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Response of Onion Plants to Minerals and Bio-fertilizers Application

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Abstract: Two field experiments were conducted during the two successive winter season of 2004/2005 and 2005/2006 at the Experimental Station of the National Research Center in Shalakan (Kalubia Governorate). This work aimed to study the effect of the combinations between three levels of NPK fertilizers i. e. 40, 70 and 100% of the recommended dose of NPK fertilizers application and bio-fertilizers (nitrobeine, Phosphorene, nitrobeine + Phosphorene) on growth, yield and quality of onion. Results show that the vegetative growth of onion plant, as well as bulbs yield and bulb quality were increased with increasing the level of mineral fertilizers application. Onion plant growth, bulbs yield and quality were affected by adding bio fertilizers. The mixture of nitrobeine + Phosphorene gave the highest values of all parameters studied followed by adding nitrobeine. But the lowest values were recorded with using Phosphorene. As for the interaction effect, results clear that adding 70% of the recommended dose of minerals fertilizer with the mixture of nitrobeine + Phosphorene gave the best vegetative growth, bulbs yield and quality. Nitrate accumulation in onion bulbs were increased with increasing the level of mineral fertilizers application. Using nitrobeine gave the highest values of No_3-N followed by the mixture of nitrobeine + Phosphorene, however the lowest values were recorded with adding Phosphorene. Results also clear that nitrate content is less than the critical level for human health.

Key words: Onion, mineral fertilizer, bio-fertilizer, bulbs yield, quality, nitrate.

INTRODUCTION

Onion (*Allium cepa L.*) is one of the most important vegetable crops grown in Egypt, not only for local consumption but also for exportation. Mineral fertilizers play an important role of onion plant growth and productivity. Nitrogen is essential for synthesis of chlorophyll, enzymes and proteins. Phosphorus is essential for root growth, phospho-proteins, phospholipids and ATP, ADP formation. Potassium play an important role of promotion of enzymes activity and enhancing the translocation of assimilates and protein synthesis[1].

Many investigators reported that the vegetative growth of onion plants and minerals uptake were increased with increasing the level of NPK-fertilizers[2,3,4]. Moreover Haggag *et al*,[5], Sato[6], Setty *et al*,[7], Rizk[3] and EL-Desuki[8] reported that total bulb yield and bulb quality were improved by increasing the level of NPK-fertilizers.

Although, the NPK-fertilizers application is essential for plant growth, development and yield productivity, but high level of mineral fertilizers may be decrease plant growth, bulbs yield and may led to increase in nitrate accumulation in onion bulb which is very dangerous on human health. Burden[9] reported that the fatal dose is about 15-70 mg NO_3-N and 20 mg NO_2-N per every kilogram of adult body weight. Moreover, the World Health Organization has tentatively fixed the acceptable daily intake of nitrate at 3.65 mg/kg body weight and for nitrite at 0.13 mg/kg body weight. So that we try reducing the application of minerals fertilizers by using bio-fertilizers.

Bio-fertilizers i. e. nitrobeine has greater amounts of bacteria which were responsible for fixation of nitrogen by atmosphere. Application of nitrobeine achieved the following merits, decreasing the amount of mineral-N by 25% and increasing the availability of various nutrients by plant[10]. Moreover, the inoculation of legumes seeds crops with associative N-fixing bacteria led to improve of plant growth and yield[11,12]. Moreover, many researchers reported that using bio-nitrogen-fertilizers with adding minerals or organic fertilizers led to improved the vegetative growth, yield and quality of garlic[13,14].

Immobilization of phosphorus is the most important problem of phosphate fertilization in Egypt, i. e. due to soil alkalinity phosphorus of the applied fertilizers could be converted to unavailable form for plant absorption. Phosphorene is a bio-fertilizer product containing active micro-organisms hydrolyzing the insoluble phosphate into soluble one under high soil pH. Therefore, the utilization of bio-fertilizers may be dissolve the unavailable form of phosphate to available form and reduce rate of chemical fertilizers application. Adding bio-phosphorus-fertilizers led to significantly increased in vegetative growth, yield and quality of onion[15,16] and tomato[17,18].

This work aimed to study the response of onion to utilization of bio and minerals fertilizers and possibility of reducing the amount of minerals fertilizers application.

