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Research Article

Onion (*Allium Cepa L.*) Growth, Yield and Economic Return under Different Combinations of Nitrogen Fertilizers and Agricultural Biostimulants

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Abstract

A two field experiment has been conducted to study the effects of application of nitrogen fertilizer, biofertilizers and organic compounds on growth, yield and economic of onion production in 2014/2015 and 2015/2016 seasons. From the data it was found that combination of N fertilization of onion plants with 100 kg N fed.-1 (hectare = 2.38 feddan) and foliar with humic acid at the rate of 1 kg fed.-1 were found to be the best combined rates in this study for giving the highest bulb yield with the highest net returns 12580 EGP (Dolar = 17.80 EGP) with B: C ratio of 2.35. While the highest cost of cultivation was obtained by 120 kg N fed.-1 and spraying onion plants with humic acid followed by compost tea. Also, from the economic view, the revenue of EGP is higher when used some bio-fertilizers and organic fertilizers if compared with chemical fertilization only.

Keywords: Onion Plant; Bio-Fertilizers; Mineral N-Fertilizer; Growth and Bulbs Yield

Introduction

Onion (*Allium cepa L.*) is one of the most popular and widely consumed vegetables. In Egypt, it occupies an important position among vegetable crops due to its multifarious use as local fresh consumption, food processing and exportation; either as fresh bulbs or dehydrated slices.

Mineral fertilizers play an important role of onion plant growth and productivity. Many investigators reported that the vegetative growth of onion plants and minerals uptake was increased with increasing the level of NPK- fertilizers. On the other hand, we can say that continuous usage of inorganic fertilizers affects soil structure. Hence, organic fertilizers can serve as alternative to mineral fertilizers as reported by [3] for improving soil structure. Abd El-Samad., *et al.* [1] in Egypt, investigated the effect of different nitrogen fertilization rates 60, 90 and 120 unit N fed.$^{-1}$ as urea fertilizer. The results suggested that the best results were obtained when onion plants fertilized with nitrogen at rate of 120 unit N fed.$^{-1}$ Abdissa., *et al.* [2] in Ethiopia, investigated the effect of different nitrogen levels (N) on the growth, biomass yield and fresh bulb yield of onion (*Allium cepa L.*). They noted that application of 69 kg N ha^{-1} increased plant height and leaf length by about 10 and 11.5%, respectively over the unfertilized check. Bavec., *et al.* [3] in Slovenia, showed that fertilizing onion plants with 60 kg N ha^{-1} was sufficient to produce 34 t ha^{-1} of onions, with > 45% of the marketable yield in the first quality class.

Bio-fertilizers, i.e. nitrobeine has greater amounts of bacteria which were responsible for fixation of nitrogen by atmosphere. Hidangmayum and Sharma [4] examined the effect of seaweed liquid extracts of *Ascophyllum nodosum* as a plant biostimulant on growth and yield of onion. Six treatments are allocated randomly with four replications viz. T0- Control (0.00%), T1- (0.35%), T2- (0.45%), T3- (0.55%), T4- (0.65%) and T5- (0.75%). On the basis of present investigation, it may be concluded that treatment receiving 0.55% was found to be the best treatment in terms of leaf number (9.08/plant), plant height (55.20cm/plant), crop growth rate (33.65g/m2/day), fresh bulb. diameter (5.13cm/plant),bulb fresh weight (120.21g/plant), harvest index (77.44%), chlorophyll 'a' (0.81mg/g), chlorophyll 'b' (0.58mg/g), carotenoid content (0.61mg/g), bulb sulphur content (1.80ppm), bulb protein content (1.19 mg/g) and leaf protein content (0.46mg/g).While the higher concentration of the extract shows decreasing trend. Vachan and Tripathi [5] studied the effect three different levels of chemical fertilizers viz., 100 per cent RDF (i.e. N, P and K @ 150:80:100 kg ha^{-1}), 75 per cent and 50 per cent along with biofertilizers like Azospyrillum and phosphate solubilizing biofertilizers (PSB) on growth, yield and economics of onion crop. Among the various treatments the treatmnt T_{13} viz. 100 per cent RDF + Azospyrillum + PSB, has recorded significantly higher plant height, length of leaves, number of leaves, diameter of bulb, shoot thickness, fresh weight per plant and fresh weight per bulb and shoot weight at 50, 75 and 100 DAT. Kahlel [6] studied three factors: four types of fertilizers (chemical, local poultry manure, local sheep manure, and manufacture poultry manure), bio-fertilizer (dry bread yeast), and two treatments of water stress (without water stress and with water stress) in growth and seed production of onion. Mahmoud., *et al.* [7] stated that the soil-available nutrients (NPK) and organic matter (OM) contents as well as total bacterial counts were increased in the plots treated with compost extract as soil application and application of nitrogen fertilizers at 214 kg N ha^{-1}. Soil salinity and pH were decreased under soil application of compost extract as compared with the foliar applications of compost extract. Growth and onion bulbs yield and its quality were higher due to application of compost extract three times, 40, 60, and 90 days after transplanting (DAT), and two times, 40 and 60 DAT, each at the same dose compared to all other treatments. Inoculation of onion plants increased the bulb dry weight by 18.6% and 19.2% during the 2009–2010 and 2010–2011 seasons, respectively, compared to uninoculated seeds. Based on the results of the current study, the combination of 214 kg ha^{-1} mineral N and biofertilizers could be considered as an integrated nutrient management to improve soil properties and onion yield.

