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Genetic Behaviour of Some Rice (*Oryza sativa* L.) Genotypes under Different Treatments of Nitrogen Levels

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Abstract: The present investigation was carried out at the experimental farm of Rice Research and Training Center, Sakha, Kafer El-Sheikh, Egypt during 2008 and 2009 seasons to study the physio-morphological behaviour of some rice genotypes under low and high nitrogen application. Twenty one genotypes were tested under three different nitrogen levels viz, 0, 75 and 150 kg N/ha for ten traits viz, flag leaf area, chlorophyll content, days to heading, panicle weight,, no. of filled grains/panicle, no. of panicles/plant,1000-grain weight, grain yield t/ha, Grain yield efficiency index (GYEI) and agronomic nitrogen use efficiency (ANUE). The genotypes were divided into three groups i.e., japonica/japonica (J/J), japonica/indica japonica (J/IJ) and indica japonica/indica japonica (IJ/IJ). GZ6296 x Giza178-1 and GZ6296 x Giza 178-3 gave the highest values of no. of filled grain/panicle and no. of panicles/hill under low input of nitrogen. Giza177/Sakha101 and Giza176/GZ6944 (J/J) gave the highest grain yield under low input of nitrogen followed by the genotypes derived from Giza178/GZ6296 (IJ/IJ).

Key words: Rice (Oryza *sativa L.*) genotypes · Nitrogen · Cluster analysis · Agronomic nitrogen use efficiency · Grain yield efficiency index

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the important food crops grown on 154 million heaters' world-wide in a wide range of environment, however rice is the principle food crop for more than half of the world's population. It is staple food in the diet of the population of Asia, Latin America and Africa. Nitrogen fertilizer is one of the most important agronomic inputs and limiting factors realizing the potential rice grain production in the world. Use of adequate nitrogen rate is important not only for obtain maximum economic return, but also to reduce environmental pollution. Excessive nitrogen application can resulted in accumulation of large amounts of post harvest residual soil N. Residual soil NO_3^- may be available for subsequent crops in the next season [1]. It is important to achieve efficient use of nitrogen in chemical fertilizers, not only through cultivation techniques, but also by breeding varieties with high nitrogen use efficiency and reducing nitrogen inputs from farming to the environment [2, 3]. The objective of the study was to determine the genotypes which gave high yield under low nitrogen application.

MATERIALS AND METHODS

The present study was carried out at the farm of Rice Research and Training Center, Sakha, Kafr El-Sheikh, Egypt during 2008 and 2009 seasons to compare the genetic behaviour of twenty one Egyptian rice lines under different nitrogen levels (0, 75 and 150 kg N/ha). Nitrogen fertilizer was supplied in the form of urea (46.5% N) in two equal splits application, i.e. half as basal and incorporated into the soil immediately before flooding, followed by the second dose after 30 days from transplanting. Pre-germinated seeds were uniformly broadcasted in the nursery on 5th and 8th May of the two seasons, respectively. Twenty five day old seedlings of each genotype were transplanted at 20 X 20 cm spacing with two seedlings per hill. The genotypes were divided into three groups i.e., japonica/japonica (J/J), japonica/indica japonica (J/IJ) and indica japonica/indica japonica (IJ/IJ). The parentage and variety group of genotypes are given in Table 1.

The experiment was laid out in a split plot design with four replications, where the varieties represented in main plot while, nitrogen levels put in sup plot.

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Table 1: The 21 rice parentage and their variety groups.

Number	Parentage	Variety Group
1	Giza176/Giza177	Japonica/Japonica
2	Giza176/Sakha101	Japonica/Japonica
3	Giza176/GZ6379	Japonica/Japonica
4	Giza176/ GZ6944	Japonica/Japonica
5	Giza177/Sakha101	Japonica/Japonica
6	Giza177/Sakha102	Japonica/Japonica
7	Sakha101/Sakha103	Japonica/Japonica
8	Sakha101/Sakha104	Japonica/Japonica
9	Sakha101/GZ6906	Japonica/Japonica
10	Sakha102/GZ6379	Japonica/Japonica
11	Giza176/Giza178	Japonica/Indic Japonica
12	Giza178/ Sakha102	Japonica/Indic Japonica
13	Sakha101/GZ6296-1	Japonica/Indic Japonica
14	Sakha101/GZ6296-2	Japonica/Indic Japonica
15	Sakha101/GZ6296-3	Japonica/Indic Japonica
16	Sakha101/GZ6296-4	Japonica/Indic Japonica
17	Giza178/GZ6296-1	Indica Japonica/Indic Japonica
18	Giza178/GZ6296-2	Indica Japonica/Indic Japonica
19	Giza178/GZ6296-3	Indica Japonica/Indic Japonica
20	Giza178/GZ6296-4	Indica Japonica/Indic Japonica
21	Giza178/GZ6296-5	Indica Japonica/Indic Japonica

All data collected were subjected to the standard statistical analysis following the proceeding described by Gomez and Gomez [4] using the computer program (IRRISTAT). Agronomic practices were followed as recommended during the growing seasons. Ten rice characters were studied viz. flag leaf area cm^2 at heading, days to heading, total chlorophyll content in the flag leaf were recorded using chlorophyll meter (SPAD-502 Minolta Camera Co. ltd., Japan) at heading stage, 7, 14 and 21 days after flowering, no. of filled grains/panicle, panicle weight g, no. of panicles/hill, 1000-grain weight g, grain yield t/ha (grains adjusted to 14% moisture content), grain yield efficiency index (GYEI) and agronomic nitrogen use efficiency (ANUE) kg kg^{-1}. The cluster analysis was carried out according to Rohlf [5]. Grain yield efficiency index (GYEI) was computed according to Fageria *et al*. [6] as follows:

GYEI = (Yield at low nutrient level X yield at high nutrient level)/(Exp. mean at low nutrient level x Exp. mean at high nutrient level)

Agronomic nitrogen use efficiency (ANUE) was computed according to Saleque *et al*. [7] as follows:

ANUE = Grain yield in fertilized plot x grain yield in unfertilized plot)/ Quantity of nutrient applied

RESULTS AND DISCUSSION

Flag Leaf Area: Data in Table 2 indicated that the mean values of flag leaf area (cm^2) were significantly increased with increasing nitrogen levels from 0 up to 150 kg ha^{-1}. This mainly due to the fact that nitrogen is the major factor influencing leaf growth and it affected average leaf size. These findings are supported by the work done by Mhaskar *et al*. [8]. Generally the increase in flag leaf area of Japonica / indica japonica was higher than japonica/japonica, this mainly due to hybrid vigor result the crosses between japonica and indica japonica (there are genetic diversity among them), while no significant difference between japonica/ indica japonica and indica japonica/indica japonica. The promising lines 16 and 14 (J/IJ) recorded the highest flag leaf area in the two seasons, indicating that these lines have more response to nitrogen fertilizer, thus it had a high response to nitrogen application. The indica/indica japonica (I/IJ) entries No. 11 and 14 recorded the highest values of flag leaf area followed by the japonica / indica japonica (J/IJ) promising line No. 16 and the indica japonica / indica japonica (IJ/IJ) entry No. 20 in the two seasons of study. The J/IJ genotypes gave values of flag leaf area higher than J/J and IJ/IJ genotypes.

Table 2: Flag leaf area (cm) and days to heading for twenty one rice entries as affected by nitrogen levels in 2008 and 2009

	Flag leaf area								Days to heading							
	2008				2009				2008				2009			
	Nitrogen levels kg/ha				Nitrogen levels kg/ha				Nitrogen levels kg/ha				Nitrogen levels kg/ha			
Entries	0	75	150	E Mean	0	75	150	E Mean	0	75	150	E Mean	0	75	150	E Mean
J/J																
Giza176/Giza177	24.533	26.800	31.233	27.522	24.367	26.400	32.367	27.711	95.00	97.00	99.00	97.000	96.00	96.67	99.67	97.44
Giza176/Sakha101	25.067	35.467	41.433	33.889	24.000	36.633	41.733	33.789	102.00	104.00	106.00	104.000	101.33	103.00	106.00	103.44
Giza176/GZ6379	27.300	32.200	38.367	32.622	27.033	31.333	37.233	31.867	93.00	95.00	97.00	95.000	93.33	94.67	97.67	95.22
Giza176/ GZ6944	27.633	32.033	35.533	31.733	26.767	31.300	36.067	31.378	92.33	96.00	100.00	96.110	91.67	95.33	99.00	95.33
Giza177/Sakha101	24.467	27.867	33.233	28.522	24.433	27.533	32.433	28.133	96.00	96.33	98.00	96.780	96.67	96.67	99.00	97.44
Giza177/Sakha102	22.567	25.667	28.233	25.489	22.267	25.367	28.333	25.322	98.00	100.00	101.00	99.667	97.00	101.00	101.67	99.89
Sakha101/Sakha103	19.067	24.267	33.467	25.600	19.267	24.333	32.167	25.256	94.00	97.33	99.00	96.780	93.00	97.00	99.33	96.44
Sakha101/Sakha104	21.300	23.733	27.800	24.278	20.833	22.367	27.033	23.411	91.00	96.00	98.00	95.000	92.33	94.00	98.00	94.78
Sakha101/GZ6906	25.733	31.700	36.233	31.222	25.300	32.200	34.967	30.822	94.00	100.00	102.00	95.670	93.33	99.00	102.67	98.33
Sakha102/GZ6379	23.500	28.533	35.500	29.178	23.500	28.400	34.667	28.856	92.00	95.00	97.00	94.670	91.33	95.00	98.00	94.78
J/IJ																
Giza176/Giza178	23.667	30.90	47.367	33.978	24.267	30.467	45.233	33.322	93.00	95.33	97.00	95.11	92.67	95.00	97.33	95.00
Giza178/ Sakha102	21.000	28.867	32.10	27.322	22.500	25.067	32.667	26.744	94.00	95.00	96.00	95.00	93.67	96.00	97.00	95.56
Sakha101/GZ6296-1	32.400	36.833	40.533	36.589	33.000	36.400	40.033	36.478	102.00	106.00	108.00	105.33	101.33	105.00	107.67	104.67
Sakha101/GZ6296-2	32.267	36.933	45.400	38.200	32.467	35.600	45.500	37.856	101.00	104.33	106.00	103.78	100.33	103.33	105.33	103.00
Sakha101/GZ6296-3	30.233	35.200	38.333	34.589	26.333	34.767	38.300	33.133	98.00	101.00	103.00	100.67	97.33	100.00	102.00	99.78
Sakha101/GZ6296-4	34.200	39.067	43.367	38.878	33.300	37.367	43.300	37.989	99.00	104.22	107.00	103.33	98.67	104.00	107.33	103.33
IJ/IJ																
Giza178/GZ6296-1	30.800	36.300	40.500	35.867	29.433	34.433	40.267	34.711	100.00	102.00	105.00	102.33	100.33	101.33	105.00	102.22
Giza178/GZ6296-2	27.100	33.233	36.267	32.200	25.833	31.300	35.500	30.878	101.00	103.00	106.00	103.33	100.33	103.00	105.00	102.78
Giza178/GZ6296-3	30.833	33.600	40.900	35.111	31.133	32.533	41.367	35.011	100.67	102.00	105.33	102.67	100.00	102.33	104.00	102.11
Giza178/GZ6296-4	26.367	40.967	43.600	36.978	25.833	41.000	42.900	36.578	99.67	102.00	104.00	101.89	99.00	101.00	103.33	101.11
Giza178/GZ6296-5	30.200	32.733	38.300	33.744	29.333	33.100	37.300	33.244	99.00	100.00	102.00	100.33	96.00	100.00	101.00	99.00
N- Mean	26.678	32.029	37.51	--	26.248	31.281	37.113	--	96.89	99.59	101.73	--	96.46	99.21	101.71	--
L.S.D.0.05																
Nitrogen	0.78				0.496				0.518				0.626			
Entries	1.154				0.934				0.992				1.342			
Interaction	2.028				1.617				1.716				2.311			

