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Effect of Nitrogen Levels, Plant Spacing and Time of Farmyard Manure Application on the Productivity of Rice

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Abstract: Two field experiments were conducted at Sedy Salem District, Kafr El-Sheikh, Governorate Egypt during 2004 and 2005 seasons to study the effect of nitrogen levels (0,35 and 70 kgN/fed), plant spacing (20x15cm, 20x20cm and 20x25cm between hills) and time of farmyard manure (FYM) application (before preceding winter crop (wheat) and direct before rice transplanting) on growth, yield and its components and grain protein content of Sakha 101 rice cultivar. The obtained results could be summarized as follows:

- Application of FYM before wheat (T_1) increased significantly days to heading, leaf area index as will as yield and the most yield components compared with application of FYM before rice(T_2) in both seasons except that plant height at harvest and grain protein content in the first season as will as straw yield in the second season.
- Increasing nitrogen levels from 0 to 70 kg N/fed significantly increased all studied characters in both seasons except 1000-grain weight in 2005 season and grain protein content in 2004 season, which responded to N up to 35 kg N/fed only.
- The narrowest spacing of 20x15cm recorded the highest values of days to heading, leaf area index, plant height, number of panicles/m^2 and grain and straw yields in both seasons compared with wider spacing of 20x20 and 20x25cm while, both wider spacing recorded the highest values of panicle length, panicle weight, number of filled grains/panicle and 1000-grain weight in both seasons as well as grain protein content in 2005 season.
- Application of 8 ton FYM/fed before preceding crop + 35kg N/fed with narrowest plant spacing of 20x15cm gave similar yield with application of 70kg N/fed with wider spacing of 20x20 or 20x25cm this treatment could be reducing soil pollution by saving 35kg N/fed.

Key words: Rice, nitrogen levels, plant spacing, farmyard manure and grain yield

INTRODUCTION

Rice is one of the most important summer annual crops grown in Egypt. Nitrogen is among the principal factors which limiting yield of lowland rice production around the world. Recently, pollution has drawn lot of attention at local and international level as well. One of the important sources of pollution is the use of various chemicals in agriculture. Increasing amounts of mineral fertilizer constitutes a major reason of soil pollution so that minimizing the use of these chemicals is a way to reduce pollution.

Applying nitrogen fertilizer is a must to inhance crop production especially for non legumes and rice is one crop requires N-fertilizer. Most of literature indicates the importance of N-fertilizer for rice crop but they differ in the optimum does to applied. Ebaid and Ghanem[1] indicated that increasing nitrogen levels up to 144 kg N/ha significantly increased plant height, panicle length, straw yield and grain yield and its components. Hari *et al*.[2] showed that there was a significant increase in grain yield and its attributes with each additional nitrogen application up to 150 or 200 kg/ha.El-Rewainy[3] recorded that applying 40 kg N/fed caused significant increase in plant height, number of panicles/m^2, panicle length, panicle weight, number of filled grains/panicle as well as grain and straw yileds. El-Batal *et al*.[4] showed that increasing nitrogen rate from 50 to 80 kg N/fed significantly increased plant height, panicle length, number of filled grains/panicle and grain and straw yields, while number of panicles/m^2, panicle weight and harvest index were not significant, but 1000-grain weight decreased. Ibrahiem *et al*.[5] found that number of grains/panicle, 1000-grain weight, panicle weight and grain and straw yields were not significant effect by increasing nitrogen levels from 30 to 60 kg N/fed. Zayed *et al*.[6] found that increasing nitrogen

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levels up to 165kg N/ha significantly increased growth and yield and its components.

