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EFFICIENCY OF BIO-FERTILIZATION UNDER DIFFERENT NITROGEN LEVELS ON THE PRODUCTIVITY AND CHEMICAL COMPOSITION OF ONION

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ABSTRACT: *Two field experiments were carried out during the two successive winter seasons of 2013 / 2014 and 2014/ 2015 on onion plants (Allium cepa L.) cv. Giza 20, grown in a sandy loam soil at El-kasasin, Farm (30° 33′ 31″ N- 30° 56′ 7″ E, elev. 15.8 m), Ismailia Governorate, Egypt to study the effect of three N fertilizer levels (60, 90 and 120kg N/ fed.) under four biofertilizer treatments , which were uninoculated control (without bacterial cells) Azotobacter and/or Azospirillum as well as their interaction on yield and yield attributing characters, bulb contents of minerals and some biochemical compounds and storability of onion bulb. The results showed significant increases in yield and yield attributing characters, mineral content and some biochemical compounds by increasing the rate of mineral nitrogen or inoculation with the tested N2-fixers.*

In addition, the dual inoculation with Azotobacter and Azospirillum performed significantly greater single inoculation. At any level of N-fertilizer, the inoculated treatments gave higher yield and yield attributing characters than the uninoculated one. Nitrogen application at 60 kg N/fed. combined with mixed bio-fertilizer resulted minimum physiological loss in weight (%) for onion bulbs during the first 60 days of storage period. But with extending storage period, the increasing nitrogen had adverse effect on storability of bulbs.

Interaction between N levels and bio-fertilizer treatments exerted significant effects for most of the studied characters and revealed that application of N at 90 or 120 kg N/fed combined with mixed bio-fertilizer gave the best results, however the most effective treatment was N application at 90kg N/fed with mixed bio-fertilizer, thus reducing N-fertilizer used without reducing of production or increasing of environmental pollution. It could be concluded that, the amount of mineral N-fertilizer could be reduced by using bio-inoculation, which in turn increases soil fertility as well as, minimizes the production cost and environmental pollution, which can occur by the excess use of chemical fertilizers.

Key words: *Azotobacter, Azospirillum, Chemical constituents, Inoculation, Nitrogen fertilizer, Nutrients content and Onion plants*

INTRODUCTION

Onion *(Allium cepa* L.*)* is one of the most important vegetable crops grown and used throughout the world. Onion being among the high nitrogen demanding vegetables, its productivity depends on the use of optimum fertilizer rates and if not adequately fertilized, considerable yield losses are apparent. Nowadays modern agriculture depends heavily on use of mineral fertilizer for boosting crop yield. However, these fertilizers are often in short supply and their indiscriminate use has an adverse effect on long-term soil health and environment, which has received global attention. Moreover, mineral fertilizers are costly and hence are hardly affordable by small and marginal farmers, which constitute the majority of the farming community in developing countries Yogita and Ram (2012a). The most realistic solution is, therefore, to exploit the possibility of supplementing mineral fertilizers with organic ones, more particularly bio fertilizers of biological origin. These days' bio-fertilizers have emerged as an important component of integrated nutrient management strategy and had a promise to improve an overall crop performance, yield and nutrient supply. Thus, of late increasing attention is being paid to derive the most benefit from bio-fertilizers. Bio-fertilizers are low cost, effective and renewable source of plant nutrients to supplement chemical fertilizers and their role in onion as well as other vegetables, therefore, assumes a special significance, particularly in the present context of very high cost of chemical fertilizers (Bhonde *et al.*, 1997).

The present study was, therefore, conducted with the view to identify the suitable N level under N2-fixing bacteria (*Azotobacter and/*or *Azospirillum* strains) for better growth and yield of onion.

MATERIALS AND METHODS

Two field experiments were carried out during two successive winter seasons of 2013 / 2014 and 2014/ 2015 on onion plants (*Allium cepa* L.) cv. Giza 20, grown in a sandy loam soil at El-kasasin, Farm(30° 33′ 31″ N- 30° 56′ 7″ E, elev. 15.8 m), Ismailia Governorate, Egypt to study the effect of biofertilization (N2-fixing bacteria)under mineral nitrogen fertilizer on yield and yield attributing characters as well as bulb contents of macronutrients, some biochemical compounds and bulb storability.

Soil samples were taken from the surface layer (0-30 cm depth) and analyzed for physical and chemical properties (Table 1) as described by Page *et al.*, (1982).The experiments included 12 treatments which were the combinations of three N levels:

- 60 kg N/fed. (50% of the recommended rate for onion).
- 90 kg N/fed. (75% of the recommended rate for onion).
- 120 kg N/fed. (100% of the recommended rate for onion).

