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Performance of a nutritional compound on onion plants under the influence of P-fixing bacteria in clay loam soil

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ABSTRACT

Two farm experiments were completed at private farm in Qalyobia Governorate, Egypt through the two sequent winter seasons of 2016/2017 and 2017/2018. The research aimed to investigate the influence of soil inoculation of P-fixed bacteria at levels of (0, 1 and 2 kg/fad.) with foliar sprinkle of a nutrient compound (Aquacool) on the growth, total bulbs yield and its components as well as bulb physical quality of onion plants cv Giza 20 grown in clay loam soil conditions. The obtained results specified that, the biggest values of plant growth criterion were achieved when sprinkle by highest level of Aquacool up to (2 cm/L) with inhibition to soil inoculation with P-fixed bacteria (phosphorein) has been set at rising standard (2 kg/fed.) as disparity to the other interaction treatments. These results held well in the two empirical seasons.

Keywords: onion- P-fixed bacteria, Aquacool, growth, total yield, bulb quality.

1. Introduction

Onion (*Allium cepa* L.) is substantial bulb crop of Egypt. As a vegetable, it is a depressed in fat and calories. It also contributes to the human diet and has a curative estate. Onion is an exporter of ascorbic acid and dietary fiber too. It furthermore possesses a big satisfaction of flavanoids (fundamentally quercetin and its conjugates) and sulpher compounds (i.e. thiosulphinates), both of which have a biggest levels of antioxidant vigor (Griffiths *et al.,* 2002).

P deposition is the maximum essential problem under soil possesses highest pH and calcium carbonate. P-fixed bacteria (Phosphorien) is a bio-fertilizer output - restrain which hydrolyzes the unsolvable phosphate into dissoluble one under the before mentioned reverse status. Complement bio-phosphorus-fertilizers lead to improving vegetative growth and total yield of onion plant (Shaheen, *et al.,* 2007). The flow directions in cultivation are concentrated on decreasing the use of inorganic fertilisers through the implementation of phosphor bio-fertilizers (Gyaneshwar, *et al.,* 2002 and Hussain, *et al*., 2013). Phosphate solubilizing microorganisms are vigorous in solution P from inorganic and organic stake of total soil P over solubilization and mineralization (Chen *et al.,* 2006). Phosphate solubilizing bacteria such as *Bacillus* sp and *Pseudomonas* sp could drive to increase the growth and yield of vegetable crops (Shafeek, *et al.,* 2004; Arguello *et al*., 2006; Darzi, *et al.,* 2012 and Bhandari, *et al.,* 2012). However, for vegetables, complement of bio-fertilizer single elevate growth 4 times. Moreover, an improving of growth by 7 times was dotted due to the complement of mineral fertilizers, in combination with the bio-fertilizer (Leaungvutiviroj *et al.,* 2010). In addition, Nainwal *et al.* (2015) reported that with pollination by phosphate solubilizing bacteria can elevate yield and profitability ratios of garlic plants. In the same respect, Shafeek *et al*. (2018) recorded that vitality plant growth and total yield of garlic plants by soil pollination at high level (2 kg/fed.) of P-fixing bacteria (phosphorein) through in downward request by that plants by (1 kg/fed.) pursue without P- fixing bacteria.

Now in Egypt, there are many foliar fertilizers contain the farthest macro and micro elements especially applied to proper any insufficiency in soil. So, foliar sprinkle beat this case (Hegab *et al.,*

