Response of Barley (*Hordeum Vulgare L.*) to Inorganic Nitrogen and Biofertilization Treatments

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ABSTRACT

Field experiments was carried out at the Experimental Farm of the Faculty of Agriculture (Saba Bacha) Alexandria University, during 2006/2007 and 2007/2008 winter seasons. The aim of the present work was to evaluate the influence of N-fertilizer levels (30, 60 and 90 kg N/fed) applied alone or in conjunction with biofertilization (Rhizobacteria, nitrobein and VA-mycorrhizal fungi) on plant growth. Application of bio-fertilizers either alone or in combined with inorganic nitrogen fertilizer lead to significant increases in barley yield characters as compared with their respective control. However, this response differed according to type of bio-fertilizers. The results revealed that biofertilization performed significant improvement in plant productivity. The highest stimulatory effect and the maximum enhancement were exerted in plants treated with VA-mycorrhizal fungi and Nitrobein with 60 kg N/fed. The highest grain and straw yield, and the highest content of phosphorus and potassium in grain were obtained from the inoculation with VA-mycorrhizal fungi and N fertilizer rate of with 60 kg N/fed. treatment, while the highest N content in grain was obtained from the inoculation with VA-mycorrhizal fungi and 90kg N/fed. treatment. The combination between seed inoculation (N_2-fixer) and reduced level of N-fertilizer (60 kg N/fed.) is recommended for reducing the excessive use of mineral N- fertilizers and hence minimizing the adverse environment and human health in agro ecosystems.

INTRODUCTION

Barley (Hordeum Vulagare, L.) is considered one of the most important cereal crops in world being used for many purposes The cultivated area of barley in increasing yearly, to meet the increasing needs for animal feed or many other uses. In order to produce high yield of barley, it requires the application of large amount of nitrogen fertilizers. Since chemical fertilizers are very expensive for most farmers and intensive farming practices are creating environmental problems, attention is given to reduce pollution by decreasing the amount of chemical nitrogen fertilizers and increasing the use of bio-fertilization. For successful inoculation effects, many authors have recommended the use of bacterial strains isolated from the same crop species (Boddey et al., 1986). Bacterial inoculation may not always in persistent responses, because of varying ecological factors and environmental conditions (Lyach,1990). The effects of inoculation of a single bacterial species have been examined on many crops. Combination of chemical nitrogen and bio-fertilization showed better growth and yield components of cereals (Suchera and Jha, 2007).The use of growth promoting bacteria, like nitrogen fixing bacteria, is assumed to have a great importance in crop production (Dobereiner,1997). Several reports emphasized the role of symbiotic N- fixing bacteria in increasing yield and improving nutrient uptake of field crops. Regarding barley and wheat, All Ozturk et al.,(2003) reported highly significant increases in growth, grain yield and yield components by inoculation of crop seeds with multistrain inoculants of a symbiotic N- fixing bacteria. Vesicular arbuscular mycorrhizal (VAM) fungi, forming symbiotic association with most economically important crop plants, can improve plant growth under low fertility conditions and have attracted a considered research due to their agricultural potential use. Khaliq and Sanders (2000) reported an increase in both P and N in barley plants, due to the effect of mycorrhizal fungi.

The objective of this study was to evaluate the effects of ammonium nitrate fertilizer with different nitrogen levels against bio-fertilization using Rizobacteria, Nitrobeen and VA-mycorrhizal fungi on yield and quality of barley plants

MATERIALS AND METHODS

Field experiments have been conducted in the experimental Farm Faculty of Agriculture Saba Bacha, Alexandria University during 2006/2207 and 2007/2008 winter seasons to evaluate the effects of inorganic N fertilizer, biofertilizers and VA-mycorrhizal on the growth characters of barley (Hordeum Vulagare, L.) variety Giza 123. Analysis of chemical and physical properties of the experimental soil (0 to 30 cm) are shown in Table (1). The determination of soil physical and chemical analysis were carried out according to the methods reported by Page et al. (1982) .