And four bio-fertilizer treatments:

-uninoculated control (without bacterial cells).

-Azotobacter *chroococcum* as a single bio-fertilizer.

-*Azospirillum brasilense* as a single bio-fertilizer.

-Mixture of Azotobacter and Azospirillum.

The experimental design was split-plot system in randomized complete blocks with three replications. The main plots were allocated for N levels, whereas, the sub-plots were occupied by the bio-fertilizer treatments. A local isolates *Azotobacter and Azospirillum* of which used in this study were supplied by the Department of Microbiology, Soils, Water and Environ. Res. Institute, Agriculture Research Center, Giza, Egypt. Seeds of onion c.v. Giza 20 were sown in nursery on October 15th and 18th in first and second seasons respectively. Roots of 60 day old seedlings were immersed in heavy cell suspension of each culture treatment for 15 minutes before transplanting. The inoculation process was achieved just before transplanting by dipping the roots in the single or mixed bio-fertilizer (containing10^7 cfu ml^{-1} from each bacterium), and transplanted at 10 cm apart on both sides of the dripper line on December 15th and 18th in 2013/2014 and 2014/2015 season respectively. Seedlings of the uninoculated control were dipped in distilled water. Only the half dose of nitrogen as ammonium sulphate (20.6%N) was applied at the time of transplanting and the other was applied in two equal splits at 30 and 50 days after transplanting (DAT). Full doses of phosphorus as single super phosphate(15% P_2O_5) and potassium as potassium sulphate (48% K_2O) were applied to all experimental units at the rate of 200 kg and 50 kg fed^{-1}, respectively.

Table (1): Physical and chemical properties of the experimental soil

Property	Value
Particle size distribution (%)	
Sand	66.82
Silt	23.22
Clay	9. 96
Texture grade	Sandy loam
pH (1:2.5 soil water suspension)	7.68
EC (dS/m, 1:5, soil: water extract.)	0.72
Soluble cations (meq/L)	
Ca++	2.85
Mg++	1.97
Na^+	1.81
K^+	0.52
Soluble anions (meq/L)	
CO3- -	0.00
HCO3-	1.23
Cl-	3.42
SO4- -	2.50
Organic matter (%)	0.60
Available nutrient (mg/kg)	
N	42.0
P	7.50
K	182.4
DTPA-extractable (mg/kg)	
Fe	3.80
Mn	3.41
Zn	1.15

Data recorded:

Yield and bulb characteristics: After 150 days from transplanting bulbs were harvested, then the following data were recorded:

- Total yield of bulb (Ton/fed.)
- Bulb diameter (cm)
- Average bulb weight (g)
- Total soluble solids (TSS) in fresh bulb (juice), were estimated using handle refractometer A.O.A.C (1990).
- Bulb contents of N, P and K in dry matter were determined according to Cottenie *et al.*, (1982) and protein percentage was estimated by multiplying nitrogen percentage by the factor 5.75 according to A.O.A.C., (1990).
- Total, reducing and non-reducing sugars contents in dry onion bulbs were determined according to Somogy (1952).

Storability:

After curing, random samples (5 kg sound bulbs/pot) were taken and stored at room temperature and physiological loss in weight (PLW) was recorded monthly for five months after harvesting. PLW include loss in onion weight due to drying effect of atmosphere temperature and due to rotting. Sprouted bulbs were also considered unsuitable for consumption and were taken for PLW count. PLW (%) was estimated on weight basis.

The obtained data were statistically analyzed according to Gomez and Gomez (1984).

RESULTS AND DISSCUSION

(1) Yield and yield attributing characters

Data in Table (2) showed the effect of bio and mineral N- fertilizer (N2-fixing bacteria and NF) individually and in together on yield attributing characters viz., the average bulb weight, bulb dimensions (length and diameter), neck diameter and total yield of onion bulb as ton/fed. Application of 120 kg N/fed gave significant higher values as compared with the other treatments. The positive effect was increased by increasing N rate. Significant increases in size and weight of bulb were recorded with increasing N rate over 60 kg N/fed. with no-significant difference between 90 and 120 kg N/fed. The increase in bulb size with increasing N rate indicated that N promoted production of large bulb. The significant higher size and weight of bulb when nitrogen fertilization was increased might be also due to better vegetative growth which accelerated photosynthesis and translocation of photosynthates (dry matter) to storage organ, resulting in an increased diameter and weight of bulb (Sorensen and Grevsen 2001 and Yadav *et al.,* 2003). In addition to the beneficial effects of N on stimulating the meristmatic activity for producing more tissues and organs. N plays a major role in the synthesis of structural proteins and other several macro molecules, and its vital contribution in several biochemical processes in the plant related to growth (Negash *et al.,* 2009).

