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ROLE OF BIOFERTILIZATION AND DIFFERENT RATES OF NITROGEN WITH FOLIAR SPRAYING OF NITROGEN AND YEAST IN RICE PRODUCTIVITY AND NUTRIENT UPTAKES.

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ABSTRACT

Field experiments, on rice crop (Oryza Sativa L. c.v. Giza 178) grown in Meet Louza Village, Mansoura Province, Dakahlia Governorate, Egypt were conducted in 2008 and 2009 seasons on a silty clay soil. Biofertilization 8 treatments involving inoculums of Azolla (Azl), Azospirillum (Azs), Azotobacter (Azt), and Cynobacreria (Cyn) as well as mixtures (Azl + Azs), (Azl + Azt) (Azs + Azt) and (Cyn + Azt), soil N-fertilization (4 treatments of no-N, portions of 50 %, 75 % and 100 % of N-recommended level of 60 kg N fed^{-1} as urea), and foliar spray of (2 treatments of yeast extract only, and yeast extract + 2 % N) were tasted in a randomized complete block design (factorial) involving the 3 above mentioned factors. Execution of experiment was a split- split plot with three replicates. The highest grain yields of (3.99 and 4.07 metric t fed^{-1}) in 1st and 2nd seasons occurred with the treatment of (Cyn + Azt) + 50 % N-level + (2 % N + yeast). The highest straw yields were given by (Cyn + Azt) + 100 % N-level+ yeast which gave 3.94 metric t fed^{-1} in 1st season, or by (Cyn + Azt) + 100 % N- level+ (2 % N + yeast) which gave 4.10 metric t fed^{-1}. The highest weight per plant (at booting stage) was due to (Azs + Azt) + 50 % N-level + (2 % N + yeast) which were125.14 and 137.65 g dry matter plant^{-1} in 1st and 2nd seasons, respectively. The highest N-uptake by grains of 59.84 and 66.62 kg fed^{-1} for 1st and 2nd seasons, respectively occurred with (Azl) + 100 % N-level +(2 % N + yeast). The highest P-uptake by grains occurred with (Azl + Azt) + 50 % N-level (2 % N + yeast) which gave (7.51 and 9.46 kg fed^{-1}) in 1st and 2nd seasons, respectively. The highest K-uptake occurred with (Cyn + Azt) + 50 % N-level + (2 % N + yeast) which gave 12.76 and 14.62 kg fed^{-1} in 1st and 2nd seasons respectively. The highest Fe-uptake of 259.89 and 308.44 g fed^{-1} in 1st and 2nd seasons respectively, were given by (Azs + Azt) + 75 % N-level + (2 % N + yeast). The highest Mn-uptake of 185.36 and 214.18 g fed^{-1} in 1st and 2nd seasons respectively occurred with (Cyn + Azt) + 100 % N-level + (2 % N + yeast). The highest Zn-uptake of 151.52 and 171.52 g fed^{-1} in 1st and 2nd seasons, respectively occurred with (Azl + Azs) + 50 % N-level + yeast.
Keywords: N fertilization, biofertilizer, foliar application, yeast and rice plant.

INTRODUCTION

Rice is the most important staple food after wheat and a second major export agricultural commodity in Egypt. The production potential of rice depends on the increased use of fertilizers. Integration of inorganic nitrogen fertilizer with biofertilizers reduces the demand of inorganic nitrogen and increases the nitrogen- use efficiency. Biofertilizers are considered as the most important factor in reducing the application of the chemical fertilizers and minimizing the induced environmental pollution El Kholi (1998).

Galal and El-Ghandour (2000) reported that rice grain yields as well as NPK uptake produced from Azolla inoculated treatments were more than from the uninoculated treatment. They also found that regarding the proportion of N derived from the atmosphere, significant percentages and values of this occurred with the Azolla treatments. Singh *et al.,* (2002) used the application of blue green algi 10 kg /ha incorporated in the soil 15 days before rice transplanting and noticed that increased nitrogen, potassium and phosphorus content in rice grain. Castro *et al.,* (2003) showed that using Azolla inoculation increased dry matter and nutritive value of rice. Aziz and Hashem (2004) stated that inoculation rice seeds by cyanobacterial inoculum resulted in 80.48 % increase in the yield of rice grown on a saline soil, and that such inoculum could supplement up to 20 % of nitrogen demand for rice. Mady (2004) noticed that all growth characters (grain yield, yield components and rice quality) were significantly increased due to treatment with algi. Ghazal *et al.,* (2006) studied that the effect of Azolla and Cynobacteria inoculation each alone or in combination with different levels of chemical nitrogen fertilizer as urea on rice. They found that the highest nitrogen uptake was recorded when Azolla was mixed with urea at 30 kg N fed^{-1}. Manjappa (2001) revealed that rice grain yield of 5330 kg ha^{-1} was obtained with Azospirillum + 75 % of recommended dose of N and was significantly higher than a yield of 5146 kg ha^{-1}given with no Azospirillum + 100 % recommended dose of N, but it was 5460 kg ha^{-1} using Azospirillum + 100 %recommended doses of N. Hammouda *et al.,* (2001) reported that combined inoculation with blue-green algi, Azotobater chroococcum and Azospirillum brasilense along with 50 % of the chemical nitrogen recommended for rice variety Giza 172 produced the highest yields of rice grain and straw. Sapatnekar *et al.,* (2001b) obtained maximum grain and straw yields of rice upon combined application of biofertilizers Azotobacter and Azospirillum and blue-green algi a composite culture of blue green algae of Anabaena, Nostoc, Aulosira, Westiellopsis and Tolypothrix algi. Manjappa (2004) reported that rice grain yield, straw yield and net returns of rice increased significantly with increasing levels of nitrogen. Sharief *et al.,* (2006) carried out field experiments on rice cv. Sakha 104., and reported that values of grain and straw yield increased with increasingly nitrogen rates up to 45 or 60 kg N fed^{-1}, grain yield increased by 28 to 31 %. Inoculation with blue green algae alone resulted in 5 % yield increase. The highest values of the parameters measured were recorded with increasing nitrogen fertilizer up to 45 or 60 kg N/fed and in combination with blue green algi. Singh and Kumar Singh (2006) conducted field experiments on nitrogen and biofertilizer for rice, and observed that, 80 kg N ha^{-1} combined with blue-green algi and Azolla recorded the highest grain yield.