One way to reduce the application of mineral N-fertilizer is the use of farmyd manure. In literatures several workers showed the importance of farmyard manure in increasing rice grain yield and its components..Nour[7]and El-Kholy *et al*.[8] found that application of either chemical nitrogen or organic manure significantly incresed grain yield compared with the control. Ebaid[9] reported that panicle weight, 1000-grain weight and grain yield 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/m^2 and number of grains/panicle. Das *et al*.[10] indicated that addition of 5 ton crop residues/ha significantly increased number of panicles/m^2, panicle length, number of grains/panicle and grain and straw yields. Bassal and Zahran[11] found that adding of 20 m^3 farmyar manure/fed significantly increased flag leaf area, plant height, number of panicles/m^2, panicle length, panicle weightnumber of filled grains/panicle, 1000-grain weight and grain and straw yields.

With respect to hill spaces, several studies reported that density is the important factor for limiting grain yield of rice and its components. Maske *et al*.[12] found that plant height, leaf area index and yield and its components were higher with 15x10cm than that of 15x15 or 15x20cm. Shin *et al*.[13] stated that the heading date wasn't affected by planting space of rice. Zahran[14] indicatd that space of 15cm between hills gave the tallest plants, highest number of panicles/m^2 as well as grain and straw yields, while 25cm space among hills gave the highest values of number of filled grains/panicle and 1000-grain weight. Omina El-Shayieb[15] showed that narrow spacing of 10x20cm gave the highest yield and yield components of Giza 177 rice cultivar compared with 20x20 or 30x20cm. Zayed *et al*.[6] stated that the narrowest spacing of 15x10cm recorded the highest days to heading, leaf area index, number of panicles/m^2 and grain and straw yields compared with wider spacing 15x15 or 15x20 cm, while wider spacing recorded the highest panicle length, panicle weight, number of filled grains/panicle and 1000-grain weight.

The present study aimed to study the effect of time of farmyard manure application at different plant spacing and diversity nitrogen levels on growth, yield and its components and grain protein content of Sakha 101 rice cultivar.

MATERIALS AND METHODS

Two field experiments were conducted at the Sedy Salem District Kafr El-Sheikh Governorate, Egypt during 2004 and 2005 seasons to study the effet of two time of farmyard manure application (before preceding winter crop and direct before rice transplanting), three nitrogen levels (0, 35 and 70 kg N/fed) and three plant spacing (20 x 15, 20x20 and 20 x 25cm between hills and rows) on productivity of Sakha 101 rice cultivar. A strip-split plot design with four replications was used. The first main plots were occupied by the two time of farmyard manure application, while the second main plots were assigned to the three nitrogen levels and the three plant spacings were devoted to the sub plots. The size of each sub plot was 3x3.5m occupying an area of 10.5m^2 (1/400 fed). The preceding winter crop was wheat in both seasons. The nursery land was will prepared through two ploughings, harrowing and leveling. Rice grain at the rate of 60 kg/fed were soaked on water for about 36 hours and incubated for 24 hours there after, it were broadcasted in the nursery land on 20th May in both seasons.

The permanent field was well prepared and calcium super phosphate (15.5% P_2O_5) at a rate of 100 kg/fed was add on the dry soil before plaughing. Farmyard manure at a rat of 8 ton/fed was incorporated in dry soil fifteen days before wheat cultvition or rice transplanting according to the treatments. Nitrogen fertilizer in the form of Urea (46%N) was applied as per treatments in two doses, two third incorporated in dry soil before transplanting and the other third at panicle initiation. Thirty days old, three seedlings/hill were transplanted in the permanent field according to the treatments. The other usual agricultural practices of growing rice were conducted as recommended by Ministry of Agriculture except the factors under study. Samples of soil were taken from the surface layer (0-30cm depth) after wheat fertilized and unfertilized by farmyard manure. Mechanical and chemical analysis of the experimental soil are shown in Table 1. The chemical analysis of FYM is given in Table 2.

Plant samples were collected randomly from all treatment at heading and leaf area index (LAI) was determined according to Yoshida *et al.*[16]. Number of days to heading was recorded at 50% heading of each sub plot.

At harvest, plant height was estimated and total number of panicles were counted from ten hills, and then computed to numbers/m^2.

