GENETIC STUDIES ON LEAF ROLLING AND SOME ROOT TRAITS UNDER DROUGHT CONDITIONS IN RICE (*ORYZA SATIVA L.*) .

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Abstract

Crossing was made between the three resistant and two susceptible parents to determine the genetic study under drought conditions during 2002 and 2003 rice growing seasons. The resistant varieties were IET 1444, Moroberekan and Gaori and the susceptible varieties were Sakha 101 and Sakha 102. Measurements on genetic variability, inbreeding depression , heritabillity, potence ratio, heterosis and genetic advance, were calculated for parents, F_1 and F_2 populations from the three studied crosses .

The F_2 and F_3 lines derived from six crosses were grown in a RCBD experiment in three replications to study the genetic of leaf rolling. The total of lines were under- taken as F_2 segregated 3 rolled and 1 unrolled and F_3 lines segregated in 1:2:1 (rolled: segregating : unrolled). The results showed that, plants which showed more leaf rolling appeared to be less drought resistance. It was found also , that the recovery ability was associated with drought resistance and leaf unrolling character.

Measurements on genetic variability, heterosis, inbreeding depression, potence ratio, heritabillity and genetic advance under selection were calculated.

Desirable significant heterosis was found for grain yield / plant, root length, root thickness and root : shoot ratio for all the studied crosses. Potence ratio indicated over dominance for all studied characters in the three crosses except for root thickness and root : shoot ratio in the cross No. 2(IET1444 x Sakha 102), for grain yield / plant and root length in the cross No. 3(Moroberekarn x Sakha 101). High heritabillity values were associated with high genetic advance for days to heading and plant height in all studied crosses, while there were no association with high genetic advance in the other characters.

INTRODUCTION

Drought is a major constraint to rice production of rainfed and upland ecosystems. Developing improved drought-resistant lines has been a major breeding objective in rain fed rice improvement programs under such environment.

Choosing parents for crossing is one of the most important steps in a breeding programs. No selection methods can identify good cultivars if the parents used in the program are not suitable. Breeders have different approaches to parent choice and have achieved success in different ways.

Leaf rolling was the first visual symptom of drought reaction and occurs due to the inability of leaves to sustain the transpiration demand of the plant (Blum, 1988).

Leaf rolling during stress reduce the leaf surface exposure to sun light energy to decrease transpiration leads to closure of stomata, so that gaseous exchange and CO_2 entry into cells are reduced and photosynthesis is decreased. Leaf rolling is the most important criteria found useful in assessing levels of drought tolerance in large scale screening (Chang et. al., 1974).

Although progress can be made by selection for yield in the target environments, using root traits that are associated with drought tolerance can hasten that progress. Root development has long been recognized as an important factor in determing the adaptability of a given plant species to varying water conditions. Root characteristics that responsible for the adaptability to drought stress are root length, root thickness, and root: shoot ratio,(Passioura,1982) . The Selection for desirable root characteristics has been a major objective in breeding for drought resistant varieties of rice plant (O' Tool *et al.*, 1980). The deep roots of rice plant help to explore different levels of soil moisture and root thickness may be important in water uptake and translocation as resistance to water flow may be less in thick roots, in addition, thick roots are able to penetrate deeper soil layers (Bashar, 1987) .

The varieties with high root : shoot ratio were more drought resistant(Yamauchi and Aragones,1997). Results of the studies indicated that most drought resistant varieties remained tall during water stress while susceptible varieties were reduced in height . Plant height is positively significantly correlated with root length, root thickness and dried shoot weight (Mao, 1984) .

This investigation aimed at studying the genetics of leaf rolling, some root and shoot characters and their relation with drought resistance characters.

MATERIALS AND METHODS

The present investigation was carried out at the Farm of the Rice Research & Training Center, Sakha, Kafr El- Sheikh, during 2002 and 2003 rice growing seasons.

Ten introduced and local rice varieties utilized in this study namely ; IET 1444, Moroberekan, Gaori, Giza 159, Giza 171, Giza 177, Giza 178, Sakha 101, Sakha 102, and Sakha 104. Those varieties had a wide variation in vegetative, yield and its component characters,(Table1).

