Growth and Grain Yield of Hybrid and Traditional Rices as Affected by Splitting Nitrogen under Saline Soil Conditions

Zayed .B. A., S. M. Shehata, A. A. Abd Allah and W. M. Elkhoby
Zayed mail ,basunyz @yahoo.com
Rice Research and Training center ,Sakha ,33717,Kafr El –sheikh ,Egypt.

ABSTRACT

Two field experiments were conducted at El-Sirw Agricultural Research Station, Damietta Governorate, during 2006 and 2007 summer seasons to find out the proper time and splitting of N application on source, sink and yield potential of hybrid and traditional rices. The treatments of nitrogen splitting consisted of ;2/3basal(B)+1/3panicle initiation (PI);1/3B+1/3at tillering stage (T)+ 1/3PI; 1/3T+ 1/3 midtillering (MT)+ 1/3PI; 1/3T+ 1/3PI+ 1/3 flowering (F), 1/4B+ 1/4MT+ 1/4PI+ 1/4F, 1/4T+ 1/4MT+ 1/4PI+ 1/4F, 1/4B+ 1/4T+ 1/4MT+ 1/4PI minus 5.0 kg urea sprayed at F (2%of urea); and weekly application from 15 days after transplanting (DAT) at the rate of 18kg/ha each time. The tested rice varieties included three hybrids; SK2025H, SK2058H and SK2047H and one traditional; i.e., Sakha 104. The most promsing results could be summarized as follows: the hybrid rice varieties had higher variation in all parameters under study over Sakha 104. The best one was SK2025H in grain yield without any significant differences with those produced by other hybrids in the second season, while with only Sk2047H in the first season. Sk2025H was better in filled grains and sink capacity, as well as harvest index, SK2047 had higher values of panicle numbers and panicle weight. The three tested hybrids did not significantly vary in the majority of their source parameters. Furthermore, all nitrogen basal applications were not so favorable under saline soil conditions for all varieties under study. Three or four nitrogen splitting i.e., 1/3T+1/3PI+1/3F for Sakha 104 and Sk2025H and/or1/4T+1/4MT+1/4PI-1/4F for the rest of tested hybrids markedly improved all sources and sink parameters leading to full expression of high yield potentiality for hybrid rice getting high grain yield in saline soil. The correlation between source. sink parameters and

the grain yield showed that most of them significantly were significantly correlated with grain yield.

INTRODUCTION

To surpass rice productivity ceiling in Egypt, hybrid vigor was recognized as one reasonable technological option .Research trials in Egypt on yield showed an increase in productivity of hybrids, ranging from 15 to 20% (in normal soil) and from 20 to 30% in saline soil, compared to traditional rice varieties. Hybrid rice was available under farmer conditions in 2005 as a just humble commencement, but poor agronomic management of hybrid rice is the main limitation to large scale adoption of hybrid rice. Moreover, rice hybrids need different nitrogen management strategy from traditional lines to maximize its grain yield. Peng *et al.* (2003) stated that nitrogen application in four splits as basal + top dressing at mid tillering , panicle initiation and small dose at flowering stages significantly increased all yield attributes, as well as grain yield of rice hybrids. Surkha *et al.* (1999), Zhang and Shoa (1999), Hembram *et al.* (2001), Balasubramanian (2002), Tao *et al.* (2002) and Edwin *et al.* (2004) reported that nitrogen application at basal + active tillering stage + panicle initiation + at panicle emergence significantly raised dry matter ,leaf area index, leaf N% percentage, chlorophyll content, flag leaf characteristics at heading and markedly enhanced yield and yield attributing traits through improving grain filling process. Leaf area index (LAI), leaf N % percentage, growth rate at maturity (GRM), dry matter, flag leaf area and its weight and sink capacity were significantly correlated with grain yield of hybrid rice (Yang *et al.* 1999 and Patniak *et al.* 1994). Hence, hybrid rice had a strong ability of growth; i.e., source parameters and all sink parameters and grain yield than those of traditional rice (Virmani 2002; Singh 2002 and Gautam, 2004). The peresnt study was mainly aimed to develop the proper strategy for time and methods of nitrogen application for hybrid rice, as compared with traditional rice under saline soil .

MATERIAL and METHODS

Two field experiments were conducted at the Farm of El- Sirw Agricultural Research Station in Dammietta Governorate, Agricultural Research Center, during 2006 and 2007 summer seasons to study the performance of hybrid rice varieties grown under nitrogen splitting application at different growth stages of rice plant under saline soil,

compared to a pure line variety. The experiments were performed in a split plot design with four replications. The main plots were devoted to the four rice varieties; namely, Sakha 104 and the three hybrids, SK2025H, SK2058H and SK2047H. The sub – plots contained eight times of nitrogen applications, as follows;
1-2/3 basal (B) +1/3 panicle initiation (PI),
2-1/3B+1/3mid tillering (MT)+1/3PI,
3-1/3 at tillering stage (T) +1/3 at MT+1/3 atPI,
4-1/3T + 1/3PI +1/3 at the beginning of flowering stage (F),
5-1/4B + 1/4MT + 1/4PI + 1/4F,
6- 1/4T +1/4MT + 1/4PI + 1/4F,
7-1/4B +1/4T + 1/4MT + 1/4PI minus 5.0 Kg urea sprayed at F (2% urea) and
8-weekly application from seven days after transplanting (DAT) (T to F stage) at the rate of 18 kg N/ha. The used nitrogen level was 180 kg N /ha in the form of urea for all treatments .In the seventh treatment, 5.0 kg urea was lifted from the last dose to be sprayed at flowering. Nitrogen applications, used in this study, were applied according to the developmental stages mentioned before for every rice variety or hybrid. The sprayed urea was prepared by dissolving in 250 liters of water and then sprayed immediately before the sun set. The salinity levels of the experimental sites were 9.5 and 9.00 dSm^{-1} in 2006 and 2007 seasons, respectively. Thirty-day old seedlings were transplanted at the rate of three seedlings per hill. The rest of package of recommendations were applied according to that of the Ministry of Agriculture. Ten days after last nitrogen application at heading, samples of ten hills were randmoly taken from each subplot and transferred into the Lab to determine the following physiological traits: dry matter ($g\ m^{-2}$) (DM), leaf area index (LAI), canopy index ,leaf N percentage, flag leaf area (cm^2) and growth rate at maturity (GRM)according to Patniak *et al.* (1994) . Plant height (cm) was measured after grain filling .At harvest, ten main panicles were randomly taken to determine the grain yield attributes; i.e., panicle length (cm), panicles numbers $(m)^2$ filled grains panicle, sterility percentage, spikletes $(m)^2$ (sink capacity), panicle density, panicle weight (g) and 1000- grain weight (g). The grain yield of six inner rows from each subplot was determined and converted into $t\ ha^{-1}$. Harvest index also was estimated .The correlation between all studied traits and the grain yield was computed. The obtained data were statistically analyzed and the means were compared according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1-Growth parameters :

