A STUDY ON THE GENETIC DIVESRSITY OF THE EGYPTIAN RICE VARIETIES UNDER NORMAL AND DROUGHT CONDITIONS.

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ABSTRACT

The present investigation was carried out at the experimental farm of the Rice Research and Training Center, Sakha, Kafr El Sheikh and Lab of Seed Technology Dep., Giza, Egypt, during 2007 and 2008 rice growing seasons, to study the genetic variability, phenotypic correlation, and to determine the best genotypes for drought tolerance at each growing stage under drought condition. The performance of seventeen rice varieties was examined under normal and drought conditions. The results showed that the best two rice entries for yield and its components and the physiological characters studied, i.e. RWC, Osmotic potential and WUE were cultivar Giza 178 and cultivar Sakha 104 at the two conditions, and their plants showed good root system. Therefore, they performed better and were more stable in yield under drought prone environment. Phenotypic coefficient of variation (PCV) was high for no. of panicles/plant, 100-grain weight, and grain shape; while it was lower for leaf area, gel consistency and kernel elongation. Genotypic coefficient of variability (GCV) showed the same trend as for phenotypic coefficient of variability (PCV). Heritability estimates were high for all studied traits except 100- grain weight, no. of roots/plant and root dry weight. Highly significant positive phenotypic correlation coefficients were determined between grain yield /plant and all yield attributes under both normal and drought conditions. Also, the associations were significant among root characters studied and yield and its components. Polyacrylamide gel electrophoresis of protein provided good information for the identification and characterization of the different 17 varieties and the results showed that the highest number of bands (13) was found in genotype no.3, and the lowest number of bands (8) was found in genotype no.12. Crossing could be made between the genotypes which having drought tolerant traits and the others which having the genes related to high yield potential to combine them in one cultivar.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important crops in the world, especially in Asia and Africa. Therefore, many agronomic studies have been made on the growth and development of shoots with direct or indirect related to yield. Drought stress is a major constraint to rice production and yield stability. In Egypt, rice is one of the major water consuming crops and continuous flooding is the only method for irrigation. Some rice cultivated areas especially which are located at the end of the terminal in the northern part of the Nile Delta, suffer from shortage of irrigation water that cause drought conditions during different growth stages, which are considered to be one of the most serious constraints to rice production in Egypt. Information on some yield and its components and grain quality characters under drought conditions is relatively limited. Rice plants can avoid water stress, to a great extent, by possessing some traits that can be considered as a main component of drought avoidance mechanism. These characters can be used in the indirect selection for drought tolerant lines or varieties. **(De Datta and Malabuyoc ,1988).**

Conventional breeding methods depend mainly at early screening phase on selecting traits for such as plant height, early maturity, plant type and grain quality characters, to improve rice varieties often under well-watered conditions, although progress can be made by selection for yield under drought conditions. Using some traits that are associated with several putative traits might affect the response of plant to drought conditions, but we have firm evidence that only few traits are contribute to yield in target environment **Pantuwan et al., (2001).** The objectives of this investigation were to identify donors through field screening to incorporate their valuable traits into other cultivars and to investigate the mechanisms that control drought resistance.

MATERIALS AND METHODS

Seventeen rice varieties, namely Giza 159, Giza 171, Giza 172, Giza 175, Giza 176, Giza 177, Giza 178, Sakha 101, Sakha 102, Sakha 103, Sakha 104, Sakha 2, Giza 181, Giza 182, Egyptian Jasmine, Basmati and Basmati 370, were grown under normal and drought conditions at the Farm of Rice Research and Training Center, Sakha, Kafr El-Sheikh, Egypt, during 2007 and 2008 seasons. Each variety was planted in four rows per plot, 5 m in length, spacing of 20 x 20 cm and three to four seedlings per hill in a Randomized

Complete Block Design with three replications. The outer two rows were used as borders; however, the inner two rows were utilized to determine yield and its components. Flush irrigation was used every 12 days for the drought condition, while continuous flooding was used for the normal condition. Recommended cultural practices were followed for the two conditions. Root characters, i.e. root length; root number/ plant and root dry weight were recorded at maximum tillering stage while, drought score (1= resistant, 3 = moderate and 5, 7, 9 = susceptible) was recorded based on leaf rolling and unrolling. At maturity, agronomic characters, i.e. grain yield per plant, number of panicles per plant, number of grains per panicle, 100-grain weight, sterility percentage, no. of days to heading, plant height, as well as physiological traits, i.e. relative water content (RWC), Osmotic potential (O.P), water use efficiency (WUE) and leaf area were recorded for randomly chosen 10 plants from the middle rows. All the grain quality traits, i.e. grain shape, hulling (%), milling (%), gelatinization temperature (G.T), gel consistency (G.C), kernel elongation and amylose content (A.C. %) were tested at the grain quality laboratory. The data were combined and statistically analyzed follows **Burton (1952), and Chang (1974)** .Also some genetic parameters, i.e., genotypic variance, phenotypic variance, genotypic coefficient of variation, heritability in broad sense and phenotypic correlation coefficients were computed ACCORDING TO **Johnson et al. (1955), Lush (1940) and Burton (1951).**

Determination of crude protein content:

A known weight of fine powdered seeds (0.1 g) was digested using a micro kjeldahl apparatus. The crude protein was calculated by multiplying the total nitrogen (**A.O.A.C., 1990).**

Protein identification:

Protein extracts of seeds of various varieties were identified by SDS-PAGE according to the method of **Laemmli (1970).**

Preparation of samples:

Samples extract (400 µl) equivalent to about 0.2 O.D per 10 µl were added to 400 µl samples buffer, thoroughly mixed and heated in a boiling water bath for 5 to 10 min, then centrifuged at 100 r.p.m. for 5 min. The samples were kept at 4 ^{0}C for analysis.

