SCREENING SOME RICE GENOTYPES *(ORYZA SATIVA L.)* UNDER DROUGHT CONDITIONS.

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ABSTRACT

A field experiment including eighteen rice genotypes from different sources selected from local and exotic materials was conducted as screening nursery in the field during 2003 and 2004 rice growing seasons under drought conditions at the farm of the Rice Research and Training Center, Sakha, Kafr EL-Sheik Egypt. Each line or variety was planted in six- rows per plot in a randomized complete block design with three replications. Flush irrigation was used every twelve days and all other recommendations were followed. Results showed that the genotypes; IET1444, Puse Basmti 370, BG 33-2, BG 35-1, Giza 178, Sakha 104 and Milyang 54 had higher grain yield/plant at the two years and their combined data and this may be due good strong root system where, these varieties showed deep and thicken roots and high root :shoot ratio. The varieties with such root system can attain high level of panicles fertility and grain filling and therefore high grain yield/plant. The results indicated that the highest values of heritability came from the characters; days to heading, plant height, no. of grains/ panicle, panicle weight, root volume and no. of roots/plant. The varieties which have good drought scores having good root system as well as more panicles/plant, indicating that these varieties could be used as a donors in rice breeding program to overcome the lacke of donor parents at reproductive stage under drought conditions. Positive correlation was found between grain yield/plant and each of root characters and yield component characters.

INTRODUCTION

The development of root system is an important factor of drought resistance because it is closely related with the efficiency of water utilization. When water stress is present the most effective defense mechanism available to the rice plant is a root system consisting of deep and mostly thick roots which enable the plant to avoid the adverse effects of internal water deficit (Chang et al,1985).

Cultivars with such root systems can attain a high level of panicles fertility and grain filling, although final grain yield is also decreased by the drought. On the other hand, cultivars with shallower and thin roots will show a cessation in growth and envelopment during severe water deficit. Most of the drought resistant cultvars have a deep and thick root system (IRRI, 1988).

Previous results showed a significant variation in root growth of rice cultivars Chang et al 1985. Roots in drought resistant cultivars developed better than in low land ones. O'Toole and Maguling (1981), found significant differences in root length , root numbers/plant, root thickness and root to shoot ratio among the cultivars tested. Four major physical or biological constraints to higher production levels of low-land rice cultivars were identified; i.e. the lack of standing water at the appropriate date for transplanting, sever water stress that often develops at the reproductive stage; lack of drought resistant cultivars during the reproductive stage; negative correlation between drought escaping mechanism and drought avoidance mechanism in one hand and with recovery ability in the other hand and missing the link between physiological drought resistant characters and plant productivity.

The influences of these constraints can be reduced and yield can be increased by several methods: Choice of appropriate cultivars based on their resistance to drought conditions and adoption of high yielding cultivars. The appropriate cultivars are early flowering and intermediate in stature, posses high yield potential and have good root system under drought conditions.

Drought tolerance in rice can minimize the high irrigation requirements and contribute to water use efficiency. Rice plants avoid water stress to a great extent, by developing more extensive and deeper root systems, which can be measured by different techniques. Greater root depth and root numbers/plant of rice resulted in more available water and nutrients during periods of drought, (O' Toole and Maguling, 1981).

In Egypt, traditionally rice is grown under continuously flooded conditions and hence most conventional water management practices aim to maintain a standing depth of water in the field through the season. Annually some rice area are exposed to drought from one time to another due to the shortage of irrigation water, and therefore developing and releasing some new rice cultivars to be grown under such conditions is one of the main components of rice research program. In this investigation, our first objective was to know selection indices for drought screening under field conditions. Our second objective was to determine the drought tolerant varieties to be used in rice breeding program.

