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Effect of Bio-chemical Fertilization and Times of Nutrient Foliar Application on Growth, Yield and Yield Components of Rice

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Abstract: Two field experiments were performed during 2003 and 2004 seasons at El-Sheikh Hamam, El-Bousrat village, El-Manzala district, Dakahlia Governorate to study the effect of four nitrogen fertilizer rates, i.e., 15, 30, 45 and 60 kg N/fed, times of foliar nutrients spraying i.e., 15, 25, 35 and 45 days after transplanting and biofertilizers sources i.e., without biofertilization, *Azospirillum* inoculation, blue green algae and combination of *Azospirillum* +blue green algae on growth, yield and yield components of rice cultivar Sakha 104. The experimental field were laid out in a strip-spelt plot design with four replications. Increasing nitrogen fertilizer rates from 15, 30, 45 and 60 kg N/fed significantly affected growth, yield and yield components in both seasons. Highest grain yield and yield components were produced from increasing nitrogen fertilizer rates upto 45 or 60 kg N/fed without significant differences between them in both seasons. Grain yield increased by 28 and 31%, respectively compared with fertilization at a rate of 15 kg N/fed over both seasons. In both seasons, times of nutrients foliar application had a significant effect on flag leaf area, plant height, number of tillers/m^2, number of panicles/m^2, panicle length (in the first season), number of filled grains/panicle, grain weight/panicle, 1000-grain weight, biological, straw and grain yields/fed. Maximum yield and yield components were produced from foliar spraying of House Green after 45 days from transplanting in both seasons. Grain yield increased by 10.2 and 11.5% when House Green foliar spraying after 35 and 45 days transplanting, respectively compared with those spraying after 15 days after transplanting over both seasons. Regarding biofertilizer treatments effects, biofertilizer sources significantly affected studied growth characters, yield and its component characters in both seasons. Inoculation of blue green algae alone or in combination with *Azospirillum* produced highest grain yield and its attributes without significant differences between them in both seasons. Inoculation with blue green algae increased grain yield/fed by 5% compared with those non-biofertilized asan average of both seasons. The interaction between nitrogen fertilizer rates and biofertilizer treatments had a significant effect on panicle grain yield, 1000-grain weight and grain yield/fed in both seasons. Maximum values produced from increasing nitrogen fertilizer upto 45 or 60 kg N/fed and using blue green algae as biofertilizer. Grain yield increased by 40.5 and 38.6%, respectively as an average of both seasons. It could be concluded that for maximizing grain yield and its quality as well as reducing environmental pollution by addition nitrogen fertilizer at a rate of 45 kg N/fed, foliar spraying of nutrients (House Green) after 45 days from transplanting and using blue green algae as biofertilizer source under soils affected with salinity at El-Manzala region, El-Dakahlia Governorate.

Key words: Nitrogen fertilizer levels, biological fertilizer sources, times of nutrient foliar spraying

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important agriculture food crops for more than half of the world population. Moreover, it's a very important cereal crop in Egypt for both consumption and export. In spite of rice is salt sensitive crop, however, it is considered as reclamation crop for saline soil because of its flooding condition. The growth of rice crop must be restricted in media containing high concentration of salts. The resistance of plant to salinity and drought are very complicated trait which results from the interaction between morphological and physiological characters in addition to environmental factors.

Nitrogen fertilizer is more urgent for security rice production. Many investigators studied the important of nitrogen fertilizer rates, Neelam and Chopra (2000) found that the highest plant height, number of panicles/m^2, seed weight/panicle, panicle length, grain and straw yields were obtained when the nitrogen fertilizer rates increased upto 80 kg N ha^{-1}. However, the seed test showed no effect due to nitrogen fertilizer levels. Similar

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conclusions were reported by Sharief *et al.* (1998), Singh *et al.* (2000), Singh and Singh (2000), Omnia, El-Shayb (2003), Shivay and Singh (2003) and El-Sheref *et al* (2004). Kamla *et al.* (2002) found that grain yield and nitrogen content of rice crop significantly increased with increasing nitrogen dose. Chopra and Chopra (2004) found that increasing nitrogen fertilizer levels from 0, 60, 120 to 180 kg N ha^{-1} had significant effect on yield attributes like plant height, panicles/ plant and 1000-seed weight. Maximum grain yield and it's attributes produced from addition of 120 kg N ha^{-1}.