The presented study, therefore aimed to involve and adopt a suitable strategy of different rates of nitrogen fertilization of an onion crop. In addition, the study aimed to evaluate the use of biostimulants and economic evaluation.

Material and Methods

Two field experiments were conducted at Nashart village, Qellin, Kafr Elsheikh Governorate, Egypt, during the two seasons of 2014/2015 and 2015/2016, to investigate the impact of application nitrogen and biofertilization on growth, yield and yield components of onion variety Behary Red.

The texture of the experimental soil is characterized as clayey (61.4% clay, 24.4% silt, and 13.2% sand) with 1.90% organic matter in the 0-60 cm surface layer, soil bulk density of 1.65 g cm-3, before seedbed preparation, the Experimental Soil was ploughed twice and randomized three soil samples (0 to 60 cm depth) were taken for analysis, physical and chemical properties in the experimental soil are shown in Table 1.

			Cations (meq L^{-1})				Anions (meq L^{-1})			
Year	EC (ds m^{-1})	pH	Na^+	K^+	Mg^{++}	Ca^{++}		Cl^-	HCo_3^-	So_4^{--}
2014/2015	2.17	7.95	24.78	0.45	7.35	10.54		25.56	4.92	17.54
2015/2016	1.09	8.02	21.65	0.46	6.43	8.29		18.21	4.78	14.98

Table 1 - Chemical properties of soil used in 2015/2016 and 2016/2017 growing seasons.

Soil analysis for pH based on soil: water extract (1: 2.5), while EC and ions based on soil: water extract (1: 5).

Experimental design and agronomic practices

Phosphorus fertilizer was applied during the soil preparation at the rate of 30 kg P2O5 fed.$^{-1}$. Potassium fertilizer was applied as one dose directly before the first irrigation of the crop at the rate of 24 kg K_2O fed. in the form of potassium sulphate (48% K_2O). Nitrogen fertilizer was applied at two equal doses directly before the second and third irrigations at a rate of 60 kg N fed.$^{-1}$ in the form of urea 46.5% N. Other agronomic practices as normally done by farmers in their fields of the experimental location.

The field experimental design was a split plot design consisted of Nitrogen rates which were arranged at random in the main plots, while bio- stimulant treatments were designed in the sub plots. The factors under investigation were as follows:

Nitrogen levels

- N1. Soil dressing of 80 kg N fed.$^{-1}$(60% of the recommended dose of N fertilizer).
- N2. Soil dressing of 100 kg N fed.$^{-1}$(80% of the recommended dose of N fertilizer).
- N3. Soil dressing of 120 kg N fed.$^{-1}$(100% of the recommended dose of N fertilizer).

Bio-stimulant substances treatments:

1. Foliar spraying with water (control).
2. Inoculated with *Azotobacter chroococum* spp. and *Azospirilium* spp., (Azot.and Azos.)
3. Foliar spraying with active dry yeast at rates of 6 g L^{-1},

4. Foliar spraying with compost tea at the rate of 20 L fed.$^{-1}$.
5. Foliar spraying with humic acid at the rate of 1 kg fed.$^{-1}$.

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 hours, then was squeezed, collected and used as compost tea according the method described by Nasef., *et al* [8]. Compost tea was applied as foliar spraying at rate 20 L fed.$^{-1}$.

With regarding to the chemical analysis of the dry yeast (*Saccharomyces cerevisiae*), Khedr and Farid [9] reported that, yeast product contained carbohydrates, sugars, proteins, fatty acids, amino acids, hormones, macro and micro elements in suitable balance. Yeast extract was prepared from active dry yeast (Saccharomyces cerevisiae) according to the method of Morsi., *et al*. [10] by dissolving amount of dry yeast in water followed by adding sugar at a ratio of 1:1 and kept 24 hours in a warm place for reproduction. The bacterial strain (*Azotobacter* spp. and *Azospirilium* spp.), which containing active bio-nitrogen 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. Foliar spraying with bio-stimulators treatments at 40, 60 and 80 days after transplanting (DAT). Samples of ten onion plants were taken randomly from each plot to determine growth parameters at 95, 110 and 125 DAT.

Observations and measurements data analysis

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 90, 110 and 125 days after transplanting (DAT). Plants were carried out to the laboratory, in polyethylene bags, and then the following data were recorded:

- A.1- Bulb diameter (cm): It was measured by a caliper at the maximum swollen part of the bulb.
- A.2- Neck diameter (cm): It was measured at the thickest part of bulb neck by a caliper.
- A.3- Bulbing ratio: It is measured as reported by Mann [11].

$$\textbf{Bulbing ratio} = \frac{\text{Neck diameter (cm)}}{\text{Bulb diameter (cm)}}$$

Yield and its components

These records were taken on the four 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 3 weeks, then tops and roots were removed and. Also the plants of each subplot were harvested and the following characters were estimated:

- **B.1. Average bulb weight (g):** It was calculated as the weight of harvested bulbs from each experimental plot and then divided by number of single bulbs per plot.
- **B.2. Marketable bulbs yield (t fed.$^{-1}$):** It was determined as the weight of single bulbs only for each experimental plot.
- **B.3. Culls bulb yield (t fed.$^{-1}$):** It is included bulbs less than 3 cm diameter, doubles, bolters, off - color and scallions.
- **B.4. Total bulbs yield (t fed.$^{-1}$):** It was determined by weighting the harvested bulbs from each experimental plot and total yield was calculated as t fed.$^{-1}$

Economic evaluation

- **C.1- Cost of cultivation:** Cost of cultivation was calculated on the basis of local charge for different agro – inputs, *i.e.* labor, fertilizer and other necessary materials. Cost of cultivation for three different methods was calculated separately.
- **C.2- Gross return** from each treatment was calculated in Egyptian pounds (L.E.); 1 L.E. = 0,056 $ = 0,048 Eur = 0,041 GBP.
- **C.3- Net return feddan^{-1}**= total return - (fixed and variable cost of onion).
- **C.4-Benefit cost ratio=**Gross return/Cost of cultivation.