MATERIALS AND METHODS

The study was conducted in 2003 and 2004 rice growing seasons at the Farm of the Rice Research and Training Center, Sakha, Kafr EL-Sheikh, Egypt. Eighteen local and exotic rice varieties of different genotype groups namely; Egyptian yasmin, Giza 171, Giza 175, Giza 176, Giza 181, Giza 170, Giza 178, Sakha 101, Sakha 102, Sakha 104 and TKY 1014 belonging to Japonica as local varietes and Indica type group and Puse Basmati 370, Dular, Milyang 23, BG 33-2, BG 35-1 and Milyang 54 as introduced rice varieties having long and short grain and belonging to Indicia/Japonica type, in addition to IET 1444 as a check variety. Were grown under drought conditions in the field in a randomized complete block design with three replications.

All the varieties studied were planted at the first half of May and each variety was transplanted in six rows of six meters length each at spacing of 20 x 20cm spacing and two seedlings/hill. Normal agricultural rice practices were applied as usual for the ordinary rice field. Fertilization was applied at recommended rates of 40 kg nitrogen/Fed., weeds were chemically controlled by adding a dose of 2 liter/Fed. of the herbicide, Saturn, four days after transplanting.

Previous studies reported that days after irrigation 50 % of soil moisture are depletion and therefore, the plants will faces drought stress because the plant needs a lot of energy to obtain the water from the soil. Flush irrigation was used every twelve days (15 days after transplanting) without standing water after irrigation. Plants which were rolled at the initiation of drought (7 or 9) and the unrolled plants hed drought resistant score of 1 and 3.

At maximum tillering stage chlorophyll content was recorded (by using chlorophyll meter SPAD –502, Minolta corp). The chlorophyll of leaves of ten plant was determined and the average was recorded. Root length (cm), was determined also as the length of the root from the base of the plant to the tip of the main axis of primary root; number of roots/hill, all developed secondary and tertiary roots per plant was counted; root volume, volume of the root system per plant was determined in cubic centimeters by displacement method, the root system was immersed in water in a 1.000 ml graduated cylinder and over flower was measured; and root: shoot ratio were measured at heading stage.

At harvesting, plant height (cm), no. of panicles/hill, total number of filled grains/panicle, panicle weight and grain yield/plant were estimated for ten plants from each reolication for each variety. Drought scores were recorded according to De Datta et al., 1988.

The data were combined and statistically analyzed, the formula suggested by Burton (1952), Singh and Choudhary (1985) were used for estimating the genetic parameters.

RESULTS AND DISCUSSION

Significant differences for root and shoot characters of 18 rice cultivas obtained from the field experiment. Analysis of variance showed highly significant variation among cultivas of each of the root and shoot characters and the drought scores (1-3 = resistant, 4-9 = susceptible) at the different growth stages was taken during 2003 and 2004 rice growing seasons under drought conditions based on De Datta et al, 1988.

Table (1): Parental rice cultivars; origin and variety group

No	Variety	Origin	Parentage	Variety group
1	IET 1444 (C.K)	India	TNI/Co29	Indica
2	Puse Basmati 370			Japonica
3	Dular	IRRI	Dumai/Larkoch	Indica
4	Milyang 23			Japonica
5	BG 33-2	Srilanka	IR8-24-6//M307HS	Indica
6	BG 35-1			Indica
7	Milyang 54			Japonica
8	TKY 1014	Egypt	J69153/Funishiki/ Taichung shin 254	Japonica
9	Egyptain yasmin	Egypt	Jamin 85 csming	Indica
10	Giza 170	Egypt	Nahda/Giza 14	Japonica
11	Giza 171	Egypt	Nahda/Calaady 40	Japonica
12	Giza 175	Egypt	IR28/IR1541-76// Giza180/Giza 14	Japonica
13	Giza 176	Egypt	Calrose 76/Giza 172// GZ 242-5	Japonica
14	Giza 181	Egypt	IR 24/IR 22	Indica
15	Giza 178	Egypt	Milyang 49/Giza 175	Indica/ Japonica
16	Sakha 101	Egypt	Giza 176/Milyang 79	Japonica
17	Sakha 102	Egypt	Giza 176/GZ 4096	Japonica
18	Sakha 104	Egypt	GZ 4096-8-1/ GZ 4100-9	Japonica

Table (2) shows the means of eighteen rice genotypes grown at two years and their combined data. Significant differences for days to heading were detected among genotypes at two years and their combined data. The delay in heading occurred in all the studied varieties due to the shortage of irrigation water compassed to the check variety IET 1444. Most of these varieties are considered as a medium duration (125-135 days) at the two years and their combined data. Plant height varied significantly in the studied genotypes, indicating high effect of drought condition on this trait. Most of these varieties were taller than the check variety IET 1444 and this trait could be used as a selection crieteria for selecting drought tolerant genotypes under drought conditions. Recent results showed that drought tolerant varieties remains a tall under drought conditions while, susceptible varieties were reduced in hight.