1-a. Rice variety performance :

The three tested hybrid rice varieties obviously surpassed the traditional one (Table 1). The hybrid ones had high heterosis in dry matter production, LAI, canopy index, leaf N% at heading, and flag leaf area and growth rate at maturity. The tested rice varieties did not differ in their LAI (in 2007) and chlorophyll content in both seasons. It was observed that Sk2025H hybrid recorded the highest values of dry matter $gm,^{-2}$ while, Sk2047H showed the largest leaf area index, the highest values of canopy index and flag leaf area, in the first season, without significant differences with those obtained by Sk2025H .As for leaf N perecentage at heading, SK2025H registered the maximum mean, but the three hybrids did not differ significantly in this trait in the first season. Regarding to the growth rate at maturity, Sk2058H was superior over the other varieties in both seasons. Sakha 104 rice variety gave the lowest values of all aforementioned traits in both seasons (Table1). The three tested hybrid rice varieties exceeded Sakha 104 rice in salinity withstanding, although Sakha 104 rice is well known as a salt- tolerant one. The ability of the three tested hybrids to withstand salinity, compared to Sakha 104, might be mainly attributed to their higher variation in early growth patterns, their fast recovery ability after transplanting, nutrients uptake, such as potassium and nitrogen, and elevated growth rate at maturity. Generally, it was observed that the three tested hybrids had a pronounced high seedling vigor that enabled them to be more salt-tolerant during vegetative growth stages and ability to produce more pre-heading assimilates; i.e., stored dry matter at heading. Thereby, hybrid rice could be recommended under saline soil conditions. Leaf nitrogen at heading is much needed for higher grain yield. With respect to heading date, it was detected that the four tested varieties markedly differed in their heading date. The longest period from sowing to heading was given by SK2047H, while, the shortest period was resulted from SK2058H (Table 2) as shown by the dry matter values in 2006 season. The current findings were similar to the results reported by Patniak *et al.* (1994), Peng *et al.* (2003), Virmani (2002), Singh (2002) and Gautam (2004).

1-b. Time of nitrogen application effect:

Data showed significant effect for times of nitrogen application on all measured source elements in both seasons (Tables 1and 2). Most of the treatments contained basal application in dry saline soil under such condition failed to get any considerable improvement in rice growth. Four equal splits of nitrogen application of 1/4T + 1/4MT + 1/4PI + 1/4F proved its superiority in dry matter, leaf area index, canopy index, leaf N persentage. chlorophyll content, flag leaf area and growth rate at maturity (GRM). The three equal splits of 1/3 T +1/3PI + 1/3 F followed such treatment in its superiority, where, it came in the second order in improving the growth characters at heading. The maximum values of aforementioned characteristics were produced by the application of 1/4T + 1/4MT + 1/4PI + 1/4F, while the minimum values were obtained when the splits of 2/3B + 1/3Pi was used, compared with other nitrogen applications. It was clear that nitrogen supply for both hybrid and traditional rice, after transplanting at certain physiological stages up to the commencement of the flowering stage was more urgent for healthy growth and contentment growth parameters at heading. It was detected here that nitrogen splitting up to flowering stage of rice had a high ability to increase its photosynthetic rate, growth rate at maturity and organized its canopy index, which enhanced high grain yield resulted from stored assimilates pre-heading. At the same time, three nitrogen splits of 1/3T + 1/3PI + 1/3F and four equal nitrogen splits of 1/4T + 1/4MT + 1/4PI + 1/4F significantly raised the leaf chlorophyll and N% content, which delayed the early senescence of leaves during grain filling period, leading to a high current photosynthesis and optimum grain filing process. Another fact, salinity stress enhanced the early leaf senescence immediately after heading, thereby, increasing leaf N % at heading that might tackle this issue.

The present results are in agreement with those published by Patniak *et al.* (1994), Surekha *et al.* (1999), Zhang and Shao (1999), Yang *et al.* (1999), Hembram *et al.* (2001), Peng *et al.* (2003), Balasubramanian (2002), Tao *et al.* 2002 and Edwin *et al.* (2004).

1-c.The interaction effect:

The interaction between rice varieties and times of nitrogen application had significant effect on dry matter only in 2006 season, canopy index only in 2007 season and leaf N %, flag leaf area and GRM in both seasons. All tested hybrid rice varieties gave their lightest dry matter, canopy index, flag leaf area and leaf N% at heading under four

Table (1): Dry mater gm^{-2} (DM) ,leaf area index (LAI),canopy index , leaf N%, chlorophyll content, flag leaf area and growth rate at maturity(GRM) of some rice varieties as affected by time of nitrogen application under saline soil.

