egypt is the seventh largest onion producer on a global level and onions are the third most important product in the country after oranges and potatoes. According to the latest Agricultural Export Council data (2017). Egypt produced 1.75 million

tons of the red (1.6 million) and golden (580 thousand) varieties. 476 thousand tons were exported abroad, mainly to the EU, Arab countries, Asian countries and Russia. As for 2018, Egypt is expecting to produce 2 million tons with the objective of exporting 600 thousand tons of them after the new agreements stipulated by the government with China, Australia and South Africa. There is no doubt that mineral fertilizers are essential in most cropping systems if maximum yields are to be realized. Therefore, utilization of bio and mi-

cro-nutrients in crops in order to sustain agricultural production and support soil fertility and healthy plant growth. In this context, the use of active natural compounds (amino acid & yeast extract) has been receiving increasing attention. According to Sarojnee *et al.* (2009) amino acids can improve fertilizer assimilation, increase uptake of nutrients and water, enhance the photosynthetic rate and dry matter partitioning, and hence increase yield and quality. Tugnoli and Bettini (2003) concluded that use of amino acids as foliar spraying makes it overcome the nutritional and environmental deficiencies that arise during the crop growth. Many authors reported that, the foliar application of amino acids can enhance plant growth, fruit yield and improve its quality in cucumber (Kandil *et al.*, 2013). Yeast as a natural source of cytokinins-stimulates cell division and enlargement as well as the synthesis and enlargement as well as the synthesis of protein, nucleic acid and chlorophyll (Fathy and Farid, 1996). Hence, the objective of this investigation was to study the response of onion plants of variety Giza 6 mohassan to foliar application of amino acids, yeast extract and boron.

2. Material and Methods

Two field experiments were carried out at the private farm in El-USayrat village El-Monshaa City, Sohag Governorate, Egypt, to study the response of onion plants to foliar application of amino acids, yeast extract and boron during two successive seasons of 2016/2017 and 2017/2018. Where the soil was clay loam. Seeds of onion cvs. Giza 6 mohassan was planted in the nursery at the 15th Sep-

tember 2016 and 2017 seasons, respectively. All agricultural processing for seedling production were followed as conventional method. Seedling was transplanted in the field after 45 days. The experimental plots were randomly assigned in a randomized complete block design with three replicates.

Treatments of foliar application were arranged as following:

- T1. Control (water)
- T2. Spraying amino acid
- T3. Spraying yeast extract
- T4. Control + boron (T1 + B)
- T5. Spraying amino acid + boron (T2 + B)
- T6. Spraying yeast extract + boron (T3 + B)

Seedlings of the cultivar Giza 6 mohassan were transplanted at the first day of November in the 1st and the 2nd seasons. Plot area was 10.5 m² (1/400 fed₅). Mineral fertilizations were applied as recommended (90 Kg nitrogen, 45 Kg phosphorous and 36 Kg potassium). Phosphorous fertilizer was applied in the form of super phosphate (15% P₂O₅) during soil preparation. Nitrogen was applied in the form of ammonium nitrate (33.5%N) after one, two month from planting. Potassium fertilizer was added in the form of potassium sulphate (48% K₂O) after 2 month from cultivation. Foliar application treatments (amino-acid & yeast extract) and boron was sprayed after 45, 60 and 75 days from planting in each season. Amino acid compound containing 23.68% free amino acids was sprayed at a rate of (1gm/l.). Yeast was extracted and sprayed at a rate of (5 gm/l.). Boron compound contain-

ing 15% boron was sprayed at a rate of (5 cm/l.)

The experiments site was prepared using the conventional method. Soil samples were collected in both seasons from a depth of 60 cm prior to land preparation, dried for analysis. Analysis was carried out according Jackson (1973). Some physical and chemical properties of the experimental soil are shown in Table (1). Normal cultural practiced of growing onion including fertilization and irrigation was followed as recommended.