Seeds of all cultivars were grown in the nursery and after thirty days from sowing seedlings of each parent were individually transplanted in the permanent field in ten rows. Each row was five meters long and contained 25 hills. Randomized complete block design was used with three replications. Weeds were chemically controlled by applying 2 liters of Saturn/feddan four days after transplanting. Nitrogen fertilizer was applied at 40 KgN/fed.

Table 1. Ordinal list of 10 rice varieties under drought Condition.

Varieties	Origin	Plant type	Drought Score at veg. Stage
Moroberekan	Guinea	Tall	1
IET1444	India	Semidwarf	2
Gaori	Korea	Semidwarf	3
Giza 159	Egypt	Tall	4
Giza 178	Egypt	Semidwarf	4
Giza 171	Egypt	Tall	5
Giza 177	Egypt	Semidwarf	8
Sakha 101	Egypt	Semidwarf	8
Sakha 102	Egypt	Semidwarf	9
Sakha 104	Egypt	Semidwarf	4

*1-3,resistant; 4-5,intermediate and 6-9,susceptible(De Datta et al,1988)

All these varieties were tested under drought conditions for two years for yield performance and other important characters that related to drought resistance such as leaf rolling. Significant differences were detected among theses varieties for all studied characters, indicating that these varieties differs genetically and some of them could be used as a drought resistant parents .

Soil water relations:

Soil moisture content was gravimetrically determined in soil samples taken from consecutive depths of 15cm down to a depth of 60cm.Soil samples were also collected just before each irrigation,48 hrs after irrigation. Field capacity was determined in the field. Permanent wilting point and bulk density were determined according to Klute,1986 to a depth of 60cm. The average values are presented in table(2)

Table 2. Some soil constants determined before each irrigation.

Soil depth(cm)	F.C.%	W.P.%	Bulk density g/cm^3
0-15 cm	45.68	24.70	1.12
15-70 cm	41.30	22.40	1.18
30-45 cm	38.75	20.28	1.23
45-60 cm	35.16	18.60	1.30
Mean	40.22	21.50	1.21

Where, F.C.% = field capacity, W.P.% = permanent wilting

Six crosses involving three resistance varieties namely IET 1444, Moroberekan and Gaori crossed with each of two susceptible varieties, Sakha 101, and Sakha 102 for studying genetics of leaf rolling in F_2 and F_3 generations.

Three other crosses involved some of the previous varieties were used to study the genetics of yield and some root characters under drought conditions.

In 2002 season, P_1, P_2, F_1 and F_2 plants were grown in a randomized complete block design with three replications. Each replicate consisted of two rows for each of P_1, P_2, F_1 populations and ten rows for each F_2 population. Additionally,25 F_3 lines were randomly selected in each three replications, making a total of 75 F_3 lines(1875 plants) for testing. The rows were five meters long with 20 cm between rows and comprised 25 hills each of a single plants. Weeds were chemically controlled by applying 2 liters Saturn/feddan, four days after transplanting.

Nitrogen fertilizer was applied at 40Kg N/fed. Flush irrigation was used every 10 days in afternoon and this was observed as sufficient to differentiate the differences in lines and segregating generations for their recovery ability.

Data were recorded on 30 plants at random in each parent and F_1 cross and on 200 plants in each F_2 cross for all characters studied. With respect to root characters , a large iron cylinders up to 20 cm in diameters and 60 cm in length were used. They were driven into the soil with a hammer and dug out with spade or pulled out by means of a hook and separating the soil from the roots by washing . This can be done directly in the field but generally the soil samples are transported to special washing place. After taking the quantitative data, the shoot was separated from the root using sharp knife and dried in an oven at 70C for five days.

Root length (cm) [the length of the root from the base of the plant to the tip of the longest root], root thickness [the average diameter (mm) of the tip portion (about 1cm from the tip) of three random secondary roots at the middle position of the root/plant], and root :shoot ratio [ratio of the root dry weight (g) to the shoot dry weight (g)] at maximum tillering stage. Days to heading was recorded after flowering and at maturity, grain yield /plant was recorded by collecting the filled grains from all the tillers in a single plant and their weight recorded.

