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EFFECT OF FARMYARD MANURE, BIO AND MINERAL NITROGEN FERTILIZER AND HILL SPACES ON RICE CROP PRODUCTIVITY.

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ABSTRACT

Two field experiments were conducted in El-Serw Agricultural Research Station, Damiatta Governorate during 2000 and 2001 seasons to study the effect of farmyard manure rates (0 and 20 m^3/fad), hill spaces (20 x 15, 20 x 20 and 20 x 25 cm) and four mineral nitrogen fertilizer rates (0, 20, 40 and 60 kg N/fad) with or without blue green algae (BGA) and their combinations on growth, yield and quality of rice "cv. Giza 178". The main results could be summarized as follows:

The obtained results showed that the adding of 20 m^3/fad of farmyard manure significantly increased flag leaf area, plant height, number of panicles /m^2, panicle length, number of filled grains/panicle, grains weight / panicle, 1000-grain weight, straw and grain yields/fad in both seasons, also P and K percentages of rice grains were significantly affected by farmyard manure in the first and second seasons, respectively, while protein percentage was not significantly affected in both seasons.

Results revealed that all estimated characters were significantly affected by the hill spaces in both seasons except K and protein percentages which were not significantly affected in the first season.

Results indicated that bio and mineral nitrogen treatments had significant effects on all studied characters in both seasons. The combination between biofertilizer (BGA) and 40 kg N/fad treatment gave the highest grain yield in both seasons. Increasing N-fertilizer rate up to 60 kg N/fad + BGA significantly increased P, K and protein percentages of rice grains in both seasons.

The interaction between the studied treatments showed that the highest grain yield of rice was obtained with application of 20 m^3/fad farmyard manure and 20 x 15 cm hill spaces. The maximum number of panicles/ m^2 and grain yield were observed in the rice plants fertilized by 20 m^3/fad farmyard manure and 20 kg N/fad with BGA inoculation treatment in both seasons. Maximum grain yield/fad was obtained when rice plants were transplanted at 20 x 15 cm and fertilized with 40 kg N/fad + BGA (biofertilization). The highest grain yield was taken from the treatment of 20 m^3/fad farmyard manure, 20 x 15 cm hill space and 20 kg N/fad + BGA in 2000 season.

Generally, it could be concluded that hill space 20 x 15 cm with the application of 20 m^3/fad farmyard manure and 20 kg N/fad + BGA produced the highest grain yield/fad for Giza 178 rice variety under the conditions of El-Serw district.

INTRODUCTION

Rice (*Oryza sativa*, L.) is one of the most important cereal crops in the world as well as in Egypt. It ranks after cotton regarding to exportation. As a food crop, it contributes over 20 percent of the per capital cereal consumption. The need to raise its productivity more and more per unit land area is a native goal to meet the consistent demands from this crop.

Improvement of rice production can be achieved through optimizing the cultural practices such as applying farmyard manure, hill spaces and nitrogen and biological nitrogen fixation [Blue Green Algae (BGA)]. Meelu and Morris (1984) reported that 10 ton/ha farmyard manure + 60 kg N/ha produced as much rice as 120 kg N/ha. Sakthiviel (1990) found that combined application of organic fertilizer and inorganic fertilizer gave maximum yield of rice. Abd El-Fattah *et al.* (1994) concluded that nitrogen fertilizer either from urea and/or farmyard manure significantly increased grain yield of rice due to the significant increase in all yield components. Also they reported that nitrogen percentage of grains was significantly increased with the application of 4 ton/fad organic manure compared with the control treatment. El-Awage *et al.* (1996) found that NPK concentration in wheat grains were significantly increased with application of farmyard manure compared with that of the control treatment. Nour (1998) indicated that application of either chemical nitrogen or organic manure significantly increased grain yield compared with control treatment. El-Kholy *et al.* (1999) found that nitrogen fertilizer either from ammonium sulphate and/or organic manure significantly increased grain yield and nitrogen content in grains of rice. Ebaid (2000) found that panicle weight, 1000-grain weight and grain yield/fad were significantly increased as the organic manure increased up to 30 ton/ha, while 20 ton/ha was edequate for the highest values of panicle length, number of panicles/hill and number of grains/panicle of rice.

With respect to hill spaces, several studies reported that density is the important factor for limiting grain yield of rice and its components. Amir *et al.* (1984) stated that the highest grain yield of rice was obtained with hill spacing of 20 x 20 cm. Abd El-Rahman *et al.* (1986) found that the closer spacing of 20 x 10 cm produced the maximum number of panicles/m^2 and grain and straw yields/fad of rice. El-Kalla *et al.* (1988b) indicated that increasing spacing between hills significantly increased grain protein content of rice. Ibrahim (1990) found that increasing hill spacing from 15 to 20 and 25 cm reduced rice grain yield. While grain protein content was increased by increasing hill spacing from 15 to 20 and 25 cm. Abd El-Rahman *et al.* (1996) revealed that hill spacing had significant effect on rice grain yield and most of its attributing variables for Giza 178 variety. The narrow hill spacing (20 x 10 or 20 x 15 cm) produced the highest grain yield/ha. El-Keredy *et al.* (2000) stated that grain yield of rice was increased by narrow hill spacing along with increasing the number of seedling per hill. Zahran (2000) indicated that the space of 15 cm between hills gave the tallest plants, highest values of number of panicles/m^2 as well as grain and straw yields/fad of rice. While transplanting rice of 25 cm space among hills gave the highest values of number of filled grains/panicle and 1000-grain weight.

