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Evaluation of promising lines in rice (*Oryza sativa* L.) to agronomic and genetic performance under Egyptian conditions

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Abstract

A field experiment was conducted during the period 2014 and 2015 at the farm of Rice Research and Training Center, Sakha, kafr el-sheikh, Egypt for evaluation the performance of promising lines in rice to agronomic and genetic performance under Egyptian conditions. Results revealed that the Giza 179 produced the highest grain yield (5.44 kg/m^2) followed by thepromising line GZ9461-4-2-3-1 (5.26 kg/m^2) and the commercial variety Giza 178 (5.07 kg/m^2). Analysis of variance revealed significant differences among genotypes for all traits. The high genotypic coefficient of variability (gcv) and phenotypic coefficient of variability (pcv) recorded for number of filled grains/panicle indicate the existence of wide spectrum of variability for this trait and offer greater opportunities for desired trait through phenotypic selection. The phenotypic variance was higher than the corresponding genotypic variance for traits. Estimation of heritability ranged from 49.16% to 99.52% for number of panicle/plant and duration traits, respectively. High heritability coupled with high genetic advance was observed for growing period and plant height and indicate the lesser influence of environment in expression of these traits and prevalence of additive gene action in their inheritance hence, amenable of simple selection. The promising rice lines GZ9461-4-2-3-1 and GZ10147-1-2-1-1 performed better as compared with the commercial variety. Selection of these traits would be more effective for yield improvement in rice and these promising lines would be more valuable materials for breeders engaged in the development of high yielding cultivars.

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Introduction

Rice (*Oryza sativa* L.) is the most important food crop and energy source for about half of the world's population and ranks second in production after wheat (Manjappa*et al.*, 2014). Rice occupies a unique position in many nations because for its importance in traditional diets and the main source of income of many peoples in the whole world. It is considered the most popular and important field crop in Egypt for several reason: as a staple food after wheat, as an exporting crop, as a land reclamation crop for improving the productivity of the saline soils widely spread in northern part of the delta and coastal area, and finally it is a social crop in which every person in the farmers family could find work in rice fields and earn money during the growing season. Rice crop plays a significant role in Egypt, as strategic crop for sustaining the food self-sufficiency and for increasing the export., The total rice production in Egypt reached 7.1 million tons with a national average of 9.9 tons/ha in 2012 growing season. This average ranked the first among the rice producing countries in the world (RRTC, 2013).

The need for expansion of rice cultivation depends not only on cultural practices but also on their inbuilt genetic variability. Hence, a successful breeding programme will depend on the genetic diversity of a crop for achieving the goals of improving the crop and producing high yielding varieties (Padulosi, 1993). To do this, the first step is to evaluate and characterize available rice germplasm or genotypes at both morphological and molecular levels as phenotypic and genotypic diversity, important traits of interest to plant breeders (Singh, 1989).

Breeding andadoption of rice cultivars with enhanced yield potential and short growth duration is a common objective of the breeders. But yield in rice is correlated with different yield contributing traits as well as environmental factors (Yousida, 1983). Variability is the difference in individual genotypes (and thus traits) within a population and the rate at which a certain genotype can change in response to environmental or genetic factors (Hub, 2011).

The availability of morpho-genetic variation in agronomic characters of a crop would be of considerable importance in determining the best method to improve the yield of that crop. It is necessary to have a good knowledge of those characters that have significant association with yield because the characters can be used to direct selection criteria or indices to enhance performances of varieties in a new plant population (Augustina *et al.*, 2013). With keeping the above points in view, the objective of this work is to evaluate twenty rice genotypes with the view of selecting those that have better yield attributes for incorporation into hybridization programme. As well as, an understanding of the genetic behavior associated with the expression of yield related traits which will facilitate the exploitation of the component approach in the improvement of rice.

