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EXPLORATION HYBRID RICE UNDER SALINE SOIL CONDITIONS IN Egypt

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ABSTRACT

Salinity is the main constrain to rice production in Egypt. The high heterosis displayed by hybrid rice might be exploited for the enhancement of rice productivity in the presence of economically-important stresses such as drought and salinity.

Three field experiments were conducted during summer seasons of 2010, 2011 and 2012 rice seasons at El- Sirw Agricultural Research Station as saline soil and EL- Gemmiza Agricultural Research Station as normal soil. The salinity levels were 8.2, 8.5 and 8.3 dsm^{-1} in ,2010, 2011 and 2012 seasons, respectively as saline soil and 1.9 and 1.8 dsm^{-1} for normal soil. In 2012 season, the best selected genotypes compared with the salt tolerant variety Giza 178 were physiologically evaluated under saline soil. Fifteen rice genotypes, nine hybrids, SK2034H, SK2046H, SK2035H, SK2058H, SK2074H,SK2010H, SK2121H, SK2122H, SK2037H, and six inbreeds rice, Giza 177 (salt sensitive), Giza 178 (the best salt Egyptian variety), Giza 182 (Sensitive one), Sakha 101 (moderate salt tolerant one), Sakha 102 (Sensitive one) and Sakha 104 (moderate salt one) were used in this investigation .

Studied genotypes significantly varied in all studied parameters under both saline and normal soils. Under normal soil all tested hybrids significantly surpassed the studied inbreeds but hybrid 8 was less all of inbreeds except Giza 177 and Sakha 102. While, under saline soil conditions, there are only three hybrids; SK2034H, SK2035H and SK2058H markedly exceeded the salt tolerant inbred rice variety Giza 178 in large score.

The hybrid SK2046H gave the highest number of panicle $hill^{-1}$ under normal condition, while, SK2058H gave the highest values of panicle number under saline soil for this trait. The ability of SK2034H, SK2055H, SK2058H, Hybrids and Giza 178 to keep high filled grains under saline soil

The results obtained indicated that the three hybrids SK2034H, SK2035H and SK2058H could be recommended to be grown under saline soil with yield increase of 16–22 % over Giza178 as inbred salt tolerant one that may be due to their high heterosis. On the other hand, SK2058H markedly surpassed the other two hybrids. It could be concluded that SK2058H gave the highest means in all seedling characteristics, number of white roots, root dry weight of seedling, shoot dry weight, root length, shoot length and number of leaves $plant^{-1}$ under saline soil during the last seasons without significant differences compared with those produced by hybrid SK2034H. On the other hand, the lowest values of aforementioned traits were recorded by Giza 178 inbred salt tolerant variety.

INTRODUCTION

Salinity is a major problem that negatively impacts agricultural activities in many regions in the world, and especially in Egypt. Generally, salinity problems increase with increasing salt concentration in irrigation water. In the absence of specific-ion effects, crop growth reduction due to salinity is generally related to the osmotic potential of the root-zone soil solution. This will lead to certain phonological changes and substantial

reduction in productivity. Rice hybrids are known to have high vegetative vigor and a stronger root system. These features enabled them to show better seedling tolerance for low temperature (Kaw and Khush 1985), salt tolerance (Akbar and Yabuno 1975, Senadhira and Virmani 1987), flood tolerance (Singh 1983), and ratooning ability (Chauhan *et al* 1983). Rice hybrids were also found to be adaptable in the aerobic rice ecosystem (George *et al* 2002). Collaborative trials in Egypt showed stronger heterosis in hybrids in saline soils than in normal soils (Varmani and Kumar 2004). Zayed *et al.* (2005, 2006 and 2007) and Babu *et al.* (2007) found that hybrid rice showed a higher degree of salt tolerance than inbred rice, and also demonstrated higher root growth, seedling vigor, nutrient uptake vegetative growth, yield attributing characteristics, yields and harvest index.

Yang *et al.* (2002) and Tao *et al.* (2006) indicated that translocation and allocation for carbohydrate from sheath to grains, as well as rice grain filling and zeatin content in the roots and shoots of hybrid rice, were severely affected by drought. Amudha and Thiyagarajan (2008) and Malarvizhi *et al.* (2009) stated that some hybrid rice varieties showed superiority for cell integrity, drought-affected root length, root dry weight, harvest index, root-shoot ratio, number of productive tillers, panicle length, number of filled grains, spikelet fertility, total dry matter production, grain yield and harvest index under drought and normal conditions as compared to inbred rice varieties. The objective of the present study was aimed to find out the possibility of exploration of agronomic traits of hybrid rice under saline soil in Egypt using its higher heterosis.

