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USE EFFICIENCY OF RHIZOBACTERIAL AND YEAST INOCULATION UNDER MINERAL NITROGEN FERTILIZATION ON RICE CROP YIELD.

El-kholy, M. H.; M. N. A. Omar; M. M. El-Zeki and S.G.Metwaly
Soil, water and Environ. Res. Inst., ARC, Giza, Egypt.

ABSTRACT

Field trials, on rice crop (*Oryza sativa*), variety Giza 178, cultivated at El-Serw Agricultural Research Station, were conducted in two successive seasons (2002 and 2003). Microbial inoculation with two strains of nitrogen fixers namely *Bacillus polymyxa* or *Azotobacter chroococcum* as well as yeast strain (*Saccharomyces cerevisiae*) was applied. Effect of inoculation time (rice nursery , transplanting and twice in the nursery and after transplanting stages) under three levels of N fertilization (20, 40 and 60 kg N/fed) as ammomium sulfate 20.5% N were studied. Split plot with 4 replicates was designed. Plant height, number of productive tillers, panicle length and weight and 1000-grain weight were recorded. Grains and straw yields were also measured. Nitrogen and phosphorus contents and uptake of grains and straw were determined. Microbial inoculation of nursery and transplanting stages revealed a positive significant effect on both yield and plant growth parameters in the presence of two thirds and full recommended dose of nitrogen in comparison with other treatments. Utilizing PGPR inoculation in rice cultivation can save about 20 kg N/feddan, which is very important from economical point of view. The highest N and P contents and uptake in both rice grain and straw resulted from the diazotrophs inoculation under using 60 kg N/fed. Similar response was detected with yeast inoculation except nitrogen content of grains. If plant growth promoting rhizobacteria (PGPR) inoculation technology introduced to even 50% of the rice cultivated area in Egypt, it may result in saving about 10.000 tons of nitrogen element and conserve environment by reducing pollution hazards.

Keywords: PGPR, *Pacillus Polymyxa*, *Azotobacter Chroococcum*, Yeast, Rice.

INTRODUCTION

Rice is the most important staple food after wheat and a second major export agricultural commodity in Egypt. Rice also provides beneficial means in reclaiming salt affected soils. Nitrogen is one of the few plant nutrients that is lost by volatilization as well as by leaching, it requires continual conservation and maintaenance, (El-Kholy,1997). Nitrogen can be supplied to rice plants either through chemical fertilizers and/or bio-fertilizers (nitrogen fixing bacteria or cyanobacteria). Pandey *et al.* (1992) stated that rice grain yield increased as N increased up to 90 kg N/ha, and no further significant increase was observed at 120 kg N/ha. Data for N and P uptake followed a similar pattern. Bacterial inoculation and nitrogen fixation in the rice rhizosphere have shown that in most cases, yield was increased after inoculation with nitrogen fixing bacteria (Omar *et al.*, 1992). Microaerophilic *azospirilla* were found to enhance yields of both lowland and upland rice. Nitrogen-fixing bacteria living, in association with roots of plants, were investigated to establish their effects on plant growth and yield (Mertens and Hess, 1984). *Azospirillum* is very common in the rice rhizosphere (Omar *et al.*, 1989b) and various strains have also been isolated from maize and wheat roots (Fages and Mulard, 1988).

Many studies indicated the importance of *Azospirillum* for fixing nitrogen in cereals (Omar *et al.*, 1989a and Zhang *et al.* 1990). These bacteria proved to be able to produce auxins and other growth substances in the plant rhizosphere (Jain and Patriquin, 1985). Sarig *et al.*, (1984) found that nitrogen content of aerial tissues was increased by *Azospirillum* inoculation. Plant growth promoting rhizobacteria (PGPR) has positive effect on the growth and yield of crops and by various mechanisms including production and secretion of plant growth regulators and by eliciting root metabolic activities. Yeasts play an important role in soil biofertility because of their capability for producing hormones, amino acids, cytokinin, indole and vitamins (Monib *et al.*, 1982).

The present study aimed to evaluate the beneficial effect of inoculation with nitrogen fixing bacteria and yeast as a plant growth promoting rhizobacterium (PGPR) by appling different techniques to inoculate rice plant either in nursery and /or transplanting.

