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SENSITIVITY OF PANICLE CHARACTERS OF RICE (*ORYZA SATIVA L.*) TO DROUGHT STRESS AND THEIR ASSOSIATION WITH GRAIN YIELD

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ABSTRACT

In experiment farm of the Rice Research and Training Center, (RRTC),Sakha, Kafr elsheikh, Egypt, during the period 2013 and 2014 rice growing seasons ,the present investigation was aimed to evaluate some panicle characters of some local and exotic rice cultivars under normal and drought conditions. These cultivars were ,i.e., Giza177, Giza 178,Sakha102, Sakha 104, Sakha 105, Sakha 106, Nishihikari, IET 155, IET1335, Suwoan 104, Milyang 109, Suwoan 332, BG 35-1, WAB 56-104, IRAT 170 and GZ-9057-6-3-. A strip plot design with three replications was used. Phenotypic correlation was used to interpret the ranking of importance of panicle characters to grain yield.

The results should that there was significant differences among cultivars under study for the panicle characters under both normal and drought conditions. The drought stress condition decreased significantly number of panicles per plant, panicle length, panicle weight, number of primary branches/panicle and number of secondary branches/panicle. Sterility % was found to be high under drought condition and this conditions caused a significantly reduction in grain yield. WAP 56-104 cultivars proved to possess useful traits associated with water stress tolerance such as number of panicles/plant, panicle length, number secondary branches/panicle, number of filled grains/panicle and grain yield per plant comparing with the other cultivars in both seasons, while Sakha 105 cultivar gave the lowest number of panicles/plant in both seasons. Milyang109 gave the shortest panicle in both seasons. The lowest sterility percentage was found in case of Nishihikari in the two seasons .The interaction between cultivars and growing conditions under study had significant effect on most tested characters except 1000-grain weight in both seasons. On the other hand, different estimates of either positive or negative correlation coefficients between and among studied panicle characters and with grain yield were found under both normal and drought growing conditions, in the two seasons of study.

In addition, the mean values of all the studied characters were significantly affected by rice cultivars and growing conditions, the value of these characters increased under normal conditions and decreased under drought conditions except Sterility %. But some cultivars had useful characters associated with drought tolerance like WAP 56-104 under this study.

INTRODUCTION

The contemporary climate and increasing demand for limited fresh water threatens agriculture in the future. Rice (*Oryza sativa* L.), in particular, is very sensitive to even milder water stress both at vegetative and reproductive stages (Centritto *et al*., 2009). Rice is one of the crops that are exposed to many environmental stresses. Lack of adequate water leading to drought stress is common in upland cultivation systems. On an average, rice needs 5,000 L of water to produce one kilogram of grains (Jones *et al*., 1981). More than half of the 40 million hectares of rain-fed lowland rice worldwide suffers water scarcity at some growth stage (Cabangon *et al*., 2002). Drought stress reduces the rice growth, and severely affects the seedling biomass, photosynthesis, stomatal conductance, plant water relations and starch metabolism (Sarkarung *et al*., 1997). As an important food crop that feeds more than one-half of the world's population, unstable rice production due to recurring drought can have potential global socioeconomic impact. In the face of these challenges, enhanced rice yield under normal as well as stress conditions is an ideal trait that will have a huge impact on rice productivity. (Venkategowda *et al*., 2014). When drought conditions occurred during vegetative, reproductive and grain formation stages, it had decreased in yield of up to 30% was due to reduced panicles number per unit area. Thesis was delayed, the number of spikelets per panicle was reduced to 60% and when drought occurred during grains filling, the percentage of filled grains decreased to 40% and individual grain mass decreased by 20% (Boonjung and Fukai, 1996). Researches have already indicated the close relationship between many panicle traits and grain yield. For example, a key point of the idea of new-plant-type rice (IRRI 1994) is to develop new varieties with large panicle but fewer tillers. Different breeding strategies, such as large panicle size versus more panicles per plant (or per area), have also been widely practiced. It was prevalently accepted that achievement of compatible increases of panicle properties is an effective way to develop super high-yielding rice.

It is therefore necessary to determine the response of different panicle characters in rice to drought stress. Based on such results, appropriate strategies can be developed for breeding of rice for use in drought-prone areas. Thus, the objective of this study was to investigate the effect of drought conditions on some characters of rice panicle since it is the sink organs of rice plants

MATERIALS AND METHODS

The present investigation was conducted at the Rice Research and Training Center, (RRTC),Sakha, Kafr elsheikh, Egypt, during 2013 and 2014 seasons to study the effect of drought and normal conditions on some panicle characters of some local and exotic rice cultivars. A total of 16 cultivars including 7 Egyptian ,i.e., Giza177, Giza 178,Sakha102, Sakha 104, Sakha 105, Sakha 106 and GZ-9057-6-3-2 and 9 exotic cultivars Nishihikari, IET 155, IET1335, Suwoan 104, Milyang 109, Suwoan 332, BG 35-1, WAB 56-104 and IRAT 170. Two studied growing conditions first, (irrigation treatments), the plants were grown under well- irrigated conditions (normal irrigation -control) and the second is drought stress (irrigation every12 days starting after transplanting. The tested materials were grown in A strip plot design experiment with three replication was used. The vertical plots were assigned for irrigation treatment, while the rice cultivars were transplanted in the horizontal ones, each plot was 7 rows-5 meter long with plant spacing of 20X20 cm between hills and beteen rows, the nurseries were raised tillage of 30 days, then they were transplanted with 3-4 seedling/hill .The recommended fertilizer (N-P-K) was applied. All other cultural practices were done as recommended. Harvesting was done after complete grains maturity and data were collected on ten guarded hills. Ten main panicles were randomly selected from each plot to determine number of panicle/plant, panicle length (cm),panicle weight (g), number of primary branches /panicle, number of secondary branches /panicle, number of filled grains /panicle, sterility%, 1000- grain weight(g) and grain yield/plant, After threshing, the grains were sun-drayed, sieved and weighted after determination of the moisture content. The grain yields were determined for corresponding weight of standard moisture of 14%.