Under salinity or alkalinity condition, rice plants are suffering from unavailability of some nutrient and absorption problem because ion imbalance. So, times of nutrients foliar application might be after proper times of solution for such problem. At the same time, foliar nutrient application times could enhance rice growth and enables it to with stand salinity harmful. Furthermore, foliar application might reduce the chemical fertilizer. In this respect, Lin and Zhu (2000) found that foliar spraying of regent at heading stage increased grain yield as a result of increasing grains number per panicle compared with control, leaf senescence was inhibited and the leaf chlorophyll and photosynthesis were increased by foliar application of regent at heading stage. Similar conclusions were reported by El-Kalla *et al.* (1988), Manivannan *et al.* (2001), Ramanathan *et al.* (2002) and Abd El-Razik (2003). Sultan *et al.* (2001) stated that foliar application of nutrient solutions partially alleviates the adverse effects of salinity on photosynthesis and photosynthesis related parameters and increased yield and yield components through mitigating the nutrient demands of salt stressed plants.

The rice yield in saline soil affected when nitrogen in given in the form algal inoculation via urea (Antarikanoda, and Amarit, 1991). The biofertilization using blue green algae or *Azospirillum* or their combination could save amount of chemical fertilizer and mitigate the pollution hazard. It had beneficial effect by reducing electrical conductivity, exchange able Na+and soil pH (Kaushik, and Subhashini, 1985). Dixit and Gupta (2000) reported that inoculation of BGA for rice paddy field increased the economic yield and the average increase in the grain yield due to BGA was 0.24 t ha^{-1} (7.5%). That application of blue green algae increased the grain and straw yields significantly over control. Blue green algae showed 7.1 and 4.6% increase in grain yield and 7.0 and 6.9% in straw yield over no BGA. Moreover, the yield components such as, plant height, panicles number/hill, filled grains/panicle and 1000-grain weight were increased due to BGA application. Patel (2000) found that application of 10 kg BGA/ha significantly improved plant height, panicles number, 1000-grain weight straw and grain yields of rice, but it did not affect the number of filled grains. Similar conclusions were found by Adhikary *et al.* (2002) and Manjappa (2001) Bassal and Zahran (2002) revealed that the biofertilizer use of BGA had positive and significant effect on rice crop. The blue green algae addition significantly increased flag leaf area, plant height, number of panicles/m^2, panicle length(cm) number of filled grains/panicle, grain weight/panicle, 1000-grain weight, grain and straw yields/fed. Similar conclusions were reported by Castro *et al.* (2002), Manivannan *et al.* (2004), Singh *et al.* (2002). Ibrahiem *et al.* (2004) reported that there was a positive effect of *Cyanobacteria* on the yield of grains and its components such as number of panicles/m^2, grains number/panicle and 1000 grain weight followed by *Azospirillum* and the use of both organism together was the best. In addition, Mady (2004) found that all growth characters significantly increased due to algalization compared to the non algalized plots. Also, grain yield, yield components and rice quality were significantly increased due to algalization compared to the non-algalized plots.

A significant interaction due to nitrogen fertilizer levels and biofertilizer treatment on grain yield was found by Sharief *et al.* (1998), Manjappa (2001) and Ibrahim *et al.* (2004).

MATERIALS AND METHODS

Two field experiments were carried out during two seasons of 2003 and 2004 at El-Sheikh Hamam, El-Bousrat village, El-Manzala district, Dakahlia Governorate. The main targets of this study aimed to find out the impact of four nitrogen fertilizer rates, times of foliar spraying of nutrients compound and various types of biofertilizer treatments on growth, yield and yield components of rice cultivar Skaha 104. The preceding crop for the nursery and the permanent field was wheat (*Triticum aestivum vulgare*, L.) in the two seasons. The soil was clay in texture with pH, EC and available nitrogen values of 8.25, 7.5 and 63.0 ppm, respectively as an average of studied seasons. A strip – split plot design with four replications was used. The horizontal plots were assigned for nitrogen fertilizer levels as follows:

- 15 kg N/fed. - 30 kg N/fed. - 45 kg N/fed. - 60 kg N/fed.