The experimental design was split plot with four replicates. Four nitrogen fertilization levels (0, 30, 60 and 90 kg N/fed. as ammonium nitrate 33.5%) were used and randomly distributed in the main plots, while the

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Table 1. Some physical and chemical properties of the experimental soil (average of two seasons)

Particle size distribution, (%)			Soil texture	pH*	EC* dS/m	Total $CO_3^{=}$ %	Total N (%)	Available P mg/kg soil	O.M.,%
Sand	Silt	Clay							
13.1	43.4	43.5	Clay loam	8.0	4.53	7.27	0.09	3.80	1.38

Soluble cations (meq/L)				Soluble anions (meq/L)		
Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
18.15	10.40	15.10	1.40	2.43	26.15	14.45

biofertilization treatments were randomly distributed in the sup plots as follows:-

1. without inoculation (control)
2. inoculation with rhizobacterin: an inoculant for all crops used in Egypt, containing nitrogen fixing bacteria:*Azotobacter* chroococcum and *Ajospirillum, barsilense*.
3. inoculation with Nitrobien: An inoculant for all crops contining of *Ajospirillum spp*.(10^9 cells/g.and *Azotobacter chroococcum*). These biofertilizers are produced by the general organization for Agriculture qualization, Ministry of Agriculture and land Reclamation, Egypt (Abou El-Naga,1993).

   The inoculation with rhizobacterin or Nitrobien was preformed by coating barley grains with each product individilly using a sticking substance (Arabic gum 5% just before sowing.
4. Inoculation with VA-mycorrhizal fungi (*Glomus macrocarpum*) strain from Gottingen university. Germany, at a rate of 100 ml infected roots and was mixed with the soil.

Nitrogen fertilizer levels were applied before irrigation after sowing plants. Phosphorus fertilizer was applied before planting as superphosphate (15.5% P_2O_5) at a rate of 50 kg P_2O_5 /fad. The experimental area of each plot was 10.5 m^2 (3x3.5m). Giza 123 cultivar, was planted on 17 and 19 November throughout 2006/2007 and 2007/2008 seasons, respectively. The main cultural practices were carried out as recommended by for barley production.

At harvest, the agronomic characteristics, spike grain weight (gm), 1000-grain weight, grain yield (t/ha), straw yield (t/ha), biological yield (t/ha)and harvest index were measured. Also, barley plant samples were collected from all treatments. Fresh plant samples (grain) were washed by tap water followed by distilled water and dried in an oven at 70° C for 48 hrs. The grains were finely ground and stored for chemical analysis. The grain was wet digested, using a mixture of H_2SO_4-H_2O_2 (Loather, 1980) and the following determinations were carried out in the digested solution: (i) Total nitrogen was measured colorimetrically by Nesslers method (Chapman and Pratt,1961).(ii) Phosphorus was measured colorimetrically by vanadate molybdate yellow method (Chapman and Pratt,1961). (iii) Potassium was measured by flame photometer according to Chapman and Pratt (1961). A mathematical approach was used to calculate the relative agronomic effect of biofertilizers to N- levels (RAE) in terms of yield (ton/fed) by using the following equations; RAE= (Y_i/Y_U) X100

Where:

Y_i : yield increase by biofertilizer over control

Y_U: yield increase by biofertilizer plus nitrogen over control (ton/fed).

Also, the quadratic polynomial equation (QPE) has been frequently used for describing the yield response to application of different rates of nutrients (El-shafei and Darwish,1980); Capurro and Voss,1981; Amer et al., 1989 and El-Zaher et al. 2001). Its general form is given by:

$Y_i = A + B_i\ C(N_I)^2$ Where Y_i is the yield corresponding to N_I rate and A,B and C are the intercept, linear and quadratic coefficients, respectively.

N-fertilizer use efficiency (NFUE).

