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Performance of some Rice Genotypes under Both Different Nitrogen Levels and Plant Spaces

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ABSTRACT

Two field experiments were conducted at the farm of Sakha Research Station, Kafr el-sheikh, Egypt in 2016 and 2017 rice seasons to study the performance of some rice genotypes under both different plant spaces and various nitrogen levels. Rice varieties i.e. SP70 (Sakha108), GZ9461, GZ7112 and GZ9057 (Giza 179) were used and cultivated under three spaces namely 15x20, 20x20 and 25x20 cm with three nitrogen levels i.e. control (without N-application), 110 and 165 kg N/ha. Statistical design of the experiment was split-split plot design. Rice varieties were applied in the main plots and plant space was allocated in the sub plots, while sub sub plots received nitrogen levels. The studied characters such as chlorophyll content, plant height, number of tillers and panicles, panicle length, panicle weight, 1000-grain weight, grain and straw yield were estimated. The main results revealed that the different genotypes slightly differed in their characters under study according to genetic background. The space of 25x20 cm was the best for all the studied characters of the tested genotypes except panicle length which responded to medium space 20x20 cm. The narrowing space of 15x20 cm was not suitable for all the genotypes and decreased most of the studied characters. The application of 165 kg N/ha caused an increased in the growth, yield attributes and grain plus straw yield. Results also indicated that the combination of wider space 25x20 cm with 165 Kg N/ha caused as a significant increase in all the previously mentioned characters expect 1000-grain weight which reached to its maximum value under both narrowing space 15x20 cm and control treatment (without N-application). The combination of all the genotypes under study with the space of 25x20 cm and 165 kg N/ha produced the same greatest grain yield except GZ7112 which gave the least. Straw yield of all the genotypes was nearly the same under both medium space (20x20cm) and narrowing space 15x20cm when fertilized by 165 kg N/ha specially GZ9057 which produced the highest straw yield under the same space and level of nitrogen.
Keywords: Rice, Nitrogen, Plant spacing, newly released Varieties

INTRODUCTION

Rice (*Oryza sativa L.*) is the most important food crop and energy source in the world for about half of the world's population Manjappa and Shailaja, (2014). In Egypt rice is considered as the most popular and important field crop for several reasons: as a staple food after wheat for the Egyptian population, as an exporting crop and land reclamation crop for improving the productivity of the saline soils widely spread in North delta and coastal. Maintaining stable rice production is extremely important to feed the constantly growing human population. Salem (2006) reported that increasing nitrogen levels from 0 to 70 kg N/fed significantly increased all studied characters in both seasons except 1000-grain weight and protein content which responded to N up to 35 kg N/fed only. Also, he indicated that the narrowest spacing of 20 x 15 cm recorded the highest values of days to heading, leaf area index, plant height, number of panicles /m^2 and grain and straw yield in both seasons compared with wider spacing of 20 x 20 and 20 x 25 cm. while, the wider spacing recorded the highest panicle length, panicle weight, number of filled grains /panicle and 1000-grain weight in both seasons as well as protein content in the grain in 2005 season. Ebaid and Ghanem (2000) reported that increasing nitrogen levels up to 144 kg N/ha significantly increased plant height, panicle length, straw yield and yield and its components. El-Batal *et al.* (2004) recorded that increasing nitrogen levels 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 significantly increased, but 1000-grain weight was decreased. Yoseftabar (2013) found that panicle number, panicle length, panicle dry matter, number of primary branches, total grain and grain yield significantly increased with nitrogen fertilizer (100,200 and 300 kg N/ha). The raising nitrogen level up to the highest level 165 kg N/ha significantly increased most of the studied traits of Giza177, Giza178, Sakha105 and, Sakha106 respectively (Metwally *et al.* 2017). Regarding to the effect of plant spacing on rice plant (Mohapatra *et al.* 1989) were recorded that plant spacing of 20x20 cm was better than of 15x15cm or 15x20cm under normal soil for rice productivity. Patel (1999) showed that the spacing of 20x20cm compared with 20 x 15 cm and 20x10cm of hill spacing recorded perceptible increase in number of panicles per m^2, grain and straw yield, while, number of grains per panicle and 1000-grain weight were not affected by hill spacing. Maske *et al.* (1997) observed that plant height, leaf area index and grain yield and its attributes were higher with 15 x 10cm than that of 15x15 or 15x20cm. Buri Maohamed moro *et al.* (2016) Reported that both the number of tillers and panicles per m2 were reduced significantly with narrow spacing than wider spacing, where the highest grain yield was obtained at 20x25 cm (11.4 t/ha) and 20 x20 cm (10.9 t/ha) for the three rice varieties under the investigation while lowest grain yield (3.0 t/ha) was recorded at 30 x10 spacing. Haque *et al.* (2015) Indicated that the highest plant height, number of tillers and effective tillers/hills and grains /panicle was obtained in the widest spacing of 25x20 cm resulting the highest grain yield followed by 20 x20 cm. On the other hand, the narrow spacing of 20x15 cm produced the lowest values of the above mentioned plant characterizes and showed the lowest grain yield.

The objective of this investigation is to study the effect of different nitrogen levels and plant spacing on the productivity of new released varieties in Egypt.

MATERIALS AND METHODS

Two field experiments were conducted at the farm of Sakha Research Station, Kafrelsheikh, Egypt in 2016 and 2017 rice seasons to study the performance of some rice genotypes under both different plant spaces and various nitrogen levels. Rice varieties i.e. SP70 (Sakha108), GZ9461, GZ7112 and GZ9057 (Giza 179) were used and cultivated under three spaces namely 15x20, 20x20 and 25x20 cm with three nitrogen levels i.e. T_1: control (without N-application), T_2: 110 and T_3: 165 Kg N/ha. Statistical design of the experiment was split-split plot design. Rice varieties were applied in the main plots and plant space were allocated in the sub plots, while sub sub plots received nitrogen levels.

Nursery area was identified and well prepared as recommended according to Rice Research and Training Center (RRTC). Phosphorus fertilizer (34.30 kg P/ha) as a single superphosphate (15 %)was applied during land preparation and nitrogen fertilizer (78.9 kg N/ha) as urea was applied after well dry leveling and the nursery immediately irrigated while, zinc as zinc sulphate at the rate of 23.8 kg/ha was added in the nursery after wet leveling. The pre-germinated seeds (soaked 24 hours and incubated 48 hr.) were broadcasted in the nursery on 5^{th} and 8^{th} of may in 2016 and 2017 rice seasons.

The permanent field area was prepared the same as nursery. Phosphorus fertilizer as form of single super phosphate (15%) at the rate of 36 kg P_2O_5/ha and potassium as form of potassium sulphate (48% K_2O) at the rate of 57 kg K_2O/ha were applied during land preparation. Nitrogen levels in the form of urea (46.5%N) was added to plots according to the recommendation (165 kg N ha^{-1}) in two splits application, i.e. two thirds as basal and incorporated into the soil immediately before flooding, followed by the on third after 30 days from the first dose. Seedling were bulled and transferred from nursery to the permanent field after 25 days from sowing and transplanted according the different spaces of the experiment (15 x 20, 20 x 20 and 20 x 25 cm) between rows and hills.

Seven days after transplanting, the herbicide Saturn 50% at the rate of 4.8 L ha^{-1} was mixed with enough amount of sand to make it easy for homogenous distribution to controlled the weeds. The plot size was 12 m^2 (3 x 4 m^2).The chlorophyll content of flag leaf using (SPAD) chlorophyll meter Minolta camera Co. Ltd., Japan. Five leaves were randomly collected and measured from the widest part of the leaf of the main culm and repeated four times randomly inside the plot and recorded the average. Plant height at maturity (cm) was measured randomly in 5 hills per plot from the soil surface to the tip of the panicle of each hill. Number of tillers and panicles/hill was counted randomly in 5 hills for each plot. Number of filled grains per panicle was counted in5 main panicles which collected randomly, then recorded the average in each plot. Panicle length (cm) was estimated from panicle base up to top of panicle in five panicles and the weight of both panicle and 1000-grain was recorded. Grain yield was determined from central 5 m^2 in each plot and kept for three days in the plots then threshed to separate both grain and straw. The weight of grains was recorded and adjusted to 14 % moisture content according to IRRI, (1996). The grain and straw yield of each plot were computed and transferred to ton/ha. All the data were collected and subjected to statistical analysis following the procedure described by Gomez and Gomez (1984) using the computer software (IRRISTAT).