The vertical plots were occupied by the four times of foliar nutrient spraying as follows:

- 15 days after transplanting (DAT).
- 25 DAT. - 35 DAT. - 45 DAT

The sub-plots were devoted to the four treatments of biofertilization as follows:

- No biofertilizer (control) - Blue green algae (BGA)
- *Azospirillum* inoculation (AZO) - BGA+AZO

The area of each experimental unit was 3×4 m^2 (12 m^2) equal to 1/350 fed. The foliar compound was House green and it contains (20% Nitrogen+20% phosphorus +20% Potassium +0.5% Zink+0.5% Iron +0.5% Manganese +0.5% Copper +0.02% Boron +0.05 Molybdenum). One kilo gram of House Green was dissolved into 120 L of water and sprayed by motor at 1-2 h before sun set with spread material.

Rice grains at a rate of 60 kg /fed were soaked in water for about 24 h and incubated for 20 h. Thereafter, it were broadcasted with 2-3 cm of standing water in the nursery at 24 and 25th May in the first and second seasons, respectively. Weeds were chemically controlled with Saturn (50%) at the rate of 2 L dissolved in 100 L of water/fed and sprayed at seven days after sowing using knapsack sprayer.

The permanent land was well prepared. Calcium Superphosphate (15.5% P_2O_5) was added at the rate of 100 kg/fed on the dry soil before ploughing. Thirty days old seedlings were transplanting at a rate of 4-5 seedlings/hill adopting a spacing of 20×20 cm, which were sown at random with the rate of 25 hills/m^2, with 2-3 cm of the standing water in the land. Nitrogen fertilizer as urea (46.5% N) was given at mentioned rates in three equal doses. The first part was added 15 days after transplanting, the second part was added 30 DAT and the third one was added at 45 DAT.

Blue Green Algae (BGA) provided by Agriculture Research Center. The algalization was inoculated 5 days after transplanting. The powder of algae inoculate was mixed very well with a suitable quantity from a soft soil. The mixture was added on the area from the water was devoted to this process and it was evened during silent wing. *Azospirillum* was provided by Agriculture Research Center. *Azospirillum* sp. (rice cyriallen) was inoculated before transplanting. The inoculants was a powder and it was mixed in a suitable soft soil then, it was added. The powder of inoculant must be preserved far from head and any chemicals.

Studies characters

Growth characters

Flag leaf area (cm^2): At heading stage flag leaf area was measured from ten flag leaves by multiplying the maximum length and width of the flag blade in constant factor (0.75).

Plant height (cm): Average of plant height was measured in a sample of ten plants from the soil surface to the top panicle of stems.

Yield attributing characters: At harvest, guarded plants of one square meter were taken at random from the inner area of each plot area to estimate the following characters:

Number of tillers/m^2: Total number of tillers/m^2 were counted.

Number of panicale/m^2: Total productive tillers of one square meter was counted.

Panicle length (cm): Panicle length was measured in cm from the collar to the top of panicle in a sample of ten main panicles.

Panicle grain weight (g): Panicle grain weight was estimated in grams by weighting the sample of 10 panicles.

Number of filled grains/panicle: Number of filled grains formed on ten panicles, randomly chosen.

1000-grain weight (g): A random sample of thousand grain rough rice were weighted to the nearest gram.

Yields in ton/fed.

Grain yield (ton/fed): Plants in the inner one square meter of each experimental unit were harvested, collected together, labeled and tied. Plants were transplanted in the threshing for air drying for five days, then the plants were threshed and the grains were separated. The grain yield was recorded in kg square meter and then it was converted to record grain yield in tons/fed.

Straw yield (ton/fed): It was estimated using the same steps for grain yield estimation.

Biological yield: It was estimated using the following equation:

Biological yield = Straw yield / fed +Grain yield/fed.

Harvest index (H.I.): It was estimated using the following equation:

$$H.I.\% = \frac{\text{Economical yield (grain yield in ton /fed)}}{\text{Biological yield (Grain+straw yield in ton /fed)}} \times 100$$

Collected data were subjected to the proper of statistical analysis as usual technique of Analysis Of Variance (ANOVA) of strip- split plot design as mentioned by Gomez and Gomez (1984). The treatment means were compared using Least Significant Difference (LSD) according to the procedure outlined by Waller and Duncan (1969).