MATERIALS AND METHODS

Three field trials on rice (*Oriza sativa*) variety Giza 178 at El-Serw Agricultural Research Station were conducted in two successive seasons (2002 and 2003). Split plot design with four replicates was used. The plot area was 10.5 m^2, where the preceding crop was wheat in the two seasons. The main plots were arranged for different doses of nitrogen fertilizers (20, 40 and 60 kg N/fed. as ammonium sulfate (20.6% N). Sub–plots were devoted to evaluate the inocula of *Azotobacter chroococcum, Bacillus polymyxa* and yeast *Saccharomyces cervisiae*, provided from Soil, Water and Environ. Res. Inst., ARC, Giza in both nursery beds of rice plants and transplanting soils.

The treatments were as follows:

I_0 - Control (uninoculated)

I_1 – Inoculation in rice nursery

I_2 – Inoculation after transplanting

I_3 – Inoculation twice in the nursery and after transplanting.

Prior planting and during plant bed preparation, a soil sample was taken from the surface layer (0-30 cm, depth) and analyzed for physico-chemical properties (Table1) as described by Black, (1982). Superphosphate (15.5% P_2O_5) was added to all plots at a rate of 15 kg P_2O_5/fed before transplanting. The mineral nitrogen fertilizer was broadcasted in three equal doses: the first one was immediately prior to transplanting of rice seedling; the other two doses were applied 30 and 50 days after transplanting.

Bacterial inoculation in nursery bed was performed using seed coating technique. Each inoculated grain harbored 10^6 cells on its surface. Maximum care was taken to avoid cross-contamination in the field after transplanting: plots were separated by mud bunds 50 cm wide inside blocks and water was prevented from flowing between plots. Bacterial and yeast inoculation was repeated again in both nursery bed and transplanting soil after seed sowing in the nursery bed and after transplanting by using liquid culture (10^9 cells/ml of bacteria or yeast) as soil application technique at a rate of 5L /fed. Liquid inoculant was added 3 times during the growth period up to the flowering stage. Before harvesting, plant height (cm), number of productive tillers, panicle length (cm) and weight (g) and weight of 1000 grain (g) were recorded for all plots. After harvesting grains and straw yields were estimated (ton/fed). The dry grain and straw samples from each plot were ground and wet digested with H_2SO_4-$HClO_4$ mixture as described by Peterburgski (1968). Nitrogen and Phosphorus percentages were determined according to Black, (1982). The uptake of these nutrients was calculated by multiplying the concentration by dry weight. The statistical analysis was carried out according to Snedecor and Cochran (1989) to compare the treatment values.

Table (1): Some physical and chemical properties of the experimental soil.

Soil properties	1st season, 2002	2nd season, 2003
Soil texture	Clayey	Clayey
Soil pH (1:2.5 water susp.)	8.4	8.2
Ec (soil paste at 25^0C) dS/m	5.8	4.2
O.M.%	1.2	1.3
$CaCO_3$%	1.5	1.4
Available-N (K_2SO_4- ext.)ppm	36.6	38.2
Available -P(Olsen method) ppm	7.8	8.2
Available-K (Amm.Acet.ext.)ppm	380	400

RESULTS AND DISCUSSION

Yield components:

The obtained results (Table. 2) revealed significant increase in plant height with increasing the dose of mineral nitrogen fertilizer. Plant height increased from 101.6 to 124.7 cm, when mineral nitrogen fertilizer increased from 20 to 60 kg N/fed. Also, significant increase with number of productive tillers was recorded. With respect to inoculation of nursery, trans-planting or twice in the nursery and after transplanting with *Azotobacter chroococcum, Bacillus polymyxa* or *saccharomyces cerevisiae,* the obtained data, showed significant increase in plant height or number of productive tillers with microbial inoculation and mineral nitrogen fertilization. Plant height increased from 115.6 to 136.2 and from 114.9 to 135.2 and from 98.4 to 113.4 cm, when nitrogen fertilizer was increased from 20 to 60 kg/fed in combination with *Azotobacter chroococcum, Bacillus polymyxa or Saccharomyces cerevisiae*, respectively. It was interesting to observe significant increase in panicle length and weight and 1000-grain weight with increasing mineral nitrogen (Table 3). With respect to inoculation with *Azotobacter chrcococcum,* *Bacillus polymyxa* and *Saccharomyces cervisiae*, data in Table (3) showed that I_3 treatment (inoculation twice in the nursery and after transplanting), gave the height values for panicle length and weight and 1000-grain weight under different N levels. Thus, it seems that mineral N fertilizer has favourable effect on plant nutrition, while PGPR inoculation act as supplemental nitrogen towards the end of the vegetative growth possibly after fertilizer nitrogen was exhausted. The treatments received 40 or 60 kg N/fed with PGPR inoculation significantly gave the best yield component.