In 2003, the experimental materials consisted of the parents, F_1, F_2 and F_3 generations of six crosses were sown and thirty days old seedlings were transplanted in a randomized complete block design with three replications. Leaf rolling observation was recorded at different hours of day from early morning to late evening, during the vegetative stage, starting from transplanting date(30 days after sowing) to panicle initiation stage (70 days after sowing), after each irrigation period (every 10 days).

Leaf rolling was estimated by a visual estimation and the susceptible varieties and lines first to start the rolling symptoms in the morning, and the highly susceptible lines did not unroll at early morning hours.

Rolling in other parents or lines started at around 8 a.m. as the transpiration demand increased and in some lines or varieties unrolling started around 1700h, while in others at 1800h or later. Unrolled plants were tagged for further observation. Leaf rolling was recorded based on methods proposed by Loresto and Chang (1981); IRRI (1988) and De Datta *et al.* (1988), (Table 3).

Table 3. Scores and symptoms for leaf rolling and drought resistance at vegetative stage. Modified from Loresto and Chang (1981); IRRI (1988) and De-Datta *et al.* (1988).

Scores	Reaction	Leaf rolling	Leaf firing
0	Highly resistant	No symptoms of stress	No symptoms
1	Resistant	No rolling	Slight leaf tip drying
3	Moderately resistant	Partially rolled, unrolled in evening	Leaf tip drying extended to ¼ in top three leaves
5	Intermediate	Partially; unrolling at late evening and early morning.	Half of yanger leaf blades dried, all lower leaf dried.
7	Susceptible	Complete, unrolling in morning	¾ of yanger leaf blade dried.
9	Highly susceptible	Like tube; no unrolling in morning	All leaves dried

Table 4. Recovery score after irrigation (first day after irrigation).

Scores	Reaction	Description of symptoms individual plant/line		
		Leaf colour	Leaf rolling	Leaf tip drying
1	Resistant	All dark green	Unrolled	Slight
3	Moderately resistant	All green	Partially rolled	¼ leaf tip drying
5	Intermediate	Greenish, lower leaves dried	Partially rolled	½ leaf blade dried
7	Susceptible	Top central leaves greenish, lower leaves yellowish	Rolled	¾ leaf drying
9	Highly susceptible	Yellowish	Tightly rolled	Near complete leaf drying

The genetical parameters in the present study were computed as follows:

1) Heterosis relative to mid parent (%) = F_1-MP / MP x 100

2) Inbreeding depression (I.D.) % = F_1-F_2 /F_1 x100

3) Potence ratio =F_1-MP/ HP-MP

Where F_1, F_2, MP, and HP are the means of the F_1, F_2 $_{generations}$, mid parent, and the higher parent, respectively.

4) Heritability in broad sense (h^2) = δ^2 G/ δ^2 ph x 100.

Where δ^2 G and δ^2 ph are the genotypic and phenotypic variances of F_2 population, respectively, Gamble (1962).

5) Genetic advance under selection (GS) = $h^2 \times K \times \sqrt{\delta^2 ph}$

Where K is the selection differential and equal 2.06 for 5% selection intensity (Lush,1949 and Johanson *et al.*,1955).

RESULTS AND DISCUSSION

The frequency distribution (not given here), proved that all characters studied were quantitatively inherited. Means, standard error and variances of six studied, traits i.e. days to heading, plant height, grain yield/plant, root length, root thickness and root : shoot ratio for P_1, P_2, $F_1$and F_2 populations are presented in table 5. The t- test and F-test showed significant differences between parents and for genetic variances among F_2 plants, for the three studied, crosses IET1444x Sakha 101, IET1444 x Sakha 102 and Moroberekan x Sakha 101.

