J. of Plant Production, Mansoura Univ., Vol. 13 (12) : 929 -936, 2022

Journal of Plant Production

Journal homepage & Available online at: www.jpp.journals.ekb.eg

Genetic Diversity Among some of Rice Genotypes under Water Shortage

Sedeek, S. E. M.; Tahany M. Mazal; Mervat M. A. Osman; A. G. Hefeina*; W. H. EL-Kallawy and Eman M. Bleih

Cross Mark

Rice Research Section, Field Crops Research Institute, Agriculture Research Center, Egypt

ABSTRACT

The experiment was carried out in strip plot design with three replications to evaluate 14rice genotypes under normal and water deficit in the field and biotechnology lab of Rice research and Training Center at Sakha Agricultural Research Station, Sakha, Kafr EL-Sheikh Egypt, during2021 and 2022summer seasons. Results revealed a wide variation among rice genotypes and their parents for agronomical characteristics and SSR markers. Data showed that days to maturity, plant height, Flag leaf area, number of panicle-^{1}, Panicle length, number of filled and unfilled grains panicles-^{1} as well as grain yield t ha-^{1} were significantly affected by irrigation treatments. Grain yield was affected significantly according to the genotypes and irrigation treatments. The combination between Egyptian Yasmin with normal irrigation produced the highest values of grain yield with the lowest percentage(14.58%) of yield reduction compared to its production under water deficit conditions. While, the lowest values of grain yield were obtained with Nerica7 (V2) under water shortage conditions with the highest percentage(33.63%) of yield reduction compared to its production under normal irrigation. Fifty SSR markers were used for estimating the genetic variation among the 14rice genotypes. Rice genotypes were divided into two main groups based on the polymorphism revealed by the SSR markers. The first group has the aromatic genotype, Egyptian yasmine and the promising newly developed genotype No.2. While, the second main group has the other tested rice genotypes, NERICA7 and the other genotypes. The data indicated that phenotypic variance was generally superior than genotypic variance for all studied traits.

keywords: Genetic diversity, Agronomical characters, SSR markers

INTRODUCTION

Most nations rely on rice as their primary source of nutrition, also rice constitutes a major part of the diet for many others. In the world the rice cultivated area around 150.000 million hectares and this area produces more than 725.5 million tons. USDA 2019). The rice production should be increase to 40% for all rice ecosystems even under drought borne area to achieve the food security by 2025 Pennisi (2008). Annual rice production increased by 2.8%, but the damage from biotic and abiotic stresses resulted in a significant loss of global production. Santhanakshmi *et al.*(2010). The rice grain yield reduced significantly by biotic stresses. Egypt is facing several problems, i.e., food security and water shortage, especially at the end of irrigation canals. Scarcity of water considered as the most constraining factors in more than thirty percent of rice cultivated area in Egypt, where the developed varieties cannot thrive well under water shortage Abdallah (2010). Development of the Egyptian rice varieties tolerance to water stress its great importance. The reduction of grain yield happens when water stress occurred during reproductive processes induced the genetic analysis of drought tolerance at the reproductive stage crucial Pantuwan *et al.*, (2002). Drought tolerance has consistently been one of the most important objectives of rice breeders in Egypt. Aromatic rice varieties are more popular over non-aromatic varieties especially in special occasions and for export to Gulf countries, therefore, they are sold by a high price in the market. Aromatic varieties are prized by many people in African countries such as Tanzania Joseph *et al.* (2004). Genetic diversity helps the rice breeders in detecting genotypes as well as expecting possible genetic potentials Chakravarthi and Naravaneni (2006). Genetic variation due to the morphological variations of quantitative traits has some disadvantages regarding to time, space and labor cost, in adding to the method cannot be gave the precise level of genetic variability among the varieties based on the effect of additive gene action on the expression of these characters Zeng *et al.* (2004) and Schulman (2007). Selection based on morphological traits is seductive due to the phenotypic expression affected by environments factors Astarini *et al.* (2004) and Astif *et al.* (2005). SSR markers are most of efficient tools for determining the genetic variability among the rice varieties Devi *et al.* (2012), Rashid *et al.* (2017) and Gyawali *et al.* (2018) stated that the phenotypic coefficient of variability was superior the genotypic coefficient of variability for studied traits indicating that environmental effect on the controlling of these traits. Also, the estimated high heritability for days to maturity, 1000-grain weight and plant height, suggesting these traits are under high genetic control. High phenotypic variance was recorded for grain yield, number of grains panicle^{-1}, number of panicles m^{-2} and straw yield. While, for grain yield had medium. Also, Adhikari *et al.* (2018), found that phenotypic coefficient of variability was high as compared to genotypic coefficient of variability, indicating the effect of environment on the expression of traits. The present investigation aims to explore the genetic variation for yield and its components among some promising genotypes and their parents and to determine

[*] Corresponding author.
E-mail address: ahmad.gamal95@yahoo.com
DOI: 10.21608/jpp.2023.178703.1197

the elite genotypes are tolerant to water stress and has aroma based on the using of specific SSR markers.