Materials and methods

Plant material and procedures

The present investigation was carried out at the farm of Rice Research and Training Center (RRTC), Sakha, Kafr El Sheikh, Egypt for two successive seasons 2014 and 2015. Twenty rice varieties (commercial and promising rice lines) were used in this study. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Genotypes were grown in five meters apart maintaining 20 cm ×20 cm plant spacing of individual genotype and all the recommended cultural practices for rice was applied.

Sampling and measurement

Eight agronomic characteristics i.e. duration (day), plant height (cm), number of panicles/plant, panicle length (cm), number of filled grains/panicle, grain yield (kg/m^2), hulling % and milling % were studied. Analysis of variance was computed by IRRISTAT program. Correlation coefficients (r) among all studied traits were computed using SPSS statistical package version 17.0 (SPSS Inc., Chicago, IL, USA). Estimates of genotypic variance (σ^2 g), environmental variance (σ^2 e), genotypic x environmental variance (σ^2gy), phenotypic variance (σ^2ph), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) components and the expected genetic advance from selection (Δg %) according to the formula suggested by (Burton, 1952) weremeasured.

Genotypic variance (σ^2 g) = M1-M2/ry,

Environmental variance (σ^2e) = M3

Phenotypic variance (σ^2ph) = σ^2g + σ^2gy+ σ^2 e

Where,

M1= Mean square due to varieties within treatment,

M2 = Mean square due to varieties x year interaction,

M3 = Mean squares due to error, and r = number of replications

Phenotypic coefficient of variability (PCV) =√Ph/ X * 100

Genotypic coefficient of variability (GCV)=√g /X*100

Other genetic parameters i.e., heritability (H^2) and genetic advance upon selection (ΔG) were calculated as follows:

Heritability (H^2): was estimated as the percent ratio of genotypic variance to phenotypic variance (Hansen *et al.*, 1956).

H_{2b} %=σ^2g/σ^2Ph*100

Genetic advance upon selection (ΔGs) as percent of the mean (ΔG %) were computed according to (Johnson *et al.*, 1955) as follows:

ΔGs = K*H_{2b}*σ_{Ph}

ΔG%=ΔG/X *100

Where, K is the selection differential and equals 2.06 at selection intensity of 5%.

Results and discussion

Mean performance

Regarding crop growing period, the most desirable mean values towards the earliness were obtained from commercial rice variety Sakha 103 followed by the new promising lines; GZ9399-4-1-1-2-1-2 (121.0 days), GZ9461-4-2-3-1 (122.0 days) and PL-GE-101-SP-26 (122.0 days) (Table 1).

The results revealed that the varieties Egyptian Yasmine and Sakha 101 were the longer life span genotypes (150.0 and 141.0 days). The results of plants height varied from 81.7 cm to 111.3 cm among studied genotypes. Short plant height is a desirable trait. GZ10147-1-2-1-1 produced the shortest plant (81.7 cm) while Egyptian Yasmine produced the longest plant height (111.3 cm). Two new promising lines GZ10101-5-1-1-1 and GZ9399-4-1-1-3-2-2 recorded desirable values for plant height with 86.7 and 88.0 cm, respectively. The obtained results are in agreement with Ramalingam *et al.* (1993).

Table 1. Mean performance values for eight agro-morphological traits in rice through 2014 and 2015 (combined data).

