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EFFECT OF NITROGEN FERTILIZATION AND BIOSTIMULATIVE COMPOUNDS ON ONION PRODUCTIVITY

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ABSTRACT. Two field experiments were carried out to investigate the optimum nitrogen rate (80, 100 and 120 kg N fed.$^{-1}$; Fed = 0.38 ha) and stimulative compounds, *i.e.* foliar spraying with water, as control, *Azotobacter* spp. and *Azospirillum* spp., yeast, compost tea and humic acid on vegetative growth, yield, quality, as well as storability of bulb yield of onion (*Allium cepa* L.) under North Delta conditions. The results showed that the vegetative growth was positive influenced, also yield its components, quality and storability of onion were related to the medium rate of nitrogen (100 kg N fed.$^{-1}$). Furthermore, foliar spraying with humic acid at the rate of 1 kg fed.$^{-1}$ led to a significant increment in the most of vegetative growth characteristics, as well as total bulb yield and its components, bulb quality and storability of onion. Both of 100 kg N fed.$^{-1}$ and spraying humic acid at the rate of 1 kg fed.$^{-1}$ significantly increased most vegetative growth characteristics, total and marketable bulbs yield fed.$^{-1}$, bulb quality and storability of onion. So, this study concluded that onion farmers at North Delta of Egypt should fertilize onions with nitrogen at the rate of 100 kg N fed.$^{-1}$ with spraying humic acid at the rate of 1 kg fed.$^{-1}$ to achieve the highest economic yield.

Keywords: yield; bulb quality; yeast; compost tea; humic acid.

INTRODUCTION

Onion (*Allium cepa* L.) in Egypt represent export commodity besides its use as food and medical product. Egypt occupies the fifth place among the ten countries in the world in terms of area onions, ranked ninth, in terms of productivity. Egypt's production of onions reached in season 2013, approximately 2 million tons. Cultivated onions area in Egypt is about 8% of the total cultivated area in the world (Annual Report of the

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Mineral fertilizers are one of the main factors that materially set up onion growth and production. Onion plants take up large amounts of three primary nutrients, *i.e.* nitrogen, phosphorus and potassium (Hafez & Kobata, 2012; Gharib *et al.,* 2016). They are essential nutrients for plant growth and yield. However, in long term field experiments, where mineral fertilizers have only been used, some problem could arise, especially environmental pollution and public health risk (Topp *et al.,* 2002; Akhter *et al*., 2017).

Many investigators reported that improving the onion yield and storability to such pure soil conditions could be achieved by application of different natural and chemical substance, to enhance its growth and maximizing the yield. It was found that humic substances (humic and fulvic acids) are the major components of soil organic matter. Humic acid is one of the most important components of bioliquid complex. Humic acid is not a fertilizer, but it considered as a compliment to fertilizer (Mackowiak *et al*., 2001; Hafez *et al*., 2014). Humic acid, essentially, helps the movement of micronutrients from soil to plant. Stumpe *et al*. (2000) stated that the positive effect of humic acid on the yield capacity of soil consists of many components. Moreover, some researchers showed that the foliar spraying of humic acid enhanced nutrient uptake, plant growth, yield and quality in a number of plant species (Yildirim, 2007; Karakurt *et al.,* 2009; El-Nemr *et al.,* 2012) at least, partially, through increasing nutrient uptake, serving as a source of mineral plant nutrients and regulator of their release (Atiyeh *et al.,* 2002; Hafez & Abdelaal, 2015). Likewise, humic substances have been shown to stimulate shoot and root growth and nutrient uptake of vegetable crops (Akinremi *et al.,* 2000; Cimrin & Yilmaz, 2005). Direct effects are those, the uptake of humic substances into the plant tissue resulting in various biochemical effects through elevate nutrient uptake and maintaining vitamins and amino acids rate in plant tissues.

The use of microbe-enriched compost tea for nutrient mobilization is becoming popular, and new systems are being developed to meet the requirements of different crops and cropping systems. Several studies have reported the benefits from the use of compost and compost tea as organic substrate additives in plant cultivation and in the suppression of soil-borne diseases. It has been reported that compost tea, obtained from agro-wastes, was able to enhance the growth and yield of okra, when sprayed weekly at full strength (Siddiqui *et al*., 2008 and 2009).