Concerning nitrogen effect, Abd El-Hafez (1982) reported that the concentration of N, P and K in rice grains increased gradually with the increase in nitrogen levels. Abd El-Rahman *et al.* (1986) found that raising nitrogen fertilizer level up to 150 kg N/ha was associated with marked increase in plant height, number of panicles/m^2, number of filled grains/panicle, panicle weight as well as grain and straw yields/ha of rice. Hamissa *et al.* (1987) reported that protein content was significantly

increased as nitrogen level increased up to 192 kg N/ha. El-Kalla *et al.* (1988a) reported that raising nitrogen levels up to 60 kg N/fad significantly increased flag leaf area, number of panicle/m^2, panicle length and weight, 1000-grain weight as well as grain and straw yields/fad of rice. Bassal *et al.* (1996) and Sharief *et al.* (1998) stated that raising nitrogen fertilizer rate up to 60 kg N/fad significantly increased grain yield of rice and its attributing variables. Ebaid and Ghanem (2001) found that increasing nitrogen level up to 165 kg N/ha significantly increased N and K percentage in rice grains.

Previous studies have shown different effects for biofertilization on the yield and its components in rice. Yanni *et al.* (1982) found that inoculation with BGA and increasing the nitrogen fertilizer rates increased plant N-content at booting stage and plant height, the effective tillers and panicle weight of rice. Ashoub *et al.* (1993) found that the highest yields/fad were given by 20 kg N + 10 kg Nostoc (biofertilization) or 40 kg N + 5 kg Nostoc. Protein concentration in rice grains increased with increasing rate of N and Nostoc. Abd El-Fattah *et al.* (1994) concluded that inoculation with BGA significantly increased rice grain yield and its components. The highest values of nitrogen content of rice grains was obtained from 30 kg N/fad (FYM) + 30 kg N/fad (Urea) + BGA treatment. El-Kholy (1997) found that the highest values of grain yield and its components and N, P, K and protein percentage in rice grains were obtained from 40 kg N/fad and inoculation by BGA at rate 1000 g/fad treatment. Hammad *et al.* (1997) concluded that the algalization significantly increased the 1000-grain weight and grain and straw yields/fad of rice. The highest yield was achieved with the treatment of BGA, 20 kg N/fad and 15 kg P_2O_5/fad. Sharief *et al.* (1998) stated that inoculation with BGA was significantly affected on growth, yield and yield components of rice compared to without biofertilization. El-Kholy *et al.* (1999) found that BGA inoculation with addition of 20 kg N/fad and organic manure at the level of 20 m^3/fad produced the highest increase of rice yield and soil fertility. While the highest value of nitrogen content in grains of rice was obtained from the treatment of BGA inoculation with addition of 40 kg N/fad and organic manure at the rate of 20 m^3/fad. Amin *et al.* (2000) stated that Algalization treatment with NPK of (60-15-24) resulted in higher grain yield of rice, while nitrogen and phosphorous percentages in rice grains was not significantly affected by different treatments.

This investigation was carried out to study the effect of farmyard manure, hill spaces as well as mineral nitrogen rates, biological nitrogen fixation (BGA) and their combinations on growth, productivity and quality of rice.

MATERIALS AND METHODS

Two field experiments were carried out in El-Serw Agricultural Research station, Dammiatta Governorate in 2000 and 2001 seasons, to study the effect of farmyard manure rates (0 and 20 m^3/fad), three hill spaces (20 x 15, 20 x 20 and 20 x 25 cm) and four nitrogen fertilizer rates (0, 20, 40 and 60 kg N/fad) with or without blue green algae (BGA) and their combinations on growth, yield components, yield and quality of Giza 178 rice variety (*Oryza sative*, L.). A split-split plot design with four replications was

