Biochemical and Molecular Genetic Studies on Rice Tolerance to Salinity

*El-Mouhamady, A.A.; I.S.El-Demardash and K.A.Aboud
Department of Genetics and Cytology, National Research Center, Cairo, Egypt.
*elmouhamady@yahoo.com lola_El-Demardash@yahoo.com Kamal_Aboud@yahoo.com

Abstract: The present investigation was carried under green house conditions from (october2009) to (march 2010) seasons included two conditions (normal irrigation and salinity) using model of half diallel analysis by five cultivars of rice “Gz1368-S-5-4, Hybrid1, Sakha102, Giza 181 and IET1444”. Five parents and ten crosses were grown under two conditions and the results showed that:

1. The most desirable mean value were positive and highly significant for heterosis, general and specific combining ability effects for all genotypes under normal and salinity conditions were observed from the genotypes.; Gz1368-S-5-4, hybrid1, IET1444, Gz1368-S-5-4 x hybrid 1, Gz1368-S-5-4 x IET1444, Hybrid 1 x IET1444, Sakha 102 x IET1444 and Giza 181 x IET 1444 under normal and salinity conditions.

2.From the foreign discussion, it could be concluded that the crosses Gz1368-S-5-4 x Hybrid 1, G21368-S-5-4 x IET1444, Hybrid 1 x IET1444 and Giza 181 x IET1444 were contained of 1, 5, 1 and 5 bands using PM15 primer, 6, 3, 6 and 6 bands using AY334988 primer and 6, 2, 4 and 5 bands using HL-17 primer, which indicated that these bands were found to be index and marker for salinity tolerance in rice by increasing K^+ content and decreasing of Na^+ content. Journal of American Science 2010;6(11):521-535]. (ISSN: 1545-1003).

Key words: Rice,salinity,yield components,some traits related to salinity

1. Introduction:

Rice is moderately susceptible to salinity. The degree of injury, however, depends on the nature and concentration of salts, soil pH, water regime, method of planting, seedling age, growth stage of the plant, duration of exposure to salt and temperature.

Most rice cultivars are severely injured in submerged soil cultured on EC of 8-10 dSm^{-1} at 25 ^{o}C, sensitive ones are damaged even at 2 dSm^{-1} (Mass and Hoffman, 1997). Rice that is tolerant to salinity during germination becomes very sensitive during the early seedling stage; gains tolerance vegetative growth again becomes sensitive during pollination and fertilization and then becomes increasingly more tolerant at maturity. Salinity during reproductive stage decreases grain yield much more than salinity during vegetative stage (Akbar and Ponnamperuma, 1982).

Symptoms of salt injury in rice are stunted growth, rolling of leaves, white leaf tips, white blotches in the laminae, drying of older leaves and poor root growth. The percentage of dead leaves is a good measure of salt injury (RRTC, 2002).

2. Materials and methods

The present study was carried out under green house conditions during October 2009 to march 2010 using five rice varieties utilized in this study namely, Gz1368-S-5-4, hybrid 1, Sakha 102, Giza 181 and IET1444 and The pedigree of the parental varieties is shown in Table (1). Each parent was grown in five rows, each row was 5 meter long and contained 25 hills. At flowers, the five parents were diallel crossed, i.e., in all possible combinations (excluding reciprocal) to produce following the method proposed by Jodon (1938) and modified by Butany (1961).

The parents and their F_1 hybrid were growing in a randomized complete block design under greenhouse conditions with three replications in two locations (normal and saline). These cultivars were taken from RRTC (Rice Research and Training Center, Sakha, Kafrel-sheikh). Fertilizers were added as recommended rate and time of application (15 days after transplanting at the rate of 40 kg N/fed., and 15 kg P_2O_5/feddan) and hand weeding was done when it was needed and were chemical controlled by adding 2 liter Saturn/feddan, four days after transplanting. All the data were recorded on the parents and their crosses under two locations. All recommended agriculture practices were applied. At ripening each plant was harvested individually

Soil analysis:

Before conducting the experiments, soil samples were taken from different sites of the experimental area. Each sample was taken from a depth of 0-30 cm, both soil samples normal and saline treatment. the chemical analysis was carried out for each soil extract 1:5 to estimate the soluble anions, cations and total dissolved salts (TDS). The electrical conductivity (EC) was estimated in the extract of the soil saturate paste. The procedure for preparation and measurements of the soil extract was taken according to the method of Black *et al.* (1965). The methods of Chapman and Parker (1961) of soil chemical analysis were followed. The description of both normal and saline types of soil used in the investigation are shown in Table (2).

Table (1):Origin and main characters of the five rice varieties used as parents in the studied diallel cross

Varieties	Origin	Type	Duration (days)	Grain type	Reaction to salinity
GZ1368-S-5-4	(IR1615-31/BG94-2) Egypt	Indica	140	Short	Tolerant
Hybrid 1	(IRmolesterility/G.178) Egypt	Japonica	135	Short	Moderate
Sakha 102	(Gz4098-7-1/Giz 177) Egypt	Japonica	125	Short	Susceptible
Giza 181	(IR1626-203/IR28//IR22) Egypt	Indica	145	Long	Susceptible
IET1444	(TN1/CO29) Egypt	Indica	135	Long	Tolerant

a,h, Japonica, I, Indica

Table(2): Some chemical characteristics of experimental soil at normal and saline soil (lyzimeter).

Characteristics	Normal soil (Tap water)	Saline water (Lyziemter)
EC (dS/m)	1.84	7.6-7.8
pH (1:2.5)	7.0	8.5
TDS mg/litre (ppm)	718.50	3216.7-4214.8
Ca^{++}	3.90	17.80-19.250
Mg^{++}	2.70	14.85
Na^{+}	11.34	50.0-54.0
K^{+}	0.43	0.14
CO_3^{--}	0.03	0.07
HCO_3^{-}	4.50	1.28
Cl^{-}	16.80	47.30
SO_4^{--}	1.70	13.70
Texture	Clay	Clay

EC = Electrical conductivity
TDS = Total dissolved salts
* Measure of soil saturation
** Measure of soil water extract 1:5

For raising seedlings, wooden 60 x nurseries were used which irrigated by tap water. After thirty days from sowing, seedlings of each parent and their crosses were individually transplanted in 1 row, 1 m length for each variety, with a spacing of 15 x 15 cm between rows and recommended culture practices were followed. The plots were salinized 15 days after transplanting and salinization was fixed till harvesting. Plants were irrigated every day by auto-pumping the salt solution from the tanks. Drainage was practiced every 48 hours through bottom out lets and water electrical conductivity (EC) were measured through the crop season.

Studied characters:

A.Yield and its components characters:

1. Heading date (days)

It was determined as the number of days from date of sowing to the date of the first panicle exertion.

2. Plant height (cm):

Length of the main culm was measured from the soil surface to the tip of the main panicle at maturity

3.Number of filled grains per panicle:

Filled grains of the main panicle was separated and counted.

4.1000-grain weight (g):

Was recorded as the weight of 1000 random filled grains per plant.

5.Grain yield per plant (g):

Was recorded as the weight of grain yield of each individual plant and adjusted to 14% moisture content.

B. Some characters related to salinity:

Were measured to determine the chemical characters Na^+ uptake, K^+ uptake Na/K ratio and salinity index for grain yield/plant.

