GROWTH AND YIELD OF HYBRID AND INBRED RICES AS INFLUENCED BY N SPLITTING UNDER SALINE SOIL CONDITIONS

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Abstract

Field experiments were conducted at El-Sirw Agricultural Research Station, Dammietta Governorate during 2004 and 2005 seasons to find out the proper time and split of N application on source, sink and yield potential of hybrid rice. 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 -5.0 kg urea sprayed at F (2% of urea), and weekly application of 18kg N ha^{-1} started just before transplanting (DAT) (10 times). The tested rice varieties included three hybrids, SK2025H, SK2058H &SK2047H and one inbred i.e. Sakha 104. The most promising 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 with out 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 while SK2047 had higher values of panicle numbers and panicle weight. The three tested hybrids did not significantly vary in majority of their source parameters. Furthermore, all nitrogen basal application were not so favorable under saline soil condition 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 source 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 show that most of them significantly correlated with grain yield.

INTRODUCTION

To surpass rice productivity ceiling in Egypt, hybrid vigor was recognized as one realizable 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 inbred rice varieties. Hybrid rice was available under farmers condition 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 inbred 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 *et al.* (1999), Hembram *et al.* (2001), Balasubramanian (2002), Tao *et al.* (2002) and Edwin *et al.* (2004) reported that nitrogen application at basal + at active tillering stage + at panicle initiation + at panicle emergence significantly raised dry mater, 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.Sink capacity significantly correlated with grain yield of hybrid rice (Yang *et al.* 1999 and Patniak *et al.* 1994). Hence hybrid rice had strong ability of growth i.e. source parameters and all sink parameters and grain yield than those of inbred rice (Vrmani 2002, Singh 2002, and Gautam 2004). The peresnt attempt was mainly aimed to develop the proper strategy for time and methods of nitrogen application for hybrid rice as compared with inbred rice under saline soil.

MATERIALS AND METHODS

Two field experiments were conducted at the farm of El- Sirw Agricultural Research Station in Dammietta governorate, Agricultural Research Center, during 2004 and 2005 seasons to study the performance of hybrid rice varieties grown under splitting of nitrogen application at different growth stages of rice plant under saline soil compared to pure line varieties. The experiments were performed in a split plot design with four replications. The main plots were devoted to four rice varieties, Sakha 104 and three hybrids, SK2025H, SK2058H and SK2047H. The sub – plots contained eight time 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 – 5.0 Kg urea sprayed at F (2% urea) and

8- Weekly application of 18kg N ha^{-1} started just before transplanting (DAT) (10 times).

In the seventh treatment, 5.0Kg urea was lifted to spray it at the beginning of flowering (F). The used nitrogen level was 180 kg N /ha in the form of urea that for all treatments. Nitrogen applications used in this study were applied according to the

developmental stages mentioned before for every rice variety or hybrid according to the field samples and observations at collected the time of fertilizeration. The sprayed urea was prepared through dissolving it in 250 liters of water and then spray it immediately before the sun set. The salinity levels of the experimental sites were 9.5 and 9.00 dSm^{-1} in 2004 and 2005 seasons, respectively. Thirty days old seedlings were transplanted with 3 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 10 hills were randmoly taken from each plot and transferred in 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 fillings .At harvest, ten main panicle the were taken to determine the yield attributes, panicle length (cm), panicles numbers $m,^{-2}$ filled grains $panicle,^{-1}$ sterility percentage, spikletes m^{-2} (sink capacity), panicle density, panicle weight (g) and 1000- grain weight (g). The yield of six inner rows from each plot was determined and converted into t ha^{-1}. Harvest index was also 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 inbred one (Table 1). The hybrid ones had high heterosis in dry matter production, LAI, canopy index, leaf N% at heading, flag leaf area and growth rate at maturity. The tested rice varieties didn't differ in their LAI and chlorophyll content in both seasons. It was observed that Sk2025H hybrid recorded the highest values of dry matter $gm,^{-2}$ while with. Sk2047H showed the largest leaf area index, 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. Regarding the growth rate at maturity, Sk2025H was superior over the other varieties in the first season while in the second season, SK2058H was better in this concern. 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 attributey 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 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). 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 1&2). Any treatment 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 the previous 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 become fact that nitrogen supply for both, hybrid or inbred rice after transplanting at certain physiological stages up to the commencement of the flowering stage is more urgent for healthy growth and contentment growth parameters at heading. It is detected here nitrogen splitting up to flowering stage of rice had 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 high current photosynthesis and optimum grain filing process. In addition, enhancing flag leaf area and other flag leaf pattern that contribute of in the current photosynthesis during grain filing period. Other fact, salinity stress enhances the early leave senescence immediately after heading thereby, increasing leaf N% at heading might tackled 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 in only 2004 season, canopy index in only 2005 season, and leaf N %, flag leaf area and GRM in both seasons. All tested hybrid rice varieties gave its higher dry matter, canopy index, flag leaf area and leaf N% at heading under four equal nitrogen splits of 1/4T + 1/4MT + 1/4PI + 1/4Fexcept, flag leaf area of SK2025H was at 1/3T + 1/3PI + 1/3MT which occupied the second rank. On the other hand, Sakha104 gave its maximum values of dry matter at 1/4B + 1/4MT + 1/4PI-2% (urea) F, while the rest of 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 inbred and hybrid rices regarding their physiological traits at heading stage. Furthermore, one third or one fourth of recommended nitrogen at beginning of heading is essential for rice growth under saline soil for both hybrid and inbred rices.