After harvestings, one hundred bulbs of randomly onion taken after curing as a representative sample from each plot and stored under room condition in both seasons during storage period in order to calculate the percentage of total weight losses at 60, 120 and 180 days according to the following equation of Wills *et al.* (1982):

$$\text{Weight loss \%} = \frac{\text{Initial weight} - \text{weight after storage}}{\text{initial weigh}} \times 100$$

Table 1. Some physical and chemical properties of the experimental soil.

Soil Analysis	Season 2016/17	Season 2017/18
Soil texture	Clay loam	Clay loam
EC 1:5 (dS m ⁻¹)	0.292	0.354
pH 1:5	8.12	8.22
Organic matter (%)	0.87	1.07
CaCO ₃ (%)	3.46	4.25
Total N (%)	0.141	0.146
Available P ppm	15.00	17.00
Exchangeable K m. eq/100 g soil	0.22	0.35

Data recorded:

A. Vegetative growth: ten plants from each plot were chosen randomly after 120 days from transplanting for measuring the following characters: Plant height (cm), Neck diameter (cm) and Bulb yield (cm).

B. yield components: including total yield, marketable yield and culls yield.

C. Bulb quality: including weight and diameter of bulbs.

Total soluble solids (T.S.S) were assayed according to A.O.A.C (1995).

D. Nutrient analysis: Bulb samples from every plot were chemically analyzed for N, P, K and B contents following standard methods (Chapman and Pratt, 1964).

The obtained data were subjected to the analysis of variance procedure and mean were compared using the L.S.D. method at 5 % level of significance according to Gomez and Gomez (1984).

3. Results and Discussion

Significant effect of foliar application treatments was observed on vegetative growth in the 1st and 2nd seasons. This study indicates that foliar application treatments are required for achieving higher bulb yield of onion. The results are discussed under five crop headings:

1. Effects of foliar application treatments on vegetative growth (cm) of onion cultivar Giza 6 Mo-hassan:

1.1 Plant height: Plant height was measured at 90 days after transplanting. There was a significant effect of treatments on the plant height of onion plant (Table 2). All treatments significantly increased plant height compared to the control (T1) in both seasons. The maximum plant height was obtained from application of yeast extract + Boron (T6). The increase percentage in plant height due to foliar application of T6 was (75.0% and 76.46%) compared to the control (T1) in the 1st and 2nd seasons. Similar results were obtained by Ahmed *et al.*, (2011) who found that increasing of foliar application of active dry yeast concentration up to 5 g/l increased the vegetative growth characters of potato plants.

The positive effects of applying active dry yeast was attributed to its own contents of different nutrients, high percentage of protein, large amounts of vitamin B and natural plant growth regulators such as cytokinins (Glick, 1995; Fathy and Farid, 1996) or might be attributed to the role of sugar which needed to produce energy, promote growth, consequently affected plant growth (Filip Rolland *et al.*, 2006).

1.2 Neck diameter: The highest bulb diameter (2.57 and 2.127 cm) was observed in the T6 treatment (Yeast extract + Boron) and gave the maximum neck diameter compared to all other treatments (Table 2). The lowest neck diameter (1.323 and 1.353 cm) was recorded in the T1 treatment (control) and statistically

similar result was observed by the T3 (yeast) treatment. This result indicates a greater effect of B supplement over yeast extract which in turn influenced the neck diameter. Many authors reported that, the foliar application of yeast can enhance plant growth, fruit yield and improve its quality in cucumber. Yeast as a natural source of cytokinins-stimulates cell division and enlargement as well as the synthesis of protein, nucleic acid and chlorophyll (Fathy and Farid, 1996).