Determination of Na^+ uptake, K^+ uptake and Na/K ratio:

Shoot sampling was determined 25 days from salinization by using different salinity levels when the sensitive parents were severely affected. the shoot samples were weighed and dried for three days at 70°C. samples were finally grounded and 1 gram dried powder from each sample was taken for Na^+ and K^+ determination by flame photometer.

Salinity index (SI):

The salinity index (SI) for each character was calculated by using the formula of Dwivedi *et al.* (1991).

$$SI = \frac{\text{Value of each character under saline situation}}{\text{value of each character under normal situation}} x100$$

Statistical analysis:

At first, the data were analyzed by using the ordinary analysis of variance to test the significance of differences among the genotypes studied (six parents and their crosses). If the genotypes mean squares were found to be significant, there was a need to proceed for further analysis; i.e., Griffing(1956) mode 1, method 2.

Estimation of heterosis effects:

The heterosis of an individual cross was determined for each trait as the increase of the F_1 hybrid mean over its better parent, (i.e. heterobeltiosis), as follows:

$$\text{Heterosis over the better parent \%} = \frac{\overline{F}_1 - \overline{B}.\overline{P}.}{\overline{B}.\overline{P}.} \text{ x } 100$$

Where:

$\overline{F}_1$ = Mean value of the first generation.

$\overline{B}.\overline{P}.$ = Mean value of the better parent.

L.S.D. values were calculated to test the significance of the heterosis effects, according to the following formula suggested by Wyanne *et al.* (1970).

L.S.D. for heterosis over better parent

$$= t\sqrt{\frac{2MSe}{r}}$$

Where:

t = Tabulated value at the specified level of probability for the experimental error.
MSe = The experimental error mean squares
r = Number of replications.
r = Number of replications.

$$GCA/SCA = \frac{MSeGCA\text{-}Mse\ TERM/B+2}{MSeSCA\text{-}Mse\ TERM}$$

B:Number of parents
Mse TERM=mean sguer of error from ANOVA.

According to Griffing (1956).

Estimation of combining ability:

Griffing (1956) stated that the mathematical model in this case was as follows:

$$Xij = U + gi + gj + sij + eijk$$

Where:

Xij= The value of a cross between parent (i) and parent (j)
U= The population mean
gi= The general combining ability (gca) effect of the i^{th} parental variety.
gj=The general combining ability (gca) effect in j^{th} parental variety.
sij=Specific combining ability effect (sca) for the cross.
eijk = The mean error effect; (i.e. the environmental effect associated with the individual observations)

Genotypes sum of squares was partitioned into GCAs and SCAs as follows:

SS due to GCA =

$$\frac{1}{P+2}\left(\sum i(xi+xii)^2-\frac{4}{P}x^2\right)$$

SS due to SCA =

$$\sum i<\sum jxij^2-\frac{1}{P+2}\sum i(xi+xii)^2+\frac{2}{(P+1)(P+2)}x^2$$

The estimates of general combining ability effects ($gi^{\wedge}$) and specific combining ability effects ($sij^{\wedge}$) were computed as follows:

$$\hat{g}i=\frac{1}{P+2}(xi+xii-\frac{2}{P}X..$$

$$\hat{s}ij=xij-\frac{1}{P+2}(xi+xii+xj+xjj)+\frac{2}{(P+1)(P+2)}x..$$

The variances of both effects and differences between effects were estimated as follows:

$$\operatorname{var}(\hat{g}i)=\frac{P-1}{P(P+2)}\sigma^2e$$

$$\operatorname{var}(\hat{s}ij)=\frac{2P+P+2}{(P+1)(P+2)}\sigma^2e(i\#j)$$

$$\operatorname{var}(\hat{s}ij-\hat{s}ik)=\frac{2(P+1)}{(P+2)}\sigma^2e$$ (i≠j, k, 1; j≠K1 and K ≠ 1)

2. Biochemical and molecular genetic analysis

2.1. PCR-based DNA analysis:

DNA was extracted from the leaves of the selected plants of all genotypes studied which different reaction of salinity “tolerant, moderate and sensitive”. The samples were single leaves for parents and first generation according to the method of Graham and Henry (1997).

2.2. Gel electrophoresis buffers

TBE buffer	10x
Tris	10.89
Boric acid	5.50 g
EDTA	0.74 g

H_2O (dd) up to 100 mL

2.3. Loading buffer:

Tris	10.89
Boric acid	5.50 g
EDTA	0.74 g

H_2O (dd) up to 100 mL

Table (3):The primer names and sequences used in PCR analysis

Primer names	Sequences
(PM15)	5`-CGGTTATGCCCAACCGGCAT-3`
(AY334988)	5`-CGTTACCCTTTAAATTCGTA-3`
(HL-17)	5`-AATTCCTCAGGTTCCCTAAC-3`

2.4. Agarose gel electrophoresis:

PCR amplification products were analyzed using 1.5% agarose gel electrophoresis in 1 x TBE buffer and stained with ethidium bromide. the run was perfolrmed at 100 V in Bio Rad submarine the bands of amplified DNA were visualized under UV light and the sizes of the fragments were estimated based on a DNA ladder of a 10 to 200 base pairs, and photographed with gel documentation system.

2.5. Gel analysis:

Gels were photographed under UV light with Polaroid film 667 and scanned with bio-rad video densitometer model 620, at a wave length of 557 software data analysis for Bio-Rad model 620 USA densitometer and computer were used.

3. Results and Discussion

Salinity is a major obstacle to increase production in rice growing areas. In Egypt rice is grown in the northern delta, whereas according to soil survey reports, it had been found that about 1.6 million feddan in the part of this area are damaged by excess soluble salts, exchangeable sodium accumulation and water logging conditions to an extent that causes crop yield reduction.

Rice is considered as moderately salt sensitive crop fort the newly reclaimed saline areas. Therefore, developing salinity tolerance rice varieties is a very important approach not only for increasing yields, but also for conquering saline soils.

To develop and sustain high yielding rice varieties combined with salinity tolerance, it is needed to know adequate genetic information about the type and magnitude of the genetic and environmental variations within the genotypes.

1. Variation and interaction:

Mean squares of the ordinary analysis and combining ability analysis for all characters under normal and saline soils are presented in Table (4 and 5).

Mean squares of genotypes (parents and their crosses) were found to be highly significant for all characters studied at the normal and saline soil, indicating overall differences among these populations.

Both general and specific combining ability variances were found to be highly significant for all characters studied at two locations exept plant height and Na/Kratio under normal conditions. These results would indicate the importance of both additive and non-additive genetic variances in determining the performance of these agronomic characters.

GCA/SCA ratio was used to clarify the nature of the gene action involved. GCA/SCA ratio were found to be greater than unity for grain yield/plant under all conditions only, while, K^+ content, Na/K ratio and salinity index for grain yield/plant under normal and salinity conditions were less than the unity, indicates that additive and additive x additive types of gene action were greater importance in the inheritance of these characters. It is therefore, could be concluded that selection procedures based on the accumulation of additive effects, would be successful in improving these characters. These findings were in agreement with those reported by Borgohain and Sharma (1998), El-Refaee (2002) and El-Mouhamady (2009).

2. Mean performance

The genotypes mean values for all studied character under normal and salinity conditions are presented in Tables (6 & 7).