Table (2): Plant height and number of tillers of rice plant (harvest stage) as affected by mineral nitrogen fertilizer and PGPR inoculation (combined results of 2002 and 2003 seasons).

PGPR inoculation	N fertilization (kg N/fed)					
	Plant height (cm)			No of productive tillers /hill		
	N_{20}	N_{40}	N_{60}	N_{20}	N_{40}	N_{60}
Azotobacter chroococcum						
I_0	101.6	117.0	124.7	13.0	16.1	18.3
I_1	114.5	122.5	129.4	15.5	17.6	20.3
I_2	114.8	126.3	134.6	17.1	19.9	22.1
I_3	115.6	130.1	136.2	17.6	20.1	22.8
LSD (5%)	4.94			0.21		
Bacillus polymyxa						
I_0	102.3	118.3	126.9	13.5	16.5	18.3
I_1	113.4	122.3	130.6	16.3	18.0	20.1
I_2	114.4	126.1	134.3	17.6	20.1	22.7
I_3	114.9	126.8	135.2	17.8	20.6	23.0
LSD (5%)	4.66			0.26		
Saccharomyces cerevisiae						
I_0	95.6	102.8	108.3	13.0	16.1	17.9
I_1	96.2	107.2	111.9	14.9	17.3	20.0
I_2	97.9	108.5	112.9	15.8	18.0	20.9
I_3	98.4	109.9	113.4	16.2	18.2	21.3
LSD (5%)	0.40			0.10		

Grain and Straw Yields:

Data in Table (4) showed significant effect of mineral nitrogen fertilizer on both grain and straw yields, confirming that nitrogen was actually the limited factor for rice production under Egyptian conditions characterized by low available nitrogen content (Table 1). The grain yield of rice responded not only to increased nitrogen dose but also to PGPR inoculation in combination with N fertilizer.

Data also revealed that the response to PGPR inoculation was nearly similar to application of 20 kg N/fed. However, combining PGPR with mineral nitrogen fertilizer, increase its efficiency greatly. Inoculation of nursery (I_1), transplanting (I_2) or nursery and transplanting (I_3) with Azotobacter chroococcum, Bacillus polymyxa and Saccharomyces cerevisiae resulted in increase of rice grain yield over control treatment.

Table (3): Panicle length and weight and 1000-grain weight of rice plant as affected by mineral nitrogen fertilizer and PGPR inoculation, (combined results of 2002 and 2003 seasons).

PGPR inoculation	N fertilization (kg N/fed)								
	Panicle length (cm)			Panicle weight (g)			1000-grain weight (g)		
	N_{20}	N_{40}	N_{60}	N_{20}	N_{40}	N_{60}	N_{20}	N_{40}	N_{60}
Azotobacter chroococcum									
I_0	18.8	20.6	21.5	2.5	3.4	3.8	23.0	23.4	23.6
I_1	19.3	21.4	21.5	2.8	3.8	4.1	23.1	23.5	24.0
I_2	19.8	21.7	21.6	2.8	3.9	4.3	23.3	23.6	24.2
I_3	20.1	21.9	21.8	3.3	4.2	4.3	23.3	23.8	24.2
LSD (5%)	0.3			0.1			0.5		
Bacillus polymyxa									
I_0	18.8	20.7	21.5	2.6	3.5	3.8	22.9	23.4	23.7
I_1	19.1	21.5	21.9	2.9	3.8	4.1	23.2	23.5	23.8
I_2	19.3	21.7	22.2	3.1	3.8	4.2	23.2	23.7	24.0
I_3	20.4	21.7	22.2	3.5	3.9	4.2	23.4	23.8	24.0
LSD (5%)	0.3			0.2			0.3		
Saccharomyces cerevisiae									
I_0	18.3	19.3	20.6	2.0	2.5	2.3	21.1	22.5	23.0
I_1	18.7	21.5	21.9	2.2	2.7	2.9	22.1	22.9	23.5
I_2	19.1	22.3	22.3	2.5	3.0	3.1	22.4	23.5	23.6
I_3	19.6	22.3	22.3	2.6	3.2	3.2	22.6	23.5	23.6
LSD (5%)	0.1			0.1			0.1		