Table 1. Soil physical and chemical analyses of the experimental soil before planting in 2016 and 2017 seasons

Soil physical and chemical	2016 season	2017 season
Soil texture (%)	Clayey	Clayey
Clay %	57.00	54.00
Sand %	11.00	11.00
Silt %	32.00	35.00
pH (1:2.5)	8.25	8. 38
Ec (ds/m)	3.15	3.41
Organic matter %	1.30	1.37
Total nitrogen mg/kg	440.00	520.00
Available P, mg/kg (0.5 M NaHCO3)	12.90	17.00
Available Ammonium (ppm) Available	16.00	17.30
Nitrate (ppm)	12.50	13.60
Available Potassium (ppm)	315.00	340.80
Anions (meq/l)		
$CO_3^=$	--	--
HCO_3	7.50	7.00
Cl-	8.16	9.70
$SO_4^=$	17.23	17.20
Cations(meq/l)		
Ca	11.00	10.88
Mg	4.00	5.00
Na	2.89	3.00
K	15.00	15.02

RESULTS AND DISCUSSION

Chlorophyll content:

Data in Table 2 show that the rice genotypes significantly differed in their chlorophyll content in flag leaf. GZ7112 gave the greatest chlorophyll content followed by SP70, while GZ9057 gave the lowest value in this aspect. The differences among the tested rice genotypes in chlorophyll content of their flag leaf might be due to genetic background. These results are agreement with those obtained by Sedeek *et al.* (2009) and Abd Alla (1996) who reported that the differences among the rice varieties in chlorophyll content may be attributed to nature of the varieties, which is mainly affected by genetic and partially by the environmental factors such as fertilizer, soil and climatic condition.

Regarding to the plant spaces data in the same table revealed that the space of 25x20 cm produced the greatest chlorophyll content in flag leaf followed by 20x20 cm while the space 15x20 cm gave the lowest value in this respect. These increases might be due to minimizing the competition among the plants which cause an increase in the uptake of nutrient that led to increase flag leaf area and the biosynthesis of chlorophyll as a result to the increase in the absorption of N and Mg as constituent nutrients in chlorophyll structure.

As for the effect of N-levels, data also demonstrated that the application of 165 kg N/ha gave the highest value of chlorophyll in flag leaf followed by 110 kg N/ha, while control treatments gave the least. It could be attributed to the role of nitrogen for the biosynthesis of chlorophyll. These results were hold true in the two studied seasons.

Table 2. Chlorophyll content of flag leaf, number of tillers /hill and number of panicles/hills as affected by plant spacing (cm) and nitrogen levels (kg N/ha) of some different rice genotypes during 2016 and 2017 seasons.

Treatments	Chlorophyll content of flag leaf (SPAD)		number of tillers /hills		number of panicles/hills	
	2016	2017	2016	2017	2016	2017
Rice genotypes(A)						
SP70	39.18ab	39.52ab	10.192 b	11.742b	9.298c	10.628c
GZ9461	39.08bc	39.42bc	11.111a	12.661a	10.448a	11.839a
GZ7112	39.72a	40.05a	10.537 b	12.087b	9.735bc	11.065bc
GZ9057	38.54c	38.88c	10.552 b	12.102b	9.893b	11.284b
F-Test	*	*	*	*	*	*
Plant spaces (B)						
15 x 20	37.41c	37.64c	9.677 c	11.227c	8.970b	10.346b
20 x 20	39.36b	39.69b	10.793b	12.343b	10.114a	11.444a
25 x 20	40.62a	41.07a	11.324a	12.874a	10.446a	11.822a
F-Test	**	**	**	**	**	**
N-Levels(C)						
control	35.37c	35.71c	8.325 c	9.875c	7.952c	9.373c
110 kg N/ha	39.16b	39.50b	10.628b	12.178b	9.944b	11.274b
165 kg N/ha	42.86a	43.20a	12.841a	14.391a	11.635a	12.965a
F-Test	**	**	**	**	**	**
Interaction						
A x B	*	*	*	*	*	*
A x C	*	*	*	*	*	*
B x C	**	**	**	**	**	**
Ax B x C	NS	NS	NS	NS	NS	NS

Whereas: control= without nitrogen fertilizer, SP70: Sakha 108 and GZ9057: Giza179

The chlorophyll content in flag leaf as influenced by the interaction between the tested rice varieties and different plant spaces is presented in Table 3. Data clarified that the spaces either 20x20 or 20x25 cm produced the highest chlorophyll content in flag leaf with all the tested varieties except GZ9057 which gave the maximum value under the space of 25x20 cm only. The space of 15x20 cm gave the lowest chlorophyll content in flag leaf with all the tested rice varieties. It might be due to the wider spaces caused a reduction in the competition among the roots and shoots which increase the nutrient uptake and penetration of light through the leaves that led to increase in the biosynthesis of chlorophyll.

Table 3. Chlorophyll content of flag leaf as affected by the interaction between some different rice genotypes and plant spaces (cm) in 2016 and 2017 studied seasons.

Plant Space (cm)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
15 x 20	37.59cd	37.63cd	38.02bcd	36.39d	37.83cd	37.86cd	38.26bcd	36.62d
20 x 20	39.75a	39.54ab	40.01a	38.14bc	40.09a	39.87ab	40.34a	38.47bc
25 x 20	40.20a	40.07a	41.12a	41.11a	40.64a	40.52a	41.56a	41.55a

Whereas: control= without nitrogen fertilizer, SP70: Sakha 108 and GZ9057: Giza179

Chlorophyll content of flag leaf as influenced by the interaction between the tested rice genotypes and nitrogen levels in 2016 and 2017 rice seasons is presented in Table4. Data pointed out that all rice varieties under study produced the greatest chlorophyll content in its flag leaf when received the highest level of nitrogen treatment (165 kg N/ha) while, the lowest value of chlorophyll content in flag leaf of the tested rice genotypes were observed under control treatment (without any nitrogen application). The increases in chlorophyll content of flag leaf in the tested rice varieties might be due to the application of the adequate amount of nitrogen enhance and increase the activity of chlorophyll biosynthesis due to the increase in the activity of chlorophyllase enzyme. Also, nitrogen nutrient is one of the main constituents in chlorophyll structure.

Table 4. Chlorophyll content of flag leaf (as affected by the interaction between some different rice genotypes and nitrogen levels (kg N/ha) in 2016 and 2017 seasons.

Nitrogen Levels (Kg N/ha)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
Control	35.89d	35.41d	35.67d	34.52d	36.23d	35.75d	36.01d	34.85d
110 kg N	39.14bc	39.15bc	40.32b	38.03c	39.48bc	39.49bc	40.66b	38.37c
165 kg N	42.51a	42.69a	43.16a	43.09a	42.84a	43.02a	43.49a	43.43a

Whereas: control= without nitrogen fertilizer, SP70: Sakha 108 and GZ9057: Giza179

As for the interaction between plant spaces and nitrogen levels in chlorophyll content of flag leaf. Data in Table5 indicated that the combination of the wider space 25x20 cm with either 165 kg N/ha or 110 kg N/ha gave the highest value in this aspect followed by the space 20x20 cm when combined with 165 kg N/ha in the two studied seasons. While, the lowest value of chlorophyll content in flag leaf was obtained when the space of 15x20 cm was combined with control (without any N-application). The increases in chlorophyll content of flag leaf due to the combination of wider spaces with either 165 kg N/ha or 110 kg N/ha could be attributed to the decrease in competition among both the roots and shoots of plants under the wider spaces although the increase in the growth of both shoots and roots due to the application of nitrogen fertilizer. Also, the increase in chlorophyll content due to nitrogen application might be due to the role or nitrogen increase the absorption of most of other nutrients such as potassium and magnesium. Nitrogen and magnesium are constituent nutrients in chlorophyll molecular and potassium as co-factor for enzyme activate the chlorophyllase enzyme which increase the biosynthesis of chlorophyll.

Table 5. Chlorophyll content of flag leaf as affected by the interaction between plant spaces (cm) and nitrogen levels (kg N/ha) in 2016 and 2017 seasons.