For number of panicles/plant, data showed that significant differences among genotypes detected at the two years and their combined data. The varieties; Egyptian Yasmin, Puse Basmati, Milyang 23, BG 33-2 and Giza 178 gave the highest mean values than the drought tolerant variety IET 1444 at the two years and their combined data and the values ranged from 18.0 to 21.0 panicles/plant.

Regarding the total number of grains /panicle, the most desirable mean values were obtained from the same varieties mentioned for No. of panicles/plant in addition to Giza 175 and Giza 181, the values ranged from 86.0 to 145.0 grains/panicle as compared with the check variety IET1444 which has 78.0 filld grains/panicle.

Concerning the panicle weight, wide differences among all genotypes studied were observed. The varieties; TKY 1014, Sakha 102, Egyptian Yasmin, Giza 170 and Milyang23 gave the highest mean values for this trait as compared with the control IET1444 and the values ranged from 2.56 to 3.0 gram. While , the genotypes Giza 181, Giza 175, Puse Basmati and Dular gave the lowest mean values and ranged from 1.98 to 2.15 grams.

.Chlorophyll content varied significantly in the studied genotypes reflecting the high effect of drought conditions on this trait. The varieties; Giza 178 and Giza 170 had higher chlorophyll content than the drought tolerant variety IET 1444 at the two years and their combined data. While, the varieties Sakha 102 and TKY 1014 ranged from 32.0 to 33.0. Means of some root characters studied in both 2003 and 2004 seasons are shown in Table (2).

The root system plays an important role under water deficit conditions and the nature and extent of root development are major

Table (2): The mean performances of eighteen rice genotypes under drought conditions at the two years and their combined data for heading date, plant eight, number of panicle/hill, number of filled grains/plant and panicle weight .

Genotypes	No. of days to heading	Plant height (cm)	No. of panicles/hill	No. of filled grains/ plant	Panicle weight (g)
IET 1444 (C.K)	105.0	87.33	17.0	78.0	2.30
Puse Basmati 370	116.67	89.0	18.0	87.0	2.88
Dular	110.67	84.0	21.0	86.0	2.14
Milyang 23	114.0	92.0	16.0	118.0	2.15
BG 33-2	115.0	74.0	21.0	86.0	2.56
BG 35-1	116.67	69.67	19.0	110.0	2.18
Milyang 54	127.0	71.33	15.0	77.33	2.17
TKY 1014	120.67	91.67	11.0	82.67	2.40
Egyptain yasmin	108.0	86.67	13.67	92.0	2.11
Giza 171	110.0	90.0	11.33	79.0	2.45
Giza 175	115.0	87.0	13.0	89.67	1.98
Giza 176	106.0	93.0	15.0	81.0	2.58
Giza 181	110.0	82.0	18.0	145.0	2.4
Giza 170	115.0	75.0	12.0	118.0	2.6
Giza 178	100.0	90.0	10.0	100.0	2.9
Sakha 101	105.0	100.0	15.0	135.0	2.6
Sakha 102	103.0	78.0	17.0	128.0	2.6
Sakha 104	110.0	85.0	11.0	125.0	3.0
L.S.D(0.0)	2.70	4.80	1.20	0.90	0.18

Table (2): Continued. The mean performances of eighteen rice genotypes under drought conditions at the two years and their combined data for Chlorophyll cont., Root length(cm), No. of roots/hill, Root volume(mm), Grain yield/pant (g), Root: shoot ratio and Drought scores