used. The main plots were occupied by the two farmyard manure rates, while the sub plots were assigned to the hill spaces and nitrogen fertilizer with or without blue green algae (BGA) treatments were devoted to the sub-sub plots. The size of each sub-sub plot was 3 x 3.5 m occupying an area of 10.5 m^2 (1/400 fad). Blue green algae (BGA) was obtained from Agriculture Research Center, Ministry of Agriculture. The nursery land was well prepared through two ploughings, harrowing and leveling. Rice grains at rate of 60 kg/fad were soaked in water for about 36 hours and incubated for 24 hours. Thereafter, it were handy broadcasted with 2-3 cm of standing water in the nursery land on 20 and 24th May in the first and second seasons, respectively. The preceding winter crop was wheat in both seasons. The permanent field was well prepared and Calcium Superphosphate (15.5 P_2O_5) at the rate of 100 kg/fad was added on the dry soil before ploughing. Thirty days old seedlings were transplanted in the permanent field. The other usual agricultural practices of growing rice were conducted as recommended by Ministry of Agriculture except the factors under study. The algalization was inoculated 7 days after transplanting by mixing blue green algae powder very well with suitable quantity of softy soil at rate of 1 kg/fad. Nitrogen fertilizer in the form of Urea (46 % N) was applied as per treatments in two equal doses, the first dose was added 20 days after transplanting, whereas the second dose was added at the panicle initiation. Samples of soil were taken from the surface layer (0-30 cm depth) before FYM addition. Mechanical and chemical analysis of the experimental soil are shown in Table (1). FYM was applied at 15 days before transplanting. The chemical analysis of FYM is given in Table (2).

Table 1: Mechanical and chemical analysis of the experimental soil in 2000 and 2001 seasons.

Soil contents		2000 season	2001 season
1- Mechanical analysis			
Sand (%)		16.20	17.15
Silt (%)		21.36	21.12
Clay (%)		62.44	61.73
Texture class		Clayey	Clayey
2- Chemical analysis			
Organic matter	(%)	1.63	1.81
Available nitrogen	ppm	25.65	27.80
Available phosphorus	ppm	7.7	7.9
Available potassium	ppm	278.0	267.0
Soil reaction pH	(1:2.5)	8.1	8.3
E.C. m-mohes	(1:5)	4.2	3.9

Table 2: Chemical analysis of FYM used in 2000 and 2001 seasons.

Analysis	2000 season	2001 season
OM %	9.0	11.0
Total N %	0.4	0.4
Total P_2O_5 %	0.4	0.3
Total K_2O %	1.2	1.4

The studied characters:

At harvest, ten guarded hills were taken at random from the inner area of each experimental plot to estimate the following characters:

1. Flag leaf area (cm^2). The flag leaf area was calculated using the following equation of Palaniswamy and Gomez (1974).
   - Leaf area (LA) = K (LW)
   - Where: L= leaf length, W= Maximum width of the leaf and K = factor of 0.75.
2. Plant height (cm). The average height of ten randomly chosen plants from each plot and measured from ground level to the panicle tip.
3. Number of panicles/m^2 counted in randomly chosen 1 m^2 in each plot.
4. Panicle length (cm). Average length of randomly ten panicles.
5. Number of filled grains/panicle. Average number of filled grains from ten panicles.
6. Grains weight/panicle (g). It was estimated from 10 randomly chosen main panicles from each plot.
7. 1000-grain weight (g). Average weight of 1000-grain randomly taken from each plot.
8. Grain and straw yields (ton/fad). The plants in the inner six square meters of each experimental unit were harvested, collected together, labeled and tied. Plants were transfered to thresh and the grains were separated. The grain and straw yields were recorded in kg/m^2, then it were converted to estimate grain and straw yields in tons/fad.

Chemical analysis:

Grains of rice were subjected to a chemical analysis to determine protein, phosphorus and potassium contents.

1- Micro Kjeldhal apparatus as described by A.O.A.C (1970) was used to determine nitrogen percentage.
2- Protein percentage of rough rice grains was calculated by multiplying its N percentage by the factor of 5.95 as outlined by Juliano (1985).
3- Phosphorus percentage was determined colourimetrically according to Jackson (1967).
4- Potassium percentage was estimated by flame photometer as described by Chapman and Pratt (1961).

Obtained data were subjected to the statistical analysis as the usual technique of analysis of variance (ANOVA) of the split-split plot design. The treatment means were presented and compared using least significant differences (LSD) method as mentioned by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

A- Effect of farmyard manure:

Data in Tables 3, 4 and 5 show clearly that flag leaf area, plant height, number of panicles/m^2, panicle length, number of filled grains/panicle, grains weight/panicle, 1000-grain weight and grain and straw yields/fad were significantly increased with application of farmyard manure in both seasons.

Table 3: Averages of flag leaf area $(cm)^2$, plant height (cm), number of panicles/m^2 and panicle length (cm) as affected by farmyard manure, hill spaces and nitrogen fertilizer (bio and mineral and their combinations) in 2000 and 2001 seasons.

