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RESPONSE OF DIFFERENT PROMISING RICE GENOTYPES TO VARIOUS NITROGEN LEVELS.

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ABSTRACT

Two field experiments were conducted at the Experimental Farm of Rice Research and Training Center, Sakha, Kafer El-Sheikh, Egypt during the rice growing seasons of 2009 and 2010 to evaluate the response of different rice genotypes namely, GZ8455, GZ8450, GZ7576, GZ8479, GZ8126, GZ7769, GZ7764 and GZ6522 (Sakha105) to various nitrogen levels (0, 40, 80, 120, 160, 200, 240, 280 and 320 Kg N ha^{-1}). Yield and yield attributes were determined at maturity. A wide variation in nitrogen response was observed in the eight rice genotypes. GZ6522 produced the highest grain yield followed by GZ8455 and GZ8126. Grain yield and most of yield attributes generally increased with increasing nitrogen levels up to 160 kg N ha^{-1}.

Keywords: Rice Genotypes Nitrogen Levels

INTRODUCTION

Rice (*Oryza sativa L*.) is one of the most important cereal crops of the world, grown in wide range of climatic zones, to nourish the mankind. It is the staple food for more than three billion people that is over half of the world's total population (FAO, 2004).

Nitrogen is clearly an extremely important and essential element, and continuing research has constantly revealed more and more facets apart from its well known roles in plant metabolism and growth. Given the importance of nitrogen fertilization on the grain yield of rice crop, it is necessary to know what the best dose needed for each variety as well as its influence on components of yield. In many parts of the world, N fertilizer recommendations continue to follow a prescriptive approach using generic models of economic response, often without regard to site-specific variations in crop N requirement (Meisinger *et al*., 2008). The efficiency of nitrogen used by rice plant is central to its overall yield potential, and efforts to improve its potential must be guided by a thorough understanding of the processes that govern N-use efficiency. Improvements in efficiency of nitrogen are also needed to reduce N-fertilizer requirements.

Shaiful Islam *et al*. (2009) reported that by applying proper dose of nitrogen lead to save money and can also keep our environment sound. Moreover, the heavy use of fertilizer affects the soil and also the environment through the residual effect of fertilizer. Selection of the most appropriate level of nitrogen fertilization is a major concern of economic viability of crop production and the impact of agriculture. Metwally *et al*. (2010) studied the physio-morphological behavior of twenty one Egyptian rice genotypes under low and high nitrogen application. He found that There was a wide variation in Agronomic Nitrogen Use Efficiency (ANUE) among genotypes under low and high nitrogen levels.

This current research aims to study the response of several promising rice genotypes to different nitrogen levels to identify the actual requirement for each rice entry under study.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of Rice Research and Training Center, Sakha, Kafer El-Sheikh, Egypt during the rice growing seasons of 2009 and 2010. A total of eight rice entries were used to evaluate the suitable requirement of each entries for nitrogen. The origin and parentage of tested genotypes (GZ8455, GZ8450, GZ7576, GZ8479, GZ8126, GZ7769, GZ7764 and GZ6522) were presented in Table 1. Soil was clay and some basic properties of the soil at the experimental sit are shown in Table 2.

Treatments were laid out in a split plot design which replicated four times. Main plots treatments received rice entries, while nitrogen levels were located in sub plots. Fertilizer-N level treatments 0, 40, 80, 120, 160, 200, 240, 280 and 320 kg N ha^{-1} were applied as form urea (46.5% N) in two equal split applications, the first dose as basal while the second dose after 30 days from transplanting.

The seed rate 96 kg seed ha^{-1} was used. Clean seeds of each genotype with at 90% germination were soaked in water for 24 hours and incubated for 48 hours. Pre-germinated seeds of rice genotypes were sown in May10th in both seasons. Seedling at 30 days old (3-4 seedling $hill^{-1}$) were transplanted at 20 X 20 cm distance between hills and rows. The plot size was kept 4 X 3 m. Phosphorus at the rate of 36 kg P_2O_5 ha^{-1} was applied as basal application during soil preparation. $ZnSO_4$ containing 22% zinc was applied at 24 kg per hectare just before transplanting to eliminate zinc deficiency. After transplanting, 5cm water depth was maintained in the experimental plots. Weeds were chemically controlled as recommended. Insects and diseases intensively controlled through the rice season to avoid any yield loss. . Ten days before harvest, the plots were drained to facilitate harvesting.

At harvest, number of panicle $hill^{-1}$, panicle length, panicle weight, number of grains $panicle^{-1}$, sterility percentage, 1000-grain weight, grain yield and straw yield were recorded. Harvest index and agronomic nitrogen use efficiency (ANUE) was calculated.

Agronomic nitrogen use efficiency (ANUE) was computed according to Saleque *et al*.(2004) as follows:

$$\textbf{ANUE} = \frac{\textbf{(Grain yield in fertilized plot kg) -(Grain yield in unfertilized plot kg)}}{\textbf{(Quantity of nutrient applied) kg}}$$

Data were analyzed by analysis of variance (ANOVA) in a split plot according to the procedure outlined by Gomez and Gomez (1984). Significant difference means were separated at $P < 0.05$ by the least significant difference (LSD) test. Statistical analyses were made with commercial software.

Table 1: Origin and parentage of tested genotypes.