It is obvious that the treatments receiving PGPR inoculation and nitrogen fertilizer produced higher grain yields than that received nitrogen fertilizer alone. No significant differences in grain yield were generally observed between treatments I_3*N_{40}, I_3*N_{60}, I_2*N_{40}, I_2*N_{60} and I_1*N_{60}. Treatment that received 60 kg N/fed plus inoculation of nursery and transplanting soil (I_3) with Azotobacter chroococcum, Bacillus polymyxa and Saccharomyces cerevisiae resulted an increase of grain yield over control treatment which were being 0.6, 0.4 and 0.9 ton/fed, respectively. Treatment that received 40 kg N/fed plus the same three inoculants which were being 0.5, 0.4 and 0.7 ton/fed, respectively.

As regards with straw yield (Table 4), the same pattern was observed. However the nitrogen fertilizer effect was more pronounced up to 60 kg N/fed either when it was applied alone or in combination with PGPR inoculation treatments as N-fertilizer was more effective on early vegetative growth and tillering initiation led to high yield of straw. Omar *et al.* (1989 a, b) reported similar trends. Moreover, the results showed that treatment of I_2 and I_3 in combination with 40 kg N/fed gave grain and straw yields more than those of the treatment which received 60 kg N/fed without inoculation. Thus, it can be concluded that utilizing PGPR inoculation in rice cultivation beside mineral nitrogen fertilizer can save about 33% of its total nitrogen requirement, which is very important from the economical point of view. In addition, the use of some PGPR inoculation conserves the environment by reducing pollution hazards caused by leaching nitrate in the drainage water, and through volatilization of NH_3 gas from $(NH_4)_2SO_4$ fertilizer and also nitrogen oxide evolved during denitrification processes. Similar trend was observed by Omar *et al.* (1989 a, b) and El-Ekholy and Omar, (2000).

Table (4): Grain and straw yields of rice plants (ton/fed) as affected by mineral nitrogen fertilizer and PGPR inoculation, (combined results of 2002 and 2003 seasons).

PGPR inoculation	N fertilization (kg N/fed)					
	Grain yield, ton/fed			Straw yield, ton/fed		
	N_{20}	N_{40}	N_{60}	N_{20}	N_{40}	N_{60}
Azotobacter chroococcum						
I_0	1.8	3.0	3.2	2.4	3.8	4.3
I_1	2.2	3.1	3.6	2.9	4.1	4.8
I_2	2.6	3.4	3.6	3.3	4.6	4.8
I_3	2.7	3.7	3.8	3.3	4.9	5.1
LSD (5%)		0.22			0.21	
Bacillus polymyxa						
I_0	1.8	3.0	3.3	2.4	3.8	4.4
I_1	2.3	3.1	3.5	3.1	4.2	4.7
I_2	2.5	3.6	3.7	3.3	4.8	4.9
I_3	2.6	3.6	3.7	3.5	4.8	5.0
LSD (5%)		0.2			0.2	
Saccharomyces cerevisiae						
I_0	1.7	2.9	3.1	2.3	3.6	3.8
I_1	2.3	3.0	3.3	2.9	4.0	4.4
I_2	2.6	3.2	3.4	3.1	4.3	4.6
I_3	2.7	3.4	3.5	3.4	4.5	4.8
LSD (5%)		0.1			0.1	

It is worthy to mention that the rice plant in both 2002 and 2003 seasons was cultivated after cereals (wheat). Therefore, the soil has less available nitrogen contents (Table1) which maximized the response to both nitrogen fertilization and PGPR inoculation. Results of such study indicated that, the rice plants inoculated and cultivated after legume require a supply of 20 kg N/feddan while, the inoculated plants cultivated after cereals required the supply of 40 kg/feddan (Mahapatra *et al.*, (1986).Thus, it can be concluded that application of PGPR contributed in saving about 20 kg N/feddan.