Traits clements	DM (gm^{-2})		Leaf area index		Canopy index		Leaf N (%)		Chlorophyll content		Flag leaf area (Cm^2)		GRM	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Varieties:	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sakha104	1015.6	818.60	5.35	5.77	12.21	13.67	2.253	2.341	40.34	40.25	29.10	29.3	10.44	8.377
Sk2025H	1157.1	951.40	5.79	6.70	15.29	16.56	2.626	2.751	43.19	42.94	32.00	33.42	11.55	9.785
Sk2058H	1048.1	943.20	5.58	5.89	14.49	15.64	2.573	2.680	40.84	40.82	31.26	32.03	11.61	10.397
SK2047H	1154.1	913.60	6.31	6.22	16.53	16.67	2.561	2.651	41.09	39.38	32.91	32.58	11.11	8.801
L.S.D (0.05)	189.00	46.49	0.57	NS	1.639	1.252	0.073	0.079	NS	NS	1.50	0.524	0.625	0.356
Time of N application	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2/3B+1/3PI	993.2	776.60	4.78	5.30	10.07	11.878	2.091	2.234	38.90	38.43	28.64	28.71	10.21	7.972
1/3B+1/3MT+1/3PI	1055.3	836.40	5.02	5.55	11.53	13.327	2.280	2.386	40.73	40.66	31.30	30.07	10.77	8.765
1/3T+1/3MT+1/3PI	1049.4	904.6	5.78	5.94	13.96	15.098	2.405	2.516	40.54	39.82	31.40	31.11	10.78	9.290
1/3T+1/3PI+1/3F	1163.8	1004.60	6.11	6.73	16.47	17.626	2.691	2.756	42.68	42.10	33.59	35.44	11.75	10.179
1/4B+1/4MT+1/4PI+1/4F	1077.6	٨٤٠,٢٠	5.85	5.91	14.42	15.124	2.464	2.564	42.17	41.71	30.74	31.53	11.03	9.211
1/4T+1/4MT+1/4PI+1/4F	1222.3	1089.60	6.69	6.49	20.14	20.440	2.957	3.052	43.37	42.72	33.73	37.00	12.29	11.013
1/4B+1/4T+1/4MT+1/4PI-	1132.5	919.30	6.01	6.14	15.24	16.552	2.532	2.602	40.96	40.86	30.72	30.74	11.68	9.362
2%f	1057.1	872.50	5.82	5.82	15.22	15.630	2.606	2.713	41.57	41.45	30.40	30.06	10.87	8.930
Weekly application	54.39	65.51	0.63	0.438	1.658	1.41	0.088	0.106	١.٣٢٩	1.41	1.35	0.787	0.571	0.698
L.S.D (0.05)	**	NS	NS	NS	**	NS	**	**	NS	NS	**	**	**	**
Interaction														

B; Basal, PI; Panicle Initiation, MT; Mid-TilleringT; tillering and F; Flowering.

** = significant at 0.01 level.

NS = Not significant.

equal nitrogen splits of 1/4T + 1/4MT + 1/4PI + 1/4Fexceptfor, flag leaf area of SK2025H at 1/3T + 1/3PI + 1/3MT in 2007. On the other hand, Sakha104 gave its maximum values of dry matter at 1/4B + 1/4MT + 1/4PI minus 2% (urea) F, while the rest of the above mentioned traits was at 1/3 T + 1/3PI + 1/3F. The lowest values of dry matter production ,canopy index, leaf N%, flag leaf area and GRM were produced by the combination of Sakha 104 and 2/3B + 1/3PI. The interaction effect data came to confirm the inferiority of basal application of nitrogen under saline soil for both traditional and hybrid rices, regarding their physiological traits at heading stage. Furthermore, one third or one fourth of recommended nitrogen at the beginning of heading could be essential for rice growth under saline soil for both hybrid and traditional rices (Tables 2,3,4 and 6).

Table(2): Dry matter g m^{-2} as affected by the interaction between rice varieties and times of nitrogen application under saline soil condition in 2006 season.

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	Sk2047H
2/3B+1/3PI	847.80	1092.50	960.70	1071.80
1/3B+1/3MT+1/3PI	1000.50	1075.40	997.20	1148.20
1/3T+1/3MT+1/3PI	1079.20	1130.90	904.00	1083.30
1/3T+1/3PI+1/3F	1037.40	1286.90	1077.10	1254.10
1/4B+1/4MT+1/4PI+1/4F	1034.60	1133.90	946.90	1195.00
1/4T+1/4MT+1/4PI+1/4F	965.90	1302.80	1317.20	1303.40
1/4B+1/4T+1/4MT+1/4PI-2%F	1137.00	1140.50	1067.10	1185.30
Weekly application	1022.80	1094.30	1115.00	996.40
LSD P (≤ 0.05)	118.90			

B; Basal, PI; Panicle Initiation, MT; Mid-Tillering, T; tillering and F; Flowering.

Tabie (3): Canopy index as affected by the interaction between rice varieties and time of nitrogen application under saline soil in 2006 season.

Time of nitrogen application	Varieties			
	Sakha 104	Sk2025H	Sk2058H	Sk2047H
2/3B+1/3PI	7.094	12.015	10.869	10.286
1/3B+1/3MT+1/3PI	8.259	13.417	12.060	12.375
1/3T+1/3MT+1/3PI	11.749	14.412	14.761	14.908
1/3T+1/3PI+1/3F	14.914	17.241	16.698	17.037
1/4B+1/4MT+1/4PI+1/4F	13.303	14.454	12.600	17.307
1/4T+1/4MT+1/4PI+1/4F	14.217	20.079	20.386	25.881
1/4B+1/4T+1/4MT+1/4PI-2%F	14.186	16.897	13.321	16.537
Weekly application	13.970	13.796	15.189	17.921

B; Basal, PI; Panicle Initiation, MT; Mid-Tillering, T; tillering and F; Flowering.

Table(4):Leaf nitrogen % at heading as affected by the interaction between rice varieties and times of nitrogen application under saline soil condition in 2006 and 2007 seasons.

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	SK2047H
	2006 season			
2/3B+1/3PI	1.887	2.214	2.167	2.099
1/3B+1/3MT+1/3PI	2.019	2.421	2.385	2.295
1/3T+1/3MT+1/3PI	2.107	2.590	2.582	2.342
1/3T+1/3PI+1/3F	2.507	2.827	2.774	2.656
1/4B+1/4MT+1/4PI+1/4F	2.268	2.769	2.319	2.500
1/4T+1/4MT+1/4PI+1/4F	2.519	2.899	3.198	3.213
1/4B+1/4T+1/4MT+1/4PI-2%F	2.450	2.616	2.525	2.538
Weekly application	2.264	2.674	2.634	2.850
LSD P (≤ 0.05)	0.181			
	2007 season			
2/3B+1/3PI	1.996	2.423	2.266	2.249
1/3B+1/3MT+1/3PI	2.124	2.544	2.480	2.394
1/3T+1/3MT+1/3PI	2.219	2.709	2.685	2.451
1/3T+1/3PI+1/3F	2.578	2.997	2.684	2.765
1/4B+1/4MT+1/4PI+1/4F	2.318	2.795	2.543	2.599
1/4T+1/4MT+1/4PI+1/4F	2.620	3.063	3.305	3.220
1/4B+1/4T+1/4MT+1/4PI-2%F	2.475	2.695	2.645	2.595
Weekly application	2.399	2.779	2.737	2.938
LSD P (≤ 0.05)	0.216			

B; Basal, PI; Panicle Initiation, MT; Mid-Tillering, t; tillering and F; Flowering.