Entry	Parentage	Origin	Group
GZ8455	GZ5603-3-3-2-1/Kanto51	Egypt	Japonica
GZ8450	GZ5603-3-2-2-1/RYNG Song 14	Egypt	Japonica
GZ7576	GZ5418/Milyang 79	Egypt	Japonica
GZ8479	GZ6214-4-1-1-1-1/Empssic 104	Egypt	Japonica
GZ8126	GZ5830-63-1-2/GZ5963-1-2-1-1	Egypt	Japonica
GZ7769	GZ5385-29-3-2/Akiyutaka	Egypt	Japonica
GZ7764	GZ5320-5-1-1/Norin22	Egypt	Japonica
GZ6522	GZ5581-46-3/GZ4316-7-1-1	Egypt	Japonica

Table 2: Some physical and chemical properties of the soil at the experimental site during 2009 and 2010 season.

Soil properties	2009	2010
Mechanical analysis		
Clay %	54.06	55.80
Silt %	30.64	31.50
Sand %	15.30	13.20
Textere	Clay	Clay
Chemical analysis		
Organic matter %	1.45	1.60
Total nitrogen , mg kg^{-1}	540.00	570.00
Available P, mg kg^{-1}	15.00	17.00
pH (1:2.5 soil suspension)	8.10	8.19
EC $dS.m^{-1}$ (soil paste)	2.95	2.87
Soluble cations, meq. L^{-1} :		
Ca^{++}	9.50	10.00
Mg^{++}	3.94	3.98
K^{+}	1.76	1.80
Na^{+}	14.80	13.20
Solube anions, meq. L^{-1}		
$CO_3^{=}$	0.00	0.00
HCO_3^{-}	6.00	6.75
Cl^{-}	8.30	8.44
$SO_4^{=}$	15.7	13.79
Available micronutrients ppm		
Fe^{++}	6.10	5.80
Zn^{++}	1.10	1.05
Mn^{++}	3.50	3.01

RESULTS AND DISCUSSION

Number of panicles hill^{-1}

Number of panicles hill^{-1} was markedly influenced by different genotypes and various nitrogen levels as well as their interaction Table (3). Among the genotypes, GZ6522 significantly produced higher panicles number hill^{-1} than the other ones. GZ7764 recorded the lowest number of panicles hill^{-1}. In the same Table, increasing nitrogen levels from 0 up to 160 kg N ha^{-1} significantly increased number of panicles hill^{-1}. Moreover, there was a gradual reduction in number of panicles due to increasing nitrogen levels from 160 up to 320 kg N ha^{-1}. These findings are hold fairly true in the two seasons under study. The increases in number of panicles under 160 kg N ha^{-1} might be due to more availability of nitrogen that played a vital role during initiation of panicles while adding N more than 160 kg N ha^{-1} increase the unproductive tillers due to increase vegetative growth period consequently decrease the productive tillers. These results are in accordance to the findings of Chaturvedi (2005) and Metwally *et al*. (2010).

Data in Table 4 revealed that the highest number of panicles ha^{-1} was obtained when GZ 6522 was fertilized by 160 kg N ha^{-1} in 2009 and 2010 seasons followed by the application of 200 kg N ha^{-1} to the same entry in 2010 season. On the other hand the lowest number of panicles hill $^{-1}$ was produced from GZ 7764 under unfertilized plots in the two seasons.

Panicle length (cm):

Data in Table 3 indicated that there were significant differences among both tested entries and N levels in panicle length. The tallest panicle was produced by GZ8455 followed by GZ6522, while GZ7764 produced the shortest panicle in both seasons. This variation in panicle length could be due to genetic background. The raising level of N up to 320 kg N ha^{-1} significantly increased panicle length.

Table 3; Number of panicles hill^{-1}, panicle length, panicle weight, number of grains panicle^{-1} and sterility % of rice entries as affected by nitrogen levels in 2009 and 2010 seasons.

Treatment	No. of panicles hill^{-1}		Panicle length cm		Panicle weight g		No. of grains panicle^{-1}		Sterility %	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Entries:										
GZ8455	20.92	20.10	22.53	22.65	2.86	3.51	142.85	153.19	6.78	6.06
GZ8450	20.03	21.22	20.82	21.58	2.49	3.43	124.41	145.12	5.40	5.32
GZ7576	18.93	19.49	20.71	21.21	2.43	3.39	108.16	124.10	3.82	4.89
GZ8479	20.84	20.15	20.60	19.77	2.97	3.28	119.89	121.03	6.88	8.18
GZ8126	20.39	20.61	20.34	20.72	2.57	3.41	140.73	143.66	3.75	2.93
GZ7769	19.62	20.24	19.65	20.59	2.79	3.40	139.08	145.34	3.77	4.98
GZ7764	17.52	18.33	19.58	19.55	2.52	3.40	114.96	125.12	4.54	4.55
GZ6522	22.65	23.13	22.13	21.11	3.05	3.67	141.72	150.92	3.77	3.14
LSD at 0.05	0.90	0.88	0.390	0.30	0.06	0.08	2.18	3.97	0.17	0.21
N kg ha^{-1} :										
0	14.731	16.00	18.79	18.68	2.38	2.96	94.48	117.36	3.00	2.98
40	7.43	18.03	19.36	19.46	2.50	3.11	112.44	124.33	3.57	3.50
80	20.05	20.34	19.63	20.05	2.61	3.44	121.77	134.35	3.74	3.65
120	22.25	22.56	20.09	20.20	2.79	3.57	134.34	144.85	3.72	3.98
160	23.61	23.63	20.93	21.09	2.94	3.74	148.30	152.60	3.96	4.21
200	22.32	22.10	21.59	21.65	3.02	3.69	146.72	154.07	4.37	4.97
240	21.00	21.08	21.82	21.97	2.84	3.60	140.66	146.91	5.41	5.85
280	20.12	20.09	22.24	22.20	2.72	3.47	133.37	137.97	6.96	7.08
320	19.52	19.85	22.74	22.79	2.59	3.36	128.70	134.62	8.88	8.83
LSD at 0.05	0.69	0.77	0.25	0.39	0.02	0.11	1.50	3.77	0.155	0.27
Interaction	**	*	*	**	**	**	*	*	**	**

The effect of the interaction between rice genotypes and nitrogen levels on panicle length was significant in both seasons (Table 5). The tallest panicle was found when GZ6522 fertilized with 320 kg N ha^{-1}, on the other hand the shortest one produced by GZ7576 when nitrogen was not applied.