1.3 Bulb diameter: Bulb diameter varied from minimum values (2.233 and 2.257 cm) recorded in foliar application with water (control) to maximum values (3.380 and 3.443 cm) recorded in foliar application of amino acid + boron (T5) in the 1st and 2nd seasons, respectively (Table 2). All the treatments (T2-T6) showed significantly higher bulb diameter over the control (T1). The highest bulb diameter obtained from foliar application of amino acid + boron (T5) was 51.56% and 52.54% higher over control in the 1st and 2nd seasons, respectively (Fig.1). The results of the foliar application of amino acid + boron (T5) effect are carefully looked in to; it appears that the effect of B application was dominant over that of amino acid. Many studies have proved that, amino acids can directly or indirectly influenced the physiological activities of the plants (El-Shabase *et al.*, 2005, Awad *et al.*, 2007; Al-Said and Kamal, 2008 and Faten *et al.*, 2010).

Table 2. Effect of foliar application on vegetative growth of onion cultivar Giza 6 Mohassan after 90 days from Transplanting

Treatments	Vegetative growth (cm)					
	Plant height		Neck diameter		Bulb diameter	
	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season
T1 (Control)	53.85	55.25	1.323	1.353	2.233	2.257
T2 (Amino Acid)	61.43	63.10	1.533	1.560	2.853	2.887
T3 (Yeast)	76.10	78.02	1.770	1.820	2.317	2.457
T4 (Boron)	62.37	65.35	1.490	1.510	2.523	2.547
T5 (Amino acid + Boron)	73.32	75.40	1.730	1.813	3.380	3.443
T6 (Yeast + Boron)	94.24	97.50	2.057	2.127	2.850	2.937
L.S.D. 0.05=	2.58	2.34	0.12	0.14	0.16	0.13

2. Effects of foliar application treatments on yield components of onion cultivar Giza 6 Mohassan:

Results of (Table 3 and Fig. 1) demonstrated the effect of foliar treatment on yield components.

2.1 Total yield (ton/fed.): All the treatments showed significantly higher bulb yield in comparison with the control (T1). Total yield (ton/fed.) varied from (15.35 and 16.01) recorded in foliar application of water (T1) (control) to (23.37 and 24.04) recorded in foliar application of Amino acid + Boron (T5) in the 1st and 2nd seasons, respectively (Table 3). The highest total yield was obtained from (T5) treatment (52.24% and 50.15%) higher than control (Fig.1).

2.2 Marketable yield (ton/fed.): The weight of marketable yield (ton/fed.) determined after harvest was significantly affected by the different treatments. The highest marketable yield (ton/fed.) (23.07 and 23.55 ton/fed.) was recorded from foliar treatment (T5). While, the lowest marketable yield (ton/fed.) (13.97 and 14.40) was recorded from (T1) treatment in the 1st and 2nd seasons, respectively. The increase percentage represented (65.13% and 63.54%)

compared to the control in the 1st and 2nd seasons, respectively.

2.3 Culls yield (ton/fed.): Culls yield (ton/fed.) was significantly affected by the different treatments. Foliar application of amino acid + Boron (T5) gave the most significant reduction in culls yield (ton/fed.) compared to the control (T1) and in comparison with all treatment under the study in the 1st and 2nd seasons, respectively. On the contrary, the maximum increase in Culls yield (ton/fed.) was obtained from foliar application with yeast extract (T3).

The positive results due to amino acid + Boron (T5) could attributed to the overall improvement in plant growth parameters and yield due to application of amino acids which may be due to providing readily source of growing substances which form the constitutes of protein in the living tissues. Generally, Amino acids were found to increase number of flowers, fruit setting and fruit yield (Neeraja *et al.*, 2005). Results could be concluded that treating onion plants with foliar application of Amino acid + Boron (T5) gave the maximum total and marketable yield (ton/fed.) and had beneficial effects on reducing the culls yield (ton/fed.).

The beneficial effects of amino acid + boron (T5) on yield components of onion may be due to boron spraying which is fundamental for the growth and development, acting as constituents of cell walls (B) and membranes

(B and Zn), as constituents of enzymes (Fe, Mn, Cu and Ni), of activation of enzymes (Mn and Zn) and in photosynthesis (Fe, Cu, Mn and Cl) (Kirkby and Römheld 2004; and Sharma 2006).