MATERIALS AND METHODS

Nine hybrids and six inbred rice varieties; SK2034H, SK2046H, SK2035H, SK2058H, SK2074H, SK2010H, SK2021H SK2022H, SK2037H, Giza 177, Giza 178, Sakha 101, Sakha 102 and Sakha 104 were evaluated during 2010, 2011 and 2012 summer seasons at El-Sirw Agriculture Research Station, Dammiatta Governorate (saline soil) and El-Gemmiza Agriculture Research Station, El Ghariba province (normal soil), Egypt. The salinity levels were 8.5, 80 and 8.3dSm^{-1} in, 2010, 2011 and 2012 seasons, respectively for saline soil and 1.9 and 1.8 dSm^{-1} for normal soil.

Table 1: Chemical soil analysis of experimental sites at El- Gemmiza and El-Sirw

	2010		2011	
Tested Characteristics	**Gemmiza**	**El -Sirw**	**Gemmiza**	**El Sirw**
pH (1:2.5 soil water suspension)	7.8	8.1	7.90	8.2
Ec_e (dSm^{-1})	1.90	8.5	1.80	8.0
OM (organic matter) %	1.96	1.52	1.90	1.66
Soluble cations, meq.l^{-1}(soil paste):				
Ca^{++}	0.36	5.8	0.26	5.8
Mg^{++}	0.21	8.4	0.19	8.4
K^{+}	0.36	0.36	0.34	0.70
Na^{+}	2.20	75.0	1.20	70.0
Soluble anions, meq.l^{-1}(soil paste):	-		-	-
CO_3^{-}	-	-	-	-
HCO_3^{-}	0.55	9.00	0.40	9.64
Cl^{-}	2.4	69.5	1.4	65.5
SO_4^{--}	0.15	6.10	0.12	6.33
Available micronutrients ppm				
Fe^{++}	6.9	5.55	7.0	5.95
Zn^{++}	1.40	0.90	1.20	0.90
Mn^{++}	5.30	4.50	5.00	4.50

In the 2012 season the best selected genotypes rice were evaluated at El-Sirw Agriculture Research Station (saline soil) to confirm their performance and to record some physiological and agronomical study. Randomized complete block with four replications was used. The recommended package of each condition was followed. The growth and chemical analysis data were collected at heading stage and yield and yield components at harvest stage.

The root characteristics were measured 30 days after sowing. Four plant samples were randomly taken from nursery for each rice entry growing under saline soil in the third season and transferred to the laboratory to implement the issue of seedling vigor. The root length, root dry weight, white root number, leaf area of seedling, shoot dry weight and number of leaves $seedling^{-1}$ were measured to fulfill the seedling vigor concern.

Determination of root characteristics and Na/K ratio

At 30 days after transplanting, three plants were harvested. Plants were uprooted carefully and washed with distilled water. After measuring the shoot dry weight and shoot length and then plants were oven-dried at 65°C to constant dry weight. At heading, five hills from each replicate for each rice entries were randomly taken, then dried and the dry biomass ground for use in determining Na^{+} and potassium plant content as well as the Na^{+}/K^{+} ratio as well as N%, which was estimated according to Yoshida *et al.* (1976). Plant leaf area, flag leaf area and chlorophyll content, as well as flag leaf dry weight, were determined at heading.

Also, plant height, number of tillers and number of panicles/pot were calculated at harvest. Five panicles were taken from each pot to determine the main yield components. Panicles were first air-dried at room temperature for 24 h before yield components were recorded. The grains were separated

from panicles to determine the number of grains and grains weight (filled and unfilled spikelets) per panicle as well as 1000-grain weight. The plants from each pot were harvested and air-dried to determine the rice grain yield and straw yield per pot at 14% moisture content.

The data of two first seasons were analyzed by combined analysis and the third season was analyzed by using ordinary analysis of variances to test the significance of differences among the genotypes according to Gomez and Gomez (1984). Multiple mean comparison analysis for treatment combinations of variety and stress treatments was performed by using least significant different at α = 0.05 level when F-test was significant (Duncan, 1955).

RESULTS AND DISCUSSION

A-Agronomic characters:

1-Days to heading((day)

The results measured in Table 2 indicated that highly significant differences among genotypes for number of days to heading under saline and normal soils in both seasons. Furthermore, salinity stress significantly affected the days to heading of investigated hybrid and inbred rice genotypes as compared to normal conditions. It was recognized that some hybrid and inbred varieties studied was delayed in heading than those observed under normal soil. Days to heading of SK2034, SK2122H, SK2074 and Giza178 wasn't affected by salt stress comparing to normal conditions (Table2). It was obviously that the heading date of SK2046, SK2058, and Sakha101 Sakha 104 was significantly prolonged under salt stress than those obtained by plants grown in normal soil in both seasons. On the other hand the genotypes; SK2034H, SK2122H, SK2010 and Giza177 Giza182, Sakha 102 were earlier in heading under salt stress in both seasons. Thereby, the salt sensitive varieties might be reached rapidly to heading date under salt stress as a result of salts leaf accumulation inducing early heading date. Similar results were obtained by Zayed *et al* (2010).