The main effects of the bio-fertilizers on yield and yield attributing characters of onion plants are illustrated in Table (2). Inoculation of onion seedlings either with of Azotobacter or Azospirillum or their mixture resulted in significant increments on yield and yield attributing characters of onion plants compared to the uninoculated control. Additionally, the mixed bio-fertilizer was found to be superior and associated with more increase of the yield and yield attributing characters comparing with the single treatments. These enhancing effects of the different bio-fertilizers could be due to the efficiency of the different bacterial strains, on N2-fixation, and producing appropriate amounts of phytohormones necessary for activating plant growth parameters. (Jagnow *et al.,*1991) demonstrated that the non-symbiotic N2-fixing bacteria of the genera Azotobacter and Azospirillum produced adequate amounts of IAA (Indoll acetic acid) and cytokinins which increase the surface area per unit of root length and enhanced root branching with an eventual increase in the uptake of nutrients from the soil and finally accelerated plant growth. Balemi *et al.,* (2007) also reported the efficiency of Azotobacter or Azospirillum strains as a potential supplement to nitrogenous fertilizer in onion.

With respect to the interaction effect between NF levels and bio-fertilizer application, data in Table (2), indicate that onion plants received 120 kg N/fed and inoculated with mixed bio fertilizer had the highest mean of yield and yield attributing characters, compared with the control and other combined treatments. This may be attributed to the increased activity and efficiency of bacteria in reduction of soil pH by secreting organic acids i.e. acetic, propionic, fumaric and succinic and consequently more solubility and availability of nutrients for plants (Osman, 2007). Furthermore, bio-fertilizers can exert a positive effect on plant growth through the enhanced levels of phytohormones (gebrilic acid, indoll acetic acid and cytokinins) that modulated by ACC deaminase enzyme (1-aminocyclopropane-1- carboxylate (ACC) deaminase), N2-fixation, and the reduction in root membrane potential. It appears from the results that inoculation with mixed bio fertilizer had enhanced all growth characters of onion compared with uninoculated plants or inoculated with Azospirillum or Azotobacter immediately. Similar results were obtained by El- Ghinbihi and Ali (2001) on potato and Ghoneim (2005).

Table (2): Effect of N2 fixing bacteria under different levels of nitrogen on yield and yield attributing characters of onion plants (combined analysis of two seasons)

Treatments		Bulb characters				
Mineral N levels	N2 fixing bacteria	Length (cm)	Neck diameter (cm)	Diameter (cm)	Average wt. (g)	Yield ton/fed.
50% N RD (60 kg/fed.)	Control	5.35	1.48	5.52	91.24	10.49
	Azotobacter	5.71	1.55	6.57	100.99	11.66
	Azospirillum	6.23	1.67	6.68	114.51	12.52
	Azotob.+ Azosp	6.69	2.05	7.55	125.25	13.64
Mean		6.00	1.69	6.58	108.00	12.08
75% N RD (90 kg/fed.)	Control	6.44	1.88	6.96	129.28	14.39
	Azotobacter	6.65	1.95	7.92	150.86	14.84
	Azospirillum	7.35	2.00	8.57	151.06	15.30
	Azotob.+ Azosp	7.29	2.15	8.68	165.74	16.27
Mean		6,93	2.00	8.03	149.24	15.20
100% N RD (120 kg/fed.)	Control	7.92	2.25	8.82	162.87	17.82
	Azotobacter	7.40	2.15	7.55	146.32	16.48
	Azospirillum	7.59	2.20	8.42	149.82	16.76
	Azotob.+ Azosp	7.81	2.23	8.76	153.40	17.27
Mean		7.68	2.21	8.39	153.10	17.08
Mean	Control	6.57	1.87	7.1	127.80	14.23
	Azotobacter	6.59	1.88	7.35	132.72	14.33
	Azospirillum	7.06	1.96	7.89	138.46	14.86
	Azotob.+ Azosp	7.26	2.14	8.33	148.13	15.73
L.S.D. at 5%	N levels	0.53	0.02	0.48	3.48	0.41
	bio	0.19	0.04	0.46	2.82	0.35
	Interaction	0.33	0.08	0.79	4.89	0.60

*N RD = Recommended dose of N –fertilizer (120 kg /fed.)