All data collected were subjected to analysis of variance according to Gomez and Gomez (1984). Treatments means were compared by Duncan's multiple range test (Duncan, 1955). Phenotypic correlation analysis and all statistical analysis were performed using variance technique by means of "MSTAT" computer software package

RESULTS AND DISCUSSION

Data in Table 1 revealed that number of panicles/plant were maximized under the normal conditions which recorded (21.63 and 22.73) in both seasons, respectively, while the lowest number of panicle/plant was realized under drought conditions, which recorded (12.65 in 2013 and 12.63 in 2014seasons). These would declare that drought cause seriously slow down of plant growth, it reduces number of panicle per tiller . Sikuku *et al*. (2010) .These results were in harmony with Centritto *et al*., (2009) and Nokkoul and Wichitparp (2014). On the other hand, data revealed that the WAP 56-104 cultivar was superior in number of panicles/plant comparing with the others in both seasons. There were no significant difference between WAP 56-104 and Giza 178 in the second season, while Sakha 105 cultivar gave the lowest number of panicle/plant in both season. These differences between genotypes might be due to their genetic background Yu *et al*. (2003).

Panicle length was found to be longest under the normal conditions (22.95 cm in the first seasons and 23.24 cm in the second season) and shortest under drought conditions which only registered 21.08cm, and 20.88 cm in both seasons, respectively, which indicates that panicle development was affected by water deficit. These results are similar to Sarkarung *et al*.(1997) and Guolan *et al*.(2010).Furthermore, data manifested that, significant differences were found among rice cultivars in regarding panicle length in both seasons. WAB56-104 cultivar was having the longest panicle as comparing with the other cultivars under study followed by IRAT 170. While Milyang 109gave the shortest panicle in both seasons.

Additionally, drought stress produced lightest panicle (2.98g and 2.91g) in 2013 and 2014, respectively as compared to normal conditions. Data indicated also that rice cultivar Sakha 104 gave the heaviest panicle, followed by BG35-1, while Nishihikari cultivar gave the lightest panicle weight in both seasons of study.

Table 1: Average of panicle characters as affected by growing conditions and rice genotypes as well as their interaction during 2013 and 2014 seasons.

Main effect And interaction	No.of panicles /plant		Panicle length (cm)		Panicle weight (g)	
	2013	2014	2013	2014	2013	2014
growing conditions(c)						
Drought(D)	12.65b	12.63b	21.08b	20.88b	2.98b	2.91b
Normal(N)	21,63a	22.73 a	22.95a	23.24a	4.08a	3.97a
F-test	**	**	*	*	**	**
Genotypes(G)						
Giza177	16.67 bc	14.83 ef	19.68hi	20.07efg	3.13e	3.17ef
Giza178	16.50 bc	23.67 a	23.12bcde	22.27bce	3.47d	3.28def
Sakha102	16.33 bc	18.33 c	20.70fghi	20.90cdefg	3.15de	3.38cdef
Sakha 104	17.17 bc	20.67 b	19.58hi	21.47bcdef	4.28a	4.07a
Sakha 105	12.,50 d	11.50 g	21.98defg	23.60 b	3.2de	3.52bcd
Sakha 106	19.16 b	18.33 c	21.17efgh	20.32defg	3.93bc	3.02f
Nishihikari	18.33 bc	17.33 c	19.22hi	19.6 efg	2.55f	2.47g
IET 155	15.67 cd	16.67cd	22.67cdef	22.76bvd	3.45de	3.0f
IET1335	16.0 bc	18.0 c	23.92bcd	23.75b	3.38de	3.23def
Suwean 104	17.67 bc	17.33 cd	19.92ghi	19.98efg	3.28de	3.65abcd
Milyang 109	16.5 bc	16.50 def	18.75i	18.0 g	3.37de	3.0f
Suwean 332	15.50 cd	13.83 f	21.18efgh	19.01fg	4.02abc	3.28def
BG35-1	18.17 bc	15.0 ef	24.68bc	23.35bc	4.13ab	3.93ab
WAB56-104	22.17 a	25.17 a	28.33a	27.85a	3.78c	3.78abc
IRAT 170	15.33 cd	14.33 f	25.08b	27.13a	3.32de	3.77abc
GZ-9057-6-3-2	17.59b	17.33 cd	20.45ghi	20.78cdefg	3.32de	3.55bcde
F-test	**	**	**	**	**	**
Interaction CXG	**	**	*	**	* *	**

***, ** and NS indicate P < 0.05, P< 0.01 and not significant, respectively. Means followed by a common letter are not significantly different at the 5% level by DMR test.**

The interaction effect between rice cultivars and growing conditions on number of panicles/plant, data presented in Table 2 revealed that Number of panicle /plant was ranged from (14.0 to 36.33) panicle under normal conditions, while it was ranged from(8.0 to 19.33) panicle under drought conditions in both seasons . Table showed that WAB56-104 produced the highest number of panicles/ plant when it was planted under normal and drought conditions in both seasons. While the lowest value was detected for Suwean332 under drought in 2013 and 2014 seasons.