2-Plant height (cm)

The tested rice genotypes significantly differed in their height in both seasons under normal and saline soils (Table 2). It was observed that plant height was significantly reduced under saline soil condition in both seasons. The shortest plants were produced by Sakha101 followed by SK2058H under saline soil .While; the tallest plants were produced by SK2122H under normal condition in both seasons, followed by SK2121H without significant effect. The plant height of SK2046H was most salt tolerant on salinity might be affected growth activators and regulators which restricted the cell division and elongation. Similar results were pointed out by Amudha and Thiyagarajan (2008) and Malarvizhi *et al.* (2009).

3- Panicle numbers/hill.

The obtained results clarified that panicles number /hill of the tested rice genotypes either hybrid or inbred markedly differed under both normal and saline soils in both seasons (Table 3). The hybrid SK2046H gave the highest number of panicle number hill^{-1} under normal condition, while SK2058H gave the highest number of panicle hill^{-1}under saline soil.

Table 2:The mean performance of genotypes for days to heading and plant height under normal and saline soils in 2010 and 2012.

Genotype	Days to heading (day)						Plant height (cm)					
	2010			2011			2010			2011		
	N	S	M	N	S	M	N	S	M	N	S	M
SK2034H	90.3	97.2	93.7	90.6	98.1	94.4	111.0	80.5	95.8	110.9	82.0	96.4
SK2046H	92.7	97.9	95.3	91.0	97.2	94.1	107.7	91.7	99.9	109.6	92.2	100.9
SK2035H	96.0	92.6	94.3	96.3	93.3	94.8	113.2	89.5	101.4	113.9	91.0	102.5
SK2058H	93.0	99.4	96.2	93.4	99.1	96.3	105.6	85.0	95.3	104.8	85.3	95.9
SK2074H	93.3	93.1	93.2	93.7	92.3	93.0	108.0	71.7	90.2	108.9	72.7	90.9
SK2010H	90.0	88.6	89.3	90.3	89.3	89.9	105.9	81.5	93.7	102.9	82.0	90.8
SK2021H	98.0	95.0	96.5	98.0	95.3	96.7	118.5	81.3	99.9	115.3	81.6	92.1
SK2022H	104.0	104.2	104.1	104.2	103.3	103.8	119.2	78.0	98.6	119.0	87.3	98.5
SK2037H	91.0	87.0	89.0	91.2	88.0	89.6	110.9	79.8	95.4	111.5	80.3	98.6
Giza177	92.0	90.3	91.1	92.7	87.3	90.0	107.5	74.2	90.8	106.6	73.3	95.9
Giza178	102.7	102.0	102.4	102.5	102.4	102.5	103.8	85.7	94.7	104.1	85.7	90.0
Giza182	105.7	98.5	102.1	105.3	97.0	101.2	102.0	74.1	88.1	103.1	74.7	94.9
Sakha101	106.3	107.5	106.9	106.7	107.3	107.0	99.0	64.0	81.5	99.1	70.0	88.9
Sakha102	87.0	85.3	86.1	87.5	88.0	87.8	102.2	76.7	89.4	103.8	78.0	84.6
Sakha104	101.0	107.0	104.0	104.3	108.5	106.4	109.3	92.8	101.5	112.5	79.0	90.9
Mean	96.7	96.3	96.5	96.5	96.1	96.4	108.3	80.4	94.3	108.4	81.5	104.2
LSD at 0.05%	1.08			1.04			1.7			2.5		
Interaction	1.05			1.10			2.4			3.55		

N= normal, S =salinity

Generally, the first four hybrids were superior regarding panicles number/hill based on the main average. Giza 178 rice inbred variety significantly surpassed other hybrids and inbred under saline soil. The first four hybrids fixed their superiority under saline soil regarding panicle number. The other tested hybrid failed to exceed the salt hybrid variety Giza 178. The order of hybrid regarding the superiority panicles number was as following, SK2058H > SK2035H > SK2034H > SK2046H under saline soil. It was indicated that Giza 177 and Sakha 101 were the most affected genotypes under saline soil for this trait. Similar results were in harmony with those reported by Amudha and Thiyagarajan (2008) and Malarvizhi *et al.* (2009) and Zayed *el al* (2010).

3-Panicle length (cm)

The panicle length of the tested rice genotypes significantly varied in their panicle length under both saline and normal soil. (Table3). The hybrid entries significantly surpassed the inbred rice genotype under both saline and normal soil SK2034H gave the longest panicle followed by SK2121H and SK2122H without significant difference. The panicle length of SK2010H under saline soil was the most affected one while, Giza 177 inbred rice variety gave the shortest panicles under saline soil. Giza178 gave the longest panicle under saline soil. The salinity might affect panicle length as reducing nutrient and water uptake as well as growth substances and growth hormones such as IAA and GA3. Similar data had been detected by Amudha and Thiyagarajan (2008) and Malarvizhi *et al.* (2009) and Zayed *el al*. (2011).