Plant Space (cm)	Nitrogen Levels Kg N/ha					
	2016			2017		
	Control	110 kg N/ha	165 kg N/ha	Control	110 kg N/ha	165 kg N/ha
15 x 20	33.00f	37.68e	41.54d	33.24f	35.93e	37.96d
20 x 20	35.60cd	38.85c	43.63b	37.92cd	39.18c	41.39b
25 x 20	37.51b	40.95a	43.41a	41.77b	43.96a	43.85a

Number of tillers and panicles /hill:

As for number of tillers and panicles/hill, data in Table 2 indicated that the rice varieties are significantly differed in their abilities in producing tillers and panicles/hill. These might be due to the differences in the genetic background among them. GZ9461 rice line gave the highest values of both number of tillers and panicles followed by GZ9057 (Giza179). SP70 (Sakha108) variety recorded the lowest values without any significant difference with the rice genotype GZ7112.

Concerning the effect of plant spacing on each of number of tillers and panicles /hill, the spacing of 25 x 20 cm gave the highest values of both tillers and panicles/hill followed by the space of 20 x 20 cm, while, the plant spacing of 15 x 20 cm gave the lowest values in the two studied characters in the both seasons. High level of nitrogen 165 kg N /ha, recorded the highest values of tillers and panicles/hill. On the other hand, the lowest values of tillers and panicles were recorded without nitrogen application Table2. Metwally *et al.* (2017) reported that the application of nitrogen fertilizer at the rate of 165 kg N/ha increased the number of panicles per hill.

Number of tillers/hill as influenced by the interaction between the tested rice genotypes and the different plant spaces are presented in Table 6. Data clarified that using the wider space 25x20 cm with rice line GZ9461 produced the greatest number of tillers followed by the space of 20x20 cm with the same rice line and GZ7112 under the space of 25x20 cm in the two studied seasons because of the previous two different rice genotypes have high ability for producing more number of tillers than the other tested varieties or lines, so the wider spaces are suitable for these lines to give its maximum number of tillers. It can be observed that the combination of SP70 with the narrows space 15x20 cm gave the least.

Table 6. Number of tillers/hill as affected by the interaction between some different rice genotypes and plant spaces (cm) in 2016 and 2017 studied seasons.

Plant space (cm)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
15 x 20	9.514d	9.861d	9.541d	9.790d	11.064d	11.411d	11.091d	11.340d
20 x 20	10.175cd	11.222b	10.902bc	10.875bc	11.725cd	12.772b	12.452bc	12.425bc
25 x 20	10.888bc	12.250a	11.166b	10.990bc	12.438bc	13.800a	12.716b	12.540bc

Data in Table 7demonstrated that, fertilized all the different rice genotypes under study by the highest level of nitrogen (165 kg N/ha) gave the greatest values number of tillers followed by the application of 110 kg N/ha with the same tested rice genotypes in the two seasons. It means that all the different rice genotypes under study responded to the same level of nitrogen (165 kg N/ha).

Table 7. Number of tillers/hill as affected by the interaction between some different rice genotypes and nitrogen levels (kg N/ha) in 2016 and 2017 seasons

Nitrogen Levels (Kg N/ha)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
control	7.661 d	8.931c	8.194cd	8.513c	9.211d	10.481c	9.744cd	10.063c
110 kg N	10.361b	11.195b	10.611b	10.346b	11.911b	12.745b	12.161b	11.896b
165 kg N	12.555a	13.207a	12.805a	12.795a	14.105a	14.757a	14.355a	14.345a

Regarding to the interaction between plant spacing and nitrogen levels in number of tillers, data in Table 8 revealed that the wider space 25 x20 cm when combined with 165 kg N/ha gave the highest values of number of tillers/hill followed by the space of 20x20 cm under the same level of nitrogen, while the narrowing space of 15 x 20 cm gave the lowest values of number of tillers/hill when combined with control treatment. These results are similar with those obtained by Abd EL-Hamed (2002) and Sorour *et al.* (2016).

Table 8. Number of tillers/hill as affected by the interaction between plant spaces (cm) and nitrogen levels (kg N/ha) in 2016 and 2017seasons.

Plant space (cm)	Nitrogen Levels kg N/ha					
	2016			2017		
	Control	110 kg N/ha	165 kg N/ha	Control	110 kg N/ha	165 kg N/ha
15 x 20	7.802f	9.458d	11.770c	9.352f	11.008d	13.320c
20 x 20	8.474ef	11.104c	12.802b	10.024ef	12.654c	14.352b
25 x 20	8.698e	11.323c	13.950a	10.248e	12.873c	15.500a

Number of panicles as affected by the interaction between different rice genotypes and plant spacing is presented in Table 9. The highest number of panicles were found when GZ9461 line was combined with the space of 25x20 cm followed by 20x20 cm with the same line, while the combination of SP70 line with the space of 15x20 cm gave the least. The increases in number of panicles under wider spaces with the same of varieties or lines could be attributed to the decline in the competition among the plants which has high tillering ability. Also, minimizing the competition among these varieties or lines cause enhancements for the initiation of panicle primordia that increase the number of panicles. These results are in harmony with those obtained by Abd EL-Hamed (2002) and Sorour *et al.* (2016).

Table 9. Number of panicles /hill as affected by the interaction between some different rice genotypes and plant spaces (cm) in 2016 and 2017seasons.

Plant space (cm)	Rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
15 x 20	8.730f	9.231ef	8.758f	9.160ef	10.060f	10.745ef	10.088f	10.490ef
20 x 20	9.475d-f	10.562b	10.112b-d	10.308b-d	10.805d-f	11.892b	11.442b-d	11.638b-d
25 x 20	9.688cde	11.550a	10.336bc	10.210b-d	11.018cde	12.880a	11.666bc	11.723b-d

Number of panicles as influenced by the interaction between some different rice genotypes and nitrogen levels in 2016 and 2017 rice seasons is presented in Table 10. Data demonstrated that combination each of the tested rice varieties or lines with either 165 kg N/ha or 110 kg N/ha caused an increase in number of panicles as compared with combination of the same tested varieties with control treatment in the two studied seasons. The greatest number of panicles were found when all varieties except SP70 combined with 165 kg N/ha. It could be attributed to the application of the adequate amount of nitrogen for these varieties beside the role of nitrogen in increase the number of panicle primordia consequently increase the number of panicles. These results are coincidence with that recorded by Abd Alla (1996), Abd EL-Hamed (2002); Koutroubas and Ntanos (2003) and Sorour, *et al.,* (2016).

Table 10. Number of panicles /hill as affected by the interaction between some different rice genotypes and nitrogen levels (kg N/ha) in 2016 and 2017 seasons.

Nitrogen Levels (kg N/ha)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
Control	7.211h	8.718f	7.577gh	8.300fg	8.541h	10.231f	8.907gh	9.813fg
110 kg N	9.578 e	10.485cd	10.077e	9.636e	10.907e	11.815cd	11.407e	10.966e
165 kg N	11.105bc	12.141a	11.551ab	11.742ab	12.435bc	13.471a	12.881ab	13.072ab

Data in Table11present the effect of the interaction between plant spacing and nitrogen levels in number of panicles in 2016 and 2017 seasons. Data indicated that the combination of wider spaces i.e. 25x20 cm and 20x20 cm with either 165 or 110 kg N/ha caused an increase in number of panicles as compared with the same spaces when combined with control. The greatest number of panicles were observed when the space of 25 x20 cm was combined with 165 kg N/ha followed by the space of 20 x20 cm when combined with 110 kg N/ha while, the lowest number of panicles were found when the space of 15 x20 cm was combined with control treatment. The increases in number of panicles under the combination of nitrogen under study with wider spaces might be due to the role of nitrogen for increasing the growth of plant roots and shoots (plant canopy) that need wide spaces to minimizing the competition among the plants specially the varieties or line which have ability for produced high number of tillers. Also, the application of nitrogen cause enhancement for the growth of initiation of panicle primordia that led to increase the number of panicles. These results are in harmony with those reported by Metwally, *et al*., (2011); Metwally, *et al*., (2010); and Manjappa and Shailaja (2014).

Table 11. Number of panicles /hill as affected by the interaction between plant spaces (cm) and nitrogen levels (kg N/ha) in 2016 and 2017 seasons.