Ten random panicles were collected from each sub plot to estimate panicle length, panicle weight, number of filled grains/ panicle and 1000-grain weight.

The central area of each sub plot(six square meter 2x3m) were harvested, dried and threshed to estimate the grain and straw yields based on 14% of moisture and converted into ton/fed. Brown rice nitrogen content was determined according to standard Kjeldahl method A.O.A.C,[17] then crude protein content in grain was calculated by multiplying nitrogen percent by a factor

Table 1: Soil mechanical and chemical properties of the experimental sites.

	2004		2005	
Soil analysis	After wheat unfertilized by FYM	After wheat fertilized by 8 ton FYM/fed	After wheat unfertilized by FYM	After wheat fertilized by 8 ton FYM/fed
Mechanical analysis:				
Sand %	12.7	11.3	13.2	11.5
Salt %	32.3	33.9	33.5	34.8
Clay %	55.0	54.8	53.3	53.7
Soil Texture	Clay	Clay	Clay	Clay
Chemical analysis:				
PH	8.2	8.0	8.0	7.9
EC ds/m	1.9	2.0	2.1	2.1
OM %	2.0	2.8	1.8	2.6
Available N ppm	18	28	16	29
Available P ppm	17	24	16	25
Available K ppm	416	420	409	415
Available Zn ppm	0.8	0.8	0.9	1.0
Available Fe ppm	2.1	2.4	2.8	2.9
Available Mn ppm	3.2	3.3	3.5	3.8

Table 2: Chemical analysis of FYM used in 2004 and 2005 seasons.

	Analysis			
Seasons	OM%	Total N%	Total P_2O_5%	Total K_2O%
2004	10.21	0.50	0.38	1.42
2005	11.10	0.54	0.40	1.71

of 5.95. The collected data were statistically analyzed according to Gomez and Gomez[18], using analysis of variance technique by means of (IRRISTAT computer)soft ware package.

RESULTS AND DISCUSSION

Growth characters

The effect of time of farmyard manure application: Time of FYM application had a significant effect on days to heading, leaf area index and plant height at harvest in both seasons except that on plant height at harvest in 2004 season (Table 3). It is clear from this table that application of FYM befor preceding winter crop (wheat) significantly increased days to heading and leaf area index in both seasons as well as plant height at harvest in 2005 season compared with application of FYM befor rice. Incorporation of FYM before preceding winter crop gave a long time to its decomposition which increased the soil humus content and thus increased soil fertility (Table 1). Humus released nutrients to soil slowly throughout the growth period of rice plant which resulted better plant growth. Bassal and Zahran[11] found that application of 20 m^3 FYM/fed significantly increased flag leaf area and plant height.

The effect of nitrogen levels: Data in Table 3 show that the nitrogen levels had a positive and significant effect on all studied growth parameters of rice plants in both seasons. Increasing nitrogen levels up to 70 kg N/fed significantly increased days to heading, leaf area index and plant height at harvest. The longest period from sowing to heading, the hightest leaf area index as well as the highest plant height at harvest were recorded when rice plants were fertilized with the highest nitrogen level of 70 kg N/fed. On contrary, the lowest values of the above mention traits were recorded when rice plants received no nitrogen fertilizer. The application of 0 N levels encouraged the rice plants to change from vegetative to reproductive stage. In addition nitrogen fertilizer enhance cell elongation and cell division and this probably resulted in large leaf area index and highest plant height. Also increasing nitrogen levels might be delaying the early leaf aging, thus leading to large leaf

Table 3: Days to heading, leaf area index and plant height at harvest of Sakha 101 rice cultivar as affected by time of FYM application, nitrogen levels and plant spacing in 2004 and 2005 seasons.