Table 2: The interaction between growing conditions and rice genotypes on number of panicles/plant during 2013 and 2014 seasons.

Genotypes	Season 2013		Season 2014	
	Growing conditions			
	Drought	Normal	Drought	Normal
Giza177	14.33 hijk	19.0 defg	14.0 jk	15.67 ij
Giza178	15.0 fghij	18.0 efghi	19.3 fgh	28.0 b
Sakha102	14.67 ghijk	18.0 efghi	14.3 jk	22.33 de
Sakha 104	14.33 hijk	20.0 bcde	13.3 jkl	28.0 b
Sakha 105	11.0 jklm	14.0 hijkl	8.67 mn	14.33 jk
Sakha 106	13.33 ijklm	25.0 a	15.33 ijk	21.33 ef
Nishihikari	14.33 hijk	22.33 abcde	18.33 gh	19.33 fgh
IET 155	9.33 lm	22.0 abcde	12.67 kl	20.67 efg
IET1335	12.67 jklm	19.33 cdef	11.0 lm	25.0 c
Suwean 104	10.0 kl	25.33 a	10.0 mn	26.67 bc
Milyang 109	9.33l m	23.67 abcd	8.67m	21.0 efg
Suwean 332	9.0 m	22.0 abcde	8.0 n	19.0 fgh
BG35-1	12.0 jklm	24.33 ab	13.0 jkl	17.0 hi
WAB56-104	18.33efgh	26.0 a	14.0 jk	36.33 a
IRAT 170	11.0 jklm	19.67 bcde	8.67 m	20.0 efg
GZ-9057-6-3-2	11.0 jklm	24.0 abc	10.0 mn	24.67 cd

Means followed by a common letter are not significantly, different at the 5% level by DMR test

Table 3: The interaction between growing conditions and rice genotypes on panicle length (cm) during 2013and 2014 seasons.

Genotypes	Season 2013		Season 2014	
	Sowing conditions			
	Drought	Normal	Drought	Normal
Giza177	19.37 jkl	20.0 ghijkl	18.47 klmn	21.67fghijk
Giza178	22.57 cdefghi	23.67 cdef	19.20 jklmn	25.33 bcde
Sakha102	20.57 fghijkl	20.83 fghijkl	19.17 klmn	22.63defghi
Sakha 104	17.67 lm	21.50 efghijkl	19.13 klmn	23.80 defg
Sakha 105	20.97 fghijk	23.0 cdefgh	21.33 fghijkl	25.87 bcd
Sakha 106	19.67 ijkl	22,67 cdefgh	18.17lmn	22.47 efghij
Nishihikari	18.77 klm	19,67 ijkl	19,57 ijklmn	19.63 ijklmn
IET 1	22.33 defghij	23.0 cdefgh	22.47 efghij	23.07 defgh
IET1335	22.67 cdefghi	25.17 bcd	23.30 defgh	24.20 def
Suwean 104	19.0 klm	20.83f ghijkl	19.23 jklmn	20.73 ghijkl
Milyang 109	16.33 m	21.17 efghijk	16.90 n	20.30 hijklm
Suwean 332	19.60 ijkl	22,67 cdefghi	17.13 mn	20.90 ghijkl
BG35-1	24.37 bcde	25.0 bcd	22.47 efghij	24.23 def
WAB56-104	25,67 bc	31.0 a	27.57 abc	29.70 a
IRAT 170	23.17 cdefg	27.0 b	24.57 cdef	28.13 ab
GZ-9057-6-3-2	19.9 hijkl	21.0 fghijk	18.57 klmn	23.0 defgh

Means followed by a common letter are not significantly different at the 5% level by DMR test

Further, data presented in Table 3 showed that panicle length was ranged from (19.63 to 31.0 cm) under normal conditions, while it was ranged from(16.33 to 25.67) cm under drought conditions in both seasons. Table 3 indicated that WAB 56-104 gave the longest panicle under normal conditions. While Milyang 109 cultivar recorded the shortest one under drought conditions in both seasons

The interaction between cultivars and growing conditions had a significant effect on panicle weight in both seasons. Data in Table 4 showed that rice cultivar WAB56-104 gave the heaviest panicle under normal conditions in both seasons. While, Nishihikari cultivar recorded the lightest weight under drought and normal conditions in the two seasons of study. While data presented in Table 4 showed that panicle weight was ranged from(2.5to 5.4 g) under normal conditions, while it was ranged from(2.13 to 3.57 g)under drought conditions in both seasons.

Table 4: The interaction between growing conditions and rice genotypes on panicle weight (g) during 2013and 2014 seasons.