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1987). On the other hand, Hassan *et al.* (2013) established that, foliar spraying with both Fe and Zn gave significantly improving in total yield and Fe, Zn and K uptake of plants. The technique work of these nutrients in metabolism operation was qualified by (Savitha 2008) as he recorded that, the implementation of some minerals as foliar sprinkle increasing plant growth, fruit yield and its physical and chemical estate of crops. In the same respect, Bhatt *et al.* (2004) found the impact of foliar application of micronutrients on yield and economics and tendency of tomato. They reported that foliar spraying of Fe SO_4 at 0.01 per cent significantly improved yield per ha which might be attributed to increasing photosynthetic competence and improve proliferation and combination of carbohydrate. However, Shafeek *et al.* (2013) reported that foliar spraying with different levels of nutritional compound stimufol significantly improved the plant growth parameters such as plant height, number of leaves and branches, fresh and dry weight of leaves and branches as well as whole plants also improved pod length, average weight of pod and total yield as ton/fed and it gave the biggest values of the proportion of protein and nitrogen as well as Fe and Mn (mg/g dry weight) of broad bean seeds with notability by spraying of high application (200 g/fed.). However, Shafeek, *et al.* (2014) found that the vitality plant growth such as number of leaves/plant and net assimilation rate (NAR) and the biggest total fruits yield and its components as well as the high signification of the percentage of N, K and protein of hot pepper fruits tissues were gained with that plants which sprayed by nutritional fertilizers at level of 3 L/fed. Moreover, Shafeek *et al.,* (2018) acquired specified that the vigor plant growth such as plant length, number of leaves/plant and fresh weight of leaves per plant and the biggest total bulbs yield and its component (bulb and neck diameter, number and weight of clove and TSS %) as well as the high content of the proportion of N, P, K and protein of garlic cloves tissues were disclose with that plants which sprayed as nutritional (Aquacool) at highest level (2 cm/L). In addition, Shafeek *et al* (2021) found that, sprinkle with high concentration (2 cm/L) of nutrient compound (Aquacool) gave the biggest values of plant height, number of leaves/ plant, leaves fresh and dry weight, total roots yield and its components (root weight, length and diameter) as well as highest contents of the percentage of N, P, K, total sugar and vitamin C in root tissue of beetroot plants.

2. Materials and Methods

Two field experiments were conducted on a private farm in Qalyobia Governorates Egypt during the two growing seasons of 2017 and 2018 in order to study the effect of soil inoculations of different levels of P-fixers bacteria Phosphorein (0, 1 and 2 kg/fed.) with various concentrations of nutritional compound (Aquacool) foliar application at (0, 1 and 2 cm /L.) on vegetative growth, total yield characters and bulb quality of onion plants (L.) cv. Giza 20. The physical and chemical properties of soil are shown in Table (1).

Table 1: Physical and chemical properties of the experimental soil during both seasons.

Depth (cm)	pH	Texture	Anions (mg/100g soil)			Cations (mg/100g soil)				Total nitrogen (mg\100g)
			Ci	P	SO_4	Na	K	Ca	Mg	
0-15	8.1	clay	0.52	4.8	2.20	1.50	0.15	9.00	0.50	123.0
15-30	8.1	clay	0.38	5.6	1.60	1.20	0.07	4.00	0.25	137.0

Aquacool is a commercial product containing macro nutrients such as N (7%), P (5%), K (5%), Mg (1%) and micro nutrients such as B (0.05%), Fe (0.3%) and S (2.1%) as well as amino acids. Phosphorus (P_2O_5) was applied 100 kg/fed. each at the time of soil preparation. The nitrogen fertilizer at 120 units/fed. as ammonium sulphate (20.6%) was side dressed in two equal portions 60 and 90 days after transplanting date. However, potassium fertilizer at rate of 90 unit of K_2O/fed. was added as potassium sulphate at 75 and 90 days old. Every experiment included 9 treatments which were the combinations between two levels of P-fixers (Phosphorein) at rate of (1 kg/fed and 2 kg/fed.) plus control treatment without bio-fertilizer with foliar spray of two levels of nutrient compound of (Aquacool) at concentration of (1 and 2 cm/L) plus control treatment (foliar spraying with water). Onion seedlings were transplanted on 19th of December for two seasons. Onion seedlings were transplanted at 25 cm distances on the two sides of each ridge. Pest control and other agriculture