Monib *et al.,* (1982) reported that yeasts produce hormones, amino acids, cytokinin, indol and and vitamins. Tartoura (2001) reported that yeast extract increased leaf area and chlorophyll content, Darweesh *et al.,* (2003) reported that yeast contains tryptophane which is the precursor of indol acetic acid which promotes plant growth. Abd El-Razik (2003) recognized that foliar application of urea at the panicle stage of rice significantly increased grain and straw yields. Krishnaveni and Balasubramanian (2003) pointed out that foliar spraying of nutrient mixture with N and K in four slphats (Skipping busal) significantly increased dry matter production and recorded the highest grain of rice crop. Sarhan *et al.,* (2004) in field experiments reported that the level of 30 g N/L in a foliar spray with applying 15 kg N fed^{-1} increased grain and straw yields as well as contents of N, P, Zn and Fe in grains of wheat. They concluded that this treatment of foliar spray + applying 15 kg N fed^{-1} was superior to applying 75 kg N fed^{-1}; and also superior to foliar spray without additional N application.

The objective of the present study is to reducing the application of the soil N-fertilization rates and minimizing the induced environmental pollution by using biofertilizers.

MATERIALS AND METHODS

Two field experiments were conducted in the Meet louza Village, Mansoura Province, Dakahlia Governorate, Egypt (+ 7 m altitude, 30^0 11$^-$ latitude and 28^0 26^{-l} longitude), during summer seasons of 2008 and 2009 to study the effect of different nitrogen levels, biofertilizer inoculations and foliar spray of nitrogen + yeast on growth, yield and chemical composition of rice (oryza sativa L., c.v. Giza 178). Rice seeds at the rate of 60 kg fed^{-1} were soaked in fresh water for 24 hour and incubated for 24 hour. Seeding was done using the pregerminated seeds by broadcast, on the 10th and 13th of May in the two seasons of 2008 and 2009, respectively. After thirty days, rice seedlings were transplanted on hills. Each plot included ten rows of four meters of length and eight columns of three meters width (area = 12 m^2).

Some physical and chemical properties of the experimental soil at the depth of (0-30 cm) were determined according to the standard procedures as described by Black *et al.*, (1965) and Page (1982) as indicated in Table 1.

The experimental design and treatments:

The experimental design was a randomized complete block split-split plot design involving 3 factors. The different combinations of treatments of the 3 factors of the experiment are 64. Treatments were replicate three times thus, and the total number plots equal 192. Factors of the experiment were:(1) foliar spray with yeast and urea-N, (2) soil application of solid urea N, and (3) biofertilization

The foliar spraying treatment (main plots):

1- Spray with yeast (as fresh yeast) 16 g L $^{-1}$ (3.2 kg/200 L fed^{-1}).

2- Spray with urea at 20 g N L^{-1}(i.e.: 2 % N) (4.00 kg N /200L fed^{-1}) plus yeast 16 g L^{-1}.

The foliar spraying was repeated 3 times; i.e 45, 60 and 75 days after transplanting.

The sub-main plots were devoted to four rates of soil-application of solid urea where the recommended rate of 60 kg N fed^{-1} for rice crop. The rates as portions of recommended rate are:

- No-fertilizer N applied through the soil, (without nitrogen), application of 50 % of recommended dose, i.e. 30 kg N fed^{-1}, application of 75% of recommended dose, i.e. 45 kg N fed^{-1} and application of 100 % of recommended dose, i.e. 60 kg N fed^{-1}.

Fertilizer of urea (46.5% N) was used as a source of nitrogen fertilization in 3 splits 1/3 the dose was added and incorporated into the soil by ploughing; 1/3 the dose was added after 40 days from transplanting and the last dose was added at maximum tillering stage. Calcium super-phosphate (6.8%P) was used as a source of P for the whole area of the experiment at a recommended rate of 6.8 kg P fed^{-1} applied during land preparation and before transplanting. Potassium sulphate (40.0 % K) was used as a source of K. The recommended rate for rice crop is 20 kg K fed^{-1} befor ploughing of the experiment field.

Table 1: Some physical and chemical properties of the studied soil before cultivation for the two seasons.