Genetic Variability Parameters:-

1- Cross I (IET1444XSakha 101) :-

Highly significant and positive heterotic effects were found for all the studied traits (Table 6). Comparing mean values, the F_1 values were higher than both mid-parent and higher parent for all these studied traits (Table 5), indicating the presence of over dominance of the higher parent for these traits which were verified by the computed positive values of potence ratio 2.92, 2.43,6.34,1.97,1.43and 1.69 for all traits, respectively (Table 6). Similar results were obtained by Souframanien *et al.*, 1998.

Significant positive values of inbreeding depression, were obtained for root length, root thickness and root: shoot ratio (Table 6). Comparing mean values of these traits (Table 5), the F_2 values were less than those of F_1 . Significant effects for both heterosis and inbreeding depression were associated for these traits (Table 6). This logic and acceptible, since the expression of heterosis in F_1will be followed by considerable reduction in F_2 performance.

High heritability values (Table 6) were estimated for days to heading, plant height, and root: shoot ratio, Moderately high values for grain yield and root thickness; and low values for root length; .

Johanson *et al.* (1955) reported that heritability estimates along with the genetic gain were more valuable than the former alone in predicting the effect of selection .

If heritability was mainly owing to non-additive gene effect, the expected gain would be low, if there was an additive gene effect, a high genetic advance might be expected (Panse,1957).

Dixit *et al.* (1970), reported that high heritability were not always associated with high genetic advance for characters. But to make effective selection, high heritability should be associated with high genetic advance.

From the foregoing discussion, individual plant selection in early segregating generations for days to heading and plant height should be effective and satisfactory for successful breeding purpose. While, the selection would be effective in advanced generations for grain yield, root length, root thickness and root : Shoot ratio.

2- Cross II (IET 1444 X Sakha 102) :-

Highly significant and positive heterotic effects were obtained for all the studied traits (Table 6).

Comparing mean values, the F_1 values exceeded the higher parent for days to heading, plant height, grain yield and root length(Table5). These findings indicated the existence of overdominance and were verified again by the respective values of potence ratio which were exceeding unity. The F_1 values for the two traits; root thickness and root: shoot ratio were between both mid-parent and higher parent values, indicating that the presence of partial dominance which were verified by the computed values of potence ratio which were less than unity, 0.13 and 0.26 (Table 6).

Regarding the effect of inbreeding depression., significant positive values were obtained for plant height, root length, root thickness and root: shoot ratio. Looking to the mean values of these traits, the F_2 values were less than these of F_1. Significant effects for both heterosis and inbreeding depression, were associated for these four traits (Table,6).This was logic, since the expression of heterosis in F1 will be followed by considerable reduction in F2 performance.

With respect to heritability, high heritability values were observed for days to heading, plant height, root length, root thickness and root: shoot ratio, the values were 90.0, 79.0, 70.0, 80.0 and 75.0. Moderate value was estimated for grain yield, (59.0). High heritability values for heading date, plant height and grain yield/plant were detected by Ganesan and Subramanian,1994. High genetic gain was associated with high heretability values in days to heading and plant height, indicating that the selection would be effective in early generations for these traits.

3- Cross III (MoroberekarnX Sakha 101) :-

Significant and highly significant and positive heterotic effects were detected for plant height, grain yield/plant, root length and root :shoot ratio (Table 6). The highest percentage of heterosis as deviation from mid-parent was found at root : shoot ratio (54.76%) followed by plant height (20.49%). Comparing mean values in table 5, it was found that the F_1 performance exceeded the higher parent for the two traits(Table5).

These findings indicated that the existence of over dominance and was ascertained again by the respective values of potence ratio which were exceeding unity. The percentages, of heterosis as deviation from mid-parent were not significant for days to heading and root thickness and the F_1 values were between both mid-parent and higher parent for days to heading, indicating the presence of partial dominance for this trait, where the value of potence ratio was less than unity .

For the effect of inbreeding depression, significant negative values were obtained for heading date, plant height and grain yield/plant (Table 6). This could be a consequence of the F_2 values were higher than those of F_1 with comparing mean values of these traits (Table 5).