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MATERIALS AND METHODS

Two field experiments were conducted during the two successive winter season of 2004/2005 and 2005/2006 at the Experimental Station of the National Research Center in Shalakan (Kalubia Governorate). This work aimed to study the effect of the combinations between three levels of NPK fertilizers i. e. 40, 70 and 100% of the recommended dose of NPK fertilizers application and bio-fertilizers (nitrobeine, Phosphorene, nitrobeine + Phosphorene) on growth, yield and quality of onion. The amount of mineral fertilizers were divided into two equal portions. First portion was applied during soil preparation and the second at 45 days after transplanting.

Amount of minerals fertilizers application as kg/fed.:

NPK% of recommended dose	Ammonium sulphate (20.5 % N)	Calcium superphosphate (15.5% P_2O_5)	Potassium sulphate (48% K_2O)
40 %	200	200	80
70 %	350	350	140
100 %	500	500	200

Bio-fertilizers i. e. nitrobeine and phosphoren are the commercial products contains active micro-organisms which were responsible for fixation of nitrogen by atmosphere and hydrolyzing the insoluble phosphate into soluble one under high soil-pH, respectively. Bio-fertilizers adding with the first irrigation (at transplanting).

Onion seedling cv. Giza 20 were transplanted at the second week of December in the two seasons. Seedlings were planted on ridges of 75 cm width and 5 m in length at 10 cm apart. Each plot included 5-redges and the plot area was 18.75 m^2. This experiment was arranged in split plot design in three replicates. Where NPK fertilizers levels were arranged in the main plots and bio-fertilizers were distributed randomly in the sub-plots. Experimental soil was clay loame in texture with pH 8.1 and the Table (A) show NPK content of the experimental soil.

Data recorded:

Vegetative growth: Random sample of ten plants from each plot were taken at 75 days after transplanting and the plant height (cm), number of leaves, diameter of bulb and nick as well as fresh and dry weight of whole plant were recorded.

Table A: The chemical characteristics (N, P and K) of the experimental soil.

	Available NPK (ppm)		
Season	N	P	K
2004/2005	90	25	72
2005/2006	88	21	66

Yield: Exportable yield (bulbs with 3.5 to 5.5 cm in diameter), local yield (bulbs more than 5.5 cm or less than 3.5 cm in diameter), unmarketable yield (cull bulbs and doubled bulbs) as well as total bulb yields were recorded as ton/fed.

Bulb quality: Random sample of 30 bulbs from each plot was taken and average bulb weight, TSS, carbohydrate, N%, P%, K% and NO_3-N contents were assayed in onion bulb. Total soluble solids (TSS %) were determined by using Carl Zies refractometer. Carbohydrate content were determined according to the method which described by Dubois *et al.*,[19]. Total nitrogen and NO_3-N content were determined according to the methods described by Black[20]. Phosphorus and potassium contents were determined according to the methods mentioned by Troug and Mayer[21] and Brown and Lilleland[22] respectively.

The obtained data were statistically analyzed according to the method described by Gomez and Gomez[23].

RESULTS AND DISCUSSIONS

Vegetative growth;

Effect of mineral fertilizers application: Results in Table (1) show the effect of NPK-fertilizers application on onion plant growth parameters i.e. plant height, number of leaves and bulbing ratio as well as fresh and dry weight of plant. Data clear that all vegetative growth parameters were significantly response to increasing the levels of minerals fertilizers application from 40, 70 up to 100% of the recommended dose of onion fertilization. These results were true in both growing seasons. This result may be due to the role of nitrogen on chlorophyll, enzymes and proteins synthesis and the role of phosphorus on root growth development, phospho-proteins and phospho-lipids formation as well as the role of potassium on promotion of enzymes activity and enhancing the translocation of assimilates. This result are in harmony with those reported by Singh *et al.*,[2], Rizk, [3], El-Desuki and Sawan[4] and EL-Desuki[8].

Effect of bio-fertilizers application: Data in Table (2) show that all vegetative growth parameters were significantly affected by using bio-fertilizers. Results clear that using mixtures of nitrobeine and phasphorene gave the highest vegetative growth characters followed by using nitrobein but the lowest values of vegetative growth of onion plants were recorded with using phasphorene as shown in both seasons. This result may be due to the role of bio-fertilizers i. e. nitrobeine on fixation of nitrogen by atmosphere which increasing the availability of nitrogen to plant absorption[10] and the role of phasphorene on

Table 1: Vegetative growth of onion plants as affected by mineral fertilizers application.