MATERIALS AND METHODS

During the rice seasons of 2021 and 2022, the research was carried out at the experimental farm of Sakha Agricultural Research Station, kafr elsheikh, Egypt, to evaluate the genetic diversity of 12 rice genotypes and their parents in terms of agronomic characteristics and SSR markers associated with particular traits. The twelve rice genotypes are selected from Fn, they were derived from crossing between Egyptian Yasmin (Egyptian aromatic variety) with NERICA 7 tolerant to drought developed by Africa Rice Center Table 1. The experiment's statistical design was a strip-plot design with three replications. Rice varieties distributed in the vertical plots and water treatments (well-watering and water deficit) were allocated in the horizontal plots. In each replication, 14 rice genotypes were sown on May 1st and were transplanted after 30 days of sowing in seven rows with a length of 5 meters for each row. The irrigation was continued in the well-watered replications until the end of the experiment and always keep on moisture at saturated or above the field capacity. Regarding to water shortage treatment, water withholding for 20 days was applied at reproductive stage (45days after transplanting) until appear the drought susceptibility traits i.e., leaf rolling and leaf drying score on the tolerant variety, and irrigated after water stress up to harvest., 36 kg P_2O_5 ha^{-1}in the form of single upper phosphate (15%P_2O_5) was added as basal application in the permanent field and incorporated with soil during land preparation Nitrogen fertilizer at the rate of 165kg Nha^{-1} in the form of urea (46.5%) was added in two splits, 2/3 as basal application and incorporated with soil during land preparation. While, the second dose was applied after 30 days of transplanting.

The studied traits were days to maturity (days), plant height (cm), flag leaf area (cm^2), number of panicles $plant^{-1}$, panicle length (cm), number of filled grains $panicle^{-1}$, number of unfilled grains $panicle^{-1}$ and grain yield t ha^{-1}, were measured according to IRRI, (1996). Analysis of variance was done for each season according to Sendecor and Cochran (1967). Error variances from separate analysis of the data were tested for homogeneity according to Bartletts test Bartlett (1937) Phenotypic (PCV%) and genotypic (GCV%) coefficient of variability were estimated related to the method of Burton (1951). The expected genetic advance from selection (g) for the studied traits as well as the phenotypic correlation between any pairs of traits was calculated according to Johnson *et al.* (1955). The value of GCV% and PCV% were estimated according to Sivasubramanian and Madhavamenon (1973).Heritability in broad sense was done based on the Burton and De vane (1953)

Table 1. Pedigree and origin of some of rice genotypes

No.	genotype	Pedigree	Origin	aromatic/non-aromatic
1	Egyptian Yasmin	IR262/ KDML 105	Egypt	Aroma (+)
2	NERICA 7	WAB56-104 x CG14//WAB5656-104	AfricaRice Center	Non –romatic(-)
3	ARD6-1-1-1-1-1-1	Egyptian Yasmin x NERICA 7	AfricaRice Center	Non-romtic(-)
4	ARD6-3-1-2-1-2-2	Egyptian Yasmin x NERICA 7	AfricaRice Center	Aromatic(+)
5	ARD6-4-1-1-2-1-3	Egyptian Yasmin x NERICA 7	AfricaRice Center	Non-aromatic(-)
6	ARD6-7-1-1-1-1-4	Egyptian Yasmin x NERICA 7	AfricaRice Center	Aromatic(+)
7	ARD6-8-1-1-1-1-5	Egyptian Yasmin x NERICA 7	AfricaRice Center	Non-romtic(-)
8	ARD6-8-1-2-1-2-6	Egyptian Yasmin x NERICA 7	AfricaRice Center	Aromatic(+)
9	ARD6-9-1-2-1-1-7	Egyptian Yasmin x NERICA 7	AfricaRice Center	Non-aromtic(-)
10	ARD6-11-1-1-1-1-8	Egyptian Yasmin x NERICA 7	AfricaRice Center	Non-romtic(-)
11	ARD6-11-1-2-1-2-9	Egyptian Yasmin x NERICA 7	AfricaRice Center	Aromatic(+)
12	ARD6-14-1-1-1-1-10	Egyptian Yasmin x NERICA 7	AfricaRice Center	Non-aromatic(-)
13	ARD6-14-1-2-1-2-11	Egyptian Yasmin x NERICA 7	AfricaRice Center	Non-aromatic(-)
14	ARD6-14-1-2-1-3-12	Egyptian Yasmin x NERICA 7	AfricaRice Center	Aromatic(+)

Genomic DNA isolation

The CTAB method, as described by Murray and Thompson in 1988, was used to extract DNA samples from the 14 genotypes' leaves during the seedling stage.