The efficiency of N-fertilizer (NFUE) at N_i the change in grain or biological yield per unit change in N, i.e., it is the first derivative of Y_i with respect to N_i (Capurro and Voss,1981) was calculated according to the equation: $(NFUE)_i = B+2C\ N_i$ where B and C are intercept

Statistical analysis: All the obtained data were statistically analyzed according to procedures described by Gomez and Gomez (1984).

RERSULTS AND DISCUSSION

A) Effect of nitrogen fertilization levels:

Analysis of variance and means of the studied characters in both seasons are presented in tables (2, 3 and 5).

1. Growth characters: The analysis indicated that nitrogen fertilization levels significantly affected the studied characters in both seasons. Plant height and weight of 1000- grain (gm) increased with increasing nitrogen level up to 90 kg N /fad. in both seasons For evaluation the effect of nitrogen level on spike grains weight, it is obviously that significant differences were obtained between nitrogen levels and control values, and the highest values of spike grains weight in both seasons (2.08 and 2.12gm) were recorded in the presence of 60 kg N /fad..

2. Yield and its components: Table 3 clearly show the positive effect of nitrogen levels on improving yield and its components. Grain yield is the most important characteristic of barley cultivar. Nitrogen has positive influence on increasing grain yield (Knezevic et al., 2000) and application of this result is very important from economical and ecological aspects (Micanovic et al., 2004). The responses of grain yield was significant when N-level was increased up to 90 kg N /fad. The highest values of grain yield in both seasons were detected by 60 kg N /fad. This result may be explained by the tendency of barley plants for more vigorous vegetative growth and delaying of heading with excessive nitrogen application which may delay grain formation and filling stage to a period of less favorable conditions.

The polynomial equations that describes the yield responses of barley grain (Y_1) (in both seasons) to the application of different rates of nitrogen was:

First season

$Y_1 = 2.003 + 0.012\,X - 9x10^{-5}\,X^2$ $R^2 = 0.99$

Second season

$Y_1 = 2.047 + 0.012\,X - 9\,e^{-05}\,X^2$ R2 = 0.97

Plant height is most important for the grain yield and its increase is directly influences the grain yield (Zecevic et al., 2004).

The polynomial equations that describe the responses of grain yield (Y_2) to Plant height in both seasons were:

First season

$Y_2 = -0.0054\,X^2 + 0.9604\,X - 40.596$ R2 = 0.94

Second season

$Y_2 = 0.0093\,X^2 - 1.5913X + 69.944$ R2 = 0.63

Table 2. Effect of inorganic nitrogen levels and biofertilization on some yield characters of barley plants

N-levels	Biofertilizers	Plant height (cm)		Spike grain weight (gm)		1000-grain weight (gm)	
		2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008
0	Unioculation	71.23	83.85	1.72	1.79	61.50	61.88
	Rhizobactrin	81.15	85.95	1.87	1.85	61.85	62.00
	Nitrobein	85.53	86.73	1.89	1.88	62.05	62.78
	VA-mycorrhizae	86.85	88.10	1.95	1.99	62.40	62.93
30	Unioculation	80.53	84.35	1.81	1.85	61.88	62.35
	Rhizobactrin	86.20	87.80	.1.90	1.90	62.20	62.68
	Nitrobein	87.60	88.08	2.02	1.96	62.93	63.55
	VA-mycorrhizae	89.25	89.58	2.17	2.18	63.83	63.70
60	Unioculation	83.40	86.80	1.90	1.86	62.03	62.80
	Rhizobactrin	86.78	88.28	1.98	1.96	62.70	62.88
	Nitrobein	91.28	91.28	2.15	2.26	63.20	63.98
	VA-mycorrhizae	92.13	93.35	2.25	2.38	64.80	64.30
90	Unioculation	85.08	87.58	1.88	1.90	62.33	62.95
	Rhizobactrin	90.20	89.45	1.97	1.95	63.10	63.38
	Nitrobein	92.63	93.95	2.05	1.99	63.45	64.18
	VA-mycorrhizae	95.35	95.25	2.14	2.23	65.68	64.93
Mean effect of nitrogen fertilizer							
0		81.19	86.16	1.86	1.88	61.95	62.39
30		85.89	87.45	1.97	1.97	62.71	63.07
60		88.39	89.93	2.08	2.12	63.18	63.49
90		90.81	91.56	2.01	2.02	63.58	63.86
L.S.D.0.05		1.44	0.78	0.04	0.04	0.17	0.15
Mean effect of biofertilizer							
	Unioculation	80.06	85.64	1.83	1.85	61.93	62.49
	Rhizobactrin	86.08	87.87	1.93	1.92	62.46	62.73
	Nitrobein	89.26	90.01	2.03	2.02	62.91	63.62
	VA-mycorrhizae	90.89	91.57	2.13	2.19	64.11	63.96
L.S.D.0.05		0.90	0.58	0.05	0.05	0.28	0.17
Interaction (NXB)		**	**	**	**	**	**