Soil characteristics	1st (2008)	2nd (2009)
Sand%	11.28	10.18
Silt%	42.98	43.62
Clay%	45.74	46.20
Texture Class	Silty clay	Silty clay
*__pH__	8.90	8.70
**__EC. dS m^{-1}__	1.19	1.15
$CaCO_3$ %	2.29	2.24
OM%	1.85	2.01
Soluble Cations ($meq.L^{-1}$)		
Ca^{++}	3.80	2.40
Mg^{++}	1.00	1.20
Na^{+}	6.10	7.50
K^{+}	1.00	0.40
Soluble Anions ($meq.L^{-1}$)		
$CO3^{--}$	n.d_	n.d_
$HCO3^{-}$	0.80	0.40
Cl^{-}	6.40	5.00
SO_4^{--}	4.70	6.10
***__Available nutrients (mg kg^{-1} soil)__		
Nitrogen (N)	38	48
Phosphorus (P)	9.78	10.66
Potassium (K)	280	300
Iron (Fe)	5.32	4.71
Zinc (Zn)	1.78	0.83
Manganese (Mn)	4.07	3.03

***pH: of saturated soil past. **Ec: 1:5 extract.**
*****Extracts for available nutrients are: KCL (for N), Na-bicarbonate (for P), NH_4 OAC (for K) and DTPA (for Fe, Zn and Mn).**

The sub-sub plots were assigned to the eight treatment of biofertilizers inoculation namely as the following:

- Azolla inoculum, Azospirillum bacteria (using biofertilizer with a trade name of "SERIALINE" inoculum), Cyanobacteria (blue-green algi inoculum), Azotobacter bacteria (using biofertilizer with a trade name of "AZOTOBACTRINE" inoculum), Azolla + Azospirillum bacteria, Azolla + Azotobacter bacteria, Azospirillum + Azotobacter bacteria and Cyanobacteria + Azotobacter bacteria.

N- Biofertilizing:

The Azolla biofertilizer was grown, multiplicated and inoculated according to Ghazal *et al.*, (1997). The blue-green algae (Cynobacteria) was provided by the Soil Microbiology Department of the Soil, Water and Environmental Research Institute, ARC, Giza Egypt. It contained Anabaena Oryza, Nostoc muscrum and Tolypothrix tenuis, (El-Kholy 1997). Other biofertilizers were provided by the Soil Microbiology Department of the Soil, Water and Environmental Research Institute, ARC, Giza Egypt.

Data recorded:

Morphological characters: at 90 days after transplanting (booting stage) was recorded plant dry matter (g. plant^{-1}).

Yield and yield components: At harvesting time, the followings were determined: grain and straw yields (metric ton fed^{-1})**.**

Chemical composition: Samples of rice grain at harvest were taken at random, then dried at 70C for 48 hour, througly, ground and wet digested by a sulphuric–perchloric acid mixture to determine the N according to Hesse (1971)., P, K, Fe, Mn and Zn content according to Jakson (1967). Statistical analysis of the collected data was done according to the methods described by Waller and Duncan (1969).

RESULTS AND DISCUSSION

Yields and dry matter:

Data tabulated in Tables 2 and 3 in 1st and 2nd seasons show the combination between foliar spray, nitrogen fertilization trough the soil and biofertilizer inoculations. The results indicate that the combination between the previous treatments had significant effect on grain, straw yields and dry matter. It is clear from the data the uppermost mean values of rice grain yield (3.99 and 4.07 metric t fed^{-1}) were obtained from the combination treatments of (cynobacteria + Azotobacter) inoculation at 50 % N fertilization level under foliar spray with (2 % N + Yeast). The highest yield caused by cynobacteria + Azotobactar reflects the action of Azotobacter in fixing nitrogen in co-operation with cynobacteria (Alexander 1971). The highest average yield under foliar application with yeast was achieved with (Azospirillum + Azotobacter) and 75 % N fertilization level, yields being 3.88, 3.92 metric t fed^{-1} in 1st and 2nd seasons, respectively. Yeasts produce growth-promoting substance such as hormones, amino acids, cytokinin, indol and vitamins (Monib *et al.,* 1982). Abd El-Razik (2003) found that foliar application of urea at the panicle stage significantly increased rice grain and straw yields. The current results agree with those reported that by Hammouda *et al.,* (2001) and Tantawy (2006) who found that inoculation with Azotobacter and cynobacteria combined with 1/4 N dose of N requirement increased soil biological activity, leading to the production of substance which act as plant growth promoting regulator (PGPR) and as well as fixing atmospheric N.

Table 2: Effect of nitrogen fertilization levels, biofertilizer inoculations and foliar spraying of nitrogen & yeast on grain yield (metric. t. fed^{-1}.), straw yield (metric. t. fed^{-1}.) at harvest and dry matter weight of plant at booting stage (g. plant^{-1}) of rice crop during 1st season.

Treat.	Char.	Grain yield (matric t.fed^{-1})		Straw yield (matric t.fed^{-1})		Dry matter weight (g.plant^{-1})	
		2%N + yeast	yeast	2%N + yeast	yeast	2%N + yeast	yeast
Control	Azl.	2.74	2.61	2.60	2.45	98.28	81.59
	Azs.	2.95	2.90	2.25	2.18	81.63	79.72
	Cyn.	3.44	3.19	2.90	2.74	91.26	90.11
	Azt.	3.46	3.38	2.99	2.95	90.68	85.85
	Azl. + Azs.	3.60	3.50	3.30	2.81	98.20	91.71
	Azl. + Azt.	3.56	3.44	3.16	3.02	97.78	92.72
	Azs. + Azt.	3.53	3.42	3.09	2.95	101.38	95.95
	Cyn. + Azt.	3.51	3.47	3.65	3.52	91.22	85.00
50%	Azl.	3.24	3.07	3.17	2.74	109.09	96.39
	Azs.	3.64	3.56	2.32	2.29	84.79	80.03
	Cyn.	3.91	3.50	3.10	3.17	109.39	102.84
	Azt.	3.96	3.53	3.78	3.20	111.94	108.20
	Azl. + Azs.	3.92	3.70	3.47	3.44	109.85	106.70
	Azl. + Azt.	3.86	3.68	3.79	3.37	122.02	118.34
	Azs. + Azt.	3.76	3.73	3.74	3.44	125.14	120.17
	Cyn. + Azt.	3.99	3.77	3.76	3.68	119.28	100.60
75%	Azl.	3.74	3.38	3.34	3.35	100.64	98.39
	Azs.	3.08	3.08	2.51	2.38	90.47	89.70
	Cyn.	3.89	3.23	3.23	3.20	97.77	91.24
	Azt.	3.72	3.75	3.48	3.31	99.15	90.34
	Azl. + Azs.	3.40	3.05	2.53	2.50	111.03	110.34
	Azl. + Azt.	3.51	3.49	2.74	2.60	110.96	109.01
	Azs. + Azt.	3.96	3.88	3.78	3.52	111.64	109.95
	Cyn. + Azt.	3.82	3.72	3.86	3.89	116.82	102.79
100%	Azl.	3.63	3.04	3.72	3.50	110.68	94.30
	Azs.	3.10	2.51	2.67	2.59	95.76	93.23
	Cyn.	3.50	3.49	3.62	3.45	98.15	95.11
	Azt.	3.78	3.42	3.51	3.47	99.36	98.85
	Azl. + Azs.	3.75	2.90	2.74	2.54	100.35	99.07
	Azl. + Azt.	3.59	3.56	3.24	2.84	114.03	105.54
	Azs. + Azt.	3.79	3.34	3.51	3.28	105.92	102.63
	Cyn. + Azt.	3.75	3.64	3.90	3.94	101.48	96.04
L.S.D $_{at\ 5\%}$		0.13		0.03		3.87	