One ton of onion = 1400 L.E., in 2014/15 and 2015/16, seasons, the average prices were taken from the local market price. Economic valuation was done using the method described by CIMMYT [12].

Statistical analysis

All obtained data were subjected to analysis of variance according to Snedecor and Cochran [13]. Treatments means were compared by Duncan's multiple Range test [14]. All statistical analysis was performed using analysis of variance technique by means of "MSTAT – C" computer software package.

Results and Discussion

A.1.Bulb diameter (cm)

Bulb diameter (cm) at 95, 110 and 125 days after transplanting as affected by N-fertilizer level and bio-stimulators and their interaction in 2014/2015 and 2015/16 seasons are presented in Table 2.

It is clearly apparent that bulb diameter was markedly affected by nitrogen fertilization at the three sampling dates in both growing seasons (Table 2). Maximum bulb diameter was observed by

100 kg N fed.$^{-1}$ followed by 120 kg N fed.$^{-1}$, while the minimum bulb diameter was belonged to the lowest level of nitrogen (80 kg N fed.$^{-1}$). This trend is true at 95, 110 and 125 DAT in the two seasons. This effect might be due to the optimum dose of nitrogen (100 kg N fed.$^{-1}$) leading to increase of nutrients elements in the soil, which may increase bulb diameter during vegetative growth period. These results are in agreement with those obtained by Mahmoud., *et al*. [7] and Sahar., *et al*. [15].

Regarding the effect of bio-stimulators on this criterion, (Table 2) show that bulb diameter tended to be higher with foliar spraying with humic acid than those foliar with compost tea. The difference between bio fertilizer treatments was significant at all growth stages in the two seasons of study. This favorable effect of humic acid might have been due to the effective role in improvement early onion growth, more dry matter accumulation and stimulated the building of metabolic products that translocated to, which resulted in increasing bulb diameter. Such findings were reported also by El-Gabry., *et al*. [16].

Treatment	**2014/2015**			**2015/2016**		
	95	110	125	95	110	125
	DAT					
N-fertilizer level (kg N fed.$^{-1}$) (A):						
80	2.16 c	3.11 c	5.21 c	1.81 c	3.33 b	4.64 c
100	2.91 a	4.60 a	6.87 a	2.50 a	4.46 a	6.05 a
120	2.51 b	3.78 b	6.13 b	2.23 b	3.79 ab	5.12 b
F-test	**	**	**	**	*	**
Bio-Stimulators (B):						
Control	2.02 d	3.12 d	5.29 c	1.70 e	2.67 d	4.39 d
Inoculated with *Azot. and Azos.*	2.36 c	3.47 c	5.46 c	1.95 d	3.27 c	4.98 c
Foliar with yeast	2.45 c	3.59 c	6.15 b	2.17 c	4.15 b	5.33 b
Foliar with compost tea	2.66 b	4.20 b	6.33 b	2.38 b	4.41 ab	5.60 b
Foliar with humic acid	3.14 a	4.75 a	7.09 a	2.69 a	4.82 a	6.04 a
F-test	**	**	**	**	**	**
Interaction:						
AxB	N.S	**	**	N.S	N.S	N.S

Table 2: Bulb diameter (cm) as affected by N-fertilizer level and bio-stimulators and their interaction at 95, 110 and 125 DAT during 2014/2015 and 2015/2016 seasons.

*, **, 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% level, using Duncan's multiple range test.

As for the interaction effect, bulb diameter of onion was significantly affected by the interaction between N-fertilizer level and bio-stimulators at 110 and 125 DAT in 2014/15 season (Table 2). The data in Table 3 shows that received 80% of the recommended dose of N fertilizer (100 kg N fed.$^{-1}$) with significantly gave the highest values of bulb diameter when foliar spraying with humic acid. On the other hand, the lowest bulb diameter was obtained by 80 kg N fed.$^{-1}$ with foliar spraying with water. Similar results were obtained by Bettoni., *et al*. [17].

Bio-Stimulators	**110 DAT**			**125 DAT**		
	N-fertilizer level (kg N fed.$^{-1}$)					
	80	**100**	**120**	**80**	**100**	**120**
Control	2.50 f	3.82 d	3.07 e	3.80 f	6.65 bc	5.43 d
Inoculated with *Azot. and Azos.*	2.88 e	4.35 c	3.17 e	4.70 e	6.43 bc	5.25 d
Foliar with yeast	2.97 e	4.50 c	3.30 e	5.48 d	6.62 bc	6.35 c
Foliar with compost tea	3.25 e	4.98 b	4.37 c	5.55 d	7.00 bc	6.45 bc
Foliar with humic acid	3.93 d	5.33 a	5.98 b	6.50 bc	7.63 a	7.15 ab

Table 3: Bulb diameter (cm) as affected by the interaction between N-fertilizer level and bio-fertilizer at 110 and 125 DAT in 2014/2015 season.