RESULTS AND DISCUSSION

Growth characters: The results in Table 1, 2 and 3 clearly showed that increasing nitrogen fertilizer rates from 15, 30, 45 and 60 kg N/fed significantly affected growth characters under study in both seasons. Maximum plant height, flag leaf area and number of tillers/m^2 were produced from increasing nitrogen fertilizer rates up to 60 kg N/fed. Increasing nitrogen fertilizer levels from 15 to 45 or 60 kg N/fed increased flag leaf area by 26.6 and 14.38%, plant height by 11.82 and 4.90% and number of tillers/m^2 by 43.47 and 22.27%, respectively over both seasons. While, the lowest growth characters under this study were produced from reducing nitrogen fertilizer rates to 15 kg N/fed. in both seasons. Increasing nitrogen dose improved rice growth photosynthesis rate, translocation of assimilates reflected increases in tillers number/m^2, flag leaf area and plant height. Similar results were reported by El-Kalla *et al.* (1988), Abd El-Rahman *et al.* (2003), Sharief *et al.* (1998) and Chopra and Chopra (2004).

In both seasons, times of foliar nutrients had a significant effect on flag leaf area, plant height and number of tillers/m^2. Maximum growth characters under study were produced from foliar nutrients spraying at 30 or 45 days from transplanting. However, early foliar spraying at 15 or 25 days after transplanting recorded the lowest increase in growth characters. Similar conclusion were reported by Sultan *et al.* (2001), Abd El-Razik (2003) and Satheesh *et al.* (2003).

Regarding biofertilizer treatments, biofertilizer sources significantly affected studied growth characters in both seasons, where maximum flag leaf area, plant height and number of tillers/m^2 were produced from biofertilization using blue green algae in both seasons. On the other hand, the lowest values of growth characters resulted from without biofertilizer treatment in both seasons. It could be noticed that biofertilization using blue green algae or combination with Azo.+BGA increased flag leaf area by 38.64 and 37.97%, plant height by 14.81, 15.05 and 14.81% and number of tillers/m^2 by 6.48%, respectively compared without biofertilizer using over both seasons. Increases in growth characters due to blue green algae biofertilization may attributed to reduction effect of blue green algae in electrical conductivity, exchangeable Na+ and soil pH were obtained which enhanced growth characters. Similar results were reported by El-Kalla *et al.* (1988), Sharief *et al.* (1998), Bassal and Zahran (2002) and Singh *et al.* (2002).

Grain yield and its attributes: Regarding to the effect of nitrogen fertilizer levels on grain yield and its attributes, the results in Table 1 and 3 indicated that increasing nitrogen fertilizer levels significantly affected panicles number/m^2, panicle length, number of filled grains/panicle, grain panicle weight, 1000 grain weight, biological, straw and grain yields/fed and harvest index in both seasons. Increasing nitrogen fertilizer levels up to 45 or 60 kg N/fed produced highest values of panicle number/m^2, panicle length, number of filled grains/panicle, grain weight/panicle, 1000 grain weight, biological, straw and grain yields/fed and harvest index without significant differences between in both seasons. Increasing nitrogen fertilizer levels from 15 to 45 or 60 kg N/fed Increased number of panicle/m^2 by 50.3 and 20.82%, panicle length by 8.92 and 9.69%, umber of filled grain by 9.1 and 9.72%, grain weight/panicle by 25.1 and 24.67%, 1000-grain weight by 14.16 and 12.85%, biological yield/fed by 25.05 and 29.61%, straw yield/fed by 22.2 and 29.1% and grain yield/fed by 16.68, 27.99 and 31.21%, respectively over both seasons. While, the lowest values produced from fertilized with 15 kg N/fed in both seasons. Increasing nitrogen fertilizer doses up to 60 kg N/fed might be improved rice growth, photosynthesis rate, strayed of assimilates, translocation of assimilates and magnified the all yield attributes leading to higher grain yield/fed. Also, increasing nitrogen fertilizer compensated growth paramieter damaged by salinity resulted in conferrable grain yield under saline soil conditions. Similar results were reported by Sharief *et al.* (1998), Singh and Singh (2000), Omnia, El-Shayb (2003), El-Sheref *et al.* (2004) and Chopra and Chopra (2004).