Preparation of protein markers and gel:

Protein markers and gel were done and low buffer tank was filled with running buffer and attached with upper buffer tank so that the gels were completely covered. The electrodes were connected to power supply and adjusted as 100 V until the bromophenol blue dye intered the resolving gel. The power was then increased to 250 V until the bromophenol blue reached the bottom of the resolving gel.

Detection of proteins:

1- Gel staining: the gels were placed in reclosable plastic bags containing staining solution.
2- Gel destaining: the gels were placed in plastic bags containing destaining solution and agitated on a shaker. The destaining solution was changed several times until the gel background was clear.

Scanning:

The software used was scan peck 11. The estimation of molecular weight of different protein bands was automatically done by the aid of a protein marker.

RESULTS AND DISCUSSION

A- Agronomic characters:-

Table (1) shows the mean values of the studied agronomic characters for the 17 rice varieties tested under normal and drought conditions, in the combined analysis of both 2007 and 2008 seasons.

For no. of days to heading, significant differences were detected among genotypes under both conditions (normal and drought) on one hand and within each condition on the other hand. The genotypes Giza 177, Sakha 102, Sakha 103 and Giza 182 were found to be earlier than the other genotypes under normal condition, their mean values ranged from 90 to 95 days. While, the genotypes Giza 159, Giza 171 and Egyptian Jasmine were earlier in heading than the remaining genotypes under drought conditions, the mean values of these varieties ranged from 97 to 100 days. It is clear from the data that drought condition caused delay in heading in most of the varieties studied (12 varieties), the mean values ranged from 100 to 130 days. While, the other six varieties showed earliness in heading under drought conditions, and their mean values ranged from 97 to 102 days. It could be concluded that the effect of drought on heading days to heading differed according to the tested genotypes.

Regarding plant height, data given in Table (1) indicated that significant differences among genotypes were detected at both normal and drought condition. The highest values of plant height were obtained from genotypes Giza 159; Giza 171; Giza 172 and Egyptian Yasmine under normal condition, while the taller plants were obtained from genotypes Giza 182, and Basmati 370 under drought condition. However, range of variability in plant height was observed within and between normal and drought conditions.

Mean values of number of panicles per plant are presented in Table (1). It was observed that the genotypes Giza 172; Giza 175, Giza 176 and Giza 178 had high values of number of panicles per plant under normal condition and the values ranged from 25 to 28 panicles per plant, compared to the varieties Giza 159; Giza 177; Sakha 101; Sakha 102; Sakha 2; Basmati and Basmati 370, where their values ranged from 16 to 18 panicles/plant. The results also showed that number of panicles per plant was decreased significantly under drought conditions comparing with normal conditions. The mean values ranged from 6 to 19 panicles per plant and varieties Sakha 101, Sakha 104, Giza 181 and Giza 182 gave the highest number of panicles per plant under drought condition compared to the remaining correspondent varieties. From these findings, it could be observed that the best varieties under both conditions for the number of panicles per plant were Giza 178 and Giza 182.

With regard to number of grains per panicle, data given in Table (1) indicated that significant differences among genotypes were observed under normal and drought conditions. Number of grains per panicle decreased in all the varieties studied due to the shortage of irrigation water. The varieties Giza 175, Giza 178, Sakha 101 and Giza 182 had the highest number of grains per panicle under normal condition and the varieties Giza 159, Giza 176, Giza 178 and Egyptian Jasmine gave the highest number of grains per panicle under drought condition, respectively compared with the remaining varieties.

For one hundred grain weight as presented in Table (1), the analysis of variance showed that significant differences among genotypes were detected under each condition. The highest values of 100- grain weight were obtained from the genotypes number Giza 177; Giza 181; Giza 182 and Egyptian Jasmine under normal conditions, while the genotypes number Sakha 104; Giza 181; Giza 182; and Egyptian Yasmine had the highest number of this trait under drought condition. Significant differences were observed between

Table (1): The genotypes mean performance for agronomic characters studied under both normal and drought conditions.

No.	Variety	Days to heading (day)		Plant height (cm)		No. of panicles/ plant		No. of grains/panicle		100-grain weight (g)		Sterility (%)		Grain yield/plant (g)	
		N	S	N	S	N	S	N	S	N	S	N	S	N	S
1	Giza. 159	110	99	120	96	18	8	160	136	2.20	1.6	8	17	32	25
2	Giza. 171	125	100	135	82	21	6	182	85	2.40	2.35	11	28	34	18
3	Giza. 172	112	102	130	95	26	7	175	98	2.38	2.15	10	23	35	19
4	Giza. 175	102	110	95	90	26	10	205	120	2.20	2.15	13	15	42	18
5	Giza. 176	110	130	100	87	28	11	187	169	2.47	2.30	11	36	38	17
6	Giza.177	90	104	95	78	18	11	150	110	2.70	2.20	9	10	40	16
7	Giza.178	105	108	100	84	25	19	215	148	2.30	2.20	7	18	45	33
8	Sakha. 101	105	113	95	85	18	19	190	120	2.50	2.30	8	16	48	20
9	Sakha. 102	95	103	110	80	16	7	155	100	2.50	2.30	9	26	40	18
10	Sakha. 103	90	100	90	75	19	8	160	128	2.50	2.20	8	22	42	17
11	Sakha. 104	110	110	105	78	20	18	180	120	2.30	2.40	7	11	44	30
12	Sakha.2	112	130	95	85	18	6	145	128	2.60	2.10	14	34	36	16
13	Giza.181	113	127	95	79	21	18	185	105	2.60	2.35	10	15	35	18
14	Giza. 182	95	128	96	100	22	17	188	128	2.60	2.35	7	16	42	17
15	Egyptian .Y.	115	97	120	75	19	13	155	135	2.60	2.40	12	19	33	19
16	Basmati	110	130	100	98	17	8	140	130	2.50	2.30	13	20	32	18
17	Basmati 370	112	128	98	100	18	10	130	117	2.50	2.30.	10	21	35	17
	L.S.D 0.05	4.5	4.2	3.5	3.8	1.5	1.	3.4	4.3	0.19	0.13	1.6	1.8	2.9	2.3