Table (5): Flag leaf area at heading (cm^2) as affected by the interaction between rice varieties and time of nitrogen application under saline soil condition in 2006 and 2007 easons.

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	Sk2047H
	2006 season			
2/3B+1/3PI	23.99	29.73	29.88	30.98
1/3B+1/3MT+1/3PI	29..85	32.59	30.37	32.39
1/3T+1/3MT+1/3PI	30.24	31.63	30.58	33.15
1/3T+1/3PI+1/3F	31.24	37.57	31.27	34.28
¼B+1/4MT+1/4PI+1/4F	29.64	31.23	30.78	3134
¼T+1/4MT+1/4PI+1/4F	30.24	33.03	35.68	35.97
1/4B+1/4T+1/4MT+1/4PI-2%F	28.70	30.65	30.54	32.73
Weekly application	28.60	29.55	31.01	32.46
LSD P (≤ 0.05)	3.55			
2007 season				
2/3B+1/3PI	26.50	31.63	27.75	28.75
1/3B+1/3MT+1/3PI	27.33	32.25	29.83	30.88
1/3T+1/3MT+1/3PI	29.00	33.00	31.55	30.90
1/3T+1/3PI+1/3F	32.38	37.55	35.03	36.25
¼B+1/4MT+1/4PI+1/4F	30.88	31.65	31.35	32.25
¼T+1/4MT+1/4PI+1/4F1	34.38	36.50	37.38	39.75
1/4B+1/4T+1/4MT+1/4PI-2%F	27.00	32.63	31.95	31.40
Weekly application	26.38	32.15	31.20	30.50
LSD P (≤ 0.05)	1.57			

B; Basal, PI; Panicle Initiation, MT; Mid-Tillering, T; tillering and F; Flowering.

2- Grain yield and its attributes:

2-a.Rice variety performance

The four tested rice varieties markedly varied in their grain yield and its attributing traits in both seasons (Tables 7and 8). Hybrid rice varieties significantly surpassed Sakha 104 in grain yield and its attributes, except for 1000- grain weight in both seasons. The four tested rice varieties did not show any significant differences in their plant height in 2007 season and panicle length in 2006 season. The highest values for number of filled grains panicle,$^{-1}$ panicle density, sink capacity and grain yield, harvest index and sterility persentage in 2007 season were produced by SK2025H hybrid rice variety. Both Sk205H and SK2047H were at a par in plant height, panicle length, panicle number m,$^{-2}$ sterility

persentage and harvest index, while in grain yield the three tested hybrid rice varieties were at a par in grain yield in 2007 season and panicles m^{-2} in 2006 season. The heaviest 1000 grain weight for Sakha 104 rice variety, while the lightest 1000-grain weight was that for SK2025H which was mainly due to the genetic background. Higher heterosis was detected in the early growth parameters of hybrids resulted in higher yield attributes, and subsequently grain yield. The current findings are in conformity with those reported by Patniak *et al.* (1994), Peng *et al.* (2003), Virmani (2002), Singh (2002), Gautam (2004) and Mohammed (2006).

Table(6): Growth rate at maturity(GRM) as affected by the interaction between rice varieties and time of nitrogen application under saline soil condition in 2006 and 2007 seasons.

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	SK2047H
	2006 season			
2/3B+1/3PI	8.783	10.953	10.643	10.473
1/3B+1/3MT+1/3PI	10.280	10.765	11.048	11.018
1/3T+1/3MT+1/3PI	11.028	11.375	10.238	10.500
1/3T+1/3PI+1/3F	10.508	12.778	11.820	12.065
1/4B+1/4MT+1/4PI+1/4F	10.705	11.373	10.568	11.46
1/4T+1/4MT+1/4PI+1/4F	9.842	12.778	14.218	12.313
1/4B+1/4T+1/4MT+1/4PI-2%F	11.768	11.635	11.853	11.458
Weekly application	10.573	10.910	12.455	9.560
LSD P (≤ 0.05)	1.241			
	2007 season			
2/3B+1/3PI	6.79	8.960	8.398	7.740
1/3B+1/3MT+1/3PI	7.565	9.120	10.168	8.205
1/3T+1/3MT+1/3PI	8.610	9.515	10.498	8.538
1/3T+1/3PI+1/3F	9.095	11.870	11.005	8.745
1/4B+1/4MT+1/4PI+1/4F	8.865	9.393	10.445	8.140
1/4T+1/4MT+1/4PI+1/4F	8.73	11.045	12.843	11.433
1/4B+1/4T+1/4MT+1/4PI-2%F	8.882	9.433	9.598	9.535
Weekly application	8.475	8.948	10.225	8.073
LSD P (≤ 0.05)	1.368			

B; Basal, PI; Panicle Initiation, MT; Mid-Tillering, T; tillering and F; Flowering.

2- b. Time of nitrogen application effects :

Time of nitrogen applications significantly affected grain yield and its attributes in both seasons, except for the plant height in both

seasons, as well as panicle length and panicle density in 2006 season (Tables 7 and 8). The same trend was recoded with grain yield and its attributes as in growth traits. The nitrogen application, as basal, failed to achieve any improvement in the main components of grain yield of hybrid or traditional rice under the present circumstances. More nitrogen splits; namely 3 or 4 doses after transplanting up to flowering stage, was found to be more effective in promoting the main grain yield components such as panicle numbers and sink capacity and lowering the sterility percentage. Also, a pronounced enhancement in harvest index resulted in a reasonable grain yield of rice.