∗Azl: Azolla **∗ Azs: Azospirillum**
∗Cyn: Cyanobacteria **∗ Azt: Azotobacter**

With regard to the straw yield, it is evident from the data in Table 2, that the treatment of foliar spray with yeast combined with Cynobacteria + Azotobacter, and applying 100 % N fertilization gave the highest straw yield of 3.94 metric t fed^{-1} in 1st season, but the data in Table 3 for 2nd season reveal that the same previous combination but with foliar spray with yeast + N led to highest straw yield 4.10 metric t fed^{-1}. This result may be attributed to the difference in the weather condition during the two seasons. The increase in straw yield at 100 % N-level due to raising the nitrogen dose. Nitrogen is highly effective on vegetative growth and yield through its effects on vital prosses, i.e. chlorophyll, enzymes, photosynthesis and endogenous hormones synthesis. Which consequently affect plant growth and yield.

Table 3: Effect of nitrogen fertilization levels, biofertilizer inoculations and foliar spraying of nitrogen & yeast on grain yield (metric. t. fed^{-1}.), straw yield (metric. t.fed^{-1}.) at harvest and dry matter weight of plant at booting stage (g.$plant^{-1}$) of rice crop during 2nd season.

Treat.	Char.	Grain yield (matric t. fed^{-1})		Straw yield (matric t.fed^{-1})		Dry matter weight (g.$plant^{-1}$)	
		2%N + yeast	yeast	2%N + yeast	yeast	2%N + yeast	yeast
Control	Azl.	2.79	2.64	2.73	2.52	108.11	88.12
	Azs.	3.01	2.93	2.36	2.25	89.79	86.10
	Cyn.	3.51	3.22	3.05	2.82	100.39	97.32
	Azt.	3.53	3.41	3.14	3.04	99.75	92.72
	Azl. + Azs.	3.67	3.54	3.47	2.89	108.02	99.05
	Azl. + Azt.	3.63	3.47	3.32	3.11	107.56	100.14
	Azs. + Azt.	3.60	3.45	3.24	3.04	111.52	103.63
	Cyn. + Azt.	3.58	3.50	3.83	3.63	100.34	91.80
50%	Azl.	3.30	3.10	3.33	2.82	120.00	104.10
	Azs.	3.71	3.60	2.44	2.36	93.27	86.43
	Cyn.	3.99	3.54	3.26	3.27	120.33	111.07
	Azt.	4.04	3.57	3.97	3.30	123.13	116.86
	Azl. + Azs.	4.00	3.74	3.64	3.54	120.84	115.24
	Azl. + Azt.	3.94	3.72	3.98	3.47	134.22	127.81
	Azs. + Azt.	3.84	3.77	3.93	3.54	137.65	129.78
	Cyn. + Azt.	4.07	3.81	3.95	3.79	131.21	108.65
75%	Azl.	3.81	3.41	3.51	3.45	110.70	106.26
	Azs.	3.14	3.11	2.64	2.45	99.52	96.88
	Cyn.	3.97	3.26	3.39	3.30	107.55	98.54
	Azt.	3.79	3.79	3.65	3.41	109.07	97.57
	Azl. + Azs.	3.47	3.08	2.66	2.58	122.13	119.17
	Azl. + Azt.	3.58	3.52	2.88	2.68	122.06	117.73
	Azs. + Azt.	4.04	3.92	3.97	3.63	122.80	118.75
	Cyn. + Azt.	3.90	3.76	4.05	4.01	128.50	111.01
100%	Azl.	3.70	3.07	3.91	3.61	121.75	101.84
	Azs.	3.16	2.54	2.80	2.67	105.34	100.69
	Cyn.	3.57	3.52	3.80	3.55	107.97	102.72
	Azt.	3.86	3.45	3.69	3.57	109.30	106.76
	Azl. + Azs.	3.83	2.93	2.88	2.62	110.39	107.00
	Azl. + Azt.	3.66	3.60	3.40	2.93	125.43	113.98
	Azs. + Azt.	3.87	3.37	3.69	3.38	116.51	110.84
	Cyn. + Azt.	3.83	3.68	4.10	4.06	111.63	103.72
L.S.D at 5%		0.13		0.04		4.22	

The results obtained are in agreement with those reported by Sapatnekar *et al.,* (2001b).