Table 4: Number of panicles hill^{-1} as affected by the interaction between rice entries and nitrogen levels in 2009 and 2010 seasons.

Season	Entry	N kg ha^{-1}								
		0	40	80	120	160	200	240	280	320
2009	GZ8455	15.00	18.00	23.00	24.67	25.33	22.33	21.00	19.67	19.33
	GZ8450	13.33	17.33	20.33	21.33	22.33	23.00	21.67	21.00	20.00
	GZ7576	13.00	15.33	18.67	23.33	22.00	20.67	19.67	19.10	18.67
	GZ8479	15.00	18.44	21.34	23.00	24.88	23.41	22.00	20.11	19.46
	GZ8126	17.00	18.67	19.33	20.33	24.33	24.10	20.67	19.87	19.27
	GZ7769	13.50	16.87	19.33	23.67	23.33	21.43	20.00	19.53	18.97
	GZ7764	12.33	14.67	17.00	18.67	20.34	19.00	18.83	18.53	18.33
	GZ6522	18.67	20.17	21.43	23.00	26.33	24.67	24.20	23.20	22.19
	LSD at 0.05	2.01								
2010	GZ8455	14.67	16.50	21.83	23.00	24.33	21.72	20.11	20.00	18.78
	GZ8450	16.50	20.33	21.50	22.17	23.78	22.83	22.23	21.00	20.67
	GZ7576	15.83	16.56	20.00	22.50	23.17	21.12	20.33	16.17	19.78
	GZ8479	17.33	19.67	20.83	22.67	21.50	20.11	20.33	19.60	19.33
	GZ8126	16.17	18.11	19.78	23.67	24.39	23.28	20.66	20.17	19.33
	GZ7769	14.87	17.64	20.11	23.00	23.67	22.22	20.67	20.50	19.56
	GZ7764	13.67	15.33	18.00	19.44	21.33	19.87	19.53	19.33	18.52
	GZ6522	19.00	20.17	20.67	24.11	26.89	25.65	24.83	23.99	22.90
	LSD at 0.05	2.21								

Table 5: Panicle length as affected by the interaction between rice entries and nitrogen levels in 2009 and 2010 seasons.

Season	Entry	N kg ha^{-1}								
		0	40	80	120	160	200	240	280	320
2009	GZ8455	20.57	22.49	22.13	22.13	22.53	22.97	23.21	23.53	23.27
	GZ8450	18.23	18.23	19.03	19.69	20.43	22.63	22.43	23.13	23.62
	GZ7576	17.13	17.77	18.37	19.91	23.24	22.25	22.21	22.53	23.00
	GZ8479	18.99	19.13	19.63	20.23	21.13	21.61	21.63	20.93	22.13
	GZ8126	19.03	19.23	19.23	19.33	19.63	20.63	21.77	21.78	22.47
	GZ7769	17.43	18.43	18.83	19.16	19.43	19.97	20.03	21.50	22.07
	GZ7764	18.47	18.93	19.03	19.23	19.43	20.03	20.23	20.33	20.53
	GZ6522	20.43	20.63	20.73	21.03	21.63	22.63	23.03	24.23	24.83
	LSD at 0.05	0.76								
2010	GZ8455	20.55	21.35	22.60	22.15	22.80	23.21	23.36	23.85	23.98
	GZ8450	19.05	20.11	20.75	20.15	21.25	22.72	23.00	23.60	23.60
	GZ7576	19.40	20.05	20.00	19.55	22.20	22.05	22.25	21.90	23.50
	GZ8479	18.05	17.60	18.85	20.75	21.30	21.00	20.75	19.70	19.96
	GZ8126	18.60	19.05	19.95	20.53	19.65	21.10	21.95	22.40	23.30
	GZ7769	17.40	19.70	21.00	19.65	20.10	21.40	21.91	22.00	22.16
	GZ7764	17.70	17.55	18.05	19.10	20.04	20.15	20.50	21.30	21.60
	GZ6522	18.70	20.30	19.20	19.70	21.35	21.60	22.05	22.85	24.25
	LSD at 0.05	1.09								

Panicle weight (g):

Panicle weight of the eight tested entries was influenced by different nitrogen levels as well as the interaction (Table 3). Data showed that in both seasons the heaviest panicle was produced by GZ6522. The application of any of tested N levels caused an increase in panicle weight compared to control. Panicle weight was significantly increased by increasing nitrogen levels up to 200 and 160 kg N ha^{-1} in the 2009 and 2010 seasons, respectively, but it was significantly decreased by increasing nitrogen levels from 200 up to 320 kg N ha^{-1} in the first season and from 160 up to 320 kg N ha^{-1} in the second season.

Regarding to the interaction effect of genotypes and nitrogen levels, data presented in Table 6 indicated that GZ6522 produced the highest values of panicle weight when fertilized with 160 kg N ha^{-1} in both seasons. While the lowest panicles weight was produced from GZ 8450 or GZ 8455 under control treatment in 2009 and 2010 seasons, respectively. Addition of suitable nitrogen fertilizer might improve the photosynthetic capacity during grain filling period and resulted in heaviest panicle and grains. These findings are in confirm with those obtained by Singh *et al*. (2004).