Elements Concentrations:

Data in Tables (5, 6, 7 and 8) show the effect of mineral nitrogen fertilizer and diazotrophs and yeast inoculation on N% and P% and uptake in grain and straw of rice. The results indicate that the effects of these two macronutrients in rice are similar to those on yield, where the PGPR inoculation under mineral nitrogen fertilizer gave much higher increase in N and P contents in grain and straw than did the control, except for the effect of Saccharomyces Cerevisisae on N% where, results showed insignificant increase . However, significant increase was obtained in N uptake with Saccharomyces cerevisae inoculation and mineral N fertilization as a result of increasing both grain and straw yields. Once again, the highest N and P contents in both grain and straw resulted from the three inoculants under 60kg N/fed.

Table (5): Nitrogen content in grains and straw of rice at harvest stage as affected by mineral nitrogen and PGPR inoculation, (combined results of 2002 and 2003 seasons).

PGPR inoculation	N fertilization (kg N/fed)					
	N% in grain			N% in straw		
	N_{20}	N_{40}	N_{60}	N_{20}	N_{40}	N_{60}
Azotobacter chroococcum						
I_0	1.10	1.25	1.37	0.464	0.540	0.595
I_1	1.20	1.38	1.50	0.498	0.602	0.623
I_2	1.26	1.42	1.62	0.543	0.632	0.702
I_3	1.33	1.44	1.65	0.583	0.648	0.714
LSD (5%)		0.02			0.01	
Bacillus polymyxa						
I_0	1.10	1.20	1.35	0.357	0.434	0.462
I_1	1.20	1.36	1.45	0.413	0.514	0.537
I_2	1.23	1.42	1.47	0.418	0.519	0.541
I_3	1.28	1.43	1.48	0.521	0.521	0.546
LSD (5%)		0.08			0.005	
Saccharomyces cerevisiae						
I_0	1.11	1.25	1.36	0.490	0.560	0.610
I_1	1.23	1.30	1.41	0.530	0.580	0.670
I_2	1.28	1.38	1.44	0.580	0.630	0.680
I_3	1.30	1.35	1.44	0.600	0.630	0.700
LSD (5%)		N.S			N.S	

The highest N content of grain and straw resulted from inoculation may be due to increased uptake by a larger root surface area associated with additional root hairs and lateral root development and /or to BNF, either directly by the inoculant's strains or indirectly by stimulating BNF activity of the associated rhizosphere community, (Ladha *et al.*, 1998).
Considering collectively, these results plus earlier studies showing positive growth responses of rice to certain diazotrophs and yeast strains even when excess N is present.

Payoff of PGPR inoculation process:

In terms of nitrogen input, an amount of 20 kg in the form of ammonium sulfate fertilizer per feddan will cost about L.E 44. The PGPR inoculant required for field inoculation to produce such amount of nitrogen will cost about L.E 4. If PGPR inoculation technology is applied in even 50% of the rice area in Egypt (500.000 feddans), it will save about 10.000 tons of nitrogen element, which worth about L.E $22 * 10^6$. So, the low cost of PGPR inoculation technology will obtain income and conserve environment by reducing pollution hazards.

Table (6): Nitrogen uptake,(kg/fed) of rice crop as affected by mineral nitrogen fertilizer and PGPR inoculation, (combined results of 2002 and 2003 seasons).

