Inoculation of barley with biofertilizers under different levels of nitrogen application in the newly reclaimed lands

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ABSTRACT

A field experiment was conducted in the 1996/97 growing season; under sprinkler irrigation system in the newly reclaimed lands at El-Bustan area. A randomized complete block design was used with four replications. The plot size was 3×3.5 m = 10.5 m^2 including 15 rows of 3.5 m long and 20 cm apart. Ten fertilizer treatments were applied including two biofertilizers. Phosphorous fertilizer was applied in one dose at sowing in the form of calcium super phosphate (15.5% P_2O_5), while nitrogen fertilizer was applied as a different levels (0, 48, 96, and 144 Kg/ha) in three equal doses at sowing, tillering, and shooting stages. Nitrogen fertilizer was in the form of ammonium sulphate (20.6% N). Azottein is composed of different fixers of the genera *Klebsiella, Bacillus, Azotobacter,* and *Azospirillum.*

Results showed significant differences in grain yield ($p < 0.01$) among fertilizer treatments. The application of biofertilizer caused an increase in grain yield, especially in the presence of nitrogen at the third level with the phosphorous fertilizers amounted about (2981 and 2960 Kg/ha) from the combination of (96 Kg N+ 35 Kg P_2O_5/ha + Microbin or Azottein) with about 327 and 325% increase respectively compared to the control, with no significant difference compared to the full dose of nitrogen and phosphorous fertilizers (144 Kg N +35 Kg P_2O_5/ha).This experiment revealed the advantage of the application of both biofertilizers, Microbin and Azottein in the presence of (96 Kg N + 35 Kg P_2O_5/ha), which could enhance plant growth and grain yield of barley, and save about 33% of the nitrogen fertilizer without any losses in the grain yield.

INTRODUCTION

Barley (*Hordeum vulgare* L.) is an important cereal crop in Egypt, especially in the marginal areas. This due to the ability of the crop to cope with the stress environment in such areas, i.e. rainfed and newly reclaimed lands. These areas suffer, mainly, from moisture stress and nutrient deficiencies (El-Sayed and Abd El-hadi, 1991a; El-Sayed et al., 1991b; and El-Sayed and Noaman, 1992). Increasing fertilizer costs and the increasing interests in non-pollutant environment led to the strong belief in biological N_2-fixation and the use of biofertilizers. In addition, inoculating seeds with biofertilizers is easier and less costs than the mineral fertilizers, especially under rainfed conditions, where the farmers were used to grow the crop without any fertilization in order to minimize the production cost. Intensive research on asymbiotic nitrogen fixation has concentrated on the positive side of the plant-microbe relationship in an effort to increase plant

growth and grain yield. Several reports have indicated that the inoculation of seeds or seedling of various C_3 and C_4 plants with associative N_2-fixing bacteria led to changes in plant growth and sometimes to yield increases (Dobereiner and Day, 1975; Van Bulow and Dobereiner, 1975; Eid, 1982; and Pohlman and McColl, 1982). In Egypt Eid et al., 1986 studied the response of the common local wheat and barley cultivars to the inoculation with the associative N_2-fixing bacteria at two experimental stations; Sids and El-Gemmaiza. They reported that barley cultivar Giza 121 and wheat cultivar Giza 155 increased by 67 and 45%, respectively, compared to the un-inoculated control. The objective of this study therefore was to investigate the effects of some biofertilizers and the effects of the interaction between biofertilizer and different levels of nitrogen fertilizer on barley.

MATERIAL AND METHODS

A field experiment was conducted in the 1996/97 growing season; under irrigation system in the newly reclaimed lands at EL-Bustan area. A randomized complete block design was used with four replications. the plot size was 3×3.5 m = 10.5 m^2 including 15 rows of 3.5 m long and 20 cm apart. Ten fertilizer treatments were applied as follows:

1 - Control (No fertilizers).
2 - Microbin.
3 - Microbin + 35 Kg P_2O_5/ha.
4 - Azottein.
5 - Azottein. +35 Kg P_2O_5/ha.
6 - 144 Kg N + 35 Kg P_2O_5/ha.
7- Microbin + 48 Kg N +35 Kg P_2O_5/ha.
8 - Microbin + 96 Kg N + 35 Kg P_2O_5/ha.
9 - Azottein + 48 Kg N + 35 Kg P_2O_5/ha.
10 -Azottein + 96 Kg N + 35 Kg P2O5/ha.