For heading date. The earlier plants were obtained from the genotypes, GZ1368-S-5-4, hybrid 1, IET1444, GZ1368-S-5-4 x IET1444, Hybrid 1 x IET1444 and Giza 181 x IET1444 under both conditions. The mean values were ranged from 83.4 to 129.33 day for normal and salinity condition, respectively. These findings were in agreement with those reported by El-Said (2007) and El-Mouhamady (2009).

Regarding plant height, the parents; GZ1368-S-5-4, Hybrid 1 and IET1444 and the crosses; GZ1368-S-5-4 x

Hybrid 1, GZ1368-S-5-4 x IET1444 and Giza 181 x IET 1444 recorded the lowest values of plant height under all conditions. These results were in agreement with those obtained by Weerakoon (2008).

Concerning 1000-grain weight, the most desirable mean values were obtained from the genotypes; Hybrid 1,Sakha 102, IET1444, GZ1368-S-5-4 x Hybrid 1, GZ1368-S-5-4 x IET1444 and Giza 181 x IET 1444 under normal and salinity conditions. These findings were in harmony with those reported by Zhang *et al.* (2007), Weerakoon (2008) and El-Mouhamady (2009).

Regarding number of filled grains/panicle, the highest mean values were obtained from the genotypes; GZ1368-S-5-4, Hybrid 1, IET1444, GZ1368-S-5-4 x IET 1444, Hybrid 1 x IET 1444, Sakha 102 x IET 1444 and Giza 181 x IET 1444 under normal and salinity conditions.

With respect to grain yield/plant, the highest mean performance were showed from the genotypes; Hybrid 1, Sakha 102, IET 1444, GZ1368-S-5-4 x Hybrid 1, GZ1368-S-5-4 x IET1444, Hybrid 1 x IET 1444, Sakha 102 x IET 1444 and Giza 181 x IET 1444 under normal and salinity conditions. The values were ranged from 28.48 to 74.82 (g) for normal and salinity conditions. These results are in conformity with those reported by El-Said (2007) and El-Mouhamady (2009).

For Na^+ content, the most desirable mean values were obtained from the genotypes; Hybrid 1, IET1444, GZ1368-S-5-4 x IET1444, Hybrid 1 x IET1444 and Giza 181 x IET 1444 under normal and salinity conditions because these genotypes recorded the lowest level of Na^+ content from the soil as index for salinity tolerance in rice. These findings were in conformity with that reported by Won *et al.* (1992), Gonzalex *et al.* (1999), and Weerakoon et al (2008).

With respect to K^+ content, the genotypes; GZ1368-S-5-4, Hybrid 1, IET1444, GZ1368-S-5-4 x Hybrid 1, GZ1368-S-5-4 x IET1444, Hybrid 1 x IET 1444 and Giza 181 x IET1444 showed the highest mean values for this trait under both conditions. Similar results were obtained by Gonzalez *et al.* (1999) and Weerakoon *et al.* (2008).

Concerning Na/K ratio, the genotypes; Sakha 102, Giza 181, GZ1368-S-5-4 x Giza 181, Sakha 102 x Giza 181 and Sakha 102 x IET1444 gave the highest mean values under both normal and salinity conditions. These results were in agreement with those reported by Alam (1990), Gonzalez *et al.* (1999) and Weerakoon *et al.* (2008).

For salinity index for grain yield/plant, the parents; GZ1368-S-5-4, Hybrid 1, Sakha 102 and IET1444 and the crosses GZ1368-S-5-4 x ET1444, Hybrid 1 x Sakha 102, Hybrid 1 x IET1444, Sakha 102 x IET1444 and Giza 181 x IET1444 were recorded the highest mean values for this trait. Similar results were showed by El-Said (2007) and et al Weerakoon (2008).

3. Heterosis:

From Tables (8 and 9) observed the percentages of heterosis over better parents for all the characters studied under normal and salinity conditions.

With respect to heading date and plant height, heterosis percentages were highly significant and negative in the crosses, GZ1368-S-5-4xHybrid 1 and GZ1368-S-5-4 x IET1444 for heading date and the first cross in addition to Hybrid 1 x Sakha 102 and Sakha 102 x Giza 181 for plant height under all conditions, respectively which indicated, that additive gene action played an importance role to control this trait under salinity conditions.. These findings were inconformity with that reported by Sedeek (2006), weerakoon et al (2008) and El-Mouhamady (2009).

Highly significant and positive of heterosis over better parent were showed in the cross; GZ1368-S-5-4 x Giza 181 under all conditions only for 1000-grain weight and the values were 8.47 and 9.72% for normal and salinity conditions. it was found to be useful for specific combining ability which indicated, that additive gene action played an importance role to control this trait under salinity conditions. These results were obtained by El-Said (2007) and El-Mouhamady (2009).

Concerning number of grains/panicle heterosis percentages as deviation from better parents was highly significant and positive in the crosses, GZ1368-S-5-4 x Giza 181 , hybrid 1 x Sakha 102, Hybrid 1 x IET 1444, Sakha 102 x Giza 181, sakha 102 x IET1444 and Giza 181 x IET1444 under normal and salinity conditions and GZ1368-S-5-4 x sakha 102 under salinity conditions only which indicated, that additive gene action played an importance role to control this trait. Similar results were reported by El-Said (2007).

For grain yield/plant, the crosses, GZ1368-S-5-4 x Hybrid 1 under normal conditions, GZ1368-S-5-4 x IET1444 under salinity conditions and Giza 181 x IET1444 under normal and salinity conditions, respectively showed highly significant and positive of heterosis over better parent and the values were ranged from 11.22 to 11.40% under normal condition and from 4.59 to 10.78% under salinity conditions ,respectively. which indicated that additive gene action played an important role in the inheritance of grain yield/plant under salinity conditions. These results were reported by Zhang *et al.* (2007) and El-Mouhamady. (2009).

For Na^+ content, the crosses; GZ1368-S-5-4 x IET1444 , Hybrid 1 x IET1444 and Giza 181 x IET1444 under all conditions showed highly significant and negative of heterosis over better parent which indicated that these parents considered a good combiners for hybridization to make a programme for salinity tolerance . Similar results were obtained by El-Said (2007), Weerakoon *et al.* (2008) and El-Mouhamady (2009).

The genotypes, GZ1368-S-5-4 x Hybrid 1 , hybrid 1 x IET1444 and Sakha 102xGiza 181were showed highly significant and positive of heterosis over better-parent for k^+ content all conditions and the values were ranged from 2.98 to 133.3% and from 2.96 to 139.20% under normal and salinity conditions respectively. which indicated that , additive gene action played an important role in the inheritance of this trait.These findings were in conformity with those reported by Sedeek (2006), El-Said (2007), Zhang *et al.* (2007), Weerakorn *et al.* (2008) and El-Mouhamady (2009).