	Days to heading		Leaf area index (LAI)		Plant height at harvest (cm)	
Treatment	2004	2005	2004	2005	2004	2005
Time of FYM application (T):						
T_1	105.55	105.82	5.25	5.22	87.44	86.92
T_2	103.61	103.58	5.05	4.95	86.71	84.46
LSD 0,05	0.34	1.87	0.07	0.14	N.S	1.15
N-levels (kg N/fed) (N)						
0	101.18	100.56	4.11	4.03	80.21	78.92
35	104.7	105.13	5.36	5.33	88.6	86.8
70	107.86	108.41	5.97	5.91	92.41	91.55
LSD 0,05	1.45	1.6	0.09	0.1	1.59	1.03
Plant spacing(S):						
20x15 cm	106.08	106.15	5.35	5.27	88.16	87.07
20x20 cm	104.43	104.46	5.17	5.14	87.03	85.34
20x25 cm	103.22	103.39	4.92	4.85	86.02	84.65
LSD 0,05	1.07	0.86	0.06	0.07	1.52	1.07
Interaction:						
TXN	NS	NS	*	*	NS	NS
TXS	NS	NS	NS	NS	NS	NS
NXS	NS	NS	NS	NS	NS	NS
TXNXS	NS	NS	NS	NS	NS	NS

*and Ns indicate P<0.05 and not significant, respectively, T_1 before preceding crop (wheat) and T_2 before rice transplanting.

Table 4: Leafarea index of Sakha 101 rice cultivar as affected by the interaction between nitrogen level and time of FYM application during 2004 and 2005 seasons.

	Time of FYM application			
	2004		2005	
N- levels (kg N/fed).	T_1	T_2	T_1	T_2
0	4.3	3.91	4.27	3.79
35	5.47	5.26	5.42	5.23
70	5.98	5.97	5.98	5.84
LSD 0.05	0.12		0.15	

T_1 before preceding crop (wheat) and T_2 before rice transplanting.

area index, which contribute to high grain yield. Similar resultes were reported by Ebaid and Ghanem[1], El-Rewainy[3] and El-Batal *et al.*[4].

The effect of plant spacing: Plant spacing had a significant effect on all studied growth parameters in both seasons (Table 3). It observed that the narrowest plant spacing (20x15cm) recorded the heights values of days to heading, leaf area index and plant height at harvest compared with the other two plant spacings in both seasons. On contrary, the lowest values of the above mention traits were recorded when rice plants were transplanted at wider plant spacing of 20x25 cm. The largest leaf area index under narrowest spacing of 20x15cm might mainly due to more leaves which accupied the same land area and consequently trapped more light and Co_2 resulting in high photosynthesis capacity and producting more dry matter production. Numerous authors came to similer results such as Zayed *et al*.[6].Maske *et al*.[12], Zahran[14] and Lee *et al.*[19].

The interaction effect: The interaction between time of FYM application and nitrogen levels on leaf area index was significant in both seasons (Table 3). Data in Table 4 show that application of FYM before wheat was superior than appliction of FYM before rice under 0 or 35 kg N/fed, while there is no difference between the two time of FYM application under 70 kg N/fed in both seasons.

Yield and its attributing characters

Effect of time of FYM application: Time of FYM application had a significant effect on all studied yield and its attributing characters in both seasons, except that straw yield in 2005 season (Tables 5 and 9). Appliction of FYM before wheat significantly increased number of panicles /m^2, panicle length, panicle weight, number of filled grains / panicle, 1000-grain weight and grain yield in both seasons as well as straw yield in 2004 season compared with application of FYM before rice. Application of FYM before wheat improved the physical and chemical properties of soil and gave enough time to its decomposition and increase the availability of different nutrients which was reflected of growth of plants and increased yield and its components. Nour[7], El-Koly *et al*.[8], Das *et al*.[10] and Bassal and Zahran[12] found that applicationof FYM significantly increased grain yield and its components.