No.	Genotypes	Duration (day)	Plant height (cm)	Number of panicles/plant	Panicle length (cm)	Number of filled grains/panicle	Grain yield (kg/m2)	Hulling %	Milling %
1	Giza 177	124	100.0	18.0	20.5	145.5	4.52	79.5	69.3
2	Giza 178	135	106.0	21.3	24.0	185.5	5.07	78.9	67.5
3	Giza 179	123	98.3	23.7	25.5	176.7	5.44	79.9	69.4
4	Sakha 101	141	90.3	20.7	25.5	162.5	4.82	79.1	68.6
5	Sakha 102	123	105.3	18.7	23.3	133.0	4.53	81.1	70.2
6	Sakha 103	120	97.3	20.7	21.3	125.0	4.43	81.0	69.1
7	Sakha 104	133	100.3	21.7	20.5	139.0	4.73	78.5	67.6
8	Sakha 105	124	99.7	18.3	20.3	111.5	4.65	82.0	70.6
9	Sakha 106	126	103.0	16.3	23.3	142.0	4.65	81.0	69.8
10	Giza 182	124	93.3	20.0	24.8	159.0	4.64	82.2	70.6
11	GZ 9461-4-2-3-1	122	94.0	18.0	20.5	105.0	5.26	81.6	70.2
12	GZ 9626-2-1-3-2-3	127	101.0	22.0	23.9	157.0	4.53	79.1	67.3
13	GZ 9807-6-3-2-1	124	98.0	21.0	23.3	139.5	4.23	81.2	70.2
14	GZ 9399-4-1-1-3-2-2	122	88.0	22.0	24.8	126.0	4.17	79.5	68.2
15	GZ 9399-4-1-1-2-1-2	121	101.0	19.3	23.8	167.0	4.29	79.3	68.6
16	GZ10101-5-1-1-1	124	86.7	19.3	23.3	141.5	4.02	80.1	68.4
17	GZ 10147-1-2-1-1	125	81.7	20.7	25.0	101.0	5.00	81.5	71.1
18	GZ 10154-3-1-1-1	126	91.7	22.0	20.5	131.5	4.06	81.5	70.6
19	PL-GE-101-SP-26	122	94.7	24.0	22.0	125.5	4.17	77.0	68.1
20	Egyptian Yasmine	150	111.3	19.0	28.8	211.0	3.99	78.5	70.1
L.S.D. 0.05 %		0.84	4.16	2.57	1.53	25.5	0.34	0.36	0.47
0.01 %		1.21	5.99	3.70	2.20	36.7	0.49	0.51	0.67

Concerning the number of panicles/plant, the rice genotypes PL-GE-101-SP-26 and Giza 179 showed the highest mean values of 24.0 and 23.7, respectively. The rice cultivar Sakha 106 recorded the lowest mean value (16.6 panicles) for panicles/plant. The differences among the rice genotypes mainly attributed to nature of variety. Similar trends were found by Hammoud (2005).

Table 2. Mean squares of twenty rice genotypes for agro-morphological and yield traits under study.

S.O.V.	DF	Sum of square							
		Duration (day)	Plant height (cm)	Number of panicles/plant	Panicle length (cm)	Number of filled grains/panicle	Grain yield (kg/m2)	Hulling %	Milling %
Replications	2	34.87	14.82	1.12	4.70	1739.62	0.93	7.27	4.58
Genotypes	19	232.98**	154.35**	13.66**	14.83**	2305.10**	0.51**	5.93**	4.14**
Error	38	0.38	9.17	3.50	1.25	344.35	0.06	0.07	0.12

The mean values of panicle length of twenty rice genotypes ranged from 20.3 cm to 28.8 cm (Table 1). In the same time, rice cultivars Egyptian Yasmine, Giza 179 and Sakha 101 gave the highest mean values of 28.8, 25.5 and 25.5 cm, respectively. On the other hand Sakha105 recorded the lowest value of 20.3 cm for this trait. Regarding the mean performance for number of filled grains/panicle, rice varieties Egyptian Yasmine, Giza 178 and Giza 179 scored the highest mean values of number of filled grains/panicle with 211.0, 185.5 and 176.7, respectively. While, the new promising line GZ10147-1-2-1-1 recorded the lowest mean value of 101.0 for this trait. The rice genotypes differed significantly in their grain yield in the study. Giza 179 produced the highest grain yield (5.44 kg/m^2)followed by the promising line GZ9461-4-2-3-1 (5.26 kg/m^2) and the commercial variety Giza 178 (5.07 kg/m^2). The superiority of these rice varieties in grain yield might be due to their no. of panicles/plant, no. of filled grains/panicle and 1000-grain weight. These results are in agreement with those obtained by Sedeek*et al.* (2009).