Phosphorous fertilizer was applied in one dose at sowing in the form of calcium super phosphate (15.5% P_2O_5), while nitrogen fertilizer was applied in three equal doses at sowing, tillering, and shooting stages. Nitrogen fertilizer was in the form of ammonium sulphate (20.6% N). Azottein is composed of different nitrogen fixers of the genera *Klebsiella, Bacilluss, Azotobacter,* and *Azospirillum.* This biofertilizer is prepared by adding equal amounts of these microorganisms to carrier material. Arabic gum was melted in amount of warm water and was added to the Azotten. Barley (Giza 123) seeds were added to the mixture of Azottein and the

gum and mixed carefully and spread over plastic sheet far from the direct sun effect for a short time before plantation. The other biofertilizer (Microbin) was used the same way, then barley seeds were planted at a rate of 120 Kg/ha. Representative soil sample was taken from the experimental site at EL-Bustan area before planting and was mechanically and chemically analyzed (Table 1). Standard analysis of variance using least significant differences (LSD) was performed to estimate the significant differences among treatments (Steel and Torrie, 1980).

Table1. Mechanical and chemical analyses of the experimental site at EL-Bustan area before planting 1996/97.

Chemical analysis						Mechanical analysis				
N (ppm)	P (ppm)	K (ppm)	Na (ppm)	EC (dsm^{-1})	p^H	Sand %	Silt %	Clay %	$CaCO_3$ %	Texture
86	8.2	9.5	34.9	0.67	8.2	92.0	3.5	4.5	10.0	Sand

RESULTS AND DISCUSSION

Data presented in (Table 2) show grain yield response of barley cv. (Giza 123) grown at EL-Bustan area to mineral and biofertilizer treatments applied in 1996/97 growing season. Significant differences in grain yield ($p < 0.01$) among fertilizer treatments. Results indicated that the biofertilizer caused an increase in grain yield, especially in the presence of nitrogen at the third level with phosphorous fertilizers. Maximum grain yield (2981 Kg/ha) was obtained from the combination of (96 Kg N + 35 Kg P_2O_5/ha +Microbin) with about 327% increase over the control, with no significant difference compared to the full dose of nitrogen and phosphorous fertilizers (144 Kg N +35 Kg P_2O_5/ha). Microbin, one of the two biofertilizers used in the experiment, had non significant effects on the enhancement of grain yield compared to Azottein, the other biofertilizer, which gave (2960 Kg/ha) grain yield with about 325% increase compared to the control when it used with the same combination of nitrogen and phosphorous fertilizers (96 Kg N + 35 Kg P_2O_5 + Azottein) (Table2). In this respect, Okon (1982) stated that inoculated plants with biofertilizers exhibited about 30 - 50% greater uptake of nitrates, phosphate and potassium than the un-inoculated plants. He suggested that associative nitrogen fixing bacteria enhance the mineral absorption of the cell cortex, which is reflected on the plant growth and yield increases.

Conclussion

It was concluded from this study (the first year) that the application of biofertilizers, Microbin and Azzotein in the presence of nitrogen at different levels with phosphorous fertilizers could enhance plant growth and grain yield through increasing the soil-nutrient uptake by plants, and it could save about 33% of the nitrogen fertilizer without any losses in the grain yield.

Table2. Grain yield of barley cultivar Giza123 grown in the newly reclaimed lands at EL-Bustan area under different fertilizer treatments, 1996/97.

Treatments	Grain yield (Kg/ha)	**%**
1 - Control (No fertilizers).	697	-
2 - Microbin.	702	0.7
3 - Microbin + 35 Kg P_2O_5/ha.	793	13.8
4 - Azottein.	741	6.3
5 - Azottein + 35 Kg P_2O_5/ha.	791	13.5
6 - 144 Kg N + 35 Kg P_2O_5/ha.	2892	314.9
7 - Microbin + 48 Kg N + 35 Kg P_2O_5/ha.	1880	169.7
8 - Microbin + 96 Kg N + 35 Kg P_2O_5/ha.	2981	327.7
9 - Azottein + 48 Kg N + 35 Kg P_2O_5/ha.	1691	142.6
10 - Azottein + 96 Kg N + 35 Kg P_2O_5/ha.	2960	324.7
LSD	313.6	
CV	13.4	

% = Percentage increase over un-inoculated control.

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