Effect of nitrogen levels: Data in Tables 5 and 9 show that increasing nitrogen levels from 0 to 70 kg N/fed significantly increased number of panicles / m^2 panicle langth, panicle weight, number of filled grains / panicle,

Table 5: Number of panicles/m^2, panicle length, panicle weight and number of filled grains / panicle as affected by time of FYM application, nitrogen levels and plant spacing in 2004 and 2005 seasons.

	Number of panicles/m^2		Panicle length (cm)		Panicle weight (gm)		Number of filled grains / panicle	
Treatment	2004	2005	2004	2005	2004	2005	2004	2005
Time of FYM application (T):								
T_1	443.64	433.9	21.94	21.88	3.25	3.21	129.24	128.54
T_2	430.48	417.95	21.61	21.59	3.15	3.11	124.94	124.69
LSD 0.05	5.2	11.77	0.11	0.25	0.09	0.07	0.86	2.36
N -levels (Kg/fed) (N):								
0	356.39	348.5	19.91	19.78	2.29	2.55	106.26	105.17
35	473.23	454.4	22.59	22.61	3.46	3.45	135.55	135.49
70	481.56	474.9	22.82	22.81	3.54	3.48	139.46	139.19
LSD 0.05	6.97	12.06	0.08	0.13	0.06	0.05	1.97	2.12
Plant spacing (S):								
20x15 cm	457.84	444.4	21.43	21.41	3.06	3.02	122.56	121.05
20x20cm	441.82	428.7	21.82	21.79	3.22	3.18	128.04	127.48
20x25cm	411.51	404.8	22.08	22	3.31	3.27	130.66	131.31
LSD 0.05	6.39	9.47	0.09	0.07	0.05	0.04	1.96	1.87
Interaction:								
TxN	NS	NS	*	*	NS	NS	NS	NS
TxS	NS	NS	NS	NS	NS	NS	NS	NS
NxS	NS	NS	*	NS	NS	*	NS	NS
TxNxS	NS	NS	NS	NS	NS	NS	NS	NS

* and Ns indicate P< 0.05 and not significant, respectively. T_1 before preceding crop (wheat) and T_2 before rice transplanting

1000-grain weight as well as grain and straw yields in both seasons except that 1000-grain weight in 2005 season which it responded to nitrogen up to 35 kg N /fed only. Increasing nitrogen fertilizer improved growth, Photosynthesis and all yield components. In addition, increasing nitrogen fertilizer had positive effect on grain filling, which reduced sterility and increased reproductive tillers leading to high grain and straw yields. Similar finding were reported by Hari *et al*.[2] Zayed *et al.*[6]. Ashoub *et al.*[20], El-Mesalamy[21] and Abd El-Wahab[22].

Effect of plant spacing: The analysis of variance in Tables 5 and 9 confirmed significant variations by plant spacing on all studied yield and its attributes in both seasons. The close spacing of 20 x 15 cm gave the maximum values of number of panicles/m^2, shortest panicles, lightest panicle weight, less number of filled grains/panicle, lightest 1000-grain weight and highest values of grain and straw yields. Bacause, the close spacing of 20x15 cm gave the huge number of panicles/m^2 as compared with wider spacing of 20x20 or 20 x 25 cm, the competition was so much high leading to little bite reduction in filled grains and panicle and grain weight. In spite of all above results, closer spacing of 20x15 cm was better in number of panicles/m^2 which played the main role in grain yield formation. On contrary, the wider spacing gave lowest number of panicles/m^2, longest panicles, heaviest panicles and 1000-grain weights, maximum filled grains/panicle and lowest grain and straw yields. Under salt affected soil in Kafr El-Sheikh salinity decreased number of panicles/m^2 under wider spacing so

Table 6: Panicle length of Sakha 101 rice cultivar as affected by the interaction between nitrogen levels and time of FYM application during 2004 and 2005 seasons.