Table 3. Effect of inorganic nitrogen levels and biofertilization on yield and yield component of barley plants

N-levels	Biofertilizers	Grain yield (t/ha)		Straw yield (t/ha)		Biological yield (t/ha)	
		2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008
0	Unioculation	1.90	1.93	4.89	5.03	6.782	6.960
	Rhizobactrin	2.00	2.04	4.99	5.07	6.938	7.113
	Nitrobein	2.03	2.08	5.02	5.11	7.053	7.193
	VA-mycorrhizae	2.12	2.19	5.08	5.14	7.200	7.331
30	Unioculation	2.10	1.99	4.96	5.07	7.064	7.055
	Rhizobactrin	2.22	2.36	5.04	5.10	7.250	7.460
	Nitrobein	2.31	2.40	5016	5.19	7.475	7.590
	VA-mycorrhizae	2.42	2.42	5.25	5.23	7.670	7.644
60	Unioculation	2.18	2.24	5.00	5.08	7.173	7.323
	Rhizobactrin	2.35	2.46	5.27	5.17	7.620	7.630
	Nitrobein	2.56	2.60	5.49	5.33	8.045	7.935
	VA-mycorrhizae	2.59	2.68	5.74	5.61	8.323	8.230
90	Unioculation	2.15	2.19	5.11	5.11	7.165	7.304
	Rhizobactrin	2.26	2.40	5.19	5.19	8.093	7.580
	Nitrobein	2.46	2.53	5.51	5.51	8.058	8.035
	VA-mycorrhizae	2.51	2.56	5.70	5.70	8.748	8.258
Mean effect of nitrogen fertilizer							
0		2.01	2.06	4.98	5.09	6.99	7.15
30		2.26	2.29	5.10	5.15	7.36	7.44
60		2.42	2.50	5.37	5.30	7.79	7.80
90		2.34	2.42	5.80	5.38	8.14	7.80
L.S.D. 0.05		0.04	0.02	0.11	0.02	0.11	0.03
Mean effect of biofertilizer							
	Unioculation	2.08	2.09	4.96	5.07	7.05	7.16
	Rhizobactrin	2.20	2.32	5.27	5.13	7.48	7.45
	Nitrobein	2.34	2.40	5.44	5.29	7.78	7.69
	VA-mycorrhizae	2.41	2.46	5.58	5.42	7.99	7.88
L.S.D.0.05		0.05	0.02	0.12	0.02	0.12	0.02
Interaction (NXB)		**	**	**	**	**	**

Table 3 revealed also that N applications were operative to induce significant effect on straw and biological yield in both seasons. Increasing level of nitrogen from 0 to 90 kg N /fad. lessen the straw yield to (5.80 and 5.38 t/ha. in first and second seasons, respectively). The data showed also, that increasing level of nitrogen from 0 to 90 kg N /fad increased significantly biological yield to 8.14 t/ha. in the first season. On the other hand, the biological yield in the second season increased with increasing N- levels without insignificant differences between 60 and 90 kg N /fad treatments