In both seasons, times of nutrients foliar spraying significantly affected number of panicles/m^2, panicle length (in the first season), number of filled grains/panicle, grain weight/panicle, 1000-grain weight, biological, straw and grain/fed in both seasons. Maximum values were produced from House Green foliar spraying after 45 days from transplanting. Spraying foliar nutrients at 45 days from transplanting increased grain weight/panicle by 6.1% compared with those spraying at 15 days from transplanting over both seasons. Foliar spraying of HG at 35 or 45 days from transplanting increased straw yield/fed by 10.18 and 11.51%, respectively compared with those spraying at 15 days from transplanting over both seasons. However, the lowest values were produced from early foliar spraying of HG at 15 days from transplanting in both seasons. Foliar spraying of House Green at of 45 days after transplanting enhance rice plant to be more with standing for salinity, increased photosynthesis rate and yield components of rice leading to high grain yield. These results are in good accordance with those reported by Lin and Zhu (2000),

Table 1: Averages of flag leaf area (cm^2), plant height (cm), number of tillers/m^2 and number of panicle/m^2 as affected by nitrogen levels, times of foliar application and biofertilizer treatments during 2003 and 2004 seasons

	Flag leaf (cm^2)		Plant height (cm)		Number of tillers/m^2		Number of panicle/m^2	
Treatments	2003	2004	2003	2004	2003	2004	2003	2004
Nitrogen levels								
15 kg N/fed	15.31	16.85	84.0	87.7	318.4	334.0	265.9	294.5
30 kg N/fed	15.91	19.69	89.6	93.4	391.2	377.0	353.3	346.5
45 kg N/fed	17.42	21.25	92.5	96.5	343.2	477.3	395.2	425.9
60 kg N/fed	19.30	21.43	94.0	98.0	451.5	487.8	416.1	429.4
F test	**	**	**	**	**	**	**	**
LSD 5%	0.17	0.32	0.4	0.5	9.9	3.0	7.6	6.6
LSD 1%	0.25	0.49	0.7	0.8	15.0	4.6	11.6	10.0
Times of foliar application								
15 DAT	16.62	19.60	89.5	93.1	387.4	417.0	351.2	369.1
25 DAT	16.83	19.69	89.8	93.6	391.9	416.4	354.8	373.3
35 DAT	17.12	19.72	90.2	94.2	396.1	418.4	358.6	375.1
45 DAT	17.38	20.22	90.7	94.7	419.9	424.3	366.0	378.7
F test	**	**	**	**	**	**	**	**
LSD 5%	0.06	0.39	0.4	0.5	12.6	4.7	8.6	3.7
LSD 1%	0.09	0.60	0.7	0.8	19.1	7.1	13.0	5.6
Biofertilization treatments								
Control	16.59	19.13	89.0	92.8	385.0	409.0	350.2	360.3
Azospirillum	16.90	19.77	89.7	93.6	390.7	416.8	352.2	370.0
Blue green algae	17.31	20.21	91.3	95.2	418.4	427.1	367.9	385.7
Azo+BGA	17.15	20.11	90.1	94.0	401.3	423.3	360.2	380.3
F test	**	**	**	**	**	**	**	**
LSD 5%	0.12	0.25	0.3	0.3	7.7	5.3	8.6	4.8
LSD 1%	0.16	0.34	0.4	0.5	10.3	7.1	11.5	6.5

**; highly significant, DAT; Days After Transplanting

Table 2: Averages of panicle length, number of filled grains/panicle, panicle grain weight and 1000-grain weight as affected by nitrogen levels, times of foliar application and biofertilizer treatments during 2003 and 2004 seasons