NPK-Fertilizer	Plant height (cm)	Number of leaves	Bulbing ratio	Fresh weight (g/plant)	Dry weight (g/plant)
First season, 2004/2005					
40%	51.88	7.44	0.50	88.99	18.14
70%	59.29	9.04	0.54	116.38	19.82
100%	66.03	9.83	0.55	128.35	22.70
L.S.D.	0.98	0.53	0.02	2.98	1.24
Second season, 2005/2006					
40%	54.61	8.11	0.53	96.00	19.44
70%	62.88	10.00	0.56	124.44	21.33
100%	68.57	10.56	0.58	138.67	24.58
L.S.D.	1.45	0.31	0.02	3.19	1.08

Table 2: Vegetative growth of onion plants as affected by bio-fertilizers application.

Bio-Fertilizer	Plant height(cm)	Number of leaves	Bulbing ratio	Fresh weight (g/plant)	Dry weight (g/plant)
First season, 2004/2005					
Nitrobeine	57.93	8.32	0.54	111.24	19.60
Phosphorene	56.25	8.51	0.47	103.45	18.25
Nitrob. + Phospho.	63.02	9.49	0.57	119.03	22.81
L. S. D.	1.36	0.34	0.03	2.932	0.74
Second season, 2005/2006					
Nitrobeine	61.21	9.00	0.56	119.82	21.17
Phosphorene	58.98	9.00	0.49	110.76	19.68
Nitrob. + Phospho.	65.87	10.67	0.62	128.53	24.50
L. S. D.	1.75	0.34	0.04	3.62	0.83

hydrolyzing the insoluble phosphate into soluble one. This results are in harmony with those reported by Wange[13], Rizk and Shafeek[12] and Ali, *et al.,* [14] as well as EL-Sheekh[15], El-Kalla, *et al.,*[16] and Amer, *et al.,* [18].

Effect of the interaction treatments: Data in Table (3) show the effect of the interaction treatments between minerals and bio fertilizers application on vegetative growth of onion plants. Results clear that all vegetative growth parameters (plant height, number of leaves and bulbing ratio as well as fresh and dry weight of plant) were significantly affected by the interaction treatments as shown in both growing seasons. The highest vegetative growth parameters were recorded with plants received high level of minerals fertilizers (100% of the recommended dose of onion fertilization) in addition to bio-fertilizers (nitrobeine + phasphorene). However, the lowest values of vegetative growth were recorded with adding low level of NPK-fertilizers (40%) with phasphorene.

This results may be due to the role of NPK-fertilizers on promotion on vegetative growth of onion plants as discussed in (Table,1) and the role of bio-fertilizers (nitrobeine + phasphorene) on increasing the availability of nutrients(nitrogen and phosphorus) to plant absorption which in turn on increasing the vegetative growth of onion plants.

Bulbs yield and its quality:

Effect of minerals fertilizers: Data in Table (4) show the effect of NPK-fertilizers on total bulbs yield, marketable yield (exportable and local) and unmarketable yield (cull and doubled bulbs) as well as bulb quality. Data clear that the total bulbs yield and its components were gradually and significantly increased with increasing the level of NPK-fertilizers from 40, 70 up to 100% of the

Table 3: Vegetative growth of onion plants as affected by the interaction treatments between minerals and bio-fertilizers application.