Genotypes	Season 2013		Season 2014	
	Growing conditions			
	Drought	Normal	Drought	Normal
Giza177	2.93 defgh	3.33 cdef	2.6 mnop	4.83 ab
Giza178	2.27 gh	3.67 cde	2.7 lmno	3.90 cdef
Sakha102	3.13 defg	3.17 defg	3.03 jklmno	3.73 defgh
Sakha 104	2.83 defgh	5.30 a	3.63efghij	4.33 bcd
Sakha 105	2.76 efgh	3.7 cde	3.03jklmno	4.0 cde
Sakha 106	2.8 defgh	5.07 ab	2.4 op	3.7 efghi
Nishihikari	2.13 h	2.90 defgh	2.23 q	2.5 nop
IET 155	3.46 cde	3.49 cde	2.7 lmnop	3.3 fghijkl
IET1335	3.0 defgh	3.76 cde	3.03 jklmno	3.4 efghijk
Suwean 104	3.07 defgh	3,7 cde	3.47 efghijk	3.83 defg
Milyang 109	2.47 fgh	4.1 ab	2.27 q	3.73 defgh
Suwean 332	3.0 defgh	3.73 cd	2.9 klmnop	3.67 efghi
BG35-1	3.13 defg	4.90 ab	2.53 nop	4.70 b
WAB56-104	2.97 defgh	5.40 a	3.23 ghijklm	5.33 a
IRAT 170	3.43 cde	4.13 bc	2.93 klmno	4.60 b
GZ-9057-6-3-2	3.57 cde	3.67 cde	3,17 hijklm	3.93 cdef

Means followed by a common letter are not significantly, different at the 5% level by DMR test

The data presented in Table 5 indicated that growing conditions had a significant effect on number of primary branches/panicle. It was the highest (11.84 and 11.51 in both seasons, respectively) under the normal conditions, while it was the lowest (9.41 and 9.49 in the two seasons, respectively) under drought conditions. It is evident from Table 5 that there were significant differences for number of primary branches/panicle between rice cultivars in both seasons. Sakha 102 cultivar gave the highest number in both seasons. On the contrary, Suwean 332 gave the lowest number.

Table 5 indicated that drought stress conditions decreased significantly number of secondary branches/panicle from (25.71 to 21.5 in the first season) and (from 22.73 to 20.57 in the second seasons). Further, data given in Table 5 revealed that highly significant differences in such character were found among rice cultivars under study in both seasons.WAB56-104 produced higher number of secondary branches/panicle than other cultivars in both seasons, while the lowest number was found in Sakha 102 in the two seasons of study.

Table 5: Average of panicle characters as affected by growing conditions and rice genotypes as well as their interaction during 2013 and 2014 seasons.

Main effect And interaction	No.of primary branches/panicle		No.of secondary branches /panicle		No.of filled grains /panicle	
	2013	2014	2013	2014	2013	2014
Growing conditions(c)						
Drought(D)	9.41b	9.49b	21.45b	20.57b	117.31b	117.71b
Normal(N)	11.84a	11.51a	25.71a	22.73a	149.26a	134.53a
F-test	**	**	**	*	**	*
Genotypes(G)						
Giza177	11.17abcd	11.83abc	21.17def	21.17efgh	103.17i	122.33bc
Giza178	11,0abcde	10.67def	26.50b	25.0abcd	158.83b	148.0 a
Sakha102	11,83a	12.17a	15.17g	17.0j	111.50h	113/0 cd
Sakha 104	11.50abc	11,67abcd	24.50bcd	18.50hij	136.67e	126/67 b
Sakha 105	11.0abcde	11,0bcde	18.33fg	19.83ghij	104.83i	110.16 cd
Sakha 106	11.67ab	10.83cdef	25.67bc	19.33hij	129.33f	94.0 de
Nishihikari	10.33bcdef	9.83fgh	21.33def	17.17ij	101.17i	93.0 de
IET1	10.83abcde	10.33efgh	25.0bcd	26.83abc	143.83d	123/67 bc
IET1335	10.67abcde	10.0efgh	22.17cdef	23.0defg	147.0d	122.67 bc
Suwean 104	9.67efg	10.0efgh	23.33bcde	24.67bcde	109.67h	127.83 bc
Milyang 109	10.17cdefg	9.17h	19.50ef	18.17hij	125.17g	111.5 cd
Suwean 332	8.83g	8.0i	21.17def	20.83fghi	134.83e	133.83 ab
BG35-1	9.83defg	9.33gh	27.0b	25.17abcd	154.33c	127.83 bc
WAB56-104	10.67abcde	10.33efg	31.83a	28.67a	170.17a	150.67 a
IRAT 170	10.67abcde	12.0ab	23.67bcd	28.50a	147.83d	150.0 a
GZ-9057-6-3-2	9.0fg	9.83fgh	23.17bcde	24.33cdef	122.0g	128.18 bc
F-test	**	**	**	**	**	**
Interaction CXG	*	**	**	*	**	**

***, ** and NS indicate P < 0.05, P< 0.01 and not significant, respectively. Means followed by a common letter are not significantly different at the 5% level by DMR test.**

Drought stress has an important effect on number of field grains/panicle. It was reduced by the effect of drought conditions during reproductive to grain formation stages. The number of filled grains decreased (from 149.26 and 134.53 grains in both seasons respectively under normal conditions to 117.31 and117.71 grains in 2013 and 2014 .respectively under drought conditions). These results are in agreement with those found by Boonjung and Fukai (1996), Nokkoul and Wichitparp (2013) and Nokkoul and Wichitparp (2014) and this might be attributed to when drought occurred during panicle development. rices was delayed, the number of spikelets per panicle was reduced

In the present study, the tested genotypes were significantly differed for number of filled grains/panicle. This could be attributed to their different genetic back-ground.From this point of view, it is worthy to note that WAB56-104 cultivar showed superiority in number of filled grains/panicle(170.1 and 150.6 grains in both seasons ,respectively), while Nishihikari recorded the lowest one(101.1 and 93,0 grains) in the first and second seasons and Table 5.

Results in Table 6 indicated that growing Suwean in the first season under drought conditions gave the lowest of number of primary branches/panicle. While, growing Sahka 102 under conditions normal gave the highest values in both seasons.