Table 3. Effect of foliar application on yield components of onion cultivar Giza 6 Mohassan

Treatments	Yield components					
	Total yield (ton/fed.)		Marketable yield (ton/fed.)		Culls yield (ton/fed.)	
	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season
T1 (Control)	15.35	16.01	13.97	14.40	1.373	1.613
T2 (Amino acid)	18.23	19.02	17.58	17.67	0.993	1.350
T3 (Yeast)	16.46	17.14	13.44	13.98	3.017	3.163
T4 (Boron)	17.44	18.12	16.51	17.02	0.933	1.107
T5 (Amino acid +Boron)	23.37	24.04	23.07	23.55	0.297	0.497
T6 (Yeast + Boron)	18.59	19.27	16.80	17.23	1.787	2.037
L.S.D. 0.05=	0.87	0.82	0.76	0.70	0.04	0.03

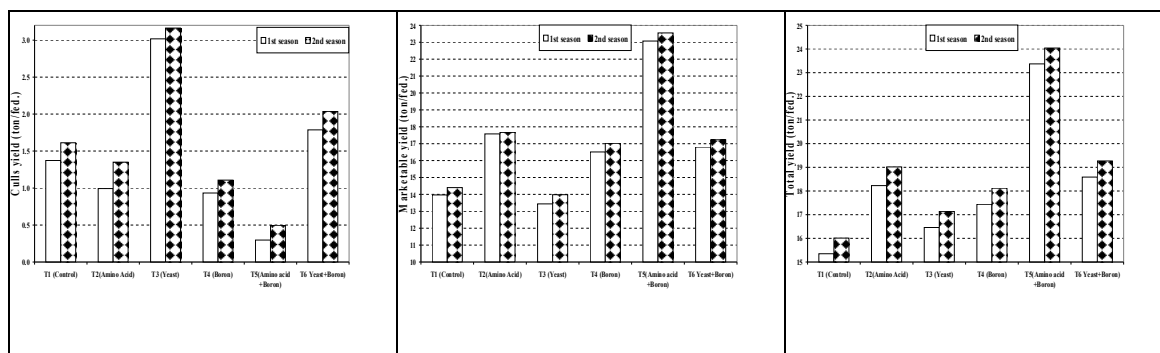


Fig. (1). Effect of foliar treatments on onion yield components of onion cultivar Giza 6 Mohassan

3. Effects of foliar application treatments on Bulb quality of onion cultivar Giza 6 Mohassan:

Data presented in Table (4) showed that all bulb quality significantly affected by foliar treatments. Foliar application of (amino acid + boron, T5) increased percentage of dry matter in bulbs (DM % and total soluble solids (TSS) by (274.34% and 298.38%) and (37.89% and 37.93%) compared to control treatment (T1) in the 1st and 2nd seasons, respectively. Foliar treatment of (T5) tended to re-

duce double bulbs, (%) and bolting bulbs (%) by 51.73% and 51.80% and 90.43% and 72.26% compared to the control (T1) in the 1st and 2nd seasons, respectively. Similar results was obtained by Tantawy, (2007) and El-Abagy *et al.*, (2014) who found that mixture of amino acids proved to be effective in improving plant growth under abiotic stress hence it is expected to improve plant growth and production under normal environmental conditions.

Table 4. Effects of foliar application treatments on Bulb quality of onion cultivar Giza 6 Mohassan

Treatments	Bulb quality							
	Double bulbs (%)		Dry matter (DM (%))		Total soluble solids (TSS)		Bolting bulbs (%)	
	seasons							
	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd
T1 (Control)	4.627	4.807	11.50	11.89	11.613	12.117	1.390	1.453
T2 (Amino acid)	2.500	2.767	25.40	25.96	14.550	14.907	0.543	0.650
T3 (Yeast)	4.840	5.170	15.84	16.10	12.340	12.933	1.497	1.640
T4 (Boron)	3.123	3.250	21.70	22.25	12.157	13.287	0.780	0.790
T5 (Amino acid + Boron)	2.233	2.317	43.05	43.92	16.010	16.713	0.133	0.403
T6 (Yeast + Boron)	3.213	3.433	26.78	27.30	13.583	14.247	0.867	0.927
L.S.D. 0.05	0.06	0.08	2.13	2.65	0.26	0.28	0.012	0.016