Table 6: Panicle weight as affected by the interaction between rice entries and nitrogen levels in 2009 and 2010 seasons.

Season	Entry	N kg ha^{-1}								
		0	**40**	**80**	**120**	**160**	**200**	**240**	**280**	**320**
2009	GZ8455	2.49	2.69	2.75	2.85	3.23	3.09	3.01	2.98	2.63
	GZ8450	1.88	2.13	2.43	2.59	2.80	2.96	2.74	2.56	2.28
	GZ7576	2.15	2.30	2.38	2.51	2.51	2.62	2.63	2.38	2.38
	GZ8479	2.64	2.83	2.87	3.31	3.37	3.10	2.93	2.90	2.77
	GZ8126	2.14	2.22	2.37	2.42	2.51	3.29	2.83	2.70	2.62
	GZ7769	2.65	2.64	2.71	2.97	2.96	3.08	2.81	2.66	2.56
	GZ7764	2.30	2.36	2.52	2.53	2.72	2.66	2.54	2.50	2.50
	GZ6522	2.73	2.78	2.84	3.09	3.43	3.36	3.18	3.06	2.99
	LSD at 0.05	0.08								
2010	GZ8455	2.64	2.83	3.68	3.41	3.59	4.01	3.87	3.79	3.75
	GZ8450	2.80	3.00	3.30	3.60	3.70	3.78	3.66	3.64	3.50
	GZ7576	2.77	3.14	3.47	3.58	3.99	3.52	3.42	3.33	3.30
	GZ8479	2.95	2.93	3.13	3.45	3.56	3.45	3.36	3.35	3.34
	GZ8126	3.17	3.25	3.51	3.54	3.75	3.61	3.50	3.40	2.97
	GZ7769	3.00	3.02	3.18	3.34	3.49	3.80	3.71	3.65	3.44
	GZ7764	2.84	2.99	3.44	3.65	3.67	3.64	3.57	3.48	3.34
	GZ6522	3.50	3.75	3.80	3.97	4.16	3.71	3.67	3.22	3.23
	LSD at 0.05	0.28								

Number of grains panicle^{-1}

Genotypes differed significantly in their number of grains panicle^{-1} (Table 3). Averaged across N levels, GZ8455 had the highest number of grains panicle^{-1}. The differences between GZ8455 and GZ6522 were not significant in number of grains panicle^{-1}. Generally the application of nitrogen fertilizer caused an increase in number of grains panicles^{-1} compared with the control (Table 3). Data indicated that nitrogen levels significantly affected number of grains panicle^{-1}. Increasing nitrogen levels from 0 to 160 and 200 kg N ha^{-1} increased significantly number of grains panicle^{-1} in the first and second seasons, respectively. Moreover, there was no significant difference between applying 160 and 200 kg N ha^{-1}. This results mainly due to the fact that the application of nitrogen at panicle initiation was found to be more efficient and used to increase spikelets number. These results supported with that obtained by Ebaid and Ghanem (2000) and Singh *et al*. (2004).

Concerning the effect of interaction, data in Table 7 showed that number of grains panicle^{-1} was significantly affected by the interaction between genotypes and nitrogen fertilizer levels. GZ6522 produced the maximum number of grains per panicle when fertilized by 200 kg N ha^{-1} while, GZ8479 produced the minimum number of grains per panicle zero nitrogen fertilizer treatment.

Table 7: Number of grains panicle^{-1} as affected by the interaction between rice entries and nitrogen levels in 2009 and 2010 seasons.

Season	Entry	N kg ha^{-1}								
		0	40	80	120	160	200	240	280	320
2009	GZ8455	104.13	121.80	120.40	145.93	164.87	163.20	158.79	149.91	156.60
	GZ8450	92.47	118.20	135.20	141.07	155.60	138.87	128.93	113.20	96.13
	GZ7576	82.80	97.27	110.40	121.13	117.07	115.24	120.47	102.20	106.87
	GZ8479	72.80	83.73	93.00	112.80	126.07	147.53	168.67	150.11	124.27
	GZ8126	104.40	118.33	134.33	143.13	153.33	165.67	142.13	150.80	154.47
	GZ7769	96.40	111.40	133.80	144.27	165.13	152.33	150.27	151.80	146.33
	GZ7764	96.87	120.47	108.93	116.00	143.47	117.20	109.80	111.47	110.47
	GZ6522	106.00	128.30	138.07	150.36	160.87	173.73	146.20	137.47	134.47
	LSD at 0.05	4.47								
2010	GZ8455	121.41	133.96	137.15	165.46	167.80	169.72	170.95	160.40	151.86
	GZ8450	115.04	132.87	148.67	158.04	166.27	155.67	146.76	142.60	140.17
	GZ7576	113.20	117.50	125.10	125.41	131.70	131.10	134.00	120.05	118.80
	GZ8479	95.30	102.06	119.00	136.16	148.50	151.90	113.66	113.16	109.50
	GZ8126	122.73	130.90	141.60	152.50	155.19	156.19	145.95	145.86	142.03
	GZ7769	130.86	140.32	147.00	153.46	156.24	157.98	144.01	140.66	137.56
	GZ7764	111.90	106.40	120.40	124.35	124.46	136.50	148.90	126.40	126.80
	GZ6522	128.40	130.60	135.84	143.43	170.60	173.51	171.08	154.60	150.20
	LSD at 0.05	10.70								

Sterility %

The tested rice genotypes and nitrogen levels had significant effect in sterility percentage in both seasons (Table 3). The highest sterility percentage was found in GZ8479 followed by GZ8455. This could be due to genetic background. Sterility percentage gradually increased as nitrogen level increased up to320 kg N ha^{-1}. These results were true in both seasons. The increase in spikelet sterility with increasing N levels may be associated with more spikelets produced per plant with increasing N levels and photoassimilate produced by source may not be sufficient to fill large number of spikelets. In other words, there was no appropriate balance between source and sink.