Characters	Flag leaf area $(cm)^2$		Plant height (cm)		No. of panicles/m^2		Panicle length (cm)	
Treatments	2000	2001	2000	2001	2000	2001	2000	2001
A- FYM (m^3/fad):								
0	14.9	14.6	84.0	79.8	284.3	280.4	20.6	20.0
20	18.2	17.4	88.4	85.1	313.8	312.7	23.9	23.4
F-test	**	**	**	**	**	**	**	**
B- Hill spaces (cm):								
20 x 15	15.6	15.1	88.5	84.3	327.6	323.3	22.0	21.5
20 x 20	16.6	16.0	86.7	83.3	298.9	296.4	22.3	21.7
20 x 25	17.4	16.9	83.4	79.4	270.6	270.0	22.5	21.9
F-test	**	**	**	**	**	**	**	**
LSD (5%)	0.2	0.1	0.5	0.7	3.0	2.8	0.1	0.2
C- Bio and mineral nitrogen fertilizer treatments (kg N/fad):								
0	13.5	12.9	82.5	77.5	260.8	256.1	19.7	19.2
20	15.3	15.0	83.7	79.1	286.8	282.5	22.0	21.4
40	17.6	17.1	86.4	82.9	313.4	307.9	22.3	21.7
60	17.9	17.4	88.3	84.8	315.1	311.0	22.4	21.8
BGA	15.1	14.6	83.3	78.9	286.1	282.0	21.6	21.1
20 + BGA	17.0	16.3	87.1	82.7	309.2	309.2	23.2	22.6
40 + BGA	17.9	17.3	88.6	86.3	319.1	315.0	23.4	22.9
60 + BGA	18.1	17.4	89.7	87.2	301.9	308.8	23.5	22.9
F-test	**	**	**	**	**	**	**	**
LSD (5%)	0.2	0.1	0.5	0.7	2.6	3.7	0.1	0.2

Applying 20 m^3/fad farmyard manure increased the grain and straw yields/fad by 22.6 % and 15.96 % compared with the control in 2000 season and by 19.30 % and 14.81 in 2001 season, respectively. These increases of grain and straw yields/fad due to farmyard manure may be attributed to that farmyard manure improves soil structure and leads to an increase in the availability of nutrients and enhances reclamation of alkali soils. Such results are in accordance with whose obtained by Meelu and Morris (1984), Sakthiviel (1990), Abd El-Fattah *et al.* (1994), Nour (1998), El-Kholy *et al.* (1999) and Ebaid (2000).

Concerning the effect of farmyard manure on P, K and protein percentages in rice grains are presented in Table (5). The data of chemical analysis revealed that P percentage in the first season and K percentage in the second season were significantly affected by farmyard manure. While protein percentage was not significantly affected by farmyard manure in both seasons. The highest values of P, K and protein percentages of rice grains were obtained with application of 20 m^3/fad farmyard manure in both seasons. These results agree with those obtained by El-Awage *et al.* (1996) and El-Kholy *et al.* (1999).

Table (4): Averages of number of filled grains/panicle, grains weight/ panicle (g), 1000-grain weight (g) and grain yield (ton/fad) as affected by farmyard manure, hill spaces and nitrogen fertilizer (bio and mineral and their combinations) in 2000 and 2001 seasons.

Characters	No. of filled grains/ panicle		Grains weight/ panicle (g)		1000-grain weight (g)		Grain yield (ton/fad)	
Treatments	2000	2001	2000	2001	2000	2001	2000	2001
A- FYM (m^3/fad):								
0	127.3	125.0	2.84	2.72	20.28	19.99	2.711	2.870
20	134.9	131.7	3.04	2.95	21.97	21.57	3.324	3.424
F-test	*	*	*	**	**	**	**	**
B- Hill spaces (cm):								
20 x 15	126.9	124.6	2.74	2.63	20.75	20.40	3.163	3.325
20 x 20	131.5	128.3	2.98	2.88	21.11	20.84	2.995	3.114
20 x 25	134.9	131.7	3.10	3.00	21.52	21.10	2.894	3.003
F-test	**	**	**	**	**	**	**	**
LSD (5%)	0.8	0.9	0.03	0.04	0.11	0.16	0.041	0.025
C- Bio and mineral nitrogen fertilizer treatments (kg N/fad):								
0	116.9	115.3	2.55	2.42	18.69	18.51	2.026	2.166
20	128.9	126.7	2.87	2.77	20.44	20.05	2.779	2. 891
40	134.5	130.4	3.11	3.01	21.86	21.48	3.255	3.365
60	137.2	132.5	3.11	3.01	21.99	21.82	3.310	3.439
BGA	125.9	122.8	2.74	2.63	20.51	19.82	2.641	2.754
20 + BGA	136.4	132.4	3.08	2.98	21.96	21.58	3.292	3.435
40 + BGA	137.1	135.7	3.11	3.04	21.92	21.73	3.535	3.715
60 + BGA	131.9	129.8	2.95	2.82	21.65	21.26	3.302	3.412
F-test	**	**	**	**	**	**	**	**
LSD (5%)	1.4	1.7	0.04	0.06	0.17	0.20	0.035	0.035

B- Effect of hill spaces:

Data listed in Tables 3, 4 and 5 show the effect of hill spaces on some characters of growth and productivity of rice in both seasons. Results revealed that all estimated characters were significantly affected by the hill space in 2000 and 2001 seasons. There was a tendency of decreasing plant height, number of panicles/m^2, grain and straw yields/fad and increasing flag leaf area, panicle length, number of filled grains/panicle, grains weight/panicle and 1000-grain weight in favor of wider spacing in both seasons. The highest grain yield was produced with hill spacing of 20 x 15 cm in both seasons. The increase in grain yield/fad with the narrow hill spaces may be attributed to the increase in number of panicles/m^2. Similar results were obtained by Abd El-Rahman *et al.* (1986), El-Kalla *et al.* (1988b), Ibrahim (1990), Abd El-Rahman *et al. (1996),* El-Keredy *et al.* (2000) and Zahran (2000).