practices were applied as commonly recommended for commercial onion production by Ministry of Agriculture. The experimental design was split plot with 3 replications, where the nutrient compound of (Aquacool) treatments were assigned in the main plots and bio fertilizer treatments were devoted within the subplots. The experimental plot area was 10.5 m^2 and included 5 rows (each was 3.5 m length and 60 cm width) and the distance between plants was 10 cm. The normal cultural practices i.e. irrigation, fertilizer and pest control for the onion plant productions were followed. The inoculation by bio fertilizer P-fixers (Phosphorein) was added at transplanting date. However, foliar spraying of nutrient compound (Aquacool) was achieved after 20 days from sowing date, every 10 days intervals for three times. Plant samples were taken 60 days after transplanting where five plants were chosen from each sub plot and the following data were recorded: plant length (cm), number of leaves per plant, fresh and dry weight of leaves as g/ plant. Yield of each sub plot was weighed and expressed as tons per feddan, bulb fresh and dry weight (g) as well as TSS % was recorded. For the some physical properties of onion bulbs samples of 20 bulbs were taken from each experimental plot and nick diameter as well as bulb length (cm), width (cm), and bulbing ratio were recorded.

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

All obtained data were subjected to the statistical analysis and means were compared according to LSD at 5% level test described by Gomez and Gomez (1984).

3. Results and Discussion

3.1. Vegetative growth characters

3.1.1. Effect of phosphorus bio fertilizer levels

The study reveal that plant growth characters like (plant length, number of leaves /plant, fresh and dry weight of leaves /plant) of onion plants were significantly improved due to soil inoculation with all the selected P-fixers bacterial (Phosphorein) rates compared to non-inoculated soil in both seasons (Table 2) and excessive increasing in plant growth was speckled in response to soil inoculation with phosphorein on high rates (2 kg/fed.). The superiority of the application of phosphorous and bacterial inoculation may be due to the promoting effects of the microorganisms of the inoculants on nutrients utilization. It may be due to the substantial function of phosphorus for the amplification of more universal root systems, which permits plants to uptake water and nutrients from deeper soil layers. This, in turn, could elevate the plants to reproduce more assimilate, which was reflected in high humidity and its component (Bhandari *et al.,* 2012). As a result, having a sufficient amount of phosphorus in root media promotes root growth and keeps roots healthy (Rady and Osman 2010). Phosphate solubilizing bacteria also memorize growth-promoting material like auxins, gibberellins, and cytokinins (Sabik *et al*., 2001). These substances improve plant growth and catalyze beneficial microbial amplification in the rhizosphere zone (Abdel-Rasoul *et al.,* 2002). Many investigator found similar finding on onion (Shaheen *et al.,* 2007) and on garlic (Badawy *et al.,* 2008).

3.1.2. Effect foliar spraying of nutritional compound fertilizer

Data relative in Table (2) found that foliar application with various levels of Aquacool significantly improved the growth parameters such as plant height, number of leaves, fresh and dry weight of leaves compared to control (water) in the two growing seasons. However, the most adequate effect in this attention was supplement Aquacool at level up to (2 cm/L). On the other hand, it significantly improved plant length, number of leaves per plant and fresh and dry weight of leaves compared to lower level of Aquacool (1 cm/L). These results were similar in the two seasons. The reputation of highest levels of Aquacool up to (2 cm/L) in improving plant growth may be reference to its high contents of macro and micro nutrients. This is probably due to provided that the plants with required nutrients which may one or more of them were insufficiently supply through the root system in such low fertile soil. During the last decades, foliar nutrition of nutrients has become a specific purchase in crop production to improve yield and increase the quality of crop produce (Roemheld and El-Fouly, 1999). Foliar spraying of nutrients could advance the nutrient action and lower environmental

pollution through decreasing the computation of fertilizers added to soil (Abou-El-Nour 2002). The obtained consequences are in good accordance with these which acquired by (El Fouly *et al*. 2010, Bozorgi *et al.* 2011; El Habbasha *et al.* 2012 and Shafeek *et al.* 2013).