PGPR Inocula-tion	N fertilization (kg N/fed)								
	N uptaked by grain (kg/fed)			N uptaked by straw (kg/fed)			Total N uptaked (kg/fed)		
	N_{20}	N_{40}	N_{60}	N_{20}	N_{40}	N_{60}	N_{20}	N_{40}	N_{60}
Azotobacter chroococcum									
I_0	19.8	37.5	43.8	11.1	20.5	25.6	30.9	58.0	69.4
I_1	26.4	42.8	54.0	14.4	24.7	29.9	40.8	67.5	83.9
I_2	32.8	48.3	58.3	17.9	29.1	33.7	50.7	77.4	92.0
I_3	35.9	53.3	62.7	19.2	31.8	36.4	55.1	85.0	99.1
LSD (5%)	5.25			3.23			9.8		
Bacillus polymyxa									
I_0	19.8	36.0	44.6	8.6	16.5	20.3	28.4	52.5	64.9
I_1	27.6	42.2	50.8	12.8	21.6	25.2	40.4	63.8	75.9
I_2	30.8	51.1	54.4	13.8	24.9	26.5	44.6	76.0	80.9
I_3	33.3	51.5	54.8	18.2	25.0	27.3	51.5	76.5	82.1
LSD (5%)	2.26			2.10			10.4		
Saccharomyces cerevisiae									
I_0	18.9	36.3	42.2	11.3	20.2	23.2	30.2	56.5	65.4
I_1	28.3	39.0	46.5	15.4	23.2	29.5	43.7	62.2	76.0
I_2	33.3	44.2	48.9	18.0	27.1	31.3	51.3	71.3	80.2
I_3	35.1	45.9	50.4	20.4	28.4	33.6	55.5	74.3	84.0
LSD (5%)	2.14			1.94			11.6		

Table (7): Phosphorus content of rice grains and straw as affected by mineral nitrogen fertilizer and PGPR inoculation, (combined results of 2002 and 2003 seasons).

PGPR inoculation	N fertilization (kg N/fed)					
	P% in grains			P% in straw		
	N_{20}	N_{40}	N_{60}	N_{20}	N_{40}	N_{60}
Azotobacter chroococcum						
I_0	0.272	0.311	0.366	0.045	0.056	0.065
I_1	0.282	0.320	0.409	0.049	0.060	0.075
I_2	0.301	0.330	0.422	0.053	0.063	0.078
I_3	0.310	0.345	0.429	0.065	0.064	0.080
LSD (5%)	0.005			0.001		
Bacillus polymyxa						
I_0	0.272	0.311	0.366	0.045	0.060	0.065
I_1	0.293	0.333	0.425	0.051	0.062	0.078
I_2	0.313	0.343	0.4.39	0.055	0.066	0.081
I_3	0.322	0.359	0.446	0.058	0.067	0.083
LSD (5%)	0.013			0.005		
Saccharomyces cerevisiae						
I_0	0.272	0.311	0.366	0.045	0.056	0.065
I_1	0.288	0.326	0.417	0.050	0.061	0.077
I_2	0.307	0.337	0.430	0.054	0.064	0.080
I_3	0.316	0.355	0.431	0.066	0.065	0.082
LSD (5%)	0.006			0.004		

CONCLUSION

The enhancement of rice production by inoculation with the nitrogen-fixing bacteria is comparable with that by nitrogen fertilization up to 60 kg N/fed. Rice inoculation with N_2-fixing bacteria supplemented the plants with a reasonable amount of their nitrogen requirements providing that there is affinity between the rice plant and bacteria. These results confirmed also that yeasts play an important role in soil biofertility, where inoculation with yeast significantly stimulated plant growth and grain yield. The effect of inoculation time in rice nursery, after transplanting and /or in nursery and after transplanting was evaluated. Data revealed that inoculation of rice nursery bed and transplanting soil gave high significant effects on rice grain yield.

Table (8): Phosphorus uptake (kg/fed) of rice grain and straw as affected by mineral nitrogen fertilizer and PGPR inoculation, (combined results of 2002 and 2003 seasons).