Therefore, this study has been carried out to evaluate the response of onion plants to different rates of nitrogen fertilization, in order to reduce the recommended mineral nitrogen doses. In addition, the study aimed to evaluate the use of biostimulants (*Azotobacter* spp. and *Azospirillum* spp. inoculation, yeast, compost tea and humic acid) on growth, yield and keeping quality of onion bulbs cv. Behary Red, under the conditions of Kafr El-Sheikh Governorate.

MATERIALS AND METHODS

The present study was carried out at Nashert village, Qallin, Kafr Elsheikh Governorate, Egypt, during two successive growing seasons of 2014/15 and 2015/16 to study the effect of nitrogen fertilization and bio-stimulators on growth, yield and yield components of onion cv. Behary Red.

Nursery land area was well prepared, through two perpendicular ploughs, well leveling and ridging (80 cm width) and dividing into units. Calcium superphosphate (15.5 % P_2O_5) at the rate of 30 kg P_2O_5 fed^{-1} and potassium sulphate (48% K_2O) at the rate of 24 kg K_2O $fed.^{-1}$ was soil incorporated during tillage operation. The nitrogen fertilizer as ammonium nitrate (33.5% N) was side dressed into two portions, half being applied before the second irrigation, while the remaining portion was applied before third irrigation. Seedlings of nearly 60 days old, when they usually were 25 cm in height, were pulled tied and moved to the permanent land for transplanting. Seedlings were transplanted at two sides of every ridge. Before, top portion of the plants was pruned to a considerable extent to reduce transpiration.

The preceding crop was cotton in the two seasons. Every experiment included 15 treatments, which were the combinations between three nitrogen rates as ammonium nitrate (80, 100 and 120 kg N $fed.^{-1}$) were added into two portions, half being applied after 30 days after transplanting (DAT), while the remaining portion was applied after 60 DAT and five biostimulators treatments (foliar spraying with water, inoculated with *Azotobacter chroococcum* spp. and *Azospirillum* spp., foliar spraying with active dry yeast at rates of 6 g L^{-1}, foliar spraying with compost tea at the rate of 20 L $fed.^{-1}$ and foliar spraying with humic acid at the rate of 1 kg $fed.^{-1}$) at 40, 60 and 80 DAT.

A split-plot design with four replications was used in all experiments. Nitrogen rates were arranged in the main plots, while biostimulators treatments were designed in the sub plots. The area of each subplot was 8.4 m^2, four ridges (3.5 m long and 2.4 m wide). Chemical and physical analysis of soil samples are given in *Table 1*. Other cultural practices were carried out in the same manner prevailing in the region.

With regarding to the chemical analysis of the dry yeast (*Saccharomyces cerevisiae*), Khedr & Farid (2002) reported that yeast preparation contained carbohydrates, sugars, proteins, fatty acids, amino acids, hormones, macro and micro elements in suitable balance. Such technique for yeast preparation was modified after Spencer *et al.* (1983). The bacterial strain (*Azotobacter* spp. and *Azospirillum* spp.), which containing active bionitrogen fixation bacteria, was obtained from Bacterilization Unite, Microbiology Dept., Soils and Water Res. Inst., ARC, Giza. Seedlings of onion were dug and inoculation by soaking their roots in the specific aqueous solution of the biofertilizer for 30 minutes, just before transplanting. Compost tea extract was prepared by soaking each 25 kg from Nile compost (produced by the Egyptian Ecaru Company) in 250 L water for 48 hrs, then was squeezed, collected and used as compost tea, according to the method described by Nasef *et al.* (2009). *Table 2* shows the chemical properties of Nile compost tea.

Table 1 - Physical and chemical analysis of the experimental field in 2014/15 and 2015/16 seasons

Determination	Season	
	2014/15	2015/16
Physical analysis		
Sand (%)	13.74	15.53
Silt (%)	24.91	23.95
Clay (%)	61.35	60.52
Texture	Clay	Clay
Chemical analysis		
Available N (ppm)	37	41
Available P (ppm)	6.9	7.4
Available K(ppm)	231.2	269.7
PH	7.9	8.2
EC (m-mhos/cm)	2.17	1.04
$CaC0_3$ (%)	3.7	2.9
Organic matter (%)	1.9	2.3