4. Effects of foliar application treatments on nutrient concentration of onion cultivar Giza 6 Mohassan after 60, 120 and 180 days from storing:

Effects of foliar treatments revealed varied response of the nutrient concentration to foliar treatments (Table 5). The maximum nutrient concentration under the study was obtained from foliar application of (amino acid + boron, T5) in both seasons. N, P and K concentration strongly responded to the foliar application of (T5), while, boron concentration of onion bulbs responded to foliar application of boron (T4) followed by (T5). It's known that the critical level of boron in crops ranges from 5 to 10 $\mu\text{g g}^{-1}$ for monocots and 20 to 70 $\mu\text{g g}^{-1}$ for dicots (Mortvedt, 1991). Tariq and Mott (2007) concluded the critical boron deficiency and toxicity levels that for most cru-

ciferous and root crops the concentration of boron in plants <15 $\mu\text{g g}^{-1}$ to be deficient, 25-100 $\mu\text{g g}^{-1}$ adequate and >200 $\mu\text{g g}^{-1}$ toxic for growth and production. It is clear that both boron deficiency and toxicity will result in reduction of crop yield and quality

This superiority of (T5) might be due to beneficial effects of foliar application of amino acid which enhance plant growth, fruit yield and improve its quality in cucumber (Kandil *et al.*, 2013). Boron play great role in carbohydrate metabolism and transport of sugars (Katyal and Randhawa, 1983), phenol and auxin metabolism (Mengel and Kirkby, 1982), water relations (Sharma and Ramchandra (1990), tissue development, differentiation and formation of cell walls (Katyal and Randhawa, 1983), and reproduction and germination of pollen and disease resistance (Bergmann, 1984).

Table 5. Effect of foliar application on N, P and K and B concentration in onion bulb of cultivar Giza 6 Mohassan

Treatments	Onion bulb concentration							
	N %		P %		K %		B ppm	
	Seasons							
	1 st	2 nd	1 st	2 nd	1 st	2 nd	1 st	2 nd
T1 (Control)	1.660	1.680	0.150	0.151	1.833	2.072	18.613	18.873
T2 (Amino acid)	1.710	1.730	0.167	0.168	1.970	2.226	19.573	19.860
T3 (Yeast)	1.770	1.790	0.197	0.198	2.047	2.313	19.817	20.110
T4 (Boron)	1.600	1.620	0.187	0.188	2.163	2.445	20.067	20.370
T5 (Amino acid +Boron)	1.810	1.830	0.203	0.205	2.083	2.354	19.797	20.090
T6 (Yeast + Boron)	1.800	1.810	0.193	0.195	1.923	2.173	19.343	19.623
L.S.D. 0.05=	0.26	0.21	0.04	0.03	0.13	0.18	0.32	0.24

5. Effects of foliar application treatments on total weight loss (%) of onion bulb of Giza 6 Mohassan after 60, 120 and 180 days from storing:

The percentage of weight loss was steadily increased until 180 days of storage (Fig. 1). Data in Table (6) show that weight losses of onion (%) significantly affected by all treatments under the study. Foliar application of yeast extract (T3) gave the maximum weight losses of onion (%) in both seasons. Boron treatment (T4) had the most pronounced effect on bulb weight loss during storage, compared to the control and other treatments. All other treatments showed higher percentage of weight loss com-

pared to the control during all storage times. Concerning shrinking percentage, it was noticed that plants sprayed with either boron (T4) or amino acid (T2) had better storability of bulbs than other treatments and the control. These results may be due to the effect of boron and amino acid on growth parameters which may reflect on enhancing the quality and storability of onion bulbs. In this regard, Bardisi (2004) found that high quality of garlic bulbs was obtained during 300 days of storage when plants were sprayed with bio-stimulants (ascorbic acid.). Ahmed *et al.* (2010) stated that plants sprayed with humic acid had better storability than untreated ones.