Genotypes	Chlorophyll cont.	Root length (cm)	No. of roots/hill	Root volume (mm)	Grain yield /pant (g)	Root: shoot ratio	Drought scores
IET 1444 (C.K)	42.30	27.17	586.33	75.67	18.0	0.39	3
Puse Basmati 370	39.08	40.83	477.33	62.33	14.0	0.39	4
Dular	42.22	29.0	494.33	70.0	20.0	0.44	4
Milyang 23	44.22	28.0	511.67	80.0	17.0	0.46	3
BG 33-2	32.85	24.17	378.67	70.0	15.0	0.39	5
BG 35-1	41.17	24.83	487.0	87.33	23.0	0.49	3
Milyang 54	43.50	30.23	526.67	94.33	25.0	0.76	2
TKY 1014	33.42	22.17	418.0	50.0	13.0	0.40	6
Egyptain yasmin	35.28	23.33	469.33	52.33	14.0	0.56	4
Giza 171	36.95	26.17	479.33	61.67	12.0	0.34	5
Giza 175	35.30	33.33	460.0	61.67	11.0	0.45	5
Giza 176	44.62	39.83	442.67	80.0	16.0	0.41	6
Giza 181	45.0	32.0	398.0	88.0	20.0	0.41	3
Giza 170	35.0	27.0	360.0	75.0	15.0	0.38	6
Giza 178	32.0	25.0	340.0	66.0	13.0	0.36	6
Sakha 101	44.0	35.0	550.0	90.0	22.0	0.42	3
Sakha 102	38.0	24.0	480.0	85.0	18.0	0.40	3
Sakha 104	33.0	26.0	510.0	65.0	15.0	0.35	4
L.S.D (0.05)	3.60	2.10	12.80	5.50	1.50	1.90	

Drought scores (DE Datta et al., 1988):
1 Resistant　3 Moderatly　5 Intermediate
7 Susceptible　9 Highly susceptible

factors governing plant response to moisture conditions. The selection for desirable root characteristics will be a major objective for development drought tolerant varieties. The plants having good root system, i.e. deeper root, volume, thickness and root numbers /plant are able to maintain high leaf water potential against evapotrans piration demand under water stress.

Significant differences among genotypes studied for all root characters studied were observed in both years and their combined data (Table 2).

The most desirable mean values for root length were obtained from the varieties Egyptian Yyasmin, BG 35-1, Giza 181, Giza 170 and Sakha 104 and the values ranged from 30.23 to 40.83cm comparing with the check variety IET 1444 (27.17cm). while the varieties Giza 171, Giza 175 and Milyang 54 had the shortest roots. The values ranged from 22.17 to 24.0cm.

The plants which have deeper root generally survive in drought better than shallower root, because it can effectively use more water stored at the deeper soil layers according to many results in this field.

For number of roots/plant, the genotypes IET 1444, Dular, BG-35-1,Sakha 104 and TKY 1014 gave the highest number of roots/plant and the mean values ranged from 510.0-586.33 roots, indicating that these varieties have good root system under drought conditions at two years and their combined data. Regarding root volume, as shown in Table (2), the maximum values of root volume were detected from the genotypes BG 33-2, BG 35-1, Giza 178, Sakha 104 and Milyang 54 values ranged from 80.0 to 94.0 mm. All these varieties mentioned before had higher root volume than IET 1444.

For root :shoot ratio, the varieties; Dular, BG 33-2, BG 35-1, Giza 175 and Giza 181 were found to have root : shoot ratio higher than the check variety IET 1444, and the values ranged from 45.0 to 76.0. Data for grain yield/plant revealed that all the varieties studied exhibit significant differences in this trait.

The varieties Puse Basmati, BG 33-2, BG 33-1, Giza 178 and Sakha 104 yielded the highest grain yield/plant. On the other hand, Giza 176 and Giza 181 gave the lowest grain yield/plant as compared with the control. In our field screening, some cultivars were found to be resistant to drought at the vegetative phase and reproductive phase. While, the other cultivars were found to be resistant to drought at vegetative phase but very few could produce more grain when stress came during the reproductive stage.