3.1.3. Effect of interaction between phosphorus bio fertilizer and nutritional fertilizer

In connection with the interaction of both factors, data in Table (2) showed that, the change of vegetative growth of onion plants was not significant in both two seasons. The obtained data indicated that the biggest values of plant growth criterion were found when foliar application by highest level of Aquacool up to (2 cm/L) with inhibition to soil inoculation with phosphorein place on high rates (2 kg/fed.) as disparity to the other interaction treatments. These results held fully in the two empirical seasons.

Table 2: Effect of P-fixing bacteria and foliar spray of nutrient compound on growth characters of onion plant.

Bio fertilizer (kg/fed.)	Nutrient compound (cm/L)	2017 season				2018 season			
		Plant length (cm)	No. of leaves /plant	Weight (g)		Plant length (cm)	No. of leaves /plant	Weight (g)	
				Fresh	Dry			Fresh	Dry
0	0	55.00	6.00	24.50	3.00	65.33	5.67	28.60	3.87
	1	59.67	6.33	25.87	3.37	72.00	6.00	30.27	3.80
	2	62.33	6.67	27.50	3.47	74.00	6.67	31.27	3.90
	Main	59.00	6.33	25.96	3.28	70.44	6.11	30.04	3.86
1	0	62.67	7.00	29.30	3.67	71.33	7.00	32.33	4.07
	1	65.33	7.67	31.93	4.03	74.67	7.67	33.17	4.17
	2	68.00	8.00	33.97	4.30	75.67	8.33	35.63	4.33
	Main	65.33	7.56	31.73	4.00	73.89	7.67	33.71	4.19
2	0	71.33	8.67	36.47	4.57	76.67	7.00	39.40	4.97
	1	74.33	10.33	39.20	4.90	79.33	8.33	41.30	5.17
	2	75.67	11.67	42.40	5.13	79.67	9.00	44.00	5.60
	Main	73.78	10.22	39.36	4.87	78.56	8.11	41.57	5.24
Average	0	63.00	7.22	30.09	3.74	71.11	6.56	33.44	4.30
	1	66.44	8.11	32.33	4.10	75.33	7.33	34.91	4.38
	2	68.67	8.78	34.62	4.30	76.44	8.00	36.97	4.61
LSD at 5%	Bio	2.74	0.71	0.95	0.15	1.42	0.52	1.67	0.35
	Nutrient	1.28	0.26	0.77	0.12	1.62	0.26	0.90	0.13
	Interaction	NS	NS	NS	NS	NS	NS	NS	NS

3.2. Total bulb yield:

3.2.1. Effect of phosphorus bio fertilizer levels:

The conclusion comparative in Table (3) that strength soil inoculation with phosphorus bio-fertilizer (phosphorein) at (2 kg/fed.) which was previously had biggest significant simulative goods on onion plant growth had a similar convenient activity on its total yield and award high to stated improving as contrast with non vaccination phosphorus bio-fertilizers. It gave the highest onion total bulbs yield (ton/fed.) as well as the excellent yield components of bulb i.e., bulb fresh and dry weight (g) and TSS% in the two studied seasons. However, the soil inoculation applied at high rates (2kg/fed.) of bio-fertilizer (phosphorein) significantly increased total yield and its components compared to placed at once. The obtained total bulbs yield per fed. was (11.446 and 12.402 ton/fed.) for 1st and 2nd seasons, respectively, compared to the deficient phosphorus bio fertilizer control produced (7.640 and 7.308 ton/fed.) for 1st and 2nd seasons respectively (Table 3). The elevated effects of soil inoculation with phosphorien on onion yield can be due to the suitable effects of phosphorien on plant growth (Table 2) and leaves photosynthetic color contents, which may work together to elevate photosynthesis to go forward. Many investigators reported similar direction on onion (El-Desuki *et al.,* 2006 and Shaheen *et al.,* 2007) on garlic (Shafeek *et al.,* 2004 and Badawy *et al.,* 2008). Mostly, the soil inoculation with bio-fertilizer (phosphorein) increases the total yield of onion bulbs. It also supplies power in the form of ADP and ATP, which are essential for nutrition transport across the cell membrane, as well as the production of nucleic acid, proteins, and other photosynthates. However, there was no evidence of enhanced

rhizosphere phosphatase activity preventing inoculation with chosen bacterial lineages. Phosphatase enzymes may have been released by bacteria to resolve P accumulation in organic waste utilised in the form of farmyard manure. These outcomes are in conformity with some reports (Rady and Osman 2010 and Badawy *et al*., 2008).