Hence, the four equal nitrogen splits of 1/4t+1/4MT+1/4PI+1/4F gave the highest values of panicle numbers/m,^{2} filled grains/panicle, penicle density, sink capacity, 1000-grain weight, panicle weight, harvest index and grain yield, while they gave the lowest value of sterility persentage. The three nitrogen splits of 1/3T + 1/3PI + 1/3 F came in the second rank after the treatment of 1/4T + 1/4MT + 1/4PI + 1/4F in all attributes and grain yield. The lowest values of such characters were produced by the treatment of 2/3B + 1/3PI. These previous results were similar to those obtained with physiological traits measured at heading .

From previous discussion, splitting nitrogen into four equal doses, applied at critical growth stages; i.e., tillering stage, panicle initiation and particularly heading stage under saline soil and for hybrid rice might be more important for considerable rice growth before heading. As seen, nitrogen application at late growth stage increased leaf nitrogen percentage, which played a great role in raising leaf Rubsco content, resulted in delaying leaf senescence during grain filling period. This lead to high filled grains and low sterility %. Nitrogen application at late growth stage enhanced the activity of roots and the three active leaves, including stage leaf during grain filling time, which resulted in optimum grain filling rate. All aforementioned results got out the full expression of high heterosis of hybrid rice and maximize its grain yield under saline soil. It is mentioning, here, that nitrogen splitting into four equal doses (1/4T + 1/4MT + 1/4PI + 1/4F) caused higher harvest index, leading to high grain yield. Similar results have been obtained by Patnaik *et al.* (1994), Surekha *et al.* (1999), Yang *et al.* (1999), Hembram *et al.* (2001), Peng *et al.* (2003), Balasubramanian (2002), Tao *et al.* (2002) and Edwin *et al.* (2004).

Table (7): Heading date, plant height, panicle length, panicles m^{-2}, filled grains /panicle, panicle density and sterility % of some rice varieties as affected by time of nitrogen application under saline soil.

Traits / Treatments	Heading date (days)		Plant height(cm)		Panicle length (cm)		Panicles/ m^2		Filled grains /panicle		Panicle density		Sterility (%)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Varieties :	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sakha104	97.83	97.31	105.39	108.84	21.58	20.70	381.8	409.5	114.28	118.54	5.281	5.77	8.58	22.50
Sk2025H	100.3	100.27	102.02	104.20	22.46	24.68	415.0	464.0	165.03	146.23	7.454	5.95	21.72	25.61
Sk2058H	91.17	90.50	98.26	100.09	21.33	24.52	414.5	439.0	122.63	136.34	5.791	5.54	12.19	21.65
SK2047H	103.68	103.64	105.58	101.77	21.97	24.71	417.3	485.5	119.01	119.97	5.432	4.82	23.00	24.55
LSD (0.05)	2.22	0.543	4.69	NS	NS	0.89	26.8	46.3	11.54	6.27	0.423	0.254	6..39	2.652
Time of N application :	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2/3B+1/3PI	97.41	97.19	101.97	102.91	21.89	23.58	380.3	384.5	118.41	120.13	5.524	5.12	24.90	35.62
1/3B+1/3MT+1/3PI	97.78	97.31	100.60	102.97	22.11	23.02	399.3	459.5	123.13	126.18	5.574	5.51	17.00	29.80
1/3T+1/3MT+1/3PI	98.09	98.09	102.03	102.92	21.70	23.81	415.5	453.3	134.00	123.29	6.297	5.21	18.13	25.91
1/3T+1/3PI+1/3F	99.16	98.94	101.69	102.98	21.57	24.31	428.5	473.5	135.31	137.85	6.119	5.66	12.58	15.98
1/4B+1/4MT+1/4PI+1/4F	97.66	97.53	103.29	104.45	21.28	23.16	397.0	457.0	133.36	127.25	6.243	5.48	16.75	21.38
1/4T+1/4MT+1/4PI+1/4F1	99.36	99.66	103.89	105.03	21.94	24.24	430.8	480.8	138.11	145.01	6.229	6.04	9.98	14.43
1/4B+1/4T+1/4MT+1/4PI-2%F	97.91	97.03	104.71	104.94	21.81	23.41	414.0	456.3	127.60	138.13	5.946	5.94	15.96	24.98
Weekly application	98.06	97.69	104.31	103.59	22.38	23.70	392.0	427.0	131.96	124.34	5.982	5.22	15 70	20.53
LSD (0.05)	0.500	0.614	NS	NS	NS	0.731	26.3	42.8	13.41	6.91	NS	0.358	4.35	3.11
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	**	**	NS	NS	NS	**

B; Basal, PI; Panicle Initiation, MT; Mid-Tillering,T; tillering and F; Flowering.

** = significant at 0.01 level.

NS = Not significant.

Table (8): Sink capacity , panicle weight, 1000-grain weight ,grain yield and harvest index of some rice varieties as affected by time of nitrogen application under saline soil.

Traits / Elements	Sink capacity spikelets m^{-2}		Panicle weigh (g)		1000-grain weight (g)		Grain yield (t/ha)		Harvest index	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Varieties:	-	-	-	-	-	-	-	-	-	-
Sakha104	43654	49613	2.91	3.31	26.94	27.21	5.77	5.96	0.412	0.410
Sk2025H	67468	67498	3.35	٣,٠٦	20.63	21.50	6.83	6.84	0.454	0.447
Sk2058H	50803	59704	3.00	3.85	23.66	25.00	6.36	6.66	0.433	0.438
SK2047H	49553	58245	3.40	٣,٩٩	24.68	25.81	6.61	6.66	0.442	0.450
LSD (0.05)	6119	6962	0.31	0.60	0.84	0.97	0.23	0.38	0.011	0.011
Time of N application:	-	-	-	-	-	-	-	-	-	-
2/3B+1/3PI	45146	46129	2.70	3 13	22.97	24.33	5.80	5.92	0.396	0.400
1/3B+1/3MT+1/3PI	48818	57989	2.92	3.30	23.84	24.58	6.20	6.40	0.412	0.413
1/3T+1/3MT+1/3PI	56070	57532	3.20	3.60	24.36	24.96	6.44	6.78	0.440	0.435
1/3T+1/3PI+1/3F	58158	68848	3..33	3.99	24.36	25.68	6.75	7.02	0.471	0.471
B+1/4MT+1/4PI+1/4F¼	52915	58488	3.25	3.76	23.54	24.71	6.28	6.48	0.426	0.417
T+1/4MT+1/4PI+1/4F¼	59500	70145	٣,٥٠	4.01	24.74	25.45	6.86	7.28	0.492	0.487
¼B+1/4t+1/4Mt+1/4Pi-2%F	53020	63612	٣,٢٦	3.83	23.86	24.53	6.50	6.28	0.421	0.429
Weekly application	49328	53126	٣,١٥	3.74	24.16	24.81	6.32	60.6	0.425	0.437
LSD (0.05)	6511	6159	0.415	0.278	0.75	0.42	0.23	0.34	0.015	0.012
Interaction	NS	NS	NS	NS	NS	NS	**	**	**	**