From the foregoing discussion, it could be concluded that the most desirable genotypes over the two years and their combined data under drought conditions were IET 1444, Puse Basmati, BG 33-2, BG-35-1, Giza 178 and Sakha 104 for most of the traits associated with drought conditions.

Genetic Parameters :-

The heritable and non-heritable (non-genetic) components of variation were ascertained with the help of some genetic parameters, like genetic coefficient of variations, and heritability estimates.

Table (3) showed high genetic coefficient of variation for days to heading, plant height, no. of panicles/plant, no. of grains/panicle, root length, root volume and root numbers/plant (the values 58.25, 102.67, 83.91, 134.18, 111.87, 160.90 and 241.64). However, moderate values were obtained for panicle weight and root: shoot ratio. These results agreed with those obtained by Loresto and Chang, 1981 and Abd Allah, 2000.

Using the genetic coefficient of variation alone however, is impossible to estimate the magnitude of heritable variation. The heritable portion of the variation could be found out with the help of heritability and genetic gain under selection (Swarup and Chaugle, 1962).

High heritability values (Table 3) had been obtained for all studied characters except for grain yield/plant.

In the present study, it is very interesting to note that characters having high heritability estimates gave almost high values of genetic coefficient of variation except for panicle weight and root: shoot ratio. These results were are similar to those obtained by El-Hissewy et al, 1986.

Dixit et al., 1970 reported that high genetic coefficient of variation and high heritability were not always associated with high genetic advance for a characters.

Table (3): Phenotypic variance, genotypic variance, genetic coefficient of variation, phenotypic coefficient of variation and heritability for the characters studied in some rice genotypes.

Characters	PV	GV	GCV	PCV	Hb
Days to heading	45.78	38.67	0.056	0.060	86.0
Plant height (cm)	92.83	84.69	0.109	0.113	92.0
No. of panicles/plant	15.30	11.18	0.222	0.250	74.0
No. of grains/panicles	168.07	159.94	0.126	0.129	95.0
Panicle weight (gm)	0.135	0.120	0.139	0.153	88.0
Chlorophyll content (ppm)	23.00	18.18	0.110	0.124	79.0
Root length (cm)	48.00	36.40	0.210	0.242	75.0
Root volume (mL)	194.00	182.37	0.195	0.201	93.0
Root numbers/plant	289.64	278.82	0.035	0.246	96.0
Root: shoot ratio	0.015	0.011	0.243	0.284	74.08
Grain yield/plant	60.00	35.00	0.354	0.463	58.00

Phenotypic correlation among yield and studied traits:

Simple correlation among the studied traits are shown in Table (4). Chlorophyll content is was positively correlated with no. of grains/panicle, while, there is was no correlation with the other traits. Days to heading was positively associated with no. of panicles/plant, panicle weight, no. of grains/panicle, root length, root numbers/plant and root: shoot ratio. Plant hieght was positively correlated with root length and root volume. The obtained results are in harmony with those reported by (Morita,1993).

Table (4) : Correlation coefficients among studied traits of 18 rice cultivars under drought conditions.

Characters	Heading (days)	Plant height (cm)	No. of panicles/ plant	Panicle weight (g)	No. of grains/ panicle	Root length (cm)	Root volume (mm)	Root numbers/ plant	Root: shoot ratio	Grain yield (g)
Chlorophyll cont.	0.240	0.313	0.118	0.250	0.445*	0.350	0.260	0.081	0.040	0.063
Days to heading (days)	-	0.210	0.410*	0.430*	0.510**	0.547**	0.280	0.680**	0.490*	0.330
Plant height (cm)		-	-0.245	0.370	-0.110	0.510**	0.440**	-0.250	0.015	0.224
No. of panicles/plant			-	0.320	0.548**	-0.150	-0.117	0.820**	-0.220	0.610**
Panicle weight (g)				-	0.580**	0.550**	0.310	0.027	0.175	0.630**
No. of grains/panicle					-	-0.280	0.240	0.140	-0.215	0.850**
Root length (cm)						-	0.425*	0.330	0.780**	0.670**
Root volume (mm)							-	0.460*	0.560**	0.470*
Root numbers/plant								-	0.870**	0.110
Root: shoot ratio									-	0.550**

**,* Highly significant and significant at 0.01 and 0.05 levels, respectively.

Number of panicles/plant were found to be associated with number of grains/panicle, root numbers/plant and grain yield/plant.