	Time of FYM application			
	2004		2005	
N levels (kgN/fed)	T_1	T_2	T_1	T_2
0	20.17	19.65	20.03	19.53
35	22.79	22.40	22.74	22.47
70	22.86	22.77	22.86	22.77
LSD 0.05	0.11		0.18	

T_1 before preceding crop (wheat). & T_2 before rice transplanting

hight plant density is much needed to obtain considerable grain yield.The highest grain yield under closer dinsity mainly due to high reproductive number of tillers/m^2. It is to be mentioned here that the colse density had only high number of panicles/m^2 against sparse density but the number of filled grains or panicle weight were not affected. So the main yield component in this case is number of panicles/m^2 which contributed to grain yield by the great part.Similar results were recorded by Zayed *et al.*[6]and Omina El-Sayieb[15]

The intercation effects: The interactions between time of FYM application and nitrogen levels significantly affected panicle length and 1000-grain weight in both seasons and grain yield in 2005 season (Tables 5 and 9). Data in Tables 6, 10 and 12 indicated that these three characters responded to nitrogen up to 35 kg N/fed under application of FYM before wheat (T_1) in most cases, while it responded to nitrogen up to 70 kg N/fed under application of FYM before rice (T_2).

Table 7: Panicle length of Sakha 101 rica cultivar as affected by the interaction between nitrogen level and plant spacing during 2004 season.

Plant spacing (cm)	N levels (kgN/fed) 0	35	70
20x15	19.63	22.25	22.40
20x20	19.85	22.65	22.95
20x25	20.25	22.89	23.10
LSD 0.05	0.28		

Table 8: Panicle weight (gm) of Sakha 101 rice cultivar as affected by the interaction between nitrogen levels and plant spacing during 2005 season.

Plant spacing (cm)	N levels (kgN/fed) 0	35	70
20x15	2.44	3.24	3.38
20x20	2.52	3.51	3.51
20x25	2.69	3.59	3.53
LSD 0.05	0.07		

Also, the interactions between nitrogen levels and plant spacing had a significant effect on panicle length in 2004 season and panicle weight in 2005 season (Table 5). Concerning panicle length data in Table 7 show that panicle length responded to nitrogen levels up to 70kg N/fed with plant spacing of 20x20 cm, while it responded to nitrogen levels up to 35kg N/fed only under plant spacing of 20x15 or 20x25 cm. Regarding to panicle weight data in Table 8 show that panicle weight responded to nitrogen levels up to 70kg N/fed with plant spacing of 20x15 cm, while it responded to nitrogen levels up to 35kg N/fed only under plant spacing of 20x20 or 20x25 cm. Furthermore, the interaction between time of FYM application and plant spacing was significant on grain yield in 2004 season (Table 9). It observed from Table 11 that T_1 superior than T_2 under plant spacing of 20x15 or 20x20 cm, while there is no significant difference between $T_1$and T_2 under plant spacing of 20x25 cm.

Grain protein content:

Effect of time of FYM application: As it was detected in Table 9, time of FYM application had markedly effected grain protein content in 2005 season. Application of FYM before wheat significantpy increased grain protein content compared with application of FYM before rice.

Effect of nitrogen levels: Data in Table 9 show a significant positive effect due to nitrogen fertilizer levels on grain protein content in both seasons. It was responded to nitrogen levels up to 35 and 70 kg N/fed in 2004 and 2005, respectively. This effect might be due to the increasing of available nitrogen for plant metabolism. Similar results were reported by Abou-Khalifa[23] and Badawi[24].

Effect of plant spacing: Data clarified that plant spacing had a positive and significantly effect on grain protein content in 2005 season only. Increasing plant spacing from 20 x 15 cm up to 20x20 or 20 x 25 cm significantly incrensed grain protein content (Table 9).

The interaction effect: The interaction between time of FYM application and nitrogen levels had positive and significant effect on grain protein content in 2005 season

Table 9: 1000-grain weight, grain yield, straw yield and grain protein content of Sakha 101 rice cultivar as affected by time of FYM application, nitrogen levels and plant spacing during 2004 and 2005 seasons.