Table 6: The interaction between growing conditions and rice genotypes on number of primary branches/panicle during 2013and 2014 seasons.

Genotypes	Season 2013		Season 2014	
	Growing conditions			
	Drought	Normal	Drought	Normal
Giza177	9.0hi	13.33 ab	9.67 efg	12.67 ab
Giza178	10.67 defgh	11.33 bcdefg	9.0 fgh	12.33 abc
Sakha102	10.67 defgh	13.67 a	11.67 bcd	14.0 a
Sakha 104	10.0 fghij	13.0 abc	11.33 bcde	12.0 bc
Sakha 105	10.0 fghij	12.0 abcdef	11.0 bcdef	11.0 bcdef
Sakha 106	10.0 fghij	12.67 abcd	9.0 fgh	12.67 ab
Nishihikari	9.33 ghij	11.33 bcdefg	9.67 efffg	10.0 defg
IET 155	10.33 efghi	11.33 bcdefg	9.67 efg	11.0 bcdef
IET1335	10.33 efghi	11.0 cdefgh	9.33 efgh	10.67 bcdef
Suwean 104	8.67 ijk	10.67 defgh	9.0 fgh	11.0 bcdef
Milyang 109	8.0 jk	12.33 abcde	7.67 h	10.67 bcdef
Suwean 332	7.0 k	11.0 cdefg	5,67 i	10.33 cdefg
BG35-1	8.33 ijk	11.33 bcdefg	7,688 h	11.0 bcdef
WAB56-104	9.0 hij	12.33 abcde	9.33 efgh	11.33 bcde
IRAT 170	10.33 efghi	12.0 abcdef	11.67 bcd	12.33 abc
GZ-9057-6-3-2	8.33 ijk	9.33 ghij	8.67gh	11.0 bcdef

Means followed by a common letter are not significantly, different at the 5% level by DMR test

Data present in Table 7 showed that the maximum number of secondary branches/ panicle was obtained when WAB56-104 was grown under normal conditions. While, the minimum value of such character was obtained by Sakha102 under drought conditions in both seasons

Table 7: The interaction between growing conditions and rice genotypes on number of secondary branches /panicle during 2013and 2014 seasons

Genotypes	Season 2013		Season 2014	
	Growing conditions			
	Drought	Normal	Drought	Normal
Giza177	18.0 lmn	24.33 efghi	17.33 ghijklm	25.0 defgh
Giza178	23.67 fghijk	29.33 cde	21.0 fghij	29.0 bc
Sakha102	11.67 o	18.67 ghijklmn	12.0 m	22.0f ghij
Sakha 104	14.0 no	35.0 b	14.0 klm	23.0 efghij
Sakha 105	18.33 klmn	18.33 klmn	18.0 ijkl	21.67 fghij
Sakha 106	24.0 efghij	27.33 cdefg	21.33 fghij	17.33 jklm
Nishihikari	18.0 lmn	24.67efghi	12.33 lm	22.0 fghj
IET 155	32.33 bc	18.67 ghijklmn	19.67 ghijk	34.0 ab
IET1335	16.0 mno	28.33 cdef	22.33 efghij	23.67 defghi
Suwean 104	21.67l mn	25.0 efghi	23.33 defghij	26.0 def
Milyang 109	15.33 no	23,67 fghijk	17.67 ijkl	18.67 ijk
Suwean 332	21.33 ijklm	21.7 ijklm	19.3 hijk	22.33 efghij
BG35-1	22.0 ghijkl	32.0 cd	18.0 ijkl	32.43 abc
WAB56-104	23.0 fghijkl	40.67 a	25.33 defg	31.67 abc
IRAT 170	22.67 ghijkl	24.67 efghi	25.0 defgh	32.33 abc
GZ-9057-6-3-2	21.33 ijklm	25.0 efghi	20.67 fghij	28.0cde

Means followed by a common letter are not significantly, different at the 5% level by DMR test

Table 8: The interaction between studied growing conditions and some rice genotypes on no. of filled grains /panicle during 2013and 2014 seasons

Genotypes	Season 2013		Season 2014	
	Growing conditions			
	Drought	Normal	Drought	Normal
GZ177	82.33 r	124.0 j	99.33 o	143.33 e
Giza178	151,67 f	166.0 d	136.0 g	160.0 b
Sakha102	110.0 m	113.0 lm	116.33 kl	109.67 m
Sakha 104	106.33 n	167.9 d	121.33 j	132.0 h
Sakha 105	96.0 p	113.67 lm	105.33 n	115.0 kl
Sakha 106	102.0 o	156.67 e	83,0 r	105.0 n
Nishihikari	80.0 r	116.33 kl	94.67 p	111.33 m
IET 155	154.67 ef	133.0 h	140.67f	106.67 n
IET1335	127.33 ij	166.67 d	131.0 h	114.33 l
Suwean 104	119.33 k	90.0 q	131.33 h	124.33 i
Milyang 109	94.67 p	155.67 ef	106.0 n	117.0 k
Suwean 332	123.67 j	146.0 g	110.33 m	157.33 c
BG35-1	126.33 ij	182.3 b	89,33 q	166.33 a
WAB56-104	129.3 i	211.0 a	150.33 d	151.0 d
IRAT 170	124.67 j	`71.0 c	132,67 h	167.33 a
GZ-9057-6-3-2	117.33 k	126.67 j	115.33 kl	141.0 ef

Means followed by a common letter are not significantly, different at the 5% level by DMR test

Results in Table 8 indicted that WAB56-104 cultivar gave the highest number of filled grains/panicle in the first season, while IRAT 170 and BG35-1 in second season under normal conditions. While, Nishihikari and Sakha 106 gave the lowest number of filled grains/panicle under drought conditions in 2013 and 2014 seasons, respectively.