(2) Chemical Composition of Bulbs

Data in Table (3) showed that there were significant differences in N, P and K concentration (%) and content (kg/fed.) and the contents of protein by bulbs as affected by different nitrogen levels. However, the highest N, P and K contents in bulbs of onion plant was associated the treatments of 120KgN/fad. followed by those resulted from the treatments of 90 kg N/fed. while the lowest contents of N, P and K were found in the bulbs of the plants treated by 60 kg N/fed. Such results might be attributed to the role of nitrogen in increasing the root surface per unit of soil volume and also the capacity of the plant supplied with N in building metabolites which increases the dry matter content and subsequently increases nutrient content by onion plants (Abd El-Kader *et al.*, 2007). Also, data in Table (3) further show that inoculation with either single or mixed bio-fertilizers significantly increased nutrient content and some biochemical compounds of onion bulbs compared with the control plants. This may be attributed to the increased availability of these nutrients because of the beneficial effects of bacteria Azotobacter chroococcum and Azospirillium brasilense on the soil pH. Such as reduce soil pH by secreting some organic acids (e.g. acetic, propionic, fumaric and succinic) and maintaining a suitable air-moisture regime. The positive effect of Azotobacter or Azospirillum or their mixture upon nutrient content could be ascribed to the high efficiency of bacteria presence in this bio-fertilizer to fix atmospheric nitrogen and/ or produce some biologically active substances, e.g. indol acetic acid, gibberellins and cytokinine like substances. Such substances would increase the root biomass and thus indirectly help in greater absorption of nutrients from surrounding environment. It is clear from the obtained data in Table (3) that bio-fertilizers significantly increased TSS and protein content of onion bulbs compared with the control. The highest values of TSS and protein content of onion bulbs were recorded by plants treated with microbial inoculated and received 100% of recommended doses of nitrogen fertilizers followed by treatment of microbial inoculated and received 75% of the recommended dose of nitrogen fertilizer. Similar results were also corroborated by Yogita and Ram (2012b).

Also, data in Table (3) revealed that the highest mean content of N, P , K and protein % in tissues of onion bulbs were obtained in the plants inoculated with the mixed bio-fertilizer and 120 Kg N fed^{-1}, On the contrary, the lowest contents were recorded by 60kg N/fad. without bio-fertilization, since the effect of bio and mineral fertilization is a complementary action (Sharma, 2002).

(3) Dry matter content and biochemical compounds:-

Dry matter content, total, reducing and non-reducing sugars (%) of onion bulbs were increased by added N levels (Table 4). Nitrogen application at rate 120kgN/fed. followed by that at 90 kg N/fed recorded the highest dry matter content and either reduced or non-reduced sugar content of onion bulbs compared to 60 kg N/fed .Similar finding for increasing onion bulb quality due to N-application were obtained by Aswani *et al.,* (2005) who mentioned that mineral N-fertilizer might promote metabolic processes within the plant, which in turn could reflect a positive effect on chemical composition of plant. The superiority of the 100% NRD might be due to the fact that nitrogen has help in vigorous vegetative growth and imported deep green color to the foliage which favored photosynthesis activity of the plants resulting in the greater accumulation of food material. These are in conformity with Ghanti and Sharangi (2009).

Data in Table (4) show that inoculation with either single or mixed bio-fertilizers significantly increased dry matter content and the content of both reduced and non-reduced sugars of those found in onion bulbs than the control plants. These results might be due to the increase in vegetative growth characters, as well as the increase in bulb size, average bulb weight and bulb dry matter content, since nitrogen is an important constituent of chlorophyll which increases photosynthesis, resulting in assimilation of more total, reducing and non-reducing sugars. Bulb quality increases might be due to Azotobacter or Azospirillum individually and mixed stimulates root growth, changes root morphology and enhances uptake of minerals. It is also possible due to the involvement in phytohormones production which all together might cause promotion of vegetative growth characters and induction of some biochemical compounds. Similar results were also corroborated by Yogita and Ram (2012b).