	1000-grain weight (gm)		Grain yield ton/fed		Straw yield ton/fed		Grain protein content %	
Treatment	2004	2005	2004	2005	2004	2005	2004	2005
Time of FYM application (T):								
T_1	28.54	28.38	4.007	3.877	4.397	4.311	9.31	9.3
T_2	28.12	27.92	3.823	3.736	4.251	4.19	8.59	8.87
	0.17	0.08	0.064	0.044	0.165	NS	NS	0.11
N levels (kgN/fed) (N)								
0	27.24	27.05	2.92	2.819	3.484	3.395	7.5	7.54
35	28.81	28.65	4.379	4.254	4.582	4.537	9.68	9.69
70	28.94	28.75	4.446	4.347	4.905	4.819	9.66	10.04
LSD 0.05	0.08	0.18	0.083	0.058	0.067	0.079	0.7	0.08
Plant spacing (S):								
20x15 cm	27.98	27.66	4.033	3.924	4.49	4.382	8.91	8.91
20x20 cm	28.34	28.17	3.948	3.864	4.312	4.262	8.73	9.14
20x25 cm	28.69	28.62	3.765	3.632	4.169	4.107	9.21	9.22
LSD 0.05	0.09	0.12	0.044	0.066	0.051	0.07	NS	0.09
Interaction:								
TxN	*	*	NS	*	NS	NS	NS	*
TxS	NS	NS	*	NS	NS	NS	NS	NS
NxS	NS	NS	NS	NS	NS	NS	NS	NS
TxNxS	NS	NS	NS	NS	NS	NS	NS	NS

* and Ns indicate P< 0.05 and not significant, respectively, T_1 before preceding crop (wheat) and T_2 before rice transplanting

Table 10: 1000-grain weight (gm) of Sakha 101 rice cultivar as affected by the interaction between time of FYM application and nitrogen levels during 2004 and 2005 seasons.

N levels (kgN/fed)	Time of FYM application			
	2004		2005	
	T_1	T_2	T_1	T_2
0	27.37	27.12	27.06	27.04
35	29.11	28.52	29.05	28.25
70	29.16	28.73	29.03	28.48
LSD 0.05	0.12		0.25	

T_1 before preceding crop (wheat) and T_2 before rice transplanting

Table 11: Grain yield of Sakha 101 rice cultivar as affected by the interaction between plant spacing and time of FYM application during 2004 season.

Plant spacing (cm)	Time of FYM application	
	T_1	T_2
20x15	4.148	3.917
20x20	4.069	3.826
20x25	3.804	3.726
LSD 0.05	0.093	

T_1 before preceding crop (wheat) and T_2 before rice transplanting

Table 12: Grain yield of Sakha 101 rice cultivar as affected by the interaction between nitrogen levels and time of FYM application during 2005 season.

N levels (kgN/fed)	Time of FYM application	
	T1	T2
0	2.965	2.874
35	4.503	4.256
70	4.553	4.339
LSD 0.05	0.082	

T_1 before preceding crop (wheat) and T_2 before rice transplanting

Table 13: Grain protein content of Sakha 101 rice cultivar as affected by the interaction between time of FYM application and nitrogen level during 2005 season.

N level (kgN/fed)	Time of FYM application	
	T_1	T_2
0	7.86	7.22
35	10.00	9.39
70	10.06	10.02
LSD 0.05	0.11	

T_1 before preceding crop (wheat) and T_2 before rice transplanting

(Table 9). Data in Table 13 indicated that grain protein content responded to nitrogen up to 35 kg N/fed under T_1, while it responded to nitrogen up to 70 kg N/fed under T_2.

From the fore-going discussion, application of 8 ton FYM before preceding crop (wheat) with 35 kg N/fed and transplanting rice plants at plant spacing of 20x15 cm can be recommended under Kafr El-Sheikh condition of this research for higher grain yield of Sakha 101 rice cultivar.

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