*N = normal conditions.
*S = stress conditions.

normal and drought conditions for this trait. The mean values ranged from 2.20 to 2.70 grams and from 1.60 to 2.40 grams for the normal and drought conditions, respectively.

Significant differences for sterility percentage character were detected among genotypes at each condition. Under drought condition, the varieties number Giza 171; Giza 172; Giza 176; Sakha 102; Sakha 103; Sakha 2 and Basmati 370 gave the highest sterility percentage. While, the higher sterility (%) for normal condition were detected for the genotypes number Giza 175; Sakha 2 and Basmati.

Wide range of variability in grain yield per plant was observed between the two conditions and also among genotypes. The high values of grain yield per plant were obtained from Sakha 101 (48 g/plant); Giza 178 (45 g/plant) and Sakha 104 (44 g/plant), respectively under normal conditions. While, low values were produced from the varieties Giza 159; Basmati (32 g/plant) and Egyptian Yasmine (33 g/plant), respectively. **Jacob (2006) and Boonjung and Fukai (1996)** reported similar findings using other varieties.

On the other side, the varieties Giza 159, Giza 178 and Sakha 104 gave higher grain yield /plant (25.0, 33.0 and 30.0 g/plant) under the drought condition as compared to the other varieties. On the average over the two conditions, Giza 178 and Sakha 104 gave the high value of grain yield per plant. Accordingly, it could be concluded that the best two varieties under both normal and drought conditions were Giza 178 and Sakha 104 for yield and its component characters. However, Giza 159 showed the least reduction in grain yield attributed to drought stress.

B- Grain quality characters:-

Table (2) presents the mean values of studied grain quality characters of the tested varieties under normal and drought conditions. Significant differences were observed among the studied varieties under both normal and drought conditions for all the tested grain quality characters except for gelatinization temperature.

The five cultivars Giza 159, Giza 172, Sakha 102, Sakha 103, and Sakha 104 Sakha 104 gave the highest hulling (%) than the other ones under normal condition, while, the five variety Giza 159, Sakha 101, Sakha 102, Sakha 104 and Giza 182 gave the highest values of hulling % under drought condition. Milling % ranged between 65% (for Basmati 370) and 74% (for Giza 172) under

Table (2): The genotypes mean performances for grain quality characters studied under both normal and drought conditions.

No.	Variety	Grain shape		Hulling %		Milling %		G.C %		G.T		A.C%		Kernel Elongation	
		N	S	N	S	N	S	N	S	N	S	N	S	N	S
1	Giza. 159	2.5	2.4	81	78	73	71	95	92	6	6	19	19	45	42
2	Giza. 171	2.4	2.2	80	77	72	70	95	94	6	6	18	17	45	40
3	Giza. 172	2.2	2.0	81	77	74	71	98	98	6	6	19.5	17	49	43
4	Giza. 175	2.6	2.4	79	75	69	65	39	40	6	6	25.0	25	51	48
5	Giza. 176	2.2	2.0	78	74	71	67	94	93	6	6	19.0	18	40	38
6	Giza.177	2.5	2.3	80	75	73	70	94	93	6	6	17.0	16	53	50
7	Giza.178	2.4	2.2	80	76	70	68	94	93	6	6	17.0	16	52	50
8	Sakha. 101	2.4	2.1	80	78	71	67	98.5	95	6	6	18.0	16	55	51
9	Sakha. 102	2.6	2.4	81	78	71	69	97	97	6	6	17.5	16	76	70
10	Sakha. 103	2.3	2.3	81	77	72	66	98	98	6	6	18.0	17	47	40
11	Sakha. 104	2.3	2.2	83	80	73	70	98	98	6	6	18.0	17	42	38
12	Sakha.2	3.5	3.2	79	75	72	67	38	38	6	6	25.0	24	44	40
13	Giza.181	3.6	3.4	77	73	69	65	70	69	6	6	21.0	20	42	40
14	Giza. 182	3.5	3.0	80	79	73	69	69	68	6	6	18.0	16	50	47
15	Egyptian .Y.	3.8	3.5	77	73	69	65	98	97	6	6	20.0	19	41	38
16	Basmati	4.5	4.1	76	73	66	61	69	69	7	6	26.0	25	45	41
17	Basmati 370	3.8	3.4	75	72	65	62	68	68	6	6	25.0	25	42	40
	L.S.D 0.05	0.25	0.36	0.88	0.65	0.68	0.90	0.85	0.88	1	1	0.66	0.78	2.55	3.12

*N = normal condition.
*S = stress condition.

normal condition. However, it differed from 61% (for Basmati 370) to 71% (for Giza 172) under drought condition.