Plant space (cm)	Nitrogen Levels kg N/ha					
	2016			2017		
	Control	110 kg N/ha	165 kg N/ha	Control	110 kg N/ha	165 kg N/ha
15 x 20	7.442e	8.743d	10.725c	8.910e	10.073d	12.055c
20 x 20	8.199d	10.514c	11.629b	9.529d	11.844c	12.959b
25 x 20	8.213d	10.575c	12.550a	9.681d	11.905c	13.880a

Plant height, panicle weight and panicle length:

Main effects for plant height, panicle weight and panicle length are presented in Table 12. Data showed that the rice varieties significantly varied in plant height, panicle weight and panicle length. As for plant height, SP70 and GZ7112 recorded the tallest plants followed by GZ9057 in 2016 and 2017 while; GZ9461 recorded the lowest value in this aspect in the both seasons. The plant spacing of 25 x 20cm gave the tallest plant followed by 20x20cm. While, the plant spacing of 15 x20cm recorded the lowest value in this respect. Data in the same table indicated that the application of the highest level of nitrogen under study (165 kg N/ha) produced the tallest plants followed by 110 kg N/ha, while the control treatments gave the least in the two studied seasons. This might due to the role of nitrogen for improving rice growth, as the result to increase the cell division and elongation of the internode. These results are in harmony with obtained by Metwally *et al.* (2011).

Table 12. Plant height (cm), panicle weight (g) and panicle length (cm) as affected by plant spacing (cm) and nitrogen levels (kg N/ha) of some different rice genotypes during 2016 and 2017 seasons.

Treatments	Plant height (cm)		Panicle weight (g)		Panicle length (cm)	
	2016	2017	2016	2017	2016	2017
Rice genotypes(A)						
SP70	99.23a	100.95a	3.778a	3.872a	21.546a	22.045a
GZ9461	91.76c	93.48c	3.516b	3.610b	21.673a	22.172a
GZ7112	98.06a	99.78a	3.688a	3.782a	21.239b	21.738b
GZ9057	96.51b	98.23b	3.721a	3.815a	21.642a	22.141a
F-Test	**	**	**	**	**	**
Plant space(B)						
15 x 20	94.03c	95.56c	3.431c	3.525c	21.018c	21.517c
20 x 20	96.65b	98.40b	3.908a	4.002a	21.555b	22.054b
25 x 20	98.49a	100.37a	3.688b	3.782b	22.002a	22.501a
F-Test	**	**	**	**	**	**
N-Levels(C)						
Control	89.23c	90.95c	3.014c	3.078c	20.	20.462c
110 kg N/ha	96.94b	98.66b	3.711b	3.806b	1.637b	22.103b
165 kg N/ha	102.99a	104.71a	4.303a	4.426a	22.840a	23.506a
F-Test	**	**	**	**	**	**
Interaction						
A x B	*	*	*	*	*	*
A x C	*	*	*	*	*	*
B x C	**	**	**	**	**	**
Ax B x C	NS	NS	NS	NS	NS	NS

Whereas: control= without nitrogen fertilizer, SP70: Sakha 108 and GZ9057: Giza179

Plant height as influenced by the interaction between different rice genotypes and plant spaces in 2016 and 2017 seasons is presented in Table 13. Data revealed that planted SP70 rice genotype under the space of 25x20 cm gave the tallest plant followed by GZ7112 and GZ9057 under the same space and both SP70 and GZ7112 rice genotypes under the space of 20x20 cm.

On contrast GZ9057 line gave the shorted plant when planted under the space of 15x20 cm. it could be attributed to the differences in the genetic constitution among the tested different genotypes. Similar results were observed in the two seasons under study. These results are in harmony agreement with those reported by Metwally, *et al*., (2011); Metwally, *et al*., (2010); and Manjappa and Shailaja (2014).

Table 13. Plant height (cm) as affected by the interaction between some different rice genotypes and plant spaces (cm) in 2016 and 2017 seasons.

Plant Space (cm)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ.9057	SP70	GZ9461	GZ7112	GZ9057
15 x 20	97.58bc	89.89f	95.00cd	93.64de	99.11bc	91.42f	96.53cd	95.17de
20 x 20	99.36ab	91.75ef	99.17ab	96.30c	101.11ab	93.50ef	100.92ab	98.05c
25 x 20	100.75a	93.63de	100.00ab	99.58ab	102.63a	95.51de	101.88ab	101.46ab

The interaction between the different rice genotypes and nitrogen levels in plant height is present in Table 14. Data demonstrated that the tallest plant was found when SP70 rice line was combined with the highest level of nitrogen under study (165 kg N/ha) followed by GZ7112 line under the same nitrogen level, while the lowest plant height was observed when GZ9461 rice line planted under control treatment in the two studied seasons. It might be due to the differences among the tested genotypes in their requirements for nitrogen. These results agree with those reported by Salem (2006); Sedeek, *et al*., (2009) and RRTC (2012).

Table 15 present the effect of interaction between nitrogen levels and plant spaces in plant height in 2016 and 2017 seasons. Data clarified that the combination of the spaces of 25 x 20 cm with the highest level of nitrogen under study (165 kg N/ha) produced the tallest plants followed by either the combination of the spaces of 20 x 20 cm or 15x20 cm with the same level of nitrogen, while the lowest value of plant height was observed when the space of 15 x 20 cm combined with control treatment in the two studied seasons. It might be due to the minimizing in the competition among the tested genotypes under wider spaces and the role of nitrogen for increasing the plant growth as a result to increase the number of plant cells (cell division) and its elongation. These results agree with those reported by Salem (2006); Sedeek, *et al*., (2009) and RRTC (2012).

Table 14. Plant height (cm) as affected by the interaction between some different rice genotypes and nitrogen levels (kg N/ha) in 2016 and 2017 studied seasons.

Nitrogen Levels (kg N/ha)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
Control	92.25e	83.10f	90.69e	90.89e	93.97e	84.82f	92.41e	92.61e
110 kg N	100.05c	91.47e	99.47c	96.78d	101.77c	93.19e	101.19c	98.50d
165 kg N	105.39a	100.70c	104.00ab	101.86bc	107.11a	102.41c	105.72ab	103.58bc

Table 15. Plant height (cm) as affected by the interaction between plant spaces (cm) and nitrogen levels (kg N/ha) in 2016 and 2017 studied seasons.

Plant space (cm)	Nitrogen Levels Kg N/ha					
	2016			2017		
	Control	110 kg N	165 kg N	Control	110 kg N	165 kg N
15 x 20	85.60f	95.33d	101.15b	87.13f	96.86d	102.68b
20 x 20	90.12e	97.08cd	102.73b	91.87e	98.83cd	104.48b
25 x 20	91.97e	98.42c	105.08a	93.85e	100.30c	106.96 a

Panicle weight (g):

Panicle weight of the tested rice genotypes as influenced by different plant spaces and nitrogen levels is presented in Table 12. Data revealed that all the different lines and varieties produced the same greatest weight of panicle except GZ9461 which gave the least. The results are hold true in the two studied seasons. It could be attributed to the differences among the different rice genotypes in their genetic constitution. The space of 20x20 cm gave the highest weight of panicle followed by 25x20 cm in the two seasons. It means that the medium and wider spaces are suitable than the narrow space. It might be due to the maximizing of light penetration which increase the photosynthesis and it assimilates. Data in the same table also clarified that the highest nitrogen level (165 kg N/ha) under study gave the heaviest panicle followed by the application of 110 kg N/ha, while the control treatment produced the lowest value in this respect in the two seasons. The increases in panicle weight under the highest level of nitrogen under study might be due to the role of adequate amount of nitrogen for increasing the plant growth, photosynthesis and dry matter production or metabolites that translocate to the panicle resulted in increases in panicle weight. These results are harmony with those obtained by Metwally *et al.* (2011), Metwally *et al.* (2017) and Yoseftabar (2013), they reported that the raising nitrogen level up to 165 kg N/ha significantly increased panicle weight.

Data in Table 16 demonstrated that the space of 20x20 cm produced the heaviest weight of panicle of all the studied varieties without any significant difference with 25x20 cm space when combined with SP70 rice genotype in the two studied seasons. It is depending on the tillering ability and the canopy of each of the studied varieties. It can be easily observed that SP70 responded to the wider and medium space while the other tested varieties responded to the medium space only. It could be attributed to minimizing the competition under the medium space 20x20 cm and maximizing the penetration of light through the plant canopy consequently increase the photosynthesis process and its assimilates resulted in increased filling rate and percentage that increase the weight of panicle. It can be concluded that the best space was 20x20 when combined with each of the tested varieties. These results are in accordance with those obtained by Abd Alla (1996), Abd EL-Hamed (2002);and Koutroubas and Ntanos (2003).