It is clear from Table 9 that sterility % was influenced significantly by growing conditions .Sterility % was found to be high under drought conditions and low under normal conditions. This could be attributed to when drought condition occurred during reproductive to grain formation stages, rice variaties had grains within the panicles were not ripening at the same time, this would cause on the lower grain yield, number of low grains per panicle, number of high empty grains and number of perfect grain per panicle lower than 80 grains Similar results were reported by Pirdashti (2009) and Nokkoul and Wijitparp (2013).

Table 9: Average of panicle characters as affected by growing conditions and rice genotypes as well as their interaction during 2013 and 2014 seasons.

Main effect And interaction	Sterility %		1000- grain weight		Grain yield / plant	
	2013	2014	2013	2014	2013	2014
Growing conditions(c)						
Drought(D)	15.44a	13.97 a	22.53b	23.5b	27.38 b	26.86b
Normal(N)	6,44b	7.02 b	24.23a	25.2a	41.72 a	41.04a
F-test	**	**	*	*	**	**
Genotypes						
Giza177	19.49 a	10,99 bcd	26.0a	27.0a	33.95 e	33.45 e
Giza178	8.49 de	11.53 bc	18.56e	19.5f	38.65 b	38.03 ab
Sakha102	13.89 bc	10.42bcde	25.83a	26.8a	31.70 g	29.53 h
Sakha 104	11.69 bc	12.11 b	26.67a	27.3a	35.55 d	35.05 d
Sakha 105	11.47 bc	8,49 def	27.17a	28.2a	30.85 h	30.05 ghi
Sakha 106	13.88 bc	16.53 a	27.0a	28.0a	29.8 i	29.30 ij
Nishihikari	5.40 f	2.85 g	23.83b	24.8b	38.0 b	37.30 bc
IET1	6.23 ef	12.95 b	22.0cd	23.0cde	36.40 c	35.90 cd
IET1335	8.44 de	9.50 bcde	21.16d	22.1e	27.75 j	27.23 k
Suwean 104	12.57 bc	8.71 cdef	23.3bc	24.3bc	38.50 b	38.0 jk
Milyang 109	10.89 cd	8.46 def	23,6b	24.7b	34.55 e	34.10 e
Suwean 332	6.93 ef	7.92 ef	21.16d	22.2e	32.0 g	31.50 fg
BG35-1	13.04 bc	12.04 b	23.17bc	24.2bcd	36.15 cd	35.6 5d
WAB56-104	14.40 b	14.89 a	21.6d	22.7de	39.50 a	39.02 a
IRAT 170	5.89 e f	6.02 f	20.83d	21.7de	33.07 f	32.57 ef
GZ-9057-6-3-2	12.75 bc	11.90 b	23.83b	24.8b	31.45gh	30.95 gh
F-test	**	**	**	*	**	**
Interaction CXG	*	**	Ns	Ns	**	**

***,** and NS indicate P < 0.05, P< 0.01 and not significant, respectively. Means followed by a common letter are not significantly different at the 5% level by DMR test.**

Further, results in Table 9 showed that Giza 177 in 2013 season and Sakha 106 in 2014 season gave the highest percentage of sterility, while the lowest percentage was found in case of Nishihikari in the first and second seasons.

The data in Table 9 indicated that 1000-grain weight showed significant increases when the rice was planted in normal conditions. (Boonjung and Fukai, 1996).

There were significant differences among the studied rice cultivars in 1000-grain weight Table 9. Sakha 105 cultivars gave the heaviest 1000-grain weight in the first and the second seasons. While, the lowest mean values of 1000- grain weight were recorded by Giza178, which recorded in both seasons.

The present data in Table 9 indicated that growing conditions had a significant effect on grain yield /plant; it was found to be highest under normal conditions, while a significant reduction was detected under drought conditions. This might be attributed to the influence of late-stage water deficit caused varied decrease in grain yield and other panicle traits. Similar results were obtainrd bywith Pantuwan(2000), Millor (2001) and Guolan *et al* (2010).

It is evident from Table (9) that there were significant differences for grain yield /plant among the rice cultivars in both seasons. WAB56-104gave the highest grain yield /plant in both seasons, while the lowest was recorded by Sakha 106 in the two seasons of study.

Results in Table 10 indicated that growing Giza 177 in the first season and growing Sakha 106 in the second season under drought conditions gave the highest percentage of sterility. While, growing IRAT 170 in 2013 season and growing Nishihikari in 2014 under normal conditions gave the lowest value of sterility

Table 10: The interaction between growing conditions and rice genotypes on sterility% during 2013and 2014 seasons