PCR amplification and electrophoresis

For genetic variation among the 14 rice genotypes, more than fifty SSR markers were utilized, only eleven markers were successful in achieving the goal Table 2.

Data analysis

The polymorphism information content for each SSR marker was analyzed using the software package, NTSYS-pc version 2.11 Rohlf (1988). Polymorphism information content was estimated according to Nagy *et al.* (2012). Genetic variability coefficient was used to make a dendrogram using the un-weighted Pair Group Method with Arithmetic Average (UPGMA) .

Table 2. List of SSR markers sequences and chromosome number.

Primer name	Chromosome number	Sequence	
		Forward	Reverse
RM148	3	ATACAACATTAGGGATGAGGCTGG	TCCTTAAAGGTGGTGCAATGCGAG
RM164	5	TCTTGCCCGTCACTGCAGATATCC	GCAGCCCTAATGCTACAATTCTTC
RM166	2	GGTCCTGGGTCAATAATTGGGTTACC	TTGCTGCATGATCCTAAACCGG
RM208	2	TCTGCAAGCCTTGTCTGATG	TAAGTCGATCATTGTGTGGACC
RM263	2	CCCAGGCTAGCTCATGAACC	GCTACGTTTGAGCTACCACG
RM5687	4	GATCGCTGGCGATTGATC	GACTTGTGGGGTGGTTTTTG
RM566	9	ACCCAACTACGATCAGCTCG	CTCCAGGAACACGCTCTTTC
RM212	1	CCACTTTCAGCTACTACCAG	CACCCATTTGTCTCTCATTATG
RM249	5	GGCGTAAAGGTTTTGCATGT	ATGATGCCATGAAGGTCAGC
RM223	8	GAGTGAGCTTGGGCTGAAAC	GAAGGCAAGTCTTGGCACTG
RM294	1	TTGGCCTAGTGCCTCCAATC	GAGGGTACAACTTAGGACGCA

Aroma test:

A 1.7% KOH solution was used for the aroma test on milled rice Sood and Siddiq (1978). At room temperature, 20 milled grains were placed in tubs containing 5 milliliters of a 1.7% KOH solution. The tubs were opened after 30 minutes and immediately smelled. The aroma was scored as either present (+) or absent (-). as depicted in Table 1

RESULTS AND DISCUSSION

Mean performance of rice genotypes under well-watering and water stress:

Results in Table (3) showed that days to maturity, plant height, flag leaf area, number of panicle plant^{-1}, panicle length, number of filled and unfilled grains panicle^{-1} as well as grain yield were significantly affected by irrigation treatments. The number of days to maturity significantly increased under water shortage condition. The variations in maturity could be related to the extended vegetative stage under water stress Lafitte *et al.* (2004) and Mohamed *et al.* (2019) stated that, water shortage results in delay heading, this is related to the reduction in dry matter production and delay the elongation of the panicle. For Plant height and number of panicle^{-1} were decreased due to water stress compared to well-watered in both seasons. The reduced in plant height may be related to reduction in cell turgor that induces reduction in cell enlargement, and turn into decreases shoots enlargement and plant height. Ahmed *et al.* (2017) reported that water deficit plays a high effect on plant growth and results in the decline of plant height. Water stress reduce the cell division and size and reduce the plant height under water shortage . However, the reduction in number of panicles^{-1} could be regarding to less ability of tiller nodes which produce more tillers under water stress. A similar finding was found by Sarvestani *et al.* (2008), El-Refaee *et al.* (2012) and Gewaily *et al.* (2019). Panicle length and number of filled grains panicle^{-1} were reduced with water deficit treatment, in both seasons. The highest values of both traits were obtained with normal followed by water shortage . These results are in agreement with those reported by Gewaily *et al.* (2019) and Muhammad, Aurangzaib *et al.* (2021) who stated that the increase in yield components under non stress condition could be due to the available water enhanced the biological and physiological process which increase the production and translocation of the dry matter production from source to sink which resulting in more panicles, grain filling and weight. These results are in harmony with those stated by Zubaer *et al.* (2007). Number of unfilled grains panicle^{-1} tended to increase under water stress compared with well-watered . increasing the number of unfilled grainpanicle^{-1} under water deficit was due to reduction in amount of dry matter production synthesized by the plants and this in turn might account much for the increase in number of unfilled grains. Also results in Table (3) indicated that, drought conditions caused a reduction in the grain yield. While, normal irrigation recorded the highest grain yield. The increasing in grain yield as affected by well-watered condition may be due to the increase in dry matter production, plant height and number of Panicles^{-1}. However, the reduction in grain yield as affected by water shortage conditions may be due to the reduction in dry matter production, , number of panicles^{-1} and number of filled grains panicle^{-1}. A similar trend was found by El-Refaee *et al.* (2012) and Gewaily *et al.* (2019).