Table (4): Mean squares estimates of ordinary analysis and combining abiling ability analysis for yiad and its components under normal and salinity conditions

S.O.V	D.F	M.S									
		Heading date(day)		plant height (cm)		1000-grain weight (g)		No.of filled grains/panicle		Grain yield/ plant	
		N	S	N	S	N	S	N	S	N	S
Genotypes	14	684.76**	766.82**	701.46**	588.59**	88.01**	93.87**	8260.66**	7437.18**	825.09**	720.16**
Porents	4	312.95**	403.17**	515.86**	380.47**	103.63**	91.78**	98.9306**	8647.10**	799.03**	636.12
Crosses	9	866.01**	1000.29**	855.55**	744.50**	90.21**	102.53**	6649.71**	5879.86**	924.40**	835.19**
P V S crosses	1	540.91**	114.46**	57.08**	17.86**	5.67*	24.26**	1622.61**	16571.41**	35.45**	21.02**
Error	28	0.69	0.99	1.27	0.79	0.91	0.82	0.28	1.12	0.75	0.62
GCA	4	408.91**	499.87**	292.00**	220.99**	65.26**	59.59**	6346.04**	5670.5**	713.85**	633.45**
SCA	10	155.99**	157.90**	210.55	186.28**	14.96**	19.97**	1316.56**	1201.07**	99.50**	82.69**
GCA/ SCA		0.37	0.45	0.19	0.17	0.62	0.42	0.68	0.67	1.02	1.09
Error	28	0.23	0.33	0.42	0.26	0.30	0.27	0.09	0.37	0.25	0.21

N: normal S: salinity *: Significant at 5% ** Significant at 1%

Table (5): Mean squares estimates of ordinary analysis and combining ability analysis for some characters related to salinity under normal and salinity conditions.

S.O.V	D.F	M.S						
		Na^+ content		k^+content		Na/ K ratio		Salinity index for grain yied plant
		N	S	N	S	N	S	N
Genotypes	14	0.113**	0.199**	1.927**	2.120**	0.093*	0.141**	326.17**
Porents	4	0.103**	0.261**	2.453**	3.551**	0.150*	0.350**	265.27**
Crosses	9	0.129**	0.191**	1.463**	1.163**	0.056	0.029**	370.46**
P.V S. crosses	1	0.007**	0.027**	4.00**	5.00**	0.200*	0.317**	171.20**
Error	28	0.00003	0.00001	0.0003	0.001	0.042	0.0002	18.27
GCA	4	0.09**	0.16**	1.46**	1.41**	0.06**	0.11**	217.03**
SCA	10	0.02**	0.03*	0.31**	0.42**	0.02	0.02**	65.40**
GCA/ SCA		0.50	0.76	0.67	0.47	0.47	0.78	0.48
Error	28	0.00	0.00	0.0001	0.00	0.01	0.00	6.09

N: normal S: salinity *: Significant at 5% ** Significant at 1%

Table (6): The genotypes mean performance for yield and components characters studied under nor,al and salinity, and itions

Genotypes	Heading date (day		plant height (cm)		1000- grain weight (g)		No.of filled grains/ panicle		Grain yield/ plant (g)	
	N	S	N	S	N	S	N	S	N	S
GZ 1368-S-5-4	92.0	105.0	92.63	90.30	22.43	19.43	140.23	105.13	41.57	32.40
Hybrid I	90.73	96.10	110.50	103.37	31.50	28.37	190.38	171.30	64.43	50.60
Sakha 102	113.17	122.67	117.0	112.30	27.37	25.23	115.57	105.57	44.40	40.43
Giza 181	97.83	104.57	115.23	109.33	19.33	16.67	133.23	121.22	28.48	21.03
IET 1444	87.30	92.83	89.0	87.17	33.20	29.23	257.23	229.37	67.16	57.87
GZ1368-S-5-4 x Hybrid I	87.17	87.37	84.33	82.03	29.40	26.67	177.34	151.44	71.66	44.10
GZ1368-S-5-4 x Sakha 102	118.33	122.33	134.43	128.33	20.50	17.23	133.53	126.80	38.57	22.71
GZ1368-S-5-4 x Giza 181	116.33	122.23	125.43	120.07	24.33	21.32	150.37	120.36	27.47	19.37
GZ1368-S-5-4 x IET 1444	83.4	85.17	95.33	93.03	34.00	30.33	232.37	221.22	69.47	60.53
Hybrid I x Skha 102	110.00	117.27	97.67	95.77	21.17	15.00	201.09	192.86	42.57	32.20
Hybrid I x Giza 181	129.33	133.33	122.37	114.40	20.93	17.00	171.30	156.29	38.40	26.57
Hybrid I x IET 1444	94.43	96.30	98.67	89.33	29.83	26.67	261.07	234.46	65.44	52.17
Sakha 102x Giza 181	120.23	126.67	108.03	95.33	19.33	15.40	241.43	221.23	28.85	19.59
Sakha 102x IET 1444	89.07	93.67	117.36	112.86	27.43	23.43	250.40	217.70	61.33	55.07
Giza 181 x IET 1444	87.38	92.89	89.09	87.37	33.80	29.83	257.83	229.39	74.82	64.11
LSD at 5%	1.39	1.67	1.88	1.48	1.59	1.51	0.88	1.77	1.45	1.32
LSD at 1%	1.88	2.25	2.55	2.01	2.16	2.04	1.19	2.39	1.96	1.78

N: normal S: salinity *: Significant at 5% ** Significant at 1%

Table (7): The genotypes mean performance for some traits related to salinity under normal and salinity conditions

Genotypes	Na$^+$ content		K$^+$ content		Na / K ratio		Salimty index for grain yield/plant
	N	S	N	S	N	S	
GZ1368-S-5-4	0.29	0.31	2.12	2.70	0.13	0.11	77.94
Hybrid I	0.12	0.14	2.77	2.87	0.04	0.05	78.53
Skha 102	0.63	0.91	1.09	1.12	0.57	0.81	91.05
Giza 181	0.41	0.54	1.11	1.03	0.37	0.52	73.84
IET 1444	0.32	0.34	3.02	3.43	0.10	0.09	86.16
GZ1368-S-5-4 x Hybrid I	0.31	0.41	2.91	3.20	0.10	0.13	61.54
GZ1368-S-5-4 x Sakha 102	0.48	0.61	2.03	2.78	0.23	0.22	58.87
GZ1368-S-5-4 x Giza 181	0.54	0.72	1.82	2.90	0.29	0.25	70.51
GZ1368-S-5-4 x IET 1444	0.04	0.10	3.11	2.84	0.01	0.03	87.13
Hybrid I x Sakha 102	0.22	0.22	2.52	2.64	0.08	0.08	75.64
Hybrid I x Giza 181	0.21	0.22	1.72	1.82	0.12	0.12	69.19
Hybrid I x IET 1444	0.11	0.13	4.06	4.24	0.02	0.03	79.72
Sakha 102x Giza 181	0.73	0.83	2.59	2.68	0.28	0.31	67.90
Sakha 102x IET 1444	0.38	0.33	2.78	2.91	0.11	0.11	89.79
Giza 181 x IET 1444	0.16	0.20	3.75	3.18	0.04	0.06	85.68
LSD at 5%	0.009	0.005	0.028	0.052	0.344	0.026	7.149
LSD at 1%	0.01	0.01	0.04	0.07	0.46	0.03	9.65

N: normal S: salinity *: Significant at 5% ** Significant at 1%

Table (8) percentages of heterosis over better parents (B.p) for grain grain yield and its components under normal and salinity conditions.