B; Basal + PI, Panicle Initiation, Mt; Mid- tillering,T =tillering and F; Flowering

2-c.The interaction effects:

Analysis of variance for the obtained results revealed that the interaction between rice varieties and time of nitrogen application had a lightly significant effect on filled grains /panicle, grain yield and harvest index, in both seasons and sterility % in 2007. Data indicated in tables (9 and 12) showed that Sakha 104 rice variety and SK2025H gave their higher filled grains and harvest index when they received their recommended nitrogen doses at 1/3T + 1/3PI + 1/3F, while the two other varieties produced their higher filled grains and harvest index when the recommended nitrogen was applied as ¼T + 1/4MT + 1/4PI + 1/4F. The treatment of 1/3T + 1/3PI + 1/3F got the highest value of sterility % in Sakha 104 while, the treatment of ¼T + 1/4MT + 1/4PI + 1/4F gave the lowest values of sterility for the three tested hybrids. With respect to grain yield, both Sakha 104 and SK2025H varieties performed better under the treatment of 1/3T + 1/3PI + 1/3F in 2007. Both SK2025H and SK2047H hybrids gave their high grain yield under the treatment of ¼T + 1/4MT + 1/4PI + 1/4F in both seasons. It is worthy to mention that the highest grain yield (8.22 t/ha) was obtained by the combination of Sk2047H and 1/4 T + 1/4MT + 1/4PI + 1/4F in the second season. All

four tested rice varieties badly performed under the treatment of 2/3B + 1/3PI, regarding the mentioned traits. The highest value of sterility % recorded by the hybrid SK2047H, under the treatment of nitrogen splitting treatment of 2/3B + 1/3PI.

Table (9) : Filled grains /panicle as affected by the interaction between rice varieties and times of nitrogen pplication under saline soil in 2006 and 2007 seasons.

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	SK2047H
	2006 season			
2/3B+1/3PI	101.85	142.075	118.85	110.20
1/3B+1/3MT+1/3PI	105.05	145.025	126.10	116.10
1/3T+1/3MT+1/3PI	113.00	176.50	124.00	122.50
1/3T+1/3PI+1/3F	125.25	199.05	109.00	107.55
B+1/4MT+1/4PI+1/4F¼	124.00	161.25	122.00	126.20
1/4T+1/4MT+1/4PI+1/4F¼	122.30	149.25	149.50	131.40
B+1/4t+1/4Mt+1/4Pi-2%F¼	103.00	159.75	121.10	126.55
Weekly application	119.75	186.05	110.50	111.55
LSD P (≤ 0.05)	27.00			
	2007 season			
2/3B+1/3PI	109.38	126.75	126.00	118.38
1/3B+1/3MT+1/3PI	117.25	147.00.	122 50	117.95
1/3T+1/3MT+1/3PI	103.43	142.83	127.75	119.18
1/3T+1/3PI+1/3F	125.75	164.50	138.75	122.40
B+1/4MT+1/4PI+1/4F¼	109.50	149.75	130.25	119.50
1/4T+1/4MT+1/4PI+1/4F¼	130.78	148 75	167.75	132.75
B+1/4t+1/4Mt+1/4Pi-2%F¼	133.00	146.25	143.75	129.50
Weekly application	119.25	144.00	134.00	100.10
LSD P (≤ 0.05)	14.41			

B; Basal, PI; Panicle Initiation, MT; Mid-TilleringT; tillering and F; Flowering.

Table (10) : Sterility %as affected by the interaction between rice varieties and times of nitrogen application under saline soil in 2007 season .

Time of nitrogen application	Varieties			
	Sakha 104	Sk2025H	Sk2058H	Sk2047H
2/3B+1/3PI	27.25	37.25	32.23	45.75
1/3B+1/3MT+1/3PI	19.25	33.58	31.20	35.18
1/3T+1/3MT+1/3PI	23.75	27.33	19.40	33.15
1/3T+1/3PI+1/3F	14.75	15.13	19.00	15.15
B+1/4MT+1/4PI+1/4F¼	17.75	25.25	21.75	20.75
1/4T+1/4MT+1/4PI+1/4F¼	17.00	13.80	11.75	15.00
B+1/4t+1/4Mt+1/4Pi-2%F¼	43..25	28.98	15.25	15.43
Weekly application	17.00	26.58	22.60	15.95
LSD P (≤ 0.05)	6.40			

B; Basal, PI; Panicle Initiation, MT; Mid-Tillering, T; tillering and F; Flowering.

Table(11):Grain yield (t/ha) as affected by the interaction between rice varieties and time of nitrogen applications under saline soil in 2006 and 2007 seasons.

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	Sk2047H
	2006 season			
2/3B+1/3PI	5.800	5.03	5.25	5.25
1/3B+1/3MT+1/3PI	5.65	6.20	6.05	6.05
1/3T+1/3MT+1/3PI	5.98	6.80	6.63	6.63
1/3T+1/3PI+1/3F	6.55	7.60	6.40	6.40
B+1/4MT+1/4PI+1/4F¼	5.70	6.85	6.23	6.23
1/4T+1/4MT+1/4PI+1/4F¼	6.95	7.35	7.40	7.40
B+1/4t+1/4Mt+1/4Pi-2%F¼	5.75	6.93	6.78	6.78
Weekly application	5.60	6.88	6.55	6.55
LSD P (≤ 0.05)	0.48			
	2007 season			
2/3B+1/3PI	5.62	5.98	6.28	5.82
1/3B+1/3MT+1/3PI	5.96	6.42	6.70	6.52
1/3T+1/3MT+1/3PI	6.58	7.46	6.50	6.58
1/3T+1/3PI+1/3F	6.80	7.78	6.90	6.62
B+1/4MT+1/4PI+1/4F¼	5.82	6.61	6.76	6.72
1/4T+1/4MT+1/4PI+1/4F¼	6.00	7.46	7.42	8.22
B+1/4t+1/4Mt+1/4Pi-2%F¼	5.72	6.62	6.36	6.46
Weekly application	5.16	6.40	6.38	6.36
LSD P (≤ 0.05)	0.47			

B; Basal, PI; Panicle Initiation, MT; Mid-Tillering, T; tillering and F; Flowering.