Table 3. Duration, plant height, flag leaf area, number of panicles-1, panicle length, filled grains panicle^{-1}, unfilled grainspanicle^{-1} and grain yield as affected by water deficit of some different rice genotypes

	Duration (days)	Plant height (cm)	Flag leaf area (cm2)	No. of panicles plant^{-1}	Panicle length (cm)	No. of filled grain /panicle^{-1}	No. of unfilled grains panicle^{-1}	Grain yield (t/ha^{-1}.)
Normal	123.36	108.50	31.857	16.024	23.84	137.12	13.17	7.61
Water deficit	129.43	104.99	29.907	13.693	22.08	120.35	17.21	5.71
F test	**	**	**	**	**	**	**	**
Egyptian Yasmine (EY)	143.67	106.17	47.98	24.17	24.88	160.00	9.80	9.98
Nerica 7	123.47	105.15	45.23	15.47	22.67	149.67	6.50	5.52
ARD6-1-1-1-1-1-1	124.67	96.47	26.57	13.000	18.97	114.00	11.67	6.53
ARD6-3-1-2-1-2-2	123.48	101.00	25.37	14.50	18.82	103.00	9.33	6.05
ARD6-4-1-1-2-1-3	127.17	105.80	24.47	8.50	24.00	135.00	16.48	6.68
ARD6-7-1-1-1-1-4	126.67	111.50	20.57	9.33	22.68	149.82	22.17	7.65
ARD6-8-1-1-1-1-5	127.80	110.15	36.27	13.17	24.25	140.50	23.97	7.35
ARD6-8-1-2-1-2-6	127.80	106.30	31.12	11.83	24.73	131.00	13.15	6.72
ARD6-9-1-2-1-1-7	124.47	116.50	30.02	15.30	24.45	115.15	10.98	6.10
ARD6-11-1-1-1-1-8	123.17	108.97	31.37	13.48	25.23	123.00	12.97	5.75
ARD6-11-1-2-1-2-9	127.82	109.97	30.37	17.17	23.12	140.67	23.30	7.15
ARD6-14-1-1-1-1-10	124.50	107.65	30.52	19.32	25.03	129.83	17.17	6.55
ARD6-14-1-2-1-2-11	123.33	103.80	27.07	20.47	22.88	102.65	17.97	5.75
ARD6-14-1-2-1-3-12	121.50	104.98	25.45	12.32	19.80	108.00	17.17	5.45
LSD	0.85	0.77	0.42	0.80	0.39	1.09	0.73	0.25
Interaction	**	**	**	**	**	**	**	**

Results in Table (3) exhibited that a significant differences were obtained among tested genotypes in respect to all studied traits i.e., days to maturity , plant height, flag leaf area, number of panicles^{-1}, Panicle length, number of filled and unfilled grains panicle^{-1} as well as grain yield. Also, the results showed that Egyptian Yasmin produced the highest values of days to maturity, plant height, flag leaf area, number of panicles^{-1}, Panicle length, number of filled grains panicles^{-1} as well as grain yield, compared to the other rice genotypes. On the other hand, Nerica 7 produced the lowest values of number of unfilled grains panicle^{-1}. Most variation among the rice genotypes in yield attributes traits might be due to the genetic background differences.

Interaction between irrigation treatments and rice genotypes significantly affected all studied traits. Results in Table (4) indicated that, the highest period needed to maturity was obtained by Egyptian Yasmin under water shortage treatment. While, ARD12-3-1-2-1-14-6 under normal irrigated recorded the lowest period needed to maturity . These data are similar to those reported by Gaballah (2009). The delay in heading of rice is common under drought conditions EL-Refaee *et al.* (2005), Gewaily *et al*. (2021) which is recommended that, the benefit in those environments exposed to water deficit. The delay in heading and maturity could be considered as good criteria in screening tests for tolerance to water shortage, because the effect of drought on the trait was consistent Mohamed *et al.* (2019). Also results in Table (4) exhibited that, Egyptian Yasmin under normal irrigated produced the tallest plants, the highest flag leaf area, the highest number of panicles plant^{-1} and tallest panicle While under drought treatment ARD6-1-1-1-1-1-1 gave the shortest plants, the lowest flag leaf area was obtained with ARD6-4-1-1-2-1-3 and ARD6-4-1-1-2-1-3 gave the lowest number of panicles plant^{-1} as well as shortest panicle length was obtained by ARD6-14-1-2-1-3-12 under drought treatment (Table 4).