Data in Table 8 revealed that the highest sterility % was obtained when GZ8479 was fertilized by 320 kg N ha^{-1} both seasons. On the other hand the lowest sterility % were produced from GZ7769 in 2009 season and GZ8126 in 2010 season under unfertilized plots.

Table 8: Sterility % as affected by the interaction between rice entries and nitrogen levels in 2009 and 2010 seasons.

Season	Entry	N kg ha^{-1}								
		0	**40**	**80**	**120**	**160**	**200**	**240**	**280**	**320**
2009	GZ8455	4.71	5.50	5.85	5.78	5.74	6.44	6.68	8.04	12.37
	GZ8450	2.67	3.02	3.38	3.55	4.35	4.97	6.77	8.54	11.41
	GZ7576	1.97	3.19	2.87	2.87	3.13	3.57	3.91	5.55	7.36
	GZ8479	4.50	4.66	4.71	4.79	4.89	5.71	8.00	11.87	12.81
	GZ8126	2.75	3.78	3.73	3.07	2.78	2.37	3.38	4.12	7.81
	GZ7769	1.91	2.39	2.67	3.12	2.74	3.92	4.29	6.39	6.74
	GZ7764	2.75	2.94	3.33	3.68	4.32	5.01	5.68	6.25	6.97
	GZ6522	2.74	3.11	3.36	2.86	3.67	3.19	4.54	4.91	5.60
	LSD at 0.05	0.45								
2010	GZ8455	2.99	4.40	5.47	4.73	5.08	5.97	6.26	8.86	10.80
	GZ8450	3.49	4.22	3.70	3.77	3.49	5.24	7.02	7.54	9.26
	GZ7576	2.16	2.51	2.94	3.94	3.70	4.68	6.40	8.70	8.97
	GZ8479	6.38	7.03	6.14	6.87	6.98	7.81	9.42	9.43	13.50
	GZ8126	1.43	1.80	1.98	1.85	2.37	2.79	3.64	4.25	6.26
	GZ7769	2.20	2.58	3.92	4.04	4.17	4.70	5.09	7.73	10.43
	GZ7764	2.64	3.28	3.03	3.62	4.89	5.37	5.04	6.27	6.80
	GZ6522	2.53	2.15	2.03	3.05	2.98	3.21	3.82	3.84	4.57
	LSD at 0.05	0.68								

1000-grain weight (g):

Data regarding 1000-grain weight are shown in Table 9 and 10. Significant variation among the tested genotypes were observed. Among the genotypes, GZ6522 produced the highest values of 1000-grain weight followed by GZ8126 and GZ8479. But GZ8450 gave the lowest values in this respect. The weight of 1000-grain significantly influenced by nitrogen application. Zero, 160 and 200 kg N ha^{-1} produced the maximum values of 1000-grain weight without any significant differences among them. Increasing nitrogen levels from 200 up to 320 N ha^{-1} decreased significantly the weight of 1000-grain. This mainly due to that nitrogen increased spikelets number at high nitrogen levels. In contrast plants can not produce enough carbohydrates to fill all spikelets produced under high nitrogen fertilization level. These results are similar to those obtained by Mauad, *et al*. (2003) and Ghanbari-Malidareh (2011).

Interaction effects between N levels and entries on 1000-grain weight were significant in both seasons (Table 10). The maximum values of 1000-grain weight were observed where GZ6522 was received 160, 200 or 240 kg N ha^{-1}.

Table 9: 1000-grain weight, grain yield, straw yield and harvest index of rice entries as affected by nitrogen levels in 2009 and 2010 seasons.

Treatment	1000 grain weight g		Grain yield t ha^{-1}		Straw yield t ha^{-1}		Harvest Index	
	2009	2010	2009	2010	2009	2010	2009	2010
Entry:								
GZ8455	24.23	24.51	8.40	9.64	10.23	11.09	45.04	46.54
GZ8450	22.98	23.43	7.73	9.03	10.40	11.43	42.90	44.18
GZ7576	24.42	24.57	7.69	8.69	10.15	11.94	43.19	42.12
GZ8479	25.32	25.98	7.77	8.42	10.31	11.54	43.15	42.20
GZ8126	25.74	26.32	7.80	9.54	10.11	12.59	43.53	43.02
GZ7769	23.85	24.71	7.52	9.86	9.63	11.22	43.94	46.90
GZ7764	23.95	24.48	7.05	8.46	9.92	11.29	41.71	42.79
GZ6522	26.63	27.13	8.83	10.38	11.44	12.69	43.72	45.03
LSD at 0.05	0.33	0.37	0.12	0.19	0.09	0.17	0.45	0.52
N kg ha^{-1} :								
0	26.00	26.28	5.97	7.59	7.47	9.77	44.36	43.69
40	25.02	25.78	6.89	8.36	8.60	10.34	44.48	44.67
80	24.11	24.90	7.44	8.84	9.37	10.90	44.23	44.69
120	24.50	24.40	8.14	9.34	9.94	11.37	45.01	45.05
160	25.70	26.59	8.74	10.12	10.60	12.01	45.13	45.70
200	25.90	26.22	8.82	10.14	11.08	12.19	44.30	45.39
240	24.28	25.17	8.50	9.96	11.41	12.67	42.69	43.97
280	23.58	24.12	8.27	9.68	11.81	13.12	41.20	42.44
320	22.71	22.82	7.87	9.24	12.21	13.14	39.18	41.28
LSD at 0.05	0.30	0.31	0.15	0.19	0.12	0.14	0.50	0.52
Interaction	**	**	**	**	**	**	*	**

Table 10: 1000-grain weight as affected by the interaction between rice entries and nitrogen levels in 2009 and 2010 seasons.