Table 3: The mean performance of rice genotypes for Panicles number/hill and Panicle length under normal and saline soils in 2010 and 2012.

Genotype	Panicles number/hill						Panicle length(cm)					
	2010			2011			2010			2011		
	N	S	M	N	S	M	N	S	M	N	S	M
SK2034H	24.9	15.8	20.3	24.8	15.7	20.2	23.5	20.0	21.7	23.4	19.9	21.6
SK2046H	24.2	15.6	19.9	24.1	15.5	19.8	24.4	20.3	22.3	24.3	20.2	22.2
SK2035H	24.7	15.9	20.3	24.6	15.8	20.2	24.2	20.7	22.5	24.5	20.6	22.4
SK2058H	22.5	18.5	20.5	22.4	18.4	20.4	25.7	20.4	23.1	25.6	20.3	23.0
SK2074H	29.6	12.7	17.0	21.1	12.6	16.9	24.1	20.5	22.3	24.0	20.6	22.2
SK2010H	19.5	11.4	18.8	19.4	11.4	15.4	23.5	18.9	21.2	23.4	18.8	20.9
SK2021H	23.5	12.3	18.0	23.4	12.3	17.9	25.8	22.2	24.0	25.7	22.1	23.9
SK2022H	20.7	11.8	16.3	20.6	11.8	16.2	25.7	21.8	23.7	25.6	21.7	23.6
SK2037H	22.9	10.9	17.0	22.8	10.9	16.9	25.6	22.3	24.0	25.5	22.2	23.9
Giza177	19.5	7.86	13.7	19.4	7.8	13.6	20.9	16.5	18.7	20.8	16.4	18.6
Giza178	22.6	14.4	18.5	22.5	14.3	18.4	22.2	19.5	20.9	22.1	19.4	20.8
Giza182	19.4	13.4	16.4	19.3	13.3	16.3	22.4	18.0	20.2	22.3	17.9	20.1
Sakha101	22.1	12.4	17.3	22.0	12.4	17.2	22.8	17.4	20.1	22.7	17.3	20.0
Sakha102	19.6	8.06	13.9	19.5	8.0	13.8	20.5	18.3	19.4	20.4	18.2	19.3
Sakha104	22.6	12.7	17.7	22.5	12.6	17.6	21.3	19.4	20.4	21.2	19.3	20.3
Mean	22.1	12.3	17.5	22.0	12.3	17.1	23.5	20.4	20.1	23.5	19.6	21.5
LSD0.05%	0.9			0.9			0.6			0.5		
Interaction	1.4			1.4			0.8			0.8		

N= normal, S =salinity

4-Number of filled grains/panicle

The results presented in Table 4 showed that number of grains/panicle was markedly affected by different levels of salinity as compared to normal soil interesting. The number of filled grains panicle^{-1} hybrid and inbred rice genotypes significantly varied under both saline and normal soil in both seasons. The most hybrid entries significantly exceed the inbred rice genotype including salt tolerant one under couple conditions of saline and normal soils. The most stable number of filled grains /panicle under saline soil was for SK2034H SK2035H and SK2058H hybrid rice entries under normal condition, SK2046H gave the highest values of number of filled grains / panicle without significant differences compared with those produced by SK2035H and SK2058H in both seasons interesting, under saline soil, SK2058H gave the highest values of number of filled grains /panicle. The rest of hybrid entries did not exceed the salt tolerant inbred rice variety Giza178 under both conditions. The lowest value of filled grains panicle^{-1} were detected by Sakha 102 inbred followed by Giza 177 under saline soil except, the first four hybrids the numbers of rest hybrid were greatly restricted under saline soil as well as the rest of inbred except, Giza 178. The ability of SK2034H, SK2055H, SK2058H, Hybrids and Giza 178 to keep high filled grains under saline soil might be attributed to its salinity withstanding, early and fast growth, high heterosis, late aging, high assimilates translocation and vital and flag leave area during active filling period. The same findings were reported by Amudha and Thiyagarajan (2008) and Malarvizhi *et al.* (2009) and Zayed *el al.* (2010).

Table 4: Number of filled grains/panicle of some rice genotypes under normal and saline soils in 2010 and 2012.