Table (3): Effect of N2 fixing bacteria under different levels of nitrogen fertilizer on quality and nutrient concentration of onion bulb(combined analysis of two seasons)

Treatments		T.S.S. %	Protein %	N %	P %	K %	N content kg/fed	P content kg/fed	K content kg/fed
Mineral N levels	N_2 fixing bacteria								
50 % N RD (60 kg/fed.)	Control	9.67	9.03	1.57	0.37	1.35	20.11	4.74	17.29
	Azotobacter	9.93	9.55	1.66	0.39	1.39	26.38	6.20	22.09
	Azospirillum	10.67	9.72	1.69	0.40	1.45	29.39	6.96	25.22
	Azotob.+ Azosp	11.47	10.06	1.75	0.45	1.47	34.16	8.78	28.69
Mean		10.43	9.60	1.67	0.40	1.42	27.51	6.67	23.32
75% N RD (90 kg/fed.)	Control	12.67	10.64	1.85	0.39	1.39	35.62	7.51	26.76
	Azotobacter	12.93	10.81	1.88	0.46	1.42	39.76	9.73	30.03
	Azospirillum	13.60	11.21	1.95	0.47	1.46	43.35	10.45	32.46
	Azotob.+ Azosp	14.47	11.33	1.97	0.48	1.50	49.55	12.07	37.73
Mean		13.42	10.98	1.91	0.45	1.44	42.07	9.94	31.75
100% N RD (120 kg/fed.)	Control	14.66	11.73	2.04	0.55	1.58	52.42	14.13	40.60
	Azotobacter	14.70	12.08	2.10	0.49	1.46	53.82	12.56	37.41
	Azospirillum	15.44	12.31	2.14	0.52	1.51	55.95	13.60	39.48
	Azotob.+ Azosp	15.57	12.94	2.25	0.53	1.54	65.36	15.40	44.73
Mean		15.09	12.25	2.13	0.52	1.52	56.89	13.92	40.56
Mean	Control	12.33	10.47	1.82	0.44	1.44	36.05	8.79	28.22
	Azotobacter	12.52	10.81	1.88	0.45	1.42	39.99	9.50	29.84
	Azospirillum	13.24	10.98	1.91	0.46	1.47	42.90	10.34	32.39
	Azotob.+ Azosp	13.84	11.44	1.99	0.49	1.50	49.69	12.08	37.05
L.S.D. at 5%	N levels	0.23	0.29	0.05	0.03	0.06	1.81	0.92	1.45
	bio	0.13	0.29	0.05	0.03	0.03	1.45	0.81	1.06
	Interaction	0.23	0.46	0.08	0.01	0.06	2.51	1.40	1.40

*N RD = Recommended dose of N –fertilizer (120 kg /fed.)

Table (4): Effect of N2 fixing bacteria under different levels of nitrogen fertilizer some biochemical estimates of onion bulbs (combined analysis of two seasons)

Treatments		Dry matter content (%)	Reducing sugar%	Non reducing sugar%	Total soluble sugar %
Mineral N levels	N2 fixing bacteria				
50% N RD (60 kg/fed.)	Control	12.21	10.63	24.86	35.49
	Azotobacter	13.63	11.12	25.94	37.06
	Azospirillum	13.89	11.28	26.42	37.70
	Azotob.+ Azosp	14.31	11.38	26.51	37.89
Mean		13.51	11.10	25.93	37.04
75% N RD (90 kg/fed.)	Control	13.38	11.61	26.81	38.42
	Azotobacter	14.25	11.88	27.12	39.00
	Azospirillum	14.53	12.13	28.21	40.34
	Azotob.+ Azosp	15.46	12.28	28.59	40.87
Mean		14.41	11.98	27.68	39.66
100% N RD (120 kg/fed.)	Control	14.42	13.00	29.57	42.57
	Azotobacter	15.55	13.33	29.80	43.13
	Azospirillum	15.60	14.23	29.87	44.10
	Azotob.+ Azosp	16.82	14.53	29.93	44.46
Mean		15.60	13.77	29.79	43.57
Mean	Control	13.34	11.75	27.08	38.83
	Azotobacter	14.48	12.11	27.62	39.73
	Azospirillum	14.67	12.55	28.17	40.71
	Azotob.+ Azosp	15.53	12.73	28.34	41.07
L.S.D. at 5%	N levels	0.03	0.08	0.18	0.23
	bio	0.07	0.11	0.10	0.13
	Interaction	0.13	0.19	0.16	0.23

*N RD = Recommended dose of N –fertilizer (120 kg /fed.)

Concerning the effects of N-levels combined with bio-fertilizer inoculation on onion bulb quality, data in Table (4) indicate that both combined factors had significant and positive effects on onion bulb quality. Similar results were obtained by El-Gamal (1996).