Significant positive inbreeding depression were found for root length, and root: shoot ratio, because of the F_2 values were less than those of the F_1 . Significant effects for both heterosis and inbreeding depression were associated for root : shoot ratio (Table 6). This logic and expected, since the expression of heterosis in F_1will be followed by considerable reduction in F_2 performance.

Heritability estimates were high for days to heading (76.0%), plant height (85.0%) and root: shoot ratio (77.0%); moderate high for grain yield/plant (62.0%) and root thickness (57.0%); low for root length (50.0%). It is very interesting to note that characters having high heritability values and gave high values of genetic advance, indicating that there was additive gene effect and this very important to make effective selection(Ganesan and Subramanain,1994).

This is was very clear in the three characters; days to heading, plant height and grain yield/plant.

It could be indicated that, for most traits, the expression of heterosis in F_1 might be followed by a considerable inbreeding depression in F_2 performance, indicating that the non- additive gene effects governed the inheritance of such traits. This is logic and expected, Since there is a tendency towards homozygosity which is accelerated by 50 percent for each selfed gene ratio. In other cases, the significant heetrosis in F_1 was associated by insignificant inbreeding depression in $F_{2\ S}$. This contradiction might be due to the effect of linkage on F_2 performance (Ram,1994). Other contradiction was the insignificant heterosis in F_1 associated with significant inbreeding depression in F_2 . This might be due to the lower magnitude of the non-additive type of gene action.

Table 5. Means, standard errors and variances of P_1, P_2, F_1 and F_2 populations of the studied characters. for the studied crosses.

Cross/trait		P_1(IET 1444)	P_2 (Sakha 101)	F_1	F_2
IET 1444XSakha 101					
Days to heading (day)	$\bar{X}$	100.0±1.78	95.0±1.12	105.40±1.08	114.0±0.98
	σ^2	15.3	10.42	11.63	46.52
Plant height(cm)	$\bar{X}$	75.0±2.0	68.0±1.56	80.0±1.49	95.0±1.22
	σ^2	18.00	11.75	13.40	107.20
Grain yield/plant(g)	$\bar{X}$	18.0±1.35	15.0±1.48	26.02±1.22	28.0±0.89
	σ^2	31.0	21.30	28.84	144.20
Root length(cm)	$\bar{X}$	33.0±083	21.0±0.72	38.82±0.69	34.0±0.44
	σ^2	7.80	5.90	5.51	33.02
Root thickness(mm)	$\bar{X}$	1.10±0.05	0.65±0.02	1.20±0.0145	1.12±0.012
	σ^2	0.0023	0.0018	0.00124	0.009
Root :shoot ratio	$\bar{X}$	0.58±0.012	0.32±0.014	0.67±0.0138	0.61±0.010
	σ^2	0.0012	0.0017	0.00148	0.0104
IET 1444XSakha 102					
Days to heading (day)	$\bar{X}$	99.0±0.91	100.0±0.99	106.7±1.32	105.0±0.77
	σ^2	25.20	20.00	25.08	66.00
Plant height(cm)	$\bar{X}$	57.0±0.75	81.0±0.87	90.0±0.85	85.0±0.65
	σ^2	19.00	10.00	18.00	120.00
Grain yield/plant(g)	$\bar{X}$	18.0±0.79	13.40±0.10	22.43±0.96	22.0±0.91
	σ^2	48.00	62.00	55.00	220.00
Root length(cm)	$\bar{X}$	33.0±0.58	18.0±0.96	36.95±0.63	33.50±0.82
	σ^2	3.18	5.70	5.25	36.80
Root thickness(mm)	$\bar{X}$	1.10±0.0068	0.53±0.008	0.85±0.0081	0.82±0.005
	σ^2	0.00072	0.00088	0.00086	0.0078
Root :shoot ratio	$\bar{X}$	0.58±0.019	0.28±0.020	0.47±0.022	0.44±0.019
	σ^2	0.0036	0.0050	0.0048	0.028
MoroberkanXSakha 101					
Days to heading (day)	$\bar{X}$	92.0±1.63	95.0±1.43	94.0±1.52	105.0±1.85
	σ^2	9.50	11.50	10.85	65.20
Plant height(cm)	$\bar{X}$	85.0±0.97	68.0±0.82	92.8±0.98	95.0±0.85
	σ^2	22.00	16.00	18.00	117.00
Grain yield/plant(g)	$\bar{X}$	20.0±1.75	15.0±1.85	17.90±1.71	22.0±1.10
	σ^2	76.0	66.0	61.0	211.0
Root length(cm)	$\bar{X}$	35.0±0.90	21.0±0.80	29.0±0.89	26.0±0.58
	σ^2	19.00	12.40	14.30	83.50
Root thickness(mm)	$\bar{X}$	98.0±0.05	65.0±0.11	99.80±0.07	98.0±0.13
	σ^2	0.12	0.11	0.10	0.22
Root :shoot ratio	$\bar{X}$	0.53±0.016	0.32±0.018	0.65±0.014	0.58±0.023
	σ^2	0.15	0.19	0.14	0.25