Means followed by a common letter are not significantly different at the 5% level, according to DMRT.

A.2- Neck diameter (cm)

Nick diameter (cm) as affected by N-fertilizer level and bio-stimulators and their interactions at 95, 110 and 125 DAT in both seasons are presented in Table 4.

Data indicated that nick diameter was increased significantly by increasing nitrogen levels from 80 to 120 kg N fed.$^{-1}$ at all growth intervals in both seasons Abou El-Hassan., *et al*. [18]. Generally, the highest nick diameter was obtained with nitrogen level of 100 kg fed.$^{-1}$ in the three periods in both seasons. Similar results were obtained by Hilman., *et al*. [19] and Sahar., *et al* [15].

The effect of foliar spraying with humic acid gave the highest nick diameter, followed by foliar spraying with compost tea at all growth stages in the both seasons. While, the lowest effect was recorded by the foliar application with water (control). Similar results was obtained by El-Gizawy and Geries [20].

Treatment	2014/2015			2015/2016		
	95	110	125	95	110	125
	DAT					
N-fertilizer level (kg N fed.$^{-1}$) (A):						
80	1.14 b	1.22 c	1.52 c	1.20 c	1.25 b	1.46 b
100	1.65 a	2.23 a	2.02 a	1.75 a	1.79 a	1.84 a
120	1.49 a	1.69 b	1.84 b	1.44 b	1.68 a	1.75 a
F-test	**	**	**	**	**	**
Bio-Stimulators (B):						
Control	1.23 c	1.42 c	1.55 d	1.29 b	1.37 d	1.53 c
Inoculated with *Azot.and Azos.*	1.35 bc	1.58 bc	1.69 c	1.41 b	1.45 cd	1.62 bc
Foliar with yeast	1.43 b	1.64 bc	1.78 bc	1.47 ab	1.57 bc	1.71 ab
Foliar with compost tea	1.47 b	1.79 b	1.85 b	1.50 ab	1.67 ab	1.72 ab
Foliar with humic acid	1.66 a	2.12 a	2.11 a	1.65 a	1.81 a	1.83 a
F-test	**	**	**	**	**	**
Interaction:						
AxB	N.S	N.S	N.S	N.S	N.S	N.S

Table 4: Effect of N-fertilizer level and bio-stimulators and their interaction on neck diameter (cm) at 95, 110 and 125 DAT during 2014/2015 and 2015/2016 seasons.

**, 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% level, using Duncan's multiple range test.

A.3-Bulbing ratio

Data shown in Table 5 about bulbing ratio, indicated that the effect of N-fertilizer level and bio-stimulators treatments and their interactions at 90, 110 and 125 days after transplanting in both seasons.

Treatment	2014/2015			2015/2016		
	95	110	125	95	110	125
	DAT					
N-fertilizer level (kg N fed.$^{-1}$) (A):						
80	0.54	0.39 b	0.30	1.53	0.40	0.32
100	0.57	0.49 a	0.29	1.44	0.41	0.31
120	0.60	0.45 a	0.30	1.55	0.45	0.34
F-test	N.S	*	N.S	N.S	N.S	N.S
Bio-Stimulators (B):						
Control	0.61	0.44	0.30	1.36	0.38 b	0.30
Inoculated with *Azot. and Azos.*	0.57	0.45	0.31	1.45	0.38 b	0.30
Foliar with yeast	0.59	0.45	0.29	1.48	0.39 b	0.33
Foliar with compost tea	0.56	0.43	0.29	1.59	0.45 b	0.33
Foliar with humic acid	0.53	0.44	0.30	1.65	0.52 a	0.35
F-test	N.S	N.S	N.S	N.S	**	N.S
Interaction:						
AxB	N.S	N.S	*	N.S	N.S	N.S

Table 5: Effect of N-fertilizer level and bio-stimulators and their interaction on bulbing ratio at 95, 110 and 125 DAT during 2014/2015 and 2015/2016 seasons**.**

*, **, 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% level, using Duncan's multiple range test.

The results indicated that increasing nitrogen levels had a significantly increased in bulbing ratio in both seasons. The highest bulbing ratio was found at 100 or 120 kg N fed.$^{-1}$ without significant difference between them, while the lowest rate found with 80 kg N fed.$^{-1}$ at 110 DAT in both seasons. Such effect of mineral nitrogen dose (100 kg N fed.$^{-1}$) was possible due to its immediate availability and quick absorption from the root zone both of that are associated with better growth, which promoted bulb diameter. Similar results was obtained by El-Gizawy and Geries [20] and Mahmoud., *et al* [7].

As for the effect of bio-stimulators treatments, the data in Table 5 exhibit that foliar spraying with humic acid gave the highest bulbing ratio comparing with other treatments at 125 DAT samples during the second season.

Regarding the (A x B) interaction at 125 DAT in first season only (Table 5) shows that received 80% of the recommended dose of N fertilizer (100 kg N fed.-1) markedly recorded the highest values of bulbing ratio when foliar spraying with water (control) at 80 kg N fed.-1 (Table 6).