(4) Cumulative weight loss

In (Table 5), Physiological loss in weight (PLW) measured during the storage period of 150 days indicated that it increased with increasing nitrogen level up to 120 kg N/fed. The treatment 120 kg N/fed resulted in the highest PLW at the end of 150 days of storage period (Figs 1&2). Nitrogen fertilization has slight significant effect on cumulative weight loss of onion stored for two month after harvesting; however during the 3^{th}, 4^{th} and 5^{th} months' storage period, high significant weight loss was observed in response to N fertilization. Starting from the 3^{th} month up to the end of the storage period, the highest cumulative weight loss of onion bulb was observed from treatments that received the highest level of N fertilizer. In latter half of the storage, higher PLW was recorded with nitrogen at 120 kg N/fed, which primarily may be due to rotting and sprouting of bulbs under higher nutrient application. Rao and Srinivas (1990) and Batal (1991) reported that higher dose of nitrogen had adverse effect on storability of onion as crops grown under high N dose tend to rot early during storage than those grown under optimum doses. This could be attributed to the development of larger sized bulbs that have higher rate of respiration in response to the higher fertilizer rates. This result is in agreement with Jilani (2004) who found that large size bulbs of onion stored for 120 days at ambient condition lost much weight as compared to small and medium size bulbs. As the storage period extends, there was an increase in cumulative weight loss that could be due to dry matter and water loss from the bulbs. Who also observed relatively low initial rate of water loss through the skin and low-level of respiration of the dormant bulbs. However it was followed by a change in steeper slope, indicating more rapid weight loss due to high respiration rate and senescence of older fleshy scales. In agreement with the current finding, Dankhar and Singh (1991) reported that weight loss of bulbs increased with increase in the N level. Similarly, in India, Singh and Dhankar (1995) and Pandey and Pandey (1994) found that increasing the rate of applied nitrogen from 50 to 150 kg ha^{-1} led to significant increases in storage loss of onion during 4 to 5 months under ambient conditions. Rotting of bulbs was significantly influenced by N fertilization. Nitrogen at the rate of 120 kg N fed^{-1} resulted in the highest rotting of bulbs as compared to the other treatments. The higher bulb rotting incidence in response to higher rates of N could be due to its effect in encouraging plants to produce large bulbs with soft succulent tissues which made them susceptible to the attack of diseases causing microorganisms. This result was in agreement with the report of Dankhar and Singh (1991) and Bhalekar *et al.,* (1987) who showed that rotting of bulbs was increased with increase in N fertilization.

Regarding to the effect of bio fertilizer on weight loss of bulb%., data also in Table (5) showed that, the bio fertilizer decreased the loss of bulb weight, might be due to one or more from the following mechanisms; production of plant growth promoting substances or organic acids, enhancing nutrient uptake or protection against plant pathogens (El-Haddad *et al.,* 1993).

Concerning the effects of N-levels applied along with bio fertilizer inoculation on weight loss of bulb%, data in Table (5) indicate that the combined factors had significant and positive effects on improving the storability of onion bulbs.

Table (5): Effect of N2 fixing bacteria under different levels of nitrogen fertilizer on Weight loss percentage of onion bulbs during storage period (combined analysis of two seasons).

Treatments		Storage period (days)				
Mineral N levels	N2 fixing bacteria	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS
50% N RD (60 kg/fed.)	Control	5.09	10.22	16.89	30.47	42.66
	Azotobacter	4.28	8.35	14.74	27.51	40.16
	Azospirillum	3.76	7.25	13.53	25.95	38.34
	Azotob.+ Azosp	3.33	6.90	11.41	22.78	35.66
Mean		4.12	8.18	14.14	26.68	39. 21
75% N RD (90 kg/fed.)	Control	7.06	12.25	22.49	38.88	51.88
	Azotobacter	6.03	11.13	20.72	36.43	47.30
	Azospirillum	4.69	9.25	16.82	29.99	42.42
	Azotob.+ Azosp	3.55	7.63	13.47	24.86	39.00
Mean		5.33	10.07	18.38	32.54	45.15
100% N RD (120 kg/fed.)	Control	9.14	16.07	26.95	42.00	59.02
	Azotobacter	7.98	14.25	24.40	39.75	51.74
	Azospirillum	6.30	11.43	22.03	38.34	49.74
	Azotob.+ Azosp	5.20	10.25	21.40	36.50	44.88
Mean		7.16	13.00	23.70	39.15	51.35
Mean	Control	7.10	12.85	22.11	37.12	51.19
	Azotobacter	6.10	11. 24	19.95	34.56	46.40
	Azospirillum	4.92	9.31	17.46	31.43	43.50
	Azotob.+ Azosp	4.03	8.26	15.43	28.05	39.85
L.S.D. at 5%	N levels	0.28	0.10	0.07	0.12	0.20
	bio	0.21	0.13	0.10	0.14	0.15
	Interaction	0.36	0.47	0.10	0.14	0.26

*N RD = Recommended dose of N –fertilizer (120 kg /fed.)