Table 16. Panicle weight (g) as affected by the interaction between some different rice genotypes and plant spaces (cm) in 2016 and 2017 seasons.

Plant space (cm)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
15 x 20	3.426cd	3.295d	3.462cd	3.543b-d	3.520cd	3.389d	3.556cd	3.637b-d
20 x 20	3.947a	3.778ab	3.963a	3.947a	4.041a	3.872ab	4.057a	4.041a
25 x 20	3.962a	3.477cd	3.641bc	3.672bc	4.056a	3.571cd	3.735bc	3.766bc

Data in Table 17 present the effect of interaction between different rice genotypes and nitrogen levels. The data pointed out that combination of either 110 kg N/ha or 165 kg N/ha with each of rice genotype under study caused an increase in the weight of panicle in the two studied seasons as compared with control when combined of each of the tested genotypes. The combination of SP70 variety with 165 kg N/ha produced the heaviest panicle followed by GZ 9057 different rice genotypes when combined with the same level of nitrogen without any significant difference between them. It might be due to the application of 165 N/ha was adequate amount for the requirement of the previous two different rice genotypes. The lowest value in this aspect was observed when GZ9461 rice line was combined with control treatment. It means that the tested rice genotypes were differ in their requirement of nitrogen due to the difference in their genetic constitutions.

Data in Table 18 is present the interaction between nitrogen levels and different plant spaces in panicle weight. The combination of either 110 or 165 kg N/ha with each of the tested spaces caused an increase in panicle weight as compared with control treatment when combined with the same spaces under study. The greatest weight of panicle was found when the spaces of 20x20 cm was combined with the highest level of nitrogen under study in the two studied seasons, followed by the space of 25x20 cm when combined with the same level of nitrogen. This increase might be due to the minimizing in the competition among the plants and increase the adequate amount of light penetrated through the plant canopy consequently increase the filling rate and percentage that cause an increase in the weight of panicles. The lowest value of panicle weight was observed when the space of 15x20 cm was combined with control treatment (without any nitrogen fertilizer).

Table 17. Panicle weight (g) as affected by the interaction between some different rice genotypes and nitrogen levels (kg N/ha) in 2016 and 2017 seasons.

Nitrogen Levels (kg N/ha)	Different rice genotypes 2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
Control	3.070d	2.816e	3.176d	2.993de	3.134d	2.880e	3.240d	3.057de
110 kg N	3.811c	3.564c	3.685c	3.785c	3.906c	3.659c	3.780c	3.880c
165 kg N	4.453a	4.169b	4.204b	4.384ab	4.576a	4.292b	4.327b	4.507ab

Table 18. Panicle weight (g) as affected by the interaction between plant spaces (cm) and nitrogen levels (kg N/ha) in 2016 and 2017 studied seasons.

Plant Space (cm)	Nitrogen Levels Kg N/ha 2016			2017		
	Control	110 kg N	165 kg N	Control	110 kg N	165 kg N
15 x 20	2.865g	3.455e	3.974c	2.929g	3.550e	4.097c
20 x 20	3.063fg	4.012c	4.651a	3.127fg	4.107c	4.774a
25 x 20	3.113f	3.667d	4.283b	3.177f	3.762d	4.406b

Data in Table 19 reveal that there were significant differences among the combination of the tested rice genotypes with three plant spaces under study. The combination of each of the varieties with either the spaces of 20x20 or 25x20 cm produced the tallest panicle as compared with the combination of narrow space 15x20 cm with each of the same genotypes under study. The tallest panicle was observed when the wider space of 25x20 cm was combined with either GZ9461 or GZ9057 rice lines in the two studied seasons. This increase might be due to the minimizing in competition among the roots of the two tested varieties that increase the uptake of nutrients especially N, P and K which cause an increase in cell division and elongation in panicles during panicles growth period.

Table 19. Panicle length (cm) as affected by the interaction between some different rice genotypes and plant spaces (cm) in 2016 and 2017 seasons.

Plant Space (cm)	Different rice genotypes 2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
15 x 20	21.161cd	20.928d	20.817d	21.167cd	21.660cd	21.426d	21.316d	21.666cd
20 x 20	21.652bc	21.692bc	21.225cd	21.650bc	22.151bc	22.191bc	21.724cd	22.149bc
25 x 20	21.825b	22.400a	21.675bc	22.108ab	22.324b	22.899a	22.174bc	22.607ab

Data in Table 12 indicated that all the tested genotypes gave the same highest length of panicle except GZ7112 rice genotype which gave the least. The wider space of 25 x 20 cm produced the tallest panicle followed by medium space (20 x 20 cm) while, the space of 15 x 20 cm gave the lowest value in this aspect. The application of 165 kg N/ha gave the highest length of panicle followed by 110 kg N/ha whereas, the control gave the lowest value in two studied seasons.

Panicle length as influenced by the interaction between tested rice genotypes and nitrogen levels is presented in Table 20.Data clarified that the combination between either 110 or 165 kg N/ha with each of the tested rice genotypes caused a significant increase in panicle length as compared with control when combined with each of the same genotypes. The tallest panicle was found when the application of 165 kg N/ha combined with each of the genotypes under study without any significant difference among them. It means that 165 kg N/ha is adequate enough for the nitrogen requirements of all the tested genotypes growth involved panicle. These results were hold true in the two studied seasons. These results are in accordance with those obtained by Abd Alla (1996), Abd EL-Hamed (2002);and Koutroubas and Ntanos (2003).

Table 20. Panicle length (cm) as affected by the interaction between some different rice genotypes and nitrogen levels (kg N/ha) in 2016 and 2017 seasons.

Nitrogen Levels (kg N/ha)	Different rice genotypes 2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
Control	20.189d	20.575d	19.508e	20.117d	20.554d	20.940d	19.873e	20.482d
110 kg N/ha	21.597bc	21.753bc	21.308c	21.892b	22.063bc	22.218bc	21.774c	22.358b
165 kg N/ha	22.852a	22.692a	22.900a	22.917a	23.518a	23.358a	23.566a	23.583a

Data in Table 21 demonstrated that there was significant difference among the combination of nitrogen levels and plant spaces. Application of either 110 or 165 kg N/ha and combined with each of medium of space 20x20 cm or wider space 25x20 cm significantly increased the length of panicle as compared with the narrow space of 15x20 cm when combined with the same nitrogen levels. The highest value of panicle length was observed when the wider space of 25x20 cm was combined with the highest nitrogen level (165 kg N/ha) in the two studied seasons. It might be due to minimizing the competition among plant roots which led to the increase in the efficiency of nitrogen uptake consequently increase the growth in the length of panicle during panicle growth period. These results are in accordance with those obtained by Abd Alla (1996), Abd EL-Hamed (2002) and Koutroubas and Ntanos (2003).

Table 21. Panicle length (cm) as affected by the interaction between plant spaces (cm) and nitrogen levels (kg N/ha) in 2016 and 2017 seasons.

Plant space (cm)	Nitrogen Levels kg N/ha					
	2016			2017		
	Control	110 kg N	165 kg N	Control	110 kg N	165 kg N
15 x 20	19.411g	21.256d	22.388e	19.776g	21.722d	23.053e
20 x 20	20.213f	21.606cd	22.845bc	20.577f	22.072cd	23.511bc
25 x 20	20.669e	22.050a	23.288a	21.034 e	22.516a	23.953a

Number of filled grains/panicle, 1000-grain weight, grain and straw yields:

The main effects of number of filled grains/panicle, 1000-grain weight, grain and straw yield are presented in Table 22. The rice line GZ9057 gave the highest number of filled grains/panicle followed by GZ7112 and SP70 rice genotype while, GZ9461 gave the lowest value of filled grains. For 1000-grain weight, SP70 exhibited the heaviest 1000-grain weight, followed by GZ9461, GZ 7112 and GZ 9057 which gave nearly the same value without any significant differences among the min two studied seasons.

Table 22. Number of filled grains /panicle, thousand grain weight (g), grain yield t/ha and straw yield t/ha as affected by plant spacing (cm) and nitrogen levels (kg N/ha) of some different rice genotypes during 2016 and 2017 seasons.