Table 4. Interaction between irrigation treatments and rice genotypes

	Duration (days)		Plant height (cm)		Flag leaf area (cm2)		No. of panicles plant^{-1}		Panicle length (cm)	
	N	D	N	D	N	D	N	D	N	D
Egyptian Yasmine (EY)	140.33	147.00	107.33	105.00	48.67	47.30	25.33	23.00	25.67	24.10
Nerica 7	120.33	126.60	107.00	103.30	45.67	44.80	16.33	14.60	23.33	21.90
(ARD6-1-1-1-1-1-1	121.33	128.00	98.33	94.60	27.33	25.80	15.00	11.00	19.33	18.60
ARD6-3-1-2-1-2-2	119.67	127.30	103.00	99.00	26.33	24.40	16.00	13.00	19.33	18.30
ARD6-4-1-1-2-1-3	123.33	131.00	107.00	104.60	25.33	23.60	10.00	7.00	24.70	23.30
ARD6-7-1-1-1-1-4	124.33	129.00	115.00	108.00	22.33	18.80	10.67	8.00	23.77	21.60
ARD6-8-1-1-1-1-5	125.00	130.60	111.00	109.30	37.33	35.20	14.33	12.00	25.50	23.00
ARD6-8-1-2-1-2-6	125.00	130.60	108.00	104.60	32.33	29.90	12.67	11.00	26.17	23.30
ARD6-9-1-2-1-1-7	121.33	127.60	118.00	115.00	31.33	28.70	16.00	14.60	25.30	23.60
ARD6-11-1-1-1-1-8	120.33	126.00	110.33	107.60	32.33	30.40	14.67	12.30	26.27	24.30
ARD6-11-1-2-1-2-9	124.33	131.30	112.33	107.60	31.33	29.40	18.33	16.00	23.63	22.60
ARD6-14-1-1-1-1-10	121.00	128.00	109.00	106.30	31.33	29.70	20.33	18.30	25.77	24.30
ARD6-14-1-2-1-2-11	120.67	126.00	106.00	101.60	28.33	25.80	21.33	19.60	23.47	22.30
ARD6-14-1-2-1-3-12	120.00	123.00	106.67	103.30	26.00	24.90	13.33	11.30	21.60	18.00
LSD	1.22		1.11		0.74		1.17		0.6250	

N: normal irrigation, D: water deficit

Interaction among water treatments and rice genotypes significantly affected the number of filled grains panicle^{-1}, number of unfilled grains panicle^{-1} and grain yield (Table 5). Results indicated, that the Egyptian Yasmin produced the highest value of number of filled grains panicle^{-1} under normal irrigation , while the lowest values were recorded with ARD6-3-1-2-1-2-2 under drought treatment. On the other hand, the highest value of number of unfilled grains panicle-1 produced by ARD6-8-1-1-1-1-5 under drought treatment , while the lowest value of number of unfilled grains panicle-1 produced by Nerica 7 and Egyptian Yasmin under Normal irrigation. These results are in harmony with those stated by Hashem *et al.* (2016), Zaman *et al.* (2018) and Gewaily *et al.* (2021) who reported that water deficit induced several changes in the structure and functional processes of reproductive organs in the rice, resulting to fluctuations in fertilization or premature abortion of the seed. leaves senescence, shortens in grain filling period, reduction in photosynthesis and enhancing soluble sugars remobilization from grains to other vegetative organs are clear with water stress at the reproductive stage. The sugars or carbohydrate assimilates depend on source activity and sink strength which vary with genotypes.

Also, the results in Table (5) and Fig. 1 indicated that, the interaction between genotypes and irrigation treatments was significantly affected grain yield. The combination between Egyptian Yasmin with normal irrigation produced the highest values of grain yield with the lowest percentage (14.58 %) of yield reduction compared to its production under water deficit conditions. While, the lowest values of grain yield were obtained with Nerica 7 under water shortage with the highest percentage (33.63 %) of yield reduction compared to its production under normal irrigation . The results are inconformity with that stated by Kondhia *et al*. (2015) and Gewaily *et al.* (2021).