Table 3. Grand mean, variance components, estimates of phenotypic (PCV) and genotypic (GCV) coefficient of variation, heritability (h_{2b}%) and genetic advance for eight characters in rice.

Characters	Grand	Genetic components						
	Mean	G.V	P.V	G.C.V	P.C.V	H_{bs}%	GA	GA%
Duration (day)	126.8	77.53	77.91	7.02	7.04	99.52	18.1	14.43
Plant height (cm)	97.08	48.39	57.56	7.17	7.81	84.07	13.14	13.53
No. of panicles/plant	20.13	3.39	6.89	9.14	13.04	49.16	2.66	13.2
Panicle length (cm)	23.22	4.53	5.77	9.16	10.35	78.41	3.88	16.72
No. of filled grains/panicle	144.08	653.58	997.94	17.74	21.92	65.49	42.62	29.58
Grain yield	4.56	0.15	0.21	8.42	10.07	69.89	0.66	14.5
Hulling %	80.13	1.95	2.02	1.74	1.77	96.7	2.83	3.53
Milling %	69.3	1.34	1.46	1.67	1.74	92.05	2.29	3.31

Highly significant differences existed among the tested rice genotypes for hulling % in the study (Table 1). Giza 182 surpassed significantly the other rice genotypes under study in this trait, while, PL-GE-101-SP-26 rice promising line gave the lowest one comparing to the other genotypes. This fact could be attributed to genetic effect. Eight rice genotypes recorded values over 70.0% for milling trait, among them GZ 10147-1-2-1-1 and Giza 182 exhibited higher values (71.1 and 70.6 %, respectively). On the other hand GZ 9626-2-1-3-2-3 gave the lowest value (67.3 %).

Analysis of variance

The analyses of variance of different advanced lines for agronomical traits are shown in (Table 2).

Analysis of variance for augmented design revealed highly significant and exploitable variability among tested genotypesforall fourteen characteristics and non-significant for the blocks. Greater variability in the initial breeding materials ensures better chances of producing desired recombinants for improvement of the crop. This suggests the presence of variation among the genotypes for all these traits. Previous studies in rice also found significant variation for these traits (Yaqoob *et al.*, 2012; Tiwari *et al.*, 2011).

Genetic parameters

A wide range of variation was observed among rice genotypes for yield contributing traits and yield as well (Table 3). The perusal data revealed that phenotypic variance was higher than the genotypic variances for all the studied traits thus indicated the influences of environmental factor on these traits. The higher genotypic coefficient of variability (GCV) and phenotypic coefficient of variability (PCV) recorded for number of filled grains/panicle, indicate the existence of wide spectrum of variability for this trait and offer greater opportunities for desired trait through phenotypic selection (Table 3). Moderate PCV and GCV values recorded for number of panicles/plant, panicle length and grain yield while, rest of the characteristics recorded low PCV and GCV. The estimates of PCV were higher than GCV for all the traits. However, Manikya and Reddy (2011) reported, lees difference between GCV and PCV for all the characteristics under study, which indicated less influence of environment over expression of the traits. The estimates of heritability ranged from 49.16% to 99.52% for number of panicle/plant and durations traits, respectively. High heritability coupled with high genetic advance was observed for the traits duration and plant height. This indicates the lesser influence of environment in expression of these characteristics and prevalence of additive gene action in their inheritance hence, amenable of simple selection. The above mentioned characteristics had high heritability with moderate genetic advance, indicating that the characteristics were also governed by both additive and non-additive gene actions. These results are accordance with Jayasudha and Sharma (2010) and Sedeek and El-Wahsh (2015).

Conclusion

From the present study, it can concluded that, the promising rice lines GZ9461-4-2-3-1 and GZ10147-1-2-1-1 produced higher grain yield compared with the commercial check variety. These promising lines of rice would beof considerable value of breeders engaged in the development of high yielding cultivars. Consequently, selection of these traits would be more effective for yield improvement in rice and these promising lines of rice would be of considerable value for breeders engaged in the development of high yielding cultivars.

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