	Panicle length		No. of filled grains/panicle		Panicle grain weight		1000-grain weight	
Treatments	2003	2004	2003	2004	2003	2004	2003	2004
Nitrogen levels								
15 kg N/fed	19.2	20.0	122.7	127.7	2.26	2.36	21.23	22.18
30 kg N/fed	19.6	21.0	125.4	129.0	2.61	2.73	23.48	24.49
45 kg N/fed	21.2	21.5	133.8	139.4	2.83	2.95	24.26	25.30
60 kg N/fed	21.3	21.7	134.0	140.0	2.82	2.94	23.98	25.01
F test	**	**	**	**	**	**	**	**
LSD 5%	0.2	0.4	2.4	2.4	0.04	0.05	0.95	0.97
LSD 1%	0.3	0.6	3.7	3.7	0.07	0.07	1.44	1.48
Times of foliar application								
15 DAT	20.1	20.9	125.8	131.0	2.57	2.67	22.96	23.92
25 DAT	20.2	20.9	126.9	132.0	2.59	2.69	23.04	23.96
35 DAT	20.4	21.2	130.9	135.3	2.65	2.76	23.33	24.35
45 DAT	20.6	21.3	132.4	137.8	2.72	2.84	23.63	24.74
F test	**	N.S	**	**	**	**	**	**
LSD 5%	0.1	-	2.3	2.5	0.07	0.08	0.36	0.36
LSD 1%	0.2	-	3.6	3.8	0.11	0.12	0.54	0.54
Biofertilization treatments								
Control	20.0	20.9	125.3	130.9	2.55	2.66	22.90	23.88
Azospirillum	20.0	21.0	125.5	131.0	2.57	2.68	22.99	24.02
Blue green algae	20.6	21.3	132.7	137.5	2.75	2.89	23.90	24.92
Azo+BGA	20.4	21.1	132.4	136.7	2.65	2.76	23.17	24.16
F test	**	**	**	**	**	**	**	**
LSD 5%	0.1	0.2	1.9	2.0	0.05	0.05	0.42	0.44
LSD 1%	0.2	0.3	2.5	2.7	0.07	0.07	0.56	0.58

NS; ** Non-Significant and highly significant, respectively, DAT; Days After Transplanting

Manivannan *et al.* (2001), Ramamathan *et al.* (2002) and Abd El-Razik (2003).

Biofertilizer treatments had a significant effect on yield and its attributes in both seasons except straw yield in the first season and harvest index in the second season which showed insignificantly affected. Using blue green algae as biofertilizer significantly maximized number of panicles/m^2, panicle length, grain weight/panicle, 1000 grain weight, biological, straw and grain yields/fed and harvest index compared with the control and other

Table 3: Averages of biological, straw and grain yields (t/fed) and harvest index (%) as affected by nitrogen levels, times of foliar application and biofertilizer treatments during 2003 and 2004 seasons

	Biological yield (t/fed)		Straw yield (t/fed)		Grain yield (t/fed)		Harvest index (%)	
Treatments	2003	2004	2003	2004	2003	2004	2003	2004
Nitrogen levels								
15 kg N/fed	5.395	5.808	3.044	3.313	2.345	2.496	43.45	42.97
30 kg N/fed	6.262	6.632	3.522	3.728	2.74	2.904	43.70	43.79
45 kg N/fed	6.819	7.190	3.820	3.949	2.999	3.197	43.93	45.08
60 kg N/fed	7.239	7.282	4.128	4.084	3.111	3.241	42.97	43.90
F test	**	**	**	**	**	**	**	**
LSD 5%	0.112	0.042	0.074	0.023	0.042	0.047	0.13	0.46
LSD 1%	0.170	0.064	0.112	0.035	0.063	0.071	0.20	0.70
Times of foliar application								
15 DAT	6.338	6.629	3.594	3.712	2.745	2.917	43.28	43.95
25 DAT	6.399	6.666	3.609	3.725	2.785	2.941	43.49	44.05
35 DAT	6.500	6.757	3.667	3.782	2.834	2.969	43.59	43.90
45 DAT	6.477	6.86	3.696	3.849	2.831	3.011	43.70	43.84
F test	**	**	**	**	**	**	N.S	N.S
LSD 5%	0.064	0.043	0.046	0.048	0.031	0.026	-	-
LSD 1%	0.097	0.065	0.070	0.073	0.047	0.04	-	-
Biofertilization treatments								
Control	6.278	6.661	3.602	3.735	2.671	2.922	42.52	43.87
Azospirillum	6.335	6.705	3.632	3.755	2.703	2.953	42.66	43.99
Blue green algae	6.572	6.767	3.652	3.787	2.920	2.980	44.46	43.97
Azo+BGA	6.530	6.780	3.629	3.796	2.900	2.984	44.41	43.95
F test	**	**	N.S	**	**	**	**	N.S
LSD 5%	0.074	0.038	-	0.027	0.038	0.027	0.29	-
LSD 1%	0.099	0.051	-	0.036	0.051	0.036	0.39	-