Table(12): Harvest index as affected by the interaction between rice varieties and times of nitrogen application under saline soil in 2006 and 2007 seasons.

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	Sk2047H
	2006 season			
2/3B+1/3PI	0.383	0.415	0.355	0.430
1/3B+1/3MT+1/3PI	0.412	0.424	0.381	0.430
1/3T+1/3MT+1/3PI	0.428	0.471	0.411	0.450
1/3T+1/3PI+1/3F	0.452	0.524	0.462	0.448
B+1/4MT+1/4PI+1/4F¼	0.383	0.455	0.455	0.410
1/4T+1/4MT+1/4PI+1/4F¼	0.444	0.500	0.510	0.510
B+1/4t+1/4Mt+1/4Pi-2%F¼	0.415	0.420	0.423	0.423
Weekly application	0.383	0.423	0.438	0.438
LSD P (≤ 0.05)	0.031			
	2007 season			
2/3B+1/3PI	0.369	0.418	0.381	0.433
1/3B+1/3MT+1/3PI	0.385	0.434	0.397	0.437
1/3T+1/3MT+1/3PI	0.415	0.445	0.423	0.455
1/3T+1/3PI+1/3F	0.445	0.502	0.466	0.470
B+1/4MT+1/4PI+1/4F¼	0.385	0.415	0.444	0.423
1/4T+1/4MT+1/4PI+1/4F¼	0.455	0.485	0.502	0.505
B+1/4t+1/4Mt+1/4Pi-2%F¼	0.407	0.438	0.438	0.432
Weekly application	0.416	0.438	0.450	0.446
LSD P (≤ 0.05)	0.0.25			

B; Basal, PI; Panicle Initiation, MT; Mid-Tillering, T; tillering and F; Flowering.

The interaction results came to prove the failure of any basal nitrogen application under saline soil . Furthermore, more nitrogen splitting after transplanting, one of them at late growth stage, had to be followed under saline soil, particularly, for hybrid rice. The present findings are in a good conformity with those produced by Peng *et al.* (2003), as well as Mohammed (2006).

3- The correlation between grain yield and the studied characters :

The data included in Table 13 stated that leaf area index , canopy index , leaf N% , flag leaf area , chlorophyll content ,GRM, number of panicles m^{-2} , filled grains $panicle^{-1}$,sink capacity, panicle weight and harvest index had positive and lightly significant correlations with grain yield in both seasons . Dry matter did not have a significant correlation with grain yield in the second season. On the other hand , heading date , plant height ,panicle length and 1000- grain weight did not

show a significant correlation with grain yield in both seasons .Sterility % showed a negative and significant correlation with grain yield in 2007 season, but not in 2006 season. it is clear that the most important physiological traits, considering grain yield production might be leaf N%, canopy index and flag leaf area, while, chlorophyll content , LAI and growth rate at maturity came in the second order and dry matter at heading occupied the third order .

Table (13): The simple correlation r values between grain yield and all studied traits during 2006 and 2007 seasons under saline soil.

Various traits	t values	
	2006	2007
Dry matter	0.5532**	0.0151NS
LAI	0.5926**	0.6152**
Canopy index	0.7362**	0.7339**
Leaf N%	0.8052**	0.7508**
Chlorophyll	0.6900**	0.4359*
Flag leaf area	0.7012**	0.8288**
GRM	0.5086**	0.7374**
Heading date	0.0240NS	0.2011 NS
Plant height	0.3448 NS	0.3428 NS
Panicle length	0.2361 NS	0.3210 NS
Panicles number	0.6741**	0.5691**
Filled grains	0.5902**	0.5454**
Panicle density	0.5474**	0.1872 NS
Sterility %	-0.1150 NS	-0.3848*
Sink capacity	0.7117**	0.8780**
Panicle weight	0.6451**	0.5781**
1000-grain weight	-0.2160 NS	-0.3178 NS
harvest index	0.6851**	0.7507**

** = significant at 0,05 and 0.01 values respectively
NS = not significant

Regarding the importance of grain yield attributes, it was found that panicles number m^{-2} filled grains/panicle, sink capacity, harvest index and panicle weight were found to be more effective and correlated with grain yield. Panicle density came in the second order in this concern. Thereby, any nitrogen management strategy has to consider the improvement of these traits in this study to get out high grain yield from hybrid and traditional rice varieties under saline soil.

REFERENCES

Balasubramnain, R (2002). Response of hybrid rice (*Oryza sativa L.*) to level and time of application of nitrogen .Indian J. Agron., 47(2):203-206.

Edwin, L., J. Krisjnarajan and M.Premsekhar (2004). Irrgation and nitrogen application schedules for hybrid ADTRH1 rice (*Oryza sativa L.,)* in Tamil Nadu.Ind.J. Agron., 49(1):37-39.

Gautam ,A.K.(2004).Effect of nitrogen levels and spacing on productivity and quality of traditional and hybrid aromatic rice. PhD. Thesis, Division of Agronomy, India Agric. Res. Institute ,New Delhi, India.

Gomez , K. A. and A.A. Gomez 1984. Statistical Procedures for Agricultural Research .
2nd .ed ., John Wiley and Sons, USA.

Hembram, S.,P.Bandyopadhyay,P.K. Jana, D. Dutta and D. Ray. (2001). Effect of depth and time of irrigation and fertilizer on yield attributes ,yield and production economics of hybrid rice (Oryza sativa L.) .Crop Research 21(1) :11-14.