Table 2 - The chemical composition of Nile compost tea

Chemical composition	Nile compost tea
Density	-
Moisture	-
EC ds/m (1:10)	0.8 %
Organic matter	-
Total nitrogen	195 ppm
Available phosphorus	13.5 ppm
Available potassium	175 ppm
Mg	113 ppm
Fe	61 ppm
Zn	5.31 ppm
Ca	66 ppm

Studied characters: growth and growth attributes, yield and its components, bulb quality and storability

Growth and growth attributes

For recording the observations on all growth attributes, ten plants were selected at random from every plot of each experiment. Sampling started approximately after 125 days after transplanting (DAT). Plants were carried out to the laboratory, in polyethylene bags, and then the following data were recorded; plant height (cm), number of leaves/plant, bulb diameter (cm), plant fresh, dry weight (g) and bulbing ratio.

Yield and its components

These records were taken on the three inner rows in each plot. The experiments were harvested when 50% of tops were down. After harvested bulbs were left in the field to cure for three weeks, then tops and roots were removed. Also, the plants of each subplot were harvested and the following characters were estimated: average weight of bulb (g), marketable bulbs yield (t fed.$^{-1}$), culls bulb yield (t fed.$^{-1}$) and total bulbs yield (t fed.$^{-1}$).

Bulb quality

Bulb diameter (cm), total soluble solids (T.S.S.) and percentage of dry matter in bulbs (D.M., %) were observed. D.M. was determined by estimating the loss of weight of fresh bulb sample after drying for 4 hours at 105^{0}C and then at 70^{0}C in a drying oven with ventilator until it reaches constant weight. The fresh sample was taken from fresh fine slices from each bulb and after proper mixing the sample was weighted (Nieuwhof *et al.,* 1973) and calculated according to the formula:

$$\text{D.M.,\%} = \frac{\text{Sample dry weight}}{\text{Sample fresh weight}} \times 100$$

Storability

Marketable yield of each plot were placed in common burlap bags and kept under normal storage conditions. Storability was measured as percentage of total loss in weight and remainder percentage of onion bulbs after harvesting till end of storability (six months). Total loss percentage was determined by examining the yield every month, then rotting and sprouting bulbs were discarded and the remaining yield was weighted.

Statistical analysis

All obtained data were subjected to analysis of variance according to Snedecor & Cochran (1980). Treatments means were compared by Duncan's multiple Range test (Duncan, 1955). All statistical analysis was performed using analysis of variance technique by means of "MSTAT – C" computer software package.

RESULTS AND DISCUSSION

Growth and growth attributes

It is clearly apparent that growth and growth attributes were markedly affected by nitrogen fertilization in both growing seasons (*Tabs. 3 and 4*). Maximum values of plant height, number of leaves/plant, bulb diameter and plant fresh and dry weight were observed by 100 kg N fed.$^{-1}$, followed by 120 kg N fed.$^{-1}$, while the minimum values was belonged to the lowest rate of nitrogen (80 kg N fed.$^{-1}$). Concerning bulbing ratio, no significant effect on bulbing ratio. This trend is true in the two seasons. This effect might be due to the optimum dose of nitrogen (100 or 120 kg N fed.$^{-1}$) leading to increase of nutrients elements in the soil, which may increase plant height, number of leaves/plant and bulb diameter during vegetative growth period. These results are in agreement with those obtained by Biesiada & Kolota (2009), Geries *et al.* (2012), Tekalign *et al.* (2012), El Hassan *et al.* (2014), Abo El-Magd & El-Azab (2015) and El Abas *et al*. (2015).

Table 3 - Effect of N fertilizer rate and biostimulators on plant height (cm), no. of leaves/onion plants and bulb diameter (cm), during 2014/15 and 2015/16 seasons

Treatment	2014/15			2015/16		
	Plant height (cm)	No. of leaves/onion plants	Bulb diameter (cm)	Plant height (cm)	No. of leaves/onion plants	Bulb diameter (cm)
N fertilizer rate (kg N fed.$^{-1}$)(N)						
80	62.85 c	8.10 b	5.21 c	72.75 c	7.61 b	4.64 c
100	82.71 a	9.20 a	6.87 a	87.53 a	9.57 a	6.05 a
120	74.58 b	8.51 ab	6.13 b	76.30 b	8.08 b	5.12 b
F-test	**	*	**	**	**	**
Biostimulators (B)						
Control	64.11 e	7.30 d	5.29 c	69.11 d	7.37 b	4.39 d
Inoculated with (z+s)	69.19 d	8.09 c	5.46 c	77.17 c	7.92 b	4.98 c
Foliar with yeast	72.86 c	8.71 b	6.15 b	81.00 b	8.69 a	5.33 b
Foliar with compost tea	75.77 b	9.21ab	6.33 b	82.20 ab	8.87 a	5.60 b
Foliar with humic acid	84.97 a	9.72 a	7.09 a	84.83 a	9.24 a	6.04 a
F-test	**	**	**	**	**	**
Interaction						
N×B	**	N.S.	**	N.S.	N.S.	N.S.