Table 3: Chlorophyll content SPAD at heading and 7 days after heading for twenty one rice entries as affected by nitrogen levels in 2008 and 2009

	Chlorophyll content SPAD at heading								Chlorophyll content SPAD at 7 days after heading							
	2008				2009				2008				2009			
	Nitrogen levels kg/ha				Nitrogen levels kg/ha				Nitrogen levels kg/ha				Nitrogen levels kg/ha			
Entries	0	75	150	E Mean	0	75	150	E Mean	0	75	150	E Mean	0	75	150	E Mean
J/J																
Giza176/Giza177	41.00	44.00	47.33	44.11	40.67	44.33	45.67	43.56	34.00	38.33	43.00	38.44	32.33	36.67	43.33	37.44
Giza176/Sakha101	43.00	45.00	48.00	45.33	41.00	45.33	46.33	44.22	36.00	41.00	44.00	40.33	34.00	41.00	41.67	38.89
Giza176/GZ6379	42.00	46.00	48.67	45.56	41.67	44.33	48.00	44.67	34.00	42.00	45.00	40.33	31.00	41.33	44.67	39.00
Giza176/ GZ6944	41.67	45.00	47.00	44.56	41.00	45.33	46.00	44.11	37.33	41.67	44.67	41.22	35.33	41.00	44.00	40.11
Giza177/Sakha101	41.00	46.00	48.00	45.00	40.33	45.00	46.00	43.78	37.00	43.00	45.00	41.67	33.33	42.33	44.33	40.00
Giza177/Sakha102	40.00	44.00	47.00	43.67	41.00	45.00	46.00	44.00	37.00	40.00	44.00	41.22	35.33	41.00	43.00	39.78
Sakha101/Sakha103	42.00	45.00	48.00	45.00	43.33	43.33	47.67	44.78	37.67	41.00	45.00	40.33	35.33	40.00	45.00	40.11
Sakha101/Sakha104	43.00	45.00	49.00	45.67	42.33	44.67	48.00	45.00	37.67	42.00	46.00	41.89	36.67	41.33	44.67	40.89
Sakha101/GZ6906	42.00	44.00	46.67	44.22	41.67	44.33	48.00	44.67	39.00	41.67	44.67	41.78	37.00	41.67	43.67	40.78
Sakha102/GZ6379	44.00	45.00	48.00	45.67	42.67	44.67	46.33	44.56	41.00	41.33	44.00	42.11	40.00	41.67	42.00	41.22
J/IJ																
Giza176/Giza178	41.00	43.00	43.33	42.44	41.33	43.67	43.33	42.78	35.00	38.00	41.00	38.00	34.33	39.00	40.00	37.78
Giza178/ Sakha102	41.00	45.00	46.67	44.22	41.67	43.67	47.00	44.11	36.00	41.00	45.00	40.67	37.33	40.00	44.67	40.67
Sakha101/GZ6296-1	41.00	43.00	46.00	43.33	41.33	42.33	45.00	42.89	37.00	41.00	42.00	40.00	35.00	39.00	41.00	38.33
Sakha101/GZ6296-2	40.00	44.00	46.33	43.44	40.33	42.67	45.33	42.78	32.33	39.00	43.00	38.11	29.33	38.00	41.00	36.11
Sakha101/GZ6296-3	41.00	44.00	46.00	43.67	39.33	42.33	45.33	42.33	35.33	39.00	43.00	39.11	34.33	40.00	41.00	38.44
Sakha101/GZ6296-4	40.67	44.00	45.00	43.22	42.00	43.67	46.00	43.89	38.00	41.00	41.00	40.00	36.33	40.67	42.00	39.67
IJ/IJ																
Giza178/GZ6296-1	36.00	39.00	43.00	39.33	33.00	38.00	43.33	38.11	27.67	34.00	40.00	33.89	26.00	34.33	39.00	33.11
Giza178/GZ6296-2	39.00	41.00	44.00	41.33	38.00	42.00	43.00	41.00	33.00	37.33	41.00	37.11	33.33	35.67	41.33	36.78
Giza178/GZ6296-3	38.00	41.00	42.33	40.44	35.00	40.33	41.67	39.00	31.33	33.33	38.00	34.22	32.33	34.00	36.00	34.11
Giza178/GZ6296-4	37.00	40.00	43.00	40.00	35.00	39.00	41.33	38.44	30.00	35.00	38.00	34.33	27.00	34.33	35.00	32.11
Giza178/GZ6296-5	35.00	36.67	41.00	37.56	34.33	37.33	40.00	37.22	28.67	31.00	38.00	32.56	26.33	33.33	34.67	31.44
N- Mean	40.44	43.32	45.92		39.86	42.92	45.21		35	39.13	42.64		33.43	38.87	41.52	
L.S.D.0.05																
Nitrogen	0.344				0.338				0.344				0.338			
Entries	1.061				1.348				1.061				1.348			
Interaction	1.809				2.291				1.809				2.291			

Table 4: Chlorophyll content SPAD at 14 and 21 days after heading for twenty one rice entries as affected by nitrogen levels in 2008 and 2009