Genotypes	Heading date (day		plant height (cm)		1000- grain weight (g)		No.of filled grains/ panicle		Grain yield/ plant (g)	
	N	S	N	S	N		N	S	N	S
GZ1368-S-5-4 x Hybrid I	-3.92**	-9.08**	-8.96**	-9.15**	-6.66*	-5.99*	-6.84	-11.59**	11.22**	-12.84
GZ1368-S-5-4 x Sakha 102	28.62**	16.50**	45.12**	42.11	-25.10**	-31.70**	-4.77**	20.41**	-13.13**	-43.89**
GZ1368-S-5-4 x Giza 181	26.44**	16.88	35.40**	32.96**	8.47*	9.72*	7.23**	-0.71	-33.91**	-40.21**
GZ1368-S-5-4 x IET 1444	-4.46**	-8.25**	7.11**	6.75**	2.40	3.76	-9.66	-3.55**	-3.43**	4.59**
Hybrid I x Sakha 102	21.23**	22.03**	-11.61**	-7.35**	-32.79**	-47.12**	5.62**	12.58**	-33.92**	-36.36**
Hybrid I x Giza 181	42.54**	38.74**	10.74**	10.67**	-33.55**	-40.07**	-10.02**	-8.76**	-40.40**	-47.49**
Hybrid I x IET 1444	8.16**	3.73**	10.86**	2.47**	-10.15**	-8.75**	1.49**	2.22**	-2.56*	-9.84**
Sakha 102 x Giza 181	22.89**	21.13**	-6.24**	-12.80**	-29.37**	-38.96**	81.21**	82.50**	-35.02**	-51.54**
Sakha 102 x IET 1444	2.02*	09.0	31.86**	29.47**	-17.37**	-19.84**	-2.65**	-5.08**	-8.68**	-4.83**
Giza 181xIET 1444	0.09	0.06	0.10	0.22	1.80	2.05	0.23	0.008	11.40	10.78**
LSD at 5%	1.39	1.67	1.88	1.48	1.59	1.51	0.88	1.77	1.45	1.32
LSD at 1%	1.88	2.25	2.55	2.01	2.16	2.04	1.19	2.39	1.96	1.78

N: normal S: salinity *Significant at 5% Significant at 1%

Table (9): Percentages of heterosis over better. Parents (B.P) for some characters related to salinity undernnormal and salinity conditions.

Genotypes	Na^+ content		K^+ content		Na / K ratio		Salimty index for grain yield/plant
	N	S	N	S	N	S	
GZ1368-S-5-4 x Hybrid I	158.33**	192.85**	5.05**	11.49**	-23.07	18.18	-21.63**
GZ1368-S-5-4 x Sakha 102	65.51**	96.77**	-4.24**	2.96**	-59.64*	-72.83**	-35.34**
GZ1368-S-5-4 x Giza 181	86.20**	132.25**	-14.15**	7.40**	-21.62	-51.92**	-9.53*
GZ1368-S-5-4 4 x IET 1444	-86.20**	-67.74**	2.98**	-17.20**	-92.30	-72.72**	1.12
Hybrid I x Skha 102	83.33**	57.14**	-9.02**	-8.01**	-85.96**	-90.12**	-16.92**
Hybrid I x Giza 181	75.0*	57.14*	-37.90**	-36.85**	-67.56	-76.92**	-11.89
Hybrid I x IET 1444	-8.33**	-7.14**	34.43**	23.61**	-80.00	-66.66**	-7.47
Sakha 102 x Giza 181	78.04**	53.70**	133.33**	139.28**	50.87	-61.73**	-25.42**
Sakha 102 x IET 1444	18.75*	-2.94	-7.94**	-15.16**	-80.70	-86.42**	-1.38
Giza 181xIET 1444	-50.0**	-41.17**	24.17**	-7.28**	-89.18	-88.46**	-0.55
LSD at 5%	0.009	0.005	0.028	0.052	0.344	0.026	7.149
LSD at 1%	0.01	0.01	0.04	0.07	0.460	0.03	9.650

N: normal S: salinity *: Significant at 5% ** Significant at 1%

For Na/K ratio, all crosses showed highly significant and negative of heterosis over better parent for this trait under normal and salinity conditions. Similar results were obtained by Sedeek (2006) and Weerakoon et al (2008).

With respect to salinity index for grain yield/plant, six crosses were showed highly significant and negative of heterosis over better parent for example, GZ1368-S-5-4 x Hybrid 1, GZ1368-S-5-4 x Sakha 102, Hybrid 1 x Sakha 102 and Sakha 102x IET1444. It could be concluded that the most desirable crosses for all traits studied under both normal and salinity conditions were GZ1368-S-5-4 x Hybrid 1, GZ1368-S-5-4 x IET1444, hybrid 1 x IET1444 and Giza 181 x IET1444.

4.Combining ability

4.1.General combining ability

Estimates of the GCA effects of individual parental lines for all characters studied under normal and salinity conditions are present in Tables (10 and 11).

The varieties GZ1368-S-5-4, Hybrid 1 and IET1444 showed highly significant and negative of general combining ability effects under two conditions for heading date and plant height characters, indicating that these varieties can be considered as a good combiners for these traits under normal and salinity conditions, and found that earliness was controlled by over-dominance, These results were in agreement with the data obtained by Sedeek (2006), El-Said (007) and Weerakoon *et al.* (2008).

Highly significantly and positively of GCA effects was showed in the genotypes; Hybrid 1 and IET1444 for 1000-grain weight and grain yield/plant under the two conditions , while number of filled grains/panicle was under normal conditions only, it is clear that these varieties were found to be the best combiners for these traits and indicating that additive x additive types of gene action were of greater importance in the inheritance of this traits under both conditions. These results were in agreement with those reported by El-Mouhamady (2009).

The parents; Hybrid 1 and IET144 under both conditions and GZ1368-S-5-4 under normal conditions only showed significant and highly significant negative GCA effects for Na^+ content, While, hybrid 1 and IET1444 under two conditions and GZ1368-S-5-4 under normal conditions showed highly significant and positively of GCA effects for K^+ content.

On the other hand, the genotypes, sakha 102 under all conditions,Giza 181 under salinity conditions for Na/k ratio and the same cultivar in addition to IET1444 for salinity index for grain yield/plant observed significant and highly significant and positive of GCA effects, which proving to be good combiners for these traits, proving to be good combiners for this traits, which indicating the importance of both additive and non-additive variances in the expression of this traits in rice. Similar results were obtained by Singh and Kumar (2005) and Weerakoon et al. (2008).

Since significant negative values of GCA effects would be of interest for earliness and short stature rice cultivars in Tables (10 and 11) for heading date, plant height and Na^+ content in the genotypes ; Hybrid 1 and IET1444 provide to be good combiners under both conditions, could be useful for rice breeders who breed for earliness or short stature rice cultivars and low level of Na^+ content considering the GCA effects for yield and its components, K^+ content, Na/K ratio and salinity index for grain yield/plant, it was suggested that population involving the parents GZ1368-S-5-4, Hybrid 1 and IET 14444 could be considered in making multiple crossing because they might possess desirable genes for earliness, short stature as well as high grain yielding ability under normal and salinity conditions. Accordingly, these parents would be the best choice as base populations.

From the foregoing discussion, it could be concluded that, the most desirable genotypes for grain yield and its components and some characters related to salinity under normal and salinity conditions were GZ1368-S-5-4, Hybrid 1, IET1444, GZ1368-S-5-4 x IET1444, Hybrid 1 x IET1444, Sakha 102 x IET1444 and Giza 181 x IET1444, which indicated the importance for the earlier selection for these traits under salinity conditions.