Treatments						
NPK	Bio-fertilizers	Plant height(cm)	Number of leaves	Bulbing ratio	Fresh weight (g/plant)	Dry weight (g/plant)
First season, 2004/2005						
40%	Nitrobeine	48.13	6.30	0.51	89.65	17.84
	Phosphorene	51.16	7.63	0.44	85.06	16.85
	Nitrob. + Phospho.	56.35	8.40	0.54	92.25	19.73
70%	Nitrobeine	59.31	8.70	0.53	114.52	19.33
	Phosphorene	56.00	8.57	0.49	109.10	18.07
	Nitrob. + Phospho.	62.56	9.87	0.59	125.51	22.05
100%	Nitrobeine	66.34	9.97	0.57	129.54	21.63
	Phosphorene	61.60	9.33	0.48	116.19	19.84
	Nitrob. + Phospho.	70.15	10.20	0.59	139.33	26.64
	L. S. D.	2.35	0.58	N.S.	5.08	1.27
Second season, 2005/2006						
40%	Nitrobeine	50.67	7.00	0.54	96.00	19.13
	Phosphorene	53.50	8.00	0.45	91.73	18.43
	Nitrob. + Phospho.	59.67	9.33	0.60	100.27	20.77
70%	Nitrobeine	63.13	9.67	0.55	122.67	20.35
	Phosphorene	60.00	9.00	0.51	117.87	19.37
	Nitrob. + Phospho.	65.50	11.33	0.63	132.80	24.27
100%	Nitrobeine	69.83	10.33	0.60	140.80	24.03
	Phosphorene	63.43	10.00	0.50	122.67	21.23
	Nitrob. + Phospho.	72.43	11.33	0.63	152.53	28.47
	L. S. D.	3.03	0.59	N.S.	6.27	1.43

Table 4: Effect of mineral fertilizers application on bulbs yield and its quality.

NPK-Fertilizer	Marketable yield (ton/fed.)		Unmarketable yield (ton/fed.)		Total yield (ton/fed.)	Bulb quality						
	Export.	Local	Cull	Doubled		Weight(g)	TSS	Carbohydrate	N%	P%	K%	NO_3-N(ppm)
First season, 2004/2005												
40%	3.34	2.68	0.15	0.25	6.42	90.60	10.81	14.14	1.25	0.27	1.11	288.46
70%	4.94	3.44	0.18	0.27	8.82	118.16	11.96	15.57	1.93	0.38	1.42	368.20
100%	4.85	3.55	0.28	0.28	8.90	165.12	12.37	15.16	2.16	0.48	1.65	389.37
L.S.D.	0.33	0.13	0.03	N.S.	0.44	2.56	0.10	0.42	0.07	0.03	0.07	1.36
Second season, 2005/2006												
40%	3.57	2.97	0.18	0.29	7.01	96.67	11.57	14.81	1.33	0.30	1.22	268.71
70%	6.05	3.92	0.21	0.31	10.49	127.11	12.73	16.21	2.02	0.45	1.57	339.74
100%	5.29	4.05	0.33	0.35	10.03	179.00	13.14	15.76	2.24	0.55	1.81	360.00
L.S.D.	0.25	0.13	0.02	N.S.	0.35	1.42	0.05	0.48	0.09	0.02	0.09	2.35

Table 5: Effect of bio-fertilizers application on bulbs yield and its quality.

Bio-Fertilizer	Marketable yield (ton/fed.)		Unmarketable yield (ton/fed.)		Total yield (ton/fed.)	Bulb quality						
	Export.	Local	Cull	Doubled		Weight (g)	TSS	Carbohydrate	N %	P %	K %	NO_3-N(ppm)
First season, 2004/2005												
Nitrobeine	4.12	3.17	0.17	0.28	7.73	120.48	11.60	14.79	1.75	0.29	1.33	360.73
Phosphorene	3.33	3.10	0.24	0.29	6.98	113.51	11.09	13.94	1.55	0.35	1.14	338.37
Nitrob. + Phospho.	5.67	3.39	0.20	0.23	9.49	139.90	12.44	16.14	2.04	0.48	1.72	346.92
L. S. D.	0.38	0.07	0.02	N.S.	0.38	4.37	0.14	0.30	0.11	0.02	0.09	0.98
Second season, 2005/2006												
Nitrobeine	4.60	3.62	0.20	0.33	8.75	127.33	12.38	15.37	1.87	0.34	1.47	332.43
Phosphorene	3.57	3.52	0.29	0.37	7.74	124.22	11.86	14.59	1.62	0.39	1.26	311.30
Nitrob. + Phospho.	6.74	3.80	0.23	0.26	11.03	151.22	13.21	16.82	2.10	0.57	1.87	324.72
L. S. D.	0.36	0.08	0.03	N.S.	0.40	3.85	0.23	0.39	0.09	0.04	0.10	1.92

recommended dose of fertilization. Except for, doubled bulbs which were not significantly affected by levels of mineral fertilizers application as shown in both seasons.