For gel consistency, the varieties the variety Sakha 101 followed by Giza 172, Sakha 103, Sakha 104, and Egyptian Jasmine gave the highest mean values under normal and drought conditions. The values ranged from 38% to 98% for both conditions.

With respect to amylsoe content (%), the mean values of the studied varieties ranged from low (17%) for Giza 177 and Giza 17, under normal condition and (16%) for Giza 177, Giza 178, Sakha 101, Sakha 102 and Giza 182 under drought condition to high (25% for Giza 175, Sakha 2 and Basmati 370 and 26% for the varieties Giza 175, Basmati and Basmati 370 under drought conditions). These findings indicated that most of tested varieties showed desirable limits of amylose content. This was bred for Egyptian consumers.

For gelatinization temperature, insignificant differences among the studied varieties under both normal and drought conditions were estimated indicating that drought conditions had no effect on this character. These findings were in agreement with those reported by **Abd Allah, 2000.**

The four varieties Giza 181, Egyptian Jasmine, Basmati and Basmati 370 were found to have the highest mean values of grain shape under both normal and drought conditions. The values ranged from 3.5 to 4.5 under normal condition and from 3.0 to 4.1 under drought condition. The varieties Giza 177, Sakha 101 and Sakha 102 had the highest values of kernel elongation while Giza 178, Sakha 101, Sakha 102 and Sakha 103 gave the highest values under drought conditions.

In general, it is clear that most of the grain quality characters studied were less affected by drought conditions comparing with the other characters.

C -Physiological characters:

The results on RWC, osmotic potential and water use efficiency are presented in Table 3.

Results of leaf area (Table 4) will be discussed with root traits due to its strong association as important indices for drought tolerance. The varieties Giza 159, Giza 178 and Sakha 104 maintained comparatively higher relative water content (RWC) under stress condition as well as exhibited lower reduction in the values comparing with normal condition. The varieties Giza 176, Giza 177 and Basmati 370 exhibited lowest values of RWC under stress condition.

then screen the lines accumulating tolerance at different stages together with high yielding ability.

It is clear from the results that a given tolerant genotype may not show positive for all the parameters associated with stress tolerance, as it clear from the response of Giza 178 which showed low no. of panicles /plant and hundred grain weight under stress conditions . So, the identification on the basis of any one of the parameters may not provide true picture of the nature of response of a genotype to stress. It can be concluded that Giza 178, Sakha 104 and Giza 159 could be considered as drought tolerant genotypes and would be useful in rice breeding program for drought tolerance.

Table (3): The genotypes mean performances for the physiological characters studied under both normal and drought conditions.

No.	Variety	Relative water content		Osmotic potential		Water use efficiency	
		N	S	N	S	N	S
1	Giza. 159	99	75	13	17	0.49	0.95
2	Giza. 171	90	65	12	13	0.52	0.69
3	Giza. 172	88	67	11	10	0.54	0.73
4	Giza. 175	94	71	15	19	0.640.58	0.69
5	Giza. 176	89	60	13	15	0.610.69	0.65
6	Giza.177	88	61	12	11	0.74	0.61
7	Giza.178	98	78	15	22	0.61	1.26
8	Sakha. 101	90	65	12	10	0.64	0.75
9	Sakha. 102	90	68	11	13	0.69	0.69
10	Sakha. 103	91	70	13	12	0.53	0.65
11	Sakha. 104	95	75	15	21	0.54	1.15
12	Sakha.2	88	63	10	14	0.64	0.73
13	Giza.181	91	68	11	15	0.49	0.69
14	Giza. 182	87	65	12	13	0.49	0.65
15	Egyptian .Y.	90	65	10	14	0.54	0.73
16	Basmati	90	66	10	12	0.10	0.69
17	Basmati 370	91	62	12	13		0.65
	L.S.D 0.05	1.45	1.10	0.95	1.26		0.18

*N = normal condition.

*S = stress condition.

The increase in osmotic potential under stress condition reflects the increased hydrolysis of macromolecules into simpler ones like mono and disaccharides and amino acids especially proline etc. In this study the genotypes Giza 178 and Sakha 104 showed higher osmotic potential under stress condition followed by Giza 175 and Giza 159 compared to the other varieties.

The three varieties Giza 159, Giza 178 and Sakha 104 had higher WUE under stress condition with values of 0.95, 1.26 and 1.15, respectively. These findings were in agreement with those reported by **Abd Allah, 2000.**

From the above results it could be indicated that identification and or selection on the basis of any one of the above three parameters might not provide true picture of the nature of response of a genotype to stress.

D- Root characters:

Table (4) showed the mean values of the different root characters and leaf area for the 17 rice varieties under drought condition. Significant differences for root length were detected among genotypes and the highest value of root length was obtained for the variety Sakha 104 followed by Basmati 370, Giza 176, Egyptian Jasmine and Giza 172 (their mean values were, 53, 50, 49, 48, and 47 cm). Regarding root number per plant, data given in Table 4 indicated that significant differences among genotypes were detected under drought condition. The variety Giza 181 followed by Basmati 370 then Giza 175 gave the higher mean values for root number per plant (their values were 58, 55, 50, and 48). Data presented in Table (4) showed that significant differences were observed among genotypes regarding root dry weight. The highest weight value was obtained for the variety Giza 175 and Sakha 102 then Giza 172. Smaller leaf area is highly associated with low tiller number; therefore, selection could be directed to plants with moderate tillering to compromise with higher yield potential. High mean values were detected for the varieties Giza 171(410 cm^2); Giza 175 (420 cm^2); and Giza 176 (435 cm^2), while moderate leaf area were found for the varieties Giza 177 (400 cm^2); Sakha 104 (4000 $cm^{2)}$; Sakha 2 (370 cm^2) and Basmati (350 cm^2). The remaining varieties had lower mean values of leaf area. Smaller leaf area helps to conserve or \maintain xylem water potential and minimizes evapotranspiration, thereby, conserving the limited soil moisture supply in times of water deficit. The variety, Giza 159; Giza 178 and Sakha 104 had the score of 3 for drought tolerance, while the others had the scores ranged from 5-9. These findings indicate that the first mentioned three varieties are likely to be resistant to drought stress compared to the others. It could be concluded that the 17 rice cultivars were differed in their reaction to drought condition and showed significant variations in root characters that contribute to field drought resistance at different growth stages. These results were in agreement with those reported by **Yamauchi, and Aragones (1997)**. Both root characters and leaf area are useful selection indices for field drought resistance. On the basis of a strong association between certain root and shoot characters, plants having deep root, high root dry weight, moderate tillering ability, short and narrow leaves and intermediate plant height would likely to perform better and more stable in yield in drought – prone environments. The same results were found by **Fukai and Cooper (1995) and Adam et al (2002).**

Genetic components:

In general, the phenotypic coefficient of variation PCV (Table 5) was high for number of panicles per plant (93.70), one hundred grain weight (132.30), and grain shape (155.00), while it was low for leaf area (3.38), gel consistency (7.80) and kernel elongation (8.20). Genotypic coefficient of variation GCV showed the same trend but the corresponding values were lower, thereby implying the influence of environment on the genotypes. Heritability estimates, in general, were higher (more than 80.00 %s) for all studied traits except one hundred grain weight, root number per plant, and root dry weight. Consequently, selection for yield components will be more effective in most of the studied characters for all these genotypes (Table 5). The same findings were found by **Ram (1994) and Fukai et al. (1999)**.

Phenotypic correlation coefficients:

Phenotypic correlation coefficients among 12 traits are shown in Table (6). Root length was significantly and highly significantly and positively associated with root dry weight, plant height, and number of grains per panicle, 100-grain weight and grain yield per plant. Root number was positively and significantly associated with root dry weight, number of panicles per plant, number of grains per panicle and grain yield per plant. Root dry weight was highly significantly and positively correlated with leaf area, plant height, number of panicles per plant and grain yield per plant. Meantime leaf area was significantly and positively correlated with sterility percentage and 100- grain weight.

Table (4): Drought score and studied root characters as well as leaf area of the studied varieties under drought condition.

No.	Variety	Root length (cm)	Root number	Root dry weight (g)	Leaf area (cm^2)	Drought score
1	Giza 159	45.00	34	0.34	300.00	3
2	Giza 171	43.00	44	0.55	410.00	5
3	Giza 172	47.00	35	0.58	380.00	7
4	Giza 175	43.00	48	0.60	420.00	7
5	Giza 176	49.00	45	0.65	435.00	9
6	Giza 177	36.00	40	0.57	400.00	9
7	Giza 178	40.00	40	0.40	310.00	3
8	Sakha 101	37.00	42	0.35	330.00	5
9	Sakha 102	44.00	44	0.41	320.00	9
10	Sakha 103	43.00	46	0.48	330.00	9
11	Sakha 104	53.50	38	0.44	400.00	3
12	Sakha 2	44.00	34	0.60	370.00	5
13	Giza 181	36.00	55	0.30	280.00	9
14	Giza 182	38.00	58	0.35	295.00	7
15	Egyptian Y.	48.00	42	0.41	320.00	7
16	Basmati	50.00	35	0.33	350.00	7
17	Basmati 370	44.00	50	0.28	288.00	7
Check	IET 1444	35.00	38	0.45	290.00	1
	L.S.D 0.05	2.66	2.70	0.05	5.60	1.50

Notes: 1-3 = tolerant 5 = moderate 7 = susceptible 9 = highly susceptible

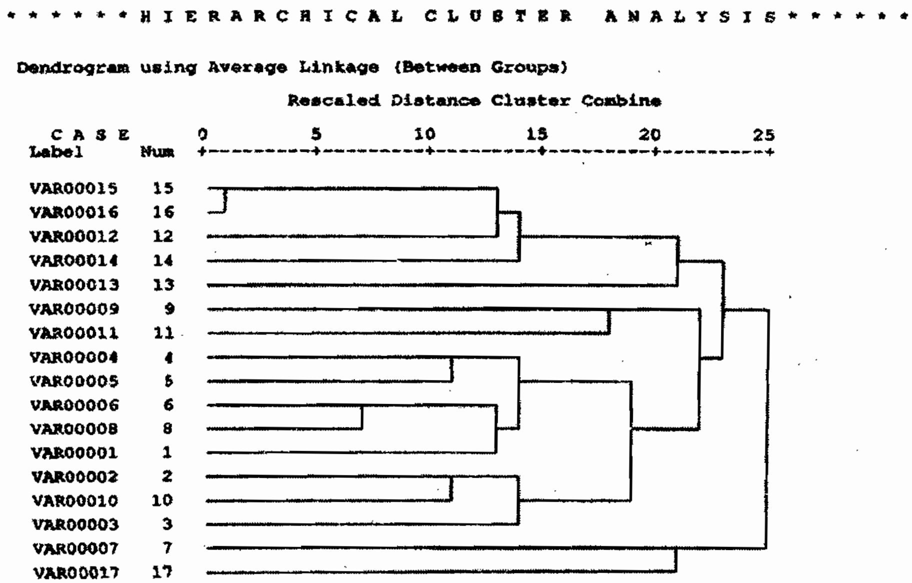

Fig. (1): Dendrogram of the genetic distances between seventeen rice genotypes based on SDS-PAGE for total soluble protein.