Highly significant and positive correlation was found between panicle weight and each of number of grains/panicle, root length and grain yield/plant. The obtained results were in agrement with IRRI, 1988.

Number of grains/panicle was found to show highly significant and positive correlation with grain yield/plant only. Root length was positively associated with root volume, root: shoot ratio and grain yield/plant. These results were in agrement with those reported by (Souframaien et al., 1998).

Positive correlation was found between root volume and each of root numbers/plant, root: shoot ratio and grain yield/plant.

Root numbers/plant was positively and highly significantly associated with root: shoot ratio.

Finally, root: shoot ratio was highly significant and positive correlated with grain yield/plant.

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الملخص العربي

تقييم بعض التراكيب الو راثية من الأرز تحت ظروف التعطيش

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مركز البحوث والتدريب في الأرز – معهد بحوث المحاصيل الحقلية

أجــري هذا البحث بمزرعة مركز البحوث والتدريب في الأرز بسخا كفر الشيخ تحت ظــروف الــتعطيش خلال المواسم الزراعية ٢٠٠٣، ٢٠٠٤ واشتملت علي ثمانية عشر تركيب وراثــي من الأرز بعضها مستورد والبعض الآخر أصناف تجارية واعتبر الصنف آي إي تي صنف مقارنة لبقية الأصناف وتم زراعة كل صنف أو سلالة في ستة سطور لكل قطعة تجريبية في تصميم قطاعــات كاملة العشوائية في ثلاثة مكررات وبعد الشتل بخمسة عشرة يوماً كان الري كل أثني عشر يوماً سطحياً وبدون بقاء ماء زيادة علي سطح الأرض بالإضافة إلي كل التوصيات الأخرى.

وأوضحت النتائج أن الأصناف آي إي تي ١٤٤٤، بوذا باسماتي ٣٧٠، بي جي ٣٣-٢ ، بي جي ٣٥-١، جيزة ١٧٨، سخا ١٠٤ وملينانج ٥٤ قد أعطت أعلي محصول للحبوب للنبات في كلا الموسمين وكذا التحليل المشترك لهما وهذا التفوق في المحصول كان راجعاً إلي قوة المجموع الجذري لهذه الأصناف حيث أن تلك الأصناف احتوت علي مجموع جذري عميق قوي وارتفاع نســبة المجموع الجذري إلي المجموع الخضري ومحتوي الكلورفيل في الأوراق وذلك حيث أن مثل هــذه الأصــناف التي لديها هذا النظام الجذري السميك تعطي نسبة مرتفعة من السنابل الخصبة وكذلك الحبوب الممتلئة مما يؤدي إلي ارتفاع محصول الحبوب/نبات.

وأظهــرت النــتائج أن صــفات عــدد الأيــام حــتي التزهير ، طول النبات، عدد الحــبوب/ســنبلة، وزن الســنبلة، حجم الجذر وعدد الجذور للنبات أعطت قيم مرتفعة لدرجة التوريث وأن الأصناف التي تحتوي علي مجموع جذري قوي تحتوي أيضاً علي درجة مقاومة عالية للــتعطيش وكذلك عدد كبير من السنابل للنبات وبالتالي يمكن استخدام هذه الأصناف كآباء في بــرامج الــتهجين لتحسين هذه الصفات المرتبطة بصفة المقاومة للتعطيش في الأرز وبذلك يمكن التغــلب عــلي مشكلة نقص الأباء المعطية في المرحلة الثمرية تحت ظروف التعطيش وأوضحت النــتائج أن هــناك ارتباط معنوي وموجب بين صفة محصول الحبوب وصفات الجذور وكذلك صفات مكونات المحصول تحت ظروف التعطيش.