Table 5. Interaction between irrigation treatments and rice genotypes

	No. of filled grains panicle^{-1}		No. of unfilled grains panicle $^{-1}$		Grain yield (tha^{-1})		Reduction (%)
	N	D	N	D	N	D	
Egyptian Yasmine	169.00	151.00	8.00	11.60	10.77	9.20	14.58
Nerica 7	156.33	143.00	7.00	6.00	6.63	4.40	33.63
(ARD6-1-1-1-1-1-1	121.00	107.00	10.33	13.00	7.57	5.50	27.34
ARD6-3-1-2-1-2-2	116.00	90.00	8.67	10.00	7.10	5.00	29.58
ARD6-4-1-1-2-1-3	146.00	124.00	14.67	18.30	7.47	5.90	21.02
ARD6-7-1-1-1-1-4	157.33	142.30	20.33	24.00	8.60	7.70	12.09
ARD6-8-1-1-1-1-5	146.00	135.00	21.33	26.60	8.40	6.30	25.00
ARD6-8-1-2-1-2-6	136.00	126.00	11.00	15.30	7.53	5.90	19.73
ARD6-9-1-2-1-1-7	126.00	104.30	8.67	13.30	7.10	5.10	28.17
ARD6-11-1-1-1-1-8	131.00	115.00	11.33	14.60	6.50	5.00	23.08
ARD6-11-1-2-1-2-9	146.33	135.00	20.00	26.60	8.20	6.10	25.61
ARD6-14-1-1-1-1-10	136.67	123.00	14.33	20.00	7.60	5.50	27.63
ARD6-14-1-2-1-2-11	111.00	94.30	15.33	20.60	6.60	4.90	25.76
ARD6-14-1-2-1-3-12	121.00	95.00	13.33	21.00	6.40	4.50	29.69
LSD	2.017		1.04		0.35		

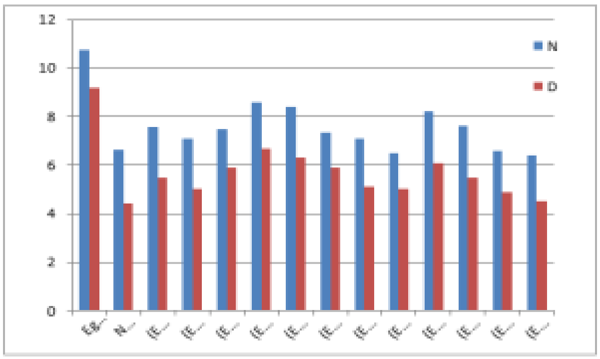

Fig.1. Reduction % of grain yield under well-watered compared to water deficit

Genetic diversity among the newly developed lines compared to their parents using molecular marker.

Fifty SSR markers used to estimate the genetic variations among the 14 rice genotypes. Only eleven markers were polymorphic Table 2. Out of these polymorphic marker, RM148 and RM294 were found to produce the highest number of alleles, with PIC value of 0.66, Table 6.

Cluster Analysis and Principal Component:

The analysis indicated that the tested rice genotypes were divided into two main groups based on the polymorphism revealed by the SSR markers Fig 2. The first group has the aromatic genotype, Egyptian Yasmine and the promising newly developed genotype No.2. While, the second main group has the other tested rice genotypes, NERICA7 and the other genotypes. The second main group was divided into 2 subgroups, the first subgroup have the newly developed rice genotypes 4, 9, 6 and 12. The present investigation seeking for determine a specific marker of aroma trait in rice, will identifies a specific band of DNA amplified product able to identify the aromatic rice varieties from non-aromatic ones. RM294 was found to be useful for determine the polymorphism and aroma trait among the rice varieties (fig. 3), Nguyen *et al.* (2006), Yan (2007) and Saba Jasim *et al.* (2018). In the current study, the marker RM566 PCR profile gave 21 amplified bands which represented 4 alleles, Table 6. However, this marker may be related to identify a specific band for aroma, compared to the bands observed in the nonaromatic genotypes. The SSR marker, RM 566 detected polymorphism among the tested rice genotypes based on aroma trait 15 amplified bands with 2 alleles (fig.4), the aromatic genotypes line 2, 4, 6.9 and 12 gave the same bands which detected in Egyptian Yasmin, while the remain genotypes are non-aromatic. Regarding to grain yield the SSR marker RM 164 showed 16 amplified bands with 2 alleles (fig.5), the rice genotypes Egyptian Yasmin, and the line 2, 4, 5, 8, 9 and 10 gave the same band and this data confirmed with the field data, where these genotypes gave the lowest reduction in grain yield under drought stress.