With respect to P, K and protein percentages in grains of rice, data presented in Table (5) indicated that P, K and protein percentage in grains of rice were significantly affected by hill spaces in the first and second seasons, except K % and protein % which were not significantly affected in the first season. Protein percentage positively responded to increase in hill spacing from 20 x 15 to 20 x 20 or 20 x 25 cm. Meanwhile, P and K % were detected with the increment of hill spacing up to 20 x 25 cm. Such results are matched with those reported by El-Kalla *et al.* (1988b) and Ibrahim (1990).

Table (5): Averages of straw yield (ton/fad), P, K and protein percentages in grains of rice as affected by farmyard manure, hill spaces and nitrogen fertilizer (bio and mineral and their combinations) in 2000 and 2001 seasons.

Characters	Straw yield/ (ton/fad)		P %		K %		Protein %	
Treatments	2000	2001	2000	2001	2000	2001	2000	2001
A- FYM (m^3/fad):								
0	3.164	2.904	0.199	0.202	0.271	0.266	9.48	9.71
20	3.669	3.334	0.212	0.211	0.291	0.293	10.31	10.45
F-test	**	**	*	N.S	N.S	*	N.S	N.S
B- Hill spaces (cm):								
20 x 15	3.622	3.340	0.204	0.213	0.284	0.285	9.79	9.85
20 x 20	3.405	3.092	0.209	0.205	0.281	0.282	9.94	10.13
20 x 25	3.222	2.925	0.203	0.203	0.277	0.271	9.96	10.25
F-test	**	**	*	**	N.S	*	N.S	**
LSD (5%)	0.073	0.041	0.004	0.004	---	0.008	---	0.17
C- Bio and mineral nitrogen fertilizer treatments (kg N/fad):								
0	2.877	2.672	0.179	0.188	0.263	0.255	8.56	8.78
20	3.245	2.959	0.200	0.200	0.273	0.276	9.72	10.02
40	3.592	3.255	0.212	0.207	0.273	0.282	10.07	10.43
60	3.617	3.293	0.215	0.212	0.290	0.289	10.27	10.51
BGA	3.163	2.903	0.197	0.188	0.271	0.262	8.89	8.98
20 + BGA	3.542	3.192	0.199	0.209	0.282	0.283	9.97	10.00
40 + BGA	3.674	3.356	0.216	0.217	0.292	0.284	10.54	10.64
60 + BGA	3.623	3.323	0.227	0.232	0.303	0.303	11.15	11.27
F-test	**	**	**	**	**	**	**	**
LSD (5%)	0.029	0.035	0.006	0.009	0.011	0.012	0.48	0.48

C- Effect of bio and mineral nitrogen fertilizer treatments:

Results presented in Tables 3, 4 and 5 indicate that bio and mineral nitrogen treatments had significant effect on flag leaf area, plant height, number of panicles/m^2, panicle length, number of filled grains/panicle, grains weight/panicle, 1000-grain weight and grain and straw yields/fad of rice in both seasons. The increasing of mineral nitrogen fertilizer rate from 0 to 60 kg N/fad increased all studied traits as compared with those of the control in both seasons. Consequently the increments of grain yield and straw yields/fad were 63.38 % and 25.72 % in 2000 season and 58.77 % and 23.24 in 2001 season, respectively. The increase in grain yield/fad may be attributed to the role of nitrogen in activation the growth and hence increasing yield components i.e. number of panicles/m^2, number of grains/panicle, panicle weight and 1000-grain weight. Similar results were obtained by Abd El-Rahman *et al.* (1986), El-Kalla *et al.* (1988a), Bassal *et al.* (1996) and Shareif *et al.* (1998).

However, inoculated plants of rice by bio nitrogen (BGA) fertilizer increased grain yield/fad by 30.36 % and 27.15 % when compared with the control in 2000 and 2001 seasons, respectively. The combination between biofertilizer (BGA) and 40 kg N/fad treatment gave the highest values for all

studied characters of growth, yield and its components except flag leaf area, plant height and panicle length which were at biofertilizer (BGA) and 60 kg N/fad treatment. The combination between biofertilizer (BGA) and 40 kg N/fad treatment increased grain yield/fad by 74.48 % and 71.51 % as compared with the control treatment in 2000 and 2001 seasons, respectively. These increases in grain yield/fad due to the combinations among biofertilizer (BGA) and mineral nitrogen may be attributed mainly to N_2-fixation by BGA. These results are in harmony with those of Yanni *et al.* (1982), Ashoub *et al.* (1993), Abd El-Fattah *et al.* (1994), Hammad *et al.* (1997), El-Kholy (1997), Shareif *et al.* (1998), El-Kholy *et al.* (1999) and Amin *et al.* (2000).