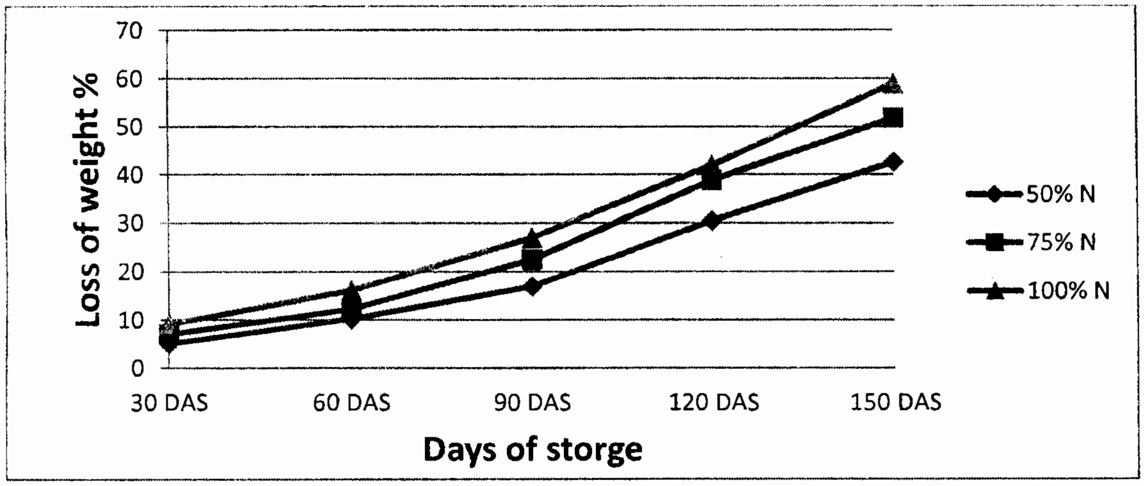

Fig. (1). Effect of nitrogen fertilization on physiological loss in weight during storage of onion bulbs.

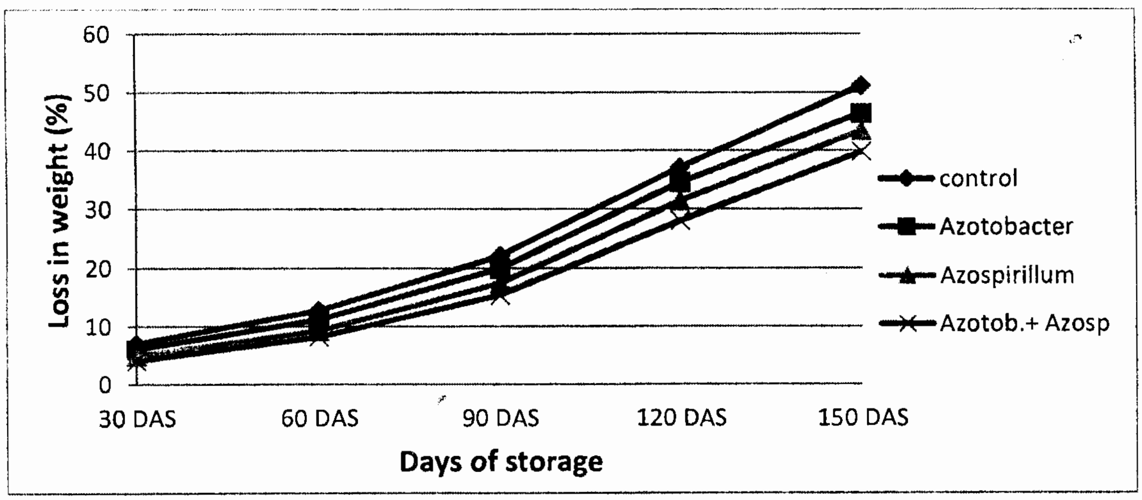

Fig. (2). Effect of Bio-fertilizer treatment on physiological loss in weight during storage of onion bulbs.