Bio-Stimulators	N-fertilizer level (kg N fed.$^{-1}$)		
	80	100	120
Control	0.37 a	0.26 ef	0.29 cd
Inoculated with *Azot.and Azos.*	0.30 bc	0.30 bc	0.32 b
Foliar with yeast	0.28 cd	0.30 bc	0.29 cd
Foliar with compost tea	0.29 cd	0.29 cd	0.30 bc
Foliar with humic acid	0.26 ef	0.31 bc	0.31 bc

Table 6: Bulbing ratio of onion plants as affected by the interaction between N-fertilizer level and bio-stimulators at 110 in 2014/2015 season.

Means followed by a common letter are not significantly different at the 5% level, according to DMRT.

B. Total bulbs yield and its components:

B.1- Average bulb weight (g)

Data presented in Table 7 show the effect of N-fertilizer levels and bio-stimulators treatments on average bulb weight (g) as well as their interaction during 2014/2015 and 2015/2016 seasons.

The obtained results clearly showed that the three studied treatments of mineral fertilization differed in average bulb weight in the two growing seasons as shown in Table. Maximum averages of bulb weight (97.08 and 102.85 g) 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, respectively [21]. However, plots that fertilized with 120 kg N fed.$^{-1}$ ranked after this treatment followed by plots that fertilized with 80 kg N fed.$^{-1}$ On the other direction, lowest averages of bulb weight (74.63 and 63.92 g) were obtained from 80 kg N fed.$^{-1}$ in the first and second seasons, respectively. The trend of these results is similar to those of total yield and marketable yield and similar discussion could be cited. Confirming this conclusion, Agumas., *et al*. [22], and Sahar., *et al*. [15] and came to similar results.

Average bulb weight was affected significantly by bio-stimulators treatments in both seasons (Table 7). The highest average bulb weight was obtained when plants received humic acid, followed by those received compost tea. This trend is true in the two seasons and is confirmed by Mahmoud., *et al*. [15] and Hafez and Geries [23].

Treatment	**2013/2014**	**2014/2015**
	Average bulb weight (g)	
N-fertilizer level (kg N fed.$^{-1}$) (A):		
80	74.63 c	63.92 c
100	97.08 a	102.85 a
120	85.26 b	80.66 b
F-test	**	**
Bio-Stimulators (B):		
Control	64.61 e	64.02 e
Inoculated with *Azot. and Azos.*	77.33 d	75.62 d
Foliar with yeast	87.13 c	82.31 c
Foliar with compost tea	92.29 b	93.65 b
Foliar with humic acid	106.90 a	96.80 a
F-test	**	**
Interaction:		
AxB	**N.S**	**

Table 7: Average bulb weight (g) as affected by mineral N-fertilizer levels and bio-stimulators treatments and their interaction during 2014/2015 and 2015/2016 seasons.

**, 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% level, using Duncan's multiple range test.

Data in Table 7 elucidate that, the interaction between mineral N-fertilizer levels and bio-stimulators treatments had a significant effect on average bulb weight in the two seasons. Since, the highest value of bulb weight was produced by 100 kg N fed.$^{-1}$ plus humic acid followed by compost tea. On the other side, the lowest average of bulb weight was obtained from the control treatment (foliar with water) and 80 kg N fed.$^{-1}$ as shown in Table 8.

Bio-Stimulators	**N-fertilizer level (kg N fed.$^{-1}$)**		
	80	**100**	**120**
Control	45.90 g	81.75 d	64.38 e
Inoculated with *Azot.and Azos.*	54.64 f	92.64 c	79.59 d
Foliar with yeast	56.06 f	109.62 b	81.24 d
Foliar with compost tea	80.73 d	113.85 ab	86.36 d
Foliar with humic acid	82.28 d	116.38 a	91.75 c

Table 8: Average bulb weight (g) as affected by the interaction between N-fertilizer levels and bio-stimulators treatments in 2015/2016 season.

Means followed by a common letter are not significantly different at the 5% level, according to DMRT.

B.2-Marketable bulbs yield (t fed.$^{-1}$)

Marketable bulbs yield as affected by N-fertilizer levels and bio-stimulators treatments as well as their interactions in 2014/2015 and 2015/2016 seasons are located in Table 9.

Treatment	**2014/2015**	**2015/2016**
N-fertilizer level (kg N fed.$^{-1}$) (A):		
80	9.17 c	9.61 c
100	15.24 a	13.30 a
120	12.85 b	11.07 b
F-test	**	**
Bio-Stimulators (B):		
Control	10.64 e	9.73 e
Inoculated with *Azot. and Azos.*	11.43 d	10.53 d
Foliar with yeast	12.68 c	11.13 c
Foliar with compost tea	13.31 b	12.20 b
Foliar with humic acid	14.03 a	13.04 a
F-test	**	**
Interaction:		
AxB	**	**

Table 9: Marketable bulbs yield (t fed.$^{-1}$) as affected by N-fertilizer levels and bio-stimulators treatments and their interaction in 2014/2015 and 2015/2016 seasons.

**, 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% level, using Duncan's multiple range test.

N-fertilizer levels treatments influenced marketable bulbs yield in both seasons. Plants that received 100 kg N fed.$^{-1}$ produced significantly greater marketable yield (15.24 and 13.30 t fed.$^{-1}$) than all other treatments, followed by 120 kg N fed.$^{-1}$ treatment (12.85 and 11.07 t fed.$^{-1}$) in the two seasons, respectively [24]. While 80 kg N fed.$^{-1}$ treatment gave the lowest value of marketable yield (9.17 and 9.61 t fed.$^{-1}$) in both seasons, respectively. This effect could be resulted from the increase in average bulb weight. Also, this may be due to an increase in plant photosynthesis accumulation and plant photosynthesis rates, which led to an increase in plant growth and development. Similar results were obtained by Lee [25].