Treatments	Number of filled grains /panicle		Thousand grain weight (g)		Grain yield (t/ha)		Straw yield (t/ha)	
	2016	2017	2016	2017	2016	2017	2016	2017
Different rice genotypes(A)								
SP70	113.95b	115.75b	26.881a	27.147a	9.671a	9.898a	11.074b	11.302b
GZ9461	107.51c	109.31c	25.159b	25.415b	9.750a	9.977a	11.243b	11.471b
GZ7112	117.41b	119.21b	25.190b	25.456b	8.662c	8.890c	11.297b	11.524b
GZ9057	122.85a	124.66a	25.237b	25.503b	9.261b	9.489b	11.613a	11.840a
F-Test	**	**	**	**	**	**	**	**
Plant space(B)								
15x20	110.00 c	111.66c	25.342c	25.608c	8.851c	9.078c	11.417a	11.645a
20x20	115.89 b	117.87b	25.613b	25.879b	9.279b	9.527b	11.494a	11.721a
25x20	120.40 a	122.17a	25.89a	26.153a	9.878a	10.084a	11.009b	11.237b
F-Test	**	**	**	**	**	**	**	**
N-Levels(C)								
Control	87.13c	88.94c	26.797a	27.063a	7.009c	7.147c	9.768c	9.906c
110 kg N/ha	119.75b	121.55b	25.780b	26.046b	9.825b	10.025b	11.661b	11.861b
165 kg N/ha	139.41a	141.21a	24.273c	24.532c	11.173a	11.517a	12.491a	12.836a
F-Test	**	**	**	**	**	**	**	**
Interaction								
A*B	*	*	*	*	*	*	*	*
A*C	*	*	*	*	*	*	*	*
B*C	**	**	**	**	**	**	**	**
A*B*C	NS	NS	NS	NS	NS	NS	NS	NS

Whereas: control= without nitrogen fertilizer, SP70: Sakha 108 and GZ9057: Giza179

Regarding to grain yield both rice genotypes i.e. GZ9461 and SP70 produced the highest grain yield followed by GZ9057 rice genotype while, GZ7112 gave the lowest value in this aspect in the both studied seasons.

The rice variety GZ9057 (Giza179) recorded the highest straw yield followed by the other tested rice varieties which gave nearly the same straw yield without any significant differences among them. The plant space of 25 x 20 cm gave the highest values of number of filled grains /panicle and 1000-grain weight followed by the space of 20 x 20 cm, while the narrow space 15 x 20 cm gave the least. Data in the same table 22 showed that the wider space 25 x 20cm produced the greatest grain yield, While, the narrow spacing 15 x20cm gave the lowest values of grain yield. Both the space of 15 x 20cm and 20 x 20 cm produced the greatest straw yield, while the wider space 25 x 20 cm gave the least. Regarding to the effect of nitrogen levels, the application of 165 kg N/ha gave the greatest grain yield followed by 110 kg N/ha, while control treatment gave the lowest values in all the previously mentioned characters except 1000-grain weight which reached to its maximum value under control treatments, while the lowest value was found with the highest N-levels under study. These results are agreed with those obtained by Abd EL-Hamed (2002) and Sorour *et al*. (2016).

Data in Table 23 indicated that there was a significant difference in the interaction between the tested rice genotypes and plant spaces in number of filled grain.

The combination of either the medium space 20x20 or wider space 25x20 cm with each of all the tested genotypes under study caused an increase in number of filled grain as compared with the combination of the narrow space 15 x 20 cm with the same rice genotypes. The lowest number of filled grains were observed when GZ9461 was cultivated under the narrow (15x20 cm), while the greatest value of number of filled grains were found when GZ9057 rice line was combined with the wider space 25x20 cm followed by both GZ7112 when cultivated under the same space and GZ9057 when cultivated under medium space 20x20 cm without any significant difference between them in the two studied seasons. The increases in number of filled grain of GZ9057 and GZ7112 rice lines when cultivated under wider or medium spaces might be due to the vigorous growth in both shoots (canopy) and roots, so the wider or medium space is suitable for minimizing the competition among both shoots and roots which led to increase both nutrient uptake and penetrated of light through the leaves of their canopy consequently increase the photosynthesis process and its products (assimilates) that translocate to the panicle and efficiently fill most of the spikelet's resulted in increase the number of filled grains. These results are coincidence with that recorded by Abd Alla (1996), Abd EL-Hamed (2002); Koutroubas and Ntanos (2003) and Sorour, *et al*., (2016).

Table 23. Number of filled grains /panicle as affected by the interaction between some different rice genotypes and plant spaces (cm) in 2016 and 2017 seasons.

Plant space (cm)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
15x20	109.08g	101.22h	109.63g	120.07b-d	110.74g	102.88h	111.29g	121.73b-d
20x20	114.63ef	107.56g	118.82cd	122.55a-c	116.61ef	109.54g	120.80cd	124.53a-c
25x20	118.13de	113.74f	123.77ab	125.9a	119.90de	115.51f	125.54ab	127.71a

Number of filled grains/ panicles as influenced by the interaction between the different rice genotypes and nitrogen levels is presented in Table 24.

Data demonstrated that, combination of either 110 or 165 kg N/ha with each of the tested genotypes caused an increase in number of filled grains /panicle as compared with control treatment when combined with the same rice genotypes under study. The lowest number of filled grains / panicle was found when GZ9461 rice line was cultivated under control treatment in the two studied seasons. While the greatest value in this aspect was observed when GZ9057 followed by SP70 rice lines were fertilized by the highest level of nitrogen under study (165 kg N/ha). This increase could be attributed to the increase in nitrogen uptake which make continuous supply to the previously mention two rice line by their nitrogen requirements. These results are coincidence with that recorded by Abd Alla (1996), Abd EL-Hamed (2002); Koutroubas and Ntanos (2003) and Sorour, *et al*., (2016).

Table 24. Number of filled grains /panicle as affected by the interaction between some different rice genotypes and nitrogen levels (kg N/ha) in 2016 and 2017 seasons.

Nitrogen Levels (Kg N/ha)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
Control	82.64i	74.05j	90.50h	101.34g	84.44i	75.85j	92.30h	103.14g
110 kg N	118.40ef	114.70f	123.40d	122.49de	120.20ef	116.50f	125.20d	124.29de
165 kg N	140.81ab	133.77c	138.32bc	144.72a	142.61ab	135.57c	140.12bc	146.53a

Data in Table 25 revealed that combination of either 110 or 165 kg N/ha significantly increased number of filled grains / panicle when combined with each of the three plant spaces under study as compared with control treatment when combined with the same plant space. The lowest number of filled grains/panicle was found when control treatment combined with the space of 15x20 cm, while the greatest number of filled grains /panicle was observed when the highest level of nitrogen (165 kg N/ha) was combined with either 20x20 cm or 25x20 cm spaces in the two seasons of study. These increases could be attributed to the role of nitrogen for increasing the growth of both plant canopy and roots resulted in increase the nutrients uptake by plant through its different stages which led to increase the photosynthesis process and its assimilate that translocate to the panicles and completely fill high number of spikelet's consequently increase the number of grains/ panicle. The medium or wider spaces (20x20 cm or 25x20 cm) were the suitable spaces in this case because of minimizing the competition among the roots and canopy of plants.

Table 25. Number of filled grains /panicle as affected by the interaction between plant spaces (cm) and nitrogen levels (kg N/ha) in 2016 and 2017 studied seasons.

Plant Space (cm)	Nitrogen Levels Kg N/ha					
	2016			2017		
	Control	110 kg N/ha	165 kg N/ha	Control	110 kg N/ha	165 kg N/ha
15x20	84.32g	112.11e	133.58b	85.98g	113.77e	135.24b
20x20	86.73fg	119.98d	140.96a	88.71fg	121.95d	142.94a
25x20	90.35f	127.16c	143.67a	92.12f	128.93c	145.44a

Data in Table 26 indicated that there were a significant differences among the tested rice genotypes when combined with each of the three studied plant spaces in 1000-grain weight. Combination of each of the tested rice genotypes with either medium space (20x20 cm) or wider space (25x20 cm) caused a signficant increase in 1000-grain weight as compared with narrow spaces (15x20 cm) when combined with the same genotypes. The lowest 1000-grain weight was observed when GZ9057 rice line combined with the space of 15x20 cm, while the greatest value of 1000-grain weight was found when SP70 was combined with the wider space (25x20 cm) followed by the same rice line when cultivated under both 20x20 cm and 15x20 cm spaces without any significant difference between them. Because of SP70 rice line has vigorous growth in its canopy, so the wider space 25x20 cm is the suitable space to give the chance of light to penetrate through most of leaves consequently increase the photosynthesis which produced adequate amount of assimilates. The high stream of assimilate which translocate to the panicle is quite enough to completely fill the spikelet's resulted in increase the weight of 1000-grain. The promoting effects of nitrogen on 1000-grain weight were reported by Metwally *et al.* (2010) and Sorour *et al*. (2016).