	Chlorophyll content SPAD at 14 after heading								Chlorophyll content SPAD at 21 days after heading							
	2008				2009				2008				2009			
	Nitrogen levels kg/ha				Nitrogen levels kg/ha				Nitrogen levels kg/ha				Nitrogen levels kg/ha			
Entries	0	75	150	E Mean	0	75	150	E Mean	0	75	150	E Mean	0	75	150	E Mean
J/J																
Giza176/Giza177	29.00	33.00	37.00	33.00	28.00	33.00	38.00	33.00	29.00	33.00	37.00	33.00	28.00	33.00	38.00	33.00
Giza176/Sakha101	28.00	38.00	41.00	35.67	28.00	38.33	41.33	35.89	28.00	38.00	41.00	35.67	28.00	38.33	41.33	35.89
Giza176/GZ6379	27.00	31.00	39.00	32.33	26.67	31.33	38.33	32.11	27.00	31.00	39.00	32.33	26.67	31.33	38.33	32.11
Giza176/ GZ6944	31.00	36.00	42.00	36.33	30.00	35.67	41.00	35.56	31.00	36.00	42.00	36.33	30.00	35.67	41.00	35.56
Giza177/Sakha101	25.00	36.00	40.67	33.89	26.00	35.00	40.00	33.67	25.00	36.00	40.67	33.89	26.00	35.00	40.00	33.67
Giza177/Sakha102	31.33	35.33	38.00	34.89	29.00	33.33	37.00	33.11	31.33	35.33	38.00	34.89	29.00	33.33	37.00	33.11
Sakha101/Sakha103	29.00	37.00	41.00	35.67	28.33	34.00	42.00	34.78	29.00	37.00	41.00	35.67	28.33	34.00	42.00	34.78
Sakha101/Sakha104	31.00	37.33	41.00	36.44	30.00	35.67	41.33	35.67	31.00	37.33	41.00	36.44	30.00	35.67	41.33	35.67
Sakha101/GZ6906	34.67	38.00	42.00	38.22	33.67	35.00	41.00	36.56	34.67	38.00	42.00	38.22	33.67	35.00	41.00	36.56
Sakha102/GZ6379	36.67	37.67	41.00	38.44	33.33	34.67	41.33	36.44	36.67	37.67	41.00	38.44	33.33	34.67	41.33	36.44
J/IJ																
Giza176/Giza178	30.67	33.00	35.33	33.00	31.33	34.00	33.67	33.00	30.67	33.00	35.33	33.00	31.33	34.00	33.67	33.00
Giza178/ Sakha102	31.33	38.00	42.00	37.11	31.33	35.00	41.00	35.78	31.33	38.00	42.00	37.11	31.33	35.00	41.00	35.78
Sakha101/GZ6296-1	32.67	36.00	35.00	34.56	31.00	35.00	35.00	33.67	32.67	36.00	35.00	34.56	31.00	35.00	35.00	33.67
Sakha101/GZ6296-2	29.00	33.33	38.00	33.44	27.00	31.67	37.00	31.89	29.00	33.33	38.00	33.44	27.00	31.67	37.00	31.89
Sakha101/GZ6296-3	32.00	33.67	37.67	34.44	31.67	33.67	35.00	33.44	32.00	33.67	37.67	34.44	31.67	33.67	35.00	33.44
Sakha101/GZ6296-4	33.00	36.00	38.00	36.67	32.00	34.00	36.33	34.11	33.00	36.00	38.00	36.67	32.00	34.00	36.33	34.11
IJ/IJ																
Giza178/GZ6296-1	23.33	28.33	34.67	28.78	21.67	26.67	32.33	26.89	23.33	28.33	34.67	28.78	21.67	26.67	32.33	26.89
Giza178/GZ6296-2	24.67	29.00	36.67	30.11	23.00	27.00	36.33	28.78	24.67	29.00	36.67	30.11	23.00	27.00	36.33	28.78
Giza178/GZ6296-3	24.67	27.00	31.00	27.56	22.00	25.67	32.67	26.78	24.67	27.00	31.00	27.56	22.00	25.67	32.67	26.78
Giza178/GZ6296-4	24.00	29.00	31.00	28.00	22.33	26.00	30.67	26.33	24.00	29.00	31.00	28.00	22.33	26.00	30.67	26.33
Giza178/GZ6296-5	22.00	26.67	30.00	26.22	23.67	23.00	30.00	25.56	22.00	26.67	30.00	26.22	23.67	23.00	30.00	25.56
N- Mean	29.04	33.78	37.71	--	28.1	32.27	37.21	--	29.04	33.78	37.71	--	28.1	32.27	37.21	--
L.S.D 0.05																
Nitrogen	0.6907				0.709				0.21				1.19			
Entries	1.0408				1.386				1.39				1.33			
Interaction	1.08272				2.396				2.35				2.40			

Days to Heading: Under the two seasons of the study, different nitrogen doses had significant effect on days to heading (Table 2). Maximum days to flowering were observed in the plots which fertilized by 150 kg N/ha followed by75 kg N/ha while minimum days were observed in unfertilized plot. Since application of nitrogen increases vegetative growth and make the plant luxuriant, this in turn gets maximum days to heading. Days to heading was significantly different among genotypes and varied from as short as 94.67 and 94.78 days by genotype No. 10 (J/J) in 2008 and 2009 respectively, to as long as105.33 and 104.67 by genotype No. 13 (J/IJ) in 2008 and 2009, respectively.

Chlorophyll Content SPAD at Heading and 7, 14 and 21 Days after Heading: Results in Tables 3 and 4 showed that the two factors urea fertilizer rate and genotypes had signification effects on chlorophyll content. The highest value of leaves chlorophyll content was obtained in the 75 and 150 kg ha^{-1} urea fertilizer. Among genotypes, the J/J crosses had the highest chlorophyll content compared with the other groups where IJ/IJ crosses recorded the lowest value of SPAD reading in leaves at the four stages. From the day 0 to the day 21 after heading, the chlorophyll content decreased gradually over the three doses of nitrogen in all crosses leaves. These results indicate that the degradation for chlorophyll content was associated with leaf senescence; this is a normal process in the growth cycle of rice. The degradation for chlorophyll content was faster in IJ/IJ more than the J/J.