With regard to the effect of bio-stimulators treatments on marketable bulbs yield, the data presented in Table 9 show that it was significantly affected by bio-stimulators in 2014/2015 and 2015/2016 seasons. Foliar with humic acid out yielded other treatment in this trait and the reverse was true for control treatment (foliar with water) for the two seasons. The detective positive effects of humic acid on marketable bulbs yield might be related to its beneficial effects on vegetative growth characters, which probably supplied more photosynthates and hence, might help in increasing yield potential. These results are in line with those obtained by Bettoni., *et al*. [17].

As for the interaction effect between (AxB), the interaction between N-fertilizer levels and bio-stimulators treatments had a significant effect in 2014/2015 and 2015/2016 seasons on marketable bulbs yield (Table 9). Table 10 show that the greatest marketable yield was obtained by applying 100 kg N fed.$^{-1}$ with humic acid followed by with foliar with compost tea compared with 80 kg N fed.$^{-1}$, which gave the lowest value of marketable bulbs yield. This effect might be due to applying bio-stimulators together with compost and mineral fertilizer, which increased microorganisms in the soil, and thus converting the ability of mobilizing the unavailable forms of nutrients elements to available forms. 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 increased, this consequently increased the marketable yield, as Hafez and Geries [23]) reported.

B.3- Culls bulb yield (t fed.$^{-1}$)

Culls bulb yield (t fed.$^{-1}$) as affected by N-fertilizer levels and bio-stimulators treatments and their interaction during 2014/2015 and 2015/2016 seasons are presented in Table 11.

Among the different N-fertilizer levels, significant differences were observed concerning culls bulb yield in both seasons. Data show that N-fertilizer at level 80 kg N fed.$^{-1}$ gave the highest culls bulb yield (1.97 and 2.22 t fed.$^{-1}$), whereas, N-fertilizer at level 120 kg N fed.$^{-1}$ recorded the lower values of culls yield (1.66 and 1.78 t fed.$^{-1}$) in the both seasons, respectively (Table 11). The trend of these results is similar to those of total and marketable yields fed.$^{-1}$ and similar discussion could be cited. Similar results were obtained by Soleymani and Shahrajabian [26], Agumas., *et al*. [22] and Sahar., *et al* [15].

Bio-Stimulators	**2014/2015**			**2015/2016**		
	N-fertilizer level (kg N fed.$^{-1}$)					
	80	**100**	**120**	**80**	**100**	**120**
Control	7.59 o	13.41 g	10.93 j	7.87 j	12.34 cd	8.97 i
Inoculated with *Azot. and Azos.*	8.41 n	14.25 e	11.62 i	8.67 i	12.74 bc	10.17 g
Foliar with yeast	9.36 m	15.56 c	13.14 h	9.59 h	12.88 bc	10.92 ef
Foliar with compost tea	9.88 l	16.16 b	13.89 f	10.56fg	14.03 a	12.03 d
Foliar with humic acid	10.64 k	16.80 a	14.65 d	11.39 e	14.48 a	13.25 b

Table 10: Marketable bulbs yield (t fed.$^{-1}$) as affected by the interaction between N-fertilizer level and bio-fertilizer and their interaction in 2014/2015 and 2015/2016 seasons.

Means followed by a common letter at the same season are not significantly different at the 5% level, according to DMRT.

Treatment	**2014/2015**	**2015/2016**
N-fertilizer level (kg N fed.$^{-1}$) (A):		
80	1.97 a	2.22 a
100	1.77 b	1.92 b
120	1.66 b	1.78 b
F-test	**	*
Bio-Stimulators (B):		
Control	2.09 a	2.36 a
Inoculated with *Azot. and Azos.*	1.74 b	2.04 b
Foliar with yeast	2.10 a	2.23 a
Foliar with compost tea	1.37 c	1.49 d
Foliar with humic acid	1.69 b	1.75 c
F-test	**	**
Interaction:		
AxB	**	N.S

Table 11: Effect of N-fertilizer levels and bio-stimulators treatments as well as their interaction on total culls (t fed.$^{-1}$) of onion bulbs in 2014/2015 and 2015/2016 seasons.

*, **, 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% level, using Duncan's multiple range test.

The obtained results revealed that all bio-stimulators treatment significantly increased culls yield fed.$^{-1}$, compared with control in both seasons. Foliar spraying with humic acid and compost tea produced a higher culls yield fed.$^{-1}$ in both seasons without significant difference between them followed by foliar with yeast. The trend of these results is similar to those of total and marketable yields fed.$^{-1}$ and similar discussion could be cited. Similar findings were reported by Fahramand., *et al.* [27], Rahman., *et al.* [28] and Bettoni., *et al* [17].

The value of total culls yield (t fed.$^{-1}$) was significantly affected by the interaction between N-fertilizer levels and bio-stimulators treatments in the first season only as shown in Table 12. The highest total culls (t fed.$^{-1}$) was obtained by foliar spraying with humic acid or compost tea + 80 or 100 kg N fed.$^{-1}$ without significant between them in 2014/2015 season.