Table (5): Variance components and genetic parameters for all studied characters of the studied rice genotypes under drought condition.

No.	Character	Phenotypic variance (PV)	Genotypic variance (GV)	PCV %	GCV %	Heritability %
1	Days to heading	236.00	202.00	13.6	12.60	92.60
2	Plant height	179.00	110.00	15.5	12.15	80.60
3	Panicle length	28.00	25.00	26.50	25.00	94.30
4	No. of panicles/pl.	95.00	82.00	93.70	87.00	92.80
5	No. of grains/pan.	340.00	285.00	15.00	13.80	92.00
6	100-grain weight	8.50	4.30	132.5	94.25	71.00
7	Sterility %	0.22	0.16	23.00	19.60	86.00
8	Grain yield/plant	85.5	58.00	47.30	38.85	80.00
9	Root length	445.00	350.00	49.00	43.50	88.00
10	Root number/plant	570.00	318.00	56.00	41.80	74.64
11	Root dry weight	38.00	18.00	14.00	9.60	68.57
12	Leaf area	137.00	128.00	3.38	3.26	96.44
13	Grain shape	14.00	10.00	155.00	131.00	84.50
14	Hulling %	0.88	0.65	13.00	11.20	86.15
15	Milling %	0.76	0.58	13.70	11.90	86.80
16	G.C.	0.36	0.25	7.80	6.50	83.30
17	G.T.	0.22	0.18	31.30	28.20	90.00
18	A.C.%	0.19	0.14	18.90	16.20	85.70
19	K.elongation	12.00	9.00	8.20	7.10	86.50
20	RWC	155.13	115.00	0.18	0.16	74.0
21	O.potential	23.00	17.5	0.33	0.29	76.00
22	WUE	0.33	0.22	0.75	0.61	66.00

Table (6): Phenotypic correlation coefficients among 12 traits of the studied varieties under drought condition.

	Characters	Root number	Root dry weight	Leaf area	Plant. height	Panicle. length	No. of panicles/pl.	No. of grains/ panicle	100 grain weight	Sterility %	Days to heading	Grain yield/ plant
1	Root length	-0.25	0.650**	0.380	0.520**	0.420*	0.180	0.400*	0.415*	0.220	0.118	0.425*
2	Root number	-	0.550*	0.780**	-0.110	-0.220	0.750**	0.570*	0.250	0.110	-0.150	0.410*
3	Root dry weight		-	0.850**	0.580**	0.310	0.450*	0.113	0.210	0.270	0.120	0.510*
4	Leaf area			-	0.330	0.475	0.210	0.280	0.300*	0.500*	-0.190	0.210
5	Plant height				-	0.350	0.225	0.119	0.187	0.155	0.090	0.525*
6	Panicle length					-	0.140	0.650**	0.300	0.220	0.280	0.610**
7	No. of panicle/pl						-	0.850**	0.286	0.380	0.120	0.750**
8	No. of grains/pa							-	0.150	0.210	0.160	0.680**
9	100-grain weight								-	0.200	0.185	0.700**
10	Sterility %									-	0.228	-0.510*
11	Days to heading										-	0.480
12	Grain yield											-

* Significant and ** highly significant

Plant height was positively correlated with grain yield per plant. Panicle length and number of panicles per plant were highly and positively associated with both numbers of grains per panicle and grain yield per plant. One hundred grain weight, sterility percentage and days to heading were significant and positively correlated with grain yield per plant. These results were in agreement with those reported by **Singh et al. (1984) and Singh (1990).**

Protein fractionation:

Polyacrylamide gel electrophoresis of proteins provides good information for the identification and characterization of different varieties. The seventeen varieties were fingerprinted by SDS-PAEE of water-soluble proteins (Fig I, 2). They exhibited a maximum number of 43 bands as shown in Tables (7, 8), which were not necessarily present in all varieties. The highest number of bands (13 bands) was found in the variety no. 3. The lowest number of bands (8 bands) was in found in the variety no. 12. Bands number 36, 40, 41 and 42 with MWs 98.11, 59.43, 58.30 and 33.42 KDa, respectively, were exhibited in all varieties and could be considered as common bands. Bands number 1, 2, 3, 5, 6, 7, 13, 14, 15, 16, 18, 22, 27, 29, 30 and 31 with MWs 333.76, 326.73, 324.39, 297.33, 284.00, 278.77, 240.00, 228.39, 226.67, 221.37, 208.92, 178.61, 142.20, 129.39, 124.16and 119.08 KDa, respectively were found only in varieties 14, 15, 16, 8, 7, 6, 9, 13, 3, 14, 8, 11, 5, 13, and 12 respectively, and could be considered as specific bands (positive markers) for these varieties.

The data of SDS-PAGE were loaded to the computer program (SPSS windows version 10) to get a dendrogram for genetic distance and similarity matrix as shown in Tables (7, 8) and Figures (1, 2, and 3). The dendrogram divided the varieties into two groups. The first group included the five varieties 13, 14, 15, 16 and 17, while the other group included the rest of inbred. The first group was included as sub group. The second group included five subgroups (9 and 11), (4 and 5), (6 and 8), (7 and 12) and (2 and10). These findings are similar with those reported **by IRRI (1990) and Pham et al. (1990)** with the other genotypes.