4.2.Specific combining ability effects:

SCA effects for the parental combinations under the two conditions (normal and salinity) are shown in Tables (12 & 13).

For heading date, four out of ten hybrid combinations had negative and highly significant desirable SCA effects under normal and salinity conditions. The best crosses were GZ1368-S-5-4 x Hybrid 1, GZ1368-S-5-4 x IET14444, Sakha 102 x IET1444 and Giza 181 x IET1444 for this trait under two conditions. These results were in agreement with those reported by Aidy et al (2006) and El-Said (2007).

Concerning plant height, four out of ten hybrid studied showed highly significant and negative of SCA effects under both conditions. These results obtained in the crosses; GZ1368-S-5-4 x Hybrid 1, Hybrid 1 x Sakha 102, Sakha 102x Giza 181 and Giza 181 and x IET1444, indicated that additive and additive x additive types of gene action were of greater importance in the inheritance of plant

Table (10): Estimates of general combining ability effect for the pornetol varieties evaluated for yield and its components characters studied under normal and salinity conditions.

Genotypes	Heading date (day		plant height (cm)		1000- grain weight (g)		No.of filled grains/ panicle		Grain yield/ plant (g)	
	N	S	N	S	N	S	N	S	N	S
GZ1368-S-5-4	-2.49**	-1.63**	-2.00**	-0.61**	-0.64**	-0.30	-27.29**	-30.22**	-1.78**	-3.64**
Hybrid I	-0.61**	-1.87**	-2.11**	-2.86	0.96**	0.80**	3.78**	5.15**	6.31**	2.75**
Sakha 102	8.19**	9.39**	7.53**	6.94**	-2.06**	-2.14**	-15.36**	-10.35**	-6.10**	-3.80**
Giza 181	6.03**	6.38**	5.21**	3.90**	-3.02**	-2.89**	-11.19**	-10.27**	-11.99**	-10.22**
IET 1444	-11.12**	-12.27**	-8.63**	-7.37**	4.75**	4.52**	50.06**	45.69	13.56**	14.91**
LSD at 5%g	0.33	04.	0.45	0.36	0.38	0.36	0.21	0.42	0.35	0.32
LSD at 1%g	0.45	0.54	0.61	0.48	0.52	0.49	0.29	0.57	0.47	0.43
LSD at 5%gi	0.53	0.63	0.71	0.56	0.60	0.57	0.33	0.67	0.55	0.50
LSD at 1 %gi	0.71	0.85	0.96	0.76	0.82	0.77	0.45	0.90	0.74	0.67

N: normal S: salinity *: Significant at 5% ** Significant at 1%

Table (11):Estimates of general combining ability effect for the parental varieties evaluated for some characters related to salinity under normal and salinity conditions.

Genotypes	Na$^+$ content		K$^+$ content		Na / K ratio		Salimty index for grain yield/plant
	N	S	N	S	N	S	
GZ1368-S-5-4	-0.01**	0.00	-0.08**	0.12**	-0.06	-0.04**	-3.65**
Hybrid I	-0.13**	-0.17**	0.30**	0.20**	-0.13**	-0.10**	-4.58**
Sakha 102	0.14**	0.19**	-0.37**	-0.43**	0.08*	0.17**	2.83**
Giza 181	0.09**	0.10**	-0.47**	0.47**	0.08	0.10**	-3.09**
IET 1444	-0.08**	-0.13**	0.62**	0.58**	0.02	-0.11*	8.49**
LSD at 5%g	0.00	0.00	0.01	0.01	0.08	0.01	1.71
LSD at 1%g	0.00	0.00	0.01	0.02	0.11	0.01	2.31
LSD at 5%gi	0.00	0.00	0.01	0.02	0.13	0.01	2.70
LSD at 1 %gi	0.00	0.00	0.01	0.03	0.18	0.01	3.65

N: normal S: salinity *: Significant at 5% ** Significant at 1%

height and These crosses were found to be the useful crosses for heterosis. which indicated that these crosses were by Bindu and shashidhear (2006) and El-Mouhamady (2009).

For 1000-grain weight, the crosses; GZ1368-S-5-4 x Hybrid 1, GZ1368-S-5-4 x IET1444 , GZ1368-S-5-4 x Giza 181 and Giza 181x IET1444 showed highly significant and positive SCA effects under normal and salinity conditions. These crosses were found to be very important for salinity tolerance in rice by the interaction between additive and additive x additive gene actions These findings were in agreement with those reported by Weerakoon *et al.* (2008).

With respect to number of filled grains/panicle, six out of ten crosses studied had positive and highly significant of SCA effects under normal and salinity conditions. These crosses were GZ1368-S-5-4 x Hybrid 1, GZ1368-S-5-4 x IET 1444, Hybrid1 x Sakha102, Hybrid 1 x IET1444,Sakha 102xGiza 181 and Giza 181 x IET 1444. The same results were obtained by Bindu and shashidhear (2006) and El-Said (2007).

For grain yield/plant, four out of ten crosses showed highly significant and positive of SCA effects. The best of these crosses were GZ1368-S-5-4 x Hybrid 1 under salinity conditions, GZ1368-S-5-4 x IET1444,Sakha 102 X IET 1444 and Giza 181 x IET1444 under all conditions, which were found to show useful heterosis for this trait under normal and salinity conditions, which indicated that these crosses were found to be useful for salinity tolerance in rice and indicating the importance of both additive and non-additive variances in the expression of these trait in rice.. Similar results were showed by Aidy (2006), Bindu and shashidhear (2006), Abd El-Lateef *et al.* (2006) and Weerakoon et al. (2008).

Regarding of Na^+ content, the crosses, GZ1368-S-5-4 x IET1444, Hybrid 1 x Sakha 102, Hybrid 1 x Giza 181,Sakha 102 x IET1444 and Giza 181 x IET1444 showed highly significant and negative of SCA effects under normal and salinity conditions, which indicated that these crosses were very important for development salinity tolerance in rice. Similar results were obtained by El-Mowafy (1954), Bindu and shashidhear (2006) and Weerakoon et al (2008).

The crosses; GZ1368-S-5-4 x Hybrid 1, GZ1368-S-5-4 x Sakha 102, Hybrid 1 x IET1444, Hybrid 1 x Sakha 102, Sakha 102xGiza 181, Sakha 102 x IET1444 and Giza 181 x IET1444 were showed highly significantly and positively of SCA effects under all conditions for K^+ content. These crosses were found to be useful for heterosis and important for salinity tolerance of rice. These results were in agreement with those reported by Bindu and shashidhear (2006) and Weerakoon et al (2008).

Highly significant and positive of SCA effects for Na/K ratio were found in the crosses; GZ1368-S-5-4 x Hybrid 1 and Hybrid 1 x IET1444 under salinity conditions only, proving to be the best crosses for this trait and indicating the importance of additive and non-additive genetic variance in the inheritance of these characters and that selection for these traits would be effective in early segregating generations.

These results were in agreement with those reported by El-Mowafy (1994), Cheong *et al.* (1995) and El-Said (2007).

For salinity index for grain yield/plant, the crosses GZ1368-S-5-4 x IET 1444 and Giza 181 x IET 1444 showed significant and highly significant and positive of SCA effects for this trait. Similar results were showed by Cheong *et al.* (1995), Zhang *et al.* (2007) and El-Mouhamady (2009).