*, **, N.S. indicate *P*< 0.05, *P*> 0.01 and not significant, respectively. Means of each factor designed by the same letter are not significantly different at 5% rate, using Duncan's multiple range test.

Regarding the effect of biostimulators on this criterion (*Tabs. 3 and 4*), show that plant height, number of leaves/plant, bulb diameter and plant fresh and dry weight tended to be higher with foliar spraying with humic acid than those foliar with compost tea. The difference between biostimulators treatments was significant in the two seasons of study. These results may be due to the role of humic acid as a nutrient, which increasing soil fertility and increasing the availability of nutrient elements, which resulted in increasing growth and growth attributes. Such findings were reported by El-Desuki *et al.* (2006), Yaso *et al.* (2007), Awad *et al.* (2011), El-Gizawy & Geries (2013) and El-Gabry *et al.* (2015).

As for the interaction effect, plant height, bulb diameter, bulbing ratio and plant fresh and dry weight of onion was significantly affected by the interaction between nitrogen fertilization rate and biostimulators in 2014/15 and 2015/16 seasons. The data in *Table 5* shows that received of N fertilizer at 100 kg N fed.$^{-1}$ significantly gave the highest values of plant height, bulb diameter and plant fresh and dry weight of onion when foliar spraying with humic acid.

Table 4 - Effect of N rate and biostimulators on bulbing ratio and plant fresh and dry weight (g) of onion plants, during 2014/15 and 2015/16 seasons

Treatment	2014/15			2015/16		
	Bulbing ratio	Plant fresh weight (g)	Plant dry weight (g)	Bulbing ratio	Plant fresh weight (g)	Plant dry weight (g)
N fertilizer rate (kg N fed.$^{-1}$)(N)						
80	0.30	201.32 c	20.36 c	0.32	188.76 c	13.78 c
100	0.29	282.72 a	27.64 a	0.31	274.05 a	18.93 a
120	0.30	246.34 b	24.23 b	0.34	241.42 b	16.91 b
LSD	N.S	**	**	N.S.	**	**
Biostimulators (B)						
Control	0.30	217.98 e	20.32 e	0.34	182.11 e	12.41 e
Inoculated with (z+s)	0.31	231.80 d	22.29 d	0.33	212.19 d	14.33 d
Foliar with yeast	0.29	245.79 c	23.63 c	0.33	229.15 c	15.91 c
Foliar with compost tea	0.29	254.89 b	25.56 b	0.31	257.69 b	17.61 b
Foliar with humic acid	0.30	266.82 a	28.27 a	0.30	292.57 a	22.43 a
LSD	N.S.	**	**	N.S.	**	**
Interaction						
N×B	*	**	**	N.S.	*	N.S.

*, **, N.S. indicate *P*< 0.05, *P*> 0.01 and not significant, respectively. Means of each factor designed by the same letter are not significantly different at 5% rate, using Duncan's multiple range test.

Table 5 - Highest values of vegetative growth characteristics of Behary Red onion as affected by significant interaction among the experimental factors in 2014/15 and 2015/16 seasons

Variable	Season	Highest values	Treatment
Plant height (cm)	2014/15	95.98	100 kg N fed.$^{-1}$ × foliar with humic acid
Bulb diameter (cm)	2014/15	7.63	
Bulbing ratio	2014/15	0.37	80 kg N fed.$^{-1}$ × foliar with water (control)
Plant fresh weight (g)	2014/15	261.89	100 kg N fed.$^{-1}$ × foliar with humic acid
	2015/16	318.61	
Plant dry weight (g)	2014/15	32.18	