The polynomial equations that describe the responses of the biological yield of barley (Y_4) to the application of different rates of nitrogen were:

First season

$Y_4 = 6.983 + 0.013X - 6x10^{-6} X^2$ $R^2 = 0.99$

Second season

$Y_4 = 7.1285 + 0.0149X - 8E^{-05} X^2$ R2 = 0.97

Nitrogen use efficiencies (NFUE):

The calculated values of nitrogen use efficiency of grain and biological yield (NUE_G and NUE_B) as affected by N-fertilizer rates are presented in Table 5. The efficiency of N-fertilizer (NFUE) is defined here as the unit change in grain or biological yield obtained per unit change in the amount of N-fertilizer applied, i.e., it is the first derivative of grain or biological yield Y_i with respect to N_i when the response of grain and biological yields to addition of N-fertilizers use is curvilinear, the slope of the curve change from a maximum values at the lower N rate a minimum values at the higher N rate. Similar results were obtained by Moustafa et al. (1997), and Gadalla(2005).

Table 4. Nitrogen fertilizer use efficiency of grain and biological yield (NUE_G and NUE_B) as affected by inorganic N levels

N-levels (kg/fed)	NUE_G(kg grain/kg N-fertilizer)		NUE_B(kg biomass /kg N-fertilizer)	
	First season	Second season	First season	Second season
30	1.72	2..33	6.59	7.50
60	1.44	2.05	6.19	7.13
90	1.15	1.77	5.79	6.75

3. Nutrients concentration: Table 5 showed that application of nitrogen increased significantly grain barley contents of N, P and K % than grains of barley plants unfertilized with nitrogen. The concentration of (N, P and K) as an indicator for grain quality increased significantly with increasing nitrogen application. The highest values of grain N content (1.87 and1.99 % in first and second seasons, respectively) were recorded in the presence of 90 kg N /fad., .while the highest values of grain P and K content (269.38, 262.19 ppm and 0.88, 0.88 %, in both seasons, respectively) were recorded in the presence of 60 kg N /fad. This could attribute to increasing the root growth proliferation with the increased N- fertilization. Also, the ability of barley plants supplied with N- fertilizer in building metabolites, which may contribute much to the increase in dry matter accumulation at growth and consequently increasing nutrients contents. In this concern, the slightly acidic nature of the used N- fertilizer (i.e., ammonium nitrate) may be considered responsible for enhancing the conversion sparingly available elements (especially P) to reduced forms which are in fact available for plant uptake. Similar results were recorded by Yossef et al., (1995) on corn and Kotb (1998) on wheat.

Table 5. Effect of inorganic nitrogen levels and biofertilization on N, P and K content in grain of barley plants

N-levels	Biofertilizers	N (%)		P (ppm)		K (%)	
		2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008
0	Unioculation	1.45	1.51	222.5	225.75	0.80	0.81
	Rhizobactrin	1.47	1.58	227.5	234.00	0.83	0.83
	Nitrobein	1.50	165	232.5	240.00	0.83	0.84
	VA-mycorrhizae	1.62	1.70	242.5	247.50	0.83	0.85
30	Unioculation	1.60	1.63	232.5	234.75	0.83	0.83
	Rhizobactrin	1.63	1.73	237.5	242.50	0.84	0.85
	Nitrobein	1.65	1.80	243.8	253.75	0.82	0.87
	VA-mycorrhizae	1.71	1.84	255.0	266.25	0.89	0.89
60	Unioculation	1.68	1.71	250.0	246.25	0.85	0.86
	Rhizobactrin	1.78	1.83	267.5	252.50	0.87	0.87
	Nitrobein	1.81	1.94	275.0	262.50	0.86	0.88
	VA-mycorrhizae	1.89	2.14	285.0	287.50	0.93	0.92
90	Unioculation	1.71	1.75	241.3	239.50	0.85	0.85
	Rhizobactrin	1.83	1.95	250.0	246.25	0.86	0.85
	Nitrobein	1.93	2.10	257.5	255.75	0.86	0.88
	VA-mycorrhizae	2.03	2.18	267.5	273.25	0.86	0.87
Mean effect of nitrogen fertilizer							
0		1.51	1.61	231.3	236.81	0.82	0.83
30		1.65	1.75	242.2	249.31	0.85	0.86
60		1.79	1.90	269.4	262.19	0.88	0.88
90		1.87	1.99	254.1	253.69	0.86	0.86
L.S.D. 0.05		0.04	0.04	4.22	3.02	0.02	0.01
Mean effect of biofertilizer							
	Unioculation	1.61	1.65	236.56	236.56	0.83	0.84
	Rhizobactrin	1.67	1.77	245.63	243.81	0.85	0.85
	Nitrobein	1.72	1.87	264.69	252.00	0.85	0.87
	VA-mycorrhizae	1.81	1.96	262.50	268.63	0.88	0.88
L.S.D.0.05		0.05	0.04	5.18	2.04	0.02	0.02
Interaction (NXB)		**	**	**	**	**	**