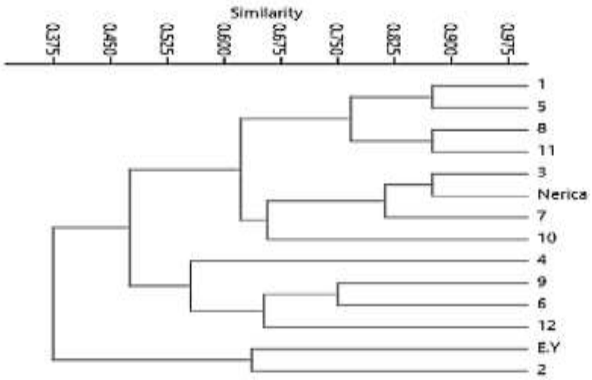

Fig. 2. Cluster analysis of 14 rice genotypes based on SSR markers polymorphism

Table 6. Molecular data for rice genotypes

SSR marker	# of amplified bands	# of amplified alleles	# of polymorphic alleles	Polymorphism %	PIC value
RM148	14	4	4	100	0.66
RM164	16	2	2	100	0.48
RM166	15	2	1	0.50	0.23
RM208	14	2	2	100	0.48
RM263	16	2	2	100	0.42
RM5687	16	2	1	0.50	0.37
RM566	15	2	2	100	0.48
RM212	16	2	1	0.50	0.21
RM249	14	2	2	100	0.35
RM223	14	2	2	100	0.51
RM294	21	4	3	0.75	0.51
Total	171	26	22		
Average	15.5	2.36	2.00	84.1	0.42

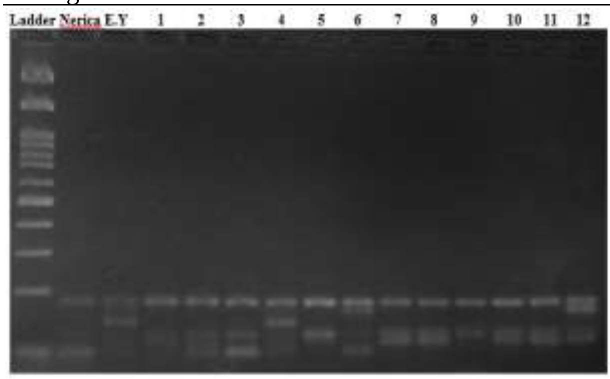

Fig. 3. Polymorphism among 14 rice genotypes using RM294,Mladder (50bp)

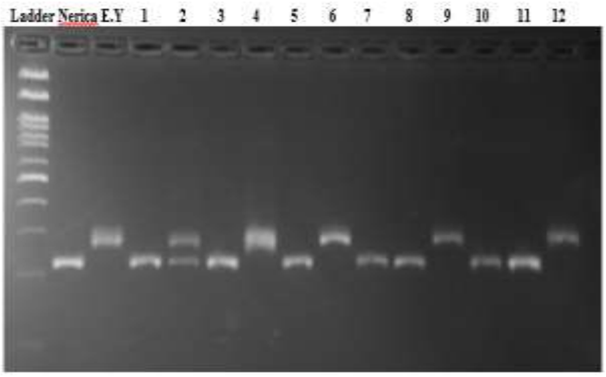

Fig. 4. Polymorphism among 14 rice genotypes using RM566,Mladder (50bp)

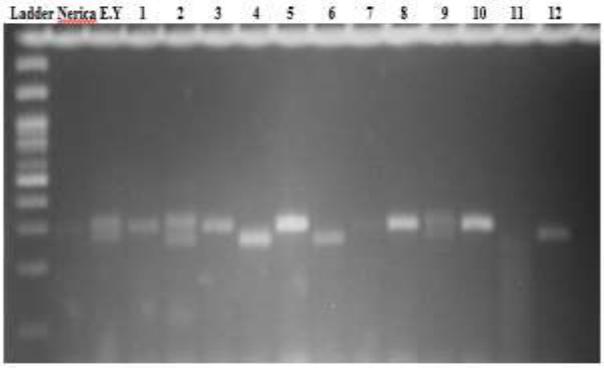

Fig. 5. Polymorphism among 14 rice genotypes using RM164,Mladder (50bp)

Estimates of genetic parameters:

Genetic parameters for phenotypic and genotypic variations, heritability and genetic advance under normal and water deficit are presented in Tables (7&8). The data exhibited that there is a big variations were found among the rice varieties for all traits over the two seasons, where mean squares were highly significant. Therefore, the selection would be effective among the rice genotypes for these characters. Similar results were obtained by Sedeek *et al.* (2009) and Ramesh *et al.* (2010). The data indicated that the phenotypic coefficient of variability was higher than genotypic coefficient of variability for all traits indicating the environmental effect on the expression of these traits, but the biggest portion of P.C.V% was contributed by the genotypic component, less by environmental component. The highest phenotypic coefficient of variability% and genotypic coefficient of variability% were observed in number of unfilled grains panicle^{-1} and number of panicles plant^{-1} Table 7under water deficit .

Heritability in broad sense was high for most of studied traits expect for flag leaf area that was low 26.02 % (Table 7) under water deficit while, it was high for all studied traits under normal irrigation Table 7. High heritability estimates are useful while, making selection as based on phenotype. High heritability coupled with high genetic advance was observed a in (Tables 7&8) were observed for days to maturity, number of filled grains panicle-1 and number of unfilled grains panicle-1. This indicates that selection process for these traits would certainly bring improvement in genotypes. Burton (1951), Pratap *et al.* (2018) and Dhakal *et al.* (2020) showed the genotypic coefficient of variation with heritability estimates would give a good image about genetic gain obtained from the selection.