From these findings, it could be concluded that two approaches can be used to improve drought resistance each with two steps: 1) select the best varieties for each factor of drought resistance , in particular good root system and then cross varieties to accumulate such good characters in one or more new lines . 2) select the most tolerant varieties of drought stress at a different developmental stage and then cross these new lines to improve yield and its components,

Table (7): Non similarity matrix among the seventeen rice inbreds based on SDS- protein analysis.

Inbred	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	0.36															
3	0.36	0.27														
4	0.36	0.64	0.46													
5	0.36	0.64	0.64	0.27												
6	0.27	0.18	0.55	0.36	0.36											
7	0.46	0.55	0.55	0.73	0.73	0.46										
8	0.36	0.46	0.64	0.27	0.46	0.18	0.55									
9	0.36	0.46	0.64	0.64	0.64	0.36	0.55	0.46								
10	0.36	0.27	0.46	0.64	0.64	0.36	0.55	0.46	0.46							
11	0.73	0.46	0.64	0.82	0.82	0.63	0.73	0.64	0.46	0.64						
12	0.46	0.55	0.73	0.73	0.73	0.46	0.64	0.55	0.55	0.36	0.55					
13	0.64	0.55	0.91	0.73	0.73	0.46	0.82	0.55	0.55	0.36	0.55	0.46				
14	0.46	0.73	0.73	0.73	0.55	0.64	0.95	0.73	0.72	0.55	0.73	0.46	0.64			
15	0.46	0.55	0.55	0.55	0.55	0.46	0.82	0.55	0.55	0.36	0.55	0.27	0.46	0.27		
16	0.55	0.64	0.64	0.64	0.64	0.55	0.91	0.64	0.46	0.46	0.64	0.36	0.55	0.36	0.11	
17	0.55	0.82	0.82	0.46	0.64	0.73	0.55	0.64	0.64	0.64	0.82	0.55	0.73	0.73	0.36	0.46

Table (8): SDS-PAGE of water- soluble protein extracted from the seventeen rice varieties.

Band no.	MW (KDa)	Inbred																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	333.76	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
2	326.73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
3	324.39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
4	308.00	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-
5	297.33	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
6	284.00	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
7	278.67	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
8	264.00	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-
9	261.00	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	+
10	253.24	-	+	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-
11	249.00	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-
12	244.00	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
13	240.00	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
14	228.39	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
15	226.67	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	221.37	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
17	219.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+
18	208.92	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
19	198.33	-	-	+	-	-	-	+	-	-	-	+	-	-	-	-	-	-
20	190.59	-	-	+	-	-	-	+	-	-	-	+	-	-	-	-	-	-
21	187.24	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-
22	178.61	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
23	175.83	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
24	169.21	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
25	157.17	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+
26	146.70	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
27	142.20	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
28	138.83	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
29	129.39	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
30	124.16	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
31	119.08	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
32	115.40	+	+	+	+	-	-	-	-	+	+	-	-	-	-	-	-	+
33	109.42	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+	-
34	106.20	+	-	-	+	+	+	+	+	+	-	+	-	+	-	-	+	+
35	103.02	+	+	+	+	+	+	+	+	-	+	-	-	-	-	-	-	-
36	98.11	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
37	89.03	-	-	-	+	+	-	-	-	-	-	-	-	-	-	+	+	+
38	84.22	-	+	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-
39	78.82	+	+	+	+	+	-	-	-	-	-	-	-	-	+	-	-	-
40	59.43	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
41	58.30	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
42	33.42	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
43	24.32	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+
Total	**43**	**11**	**11**	**13**	**12**	**12**	**9**	**11**	**10**	**10**	**10**	**13**	**8**	**11**	**11**	**9**	**11**	**11**

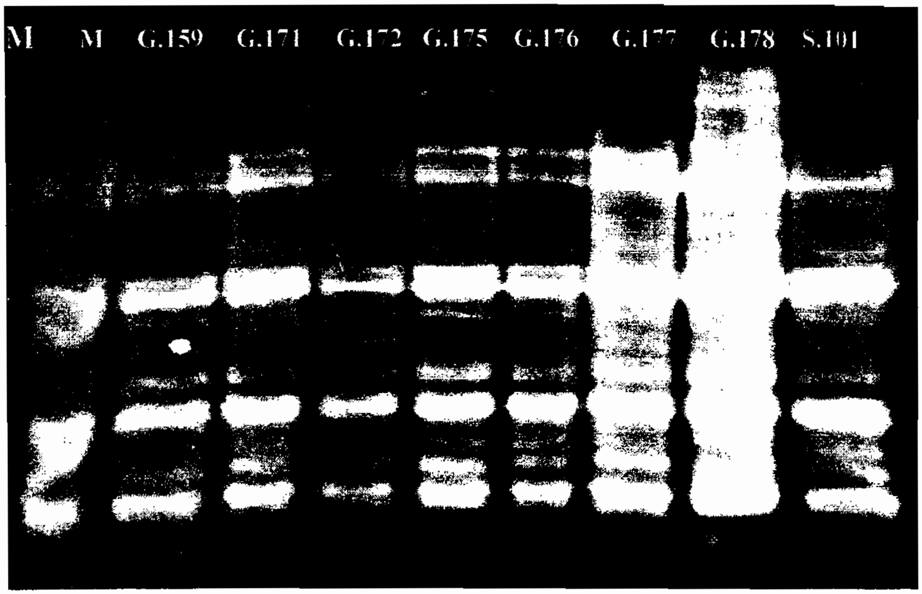

Fig. (2): Electrophoretic Patterns of SDS-PAGE for total soluble protein of the studied rice genotypes