NS; **Non-Significant and highly significant, respectively DAT: Days After Transplanting

Table 4: Means of panicle grain weight as affected by the interaction between nitrogen fertilizer levels and biofertilizer treatments during 2003 and 2004 seasons

	2003				2004			
Treatments	15 kg N/fed	30 kg N/fed	45 kg N/fed	60 kg N/fed	15 kg N/fed	30 kg N/fed	45 kg N/fed	60 kg N/fed
Control	2.06	2.54	2.65	2.94	2.15	2.65	2.77	3.06
Azospirillum	2.25	2.53	2.77	2.73	2.35	2.64	2.89	2.85
Blue green algae	2.44	2.74	2.97	2.84	2.55	2.86	3.09	2.97
Azo+BGA 2.27	2.65	2.91	2.77	2.37	2.76	3.04	2.89	
F test			**				**	
LSD 5%			0.10				0.11	
LSD 1%			0.14				0.14	

Table 5: Means of 1000 grain weight as affected by the interaction between nitrogen fertilizer levels and biofertilizer treatments during 2003 and 2004 seasons

	2003				2004			
Treatments	15 kg N/fed	30 kg N/fed	45 kg N/fed	60 kg N/fed	15 kg N/fed	30 kg N/fed	45 kg N/fed	60 kg N/fed
Control	20.87	22.55	23.70	24.85	21.78	23.51	24.71	25.91
Azospirillum	20.89	23.58	24.17	22.94	21.93	24.59	25.2	23.93
Blue green algae	22.12	24.06	24.69	24.72	23.07	25.09	25.75	25.78
Azo+BGA 21.05	23.74	24.48	23.40	21.96	24.75	25.53	24.41	
F test			**				**	
LSD 5%			0.80				0.90	
LSD 1%			1.10				1.20	

treatments. Inoculation using blue green algae significantly increased number of panicle/m^2 by 6.6% compared without biofertilizer treatment over both seasons. Moreover, inoculation using BGA or combination of AZO+BGA increased grain yield/fed by 4.98 and 4.69%, respectively over both seasons. However, the lowest values of yield and its components characters produced from without biofertilization. Biofertilization application had useful effect in nutrient availability and its uptake as well as a soil amendments resulting in good rice growth. Thereby, biofertilization with blue green algae increased rice source and sink leading to high grain yield/fed. Similar conclusion were reported by Sharief *et al.* (1998), Castro *et al.* (2002), Manivannan (2004), Ibrahim *et al.* (2004) and Mady (2004).

The results in Table 4, 5 and 6 clearly showed that the interaction between nitrogen fertilizer levels and biofertilizer treatments had significant effect on grain weight/panicle, 1000-grain weight and grain yield/fed on both seasons. Maximum values recorded from

Table 6: Means of grain yield (t/fed) as affected by the interaction between nitrogen fertilizer levels and biofertilizer treatments during 2003 and 2004 seasons

	2003				2004			
Treatments	15 kg N/fed	30 kg N/fed	45 kg N/fed	60 kg N/fed	15 kg N/fed	30 kg N/fed	45 kg N/fed	60 kg N/fed
Control	2.268	2.55	2.783	3.082	2.475	2.886	3.188	3.138
Azospirillum	2.283	2.576	2.882	3.072	2.487	2.905	3.179	3.243
Blue green algae	2.44	2.922	3.186	3.132	2.512	2.919	3.19	3.297
Azo+BGA	2.389	2.911	3.144	3.158	2.508	2.907	3.233	3.287
F test			**				**	
LSD 5%			0.076				0.054	
LSD 1%			0.103				0.073	

increasing nitrogen fertilizer of 45 or 60 kg N/fed with using blue green algae or its combination with Azospirillum as biofertilizer without significant differences between them in both seasons. Increasing nitrogen fertilizer levels up to 45 or 60 kg N/fed and biofertilization using blue green algae alone or in combination with Azospirillum increased grain yield/fed by 40.5, 38.6 and 33.2, 32.8%, respectively compared with fertilization with 15 kg N/fed and without biofertilization over both seasons.

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