2-Yield and yield attributes:

2-a.Rice variety performance

The four tested rice varieties markedly varied in their grain yield and its attributing traits (Tables 7 & 8). Hybrid rice varieties significantly surpassed Sakha 104 in grain yield and its attributes except for 1000- grain weight. The four tested rice varieties did not show any significant differences in their plant height in 2005 season and panicle length in 2004 season. The highest values for number of filled grains panicle,$^{-1}$ panicle density, sink capacity and grain yield, harvest index and sterility persentage in 2005 season were produced by the 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 while the three tested hybrid rice varieties were at a par in grain yield in 2005 season and panicles m^{-2} in 2004 season. The heaviest 1000 grain weight was for Sakha 104 rice variety, while the lightest 1000-grain weight was for SK2025H that mainly due to the genetic background. Higher variation 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 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 Elements	DM gm^{-2}		Leaf area index		Canopy index		Leaf N%		Chlorophyll Content		Flag leaf area Cm^2		GRM	
	٢٠٠٤	٢٠٠٥	٢٠٠٤	٢٠٠٥	٢٠٠٤	٢٠٠٥	٢٠٠٤	٢٠٠٥	٢٠٠٤	٢٠٠٥	٢٠٠٤	٢٠٠٥	٢٠٠٤	٢٠٠٥
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	39.88	32.91	32.58	11.11	8.801
LSD0.05	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-2%f	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
weekly application	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
LSD0.05	54.39	65.51	0.63	0.438	1.658	1.41	0.088	0.106	١,٢٣٩	1.41	1.35	0.787	0.571	0.698
Interaction	**	NS	NS	NS	**	NS	**	**	NS	NS	**	**	**	**

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

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 2004 season

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	Sk2047H
٢/3B+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 and F, Flowering

Table 3. Canopy index as affected by the interaction between rice varieties and time of nitrogen application under saline soil in 2004 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
LSD P ≤ 0.05	3..518			

B, Basal + PI, Panicle Initiation, Mt, Mid- 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 2004 and 2005 seasons

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	Sk2047H
	2004 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			
2005 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	2.473	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 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 2004 and 2005 seasons

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	Sk2047H
	2004 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
¼B+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			
	2005 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%F1	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 and F, Flowering

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 2004 and 2005 seasons

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	Sk2047H
	2004 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			
	2005 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 and F, Flowering

2- b. Time of nitrogen application effect:

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 2004 season (Tables 7& 8). The same trend was recoded with yield and yield attributes as in growth traits. The nitrogen application as basal failed to achieve any improvement in the main component of grain yield of hybrid or inbred rice under the present circumstances. More nitrogen splits, 3 or 4 doses, after transplanting up to flowering stage was found to be more effective in promoting the main yield components such as panicle numbers, sink capacity and lowering the sterility percentage. Also, pronounced enhancement in harvest index resulted in reasonable grain yield of rice.

Therefore, 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/$panicle^{-1}$, panicle density, sink capacity, 1000-grain weight, panicle weight, harvest index and grain yield while, it 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 yield attributes and yield. The lowest values of the above mentioned characters were produced by the treatment of 2/3B + 1/3PI. The previous results were similar to those obtained with physiological traits measured at heading .