Yield and its components

The obtained results clearly show that the three studied treatments of mineral fertilization differed in average bulb weight (g), marketable bulbs yield and total yield (t fed.$^{-1}$) in the two growing seasons as shown in *Table 6*. Maximum averages of bulb weight, marketable bulbs yield and total yield were resulted from onion plots that mineral fertilized with N at the rate of 100 kg N fed.$^{-1}$ in the first and second seasons. However, plots that fertilized with 120 kg N fed.$^{-1}$

ranked after this treatment (Abou-Khadrah *et al.*, 2014). On the other direction, lowest averages of values were obtained from 80 kg N fed.$^{-1}$, which recorded the highest values of culls yield in the two seasons. The trend of these results is similar to those of total yield and marketable yield. This may be due to the increase in plant photosynthesis accumulation and plant photosynthesis rates, which led to an increase in plant growth and development. Resende & Costa (2014), Eldardiry *et al.* (2015), El Abas *et al.* (2015) and Hafez (2016) came to similar results.

Table 6 - Effect of N fertilizer rate and biostimulators on average bulb weight (g), marketable bulbs yield (t fed.$^{-1}$), culls yield (t fed.$^{-1}$) and total yield (t fed.$^{-1}$) of onion plants, during 2014/15 and 2015/16 seasons

Treatment	2014/15				2015/16			
	Average bulb weight (g)	Marketable bulbs yield (t fed.$^{-1}$)	Culls yield (t fed.$^{-1}$)	Total yield (t fed.$^{-1}$)	Average bulb weight (g)	Marketable bulbs yield (t fed.$^{-1}$)	Culls yield (t fed.$^{-1}$)	Total yield (t fed.$^{-1}$)
N fertilizer rate (kg N fed.$^{-1}$)(N)								
80	74.63c	9.17c	1.97a	11.14c	63.92c	9.61c	2.22a	11.84c
100	97.08a	15.24a	1.77b	17.00a	102.85a	13.30a	1.92b	15.22a
120	85.26b	12.85b	1.66b	14.51b	80.66	11.07b	1.78b	12.85b
F-test	**	**	**	**	**	**	*	**
Biostimulators (B)								
Control	64.61e	10.64e	2.09a	12.73d	64.02e	9.73e	2.36a	12.09d
Inoculated with (z+s)	77.33d	11.43d	1.74b	13.17c	75.62d	10.53d	2.04b	12.57c
Foliar with yeast	87.13c	12.68c	2.10a	14.78b	82.31c	11.13c	2.23a	13.36b
Foliar with compost tea	92.29b	13.31b	1.37c	14.68b	93.65b	12.20b	1.49d	13.69b
Foliar with humic acid	106.90a	14.03a	1.69b	15.72a	96.80a	13.04a	1.75c	14.79a
F-test	**	**	**	**	**	**	**	**
Interaction								
N×B	N.S.	**	**	**	**	**	N.S.	**

*, **, N.S indicate $P < 0.05$, $P > 0.01$ and not significant, respectively. Means of each factor designed by the same letter are not significantly different at 5% rate, using Duncan's multiple range test.

With regard to the effect of biostimulators on bulbs yield and its components, the data presented in *Table 6* show that there was a substantial difference in total yield fed.$^{-1}$ due to addition biostimulators in both seasons. Used humic acid at 1 kg fed.$^{-1}$ (15.72 and 14.79 t fed.$^{-1}$) out-yielded than those at the control treatment (12.73 and 12.09 t fed.$^{-1}$) in the both seasons, respectively. The detective positive effects of humic acid on average bulb weight (g), marketable bulbs yield and total yield (t fed.$^{-1}$) might be related to its beneficial effects on vegetative growth characters, which probably supplied more photosynthesis and hence, might help in increasing yield potential. These results are in line with those obtained by Sajid *et al.* (2012), Kandil *et al.* (2013), Rahman *et al.* (2015), Shafeek *et al.* (2015) and El-Hamdi *et al.* (2016).

The interaction between N fertilizer rate and biostimulators had a significant effect in 2014/15 and 2015/16 seasons on yield and its components. *Table 7* show that the greatest values of average bulb weight, marketable bulbs yield and total yield were obtained by applying 100 kg N fed.$^{-1}$, with humic acid, followed by treatments 120 kg N fed.$^{-1}$, with humic acid, compared with 80 kg N fed.$^{-1}$, which gave the lowest values with control. This effect might be due to applying biostimulators together with mineral fertilizer, which increased microorganisms in the soil, consequently converting the ability of mobilizing the unavailable forms of nutrients elements to available ones (Hafez & Gharib, 2016). On the other hand, the microorganisms produced growth-promoting substances, which increase the plant growth. This increase in plant growth may be increasing the photosynthetic rates leading to an increase of the assimilation rates. So, that the average bulb weight, marketable bulbs yield and culls yield increased, this consequently total yield.