3.2.2. Effect of foliar spring of nutritional compound fertilizer:

Data in Table (3) indicated that foliar sprinkle of different levels of nutritional fertilizer (Aquacool) significantly increased fresh and dry weight of bulb (g) and total yield as (ton/fed.) compared to the untreated treatment (control). Foliar sprinkle by high concentration of nutritional fertilizer (2 cm/L.) obtained its highest values of total yield (9.8078 and 10.6822 ton/fed.) for 1st and 2nd seasons respectively resemble (8.7567 and 9.1322 ton/fed.) for 1st and 2nd seasons respectively by without foliar sprinkle (Table 3). The assignment of micronutrients and other macro components in nutritional compounds to boost the metabolic process and conversion in plant growth is clearly responsible for these results. Outside of their immediate effect on the enzymatic restraint, foliar spray of micronutrients promoted the metabolic procedure in the plant (Peyve 1969). However, the direction of obtained result is in good accordance with that of the previous investigators such as (El Fouly *et al*., 2010; Bozorgi *et al.,* 2011; El-Habbasha *et al.,* 2012 and Shafeek *et al.,* 2013).

3.2.3. Effect of interaction between phosphorus bio fertilizer and nutritional fertilizer:

Table (3) establishes the interaction effect amongst soil vaccination by phosphorus bio fertilizer (phosphorein) and sprinkle by various levels of (Aquacool). It is obvious that the interaction was in significant in its effect on bulb fresh and dry weight, TSS % and total yield (ton/fed.). These results were original in the two seasons of study.

Table 3: Effect of P-fixing bacteria and foliar spray of nutrient compound on total yield and yield components of onion plant.

Bio fertilizer (kg/fed.)	Nutrient compound (cm/L)	2017 season				2018 season			
		Total yield (ton/fed.)	Bulb weight (g)		TSS %	Total yield (ton/fed.)	Bulb weight (g)		TSS %
			Fresh	Dry			Fresh	Dry	
0	0	7.3733	48.00	6.00	10.67	6.7200	57.33	7.07	10.00
	1	7.6867	51.67	6.47	12.33	7.5167	62.00	7.20	11.67
	2	7.8600	56.00	7.00	13.00	7.6867	65.33	7.80	13.50
	Main	7.640	51.89	6.49	12	7.308	61.56	7.36	11.72
1	0	8.2167	62.00	7.73	14.67	8.9000	60.67	7.60	15.17
	1	9.0833	68.33	8.53	15.33	9.5233	72.33	8.23	16.00
	2	9.5033	77.33	9.50	16.33	11.1400	88.00	9.77	16.67
	Main	8.934	69.22	8.59	15.44	9.854	73.67	8,53	15.94
2	0	10.6800	89.00	11.00	15.67	11.7767	105.00	10.70	17.00
	1	11.5967	97.67	11.47	16.00	12.2100	112.67	12.67	18.00
	2	12.0600	103.67	13.10	17.00	13.2200	119.67	13.37	18.33
	Main	11.446	96.78	11.86	16.22	12.402	112.44	12.24	17.78
Average	0	8.7567	66.33	8.24	13.67	9.1322	74.33	8.456	14.06
	1	9.4556	72.56	8.82	14.56	9.7500	82.33	9.37	15.22
	2	9.8078	79.00	9.87	15.44	10.6822	91.00	10.31	16.17
LSD at 5%	Bio	0.1466	5.90	0.49	0.69	0.5752	12.47	0.96	1.55
	Nutrient	0.1786	2.15	0.32	0.60	0.4648	3.78	0.44	0.48
	Interaction	NS	NS	NS	NS	NS	NS	NS	NS