B) Effect of bio-fertilization:

1. Growth characters: Table 2 indicate the influence of different bio-fertilizers i.e. Rhizobacterin, nitrobein and VA-mycorrhizal fungi on growth characters. The result showed that, all growth characters were significantly affected by three of bio-fertilizers as individual compared with control. VA-mycorrhizal fungi gave the highest growth characters, followed by nitrobein, then Rhizobacterin.

2. Yield and its components: regarding the effects of different bio-fertilizers on yield and its components (table 3), a highly significant response were obtained for yield and its components. Inoculation of barley plant with VA-mycorrhizal significantly increased grain yield by (15.78 and 17.7%,in first and second seasons, respectively) compared to the control. Also, inoculation of barley plant with VA-mycorrhizal increased the biological yields in both seasons compared with the other treatments. These results could be attributed to the high activity of VA-mycorrhizal and N-fixing bacteria. The promotion effect of VA-mycorrhizal on growth of barley could be attributed to the ability of VA-mycorrhizal to make immobile elements notably N, P and K more available to plants. The ability of AM fungi to make immobile elements notably P, Zn and Cu more available to plants in general is well documented (, Smith and Read, 1997, Clark and Zeto, 2000; Mohammid et al., 2005; Javaid, 2009). There are several possible mechanisms affect on the growth of inoculated plants. One may be that the bacteria produce plant growth hormones such as gibberelic acid, indole-3 acetic acid, and cytokinin, which promote plant growth (Barea and Brown, 1974; and Tine et al., 1979). Glick et al. (1994) suggested that rhizobacteria synathesize low molecular compounds or enzymes that are not well characterized and these can modulate plant growth and development. Lin et al. (1983) reported that plant nutrient uptake can be enhanced by the inoculation with free- living bacteria. Moreover, Brown (1974) suggested another mechanism that diseases could be suppressed by bacteria inoculation, which in turn stimulate growth of plant. Growth and yield of barley plants, might, therefore, be affected by one or more of these mechanisms.

3. Nutrients concentration: Regarding the effects of inoculation with different biofertilizers, i.e. Rhizobacterin, Nitrobein and VA-mycorrhizal fungi on N, P and K content (Table 5), the data showed that the various treatments improved the respective nutrient in grains compared with that of the un-inoculation plants. The amount of nitrogen was increased by the inoculation with biofertilizers and this suggests that free-living rhizobacteria may have some effects on the nitrogen accumulation in the inoculation plants. Gohen et al.(1980) conducted an inoculation experiment with sweet corn and foxtail, and presented a similar result, and hypothesis. The exact mechanisms involved in this stimulatory effect of the inoculation of rhizobacteria on nitrogen accumulation are yet unclear. It is worthy to point out the highest N (1.81 and 1.96%) in grain was recorded when the plants received a single VA-mycorrhizal fungi application, in compared with the other treatments. It could be concluded that, the addition of VA-mycorrhizal fungi was better than using Rhizobacterin and / or Nitrobein as bio-fertilization. It has been suggested that mycorrhizal acquire N from organic substances by enhancing decomposition (Hodge et al., 2001). Therefore, it can be postulated that VA-mycorrhizal fungi might have been better decomposers of organic substances.