Genotype	Number of filled grains/panicle					
	2010			2011		
	N	S	M	N	S	M
SK2034H	150.3	140.0	145.0	151.3	142.2	146.8
SK2046H	153.0	137.3	145.2	154.3	139.5	147.0
SK2035H	152.7	143.7	148.2	154.0	146.0	150.0
SK2058H	151.0	145.7	148.3	152.3	148.0	150.1
SK2074H	140.0	130.3	135.2	141.2	130.4	136.9
SK2010H	140.3	126.7	133.5	141.6	128.8	135.2
SK2021H	141.0	129.0	135.0	142.2	131.1	137.0
SK2022H	139.0	131.7	135.3	140.2	133.9	136.7
SK2037H	145.0	123.0	134.0	146.3	125.1	135.7
Giza177	134.3	94.7	114.5	144.8	96.5	116.0
Giza178	143.0	134.0	137.0	144.2	133.2	138.7
Giza182	122.7	99.3	111.0	123.8	101.2	112.5
Sakha101	132.0	119.0	125.5	133.1	121.0	127.1
Sakha102	131.0	92.7	111.8	132.1	94.5	113.3
Sakha104	134.7	116.7	125.7	135.9	118.7	127.4
Mean	140.0	124.1	132.1	141.2	126.2	131.8
LSD at 0.05%	2.9			2.9		
Interaction	4.2			4.2		

N= normal, S =salinity

5-1000-grain weight (g)

Regarding the 1000-grain weight, the obtained results showed the same trend of number of filled grains panicle^{-1}. The SK2034H, SK2046H, SK2035H and SK2058H,(hybrids) as well as Giza 178 inbred one gave the desirable values for 1000-grain weight. In spite of SK2022H and Giza 177 gave almost the heaviest panicles under normal soil but their 1000-grain weight were sharply decreased under saline soil. The hybrid SK2010H gave the lowest weight of 1000-grain under saline soil compared to the tolerant variety. The salinity might affect grain filling process contributing to assimilate translocation block, reducing current photosynthesis and shortening the period of active filling by early aging. Similar findings had been reported by Amudha and Thiyagarajan (2008) and Malarvizhi *et al.* (2009) and Zayed *el al.*(2010).

6- Grain yield (t/ha.)

The results presented in Table 5 indicated that certain variation among the tested rice genotypes for rice grain yield in both seasons. Furthermore, the hybrid showed great variation among them regarding grain yield in both seasons. Both condition including normal and saline soil developed significant differences among screened rice entries including hybrid and inbred ones. Under normal condition, all hybrid exceed the inbred rice varieties, except, SK2010H and SK2037H. Interestingly, three hybrids, SK2034H, SK2035H and SK2058H significantly surpassed the salt tolerant inbred variety Giza 178 under saline soil. Under normal, SK2034H and SK2035H gave highest grain yield, while SK2085H gave the highest grain yield(t/ha.) under saline soil in both seasons without any significant differences with those produced by SK2035H under the

same condition (Table5). Both hybrids of SK2034H and SK2035H were superior regarding rice grain yield under normal soil. Giza 178 was the best inbred rice entries regarding rice grain yield under saline soil, while Sakha 101 under normal soil. Giza 177 gave the lowest grain yield in the second season while Sakha 102 gave the lowest grain yield in the first season under saline soil. By the way, the three hybrids of SK2034H, SK2035H and SK2058H confirmed their high salt tolerance and significantly surpassed the inbred salt tolerant one Giza 178 in both seasons. The order of the three hybrids was as follows; SK2058H > SK2035H > SK2034H. The rest of tested hybrid failed to exert the salt tolerant inbred variety Giza 178. Since, the above mentioned three best hybrids could keep their high heterosis under salt stress regarding their high yield components resulted in high rice grain yield comparing to the rest of hybrid and inbred ones. Amudha and Thiyagarajan (2008) and Malarvizhi *et al.* (2009) and Zayed *el al.* (2010) claimed similar findings.

Table 5:1000-grain weight (g) and grain yield (t ha^{-1}) of some rice genotypes under normal and saline soils in 2010 and 2011.