Number of Filled Grains per Panicle: Number of filled grains per panicle was significantly affected by nitrogen fertilizer application and genotypes. Plants which fertilized with 150 kg N/ha produced the highest number of filled grain per panicle, followed by plants which received 75 kg N/ha. However, the plants that didn't receive nitrogen gave the lowest values of number of filled grain per panicle. It could be concluded that nitrogen fertilization resulted in an increase in the amount of metabolites synthesized by rice plant and this, in turn, might account much for the superiority of number of filled grains per panicle. These results were true in both seasons. The pervious results are in good agreement with those obtained by Khanda and Dixit [9]. The tested genotypes of rice showed significant difference in number of filled grain per panicle in the same management. Under the nitrogen control environment, the number of filled grains per panicle ranged from 71.03 to 122.67 and from 61.00 to 118.67 in 2008 and 2009, respectively. The promising line

Table 5: Number of filled grains per panicle and Panicle weight (g) for twenty one rice entries as affected by nitrogen levels in 2008 and 2009

	Number of filled grains per panicle								Panicle weight (g)							
	2008				2009				2008				2009			
	Nitrogen levels kg/ha				Nitrogen levels kg/ha				Nitrogen levels kg/ha				Nitrogen levels kg/ha			
Entries	0	75	150	E Mean	0	75	150	E Mean	0	75	150	E Mean	0	75	150	E Mean
J/J																
Giza176/Giza177	84.33	112.67	168.67	121.89	88.33	115.00	167.67	123.67	2.80	3.50	3.93	3.41	2.23	3.37	3.73	3.11
Giza176/Sakha101	109.00	134.33	163.33	135.56	104.00	133.67	166.33	134.67	3.00	3.67	4.93	3.87	2.73	3.60	4.70	3.68
Giza176/GZ6379	89.00	126.00	144.33	119.78	83.00	125.33	143.00	117.11	2.03	2.90	4.83	3.26	1.93	3.33	4.27	3.18
Giza176/ GZ6944	107.33	140.67	174.67	140.89	105.00	144.33	182.67	144.00	1.90	3.20	3.70	2.93	1.80	3.23	3.60	2.88
Giza177/Sakha101	71.033	134.33	154.67	120.11	61.00	135.67	150.67	115.78	1.80	3.00	3.77	2.86	1.67	2.83	4.00	2.83
Giza177/Sakha102	110.67	130.00	147.67	129.44	112.67	129.33	143.00	128.33	2.50	3.23	3.83	3.19	2.13	3.20	3.77	3.03
Sakha101/Sakha103	80.33	111.67	143.33	111.78	75.00	107.67	136.00	106.22	2.00	3.30	4.00	3.10	2.17	3.23	4.07	3.16
Sakha101/Sakha104	104.00	123.67	159.33	129.00	101.67	126.00	160.67	129.44	2.80	3.63	4.80	3.74	2.53	3.63	4.50	3.56
Sakha101/GZ6906	101.67	112.00	154.00	122.56	97.67	115.00	155.00	122.56	2.30	3.13	3.77	3.07	2.17	3.2	3.87	3.08
Sakha102/GZ6379	95.33	123.00	143.67	120.67	89.00	123.67	143.33	118.67	2.20	3.10	4.10	3.13	2.03	3.1	3.97	3.03
J/IJ																
Giza176/Giza178	93.33	160.00	172.00	141.78	89.33	161.00	171.67	140.67	2.97	3.77	4.77	3.83	2.70	3.70	4.67	3.69
Giza178/ Sakha102	109.67	130.67	157.00	132.44	113.00	130.67	156.67	133.44	2.50	3.17	3.73	3.13	2.30	3.23	3.60	3.04
Sakha101/GZ6296-1	102.33	136.33	139.67	126.11	103.00	133.00	138.67	124.89	2.00	3.10	4.80	3.30	2.33	3.13	4.60	3.36
Sakha101/GZ6296-2	82.00	125.00	155.00	120.67	88.00	124.33	153.33	121.89	2.17	2.70	3.37	2.74	2.10	2.70	3.20	2.67
Sakha101/GZ6296-3	96.00	135.00	163.00	131.33	92.67	139.33	164.67	132.22	2.70	3.20	4.67	3.52	2.53	3.37	4.53	3.48
Sakha101/GZ6296-4	81.67	112.67	160.00	118.11	80.00	116.00	165.33	120.44	2.60	3.40	4.40	3.47	2.40	3.30	4.07	3.26
IJ/IJ																
Giza178/GZ6296-1	122.67	137.67	175.33	145.22	118.67	139.67	169.67	142.67	2.70	3.63	4.77	3.70	2.50	3.70	4.73	3.64
Giza178/GZ6296-2	116.00	142.67	167.67	142.11	116.00	137.67	168.33	140.67	2.33	3.70	4.80	3.61	2.13	3.27	4.80	3.40
Giza178/GZ6296-3	104.33	156.33	188.33	149.67	105.67	155.33	174.67	145.22	2.90	3.87	4.50	3.76	2.53	3.6	4.67	3.60
Giza178/GZ6296-4	116.33	131.33	184.00	143.89	115.00	133.00	172.67	140.22	2.97	3.40	5.00	3.79	3.03	3.43	4.97	3.81
Giza178/GZ6296-5	113.33	145.33	180.00	142.22	111.00	148.00	178.67	145.89	2.70	3.63	5.00	3.78	2.50	3.70	4.97	3.72
N- Mean	99.56	131.49	161.70	--	97.60	132.08	160.13	--	2.47	3.34	4.36	--	2.31	3.33	4.25	--
L.S.D 0.05																
Nitrogen	3.97				2.68				0.10				0.14			
Entries	6.03				4.63				0.24				0.21			
Interaction	10.58				8.05				0.41				0.37			

No. 17 (IJ/IJ) gave the highest number of filled grains per panicle under nitrogen control treatments in the two season of study, thus we can utilize by the this genotype in breeding program to breeding for low input. While under fertilized plots, the promising lines No. 19 and 21 (IJ/IJ) was superior in 2008 and 2009, respectively (Table 5).