Results listed in Tables 2 and 3 noticed that the two most effective combinations of treatment were those of Azospirillum + Azotobacter combined with 50 % N-level along with (2 % N + yeast) or the same along with yeast only. Those 2 treatments gave 125.14 g and 137.65 g dry weight / plant respectively in season 1; and 120.17 and 129.78 g respectively in season 2. The increases in dry matter could be attributed to that nitrogen which is an essential element for building up protoplasm, amino acids and protein and induced cell division and initiate merestimatic activity. These results are in harmony with those obtained by Darweesh *et al.,* (2003).

Macronutrient uptake:

Data presented in Tables 5 and 6 in 1st and 2nd seasons show results of nitrogen fertilization levels, biofertilizer inoculations and foliar spray using 2 % N + yeast , or only yeast. The results point out that content of N, P and K in rice grains were significantly affected by the treatments. It is quite clear that treating rice plants with Azolla at 100 % N fertilization level in combination with 2 % N + yeast foliar spraying gave the highest values of N-uptake (59.84 and 66.62 kg fed^{-1} in 1st and 2nd growing seasons, respectively). However, the values of N-uptake (46.17 and 49.48 kg fed^{-1} in 1st and 2nd seasons respectively) by grains obtained when plants received 75 % N-level in combination with Azospirillum +Azotobacter as well as foliar application with yeast were the highest.

As for P-uptake by rice grains the highest p-uptake given by spray with 2 % N + yeast was achieved by combining the treatment with 50 % N-level with (Azolla + Azotobacter) which gave 7.51 and 9.46 kg fed^{-1} in 1st and 2nd seasons, respectively. However, regarding spraying with yeast only, the highest yields were obtained with combination 75 % N-level and (Cynobacteria + Azotobacter) which gave uptake of 7.77 and 8.81 kg fed^{-1} in 1st and 2nd seasons, respectively.

Concerning the effect of treatments on K-uptake by rice grains data in Tables 4 and 5 for the 1st and 2nd seasons respectively reveal that for the (2 % N + yeast) spray the highest uptake was with 50 % N fertilization level combined and (Cynobacteria +Azotobacter) giving values of 12.76 and 14.62 kg fed^{-1} in 1st and 2nd seasons, respectively. Concerning the foliar spraying with yeast, the highest uptake values occurred in combination with 75 % N-level with (Cynobacteria + Azotobacter) (12.63 and 13.93 kg fed^{-1} in 1st and 2nd seasons, respectively) biofertilization treatment produce organic acids which solubilize inorganic and organic forms of phosphorus and other elements that are unavailable to plant. Farah-Ahmed *et al.,* (2008) tested some microbial inoculums as biofertilizer and found that more than 80 % are able to solubilize of phosphate and that the isolates produced ammonia. These results could be confirmed with the findings of Galal and El-Ghandour (2000) and Singh *et al.,* (2002).

Table 4: Effect of nitrogen fertilization levels, biofertilizer inoculations and foliar spraying of nitrogen & yeast on N, P and K uptake ($kg.fed^{-1}$) in rice grain during 1st season.

Treat.	Char.	N uptake $kg.fed^{-1}$		P uptake $kg.fed^{-1}$		K uptake $kg.fed^{-1}$	
		2%N + yeast	yeast	2%N + yeast	yeast	2%N + yeast	yeast
Control	Azl.	30.16	26.59	4.84	4.61	7.54	7.23
	Azs.	24.81	22.89	3.96	4.10	7.09	7.76
	Cyn.	31.69	27.81	4.18	4.00	8.76	7.84
	Azt.	31.93	30.48	4.01	4.01	8.91	8.53
	Azl. + Azs.	39.26	31.98	6.86	5.96	7.75	8.04
	Azl. + Azt.	33.21	30.66	5.50	5.68	8.72	8.46
	Azs. + Azt.	36.77	29.44	4.88	4.40	10.32	7.58
	Cyn. + Azt.	38.35	35.73	6.79	6.90	9.64	11.02
50%	Azl.	41.08	28.75	5.20	4.60	9.48	9.45
	Azs.	27.23	26.84	3.81	3.80	7.96	8.24
	Cyn.	42.34	32.15	4.78	4.94	9.03	8.68
	Azt.	43.88	37.67	5.90	5.05	11.69	9.72
	Azl. + Azs.	43.16	40.32	5.28	5.57	8.68	9.07
	Azl. + Azt.	57.08	40.07	7.51	6.70	9.75	10.10
	Azs. + Azt.	48.09	39.70	7.00	6.81	11.19	8.59
	Cyn. + Azt.	40.85	36.04	7.34	7.43	12.76	11.47
75%	Azl.	45.58	43.41	5.54	6.23	9.35	10.99
	Azs.	33.70	29.29	3.61	4.72	6.62	9.00
	Cyn.	41.27	39.80	6.14	6.12	9.40	8.58
	Azt.	48.12	38.85	6.26	6.39	11.17	10.17
	Azl. + Azs.	32.38	31.47	4.00	3.95	6.88	7.64
	Azl. + Azt.	39.31	31.38	4.99	5.19	7.81	9.32
	Azs. + Azt.	51.58	46.17	6.46	6.79	11.34	11.22
	Cyn. + Azt.	51.05	42.16	6.71	7.77	11.85	12.63
100%	Azl.	59.84	45.92	7.14	7.03	11.08	9.90
	Azs.	37.35	35.80	4.16	5.07	6.38	8.59
	Cyn.	51.30	44.06	5.72	6.21	12.37	11.48
	Azt.	46.65	44.32	5.89	6.03	12.66	11.27
	Azl. + Azs.	39.43	32.87	4.68	5.53	8.57	8.38
	Azl. + Azt.	55.53	36.78	5.83	5.96	9.00	9.74
	Azs. + Azt.	48.51	44.22	6.00	5.77	10.98	10.69
	Cyn. + Azt.	58.15	44.13	6.78	7.25	10.91	12.29
L.S.D at 5%		1.35		0.22		0.35	