Genotypes	Season 2013		Season 2014	
	Growing conditions			
	Drought	Normal	Drought	Normal
Giza177	24.38 a	14.59 cdefg	17.02 bc	4.97 ijklm
Giz178	13.12 fghij	3.86 opqr	18.22 b	9.84 fgh
SK102	18.38 bcd	9.41 hijklm	11.75 defg	9.07 fghi
SK104	19.02 bc	4.35 nopqr	17.19 bc	7.03 hijkl
SK105	15.14 cdefg	7.81 klmnopqr	13.06 cdef	3.93 jklm
SK106	21.59 ab	6.17 klmnopqr	22.36 a	10.64efgh
Nishihikari	7.91klmnop	4.06 nopqr	3.49 klm	2. 27m
IET 155	9,71 hijkl	2.73 qr	10.80 bc	9.19 fi
IET1335	13.41 efghi	3.47 0qr	14.69 bcde	4.31 jklm
Suwean 104	18.06 bcde	7.09 klmnopq	9.68 fgh	7.73 ghijk
Milyang 109	14.0 defgh	7.78 klmnop	9.62 fgh	7.29 hijkl
Suwean 332	8.51 jklmno	5.36 lmnopqr	11.86 defg	3.98 jklm
BG35-1	17.23 bcdef	8.85 ijklmn	17.25 bc	6.83 hijkl
WAB 56-104	17.7 bcdef	11.10 ghjk	15.06 bcd	14.72 bcde
IRAT 170	8.95 ijklmn	1.84 r	9.11 fghi	2.93 lm
GZ-9057-6-3-2	20.98 ab	4.52 mnopqr	15.84 bcd	7.97ghij

Means followed by a common letter are not significantly, different at the 5% level by DMR test

Data presented in Table 11 showed that the highest grain yield/plant was obtained by growing WAB 56-104 in normal conditions in the firs and the second seasons, .While, the lowest grain yield/plant obtained by growing Sakha 106 under drought conditions in both seasons

Table 11: The interaction between studied growing conditions and some rice genotypes on grain yield/plant during 2013and 2014 seasons.

Genotypes	Season 2013		Season 2014	
	Growing conditions			
	Drought	Normal	Drought	Normal
GZ177	25.50 m	42.40 cd	25.0 k	41.90 cd
GZ178	30.80 k	46.50 a	30.07 j	46.0 a
SK102	26.0 m	37.4 gh	25.5 k	33.57 i
SK104	27.59 l	43.60 bc	27.0 k	43.10 bc
SK105	21.20 o	40.50 ef	20.70 lm	40.0 def
SK106	18.10 p	41.50 de	17.60 n	41.0 cde
Nishihikari	32.50 j	43.50 bc	32.0 ij	43.o3 bc
IET 155	34.50 i	38.30 g	34.0 hi	37.80 fg
IET1335	23.50 n	32.20 j	22.80 l	31.67 ij
Suw ean 104	32.80 j	44.20 b	32.30 ij	43.70 b
Milyang 109	26.7 lm	42.40 cd	26.20 k	42.0 bcd
Suw ean 332	20.50 o	43.50 bc	20.0 m	43.0 bc
BG35-1	32.20 j	40.10 f	31.63 ij	39.60 ef
WAB56-104	32.50 j	46.50 a	32.0 ij	46.03 a
IRAT 170	22.31 n	43.83 b	21.0 lm	43.33 bc
GZ-9057-6-3-2	26.60 lm	36.30 h	26.10 k	35.80 gh

Means followed by a common letter are not significantly, different at the 5% level by DMR test

Phenotypic correlation coefficients:

The study of relationships among morphological characters of panicle and grain yield are great importance. The estimates of correlation coefficient among all studied characters are presented in Table 12.

Concerning number of panicles /plant, data showed that no significant correlation, either positive or negative, with the other panicle characters and grain yield under normal and drought conditions in both seasons of study.

Regarding to correlation between panicle length and all other studied traits, panicle length was highly significantly and positively correlated with panicle weight in 2013 season under normal conditions, number of primary branches / panicle in negative direction in both seasons under drought conditions, number of secondary branches / panicle in negative direction under drought conditions in 2014 season, number of filled grains per panicle in positive direction percentage in 2013 season under normal conditions and 1000-weight in negative direction in 2014 season under drought conditions.

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As for panicle weight, it showed highly significant positive correlation coefficient with grain yield under normal conditions in 2014 season. These results were observed in previous study (Zou et al. 2005) . Furthermore, results showed that highly significant positive correlation coefficient between number of primary branches / panicle number of secondary branches /panicle and sterility in both seasons under drought and normal conditions, and the same correlation coefficient between number of primary branches / panicle and sterility %in 2014 season under drought and under normal conditions in both seasons,1000- grain weight in 2013 season under normal conditions.

As far as number of secondary branches per panicle was concerned, positive significant and highly significant correlation coefficient estimates were found between this trait and sterility% and 1000- grain weight under normal conditions in both seasons.

Also Data in Table 12 showed that number of filled grains was concerned, positive significant and significant correlation coefficient between sterility % in 2014 season under normal conditions.

Sterility percentage showed significant positive correlation coefficient with 1000-grain weight under normal conditions in both seasons.

CONCLUSION

Finally it can be concluded that significant differences were found among rice cultivars in studied panicle characters under normal drought conditions in both seasons. The value of these characters increased under normal conditions and decreased under drought conditions except Sterility %. But some cultivars had useful characters associated with drought tolerance like WAP 56-104 under this study. On the other hand, different estimates of either positive or negative correlation coefficients between and among studied panicle characters and with grain yield were found under both normal and drought growing conditions, in the two seasons of study.