Concerning the effect of nitrogen fertilizer treatments on P, K and protein percentages in rice grains, the data presented in Table (5) indicate that P %, K % and protein % of rice grains were significantly affected by nitrogen fertilizer treatments in both seasons. Increasing nitrogen rates from 0 to 60 kg N/fad significantly increased P, K and protein percentages of rice grains in both seasons. Inoculation plants of rice by biofertilization (BGA) increased P, K and protein percentages compared with the control (0 kg N/fad) in 2000 and 2001 seasons. The combination between biofertilizer (BGA) and 60 kg N/fad treatment gave the highest values from P, K and protein percentages of rice grains in both seasons. This increase in protein percentage could be attributed to the role of BGA which was more effective in supplying plants with extra nitrogen lately during the grain filling period. Such results were supported by findings of Abd El-Hafez (1982), Hamissa *et al.* (1987), Ashoub *et al.* (1993), Abd El-Fattah *et al.* (1994), El-Kholy (1997) and Ebaid and Ghanem (2001).

D- Interaction effects:

The interaction between farmyard manure and hill spaces (Table 6) had significant effects on number of panicles/m^2 and straw yield/fad in both seasons and panicle length and grain yield/fad in one season only. Maximum grain yield/fad of rice was obtained with application 20 m^3/fad farmyard manure and 20 x 15 cm hill spacing.

Table 6: Number of panicles/m^2, panicle length (cm), grain yield (ton /fad) and straw yield (ton /fad) as affected by the interaction between farmyard manure and hill spaces.

Characters / Treatments		No. of panicles/m^2		Panicle length (cm)	Grain yield (ton/fad)	Straw yield (ton/fad)	
FYM m^3/fad	Hill spaces (cm)	2000	2001	2000	2000	2000	2001
0 m^3/fad	20x15	314.8	310.7	20.4	3.091	3.352	3.087
	20x20	284.0	278.7	20.6	2.818	3.163	2.912
	20x25	254.0	252.0	20.8	2.701	2.977	2.714
20 m^3/fad	20x15	340.3	335.9	23.6	3.559	3.893	3.593
	20x20	313.9	314.1	23.9	3.409	3.646	3.273
	20x25	287.3	288.0	24.2	3.304	3.468	3.135
F-test		*	**	*	**	**	*
LSD (5%)		4.2	4.0	0.1	0.035	0.018	0.057

The interaction between farmyard manure and nitrogen treatments (Table 7) had significant effect on flag leaf area, number of panicles/m^2, number of filled grains/ panicle, 1000-grain weight and grain yield/fad of rice in both seasons. The highest value of grain yield/fad was produced by application 20 m^3 /fad farmyard manure and the addition of 20 kg N/fad + BGA in both seasons.

Table 7: Flag leaf area $(cm)^2$, number of panicles/m^2, number of grains/panicle, 1000-grain weight (g) and grain yield (ton/fad as affected by the interaction between farmyard manure and nitrogen fertilizer (bio and mineral and their combinations).

Characters / Treatments		Flag leaf area (cm^2)		No. of panicles/m^2		No. of filled grains /panicle		1000-grain weight (g)		Grain yield (ton/fad)	
FYM m^3/fad	N-fertilizer (kg/fad)	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
0 m^3/fad	0	11.9	11.5	235.3	230.4	112.4	113.6	17.7	17.6	1.834	1.680
	20	13.5	13.5	256.9	253.8	123.7	120.9	19.6	19.3	2.520	2.399
	40	16.0	15.4	304.9	296.7	128.9	126.0	21.4	21.1	3.131	3.038
	60	16.3	16.0	313.8	307.3	140.7	135.2	22.1	21.8	3.360	3.195
	BGA	13.2	13.1	259.3	253.6	120.7	118.3	18.7	18.3	2.395	2.245
	20+BGA	15.4	14.9	274.3	279.0	126.7	123.9	20.8	20.5	2.949	2.734
	40+BGA	16.4	16.1	316.8	313.6	134.1	133.6	21.1	21.0	3.444	3.220
	60+BGA	16.7	16.2	312.7	309.2	130.9	128.6	20.9	20.4	3.328	3.173
20 m^3/fad	0	15.0	14.4	286.2	281.8	121.3	117.0	19.6	19.4	2.498	2.371
	20	17.0	16.5	316.8	311.2	134.2	132.6	21.3	20.8	3.262	3.159
	40	19.2	18.7	325.3	319.1	140.1	134.9	22.3	21.9	3.598	3.472
	60	19.6	18.9	313.1	314.7	133.7	129.8	21.9	21.8	3.519	3.425
	BGA	16.9	16.0	312.9	310.4	131.1	127.3	22.3	21.3	3.113	3.038
	20+BGA	18.7	17.8	344.0	339.3	146.2	140.9	23.1	22.7	3.921	3.850
	40+BGA	19.5	18.5	321.3	316.4	140.0	137.9	22.8	22.5	3.786	3.649
	60+BGA	19.6	18.6	291.1	308.3	132.9	131.0	22.4	22.1	3.696	3.631
F-test		**	**	**	**	**	**	**	**	**	**
LSD (5%)		0.2	0.2	3.7	5.2	1.9	2.4	0.2	0.3	0.050	0.050