Season	Entry	N kg ha^{-1}								
		0	40	80	120	160	200	240	280	320
2009	GZ8455	25.73	25.87	25.88	24.19	26.44	24.03	22.44	21.95	21.54
	GZ8450	23.42	22.77	21.87	23.78	25.16	24.13	22.87	22.12	20.73
	GZ7576	25.79	25.25	23.32	23.24	24.06	26.21	25.11	23.78	23.01
	GZ8479	26.99	25.42	25.49	24.37	25.96	25.73	25.62	24.30	23.97
	GZ8126	27.42	25.32	24.70	26.69	26.82	27.61	24.33	24.85	23.88
	GZ7769	25.79	25.23	22.67	23.69	23.95	25.32	23.29	23.17	21.51
	GZ7764	24.83	23.88	23.22	24.88	25.41	26.07	22.74	22.53	22.00
	GZ6522	27.66	26.41	25.76	25.17	27.77	28.08	27.80	25.96	25.08
	LSD at 0.05	0.85								
2010	GZ8455	25.31	26.00	24.80	24.02	26.61	24.06	23.76	22.77	22.73
	GZ8450	24.14	23.87	23.08	23.17	24.91	24.65	23.62	22.72	20.75
	GZ7576	26.14	25.70	23.88	22.75	26.09	26.25	24.17	23.93	22.28
	GZ8479	26.58	26.00	25.84	24.67	27.01	27.01	26.67	25.51	24.53
	GZ8126	27.59	27.02	26.07	26.45	27.35	27.16	26.27	25.35	23.62
	GZ7769	26.27	25.61	25.14	24.11	26.32	26.01	24.86	22.94	21.14
	GZ7764	26.39	25.33	24.30	23.82	26.13	25.00	23.60	23.16	22.60
	GZ6522	27.81	26.74	26.08	26.21	28.30	29.08	28.46	26.59	24.92
	LSD at 0.05	0.89								

Grain yield (t ha^{-1}):

Grain yield of eight rice genotypes as influenced by the application of different nitrogen levels and their interaction are presented in Tables 9 and 11. There was significant variation among various genotypes in grain yield. Maximum grain yield was produced by GZ6522 rice line followed by GZ8455.

While GZ7764 genotype produced the lowest grain yield as compared with the other rice genotypes. Data in Table 9 showed that the grain yield was significantly affected by nitrogen application. Nitrogen application increased the yield of all eight genotypes as compare with no N application treatment. It might be due to the effect of nitrogen on the proliferation of roots so the uptake level from soil was increased and supplying the upground parts of the plant. Data showed also that significant increase in grain yield as nitrogen levels increased from 0 up to 200 kg N ha^{-1} in the first and second seasons. The difference in grain yield between 160 and 200 kg N ha^{-1} was not significant. The increase in grain yield by increasing nitrogen level from 0 up to 200 kg N ha^{-1} was due to the increase in most of yield components as a result to establish optimal canopy which led to produced sufficient photosynthetic products consequently increase filling and gave greatest grain yield. Similar results were previously drawn by Singh *et al*. (2004), Mhaskar *et al*. (2005) and Fageria *et al*. (2006) who stated that optimal yield may be achieved by successful regulation of source-sink relationships for production and utilization of photoassimilate within plants.

The interaction effect between genotypes and N fertilizer levels on grain yield was significant. The maximum grain yield was observed in GZ6522 when fertilized with 160 or 200 kg N ha^{-1} in both seasons while, the minimum grain yield were recorded by GZ7764 in the first season and GZ8479 and GZ7764 in the second season under control plots.

Table 11: Grain yield as affected by the interaction between rice entries and nitrogen levels in 2009 and 2010 seasons.

Season	Entry	N kg ha^{-1}								
		0	**40**	**80**	**120**	**160**	**200**	**240**	**280**	**320**
2009	GZ8455	5.97	6.78	7.52	8.62	9.96	9.64	8.89	9.23	9.01
	GZ8450	6.84	7.17	7.45	8.32	8.09	8.02	8.00	7.99	7.72
	GZ7576	6.40	6.70	6.70	7.79	8.16	8.24	8.56	8.46	8.24
	GZ8479	6.25	7.13	7.47	7.78	8.90	8.89	8.30	7.88	7.29
	GZ8126	5.66	6.75	7.56	7.91	8.48	9.11	9.03	7.91	7.77
	GZ7769	5.50	6.45	7.22	7.70	8.39	8.61	8.11	7.96	7.78
	GZ7764	5.00	6.57	6.83	7.40	7.51	7.92	7.76	7.75	6.75
	GZ6522	6.10	7.60	8.79	9.62	10.46	10.13	9.31	9.00	8.43
	LSD at 0.05	0.41								
2010	GZ8455	8.02	8.97	9.19	9.63	10.48	10.76	10.10	10.02	9.55
	GZ8450	7.90	8.53	8.64	9.47	9.63	9.87	9.27	9.04	8.88
	GZ7576	7.38	7.58	7.83	8.89	9.23	9.45	9.55	9.25	9.03
	GZ8479	6.59	7.55	7.80	7.94	9.67	9.24	9.39	8.97	8.65
	GZ8126	7.45	8.02	9.59	9.98	10.33	10.39	10.52	10.11	9.48
	GZ7769	8.86	9.43	9.72	10.15	10.79	10.44	10.13	9.95	9.30
	GZ7764	6.60	7.66	7.86	8.05	9.10	9.45	9.49	9.29	8.62
	GZ6522	7.95	9.10	10.06	10.59	11.73	11.53	11.21	10.83	10.43
	LSD at 0.05	0.53								

Straw yield

Straw yield also significantly differ among the genotypes (Table 9). The highest straw yield was produced in GZ6522. Data in Table 9 also showed that straw yield gradually increased as nitrogen level increased up to 320 kg N ha^{-1}. Minimum straw yield was observed in control.