It was obvious in Tables (12 and 13) that most of the crosses showing high SCA effects involved diverse parents. The superior F's having SCA effects are expected to produce desirable transgressive segregates, provided that the desirable complementary genes and epistatic effects are coupled in the same direction to maximize these traits in view.

Also, desirable SCA effects in the crosses, GZ1368-S-5-4 x Hybrid 1, GZ1368-S-5-4 x IET1444 and Giza 181 x IET1444 might be recommended to be utilized in hybrid rice breeding. The population would posses desirable genetic for yield components and salinity traits, which indicated that this different origin of these parent would widen the genetic base for selection.

5.Biochemical genetic markers:

The importance and need of rice genotypes at global level requires evaluation of germplasm to assist the future of Salinity tolerance programs. Hence, it is essential top characterize rice genotypes using PCR-based markers such as PM15 primer in Table (14), Figure (1).

Table (12): Estimates of specific combining ability effects for the crosses evaluated for yield and its components characters studied under normal and salinity conditions.

Crosses	Heading date (day		plant height (cm)		1000- grain weight (g)		No.of filled grains/ panicle		Grain yield/ plant (g)	
	N	S	N	S	N		N	S	N	S
GZ1368-S-5-4 x Hybrid I	-10.85**	-15.72**	-18.02	-15.88**	2.81**	3.42**	6.67**	2.91**	-16.67	5.49**
GZ1368-S-5-4 x Sakha 102	11.53**	7.99**	22.44**	20.62**	-3.06**	-3.08	-18.00**	-6.24**	-4.02	-9.35**
GZ1368-S-5-4 x Giza 181	11.68**	10.90**	15.75**	15.38**	1.73**	1.76**	-5.34**	-12.75**	-9.22**	-6.27**
GZ1368-S-5-4 x IET 1444	-4.10**	-7.52**	-0.50	-0.37	3.62**	3.36**	15.41**	32.14**	7.22**	9.76**
Hybrid I x Sakha 102	1.31**	3.15**	-14.22**	-9.69**	-4.00**	-6.41**	18.49**	24.45**	-8.11**	-6.28**
Hybrid I x Giza 181	22.80**	22.23**	12.79**	11.97**	-3.28**	-3.66**	-15.48**	-12.18**	-6.38**	-5.46**
Hybrid I x IET 1444	5.05	3.85**	2.94**	-1.82**	-2.15**	-1.40**	13.04**	10.02**	-4.89**	-4.99**
Sakha 102 x Giza 181	4.91**	4.31**	-11.18**	-16.89**	-1.85**	-2.33**	73.80**	68.25**	-3.53**	-5.90**
Sakha 102 x IET 1444	-9.11**	-10.04**	12.00**	11.88**	-1.53**	-1.70**	21.51**	8.75	3.40**	4.45**
Giza 181 x IET 1444	-8.72**	-7.87**	-14.05**	-10.75**	5.20**	4.85**	24.18**	20.34**	15.13**	13.68**
LSD at 5% Sij	0.86	1.03	1.17	0.92	0.99	0.93	0.55	1.09	0.90	0.82
LSD at 1% Sij	1.16	1.39	1.57	1.24	1.33	1.26	0.74	1.48	1.21	1.10
LSD at 5% Sij- sik	1.29	1.55	1.75	1.38	1.48	1.40	0.82	1.64	1.35	1.22
LSD at 1% Sij- sik	1.74	2.09	2.36	1.86	2.00	1.89	1.10	2.21	1.82	1.65
LSD at 5% Sij- sk	1.18	1.41	1.60	1.26	1.35	1.28	0.75	1.50	1.23	1.12
LSD at 1% Sij- sk	1.59	1.90	2.15	1.80	1.82	1.73	1.05	2.02	1.66	1.51

N: normal S: salinity *: Significant at 5% ** Significant at 1%

Table (13): Estimates of speaific combining ability effect for the crosses evaluated for some characters related to salinity under normal and salinity conditions.

Genotypes	Na^+ content		K^+ content		Na / K ratio		Salimty index for grain yield/plant
	N	S	N	S	N	S	
GZ1368-S-5-4 x Hybrid I	0.11**	0.18**	0.25**	0.18**	0.07	0.08**	-7.10**
GZ1368-S-5-4 x Sakha 102	0.02**	0.01**	0.03**	0.31**	0.00	-0.08**	-16.16
GZ1368-S-5-4 x Giza 181	0.12**	0.20**	-0.08**	0.55**	0.05	0.01	0.12
GZ1368-S-5-4 x IET 1444	-0.21**	-0.18**	0.13**	-0.56**	-0.17	-0.01	6.19**
Hybrid I x Sakha 102	-0.13**	-0.12**	-0.56**	-0.61**	-0.04	-0.06**	0.34
Hybrid I x Giza 181	-0.07**	-0.12**	-0.56**	-0.61**	-0.04	-0.06**	0.34
Hybrid I x IET 1444	-0.01**	0.01**	0.69**	0.76**	-0.09	0.04**	-0.68
Sakha 102 x Giza 181	0.16**	0.13**	0.99**	0.89**	-0.10	-0.15**	-7.75**
Sakha 102 x IET 1444	-0.07**	-0.14**	0.08**	0.06**	-0.21	-0.15**	2.96
Giza 181 xIET 1444	-0.02**	-0.05**	0.43**	0.62**	0.12	-0.10**	4.90*
LSD at 5% Sij	0.01	0.00	0.02	0.03	NS	0.02	4.41
LSD at 1% Sij	0.01	0.00	0.02	0.04	NS	0.02	5.95
LSD at 5% Sij- sik	0.01	0.00	0.03	0.05	NS	0.02	6.62
LSD at 1% Sij- sik	0.01	0.01	0.04	0.06	NS	0.03	8.93
LSD at 5% Sij- sk	0.01	0.00	0.02	0.04	NS	0.02	6.04
LSD at 5% Sij- sk	0.01	0.01	0.03	0.06	NS	0.03	8.15

N: normal S: salinity *: Significant at 5% ** Significant at 1% NS: not significant

The results indicated that the bands number 1, 2, 3, 9 and 10 were found in the parents; GZ1368-S-5-4, Hybrid 1, Sakha 2 and the crosses; GZ1368-S-5-4 x IET1444, Hybrid 1 x Sakha 102, Hybrid 1 x Giza 181 and Giza 181 x IET 1444, which indicated that these bands were common bands in these genotypes and were index for salinity tolerance in rice. This high degree of polymorphism for these DNA markers could be a very powerful tool for studying the phytogenetic relationships among rice genotypes.

These results were found by Champoux *et al.* (1995), Roy *et al.* (1996), Yadav *et al.* (1997), Price and Tomas (1997), Thank *et al.* (1999), Tripathy *et al.* (2000), Zhang *et al.* (2001), Courtois *et al.* (2003), Lanceras *et al.* (2004), Weerakoon *et al.* (2008) and El-Mouhamady. (2009).