The interaction between hill spaces and nitrogen treatments (Table 8) had significant effect on grains weight/panicle and grain yield/fad in both seasons and flag leaf area, number of panicles/m^2, panicle length and protein percentage in the first season only. Grain yield/fad of rice reached its maximal from the treatment had the combination of 20 x 15 hill spacing and the addition of 40 kg N/fad + BGA. It was 3.917 and 3.670 ton/fad in 2000 and 2001 seasons, respectively.

The interaction among farmyard manure, hill spaces and nitrogen treatments (Table 9) had significant effects on grain yield/fad of rice in 2000 season only. Maximum grain yield/fad (4.032 ton/fad) was taken from the treatment 20 m^3/fad farmyard manure, 20 x 15 cm hill spacing and 20 kg N/fad + BGA inoculation.

Finally, it can be stated that transplanting rice in hills 20 x 15 cm with adding 20 m^3/fad farmyard manure and 20 kg N/fad + BGA inoculation was the recommended treatment to increase rice productivity under the conditions of El-Serw district.

Table 8: Flag leaf area $(cm)^2$, number of panicles/m^2, panicle length (cm), grains weight/ panicle (g), grain yield (ton/fad) and protein percentage as affected by the interaction between hill spaces and nitrogen fertilizer (bio and mineral and their combinations).

Characters / Treatments		Flag leaf area (cm^2)	No. of panicles /m^2	panicle length (cm)	grain weight /panicle (g)		Grain yield (ton/fad)		Protein %
Hill spaces	N-fertilizer (kg/fad)	2000	2000	2000	2000	2001	2000	2001	2000
20 x 15 cm	0	12.0	288.7	19.7	2.4	2.2	2.355	2.177	8.24
	20	13.8	315.3	21.7	2.6	2.5	3.073	2.996	10.20
	40	15.9	342.7	21.9	2.8	2.7	3.514	3.374	10.48
	60	16.3	342.7	22.1	3.0	2.8	3.605	3.456	10.11
	BGA	13.4	310.7	21.3	2.5	2.4	2.857	2.786	8.73
	20+BGA	16.0	338.7	22.9	2.9	2.8	3.688	3.388	9.77
	40+BGA	16.5	348.7	23.1	2.9	2.8	3.917	3.670	10.07
	60+BGA	16.6	333.7	23.2	2.9	2.7	3.590	3.456	10.70
20 x 20 cm	0	13.0	259.0	19.6	2.6	2.5	2.142	2.010	8.52
	20	15.1	286.8	22.0	3.0	2.9	2.870	2.737	9.59
	40	17.2	316.0	22.4	3.2	3.1	3.346	3.248	10.28
	60	17.7	315.3	22.4	3.1	3.0	3.395	3.290	10.29
	BGA	14.8	287.0	21.6	2.8	2.7	2.744	2.611	9.18
	20+BGA	15.3	306.5	23.2	3.2	3.1	3.361	3.262	9.93
	40+BGA	17.4	319.0	23.5	3.1	3.1	3.670	3.509	10.80
	60+BGA	17.6	301.7	23.5	2.9	2.8	3.582	3.295	10.95
20 x 25 cm	0	13.8	234.7	19.8	2.7	2.6	2.002	1.890	8.75
	20	16.1	258.3	22.2	3.1	2.9	2.730	2.604	9.37
	40	18.1	286.7	22.6	3.3	3.2	3.234	3.143	9.45
	60	18.3	282.3	22.6	3.3	3.2	3.318	3.185	10.41
	BGA	15.4	260.7	21.8	2.9	2.8	2.660	2.527	8.93
	20+BGA	17.7	282.7	23.4	3.3	3.1	3.255	3.226	10.21
	40+BGA	18.0	289.5	23.7	3.2	3.2	3.558	3.425	10.75
	60+BGA	18.0	270.3	23.7	3.1	2.9	3.263	3.155	11.81
F-test		**	*	*	**	**	**	**	*
LSD (5%)		0.3	6.4	0.3	0.1	0.1	0.086	0.086	1.16

Table (9): Grain yield (ton/fad) as affected by the interaction among farmyard manure, hill spaces and nitrogen fertilizer (bio and mineral and their combination).