From going discussion, nitrogen splitting 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 is more important for considerable rice growth before heading. As seen nitrogen application at late growth stage increased leaf nitrogen persentage which play great role in raising leaf Rubsco content resulted in delaying of leaf senescence during grain filling period this lead to high filled grain and low sterility %. Nitrogen application at late growth stage enhanced the activity of root and the three active leaves including flag leave 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 application into four equal doses 1/4T + 1/4MT + 1/4PI + 1/4F cause 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).

2-c.The interaction effect

Analysis of variance for obtained results revealed that the interaction between rice varieties and time of nitrogen applications had significant effect on filled grains /panicle^{-1}, grain yield and harvest index in both seasons, and sterility % in 2005 season. Data listed in tables 9,& 12 show that Sakha 104 rice variety and SK2025H gave its higher filled grains and harvest index when they received their recommended nitrogen doses at 1/3T + 1/3PI + 1/3F, while the other two 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 values of sterility % in Sakha 104 while, the treatment of ¼T + 1/4MT + 1/4PI + 1/4F gave the lowest values of sterility of the three tested hybrids. With respect to grain yield, both varieties, Sakha 104 and SK205H performed better concerninggrain yield under the treatment of 1/3T + 1/3PI + 1/3F. Both hybrid varieties of SK2058H and SK2047H gave their high grain yield under the treatment of ¼T + 1/4MT + 1/4PI + 1/4F. It is worthy to mention that the higher grain yield 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 values of sterility % recorded by the hybrid SK2047H the treatment of Nitrogen application of 2/3B + 1/3PI.

Table 7. Heading date ,plant height , panicle length cm, 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)		Panicles length (cm)		Panicles/ m^2		Filled grains /panicle		Panicle density		Sterility %	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
,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
LSD0.05	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	٦,119	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
¼T+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-	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
2%f	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
weekly application	0.500	0.614	NS	NS	NS	0.731	26.3	42.8	13.41	6.91	NS	0.358	4.35	3.11
LSD0.05	NS	NS	NS	NS	NS	NS	NS	NS	**	**	NS	NS	NS	**
Interaction														

B, Basal + PI, Panicle Initiation, Mt, Mid- tillering and F, flowering

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	
	٢٠٠٤	٢٠٠٥	٢٠٠٤	٢٠٠٥	٢٠٠٤	٢٠٠٥	٢٠٠٤	٢٠٠٥	٢٠٠٤	٢٠٠٥
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	٣,٥٦	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
LSD0.05	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
¼B+1/4MT+1/4PI+1/4F	52915	58488	3.25	3.76	23.54	24.71	6.28	6.48	0.426	0.417
¼T+1/4MT+1/4PI+1/4F	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-	53020	63612	٣,٢٦	3.83	23.86	24.53	6.50	6.28	0.421	0.429
2%f	49328	53126	٣,١٥	3.74	24.16	24.81	6.32	60.6	0.425	0.437
weekly application	6511	6159	0.415	0.278	0.75	0.42	0.23	0.34	0.015	0.012
LSD0.05	NS	NS	NS	NS	NS	NS	**	**	**	**
Interaction										

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

Table 9. Filled grains /panicle as affected by the interaction between rice varieties and times of nitrogen application under saline soil in 2004 and 2005 seasons

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	Sk2047H
	2004 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
T+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			
	2005 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
T+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- tillering and F, Flowering

Table 10. Sterility %as affected by the interaction between rice varieties and times of nitrogen application under saline soil in 2005 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
T+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 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 2004 and 2005 seasons

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	Sk2047H
	2004 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
T+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 appliication	5.60	6.88	6.55	6.55
LSD P ≤ 0.05	0.48			
	2005 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
T+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 and F, Flowering

Table 12. Harvest index as affected by the interaction between rice varieties and times of nitrogen application under saline soil in 2004 and 2005 seasons.

Time of nitrogen application	Varieties			
	Sakha104	SK2025H	SK2058H	Sk2047H
	2004 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
T+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			
	2005 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
T+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 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 has 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 Mohamed (2006).

3- The correlation between yeild and the studied characters :

The data arranged in table 13 stated that leaf area index, canopy index, leaf N%, flag leaf area, chlorophyll content, GRM at, number panicles m^{-2}, filled grains $panicle^{-1}$,sink capacity, panicle weight and harvest index had positive and significant correlation with grain yield in both seasons. Dry matter didn't have significant correlation with the grain yield in the second season. On the other hand , heading date , plant height ,panicle length and 1000- grain weight did n't show significant correlation with grain yield in both seasons. Sterility % showed negative and significant correlation with grain yield in 2005 season but not the case in 2004 season. it is clear that the most important physiological traits considering grain yield formation are 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 correlation values ® between grian yieldand all studied traits during 2004 and 2005 seasons under saline soil.