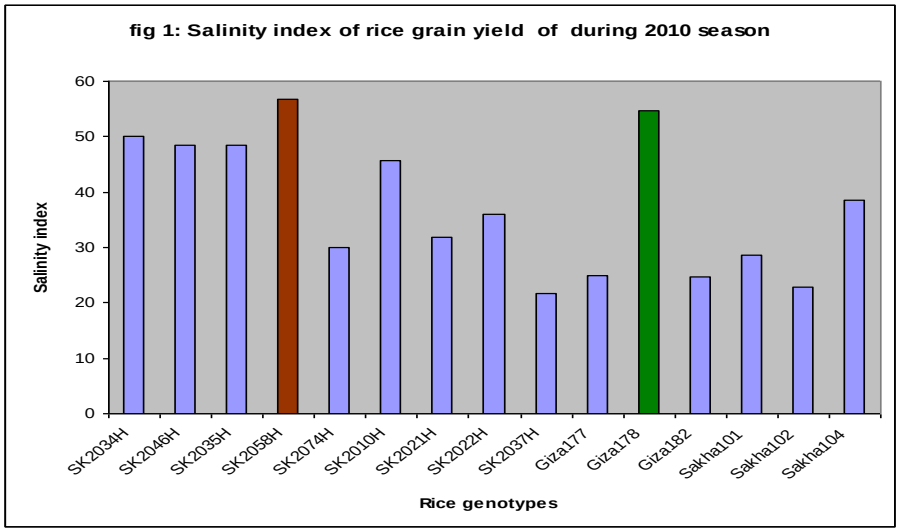
Genotype	1000-grain weight(g)						Grain yield(t/ha.)					
	2010			2011			2010			2011		
	N	S	M	N	S	M	N	S	M	N	S	M
SK2034H	24.4	23.5	24.0	25.0	23.3	24.1	12.6	6.3	9.4	12.6	6.4	9.5
SK2046H	25.1	24.5	24.8	25.8	24.2	25.0	11.3	5.5	8.4	11.3	5.6	8.4
SK2035H	24.6	14.3	24.5	24.8	24.3	24.6	12.6	6.1	9.3	12.1	6.1	9.2
SK2058H	26.4	24.3	24.8	24.6	21.8	23.2	11.5	6.5	9.0	11.3	6.7	9.0
SK2074H	26.5	20.5	23.5	26.8	20.2	23.5	10.9	3.3	7.1	10.5	2.9	6.7
SK2010H	26.2	18.6	22.4	27.5	18.5	23.0	9.0	4.1	6.5	9.0	2.7	5.8
SK2021H	28.2	21.8	25.0	28.3	21.7	25.0	11.8	3.7	7.8	11.7	4.0	7.9
SK2022H	25.1	19.8	22.5	25.3	19.5	22.4	9.3	3.3	6.3	9.3	3.4	6.3
SK2037H	28.3	22.2	25.2	28.7	22.0	25.4	11.3	2.4	6.9	11.3	3.3	7.3
Giza177	28.3	23.3	25.8	27.2	23.6	25.4	8.8	2.2	5.4	8.7	2.3	5.5
Giza178	21.0	20.1	20.7	20.5	20.3	20.4	9.9	5.4	7.6	9.7	5.5	7.6
Giza182	23.3	18.7	21.0	23.4	18.7	20.9	9.7	2.4	6.0	9.9	2.3	6.0
Sakha101	27.1	24.7	25.9	26.8	24.8	25.8	10.1	2.9	6.5	9.9	2.9	6.4
Sakha102	26.8	23.3	25.0	26.1	24.3	25.2	8.5	1.9	5.2	8.5	2.6	5.5
Sakha104	27.4	24.3	25.8	27.4	23.7	25.5	9.7	3.7	6.7	9.5	3.5	6.5
Mean	25.8	22.3	24.0	25.9	22.0	23.9	10.4	4.0	7.2	10.3	4.0	7.2
LSD 0.05%	0.5			0.8			0.3			0.5		
Interaction	0.7			1.2			0.5			0.7		

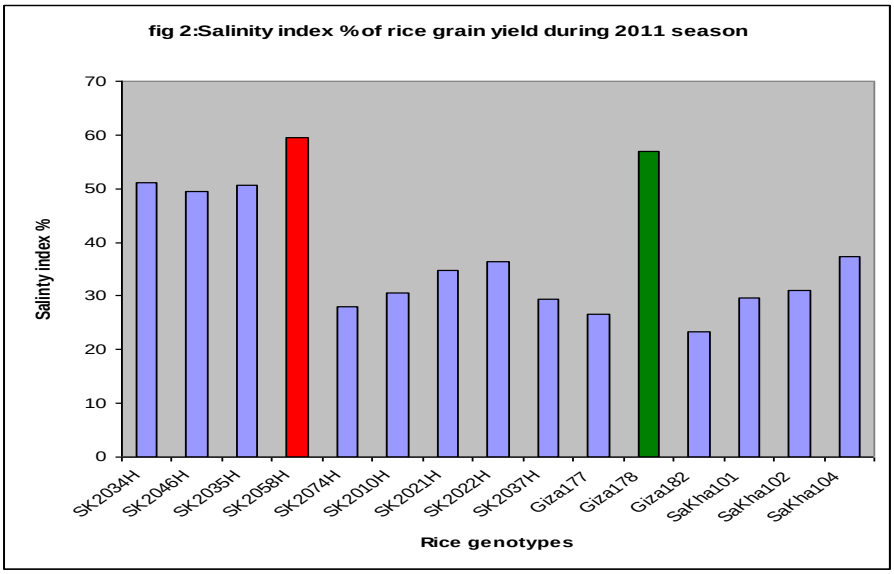
N= normal, S =salinity

Salinity Index tolerance

Data illustrated in Fig. 1 showed that the different tested rice genotypes varied in their salinity index based on rice grain yield. It was found that Sk2058H hybrid rice variety gave the highest values of salinity indices in both seasons followed by Giza 178 inbred salt tolerant variety.