Characters / Treatments		Grain yield (ton/fad) in 2000 season							
		N-fertilizer (kg/fad)							
FYM m^3/fad	Hill spaces (cm)	0	20	40	60	BGA	20+BGA	40+BGA	60+BGA
0 m^3/ fad	20 x 15	2.044	2.730	3.290	3.570	2.481	3.345	3.724	3.544
	20 x 20	1.806	2.492	3.108	3.276	2.394	2.814	3.374	3.283
	20 x 25	1.652	2.338	2.996	3.234	2.310	2.688	3.234	3.157
20 m^3 /fad	20 x 15	2.665	3.416	3.738	3.640	3.234	4.032	3.909	3.836
	20 x 20	2.478	3.248	3.584	3.514	3.094	3.909	3.766	3.682
	20 x 25	2.352	3.122	3.472	3.402	3.010	3.822	3.682	3.570
F-test		**							
LSD (5%)		0.086							

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تأثير السماد العضوى والنيتروجينى المعدنى والحيوى ومسافات الزراعة على إنتاجية محصول الأرز.

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أجريت تجربتان حقليتان فى محطة البحوث الزراعية بالسرو بمحافظة دمياط خلال موسمى ٢٠٠٠ و ٢٠٠١ لدراسة تأثير السماد العضوى (صفر و ٢٠ م^{٣} / فدان) ومسافة الزراعة (٢٠ × ١٥ ، ٢٠ × ٢٠ و ٢٠ × ٢٥ سم) والسماد النيتروجينى الحيوى (التلقيح بالطحالب الخضراء المزرقة) والمعدنى (صفر ، ٢٠ ، ٤٠ و ٦٠ كجم نيتروجين / فدان) والتفاعل بينهم على النمو والمحصول وجودته لصنف الأرز جيزة ١٧٨ . وتتلخص أهم النتائج المتحصل عليها فيما يلى:

١ــ أدت إضافة السماد العضوى بمعدل ٢٠ م^{٣} / فدان إلى زيادة معنوية فى مساحة ورقة العلم وطول النبلت وعدد السنابل / م^{٢} وطول السنبلة وعدد الحبوب الممتلئة / سنبلة ووزن حبوب السنبلة ووزن الألف حبة ومحصول القش والحبوب للفدان فى موسمى الزراعة.

٢ــ كان للتسميد العضوى تأثيرا معنويا على نسبة الفوسفور فى الموسم الأول والبوتاسيوم فى الموسم الثانى بينما لم يكن له تأثيرا معنويا على نسبة البروتين فى حبوب الأرز فى كلا الموسمين.

٣ــ أشارت النتائج إلى التأثير المعنوى لمسافات الزراعة على كل الصفات تحت الدراسة خلال موسمى الزراعة عدا صفتى نسبة البوتاسيوم والبروتين فى حبوب الأرز لم يكن لمسافة الزراعة تأثيرا معنويا عليهما فى الموسم الأول.

٤ــ كان للتسميد النيتروجينى المعدنى والحيوى تأثيرا معنويا على كل الصفات المدروسة وقد أعطت إضافة ٤٠ كجم نيتروجين / فدان + التلقيح بالطحالب الخضراء المزرقة أعلى محصول من الحبوب / فدان خلال موسمى الزراعة.

٥ــ بزيادة معدل التسميد المعدنى حتى ٦٠ كجم نيتروجين / فدان + التلقيح بالطحالب الخضراء المزرقة زادت نسبة كل من الفوسفور والبوتاسيوم والبروتين فى حبوب الأرز فى موسمى الزراعة.

٦ــ أوضح التفاعل بين عوامل الدراسة أن أعلى محصول من الحبوب / فدان تم الحصول عليه من إضافة ٢٠ م^{٣} سماد عضوى / فدان وشتل الأرز على مسافة ٢٠ × ١٥ سم بين الجور وكذلك بلغ عدد السنابل/م^{٢} ومحصول الحبوب للفدان أقصاه عند تسميد الأرز بمعدل ٢٠ م^{٣} سماد عضوى مع إضافة ٢٠ كجم نيتروجين / فدان + التلقيح بالطحالب الخضراء المزرقة خلال موسمى الزراعة. وأيضا تم الحصول على أعلى محصول من الحبوب / فدان عند شتل الأرز على مسافة ٢٠ × ١٥ سم والتسميد بمعدل ٤٠ كجم / فدان + التلقيح بالطحالب الخضراء المزرقة وذلك فى موسمى الزراعة ، وتم الحصول على أعلى محصول من حبوب الأرز أيضا بإضافة السماد العضوى بمعدل ٢٠ م^{٣}/فدان والشتل على مسافة ٢٠ × ١٥ سم والتسميد بالسماد المعدنى بمعدل ٢٠ كجم نيتروجين / فدان + التلقيح بالطحالب الخضراء المزرقة فى موسم ٢٠٠٠.

وعموماً توصى الدراسة بإضافة السماد العضوى بمعدل ٢٠ م^{٣} / فدان والشتل على مسافة ٢٠ × ١٥ سم مع إضافة السماد المعدنى بمعدل ٢٠ كجم نيتروجين / فدان والتسميد الحيوى بالطحالب الخضراء المزرقة وذلك بهدف إنتاج أعلى محصول من الحبوب لصنف الأرز جيزة ١٧٨ تحت ظروف منطقة السرو.