Mohammed M.M.A.(2006). Effect of some agricultural treatments on hybrid rice.
M. Sc.Theis , Agron. Dept., Fac.of Agric. Al-Azhar University, Cairo, Egypt

Patniak, S., N., K. Pande and P.J.Jachuch. (1994). Effect of different levels of nitrogen on growth rate at maturity and yield of rice hybrid .Crop Res. Hisar J. 8(2):207-212.

Peng S., R.C. Laza, A. L. Sanico, R. M. Visperas and T.T. Son. (2003). Physiological bases of heterosis and crop management strategies for hybrid rice in the tropics .Hybrid Rice for Food Security Poverty Alleviation and Environment Protection .Proceedings of the 4th International Symposium on Hybrid Rice, Hanoi , Vietnam, 14-17 May, 2002 .Los Banos., Philippines ,IRRI.

Singh , T. (2002) . Effect of nitrogen levels and date of transplanting on the performance of hybrid rice and non –hybrid rice cultivars. M. Sc Thesis submitted to Postgraduate School, IRAI, New Delhi, India .

Surekha , K., M. Narayana Reddy and R. Mahender Kumar. (1999) . Yield attributes and yield of rice (*Oryza Sativa L.,)* hybrids as

influenced by nitrogen sources and its splits application .Indian J. of Argon. 44(1) :88-90.

Tao, S. S., X.C. Xiang and X. F. Zhang. (2002). Studieds on application of N fertilizer in scattered – transplanting cultivation of large panicle hybrid rice. Southwest China J. Agric. Sciences 15(3):39-42.

Virmani, S. S. (2002) . Development and large scale adaptation of hybrid rice in India .In: India Grains .,PP 15-16.

Yang ,J.,B.Su,Z.Wang ,Y.Lang and Q. Zhu . (1999). Characteristics and physiology of grain filling in inter-subspecfic hybrid rice .Chinese Agric. Sci. J. 40:1645-1655.

Zhang, X. F. and G. S. Shao . (1999). Effects on rice yield and quality by applying N fertilizer at late growth stage. Chinese Rice Research Newsletter, 7(2)11-12.

الملخص العربي

نمو ومحصول الحبوب للأرز الهجين والأرز العادي المتأثر بإضافة النيتروجين على دفعات تحت ظروف الأراضي الملحية

بسيوني عبد الرازق زايد وسعيد محمد شحاتة وعبدالله عبدالنبي عبدالله ووليد محمد الخبي

مركز البحوث والتدريب في الأرز ،معهد المحاصيل الحقلية،
مركز البحوث الزراعية،سخا،كفر الشيخ.

أقيمت تجربتان حقليتان بمحطة بحوث السرو الزراعية ،بمحافظة دمياط ضمن برنامج الأرز وذلك لايجاد انسب ميعاد لإضافة النتـروجين علي دفعات علي نمو و محصول الأرز الهجين و العادي وذلك خـلال موسمي صيف٢٠٠٦و٢٠٠٧م .وكان التصميم المستخدم في هذه الدراسة هو القطع المنشقة مرة واحدة، واحتوت القطع الرئيـسية احتـوت علـي الأصـناف وهـي ، سـخا ١٠٤ و SK2025H و SK2058Hو SK2047H. بينما وزعت مواعيد إضافة النتروجين بالقطع الشقية وهي ٣/٢ علي الشر اقي +٣/١ عند مرحلة تكوين النورة و ٣/١ الشر اقـي +٣/١ عند مرحلة التفريع المتوسط +٣/١ عند مرحلة تكـوين النـورقو ٣/١ عند بداية التفريع +٣/١ عند مرحلة التفريع المتوسـط +٣/١ عنـد

مرحلة تكوين النورة و ٣/١ عند بداية التفريع +٣/١ عند مرحلة تكوين النورة +٣/١ عند بداية الإزهار ،٤/١ علي الشراقي +٤/١ عند التفريع المتوسط + ٤/١ عند بداية تكوين النورة +٤/١ عند بداية الإزهار ،٤/١ عند بداية التفريع +٤/١ عند التفريع المتوسط +٤/١ عند بداية تكوين النورة +٤/١ عند بداية الإزهار و ٤/١ الشراقي +٤/١ عند بداية التفريع +٤/١ عند مرحلة التفريع المتوسط +٤/١بداية تكوين النورةتاقص٢% رشا عند بداية الإزهار (5كجم يوريا / ٢٥٠ لتر ماء) و الإضافة أسبوعيا (١٨ كجم /هكتار بمعدل عشرة أسابيع). ويمكن تلخيص أهم النتائج كما يلي :ثبت من الدراسة تفوقا واضحا لأصناف الأرز الهجين الثلاثة علي الصنف سخا ١٠٤ سواء في صفات المصادر ، و المادة الجافة ودليل مساحة الورقة و محتوي الورقة من النتروجين ودليل الغطاء النباتي ومساحة ورقة العلم ومعدل النمو عند النضج .غير أن الأصناف لم تختلف معنويا في محتوي الكلوروفيل في موسمي الدراسة ودليل مساحة الورقة في الموسم الثاني . وجد أيضا أن أصناف الأرز الهجين أظهرت تفوقا واضحا في محصول الحبوب ومكوناته .وكان أحسن الهجن الهجين SK2025H بدون فروق مع الهجنين الأخريين في محصول الحبوب في السنة الثانية والهجين SK2047H في السنة الأولي .وجد أيضا أن أي معامله تتضمن إضافة أرضيه غير مفضلة تحت ظروف الأراضي الملحية .وكانت أفضل المعاملات هي ٤/١ عند بداية التفريع +٤/١ عند التفريع المتوسط +٤/١ عند بداية تكوين النورة +٤/١ عند بداية الإزهار وتلتها المعامله٣/١ عند بداية التفريع +٣/١ عند مرحلة تكوين النورة +٣/١ عند بداية الإزهار وذلك حيث نجحت في تحسين كل من المصدر والمصب و القدرة المحصولية لكل من الأرز والهجين والصنف سخا ١٠٤. وجد أن هناك تلازما ايجابيا بين محصول الحبوب وكل من نسبة النتروجين بالأوراق ومساحة ورقة العلم و دليل الغطاء النباتي ومعدل النمو عند النضج ودليل مساحة الورقة والمادة الجافة و عدد النورات وعدد الحبوب الممتلئة وسعة المصب النورة و دليل الحصاد .