Table 6. Heterosis, inbreeding depression, potence ratio, heritability in broad sense and genetic advance for the characters studied in the crosses IET 1444XSakha 101, IET 1444XSakha 102 and Moroberekan X Sakha 101.

Cross/trait	Heterosis %	Inbreeding depression %	Potence ratio	Heritabiliy %	Δ G
IET 1444XSakha 101					
Days to heading(day)	8.43**	-8.15**	2.92	75.0	10.53
Plant height(cm)	11.93**	-18.70**	2.43	84.0	17.89
Grain yield/plant(g)	57.69**	-7.60**	6.34	65.0	16.06
Root length(cm)	43.77**	12.41**	1.97	47.0	5.56
Root thickness(mm)	37.93**	6.66**	1.43	69.0	0.13
Root :shoot ratio	48.88**	8.95**	1.69	82.0	0.16
IET 1444XSakha 102					
Days to heading (day)	7.23**	1.59	14.40	90.00	15.06
Plant height(cm)	15.38**	5.55**	4.00	79.00	17.82
Grain yield/plant(g)	42.67**	-11.45**	2.90	59.00	18.02
Root length(cm)	44.90**	9.33**	1.52	70.00	8.74
Root thickness(mm)	4.93**	3.52*	0.13	80.00	0.14
Root :shoot ratio	9.30**	6.38**	0.26	75.00	0.25
MoroberekanXSakha101					
Days to heading (day)	2.17	-11.70**	0.66	76.0	12.64
Plant height(cm)	20.49**	-3.05*	1.84	85.0	18.93
Grain yield/plant(g)	2.28*	-22.90**	0.16	62.0	18.55
Root length(cm)	3.59*	10.34**	0.14	50.0	9.41
Root thickness(mm)	0.22	1.80	1.10	57.0	0.55
Root :shoot ratio	54.76**	10.76**	2.09	77.0	0.79

** and* :High significant and significant: at 0.01 and 0.05 significant respectively, Δ G=genetic advance.

Genetics of leaf rolling:

For leaf rolling (L.R), the susceptible varieties and crosses were to start showing the rolling symptoms before irrigation by three days (7 days after irrigation) in the morning and evening. While, the resistant varieties did not roll at early morning hours, but rolling starts at around 1 p.m. as the plant transpiration demand increased before irrigation (after 10 days from irrigation). These results were recorded based on the methods proposed by Loresto and Chang (1981), IRRI (1988) and De Datta *et al.*(1988),(Table 3).

The data for recovery was recorded based on present plant recovery in lines after irrigation by six hours according to scale for recovery as proposed by Loresto and Chang (1981) to differentiate plants or lines in segregating and non segregating generations.

Many of the tolerant plants in segregating generations did not roll and leaves remained to meet the transpiration demand of the plant. Similar results were reported by Otoole and Maguling (1981).

The segregation for this trait in all crosses studied, at F_2 generation which is shown in table(7) was found to fit a ratio of 3 rolled to 1 unrolled implying therefore that segregation is at one locus only. Also, the segregation of F_3 generation was detected to fit a ratio of 1 rolled :2 segregated: 1 unrolled which would ascertained that segregation is at one locus only.