Bio-Stimulators	N-fertilizer level (kg N fed.$^{-1}$)		
	80	100	120
Control	2.02 abc	2.27 a	1.99 bc
Inoculated with *Azot.and Azos.*	2.01 bc	1.43 fg	1.78 cde
Foliar with yeast	2.27 a	2.20 ab	1.82 cde
Foliar with compost tea	1.69 de	1.30 gh	1.12 h
Foliar with humic acid	1.86 cd	1.61 def	1.59 ef

Table 12: Total culls (t fed.$^{-1}$) as affected by the interaction between N-fertilizer levels and bio-stimulators treatments in 2014/2015 season.

Means followed by a common letter are not significantly different at the 5% level, according to DMRT.

B.4.Total bulbs yield (t fed.$^{-1}$)

Results showing the effect of N-fertilizer levels, bio-stimulators treatments and their interaction on total bulbs yield (t fed.$^{-1}$) in the two seasons 2014/2015 and 2015/2016 are presented in Table 13.

The total yield is an important yield parameter of onion. Referring the effect of N-fertilizer levels on total bulbs yield, it was significant in the two growing seasons (Table 13). As presented in Table 13, using 100 kg fed.$^{-1}$ surpassed other studied fertilizer levels and resulted in highest means of total bulbs yield (17.00 and 15.22 t fed.$^{-1}$) in the first and second seasons, respectively. This fertilization treatment followed by 120 kg fed.$^{-1}$ On the contrary, lowest means of marketable bulbs yield (11.14 and 11.84 t fed.$^{-1}$) were produced from 80 kg fed.$^{-1}$ in the first and second seasons, respectively. The increases in total bulbs yield because of using 100 kg fed.$^{-1}$ can be easily ascribed to its role in improvement early growth, more dry matter accumulation and stimulation the building of metabolic products. These results are in compatible with those found by Yaso., *et al.* [29] and Hafez and Geries [23].

Treatment	2014/2015	2015/2016
	Total bulbs yield (t fed.$^{-1}$)	
N-fertilizer level (kg N fed.$^{-1}$) (A):		
80	11.14 c	11.84 c
100	17.00 a	15.22 a
120	14.51 b	12.85 b
F-test	**	**
Bio-Stimulators (B):		
Control	12.73 d	12.09 d
Inoculated with *Azot. and Azos.*	13.17 c	12.57 c
Foliar with yeast	14.78 b	13.36 b
Foliar with compost tea	14.68 b	13.69 b
Foliar with humic acid	15.72 a	14.79 a
F-test	**	**
Interaction:		
AxB	**	**

Table 13: Effect of N-fertilizer levels, bio-stimulators treatments and their interaction on total bulbs yield (t fed.$^{-1}$) in 2014/2015 and 2015/2016 seasons.

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

The data concerning total yield fed.$^{-1}$ are presented in Table 13. There was a substantial difference in total yield fed.$^{-1}$ due to addition bio-stimulators in both seasons. Used humic acid at 1.00 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. These increases in total onion yield may be due to hormonal effect of humic acid that improve the nutrient status of plants [23].

Data presented in Table 14 show that the interaction between N-fertilizer levels, bio-stimulators treatments for total bulb yield was highly significant in the two seasons. Data cited in Table 14 reveal that the 100 kg N fed.$^{-1}$ plus foliar with humic acid gave the highest total bulbs yield (18.41 and 16.27 t fed.$^{-1}$) and ranked first, while 80 kg N fed.$^{-1}$ and control (foliar plants with water) gave the lowest value (9.61 and 10.53 t fed.$^{-1}$) and ranked last in both seasons, respectively Hafez and Geries [23].

Bio-Stimulators	2014/2015			2015/2016		
	N-fertilizer level (kg N fed.$^{-1}$)					
	80	100	120	80	100	120
Control	9.61 k	15.68 d	12.92 g	10.53 f	14.65 c	11.10 f
Inoculated with *Azot. and Azos.*	10.42 j	15.68 d	13.41 f	10.84 f	14.68 c	12.19 e
Foliar with yeast	11.62 i	17.76 b	14.96 e	12.05 e	14.99 bc	13.03 d
Foliar with compost tea	11.57 i	17.46 b	15.01 e	12.30 e	15.49 b	13.28 d
Foliar with humic acid	12.50 h	18.41 a	16.24 c	13.46 d	16.27 a	14.63 c

Table 14: Total yield (t fed.$^{-1}$) as affected by the interaction between N-fertilizer levels, bio-stimulators treatments in 2014/2015 and 2015/2016 seasons.

Means followed by a common letter at the same season are not significantly different at the 5% level, according to DMRT.

C. Economic evaluation

C.1- Cost of cultivation

The results of the partial budget analysis (Figure 1) showed that 120 N fed.$^{-1}$ had the highest cost of cultivation 9380 EGP fed.$^{-1}$ followed by 100 N fed.$^{-1}$ with cost of cultivation 9130 EGP fed.$^{-1}$ While, the lowest cost of cultivation 8880 EGP fed.$^{-1}$ was obtained from 80 N fed.$^{-1}$

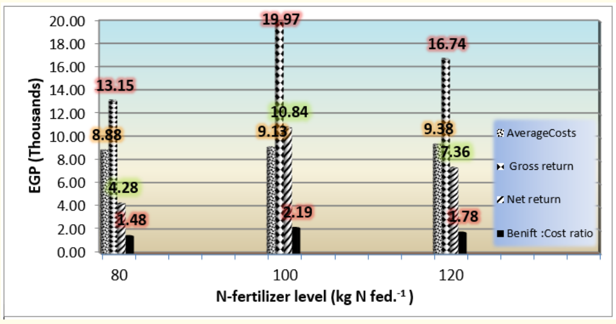

Figure 1: Average costs, gross return, net return and benefit: cost ratio (EGP fed.-1) of Behary Red onion yield as influenced by N-fertilizer levels as overall mean values through the two growing seasons.