Results also clear that the bulb quality i. e. average weight, TSS, N, P, K and carbohydrate content as well as nitrate accumulation were gradually increased with increasing the level of NPK-fertilizers application. These results were true in both seasons. These results may be due to the role of minerals fertilizers on promotion of onion plant growth as shown in Table,1 which in turn on increasing bulbs yield and improving bulb quality as a results of increasing the level of mineral fertilizers application. These results are in harmony with those reported by Singh *et al.*,[2], Setty *et al*,[7], Rizk[3], EL-Desuki and Sawan[4] and EL-Desuki[8].

Effect of bio-fertilizers: Results clear that the marketable yield (exportable and local), cull bulbs and total bulbs yield were significantly affected by using bio-fertilizers (Table, 5). However, doubled bulbs were not significantly affected. This trend was noticed with bulb quality (average bulb weight and TSS, carbohydrate, N, P, K content) These results were true in both growing seasons. Generally, the highest values of total yield and its components as well as bulb quality were recorded with using the mixture of nitrobeine and phosphorene followed by adding nitrobeine. However, the lowest values were recorded with phosphorene application as shown in both seasons.

Respecting No_3-N content, results clear that the highest values of nitrate accumulation was recorded with adding nitrobeine followed by adding the mixture of nitrobeine and phosphorene, but the lowest values were recorded with using phosphorene.

Effect of the interaction treatments: Data in Table (6) show that the total bulbs yield and its components as well as bulb quality were significantly affected by the interaction treatments between mineral and bio-fertilizers application as shown in both growing seasons. Data clear that the highest values of total yield and its components were recorded with using bio-fertilizers (mixture of nitrobeine and phosphorene) followed by using nitrobeine but the lowest values were recorded with those received phosphorene under different levels of NPK-fertilizers. Results also show that the highest values of exportable, local and total yield were recorded with plants received 70% of minerals fertilizers application with using nitrobeine and phosphorene. However the lowest values were recorded with those received 40% of minerals fertilizers application with using phosphorene as shown in both growing seasons. Results also clear that the bulb quality i. e. average bulb weight and TSS, carbohydrate, N, P, K contents were significantly affected by the interaction treatments between levels of minerals fertilizers and bio-fertilizers application. The highest values of average bulb weight and TSS, N, P, K contents were recorded with plants received the highest level of minerals fertilizers (100%) with using mixture of nitrobeine and phosphorene. However, carbohydrate content gave the highest values with adding 70% of minerals fertilizers with using mixture of nitrobeine and phosphorene. But the lowest values of bulbs quality were recorded wit adding 40% of minerals fertilizers with phosphorene as shown in both seasons.

This results may be due to the role of minerals fertilizers on promotion of onion plants growth and the role of bio-fertilizers on increasing the availability of nitrogen and phosphorus to onion plant absorption which

Table 6: Effect of interaction treatments between mineral and bio-fertilizers application on bulbs yield and its quality.