Table 7. Reaction of F_2 population and F_3 lines for leaf rolling and unrolling .

Parents/Cross	F_2 Population		X^2 (df=1)	F_3 lines		
	Rolled	Unrolled		Rolled	Segregating	Unrolled
IET 1444Xsakha 102	658	186	1.98	17	26	16
IET 1444Xsakha 101	775	305	3.02	18	29	17
MoroberekanXSakha 102	646	190	1.15	16	34	19
MoroberekanXSakha 101	654	268	4.19	17	32	14
GaoriXSakha 102	605	157	3.83	13	36	19
GaoriXSakha 101	693	279	2.47	17	32	16

$X^2 = 0.48$

Table 8. Recovery ability of non segregating rolled and unrolled F_3 lines.

Cross	Total lines	Rolled					Total lines	Unrolled				
		Recovery Scores						Recovery Scores				
		1	3	5	7	9		1	3	5	7	9
IET 1444XSakha 102	17	3	1	6	7	0	16	13	3	0	0	0
IET 1444XSakha 101	18	2	5	2	5	4	17	13	4	0	0	0
MoroberekanXSakha 102	16	1	6	0	4	5	19	11	5	3	0	0
MoroberekanXSakha 101	17	4	0	2	8	3	14	10	3	1	0	0
GaoriX Sakha 102	13	0	0	2	5	6	19	15	4	0	0	0
GaoriX Sakha 101	17	2	3	2	5	5	16	14	2	0	0	0
Total	98	12	15	14	34	23	101	76	21	4	0	0
%		12.2	15.3	14.3	34.7	23.5		75.2	20.7	3.9		

The X^2 values for these trait were 0.44, 1.98,3.02,1.15,4.19,3.83, and 2.47 for the six crosses studied which was lower than the tabular X^2 value with 1d.f.

Relationship of leaf rolling and drought tolerance character was found for the parents or lines which have no leaf rolling and had score of 0 to 3 for drought tolerance. Plants showing leaf rolling at early stage of stress appears to have poor drought tolerance Leaf rolling also reduces the photosynthetic surface and light absorption area and thus leads to reduce assimilate levels.

The varieties like, Moroberekan, IET 1444 which starts rolling after 8 days from irrigation and unrolled with morning and evening had score from 1-2 for drought tolerance (Table 2). The rice variety, Gaori had still the score of 3 for drought tolerance and don't roll at morning or evening during the first week after irrigation. The varieties, Giza 178 and Sakha 104 starts rolling at midday till evening during late stage of stress (from 7-10 day) had score of 5 for drought tolerance. While, the other varieties, Giza 159, Giza 171, Sakha101starts rolling within a week after irrigation at midday and evening and had score of 7 for drought tolerance and the variety, Sakha 102 was rolled at the initiation of drought and had susceptible score for drought (7 or 9).

These suggests a close relationship between leaf rolling and drought tolerance (Table 2).

Recovery scores for non segregating rolled and unrolled lines were taken in Table (8). Scoring system for recovery (Table, 4) has been developed for breeding lines, using percent plant recovery,10 days after irrigation (IRRI,1988).

Recovery scores were higher for all the breeding lines and segregating population in the first days after irrigation. The results revealed that tagged plants which were unrolled , had a high recovery scores as compared to rolled plant, during observation of individual plant or lines. These observations were recorded based on a new scale developed earlier, (Table,4). Loresto *et al.*(1976) and Murty and Ramakrishnayya(1982) have reported the marked differences in drought recovery 12-20 hrs after irrigation.

It was observed that recovery ability is associated with drought resistance and leaf unrolling . About 72% of rolled F3 lines had poor recovery scores(5-9). However, around 28% of rolled F3 lines had high recovery scores of (1-3). While, 96% of unrolled F3 lines had high recovery ability (1-3), and around 4% of unrolled F3 lines had poor recovery scores(5-9).

Blum, 1988 reported that leaf rolling as a drought symptoms occurs because of the inability of leaves to sustain the transpiration demand of the plant.