Panicle Weight (g): The application of nitrogen increased significantly panicles weight (Table 5). Plants which fertilized with 150 kg N ha^{-1} produced the heaviest panicle followed by the plants which fertilized with 75 kg N ha^{-1}. The lightest panicles were obtained when no nitrogen was applied. The significant increase in panicle weight by increasing nitrogen levels up to 150 kg N ha^{-1} is attributed to the increase in the number of filled grains per panicle. These findings agreed with Raghuwanshi *et al.* [10]. Panicle weight was significantly different among genotypes and varied from as low as 2.74 and 2.67 g produced by genotype, No. 14 (I/IJ) in the two seasons of study, respectively to as high as 3.87 and 3.69 g in 2008 and 2009 produced by promising lines No. 2 (J/J) and promising lines No. 11 (J/IJ), respectively.

Number of Panicles per Hill: A significant positive effect on the number of panicles per hill of the rice entries was observed from the application of nitrogen fertilizer. The application of nitrogen fertilizers at the rate of 75 or 150 kg N ha^{-1} increased number of panicles per hill over the control. The effect of nitrogen application on number of panicles per m^2 attributed mainly to the stimulation effect of nitrogen on effective tillers formation. These findings are consistent with those reported by Ebaid and Ghanem [11], Chopra and Chopra [12] and Singh *et al.* [13]. Genotypes differed significantly in the number of panicles per hill under all nitrogen levels in the two seasons of the study. The data in Table 6 indicated that the genotypes No. 17 (IJ/IJ), 19 (IJ/IJ), 21 (IJ/IJ), 7 (J/J) and 16 (J/IJ) produced the greatest number of panicles per hill in the first season while in the second season the greatest number recorded by promising lines No. 21 (IJ/IJ), 17 (IJ/IJ), 18 (IJ/IJ), 6 (J/J), 7 (J/J) and 16 (J/IJ).

Table 6: Number of panicles per hill and 1000 grain weight (g) for twenty one rice entries as affected by nitrogen levels in 2008 and 2009

	Number of panicles per hill								1000 grain weight (g)							
	2008				2009				2008				2009			
	Nitrogen levels kg/ha				Nitrogen levels kg/ha				Nitrogen levels kg/ha				Nitrogen levels kg/ha			
Entries	0	75	150	E Mean	0	75	150	E Mean	0	75	150	E Mean	0	75	150	E Mean
J/J																
Giza176/Giza177	15.67	20.00	22.00	19.22	15.00	19.00	21.33	18.44	26.33	25.00	21.00	24.11	25.70	24.33	21.00	23.68
Giza176/Sakha101	16.00	18.33	21.67	18.67	15.00	17.67	20.33	17.67	28.67	26.67	24.00	26.44	28.00	26.00	24.67	26.22
Giza176/GZ6379	16.33	19.00	20.33	18.56	17.00	18.00	21.00	18.67	29.67	27.00	24.00	26.89	29.00	26.00	23.33	26.11
Giza176/ GZ6944	16.67	20.00	23.00	19.89	16.67	19.67	22.67	19.67	26.67	25.00	21.33	24.33	26.00	24.67	21.00	23.89
Giza177/Sakha101	17.67	20.67	23.33	20.56	18.33	20.00	23.00	20.44	28.67	26.00	24.00	26.22	28.00	25.67	23.33	25.67
Giza177/Sakha102	16.67	20.00	21.00	19.22	16.00	19.00	22.00	19.00	29.67	28.67	25.00	27.78	29.00	27.00	25.00	27.00
Sakha101/Sakha103	18.33	21.00	24.00	21.11	17.00	20.67	23.00	20.22	28.33	26.00	24.00	26.11	28.00	25.00	23.67	25.56
Sakha101/Sakha104	18.00	19.00	22.00	19.67	18.33	20.00	21.33	19.89	31.00	28.033	25.00	28.11	29.67	27.00	24.67	27.11
Sakha101/GZ6906	15.00	19.00	21.00	18.33	17.00	18.67	20.00	18.56	27.67	25.00	22.00	24.89	28.00	24.67	20.33	24.33
Sakha102/GZ6379	16.33	19.00	21.00	18.78	15.67	18.33	21.67	18.56	25.00	24.33	19.00	22.78	25.00	23.00	18.33	22.11
J/IJ																
Giza176/Giza178	16.33	19.00	22.00	19.11	17.67	20.00	22.67	20.11	27.67	25.67	23.00	25.44	27.00	25.00	22.67	24.89
Giza178/ Sakha102	17.33	20.00	21.67	19.67	16.67	19.00	22.67	19.44	24.00	24.00	21.00	23.00	25.00	22.67	20.33	22.67
Sakha101/GZ6296-1	18.67	20.00	22.00	20.22	17.00	20.00	22.33	19.78	27.00	24.00	20.00	23.67	26.00	23.00	19.67	22.89
Sakha101/GZ6296-2	16.33	19.67	21.33	19.11	18.00	20.00	21.00	19.67	26.00	23.00	19.00	22.67	25.00	23.00	18.00	22.00
Sakha101/GZ6296-3	16.00	19.00	21.00	18.67	15.67	20.00	20.00	18.56	25.67	24.00	18.00	22.56	25.00	24.00	17.00	22.00
Sakha101/GZ6296-4	17.00	22.00	24.00	21.00	16.67	21.00	23.00	20.22	26.33	25.00	21.33	24.22	27.00	24.67	20.33	24.00
IJ/IJ																
Giza178/GZ6296-1	17.67	22.00	25.00	21.56	18.33	21.00	23.00	20.78	25.67	24.00	23.00	24.22	26.00	24.33	22.00	24.11
Giza178/GZ6296-2	17.33	21.00	23.00	20.44	16.67	20.33	23.00	20.00	25.67	24.33	22.33	24.11	25.00	23.00	22.00	23.33
Giza178/GZ6296-3	17.00	20.33	24.00	20.44	17.67	19.67	22.67	20.00	28.00	24.67	22.67	25.11	26.00	24.67	22.67	24.44
Giza178/GZ6296-4	16.67	19.67	22.00	19.44	16.00	19.00	21.00	18.67	25.33	23.00	20.33	22.89	24.00	23.67	20.67	22.78
Giza178/GZ6296-5	17.67	21.00	24.00	20.89	19.00	20.00	24.00	21.00	28.33	25.00	22.33	25.22	27.00	25.33	21.33	24.56
N- Mean	16.89	19.98	22.35	--	16.92	19.57	21.98	--	27.21	25.18	22.02	--	26.64	24.6	21.52	--
L.S.D at 0.05																
Nitrogen	0.23				0.6				0.49				0.46			
Entries	1.14				1.19				0.83				1.01			
Interaction	1.94				2.06				1.44				1.74			