The performance of genotypes significantly varied according to nitrogen application. GZ6522 recorded the highest straw yield when fertilized with 320 kg N ha^{-1} in both seasons (Table 12). Chaturvedi (2005) reported that nitrogen nutrition influences the content of photosynthetic pigments, the biosynthesis of the enzymes taking part in the carbon reduction. Thus the increase in growth and yield owing to the application of N-fertilizers may be attributed to the fact that these nutrients being important constituents of proteins, chlorophyll and enzymes, involve in various metabolic processes which have direct impact on vegetative and reproductive phases of plants.

Table 12: Straw yield as affected by the interaction between rice entries and nitrogen levels in 2009 and 2010 seasons.

Season	Entry	N kg ha^{-1}								
		0	40	80	120	160	200	240	280	320
2009	GZ8455	7.73	8.68	8.78	9.81	10.81	11.21	11.41	11.84	11.82
	GZ8450	7.81	8.57	9.31	10.34	10.37	10.78	11.70	12.11	12.61
	GZ7576	7.77	8.83	9.07	10.01	10.77	10.86	11.01	11.37	11.63
	GZ8479	7.38	8.44	9.43	10.37	10.11	11.37	11.66	11.86	12.19
	GZ8126	7.88	9.09	9.24	9.42	10.02	10.72	10.77	11.53	12.33
	GZ7769	6.87	8.00	9.72	8.90	9.91	10.25	10.62	10.92	11.46
	GZ7764	6.67	8.39	9.00	9.62	10.42	10.68	11.01	11.38	12.15
	GZ6522	7.61	8.80	10.41	11.02	12.39	12.73	13.11	13.44	13.46
	LSD at 0.05	0.34								
2010	GZ8455	9.49	9.50	10.31	10.24	11.99	11.85	12.09	12.20	12.14
	GZ8450	9.14	10.67	10.71	11.64	11.46	11.56	12.65	12.69	12.37
	GZ7576	10.04	10.41	11.19	11.61	12.36	12.30	12.67	13.25	13.67
	GZ8479	9.75	10.18	10.20	10.50	11.43	12.27	12.25	13.68	13.59
	GZ8126	11.40	11.59	11.55	12.52	12.99	12.81	13.59	13.61	13.22
	GZ7769	9.37	9.66	10.6.	10.95	11.12	11.48	12.01	12.69	13.04
	GZ7764	9.60	9.93	10.46	10.62	11.35	11.59	12.58	12.74	12.80
	GZ6522	9.40	10.79	12.16	12.93	13.38	13.65	13.56	14.11	14.28
	LSD at 0.05	0.41								

Harvest Index

Genotypes differences, nitrogen levels and their interaction are presented in (Table 9). GZ8455 produced the highest values of harvest index and was superior to other genotypes. GZ7764 and GZ7576 recorded the lowest values in the first and second seasons, respectively. Data showed that significant increase in harvest index as nitrogen levels increased from 0 up to 160 kg N ha^{-1}. A significant reduction in harvest index was happened when nitrogen levels increased from 240 to 320 kg N ha^{-1}.

With regard to the interaction effect, application of 120 or 160 kg N ha^{-1} with GZ8455 in the first season and with GZ7769 in the second season caused the highest values of harvest index. GZ7764 and GZ8479 at 320 kg N ha^{-1} recorded the lowest values of harvest index in the first and second seasons, respectively (Table 13).

Sinclair (1998) stated that harvest index is a critical character associated with dramatic increase in grain yield that have occurred in recent century. This trait actually reflects the partitioning of photosynthate between the grain and vegetative parts of plant and improvements in harvest index emphasize the importance of carbon allocation in grain production.

Table 13: Harvest Index as affected by the interaction between rice entries and nitrogen levels in 2009 and 2010 seasons.

Season	Entry	N kg ha^{-1}								
		0	40	80	120	160	200	240	280	320
2009	GZ8455	43.58	43.86	46.13	46.77	47.95	46.24	43.79	43.81	43.25
	GZ8450	46.69	45.55	44.45	44.59	43.82	42.66	40.61	39.75	37.97
	GZ7576	45.17	43.14	42.49	43.76	43.11	43.14	43.74	42.66	41.47
	GZ8479	45.85	45.79	44.20	42.87	46.82	43.88	41.58	39.92	37.42
	GZ8126	41.80	42.61	45.00	45.64	45.84	45.94	45.61	40.69	38.66
	GZ7769	44.46	44.64	42.62	46.39	45.85	45.65	43.30	42.16	40.44
	GZ7764	42.84	43.92	43.15	43.48	41.89	42.58	41.34	40.51	35.71
	GZ6522	44.49	46.34	45.78	46.61	45.78	44.31	41.53	40.11	38.51
	LSD at 0.05	1.38								
2010	GZ8455	45.80	48.57	47.13	48.46	46.63	47.58	45.53	45.10	44.03
	GZ8450	46.34	44.43	44.66	44.86	45.67	46.04	42.28	41.57	41.80
	GZ7576	42.38	42.15	41.16	43.38	42.72	43.45	42.96	41.11	39.76
	GZ8479	40.30	42.59	43.33	43.06	45.81	42.92	43.38	39.59	38.85
	GZ8126	39.51	40.89	45.34	44.36	44.30	44.79	43.63	42.62	41.77
	GZ7769	48.61	49.39	47.76	48.11	49.24	47.64	45.75	43.95	41.62
	GZ7764	40.74	43.56	42.89	43.13	44.49	44.91	43.01	42.16	40.24
	GZ6522	45.82	45.77	45.27	45.04	46.70	45.79	45.22	43.40	42.20
	LSD at 0.05	1.47								