Micronutrient uptake

Data in Tables 6 and 7 for the 1st and 2nd seasons respectively, show that the effect of nitrogen fertilization levels, biofertilizer inoculations and foliar spraying treatments regarding uptake of Fe, Mn and Zn by rice grains. For treatments sprayed with (2 % N + yeast), the maximum of Fe-uptake were 259.89 and 308.44 g Fe fed^{-1} in the 1st and 2nd seasons obtaining which occurred when spray was combined with 75 % N-level with (Azospirillum +Azotobacter). On the other hand, under foliar application with yeast the highest uptake occurred in combination with 100 % N-level coupled with

(Cyanobacteria + Azotobacter) which gave Fe-uptake of 260.11 and 297.51 g Fe fed^{-1} in 1st and 2nd seasons, respectively. For the Mn-uptake the data in Tables 6 and 7 for 1st and 2nd seasons respectively show that under spray with (2 % + yeast), the highest Mn -uptake occurred in combination with 100 % recommended N dose coupled with (Cyanobacteria +Azotobacter) which gave 185.36 and 214.18 g Mn fed^{-1} in 1st and 2nd seasons, respectively.

Table 5: Effect of nitrogen fertilization levels, biofertilizer inoculations and foliar spraying of nitrogen & yeast on N, P and K uptake ($kg.fed^{-1}$) in rice grain during 2nd season.

Char. / Treat.		N uptake $kg.fed^{-1}$		P uptake $kg.fed^{-1}$		K uptake $kg.fed^{-1}$	
		2%N + yeast	yeast	2%N + yeast	yeast	2%N + yeast	yeast
Control	Azl.	33.56	28.45	6.09	5.21	8.63	7.96
	Azs.	27.63	24.54	4.99	4.65	8.11	8.56
	Cyn.	35.29	29.81	5.26	4.54	10.03	8.64
	Azt.	35.54	32.66	5.05	4.55	10.20	9.40
	Azl. + Azs.	43.72	34.25	8.65	6.75	8.88	8.86
	Azl. + Azt.	36.95	32.83	6.92	6.43	9.98	9.32
	Azs. + Azt.	40.90	31.56	6.15	4.98	11.81	8.36
	Cyn. + Azt.	42.66	38.29	8.55	7.82	11.03	12.15
50%	Azl.	45.70	30.80	6.55	5.21	10.85	10.41
	Azs.	30.32	28.73	4.80	4.30	9.12	9.07
	Cyn.	47.15	34.45	6.02	5.60	10.34	9.57
	Azt.	48.85	40.36	7.44	5.72	13.38	10.71
	Azl. + Azs.	48.04	43.15	6.65	6.30	9.93	9.99
	Azl. + Azt.	63.54	42.91	9.46	7.59	11.16	11.13
	Azs. + Azt.	53.52	42.49	8.82	7.70	12.81	9.46
	Cyn. + Azt.	45.49	38.60	9.26	8.41	14.62	12.64
75%	Azl.	50.73	46.49	6.98	7.06	10.70	12.12
	Azs.	37.52	31.36	4.56	5.34	7.59	9.91
	Cyn.	45.96	42.64	7.73	6.93	10.76	9.46
	Azt.	53.54	41.62	7.89	7.24	12.78	11.21
	Azl. + Azs.	36.04	33.73	5.04	4.47	7.87	8.43
	Azl. + Azt.	43.80	33.64	6.29	5.89	8.94	10.28
	Azs. + Azt.	57.43	49.48	8.14	7.69	12.98	12.37
	Cyn. + Azt.	56.78	45.20	8.45	8.81	13.55	13.93
100%	Azl.	66.62	49.22	8.99	7.97	12.68	10.91
	Azs.	41.57	38.33	5.24	5.75	7.30	9.47
	Cyn.	57.13	47.15	7.21	7.02	14.17	12.64
	Azt.	51.94	47.46	7.43	6.83	14.50	12.42
	Azl. + Azs.	43.88	35.22	5.90	6.27	9.81	9.23
	Azl. + Azt.	61.77	39.42	7.34	6.76	10.30	10.74
	Azs. + Azt.	54.01	47.39	7.56	6.54	12.57	11.79
	Cyn. + Azt.	64.75	47.30	8.55	8.22	12.50	13.56
$L.S.D_{\text{at } 5\%}$		1.45		0.25		0.39	

Table 6: Effect of nitrogen fertilization levels, biofertilizer inoculations and foliar spraying of nitrogen & yeast on Fe, Mn and Zn uptake (g.fed^{-1}) in rice grain during 1st season.