Table 7: Grain yield (t/h), grain yield efficiency index GYEI and Agronomic Nitrogen use efficiency ANUE (kg kg-1) for twenty one rice entries as affected by nitrogen levels in 2008 and 2009

	Grain yield (t/ha)								Grain yield efficiency index GYEI				Agronomic Nitrogen use efficiency ANUE (kg kg-1)			
	2008				2009				2008		2009		2008		2009	
	Nitrogen levels kg/ha				Nitrogen levels kg/ha				Nitrogen levels kg/ha		Nitrogen levels kg/ha		Nitrogen levels kg/ha		Nitrogen levels kg/ha	
Entries	0	75	150	E Mean	0	75	150	E Mean	75	150	75	150	75	150	75	150
J/J																
Giza176/Giza177	6.59	10.97	13.13	10.23	6.3	10.91	12.89	10.03	1.19	1.14	1.20	1.15	58.40	43.6	61.47	43.93
Giza176/Sakha101	5.72	9.86	12.66	9.41	5.48	9.22	11.55	8.75	0.93	0.96	0.88	0.89	55.20	46.27	49.87	40.47
Giza176/GZ6379	5.25	8.75	11.84	8.16	5.43	8.58	11.20	8.40	0.75	0.82	0.81	0.86	46.67	43.93	42.00	38.47
Giza176/ GZ6944	8.81	10.85	12.48	10.71	7.64	10.79	12.37	10.27	1.57	1.45	1.44	1.33	27.20	24.47	42.00	31.53
Giza177/Sakha101	9.04	10.97	12.25	10.75	8.93	10.79	11.78	10.50	1.63	1.46	1.68	1.48	25.73	21.4	24.80	19.00
Giza177/Sakha102	6.01	9.33	11.08	8.80	5.89	9.39	10.79	8.69	0.92	0.88	0.96	0.90	44.27	33.8	46.67	32.67
Sakha101/Sakha103	5.66	8.81	11.14	8.54	5.83	8.63	10.79	8.42	0.82	0.83	0.88	0.89	42.00	36.53	37.33	33.07
Sakha101/Sakha104	7.29	10.5	12.25	10.01	7.35	9.92	11.9	9.72	1.26	1.18	1.27	1.23	42.80	33.07	34.27	30.33
Sakha101/GZ6906	6.01	9.33	10.91	8.750	5.72	9.16	10.5	8.46	0.92	0.87	0.91	0.85	44.27	32.67	45.87	31.87
Sakha102/GZ6379	5.48	7.64	9.86	7.66	5.6	7.53	9.1	7.41	0.69	0.71	0.74	0.72	28.80	29.20	25.73	23.33
J/IJ																
Giza176/Giza178	5.08	8.81	10.5	8.13	4.73	8.40	10.15	7.76	0.74	0.70	0.69	0.68	49.73	36.13	48.93	36.13
Giza178/ Sakha102	4.96	7.64	10.03	7.54	4.38	7.23	9.63	7.08	0.62	0.66	0.55	0.59	35.73	33.80	38.00	35.00
Sakha101/GZ6296-1	5.76	7.58	9.1	7.49	5.60	7.18	9.04	7.27	0.72	0.69	0.70	0.71	24.27	22.27	21.07	22.93
Sakha101/GZ6296-2	5.08	6.77	8.81	6.88	4.90	6.71	8.81	6.81	0.57	0.59	0.57	0.61	22.53	24.87	24.13	26.07
Sakha101/GZ6296-3	5.48	7.47	10.15	7.70	5.60	7.12	9.22	7.31	0.67	0.73	0.69	0.73	26.53	31.13	20.27	24.13
Sakha101/GZ6296-4	6.07	8.05	10.97	8.36	5.89	7.58	10.38	7.95	0.80	0.88	0.78	0.86	26.40	32.67	22.53	29.93
IJ/IJ																
Giza178/GZ6296-1	7.88	10.91	13.88	10.89	7.18	10.15	13.71	10.34	1.41	1.44	1.27	1.39	40.40	40.00	39.60	43.53
Giza178/GZ6296-2	7.29	10.27	13.65	10.40	7.41	10.21	12.71	10.11	1.23	1.31	1.32	1.33	39.73	42.40	37.33	35.33
Giza178/GZ6296-3	7.64	11.38	14.23	11.08	7.23	11.20	14.29	10.91	1.43	1.44	1.41	1.46	49.87	43.93	52.93	47.07
Giza178/GZ6296-4	6.65	10.85	13.07	10.19	7.35	10.62	13.18	10.38	1.19	1.15	1.36	1.37	56.00	42.80	43.60	38.87
Giza178/GZ6296-5	7.82	11.03	14.12	10.99	7.29	10.85	13.48	10.54	1.42	1.46	1.38	1.39	42.80	42.00	47.47	41.27
N- Mean	6.46	9.42	11.72		6.27	9.150	11.31	--	--	--	--	--	--	--	--	--
L.S.D at 0.05																
Nitrogen	0.22				0.14				--	--	--	--	--	--	--	--
Entries	0.29				0.3				--	--	--	--	--	--	--	--
Interaction	0.51				0.51				--	--	--	--	--	--	--	--

1000 Grain Weight (g): Resulted revealed that application of nitrogen significantly decreased the 1000-grain weight. Thus, the highest values of 1000-grain weight appear when nitrogen was not applied (Table 6). This Mainly due to the higher number of spikelets per panicle in plants received nitrogen at any of the rates than those did not received any nitrogen. So the sink capacity is high and the source is limited, therefore, the filling of grains will be more consequently the weight of grains will be high. These findings are in agreement with those reported by Lai *et al*. [14], Xu and Zhou [15] and Singh *et al*. [13].