From the present findings the resistant parents showed leaf rolling symptoms at later periods of stress. The lines that rolled earlier had early symptoms of drying of leaves, flowed by drying of upper leaves.

Transgressive segregation in the crosses involving the resistant varieties were recorded based on leaf rolling observation. The transgressive sergeants (table,9) for drought resistance were detected in all crosses studied which were varied from 9.4% to 13.15% in the F2 generation and from 10.8% to 20.0 % in the F3 generation. These results would indicate that these superior lines had better leaf rolling and consequently better drought resistance than their corresponding resistant parents and that could be due to drought resistance.

Table 9. Transegressive segregation (T.S.) of drought resistance in F_2 and F_3 generations of different crosses.

Cross	T.S. in F_2 Population		T.S. in F_3 lines	
	No. of lines	% of F_2 lines	No. of lines	% of F_3 lines
IET 1444XSakha 102	111.00	13.15	8.00	16.00
IET 1444X Sakha 101	151.00	11.78	25.00	20.00
MoroberekanX Sakha 102	120.00	11.00	31.00	17.70
MoroberekanXSakha 101	135.00	9.50	38.00	10.80
GaoriX Sakha 102	100.00	9.40	7.00	14.00
GaoriXSakha 101	120.00	9.80	19.00	19.00

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دراسات وراثية علي التفاف الورقة وبعض صفات الجذر تحت ظروف الجفاف في الأرز

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مركز البحوث والتدريب في الأرز – سخا – معهد بحوث المحاصيل الحقلية

تم عمل عدة هجن بين ثلاثة أصناف مقاومة للجفاف واثنين من الأصناف الحساسة للجفاف وذلك بغرض دراسة وراثة صفة التفاف الورقة وصفات الجذر تحت الظروف الجافة خلال المواسم الزراعية ٢٠٠٢ ، ٢٠٠٣ .وكانت الأصناف المقاومة هي آي إي تي ١٤٤٤، موروبريكن وجاوري والأصناف الحساسة هي سخا ١٠١ ، سخا ١٠٢ . وتم تقدير بعض الثوابت الوراثية مثل التباين الوراثي ، قوة الهجين، التدهور الناتج عن التربية الداخلية ، درجة التوريث ، درجات السيادة وكذلك التحسين الوراثي وذلك للآباء والجيل الأول والجيل الثاني الانعزالي في ثلاثة هجن ودراسة وراثة التفاف الأوراق في ستة هجن.تم زراعة سلالات الجيل الثاني والجيل الثالث للستة هجن سابقة الذكر في قطاعات كاملة العشوائية في ثلاثة مكررات .

أوضحت النتائج أن إنعزال صفة التفاف الأوراق في الجيل الثاني آخذ النسبة ٣ : ١ (٣ نباتات تحتوي علي أوراق ملتفة و ١ نباتات تحتوي علي أوراق غير ملتفة) وكانت نسبة الانعزال في الجيل الثالث هي ١:٢:١ (١ملتف: ٢انعزالي: ١غير ملتف) .

وأوضحت النتائج أن النباتات التي تحتوي علي نسبة كبيرة من الأوراق الملتفة تميل لأن تكون فقيرة في المقاومة للجفاف وقد وجدت أيضاً علاقة بيين استعادة النمو الطبيعي للنبات بعد انتهاء مرحلة الجفاف وبين المقاومة للجفاف وكذلك صفة عدم التفاف الأوراق.

وأظهرت النتائج وجود قوة هجين عالية المعنوية ومرغوبة بالنسبة لصفات المحصول وطول الجذر وسمك الجذر ونسبة الوزن الجاف للجذر إلي الوزن الجاف للمجموع الخضري في الهجين رقم ٢ وبالنسبة للمحصول وطول الجذر في الهجين رقم ٣.

ووجدت هناك قيم عالية لدرجة التوريث ومصحوبة بقيم عالية للتحسين الوراثي بالنسبة لصفات طول النبات وعدد أيام التزهير في كل الهجن المدروسة.