Various traits	Correlation values	
	2004	2005
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	0.2011ns
Plant height	0.3448ns	0.3428ns
Panicle length	0.2361ns	0.3210ns
Panicles NO	0.6741**	0.5691**
Filled grains	0.5902**	0.5454**
Panicle density	0.5474**	0.1872ns
Sterility %	-0.1150ns	-0.3848*
Sink capacity	0.7117**	0.8780**
Panicle wt	0.6451**	0.5781**
1000-grain wt	-0.2160ns	-0.3178ns
harvest index	0.6851**	0.7507**

Regarding the importance of yield attributes, it was found that panicles numbers 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 improvement the above mentioned traits in this study to get out high grain yield from hybrid and inbred rice varieties under saline soil.

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نمو و محصول الأرز الهجين والأرز العادي المتأثر بإضافة النيتروجين على دفعات تحت ظروف الأراضي الملحية

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

أقيمت تجربتان حقليتان بمحطة بحوث السرو الزراعية بدمياط ضمن برنامج الأرز وذلك لدراسة تأثير مواعيد إضافة النتروجين المختلفة النمو و محصول الأرز الهجين و العادي وذلك خلال موسمي ٢٠٠٤و٢٠٠٥م .وكان التصميم المستخدم في هذه الدراسة هو القطع المنشقة مرة واحدة,القطع الرئيسية احتوت علي الأصناف وهي , سخا ١٠٤ ، SK2025H ، SK2058H ، SK2047H. بينما مواعيد إضافة النتروجين وزعت بالقطع الشقية وهي ٣/٢ الشر اقي +٣/١ عند مرحلة تكوين السنبلة , ٣/١ الشر اقي +٣/١ عند مرحلة التفريع المتوسط +٣/١ عند مرحلة تكوين السنبلة , ٣/١ عند بداية التفريع +٣/١ عند مرحلة التفريع المتوسط +٣/١ عند مرحلة تكوين السنبلة , ٣/١ عند بداية التفريع +٣/١ عند مرحلة تكوين السنبلة +٣/١ عند بداية الإزهار ,٤/١ علي الشراقي +٤/١ عند التفريع المتوسط + ٤/١ عند بداية تكوين السنبلة +٤/١ عند بداية الإزهار ,٤/١ عند بداية التفريع +٤/ عند التفريع المتوسط +٤/١ عند بداية تكوين السنبلة +٤/١ عند بداية الإزهار, ٤/١ الشراقي +٤/١ عند بداية التفريع +٤/١ عند مرحلة التفريع المتوسط +٤/١بداية تكوين السنبلة-٢% رشا عند بداية الإزهار (5.0كجم يوريا / ٢٥٠ لتر ماء) و الإضافة أسبوعيا (١٨ كجم /هكتار بمعدل ١٠ أسابيع). ويمكن تلخيص أهم النتائج كما يلي :ثبت من الدراسة تفوق واضحا لأصناف الأرز الهجين الثلاثة علي الصنف سخا ١٠٤ سواء في صفات المصادر , المادة جافه 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 تفوق واضح في المحصول ومكوناته .أحسن الهجن كانت الهجين SK2025H بدون فروق مع الهجنين الأخريين في المحصول في السنة الثانية والهجينِ SK2047H في السنة الأولي .وجد أيضا أن أي معامله تتضمن إضافة أرضيه غير مفضلة تحت ظروف الأراضي الملحية .كانت افضل المعاملات هي ٤/١ عند بداية التفريع +٤/١ عند التفريع المتوسط +٤/١ عند بداية تكوين السنبلة +٤/١ عند بداية الإزهار وتلتها المعامله٣/١ عند بداية التفريع +٣/١ عند مرحلة تكوين السنبلة +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 علاقة ارتباطيه واضحة بين المحصول وكل من نسبة النتروجين بالأوراق ومساحة ورقة العلم و دليل الغطاء النباتي ومعدل النمو عند النضج ودليل مساحة الورقة والمادة الجافة و عدد السنابل وعدد الحبوب الممتلئة سعة المصب ووزن السنبلة و دليل الحصاد .