CONCLUSION

In conclusion, the obtained results of the current study indicated that the inoculation of onion plants with bio-fertilizer of Azotobacter or Azospirillum alone or their mixture combined with mineral N fertilizer resulted in significant increments on yield and yield attributing characters of onion plants compared to the uninoculated control.

The results concluded also that the most effective treatment combination, which gave the highest mean values of bulb weight, and total bulbs yields, was the combination of the moderate level of mineral-N (90 kg N fed^{-1}.) and the inoculation by bio-fertilizer mixture. Moreover, the use of bio-fertilizer mixture in onion can be considered as a partial good alternative to replace some of the chemical nitrogen fertilizer application (for about 1/3 of the recommended quantity), and consequently can reduce the total production cost of onion crop; in addition to reducing the environmental pollution.

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كفاءة التسميد الحيوى تحت مستويات مختلفة من النيتروجين على الانتاجية والمكونات الكيميائية للبصل

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الملخص العربى

اجريت تجربتان حقليتان فى الموسمين الشتويين لعامى ٢٠١٣/٢٠١٤ و ٢٠١٤/٢٠١٥ على أرض رملية طميية بمزرعة بمنطقة القصاصين بمحافظة الاسماعيلية بهدف دراسة تاثير تلقيح شتلات البصل بنوعين مختلفين من الاسمدة الحيوية Azospirillum ، Azotobacter ، سماد حيوى مختلط من الجنسين السابقين بالاضافة الى

الكنترول الغير ملقح ، ثلاثة مستويات من التسميد النيتروجينى المعدنى(٩٠،١٢٠،٦٠ كجم نتروجين/فدان) والتداخلات بينهم وذلك على صفات المحصول ومحتوى العناصر المعدنية بالاضافة الى بعض المواد البيوكميائية مثل السكريات الذائبة الكلية – المختزلة وغير مختزلة– المواد الصلبة الذائبة والبروتين الكلى والمادة الجافة والمحصول وجودته والقدرة التخزينية للبصل صنف جيزة ٢٠ ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى :

١ – أدت اضافة السماد النتروجينى بمعدل ٩٠, ١٢٠ كجم نتروجين/فدان الى زيادة معنوية على صفات المحصول ومحتوى العناصر المعدنية بالاضافة الى بعض المواد البيوكميائية مثل السكريات الكلية – المختزلة وغير المختزلة– المواد الصلبة الذائبة والبروتين الكلى والمادة الجافة والمحصول وجودته

٢– أظهرت النتائج أن هناك تأثيرات معنوية للتداخل بين التسميد النيتروجينى المعدنى والحيوى على صفات المحصول بالاضافة الى بعض المواد البيوكميائية ومحتوى العناصر المعدنية

٣– وقد بينت النتائج أن استخدام التسميد الازوتى عند اى معدل مع التلقيح بالسماد الحيوى المختلط Azotobacter+Azospirillum كانت أكثر المعاملات كفاءة فى التأثير على جميع الصفات عن السماد الحيوى المنفرد

٤ – تبين أن المعاملة (٦٠ كجم ن/فدان + التلقيح بالسماد الحيوى المختلط) أكثر المعاملات كفاءة فى تقليل الحد الادنى من فقد الوزن الفسيولوجى خلال ٦٠ يوم من فترة التخزين ولكن مع طول فترة التخزين وزيادة معدل التسميد النيتروجينى كان له الاثر السيئ على القدرة التخزينية للابصال

٥– أظهرت النتائج أن هناك تأثيرات معنوية للتداخل بين التسميد النتروجينى المعدنى والحيوى على معظم الصفات تحت الدراسة .وقد بينت النتائج أن استخدام التسميد الازوتى بمعدل ٩٠, ١٢٠ كجم نتروجين/فدان مع التلقيح بالسماد الحيوى المختلط كانت أكثر المعاملات كفاءة فى التأثير على جميع الصفات و أن المعاملة (٩٠ كجم ن/فدان + التلقيح بالسماد الحيوى المختلط) أكثر المعاملات كفاءة حيث انها تؤدى لخفض معدل استخدام السماد الازوتى دون ان تؤدى لتقليل المحصول او زيادة التلوث البيئى.

٦– تشير النتائج المتحصل عليها من هذه الدراسة الى أهمية التلقيح بمثبتات النيتروجين الجوى مما يؤدى الى تقليل استخدام السماد الازوتى المعدنى وذلك يقلل من تكاليف الانتاج ويحد من التلوث البيئى الناتج عن الافراط فى استخدام هذه الاسمدة المعدنية.