Agronomic Nitrogen Use Efficiency ANUE

Agronomic use efficiency of nitrogen fertilizer is presented in Table 14. Data indicted that ANUE was decrease by increasing N levels. Eagle *et al*. (2000) reported that in rice N use efficiency, which has both a physiological and soil N supply components, decreased with increase in soil N supply.

Table 14: Agronomic nitrogen use efficiency (ANUE) of rice entries as affected by nitrogen levels in 2009 and 2010 seasons.

Season	Entry	N kg ha^{-1}							
		40	80	120	160	200	240	280	320
2009	GZ8455	20.25	19.38	22.08	24.94	18.35	12.17	11.64	9.50
	GZ8450	8.25	7.63	12.33	7.81	5.90	4.83	4.11	2.75
	GZ7576	7.50	3.75	11.58	11.00	9.20	9.00	7.36	5.75
	GZ8479	22.00	15.25	12.75	16.56	13.20	8.54	5.82	3.25
	GZ8126	27.25	23.75	18.75	17.63	17.25	14.04	8.04	6.59
	GZ7769	23.75	21.50	18.33	18.06	15.55	10.88	8.79	7.13
	GZ7764	39.25	22.88	20.00	15.69	14.60	11.50	9.82	5.47
	GZ6522	37.50	33.63	29.33	27.25	20.15	13.38	10.36	7.28
2010	GZ8455	23.75	14.63	10.06	15.38	13.70	8.67	7.14	4.78
	GZ8450	15.75	9.25	9.81	10.81	9.85	5.71	4.07	3.06
	GZ7576	5.00	5.63	9.44	11.56	10.35	9.04	6.68	5.16
	GZ8479	24.00	15.13	8.44	19.25	13.25	11.67	8.50	6.44
	GZ8126	14.25	26.75	15.81	18.00	14.70	12.79	9.50	6.34
	GZ7769	14.25	10.75	8.06	12.06	7.90	5.29	3.89	1.38
	GZ7764	26.50	15.75	9.06	15.63	14.25	12.04	9.61	6.31
	GZ6522	28.75	26.38	16.50	23.63	17.90	13.58	10.29	7.75

Agronomic nitrogen use efficiency (ANUE) was varied among genotypes and it ranged from 2.75 to 39.25 and from 1.38 to 28.75 kg grain produced per kg of N applied in the first and second season, respectively. Across N levels, GZ6522 recorded the highest values of ANUE at all nitrogen levels in the two seasons except at 40 kg N ha^{-1} in the first season where GZ7764 recorded the highest value. Many researchers have reported significant variations of N-use efficiency among lowland rice genotypes (Fageria and Baligar 2003). Such differences may be related to genetic factors, physiological processes (absorption, translocation, assimilation, N remobilization, and storage), and biochemical processes (enzyme nitrate reductase efficiency) (Isfan, 1993 and Fageria and Baligar 2003).

Conclusion

Among the tested rice genotypes, GZ6522 (Sakha105) had higher response to nitrogen fertilization than the other tested genotypes while, GZ7764 had the less responded. The optimum dosage of nitrogen fertilizer for the tested genotypes was 160 kg N ha^{-1}. GZ6522 (Sakha105) was the best in grain yield which produced 10.46 and 11.73 t ha^{-1} in 2009 and 2010 seasons, respectively.

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استجابة بعض تراكيب الأرز الوراثية المبشرة تحت مستويات مختلفة من النيتروجين

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مركز البحوث والتدريب في الأرز- معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية

أجريت تجربتان حقليتان بمزرعة مركز البحوث والتدريب في الأرز سخا – كفرالشيخ – مصر خلال موسمى زراعة الأرز ٢٠٠٩ و٢٠١٠ وذلك لدراسة استجابة بعض التراكيب الوراثية المبشرة من الأرز لمستويات مختلفة من التسميد النيتروجيني. وقد تم استخدام ثمانية تراكيب وراثية وهي : GZ8455, GZ8450, GZ7576, GZ8479, GZ8126, GZ7769, GZ7764 and GZ6522 وذلك تحت تسعة مستويات من السماد النيتروجيني وهي ٠ , ٤٠ , ٨٠, ١٢٠, ١٦٠, ٢٠٠, ٢٤٠, ٢٨٠, ٣٢٠ كجم نيتروجين للهكتار.

وقد دلت النتائج على وجود اختلافات معنوية بين التراكيب الوراثية في استجابتها للتسميد النيتروجيني. وقد أعطى GZ6522 أعلى محصول و اتبعه GZ8455 و GZ8126. وقد زادت محصول الأرز ومكوناته بزيادة مستويات التسميد النيتروجين من صفر حتى ٢٠٠ كجم نيتروجين للهكتار, بينما لم يكن هنا أي فروق معنوية بين إضافة ١٦٠ أو ٢٠٠ كجم نيتروجين للهكتار.

قام بتحكيم البحث

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