Treat.	Char.	Fe uptake g.fed^{-1}		Mn uptake g.fed^{-1}		Zn uptake g.fed^{-1}	
		2%N + yeast	yeast	2%N + yeast	yeast	2%N + yeast	yeast
Control	Azl.	84.52	173.38	32.51	33.70	48.11	57.91
	Azs.	90.59	79.59	59.08	67.60	94.23	72.35
	Cyn.	119.66	94.75	90.65	85.65	53.84	55.50
	Azt.	100.94	202.87	71.03	84.84	60.68	54.77
	Azl. + Azs.	114.71	100.48	37.13	52.70	100.68	133.17
	Azl. + Azt.	129.59	113.28	51.36	49.15	64.01	65.25
	Azs. + Azt.	153.00	90.21	125.95	73.77	78.29	64.74
	Cyn. + Azt.	193.66	198.12	123.21	118.83	86.39	83.27
50%	Azl.	99.23	189.26	75.41	56.45	64.33	83.33
	Azs.	90.05	69.58	66.81	67.79	110.10	88.97
	Cyn.	187.86	154.70	93.16	146.77	110.05	69.62
	Azt.	123.05	213.83	146.72	86.49	89.47	75.70
	Azl. + Azs.	112.09	163.57	62.39	67.15	106.01	151.52
	Azl. + Azt.	180.33	130.73	83.52	80.97	103.07	74.15
	Azs. + Azt.	219.15	120.53	149.85	86.09	97.78	77.86
	Cyn. + Azt.	156.30	155.65	145.94	133.69	115.62	109.71
75%	Azl.	223.79	248.05	70.14	83.80	78.93	85.44
	Azs.	112.33	110.74	47.62	68.47	132.49	116.17
	Cyn.	173.62	100.06	105.01	108.06	83.82	66.73
	Azt.	221.86	233.50	165.31	101.74	123.34	117.84
	Azl. + Azs.	80.33	99.43	56.98	68.79	98.65	97.51
	Azl. + Azt.	191.81	150.24	59.60	58.54	69.35	54.50
	Azs. + Azt.	259.89	215.73	141.76	136.59	108.53	83.23
	Cyn. + Azt.	208.45	243.27	183.36	160.56	91.22	91.98
100%	Azl.	231.71	239.81	88.40	68.27	87.96	135.87
	Azs.	114.88	77.49	54.82	68.01	91.24	109.61
	Cyn.	144.89	103.53	149.41	142.35	101.38	75.71
	Azt.	208.97	192.64	144.87	153.59	95.70	105.86
	Azl. + Azs.	145.31	139.74	55.16	60.98	79.51	74.95
	Azl. + Azt.	205.05	170.45	89.15	99.43	93.01	71.90
	Azs. + Azt.	210.73	185.73	106.24	98.43	71.37	70.64
	Cyn. + Azt.	195.12	260.11	185.36	177.62	96.35	93.64
L.S.D $_{at\ 5\%}$		5.62		4.13		2.32	

On the other hand, highest uptake for yeast spray was that where 100 % N and (Cyanobacteria +Azotobacter) were combined, giving uptake of 177.62 and 197.67 g Mn fed^{-1} in 1st and 2nd seasons, respectively. Regarding Zn-uptake, results show that for treatments of foliar spray with (2 % N + yeast), the highest uptake occurred with combination with 75 % N-level + Azospirillum given uptake of 132.49 and 161.44 g Zn fed^{-1} in 1st and 2nd seasons, respectively. The highest uptake for treatments sprayed with yeast was given by combination with 50 % N-level and Azolla + Azospirillumwith uptake of 151.52 and 171.52 g $Zn.fed^{-1}$ in 1st and 2nd seasons, respectively.

Various increases in N, P, K, Fe, Mn, and Zn uptake through inoculation of seeds using inoculums of micro-organisms reflect enhancement of mineral uptake by plants and increases in both dry matter of plants. Mervat and Dahdoh (1997) reported increased concentration and uptake of N, P, K, Fe, Mn, and Zn and as a result of biofertilization. The obtained results were in agreement with those of Sarhan *et al.,* (2004).

Table 7: Effect of nitrogen fertilization levels, biofertilizer inoculations and foliar spraying of nitrogen & yeast on Fe, Mn and Zn uptake ($g.fed^{-1}$) in rice grain during 2nd season.

Treat.	Char.	Fe uptake $g.fed^{-1}$		Mn uptake $g.fed^{-1}$		Zn uptake $g.fed^{-1}$	
		2%N + yeast	yeast	2%N + yeast	yeast	2%N + yeast	yeast
Control	Azl.	100.28	197.96	37.55	37.43	58.60	65.52
	Azs.	107.52	91.05	68.26	75.24	114.81	82.02
	Cyn.	142.05	108.37	104.76	95.31	65.62	62.91
	Azt.	119.78	232.05	82.05	94.42	73.92	62.08
	Azl. + Azs.	136.16	114.84	42.91	58.60	122.68	150.83
	Azl. + Azt.	153.70	129.49	59.30	54.66	77.93	73.91
	Azs. + Azt.	181.47	103.19	145.42	82.10	95.32	73.39
	Cyn. + Azt.	229.63	226.58	142.21	132.23	105.16	94.37
50%	Azl.	117.67	216.47	87.06	62.82	78.31	94.45
	Azs.	106.88	79.48	77.19	75.34	134.15	100.72
	Cyn.	223.02	176.96	107.65	163.35	134.11	78.93
	Azt.	146.04	244.53	169.50	96.24	109.00	85.78
	Azl. + Azs.	133.00	186.84	72.06	74.63	129.12	171.52
	Azl. + Azt.	213.99	149.41	96.48	90.04	125.56	83.99
	Azs. + Azt.	260.00	137.68	173.06	95.68	119.08	88.14
	Cyn. + Azt.	185.55	177.93	168.65	148.70	140.91	124.28
75%	Azl.	265.51	283.54	81.01	93.21	96.12	96.79
	Azs.	133.34	126.53	55.02	76.11	161.44	131.53
	Cyn.	206.12	114.42	121.36	120.23	102.15	75.62
	Azt.	263.20	267.01	190.90	113.20	150.20	133.54
	Azl. + Azs.	95.32	113.76	65.81	76.57	120.16	110.55
	Azl. + Azt.	227.82	171.90	68.91	65.16	84.56	61.80
	Azs. + Azt.	308.44	246.71	163.77	151.98	132.22	94.32
	Cyn. + Azt.	247.15	278.36	211.63	178.75	111.02	104.29
100%	Azl.	274.97	274.31	102.12	75.98	107.15	154.01
	Azs.	136.30	88.56	63.31	75.62	111.12	124.14
	Cyn.	172.01	118.25	172.68	158.19	123.56	85.70
	Azt.	248.03	220.20	167.39	170.82	116.61	119.92
	Azl. + Azs.	172.38	159.79	63.71	67.84	96.83	84.93
	Azl. + Azt.	243.15	194.97	102.91	110.66	113.22	81.50
	Azs. + Azt.	250.11	212.45	122.75	109.54	86.95	80.07
	Cyn. + Azt.	231.60	297.51	214.18	197.67	117.40	106.14
L.S.D at 5%		0.39		4.74		2.71	