PGPR inoculation	N fertilization (kg N/fed)								
	P uptaked by Grains, (kg/fed)			P uptaked by straw (kg/fed)			Total P uptake (kg/fed)		
	N_{20}	N_{40}	N_{60}	N_{20}	N_{40}	N_{60}	N_{20}	N_{40}	N_{60}
Azotobacter chroococcum									
I_0	4.9	9.3	11.7	1.1	2.1	2.8	6.0	11.4	14.5
I_1	6.2	9.2	14.7	1.4	2.5	3.1	7.6	11.7	17.8
I_2	7.8	11.2	15.2	1.7	2.9	3.7	9.5	14.1	18.9
I_3	8.4	12.8	16.3	2.1	3.1	4.1	10.5	15.9	20.4
LSD (5%)	1.2			0.3			1.5		
Bacillus polymyxa									
I_0	4.9	9.3	12.1	1.1	2.0	2.3	6.0	11.3	14.4
I_1	6.7	10.3	14.9	1.6	2.6	3.7	8.3	12.9	18.6
I_2	7.8	12.3	16.2	1.8	3.2	4.0	9.6	15.5	20.2
I_3	8.4	12.9	16.5	2.0	3.2	4.2	10.4	16.1	20.7
LSD (5%)	1.6			0.5			2.2		
Saccharomyces cerevisiae									
I_0	4.6	9.0	11.3	1.1	2.0	2.5	5.6	11.0	13.8
I_1	6.6	9.8	13.8	1.3	2.4	3.4	7.9	12.2	17.2
I_2	8.0	10.8	14.6	1.6	2.8	3.7	9.6	13.6	18.3
I_3	8.5	12.1	15.1	2.2	2.9	3.9	10.7	15.0	19.0
LSD (5%)	1.6			0.5			2.7		

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كفاءة استخدام التلقيح بالريزوبكتريا والخميرة تحت مستويات من التسميد الأزوتي المعدني على محصول الأرز

محمود حسن الخولي ، محمد نبيل عبد المجيد عمر،محمد محسن الذكي وسمير غريب متولي
معهد بحوث الاراضي والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

أجريت ثلاثة تجارب حقلية على محصول الارز صنف جيزة ١٧٨ في محطة بحوث السرو الزراعية في موسمين متتاليين ٢٠٠٢ / ٢٠٠٣. أستخدمت سلالتين من مثبتات الازوت الجوى في التلقيح البكتيري(باسلس بوليمكسا والازوتوباكتر كروكوكم) واستخدمت كذلك سلاله الخميرة سكاروميسس سرفنيزيا كمنشط حيوي . تم دراسة تاثير ميعاد اضافة اللقاح البكتيرى في مشتل الارز وكذلك الارض المستديمة مع ثلاثة مستويات من التسميد الأزوتي(٢٠ ، ٤٠ و٦٠كجم نتروجين /فدان) على صورة سماد كبريتات الأمونيوم ٦و٢٠ %. صممت تجربة قطع منشقة مع اربع مكررات .سجلت أطوال النباتات ، عدد الافرع ، طول السنبلة ووزنها ووزن الألف حبه كذلك قدرت اوزان محصول الحبوب والقش بالطن/فدان . قدرمحتوى كل من الازوت والفوسفور(%) في القش والحبوب وكذلك الكمية الممتصة من كل منهما كجم/فدان . وقد أظهرت النتائج أن التلقيح البكتيري في المشتل والارض المستديمة له تأثير ايجابى معنوى على المحصول و دلائل نمو النبات في وجود ثلثي الجرعة الكاملة للأزوت المعدني بالمقارنة بالمعاملات الاخرى مما يوفر حوالي ٢٠ كجم نتروجين/فدان . كان أعلى محتوى من عنصري النتروجين والفوسفور في كل من الحبوب والقش ناتجا من التلقيح بالريزوبكتريا في وجود أعلى مستوى من التسميد الأزوتي المعدني(٦٠ كجم ،تروجين/فدان)، واعطت سلالة الخميرة نفس اتجاه النتائج ماعدا نسبة الازوت (%) في الحبوب والقش.

وعلى ذلك فانه اذا تم تلقيح ٥٠ % من مساحة الأرز المنزرعة بمصر سوف يؤدي ذلك الى توفير حوالي ١٠٠٠٠ طن من عنصر النتروجين ويقلل ذلك من مخاطر التلوث البيئي.