Table 7 - Highest values of yield and its components of Behary Red onion as affected by significant interaction between the experimental factors in 2014/15 and 2015/16 seasons

Variable	Season	Highest values	Treatment
Average bulb weight (g)	2015/16	116.38	100 kg N fed.$^{-1}$ × foliar with humic acid
Marketable bulbs yield (t fed.$^{-1}$)	2014/15	16.80	
	2015/16	14.48	
Culls yield (t fed.$^{-1}$)	2014/15	2.02	80 kg N fed.$^{-1}$ × foliar with water
Total yield (t fed.$^{-1}$)	2014/15	18.41	100 kg N fed.$^{-1}$ × foliar with humic acid
	2015/16	16.27	

Bulb quality

Bulb diameter, total soluble solids and dry matter percentage in bulbs at harvesting was significantly affected by N fertilizer in both seasons as shown from data presented in *Table 8*. Highest total soluble solids and dry matter (%) in bulbs were resulted from 80 kg N fed.$^{-1}$, in both seasons. On the contrary, the lowest effect was recorded by 120 kg N fed.$^{-1}$. However, the lowest onion bulb diameter attained with 80 kg N fed.$^{-1}$ treatment. Such increases in bulb diameter due to addition mineral N fertilizer may be attributed to the role of nitrogen in increasing the metabolic components synthesized on the plant, which reflected on a better growth and increasing bulb diameter. El-Gizawy *et al.* (2013) and Hafez & Seleiman (2017) confirm these findings.

Results shown in *Table 8* illustrated that the biostimulators treatments achieved higher values of bulb quality, compared to the control. It was also observed that the highest bulb diameter and total soluble solids and dry matter (%) in bulbs were attained by humic acid, followed by foliar with compost tea. The increment in bulb quality by foliar spraying with humic acid may be attributed mainly to the role of humic acid as a nutrient, which increasing soil fertility and increasing the availability of nutrient elements, that resulted in bulbs of bigger diameter.

Table 8 - Effect of N fertilizer rate and biostimulators on bulb diameter (cm), total soluble solids and dry matter percentage %, during 2014/15 and 2015/16 seasons

Treatment	2014/15			2015/16		
	Bulb diameter (cm)	T.S.S (%)	DM (%)	Bulb diameter (cm)	T.S.S (%)	(DM (%)
N fertilizer rate (kg N fed.$^{-1}$)(N)						
80	6.09 b	14.94 a	14.31 a	4.99 c	15.12 a	16.10 a
100	8.21 a	13.10 b	13.42 b	6.92 a	14.38 b	14.39 b
120	6.70 b	11.81 c	12.21 c	6.25 b	12.99 c	12.30 c
F-test	**	**	**	**	*	**
Biostimulators (B)						
Control	5.79 d	11.39 e	11.79 d	4.74 d	12.61 e	13.31 d
Inoculated with (z+s)	6.40 c	12.80 d	12.78 c	5.43 c	13.48 d	13.98 c
Foliar with yeast	7.22 b	13.42 c	13.46 b	6.18 b	14.19 c	14.38 bc
Foliar with compost tea	7.53 b	14.12 b	13.81 b	6.70 ab	14.77 b	14.54 b
Foliar with humic acid	8.07 a	14.69 a	14.73 a	7.21 a	15.78 a	15.08 a
F-test	**	**	**	**	**	**
Interaction						
N×B	N.S.	*	N.S.	N.S.	**	**

*, **, N.S. indicate *P*< 0.05, *P*> 0.01 and not significant, respectively. Means of each factor designed by the same letter are not significantly different at 5% rate, using Duncan's multiple range test.