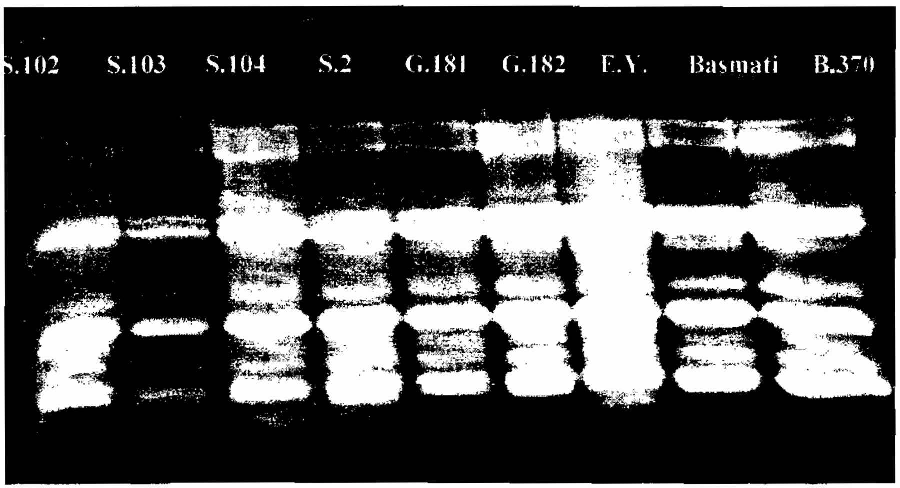

Fig. (3): Electrophoresis Patterns of SDS-PAGE for total soluble protein of the studied rice genotypes.

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الملخص العربي

دراسات على التباين الوراثى فى أصناف الأرز المصرية تحت الظروف العادية وظروف الجفاف

الملخص

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معهد بحوث المحاصيل الحقلية-مركز البحوث الزراعية

أجرى هذا البحث فى مزرعة مركز البحوث والتدريب فى الأرز بسخا ومعمل تكنولوجيا البذور - معهد بحوث المحاصيل الحقلية بالجيزة - مصر خلال المواسم الزراعية ٢٠٠٧م ,٢٠٠٨م وذلك لدراسة التباين الوراثى والإرتباط المظهرى وكذلك تحديد أفضل التراكيب الوراثية المستخدمة فى الدراسة لتحمل الجفاف عند كل مرحلة من مراحل النمو تحت ظروف الجفاف. وقد تم فحص وأختبار سلوك كل من السبعة عشرة صنف من الأرز تحت الظروف العادية وظروف الجفاف .

وقد أوضحت النتائج أن أفضل الأصناف تحت الدراسة من حيث صفات المحصول ومكوناته وكذلك بعض الصفات الفسيولوجية مثل محتوى الماء بالورقة والضغط الأسموزى وكفاءة إستخدام مياه الرى كانت جيزة ١٧٨, وسخا ١٠٤ تحت كل من الظروف العادية (الغمر) وظروف الجفاف , حيث إحتوت نباتات تلك الأصناف على مجموع جذرى قوى. وكانت قيم معامل التباين المظهرى عالية لصفات عدد السنابل /نبات , وزن ١٠٠حبة وشكل الحبة , بينما كانت القيم منخفضة بالنسبة لصفات مساحة الورقة , مدى تماسك الجيل بعد الطهى وإستطالة الحبوب بعد الطهى . وقد أخذت قيم معامل التباين الوراثى نفس إتجاه معامل التباين المظهرى وكانت قيم درجة التوريث مرتفعة بالنسبة لكل الصفات المدروسة عدا صفات وزن ١٠٠ حبة وعدد الجذور /نبات . ووجد إرتباط معنوى وموجب بين صفة محصول الحبوب /نبات وكل صفات مكونات المحصول المدروسة تحت كل من الظروف العادية وظروف الجفاف. وأوضحت النتائج أيضا وجود علاقة إرتباط موجبة بين صفات الجذور وصفات مكونات المحصول . وقد أوضحت النتائج المتحصل عليها من خلال عمليات الترحيل (التفريد) الكهربائى فى الحبوب بإستخدام بيئة صناعية (البولى أكريلاميد) معلوملت عن توصيف البروتينات الموجودة فى الحبوب وتمييزها عن بعضها عن طريق تحديد معدل سرعة إنتقال البروتين فى المجال الكهربائى فيكون ما يشبه البصمة لكل صنف مما أدى إلى تمييز الأصناف بعضها عن بعض وكذلك قياس الأوزان الجزيئية للبروتين داخل الحبة . وأوضحت النتائج أن أعلى عدد من الإختلافات كان ١٣ وقد وجد فى الصنف رقم ٣ وأن أقل عدد كان ٨ ووجد فى الصنف رقم ١٢. وبناء على ما سبق فإنه يمكن الإستفادة من هذه الدراسة فى تحديد الأصناف التى يمكن إستخدامها كآباء معطية والتى تحمل صفة تحمل الجفاف والأخرى التى تحمل صفة المحصول العالى تحت ظروف الجفاف وعمل تهجينات بينهما لنقل الجين المسئول عن الإنتاجية العالية إلى تلك الأصناف المتحملة للجفاف (تجميع الصفات المرغوبة فى صنف واحد).