Unlike N, the K and P content of the various treatments improved the respective K% in grains compared with the un-inoculation plants and the highest K content in both seasons, were observed with VA-mycorrhizal fungi. On the other hand, P in grains is higher in Nitrobein plants in the first season, while the highest P content in the second season, was observed with VA-mycorrhizal fungi. This may be due to the role of mycorrhiza in soil pH reduction which increased in the availability of P. The increased P content in AM inoculated plants is well documented (Smith and Read, 1997, Clark and Zeto, 2000; Javaid, 2009). This has been attributed to the extended AM hyphate, which explore a larger volume of soil and to solubilization by AM root exudates from unavailable sources present in the soil. Other researches have indicated that mycorrhizal inoculation tends to increase pH in the rhizosphere soil, but not in the bulk soil (Mohammid et al., 2005). This pH decrease was attributed to the ability of mycorrhiza plants to produce more CO_2, which eventually leads to increase in soil acidity.

C) Interaction effect:

1. Conjunction of N- fertilizer and seeds inoculation improved the nutritional status of plants, over that of the individual treatment of each. The combined effects of the nitrogen levels and biofertilizers on growth characters are shown in table 2. It is evident that the highest plant height (95.35 and 95.25 cm in both seasons, respectively) and 1000- grain weight (65.68 and 64.93 gm in both seasons, respectively) were obtained from barley plants fertilized by VA-mycorrhizal with N (90 kg N /fad) level. Spike grains weight (gm) in both seasons increased when plants were grown under 60 kg N /fad, and VA-

mycorrhizal fungi treatments, compared to the all treatments.

2. The differences in yield and its components due to the interaction between nitrogen fertilization levels and biofertilization treatments were significant. Our data also indicated that grain yield of barley per hectare in both seasons increased when plants were grown with 60 kg N /fad, and VA-mycorrhizal treatments, compared to the all treatments. Thus it can be mentioned that N X bio-fertilizers is important for high yield and good quality of barley.

The calculated relative agronomic effectiveness (RAE) indicated that the best results obtained from the addition of VAM + N (60 kg /fad .) . In general, the RAE could be arranged as follows : VA-mycorrhizal fungi > Rhizobactrin > Nitrobein (80.49, 70.59 and 68.42 respectively).

The exponential equation that relates the effect of bio-fertilizer types at different levels of nitrogen (Y) on grain yield (ton/ha) of barley plants (X) in two seasons were:

Bio-fertilizers	Firest season	Second season
Rhizobactrin	$Y1 = 2.068\ e^{0.001\ X}$	$Y1 = 2.1328e^{0.0018x}$
	$R^2 = 0.63$	$R2 = 0.66$
Nitrobein	$Y2 = 2.105\ e^{0.002\ X}$	$Y2 = 2.1657e^{0.0022x}$
	$R^2 = 0.80$	$R2 = 0.75$
VA-mycorrhizae	$Y3 = 2.205\ e^{0.002\ X}$	$Y3 = 2.2543e^{0.0019x}$
	$R^2 = 0.71$	$R2 = 0.71$

The comparison of the efficiency index of each bio-fertilizer in the calculated equations in both seasons gives a quantitative estimate for the efficiency of one bio-fertilizer to the other.