The interaction between the two factors studied was significant for dry matter percentage in the second season and for total soluble solids in both seasons (*Table 8*). *Table 9* shows that the highest total soluble solids and dry matter percentage of onion was achieved from foliar spraying with humic acid at 80 kg N fed.$^{-1}$

Table 9 - Highest values of bulb quality and storability of Behary Red onion as affected by significant interaction between the experimental factors in 2014/15 and 2015/16 seasons

Variable	Season	Highest values	Treatment
Total soluble solids	2014/15	16.14	80 kg N fed.$^{-1}$ × foliar with humic acid
	2015/16	16.90	
Dry matter percentage	2015/16	17.13	
Total weight loss percentage	2015/16	44.32	120 kg N fed.$^{-1}$ × foliar with water (control)
Remainder percentage	2015/16	84.19	80 kg N fed.$^{-1}$ × foliar with humic acid

Storability

Concerning the effect of fertilization treatments on total weight loss percentage in bulbs after harvesting till end of storability (six months), it is obvious from data listed in *Table 10* that fertilization treatments accompanied with significant effect on this quality trait in both seasons. The maximum total weight loss percentages in bulbs (33.27 and 35.32%) were resulted from fertilizing onion plants by using 120 kg N fed.$^{-1}$ after 180 days from harvesting in the first and second seasons, respectively. However, plots that fertilized with 100 kg N fed.$^{-1}$ ranked after this treatment concerning total weight loss percentage in bulbs after harvesting till end of storability, followed by plots that fertilized with 80 kg N fed.$^{-1}$ in both growing seasons. On the other direction, highest remainder percentage of onion bulbs (70.47 and 73.77%) were obtained from onion plants that mineral fertilized with 80 kg N fed.$^{-1}$, after 180 days from harvesting in the first and second seasons, respectively. The trend of these results is similar to those of total soluble solids and dry matter percentages and similar discussion could be cited. Confirming this conclusion, El-Sheekh & El-Gamili (1999), Fatideh & Asil (2012), Tekalign *et al*. (2012), Hafez & Hafez (2016) came to similar results and conclusion.

As for the effect of the bio-stimulators treatments, data collected in *Table 10* show a positive effect on total weight loss till end of storability in the two seasons. Therefore, minimum weight loss percentage with highest remainder percentage of onion bulbs was obtained from applying humic acid, followed by compost tea and, finally, spraying with water (control). These results may be attributed to the main effect of humic acid application on the increment of total soluble solids and dry matter percentage consequently decreased the weight losses of bulbs and improved the storability of onion bulbs. Similar results were reported by El-Gizawy *et al.* (2013), Shafeek *et al.* (2015) and Hafez & Abou El-Hassan (2015).

The data presented in *Table 10* reveal that the highest remainder percentage of onion bulbs was obtained when onions were fertilized with 80 kg N fed.$^{-1}$ and foliar with humic acid. On the contrary, the maximum total weight loss percentages in bulbs was produced when onion was fertilized with 120 kg N fed.$^{-1}$ under control treatment (foliar application with water) in the second season.

Table 10 - Effect of N-rate and biostimulators on total weight loss percentage and remainder percentage of onion bulbs during 2014/15 and 2015/16 seasons

Treatment	2014/15		2015/16	
	Total weight loss percentage	Remainder percentage of onion bulbs	Total weight loss percentage	Remainder percentage of onion bulbs
N fertilizer rate (kg N fed.$^{-1}$)(N)				
80	29.53 c	70.47 a	26.23 c	73.77 a
100	30.91 b	69.09 b	30.46 b	69.54 b
120	33.27 a	66.73 c	35.32 a	64.68 c
LSD	**	**	**	**
Biostimulators (B)				
Control	35.35 a	64.65 e	40.13 a	59.87 e
Inoculated with (z+s)	33.04 b	66.96 d	36.70 b	63.30 d
Foliar with yeast	30.77 c	69.23 c	30.71 c	69.29 c
Foliar with compost tea	29.62 d	70.38 b	24.79 d	75.20 b
Foliar with humic acid	27.39 e	72.61 a	21.02 e	78.98 a
LSD	**	**	**	**
Interaction				
N×B	N.S.	N.S.	**	**

**, N.S. indicate *P*> 0.01 and not significant, respectively. Means of each factor designed by the same letter are not significantly different at 5% rate, using Duncan's multiple range test.

CONCLUSION

It can be concluded that fertilization of onion plants with 100 kg N fed.$^{-1}$, foliar with humic acid at the rate of 1 kg fed.$^{-1}$ obtained the heights values of bulb yield and bulb quality, with the revenue of EGP is higher under the environmental conditions of this study.

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