The bands number 1, 2, 3, 8, 9 and 10 were appeared in the genotypes; GZ1368-S-5-4, Hybrid 1, IET1444, GZ1368-S-5-4x Hybrid 1, GZ1368-S-5-4 x Sakha 102, Hybrid 1 x IET 1444, Sakha 102 x Giza 181, Sakha 102, and Giza 181 x IET1444 and not appeared in the other genotypes, which means that these bands were found to be marker for salinity tolerance in these genotypes using AY334988 primer in Table (15) and Figure (2).

In Figure (16), the results indicated that the bands number 4, 5, 6, 7 and 10 were appeared in the gene types; GZ1368-S-5-4, Hybrid 1, IET1444, GZ1368-S-5-4 x Hybrid 1, , GZ1368-S-5-4 x Sakha 102, Sakha 102 x Giza 181, Sakha 102 x IET 1444 and Giza 181 x IET 1444 and weren't appeared in the other genotypes, which indicated that, these bands were common bands and index for salinity tolerance in these crosses using HL-17 primer in Figure (3). Similar results were obtained by El-Mouhamady (2009).

Table (14) The densitometric analysis of Rapd- PCR products for all genotypes studied of rice using PM15 primer

Band No.	Base pairs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	2000	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+
2	1500	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+
3	1000	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+
4	950	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	750	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	500	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
8	450	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
9	350	+	+	-	-	+	-	-	-	+	-	+	-	-	-	+
10	300	+	+	-	-	+	+	-	-	+	-	+	-	-	-	+

1- 1368-S-5-4 2- Hydrid I 3- SaKHa102 4- Giza 181 5- IET 1444 6- Gz1368-S-5-4 x Hybrid I
7- GZ1368-S-5-4 x Sakha 102 8- GZ1368-S-5-4 x Giza 181 9- GZ1368-S-5-4 x IET 1444 10- Hybrid I x Skha 102
11- Hybrid I x Giza 181 12- Hybrid I x IET 1444 13- Sakha 102 x Giza 181 14- Sakha 102 x IET 1444
15- Giza 181 xIET 1444

Table (15) The densitometric analysis of Rapd- PCR products for all genotypes studied of rice using Ay334988 primer

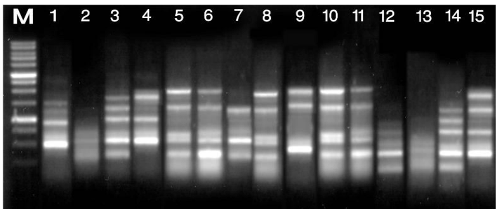
Band No.	Base pairs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	2000	+	+	-	-	+	+	+	-	-	-	-	+	+	+	+
2	1500	+	+	-	-	+	+	+	-	-	-	-	+	+	+	+
3	1000	+	+	-	-	+	+	+	-	-	-	-	+	+	+	+
4	950	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	800	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
6	750	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
7	500	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
8	450	+	+	-	-	+	+	+	-	-	-	-	+	+	+	+
9	350	+	+	-	-	+	+	+	-	+	-	-	+	+	+	+
10	300	+	+	-	-	+	+	+	-	+	-	-	+	+	+	+

1- 1368-S-5-4 2- Hydrid I 3- SaKHa102 4- Giza 181 5- IET 1444 6- Gz1368-S-5-4 x Hybrid I
7- GZ1368-S-5-4 x Sakha 102 8- GZ1368-S-5-4 x Giza 181 9- GZ1368-S-5-4 x IET 1444 10- Hybrid I x Skha 102
11- Hybrid I x Giza 181 12- Hybrid I x IET 1444 13- Sakha 102 x Giza 181 14- Sakha 102 x IET 1444
15- Giza 181 xIET 1444

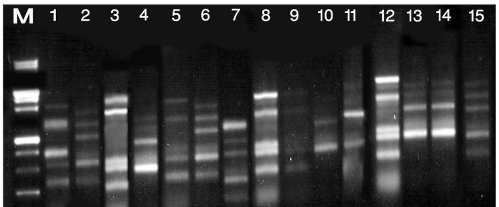
Table (16) The densitometric analysis of Rapd- PCR products for all genotypes studied of rice using HL-17 primer

Band No.	Base pairs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	2700	-	-	+	+	-	-	-	+	-	-	+	+	+	+	+
2	2000	-	-	+	+	-	-	-	+	-	+	+	+	-	-	+
3	1500	-	-	-	+	-	-	-	-	+	-	+	+	+	+	+
4	1350	+	+	-	-	+	+	+	-	+	-	-	+	-	-	-
5	1300	+	+	+	-	+	+	+	-	+	+	-	-	+	+	-
6	1150	+	+	+	-	+	+	+	+	-	-	-	-	-	-	-
7	1000	+	+	+	+	+	+	+	-	+	-	-	+	+	+	-
8	750	-	-	-	+	-	-	+	-	+	+	+	+	+	+	+
9	500	-	+	+	+	+	+	+	+	+	+	+	+	-	-	+
10	350	+	+	-	+	+	+	+	+	-	+	+	-	+	+	+

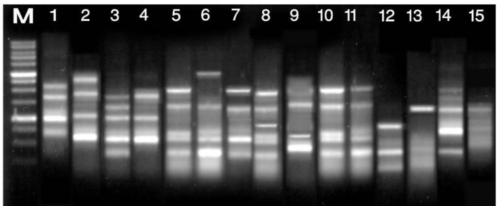
1- 1368-S-5-4 2- Hydrid I 3- SaKHa102 4- Giza 181 5- IET 1444 6- Gz1368-S-5-4 x Hybrid I
7- GZ1368-S-5-4 x Sakha 102 8- GZ1368-S-5-4 x Giza 181 9- GZ1368-S-5-4 x IET 1444 10- Hybrid I x Skha 102
11- Hybrid I x Giza 181 12- Hybrid I x IET 1444 13- Sakha 102 x Giza 181 14- Sakha 102 x IET 1444
15- Giza 181 xIET 1444



Fig(1): the denositometric analysis of rapd- pcr for all genotypes using pm15 primer .



Fig(2): the denositometric analysis of rapd- pcr for all genotypes using AY334988 primer .



Fig(3): the denositometric analysis of rapd- pcr for all genotypes using HL-17 primer .

4. Conclusion

1.The most desirable mean value , positive and highly significant for heterosis, general and specific combining ability effects for all genotypes under normal and salinity conditions were obtained from the genotypes.; GZ1368-S-5-4, IET1444, GZ1368-S-5-4 x hybrid 1, Gz1368-S-5-4 x IET1444 and Giza 181 x IET 1444 for all traits studied.

2.From the foreign discussion, it could be concluded that the crosses GZ1368-S-5-4 x Hybrid 1, G21368-S-5-4 x IET1444, Hybrid 1 x IET1444 and Giza 181 x IET1444 were contained of 1, 5, 1 and 5bands using PM15 primer, 6, 3, 6 and 6 bands using AY334988 and 6, 2, 4 and 5 bands using HL-17 primer, which indicated that these bands were found to be index and marker for salinity tolerance in rice by increasing K^+ content and decreasing of Na^+ content.

3.The crosses GZ1368-5-5-4 x hybrid 1and Giza 181 x IET 1444 were the best crosses for salinity tolerance in rice and were important for breeder to selection the cultivars for the earlier and short stature would be the best choice as base populations.

Corresponding author
*El-Mouhamady, A.A
Dept., of Genetics and Cytology, National Research Center, Cairo, Egypt.
ElMouhamady@yahoo.com

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