The salinity indices on both mentioned rice varieties were above 50 %, while the rest varieties were less than 50%. The hybrid SK2037H gave the lowest percentages of salinity indices followed by Giza 177 and Sakha 102 inbred salt sensitive rice varieties in both seasons.





B- Physiological characters:

6-1. Seedling vigor characters:

The results in Table 6 indicated marked and great variations among tested genotypes regarding seedling vigor characters involving hybrids and Giza 178 inbred salt tolerant variety. The three best tested and selected hybrids significantly surpassed Giza 178 inbred salt tolerant variety in all seedling characters, number of white roots, root dry weight of seedling, shoot dry weight, root length, shoot length and number of leaves plant^{-1} under saline soil during the 2012 season. Among the three selected hybrids SK2058H markedly surpassed

the other two hybrids. Generally, SK2058H gave the highest means of above-mentioned characteristics without significant differences with those produced by SK2034H inbred variety except, for number of white roots, shoot dry weight and leaf area plant^{-1}. On the other hand, the lowest values of aforementioned traits were recorded by Giza 178 inbred salt tolerant variety (Table 6). High seedling vigor is one the mechanism of plant salt tolerance particularly, rice crop during seedling growth stage and had good impedes on advance rice growth stages such accelerate rice growth, early growth avoiding bad climate condition during sensitive growth stage, increasing dry matter production, high photosynthesis. As seen in table 6 the hybrid rice varieties had sturdy root under saline soil condition indicated that these sturdy root had high ability to supply shoot with water and enough nutrients to shoot ensuing healthy growth under saline soil since ion imbalance, ion toxicity, ions deficiency and high osmotic pressure. High root growth of rice plants, enabling them to acquire more nutrients locked in soils coping with the problem ion uptake under saline soils.

These might be ensured good shoot growth during early seedling stage and vegetative growth as well as pushing early and optimum vegetative growth avoiding the hazardous effect of salts. Fasting growth as result of high seedling vigor increase rice salty tolerance by salts dilution in the cell plant enable plants to grow healthy under such condition. Similar results had been claimed by Zayed *et al* (2005)

Table 6: Seedling vigor of some hybrids against Giza 178 inbred rice salt tolerant variety under saline soil in 2012.

Gentypes	No. of white root/plant	Root dry weight/15 seedling (g)	Shoot dry weight/15 seedling (g)	Leaf area cm^2/plant	Root length cm/plant	Shoot length cm/plant	No. of leaves/plant
Giza 178	7.4 c	5.8 c	7.6 d	26.2 c	10.3 c	23.1 b	3.6 c
SK2034H	9.5 b	7.3 ab	9.5 b	36.7 b	12.3 ab	26.4 b	4.9 ab
SK2035H	9.9 b	7.1 b	9.0 c	36.5 b	11.9 b	25.0 c	4.7 b
SK2058H	10.8 a	8.1 a	9.9 a	38.7 a	12.9 a	27.1 a	5.0 a
LSD0.05	0.71	0.89	0.38	1.11	0.74	0.73	0.27

Growth traits

Results in table 7 showed that genotypes including hybrids and inbred salt tolerant variety Giza 178 in their measured growth characteristics at heading stage as well as measured chemical nutrients of leaves under saline soil. It was detected that hybrids significantly exceeded inbred salt tolerant variety Giza 178 in all measured crop physiology traits. Leaf area index (LAI), flag leaf area, chlorophyll content, flag dry weight, N% of leaf, Na and K leaf contents. The three hybrid entries were at the level of significant regarding chlorophyll content and Na^+ leaf content as well as N% of leaf (Table7). SK2034H showed significant superiority over other two hybrids entries in the rest of physiological parameters. Optimum leaf area index, good flag leaf characteristics, high nitrogen and potassium leaf content at late growth stage and low sodium leaf content will encourage proper growth, appropriate photosynthesis pre and post heading, delaying early aging happing in hybrid and under salt stress result in improving yield component of

rice under current conditions particularly grain filling. The most of yield of rice is coming from current photosynthesis located in the flag leaf, thereby improving flag leaf characteristics certainly attributed to high yield especially, under saline soil. High potassium leaf content with low sodium contend will proved low sodium/potassium ratio result in high salinity withstanding giving considerable rice grain yield. All previous mentioned scientific point views had been recognized with three hybrid entries in the current investigation under saline soil. The results support the fact that the best three selected hybrids entries, Sk2034H, SK2035H and SK2058H could explore under saline soil conditions. Similar findings were reported by Zayed *et al.* (2007 and 2011).

Table 7: Physiological traits of some hybrids against Giza 178 inbred rice salt tolerant variety under saline soil in 2012.