Table 26. Thousand grain weight (g) as affected by the interaction between some different rice genotypes and plant spaces (cm) in 2016 and 2017 seasons.

Plant space (cm)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
15x20	26.676b	24.976de	24.959de	24.757e	26.942b	25.242de	25.225de	25.023e
20x20	26.751b	25.101cde	25.217cde	25.384cd	27.017b	25.367cde	25.483cde	25.650cd
25x20	27.217a	25.401cd	25.392cd	25.569c	27.483a	25.637cd	25.658cd	25.835c

Thousand grain weight as influenced by the interaction between some rice genotypes and nitrogen levels is presented in Table 26. Data clarified that 1000-grain weight was increased when all the tested rice genotypes did not receive any nitrogen fertilizer (control treatment) as compared with the combination of either 110 or 165 kg N/ha with each of the same genotypes. The lowest 1000-grain weight was observed when both GZ7112 and 9057 combined with 165 kg N/ha in the studied seasons. On contrast the greatest 1000-grain weight was found when SP70 rice line was combined with control treatment followed by the combination of same rice line with 110 kg N/ha. These results were hold true in the two studied seasons. The increase in 1000-grain weight when the tested genotypes were cultivated under control treatment (without N-application) might be due to the decrease in number of spikelet's with the present of adequate enough of assimilates which translocated from source to sink and completely fill the lowest number of spikelet's consequently increase the weight of 1000-grain weight. These results are coincidence with that recorded by Abd Alla (1996), Abd EL-Hamed (2002); Koutroubas and Ntanos (2003) and Sorour, *et al*., (2016).

Table 27. Thousand grain weight (g) as affected by the interaction between some different rice genotypes and nitrogen levels (kg N/ha) in 2016 and 2017 seasons.

Nitrogen Levels (Kg N/ha)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
Control	27.859a	25.851d	26.659c	26.819bc	28.125a	26.117d	26.925c	27.085bc
110 kg N	27.234b	25.426de	25.376de	25.084e	27.500b	25.692de	25.642de	25.350e
165 kg N	25.551de	24.201f	23.534g	23.807fg	25.817de	24.437f	23.800g	24.073fg

Table 27 and 28 present the interaction between nitrogen levels and plant spaces in 1000-grain weight. Data demonstrated that combination of control treatment (without any nitrogen application) with the three tested spaces produced the greatest 1000-grain weight as compared with the combination of both 110 and 165 kg N/ha with the same spaces in the two studied seasons. When the plants did not receive any of nitrogen fertilizer even under the three tested spaces, the growth of both shoots and roots dramatically decreased due to the reduction in nitrogen uptake resulted in small panicle and tiller number of spikelet's/ panicle. In this case the amount photosynthetic products (assimilates) is a quiet to fill the small number of spikelet's completely that led to increase the weight of 1000-grain.

Table 28. Thousand grain weight (g) as affected by the interaction between plant spaces (cm) and nitrogen levels (kg N/ha) in 2016 and 2017 seasons.

Plant Space (cm)	Nitrogen Levels Kg N/ha					
	2016			2017		
	Control	110 kg N/ha	165 kg N/ha	Control	110 kg N/ha	165 kg N/ha
15x20	26.696a	25.421c	23.908e	26.962a	25.687c	24.174e
20x20	26.740a	25.884b	24.215e	27.006a	26.150b	24.481e
25x20	26.954a	26.034b	24.696d	27.220 a	26.300b	24.940d

Data in Table 29 indicated that there was a significant difference in the interaction between the tested rice genotypes and plant spaces in grain yield. The combination of either medium space 20x20 or wider space 25x20 with each of the tested genotypes under study caused an increase in grain yield as compared with the combination of the narrow space 15x20 with the same rice genotypes.

The lowest number of grain yield was observed when GZ7112 was cultivated under the narrow (15x20 cm) and medium space (20x20), while the greatest value of grain yield t/ha was found when SP70 (Sakha 108) and GZ9461 rice lines was combined with the wider space 25x20 cm followed by GZ9057 (Giza179) when cultivated under the same space in the two studied seasons. The increases in grain yield of SP70 (Sakha108) and GZ9461 rice lines when cultivated under wider or medium plant spaces might be due to the vigorous growth in both shoots (canopy) and roots, so the wider or medium spaces are suitable for minimizing the competition among both shoots and roots which led to increase both nutrient, uptake and penetrated of light through the leaves of their canopy specially flag leaf plus second and third leaves that representative about 75% from total photosynthesis consequently increase the photosynthesis process and its products (assimilates) that translocate to the panicle and efficiently fill most of the spikelet's resulted in increase the number of filled grains consequently grain yield.

These results are coincidence with that recorded by Abd Alla (1996), Abd EL-Hamed (2002); Koutroubas and Ntanos (2003) and Sorour, *et al*., (2016).

Table 29. Grain yield (t/ha) as affected by the interaction between some different rice genotypes and plant spaces (cm) in 2016 and 2017 seasons.

Plant Space (cm)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
15x20	9.186bc	9.255bc	8.293d	8.670cd	9.413bc	9.482bc	8.520d	8.897cd
20x20	9.461b	9.810ab	8.519d	9.324b	9.688b	10.122ab	8.777d	9.551b
25x20	10.365a	10.183a	9.174bc	9.790ab	10.592a	10.326a	9.402bc	10.018ab

Grain yield as influenced by the interaction between different rice genotypes and nitrogen levels is presented in Table 30.Data demonstrated that, combination of either 110 or 165 kg N/ha with each of the tested genotypes caused an increase in grain yield compared with control treatment when combined with the same rice genotypes under study. The lowest grain yield was found when GZ7112 rice line was cultivated under control treatment in the two studied seasons. While the greatest value in grain yield was observed when GZ9057 and SP70 rice lines fertilized by the highest level of nitrogen under study (165 kg N/ha) followed by both GZ7112 and GZ 9461 rice lines under the same level of nitrogen. This increase could be attributed to the increase in nitrogen uptake which make continuous supply to the previously mention rice lines with nitrogen requirements. Also, one of the most important role of nitrogen is the increase in both protein and chlorophyll that increase the viability of flag leaf, by the other meaning late the senescence of flag leaf which cause an increase in photosynthetic processes and the stream of metabolites that immediately translocate to the panicles and completely fill most of the spikelet's consequently increase the grain yield. These results are coincidence with that recorded by Abd Alla (1996), Abd EL-Hamed (2002); Koutroubas and Ntanos (2003) and Sorour, *et al*., (2016).

Table 30. Grain yield (t/ha) as affected by the interaction between some different rice genotypes and nitrogen levels (kg N/ha) in 2016 and 2017 seasons.

Nitrogen Levels (Kg N/ha)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
Control	7.165e	7.752e	6.204f	6.467f	7.753e	7.889e	6.341f	6.604f
110 kg N	10.165c	10.444bc	8.915d	9.779c	10.364c	10.553bc	9.115d	9.979c
165 kg N	11.233a	11.053ab	10.868ab	11.538a	11.577a	11.397ab	11.212ab	11.882a

Data in Table 31 revealed that combination of either 110 or 165 kg N/ha significantly increased grain yield when combined with each of the three plant spaces under study as compared with control treatments when combined with the same plant spaces. The lowest grain yield was found when control treatment combined with the space of 15x20 cm, while the greatest grain yield was observed when the highest level of nitrogen (165 kg N/ha) was combined with either 25x20 cm or 20x20 cm spaces in the two seasons of study. These increases could be attributed to the role of nitrogen for increasing the growth of both plant canopy and roots resulted in increase the nutrients uptake by plant through its different stages which led to increase the photosynthesis process and its assimilate which translocate to the panicles and completely fill high number of spikelet's consequently increase the number of grains/ panicle, panicle weight and 1000 grain weight that led to increase grain yield. which increasing grain yield. The medium or wider spaces (20x20 cm or 25x20 cm) were suitable spaces in this case because of the minimizing in the competition among either or shoots roots and gave the chance for light to penetrate most of the leaves in the canopy that cause an increases the photosynthesis process and its products which led to increase grain yield.