3.3. Physical bulbs characters:

3.3.1. Effect of phosphorus bio fertilizer levels:

Neck diameter cm (1.89), bulb length cm (6.07) and bulb diameter (2.40) were recorded by soil inoculation with high rate (2kg/fed.) of bio fertilizer (phosphorein) (Table 4). The gained improvement in physical bulb characters might be attributed to the progression effect of soil inoculation by P-fixed bacteria on the plant growth which help absorbing more elements from the soil solution, consequently their values increased in bulbs (Shafeek *et al.,* 2012). The phosphorus bio fertilizer (phosphorein)

enhanced root growth that improve better uptake and translocation of these food substance through the bulbs.

3.2.3. Effect of nutritional compound fertilizer

The impact of nutrient fertilizer (Aquacool) on the physical bulb parameters of onion bulb was significant in both seasons (Table 4). However, increasing nutritional spraying levels up to (2cm/L.) improved the physical bulb characters such as (neck diameter, bulb length and diameter). Foliar application of (2cm/L.) resulted in further physical bulb characters compared with the other levels and control treatment. Moreover, foliar application of fertilizers can increase nutrient availability and uptake relatively in the new reclaim lands (El-Habbasha *et al*., 2012). These findings are similar in both seasons. The obtained outcome is in exemplary conformity with that reported by (Savitha 2008 and Shafeek *et al.,* 2013) on pepper.

3.3.3. Effect of interaction between phosphorus bio fertilizer and nutritional fertilizer

In connection with the impact of the interaction among phosphorus bio fertilizer levels and nutrient fertilizer, the effect was not significant on the physical bulbs parameters compared to control treatment (Table 4). However, the highest values of physical bulb parameters were recorded when foliar sprayed by highest level of Aquacool up to (2 cm/L) with inhibition to soil inoculation with phosphorein at high concentration (2 kg/fed.) as contrast to the other interaction treatments. These results held well in both two empirical seasons.

Table 4: Effect of P-fixing bacteria and foliar spray of nutrient compound on physical bulb quality of onion plant.

Bio fertilizer (kg/fed.)	Nutrient compound (cm/L)	2017 season				2018 season			
		Neck diameter (cm)	Bulb (cm)		Bulbing Ratio	Neck diameter (cm)	Bulb (cm)		Bulbing ratio
			length	Width			Length	Width	
0	0	0.86	3.70	1.23	0.65	1.27	4.30	1.50	0.86
	1	0.94	4.13	1.40	0.62	1.40	4.67	1.77	0.85
	2	1.03	4.50	1.60	0.64	1.43	5.00	1.80	0.87
	Main	0.94	4.11	1.41	0.64	1.37	4.66	1.69	0.86
1	0	1.14	4.87	1.80	0.64	1.63	5.13	1.87	0.88
	1	1.17	5.20	1.97	0.60	1.67	5.47	2.00	0.88
	2	1.22	5.40	2.13	0.62	1.70	5.67	2.17	0.77
	Main	1.18	5.16	1.97	0.62	1.67	5.42	2.01	0.85
2	0	1.42	5.60	2.23	0.60	1.77	5.73	2.30	0.76
	1	1.62	5.83	2.40	0.66	1.90	6.10	2.37	0.78
	2	1.77	6.00	2.53	0.70	2.00	6.37	2.53	0.80
	Main	1.60	5.81	2.39	0.65	1.89	6.07	2.40	0.78
Average	0	1.14	4.72	1.76	0.63	1.56	5.06	1.89	0.83
	1	1.24	5.06	1.922	0.63	1.66	5.41	2.04	0.84
	2	1.39	5.30	2.09	0.65	1.71	5.68	2.17	0.82
LSD at 5%	Bio	0.11	0.23	0.13	NS	0.14	0.22	0.06	NS
	Nutrient	0.06	0.10	0.07	NS	0.05	0.15	0.05	NS
	Interaction	NS	NS	NS	NS	NS	NS	NS	NS

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