3. Nutrients concentration: Results documented on N, P and K contents in barley grains showed that the combined nitrogen levels and bio-fertilizers application induced marked significant effects (Table5). Conjunction of N- fertilizer and seeds inoculation improved the nutritional status of plants, over that of the individual treatment of each. The increase of N% being liked to the level of N-fertilizer up to the full recommended one (90 kg N/fed) with seed bio fertilization. These results might be ascribed to that the efficiency of N_2-fixers (used as bio-N-fertilizers on seeds), in the soil received 2/3 full N-dose, was higher to fix atmospheric nitrogen as well as production of physiologically active compounds to stimulate root growth and solubilizing and availability of elements from soil native sources and subsequently improving the nutritional status of whole plant tissues. This trend is supported by Fayez et al., (1986), where stated that the beneficial effects of the dual N-fertilization (i.e., mineral plus biology) depending up on the N-application levels, the higher N- level the lower activity of associated N_2-fixing bacteria. The combined treatment of 60 kg N/fed with seed biofertilization may be effective in improving soil conditions, resulting in availability of P and K elements, efficient in creating the favorable response of nutrients content, in turn- sufficient supplementation of nutrients to plants. This trend is supported by (Tester,1990 and Mazzarino et al., 1991).

As for the differences among the three bio-fertilizers and N levels, it is clearly reveal that the highest N, P and K % in grains was obtained from barley plants fertilized by application VA-mycorrhizal fungi. It was noted that their contents were more than those obtained by Rhizobacterin and / or Nitrobein as bio-fertilizers addition with nitrogen levels.

CONCOLUSION

It can be concluded from the obtained data that nitrogen at the rate of 60 kg N /fad, can be recommended for mixing with bio-fertilizers application especially VAM fungi in order to enhance the yield of barley plants grown under similar soil conditions

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الملخص العربي

استجابة الشعيرلمعاملات التسميد النيتروجيني الغير عضوي و الحيوي

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تم إجراء تجربتان حقليتان في مزرعة التجارب الخاصة بكلية الزراعة-سابا باشا جامعة الأسكندرية خلال فصلي الشتاء ٢٠٠٦/٢٠٠٧ و٢٠٠٧/٢٠٠٨. وكان الهدف من هذه الدراسة هو تقييم تأثير مستويات مختلفة من النيتروجين (٣٠،٦٠،٩٠ كجم نيتروجين/فدان) المضاف منفردا أو مع التسميد الحيوي (التلقيح بالريزوبكتريا- النتروبين- الميكوريزا) بهدف زيادة نمو النبات.

أدت أضافة الأسمدة الحيوية أما منفردة أو مع مستويات النيتروجين المختلفة الى تحسن معقول لخصائص محصول الشعير مقارنة بالكونترول. ولقد أختلفت الأستجابة تبعا لنوع السماد الحيوي. وقد أظهرت النتائج أن التسميد الحيوي قد أدى الى تحسن معنوي في أنتاجية النبات. والتأثير المشجع العالي وأقصى إستجابة قد ظهرت في النباتات المعاملة بفطر الميكوريزا والنتروبين مع معدل سماد نيتروجيني معدني قدره ٦٠كجم ن /فدان.

بينما وكان أعلى محصول من الحبوب والقش وكذلك من محتوي الحبوب من عنصري الفوسفور والبوتاسيوم قد تم الحصول عليه من التلقيح بفطر الميكوريزا مع معدل سماد نيتروجيني معدني قدره ٦٠كجم ن/فدان. بينما كان أعلى محتوى للحبوب من النيتروجين قد تم الحصول عليه من التلقيح بفطر الميكوريزا مع معدل سماد نيتروجيني معدني قدره ٩٠كجم ن/ فدان. وأخيرا فأن تلقيح البذور بمثبتات النيتروجين وتخفيض مستوى النيتروجين المعدني (٦٠كجم ن/فدان) يوصى به لأنه يحقق أكثر من هدف مثل تقليل إستخدام الأسمدة المعدنية النيتروجينية ومن ثم تقليل الضرر البيئي ومخاطر الصحة الناتجة من إستخدام النيتروجين المعدني، بالأضافة الى تحسين خصوبة التربة والذي ينعكس على إنتاجيتها.