Gentotypes	LAI	Flag leaf area cm^2	Chlorophyll content	Flag leaf dry w/4leaves	Na ppm	K ppm	N %
Giza 178	5.5 c	37.0 c	40.0 b	0.58 c	559.6 b	765.0 d	2.4 b
SK2034H	6.1 b	43.6 b	43.5 a	0.70 b	605.0 a	846.6 b	3.0 a
SK2035H	6.2 ab	44.6 b	43.2 a	0.71 b	598.3 a	830.0 c	3.0 a
SK2058H	6.5 a	47.0 a	44.4 a	0.81 a	611.6 a	877.0 a	3.1 a
LSD0.05	0.285	2.33	1.79	0.028	15.51	13.1	0.245

6-3. Yield and yield components

Results in Table 8 clarified significant differences in the yield and yield components of tested three hybrids and salt tolerant inbred variety Giza 178 under saline soil attributed to variation in its salt tolerance and heterosis. The three hybrids significantly yielded more than that obtained by salt tolerant inbred variety Giza 178. The yield components of three hybrids significantly surpassed those obtained by Giza 178 salt tolerant inbred variety (Table 8). Among the three hybrids, SK2058H was the best under saline soil without significant differences with those produced by SK2034H in rice grain yield and panicle number. SK2035H gave the tallest plants. The lowest sterility% was produced by Giza 178 followed by SK2058H without significant differences. The superiority of SK2058H in rice grain yield mainly attributed high field grains and heavy 1000 – grain weight with low sterility comparing to other hybrids. The hybrids SK2058H, SK2034H and SK2035H yielded increase by 22,5%, 18.8 and 12.6% over Giza 178 salt tolerant inbred variety, respectively. As previously recognized the superiority of mentioned hybrids in seedling vigor and physiological performance might be enabling them to grow healthy with high capability for salinity tolerance resulted in high yield components and ultimately higher grain yield. Current findings are similar to obtained by Zayed *et al* (2006 and 2008) as well as Amudha and Thiyagarajan (2008) and Malarvizhi *et al.* (2009) and Zayed *et al*. (2010 and 2011).

Table 8 : Yield and yield components of some hybrids against Giza 178 inbred rice salt tolerant variety under saline soil in 2012.

Variety	Grain yield (t/ha)	1000 grain weight (g)	Field grains/ panicle	Sterility (%)	No. of panicles hill^{-1}	Panicle length/cm	Plant height (cm)
Giza 178	5.3 c	19.7 d	131.3 c	6.50b	14.6c	19.5c	85.4 b
SK2034H	6.3 ab	22.8 c	140.6 b	10.0a	16.2ab	21.0b	85.1 b
SK2035H	6.0 b	23.5 b	139.0 b	10.6a	15.4bc	21.7 ab	92.7 a
SK2058H	6.5 a	24.2 a	145.6 a	8.1b	17.2a	22.2 a	86.5 b
LSD0.05	0.49	0.533	4.81	1.74	1.26	0.841	1.637

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استكشاف زراعة الأرز الهجين تحت ظروف الأراضي الملحية بمصر .

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أجريت تجربتين حقليتين خلال الموسم الصيفية ٢٠١٠ و٢٠١١ تجربة بالاراضى العادية بمحطة بحوث الجميزة واخرى بالاراضى المتاثرة بالملوحة بمحطة بحوث السرو ثم اجريت تجربة ٢٠١٢ فى محطة بحوث السرو حيث الاراضى المتاثرة بالملوحة بهدف دراسة بعض الصفات المحصولية الفسيولوجية لافضل ثلاث هجن تم اختيارها مقارنة بالصنف جيزة ١٧٨ , اتحت ظروف الملوحة حيث

تم تقييم تسعة هجن و ستة اصناف مرباة داخليا من بينها الصنف حيزة ١٧٨ المعروف بتحملة للملوحة في تجربة قطاعات كاملة العشوائية في كل الأماكن مع تحليلها احصائيا تحليل تجمعي ويمكن تلخيص اهم النتائج كمايلى:

١- اظهرت النتائج ان الارز الهجين SK 2034H اعلى القيم لعدد السنابل بالجورة تحت ظروف الارض الطبعيية بينما اعطى الارز الهجين SK2058H اعلى القيم لعدد السنابل بالجورة تحت ظروف الارض الملحية.

٢- اشارت النتائج الى ان زراعة الارز الهجين SK2034H, SK2035H and SK2058H تحت ظروف الارض الملحية سجل زيادة قدرها ١٦-٢٢% فى المحصول مقارنة بالصنف جيزة ١٧٨ وتفوق الارزالهجين SK2058H على الهجنيين الاخريين.

٣- اوضحت النتائج ان الارز الهجين SK2058H سجل اعلى القيم لصفات البادرة, عدد الجذور البيضاء، الوزن الجاف لجذور البادرة، الوزن الجاف للبادرة، طول الجذر، طول البادرة وعدد الاوراق للنبات تحت ظروف الارض الملحية على الجانب الاخر اعطى الصنف جيزة ١٧٨ اقل القيم لصفات البادرة تحت نفس الظروف.

قام بتحكيم البحث

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