Treatments		Marketable yield (ton/fed.)		Unmarketable yield (ton/fed.)		Total yield	Bulb quality						
NPK	Bio-fertilizers	Export.	Local	Cull	Doubled	(ton/fed.)	Weight (g)	TSS	Carbohydrate	N%	P%	K%	NO_3-N(ppm)
First season, 2004/2005													
40%	Nitrobeine	3.09	2.56	0.13	0.24	6.02	91.35	10.90	13.93	1.17	0.23	1.11	307.20
	Phosphorene	2.71	2.50	0.20	0.30	5.71	76.80	10.33	13.73	1.21	0.24	0.99	272.03
	Nitro. + Phosp.	4.21	2.97	0.13	0.22	7.53	103.65	11.19	14.75	1.38	0.32	1.25	286.13
70%	Nitrobeine	4.95	3.39	0.16	0.26	8.76	114.31	11.82	15.23	2.03	0.29	1.28	378.90
	Phosphorene	3.13	3.31	0.23	0.30	6.96	112.92	11.07	14.29	1.47	0.37	1.15	360.00
	Nitro. + Phosp.	6.75	3.61	0.15	0.23	10.75	127.27	12.99	17.18	2.28	0.48	1.84	365.70
100%	Nitrobeine	4.32	3.56	0.21	0.33	8.43	155.79	12.09	15.20	2.05	0.36	1.60	396.10
	Phosphorene	4.17	3.51	0.30	0.28	8.26	150.80	11.88	13.79	1.97	0.44	1.29	383.07
	Nitro. + Phosp.	6.05	3.58	0.32	0.24	10.19	188.79	13.13	16.48	2.46	0.65	2.06	388.93
	L. S. D.	0.66	0.12	0.04	N.S.	0.62	7.57	0.24	0.52	0.20	0.04	0.15	1.70
Second season, 2005/2006													
40%	Nitrobeine	3.35	2.88	0.16	0.28	6.67	95.67	11.67	14.67	1.30	0.26	1.22	283.62
	Phosphorene	2.77	2.77	0.24	0.35	6.13	81.67	11.13	14.38	1.27	0.26	1.10	250.27
	Nitro. + Phosp.	4.58	3.27	0.14	0.24	8.23	112.67	11.90	15.38	1.42	0.39	1.34	272.24
70%	Nitrobeine	5.81	3.90	0.19	0.30	10.21	117.00	12.50	15.68	2.14	0.36	1.44	348.59
	Phosphorene	3.51	3.86	0.27	0.37	8.01	126.00	11.88	14.87	1.55	0.42	1.23	329.87
	Nitro. + Phosp.	8.83	4.00	0.17	0.26	13.25	138.33	13.82	18.08	2.36	0.57	2.05	340.78
100%	Nitrobeine	4.65	4.09	0.24	0.41	9.38	169.33	12.97	15.75	2.16	0.41	1.74	365.08
	Phosphorene	4.42	3.93	0.37	0.38	9.10	165.00	12.57	14.52	2.03	0.48	1.45	353.75
	Nitro. + Phosp.	6.81	4.13	0.38	0.28	11.60	202.67	13.90	17.00	2.52	0.76	2.23	361.15
	L. S. D.	0.63	0.13	0.05	N.S.	0.70	6.66	0.40	0.67	0.15	0.06	0.18	3.33

in turn on increasing total bulbs yield and its components as well as improving bulb quality. This result are in harmony with those reported by Sato[6], Setty *et al*, [7], Rizk[3], EL-Desuki and Sawan[4] and EL-Desuki[8], they reported that the total onion bulbs yield and its components as well as bulb quality were improved by increasing the level of minerals fertilizers application. Moreover, Wange[13], Rizk and Shafeek[12]and Ali, *et al.*,[14] as well as EL-Sheekh[15], El-Kalla, *et al.*,[16] and Amer, *et al.*,[18], they mentioned that using bio-fertilizers improved vegetative growth, yield and quality of many vegetable crops.

With respect to nitrate accumulation of onion bulbs, results clear that the highest values of NO_3-N-accumulation were recorded with added 100% of NPK-fertilizers with using nitrobeine followed by using 100% of NPK-fertilizers with mixture of nitrobeine and phosphorene and followed by adding 100% of NPK-fertilizers with phosphorene. But the lowest values were recorded with adding low level of minerals fertilizers application with phosphorene as shown in both seasons. Generally, NO_3-N-accumulation were gradually increased with increasing the levels of minerals fertilizers application as well as increasing with using nitrobeine followed by using mixture of nitrobeine and phosphorene and the lowest values were recorded with using phosphorene under different levels of minerals fertilizers application. Results also clear that nitrate content is less than the critical level for human health.

This result may be due to the role of nitrogen-fertilizer and bio-fertilizers (nitrobeine) application on increasing the availability of nitrogen to onion plant absorption which increasing the accumulation of nitrate on onion bulbs. This result are in harmony with those reported by EL-Desuki and Sawan[4] and EL-Desuki[8].

Finely, from the previous mentioned results we could concluded that using 70% of the recommended dose of NPK application (350 kg ammonium sulphate, 350 kg calcium superphosphate and 140 kg potassium sulphate / fed.) with using bio-fertilizers (mixture of nitrobeine and phosphorene) were recommended to obtain the highest bulbs yield with the best quality and reducing nitrate accumulation in onion bulbs.

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