Conclusion

It could be concluded that, inoculation with biofertilizer mixtures along with foliar spray with yeast or yeast + N-solution could be used along with application of 50 to 75 % of the recommended rate of N, thus saving 25 to 50 % of N requirement.

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دور التسـميد الحيـوي ومعـدلات مختلفـة مـن النيتـروجين مـع الـرش بـالخميرة والنيتروجين في انتاجية الارز وامتصاص العناصر.

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**** قسم بحوث تغذية النبات- معهد بحوث الاراضي والمياة والبيئة- مركز البحوث الزراعية- الجيزة- مصر.**

تم اجراء تجربتين حقليتين علي محصول الارز صنف جيزة ١٧٨ بقرية ميت لوزة مركز المنصورة بمحافظة الدقهلية مصر خلال مواسم ٢٠٠٨و ٢٠٠٩ في ارض طينية سلتية. وتم دراسة العوامل الاتية في تصميم القطاعات الكاملة العشوائية التسميد الحيوي يشمل ٨ معاملات (الأزولا), (الأزوسبيريليم), (الأزوتوباكتر), (السيانوباكتيريا) وكذلك(الأزولا+ الأزوسبيريليم), (الأزولا+ الأزوتوباكتر), (الأزوسبيريليم+ الأزوتوباكتر), (السيانوباكتيريا+ الأزوتوباكتر) والتسميد النيتروجيني الأرضي (بدون تسميد - ٥٠ %- ٧٥ %- ١٠٠ % من الجرعة الموصي بها ٦٠ كجم نيتروجين /فدان)في صورة يوريا ٤٦.٥ % والرش ب مستخلص (الخميرة فقط) ,(الخميرة+ ن ٢%).تم إجراء التجربة في قطع منشقة مرتين مع ٣ مكررات.و تم الحصول علي الأتي. أعلي محصول حبوب (٣.٩٩-٤.٠٧ طن متري/فدان) مع (السيانوباكتيريا+ الأزوتوباكتر) + ن ٥٠ % + (الخميرة+ ن ٢%) خلال الموسم الأول والثاني بالترتيب .أعلي محصول قش (٣.٩٤طن متري/فدان) مع (السيانوباكتيريا+ الأزوتوباكتر)+ ن ١٠٠ % + (الخميرة) في الموسم الأول و(٤.١٠ طن متري / فدان) مع (السيانوباكتيريا+ الأزوتوباكتر) + ن ١٠٠ % + (الخميرة+ ن ٢%) في الموسم الثاني.وكان اعلي وزن للمادة الجافة (١٢٥.١٤, ١٣٧.٦٥ جم مادة جافة/نبات) بسبب (الأزوسبيريليم+ الأزوتوباكتر) + ن ٥٠% +(الخميرة+ ن ٢%)خلال الموسم الأول والثاني بالترتيب. اعلي نيتروجين ممتص في الحبوب (٥٩.٨٤, ٦٦.٦٢ كجم /فدان) للموسم الأول والثاني علي الترتيب مع (الأزولا)+ ن ١٠٠ %+ (الخميرة+ ن ٢%) .أعلي فوسفور ممتص بواسطة الحبوب (٩.٤٦,٧.٥١ كجم/فدان) مع (الأزولا+ الأزوتوباكتر) + ن ٥٠ %+(الخميرة+ ن ٢%) خلال الموسم الاول والثاني بالترتيب.اعلي قيم للبوتاسيوم الممتص (١٤.٦٢,١٢.٧٦ كجم/فدان) مع (السيانوباكتيريا+ الأزوتوباكتر)+ن ٥٠ %+ (الخميرة+ ن ٢%) خلال الموسم الاول والثاني بالترتيب . اعلي حديد ممتص (٣٠٨.٤٤,٢٥٩.٨٩ جم/فدان) خلال الموسم الأول والثاني بالترتيب مع (الأزوسبيريليم+ الأزوتوباكتر)+ ن ٧٥ % +(الخميرة+ ن ٢%). وكان أعلي ممتص من المنجنيز (٢١٤.١٨,١٨٥.٣٦ جم/فدان) في الموسم الأول والثاني بالترتيب مع (السيانوباكتيريا+ الأزوتوباكتر) +ن ١٠٠ % + (الخميرة+ ن ٢%). أعلي امتصاص للزنك (١٧١.٥٢,١٥١.٥٢ جم/فدان) في الموسم الاول والثاني بالترتيب تحصل علية مع (الأزولا+ الأزوسبيريليم)+ ن ٥٠ %+ الخميرة فقط).

قام بتحكيم البحث

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