Figure 2 showed that the foliar with humic acid had the highest cost of cultivation 9320 EGP fed.$^{-1}$ followed by compost tea with cost of cultivation 9120 EGP fed.$^{-1}$ While, the lowest values of cost 8970 EGP fed.$^{-1}$ were obtained by control.

Data presented in Figure 3 indicated that, combination of humic acid with 120 kg N fed.$^{-1}$ gave the highest values of average cost (9570 EGP fed.$^{-1}$).

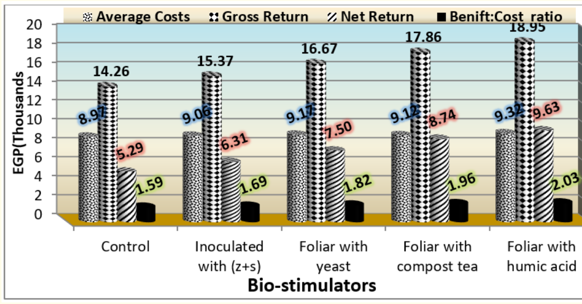

Figure 2: Average costs, gross return, net return and benefit: cost ratio (EGP fed.-1) of Behary Red onion yield as influenced by bio-stimulators as overall mean values through the two growing seasons.

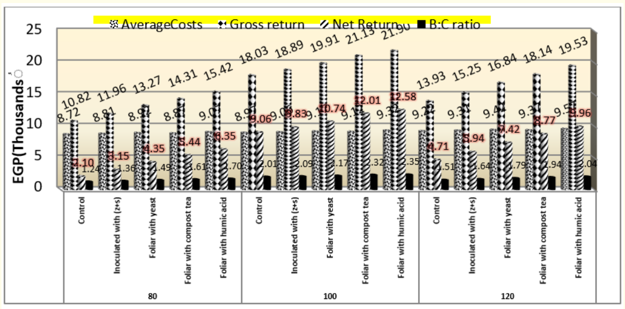

Figure 3: Average costs, gross return, net return and benefit: cost ratio (EGP fed.-1) of Behary Red onion yield as influenced by the interaction between N-fertilizer level and bio-stimulators treatments as overall mean values through the two growing seasons.

C.2- Gross return

Gross return as influenced by different N-fertilizer levels during 2014/2015 and 2015/2016 seasons are presented in Figure 1. Fertilization level of 100 N fed.$^{-1}$ recorded the highest gross returns followed by 120 N fed.$^{-1}$ and the lowest gross return belonged to 80 N fed.$^{-1}$, with 13150 EGP fed.$^{-1}$

Foliar treatment with humic acid resulted in the highest gross returns(18950 EGP fed.$^{-1}$) followed by compost tea (17860 EGP fed.$^{-1}$) as presented in Figure 2.

Data presented in Figure 3 indicated that, spraying onion plants with humic acid and with 100 N fed.$^{-1}$ resulted the highest gross return (21900 EGP).

C. 3- Net return

Applying 100 N fed.$^{-1}$ given the highest net returns resulted in the highest net return fed.$^{-1}$, followed by 120 N fed.$^{-1}$ as showed in Figure 1, while 80 N fed.$^{-1}$ recorded the lowest net return per fed.

With respect to bio-stimulators, the highest values of net return per fed. were belonged to humic acid, compared other bio-stimulators treatmentas shown in Figure 2.

Depending on Figure 3, 100 N fed.$^{-1}$ with humic acid had the highest net return per fed. followed by 100 N fed.$^{-1}$ with compost tea, while the lowest net return was obtained by 100 kg N fed.$^{-1}$ with control.

C.4. Benefit-cost ratio

The net benefit-cost (B:C)/ratio was highest with 100 kg N fed.-1, followed by 120 kg N fed.$^{-1}$. While the lowest benefit-cost ratio was obtained with 80 kg N fed.$^{-1}$ as presented in Figure 1.

Foliar with humic acid surpassed all bio-stimulators treatments in the net benefit-cost ratio (Figure 2).

Concerning the effect of interaction between N-fertilizer level and bio-stimulators treatments, Figure 3 showed that 100 N fed.$^{-1}$ with humic acid gained the highest net benefit-cost ratio followed by 100 N fed.$^{-1}$ with compost tea, in order in 2014/15 and 2015/16 seasons. Vachan and Tripathi [5] came to similar results and conclusion.

Conclusion

In conclusion, combination of fertilization of onion plants with 100 kg N fed.$^{-1}$ and foliar with humic acid at the rate of 1 kg fed.$^{-1}$ were found to be the best combined rates in this study for giving the highest bulb yield, with the highest net returns 12580 EGP, under the environmental conditions of this study. with B:C ratio of 2.35. While the highest cost of cultivation was obtained by 120 kg N fed.$^{-1}$ and spraying onion plants with humic acid, followed by compost tea. Also, from the economic view, the revenue of EGP is higher when used some bio-stimulators if compared with chemical fertilization.

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Volume 3 Issue 4 April 2019