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حساسية صفات سنبله الأرز لإجهاد الجفاف وارتباطها بمحصول الحبوب

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أجري هذا البحث بمزرعة مركز البحوث والتدريب في الأرز بسخا كفر الشيخ مصر–خلال موسمي الزراعة ٢٠١٣ و٢٠١٤ وذلك بهدف تقييم بعض صفات النوره الدالية تحت ظروف الجفاف وظروف الغمر العادية في ١٦ صنف من الأصناف المصرية والمستوردة وقد اشتملت التجربة علي ٣٢ معامله عبارة عن التواليف بين ٢ ظرف نمو(ظروف جفاف وظروف نمو عاديه) و١٦ صنف من الأرز وهم (جيز ١٧٧ ، جيز١٧٨ ، سخا١٠٤، سخا١٠٢ ، سخا١٠٥، سخا ١٠٦،نيشيهيكاري، أي ايه تي ايه ١٣٣٥، أي ايه تي ايه ١٥٥، سيون ١٠٤ ،ميلينج ١٠٩ ، سيون ٣٣٢، بجي ٣٥، واب٥٦-١٠٤، ايراط ١٧٠، جي زد-٩٠٥٧-٦-٣-٢).ونفذت التجارب في تصميم الشرائح المتعامدة في ثلاثة مكررات حيث وزعت الأصناف في القطع الأفقية بينما وزعت ظروف النمو في القطع الرأسية ،و تم تقييم الارتباط المظهري بين هذه الصفات ومحصول الحبوب.

أشارت النتائج إلي ما يلي:

كان تأثير متوسطات القيم لكل الصفات النوره الدالية المدروسة تأثير معنوي للأصناف تحت الدراسة، وأكدت النتائج علي وجود إستجابه مختلفة للأصناف تحت ظروف النمو لكل الصفات المدروسة،حيث يوجد نقص معنوي في عدد الداليات للنبات ، طول الدالية (سم)، وزن الدالية(جم)، عدد الفروع الأولية للدالية ، عدد الفروع الثانوية للدالية ،وزن الألف حبه(جم)في كلا الموسمين و حيث ازدادت قيم متوسطات هذه الصفات تحت ظروف العادية للنمو ، ازدادت نسبه العقم تحت ظروف الجفاف في كلا الموسمين،وأدي ذلك إلي نقص المحصول تحت ظروف الجفاف وأثبت الصنف واب٥٦- ١٠٤, قدرته غلي تحمل الجفاف فأعطي أعلي القيم في عدد الداليات للنبات ، طول الدالية عدد الفروع الثانوية للدالية وزن الألف حبه للنبات ووزن المحصول للنبات مقارنه بالأصناف تحت الدراسة ،بينما أعطي الصنف نيشيهيكاري أقل نسبه عقم في السنتين. وكان التفاعل بين الأصناف وظروف النمو تحت الدراسة معنوي في كلا الموسمين لكل الصفات فيما عدا وزن الألف حبه. وعلي الجانب الأخر ارتبط المحصول ارتباط معنوي موجب وسالب مع بعض صفات النوره الدالية المدروسة تحت ظروف الغمر العادية وظروف الجفاف في الموسمين .

وتوضح هذه الدراسة

تأثير جميع صفات الدالية المدروسة تأثير معنوي علي محصول الحبوب تحت ظروف النمو العادية و الجفاف ولكن يوجد بعض الأصناف لديها بعض الصفات المرتبطة بتحمل الجفاف مثل واب٥٦- ١٠٤تحت هذه الدراسة.

Table 12: Estimates of phenotypic correlation coefficients among all cultivars of studied characters:

N0		NPP		PL		PW		NPTP		NSTP		NFG		S%		1000-GW		GY	
YEAR		2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
NPP	D	1.0	1.0																
	N	1.0	1.0																
PL	D	-.045	-.185	1.0	1.0														
	N	.002	-.044	1.0	1.0														
PW	D	-.063	-.272	0,427	.200	1.0	1.0												
	N	-.184	-.193	.608**	.024	1.0	1.0												
NPTP	D	.288	.233	-.68**	-.64**	-.308	-.146	1.0	1.0										
	N	-.268	.381	-.305	-.492	.047	-.024	1.0	1.0										
NSTP	D	.349	.324	-.32	-.62**	-.413	-.108	.555*	.556*	1.0	1.0								
	N	-.229	-.066	.034	-.252	.252	.174	. 73**	.77**	1.0	1.0								
NFG	D	.058	.016	.155	.226	-.022	-.116	.208	.294	.105	.023	1.0	1.0						
	N	-.195	.082	.520*	.357	.442	,154	.211	.221	,187	.212	1.0	1.0						
S%	D	.060	.165	-.06	-.040	.190	.057	.377	.67**	.023	.097	-.050	.381	1.0	1.0				
	N	-.106	.024	.180	.116	.084	.299	,74**	.65**	.848**	.79**	.385	.568*	1.0	1.0				
1000 GW	D	.030	-.030	-.457	-.51*	-.265	-.054	.682**	.487	.446	.396	.109	.124	.345	.276	1.0	1.0		
	N	-.444	-.238	-.370	-.033	.012	0.36	.76**	.268	.618*	.53**	.082-	.282	.555**	.551*	1.0	1.0		
GY	D	.021	.311	.099	.072	.351	.214	-.097	-.077	.-.098	.180	.378	.174	-.32	.299	.207	-.114	1.0	1.0
	N	.069	-.110	-.119	-.283	.053	.69**	.242	.120	.458	.243	.181	-.008	.329	.252	.139	.445	1.0	1.0

NNP number of panicle/ plant - PL panicle length - PW panicle weight - NPTP number of primary tillers/panicle
NSTP number of secondary tillers/panicle - NFG number filled grain /panicle -S% sterility -1000GW 1000 grain weigh
t-GY grain yield