Grain Yield (t/ha): Grain yield was significantly varied among nitrogen levels and genotypes. The application of nitrogen fertilizer up to 150 kg N ha^{-1} increased rice grain yield in all genotypes in the two seasons of study (Table 7). Grain yield, in fact, is the out-product of its main components. Any increase in one or more of such components without decrease in the others will lead to an increase in grain yield. Therefore, the increase in grain yield due to applying nitrogen was the logical resultant due to the achieving increased in its components, i.e. the number of panicles per hill and number of filled grains per panicle. Similar trend was found by Ebaid and Ghanem [11], Chopra and Chopra [12], Singh *et al*. [13] and Mhaskar *et al*. [8]. The promising line No. 19 (IJ/IJ) gave the highest grain yield in the two seasons of study. The yield of genotypes No. 17 (IJ/IJ) and No. 21 (IJ/IJ) were statistically similar to that of line No. 19 (IJ/IJ) in 2008 season only. Under the nitrogen control plots, the promising line No. 5 (J/J) gave the highest grain yield (9.04 and 8.93 t ha^{-1} in 2008 and 2009, respectively).On the hand, this genotype yielded 10.97 and 10.79 with 75 kg N ha^{-1} as well as 12.25 and 11.78 with 150 kg N ha^{-1} in the two seasons of study. Generally the IJ/IJ crosses gave the highest grain yield followed by J/J crosses while, J/IJ crosses gave the lowest grain yield. This mainly due to there is genetic diversity among them.

Grain Yield Efficiency Index (GYEI): The GYEI helps to separate genotypes into high-yielding, stable, nutrient efficient genotypes and low-yielding, unstable, nutrient inefficient genotypes. Tolerant genotypes have a GYEI of 1 or higher. The susceptible or nutrient inefficient genotypes have a GYIE in the range of 0 to 0.50 and the genotypes between these two limits are considered intermediate types Fageria *et al*. [6] and Fageria and Baligar [1]. Data in table 7 indicated that the genotypes No. 1, 4, 5 and 8 (J/J) and genotypes derived from crossing between Giza178/GZ6296 gave more than unity GYEI. This indicated that these genotypes classified as tolerant, high-yielding, stable and nutrient efficient genotypes. While the other genotypes gave intermediate values. There was a wide variation in GYEI among genotypes under low and high nitrogen condition.

Agronomic Nitrogen Use Efficiency (ANUE): The nitrogen use efficiency can be defined as the maximum economic yield produced per unit of nitrogen applied, absorbed or utilized by the plant to produce grain and straw. However, in the literature, nutrient use efficiency has been defined is several ways. Agronomic nitrogen use efficiency ANUE is one of the most important nitrogen use efficiencies. ANUE were from 21.07 to 61.47 kg kg^{-1}. Generally ANUE decreased with increasing N rate. Similar results are reported by Saleque *et al*. [7] and Xie *et al*. [16]. The tested genotypes in table 7 showed a wide variation in ANUE. The highest ANUE was obtained with promising line No. 1 (J/J) and the lowest with genotypes No. 13 (IJ/IJ) and No. 5 (J/J).

Classification of Rice Genotypes: Cluster analysis was carried out using the mean values of all traits studied for the 21 varieties. The varieties were grouped into four clusters (Fig. 1). Cluster I consisted of five indica/japonica type varieties, (promising lines No. 18,19,21,20 and 17 indicating high similarity among them, while the lines no. 11 (J/IJ), No.4 (J/J) and No.2 (J/J) cluster together in the first group. Cluster II consisted of six rice genotypes, 15,16,14,13 (J/IJ) and the line No.10 (J/J) and No.5 (J/J) type. On the other hand the cluster IV consisted of six rice varieties, included one rice variety (J/IJ) type No.12, the other 5 genotypes of (J/J) type. These classification by cluster analysis corresponded to varieties response to varying nitrogen levels. The varieties in cluster I always had an increased grain yield with an increase in nitrogen application; also these genotypes displayed the highest values of grain yield efficiency index and agronomic nitrogen use efficiency (Table 7).

It is concluded that the classic breeding program (hybridization and selection) is still more efficiency to generate a new desirable varieties which can grow under low levels of nitrogen utilization. The further development of breeding programs are required in the future to increase the yield under low levels of nitrogen utilization and more genetic and molecular genetic investigation are needed to determine genes responsible for the efficiency of nitrogen utilization in the plant.

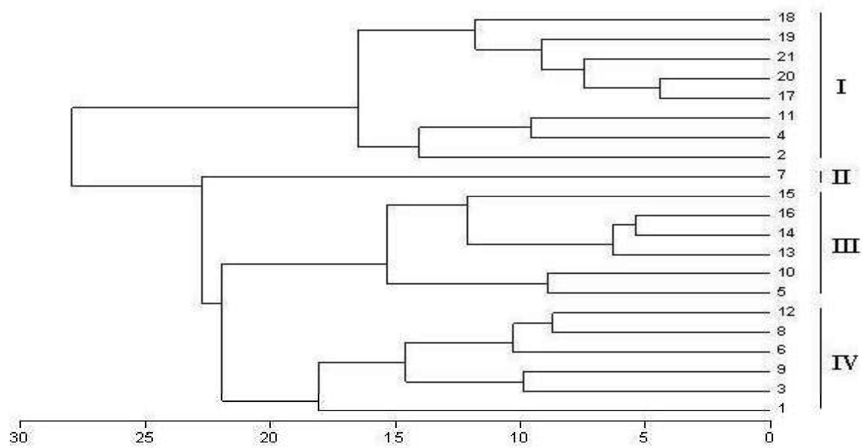

Fig. 1: Hierarchical cluster analysis based on all studied for the 21 rice genotypes

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