Table 6. Effect of foliar application treatments on total weight loss (%) of Giza 6 Mohassan onion bulb during storage period.

Treatments	Days after storage time					
	60		120		180	
	Seasons					
	1 st	2 nd	1 st	2 nd	1 st	2 nd
T1 (Control)	0.327	0.190	0.567	0.433	0.603	0.490
T2 (Amino acid)	0.380	0.280	0.597	0.483	0.640	0.563
T3 (Yeast)	0.467	0.303	0.643	0.520	0.707	0.640
T4 (Boron)	0.270	0.150	0.503	0.403	0.510	0.447
T5 (Amino acid + Boron)	0.330	0.203	0.540	0.440	0.583	0.523
T6 (Yeast + Boron)	0.407	0.253	0.573	0.477	0.630	0.570
L.S.D. 0.05=	0.04	0.03	0.02	0.03	0.04	0.03

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استجابة محصول البصل للرش الورقي بالأحماض الأمينية ومستخلص الخميرة والبورون في صعيد مصر

جمال حسين عبد الرحيم^١، عبد المنعم عباس جامع^٢، محمد سليمان سليمان البسيوني^١
ومحمد عبد الله عزب عبد الله^١

^١كلية الزراعة قسم البساتين (الخضر) جامعه الازهر بأسسيوط
^٢مركز البحوث الزراعية قسم بحوث البصل

المخلص

اجريت دراسته حقلية شملت تجربتين حقليتين في موسمين متتاليين في عامي ٢٠١٧/٢٠١٦ و ٢٠١٨/٢٠١٧ في تربة طينية طمييه بمزرعة خاصة في قرية العسيرات بمدينة المنشأة ، محافظة سوهاج ، مصر ، لدراسة استجابة نباتات البصل (*Allium cepa* L.) صنف جيزة ٦ محسن للرش الورقي بالأحماض الأمينية (١ جم / لتر من مركب يحتوي على ٢٣,٦٨ % من الأحماض الأمينية الحرة) ، مستخلص الخميرة (٥ جم الخميرة / لتر) والبورون (٥ سم / لتر) من مركب يحتوي على ١٥ % بورون.

أظهرت النتائج أن نبات البصل تأثر بشكل كبير بالرش الورقي للأسمدة الحيوية (الأحماض الأمينية والخميرة) والبورون. أعطى الرش الورقي من مستخلص الخميرة + البورون أقصى نمو خضري لنباتات البصل بما في ذلك ارتفاع النبات وقطر الرقبة. في حين تأثر محصول البصل بالرش الورقي للأحماض الأمينية + البورون.

خلصت النتائج إلى أن الرش الورقي بالأحماض الأمينية + البورون (T5) قد أدى إلى زيادة الإنتاج الكلي بنسبة (٥٢,٢٤% و ٥٠,١٥%) والمحصول القابل للتسويق بنسبة (٦٥,١٣% و ٦٣,٥٤) مقارنة بمعاملة الكنترول في كلا الموسمين. كذلك يميل الرش الورقي (T5) في نفس الوقت إلى تقليل محصول النقضه، والبصل المزدوج ، (%،) والبصل الحنبوط (%). بالمقارنة مع الكنترول (T1) في الموسم الأول والثاني على التوالي. أشارت فترة التخزين إلى أن أقل القيم في الفقد في وزن البصل (%). قد تم الحصول عليها بسبب الرش الورقي للبورون (T4) بعد ٦٠ و ١٢٠ و ١٨٠ يوماً من التخزين في كلا الموسمين. اوضحت النتائج ان تركيز المغذيات في البصل (النيتروجين ، الفوسفور والبوتاسيوم قد زاد بالرش الورقي للمعامله T5 ، في حين أن تركيز البورون في البصل استجاب للرش الورقي للبورون(T4).