Table 31. Grain yield (t/ha) as affected by the interaction between plant spaces (cm) and nitrogen levels (kg N/ha) in 2016 and 2017 seasons.

Plant Space (cm)	Nitrogen Levels Kg N/ha					
	2016			2017		
	Control	110 kg N/ha	165 kg N/ha	Control	110 kg N/ha	165 kg N/ha
15x20	6.367g	9.365d	10.822bc	6.504g	9.564d	11.167bc
20x20	6.974f	9.714d	11.148ab	7.175f	9.914d	11.492ab
25x20	7.688e	10.399c	11.548a	7.762e	10.598c	11.548a

Straw yield (t/ha) as influenced by the interaction between some different rice genotypes and plant spaces (cm) in 2016 and 2017 rice seasons is presented in Table 32.

Data revealed that the combination of all the genotypes with either narrowing spaces (15x20 cm) or medium space (20x20 cm) produced the greatest straw yield as compared with the wider space (25x20 cm) when combined with the same tested genotypes. The lowest values of straw yield were observed when either SP70 or GZ7112 rice lines cultivated under the wider space (25x20 cm). While the greatest value of straw yield was found GZ9057 rice line cultivated under both 20x20 cm and 15x20 cm spaces and came in the first rank followed by GZ7112 and GZ9461 when cultivated under the same spaces plus SP70 under the space of 20x20 cm and came in the second rank. The increases of straw yield under narrow and medium spaces might be due to the increase in number hills under these spaces than in wider space. These results are coincidence with that recorded by Abd Alla (1996), Abd EL-Hamed (2002) and Sorour, *et al*., (2016).

Table 32. Straw yield (t/ha) as affected by the interaction between some different rice genotypes and plant spaces (cm) in 2016 and 2017 seasons.

Plant Space (cm)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
15x20	11.074b-d	11.396ab	11.473ab	11.725a	11.302b-d	11.624ab	11.701ab	11.953a
20x20	11.459ab	11.308a-c	11.496ab	11.711a	11.687ab	11.536a-c	11.724ab	11.939a
25x20	10.689d	11.025b-d	10.921cd	11.402ab	10.917d	11.253b-d	11.149cd	11.630ab

Data in Table 33 indicated that combination either 165 or 110 kg N/ha with all the tested genotypes produced the highest straw yield as compared with control when combined with the same genotypes. The greatest value of straw yield was observed when GZ9461, GZ7112 and GZ9057 rice lines fertilized by 165 kg N/ha. It could be attributed to the increases in number of tillers under the highest level of nitrogen under study 165 kg N/ha. These results are agreement with those reported by Singh *et al.* (2000).

Table 33. Straw yield (t/ha) as affected by the interaction between some different rice genotypes and nitrogen levels (kg N/ha) in 2016 and 2017 seasons.

Nitrogen Levels (Kg N/ha)	Different rice genotypes							
	2016				2017			
	SP70	GZ9461	GZ7112	GZ9057	SP70	GZ9461	GZ7112	GZ9057
Control	9.570d	9.452d	9.452d	10.598c	9.708d	9.591d	9.591d	10.736c
110 kg N	11.660b	11.585b	11.746b	11.653b	11.860b	11.785b	11.946b	11.853b
165 kg N	11.992b	12.692a	12.692a	12.587a	12.338b	13.037a	13.037a	12.932a

Straw yield as affected by the interaction between plant spacing and nitrogen levels the data in Table 34.

Data clarified that combination of either 165 or 110 kg N/ha with all the spaces under study produced the greatest straw yield as compared with control treatment when combined with the same spaces the highest straw yield was obtained when the highest nitrogen level 165 kg N/ha was combined with either the space of 20 x20 cm or 15x20 cm. These results were hold true in the two studied seasons. The increases in straw yield under medium 20 x20 cm and narrow 15x20 cm spaces could be attributed to the increase in number of hills with the greatest number of tillers/hill due to the application of high level of nitrogen under study 165 kg N/ha.

Table 34. Straw yield (t/ha) as affected by the interaction between plant spaces (cm) and nitrogen levels (kg N/ha) in 2016 and 2017 studied seasons.

Plant space (cm)	Nitrogen Levels Kg N/ha					
	2016			2017		
	Control	110 kg N/ha	165 kg N/ha	Control	110 kg N/ha	165 kg N/ha
15x20	9.931e	11.742c	12.578a	10.069e	11.942c	12.923a
20x20	9.907e	11.984bc	12.589a	10.046e	12.184bc	12.934a
25x20	9.466 f	11.257d	12.305ab	9.604f	11.457d	12.650ab

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سلوك بعض سلالات الارز المختلفة وراثيا تحت مستويات مختلفة من النتروجين ومسافات الزراعة

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أجريت تجربتان حقليتان بالمرزعه البحثية لقسم بحوث الأرز بسخا – كفرالشيخ – مصر فى موسمى زراعة ٢٠١٦ – ٢٠١٧ لدراسة سلوك بعض التراكيب الوراثية تحت مسافات الزراعة ومستويات التسميد النيتروجينى مختلفة. وكانت أصناف الأرز المستخدمة تحت الدراسة هى سلالة SP70 (سخا ١٠٨)، GZ 9461 ، GZ7112، GZ9057 (جيزة ١٧٩). ومسافات الزراعة تحت الدراسة كانت ٢٥×٢٠سم، ٢٠×٢٠سم، ١٥×٢٠ سم، وذلك تحت ثلاث مستويات تسميد نيتروجينى وهى المعاملة الكنترول (بدون تسميد)، ١١٠ كجم نيتروجين /هكتار، ١٦٥ كجم نيتروجين /هكتار. وكان التصميم الأحصائى المستخدم تصميم القطع المنشقة مرتان فى قطاعات كاملة العشوائية، وتم وضع الأصناف فى القطع الرئيسية ومسافات الزراعة فى القطع المنشقة الأولى ومستويات التسميد النيتروجينى فى القطع المنشقة الثانية . وكانت الصفات المدروسة هى محتوى الكلورفيل فى ورقة العلم وطول النبات وعدد الفروع والسنابل وطول السنبلة ووزن السنبلة ووزن الألف حبة وتم تقدير محصول القش والحبوب. أشارت النتائج إلى وجود إختلافات فى الصفات المدروسة بين الأصناف المختلفة تحت الدراسة والراجعه الى الأختلافات الوراثية بين الأصناف. وكانت أفضل مسافة زراعة هى ٢٥×٢٠سم وذلك بالنسبة للصفات المدروسة للتراكيب الوراثية ما عدا صفة طول السنبلة والتى إستجابت لمسافة الزراعة ٢٠×٢٠سم، أما بالنسبة لمسافات الزراعة ١٥×٢٠سم لم تكن مناسبة للتراكيب الوراثية تحت الدراسة والتى سجلت أقل القيم بالنسبة للصفات المدروسة. كما اظهرت النتائج أن إضافة ١٦٥ كجم نيتروجين / هكتار سجلت زيادة فى صفات النمو ومكونات المحصول ومحصول القش والحبوب. كما أظهرت النتائج أيضاً إلى أن إضافة ١٦٥ كجم نيتروجين /هكتار مع مسافة زراعة ٢٠× ٢٥ سم قد سجلت زيادة معنوية فى معظم الصفات تحت الدراسة ما عدا صفة وزن الالف حبة والتى سجلت أعلى زيادة منها تحت مسافة ١٥×٢٠سم مع المعاملة الكنترول (بدون تسميد). وقد وجد ان كل التراكيب الوراثية تحت مسافات زراعة ٢٠×٢٥ سم ومعدل تسميد ١٦٥ كجم نيتروجين/ هكتار قد أعطت أعلى قيم لمحصول الحبوب ما عداً السلالة GZ7112 والتى أعطت أقل محصول حبوب وقش. وبالنسبة لمحصول القش لمعظم التراكيب الوراثية تحت الدراسة فقد أظهرت النتائج أن كلا من مسافتى الزراعة ٢٠× ٢٠سم، ١٥×٢٠ سم، ٢٥×٢٠ سم مع ١٦٥ كجم نيتروجين /هكتار قد أعطت أعلى قيم لمحصول القش وخاصة GZ9057 والتى أعطت أعلى محصول قش تحت نفس مسافة الزراعة ومستوى التسميد النيتروجينى.