Table 7. Estimates of phenotypic and genotypic coefficients of variability, heritability and genetic advance for studied traits of 14 rice genotypes (combined data of 2021 and 2022).under water deficit

Trait	Gran mean	MS.G	Error	GV	PV	GCV	PCV	h2	GA
Duration	129.43	92.87	0.62	30.75	31.37	4.28	4.32	98.02	11.30
Plant height	104.98	70.27	0.28	23.33	23.61	4.60	4.63	98.81	9.87
Flag leaf area	29.91	1.86	0.91	0.32	1.23	1.89	3.71	96.02	5.00
No.of panicles plant^{-1}	13.69	58.25	0.52	19.24	19.76	32.04	32.47	97.36	8.91
Panicle length	22.10	14.69	0.11	4.86	4.97	9.97	10.08	97.78	4.49
Number of filled grains panicle^{-1}	120.35	1182.12	0.84	393.76	394.60	16.48	16.51	99.78	40.83
No.of unfilled grains panicle^{-1}	17.21	117.66	0.44	39.07	39.51	36.32	36.52	98.88	12.80
Grain yield	5.71	4.39	0.085	1.44	1.53	21.01	21.66	94.12	2.39

MS. G= mean square genotype, GV= genotypic variance, PV= phenotypic variance, GCV= genotypic coefficient of variability, PCV= phenotypic coefficient of variability, h2= heritability in broad sense, GA= genetic advance and GA%= genetic advance %.

Table 8. Estimates of genotypic and phenotypic coefficients of variability, heritability and genetic advance for studied traits of 14 rice genotypes (combined data 2021 and 2022).under normal irrigation

Trait	Gran mean	MS.G	Error	GV	PV	GCV	PCV	h2	GA
Duration	123.36	82.99	0.45	27.51	27.96	4.25	4.28	98.30	56.44
Plant height	108.5	7.70	0.58	2.37	2.95	1.42	1.58	80.30	4.87
Flag leaf area	31.85	169.72	0.25	56.49	56.74	23.61	23.64	99.50	116.29
No.of panicles plant^{-1}	16.02	52.63	0.42	17.40	17.82	26.02	26.34	97.60	35.82
Panicle length	23.84	16.16	0.11	5.35	5.46	9.70	9.80	97.90	11.01
Number of filled grains panicle^{-1}	137.12	887.82	0.92	295.63	296.55	12.54	12.56	99.60	608.40
No.of unfilled grains panicle^{-1}	13.16	67.93	0.359	22.52	22.87	36.10	36.34	98.40	46.35
Grain yield	7.61	3.95	0.098	1.28	1.37	14.86	15.38	93.40	2.63

MS. G= mean square genotype, GV= genotypic variance, PV= phenotypic variance, GCV= genotypic coefficient of variability, PCV= phenotypic coefficient of variability, h2= heritability in broad sense, GA= genetic advance and GA%= genetic advance

Water saving:

Data in Table 9, revealed that the water consumption for Egyptian Yasmin, Nerica 7 and their promising lines. Egyptian Yasmin recorded the highest value of water consumption under both normal and water deficit treatments 5240 and 4800 m3 compared to Nerica 7 and the promising lines 4800 and 4360m3 under the same water treatments.

Table 9. water consumption for rice genotypes and promising lines

Genotype	Water uptake		
	Number of irrigation and total water consumption under normal irrigation		Total water consumption under water deficit
Egyptian Yasmin	17 x 220 +1500	5240m^3	4800
Nerica + lines	15 x 220 +1500	4800 m^3	4360
Water saving			440m^3

17 &15 number of irrigation, 220 water consumption in each irrigated, 1500 water consumption at preparation

ACKNOWLEDGEMENT

The authors express about their thankful to Dr. ELsayed Gewaily for his contributions in this manuscript

REFERENCES

AbdAllah, A. A. (2010). Development of some high yielding rice lines tolerant to drought stress conditions. J. Medi. Plants Res., 4(7): 528-535.

Adhikari, B. N., B. B. Pokhrel and J. Shrestha (2018). Evaluation and development of finger millet (*Eleusine Coracana* L) genotypes for cultivation and high hills of Nepal. Farming and Management, 3(1): 37-46.

Ahmed, M., Md. Ehsanul Haq, Md. Monir Hossain, Md. Shefat-al-Maruf and M. M. Hasan (2017). Performance of four different rice cultivars under drought Stress in the North-Western Part of Bangladesh. International J. Agric. and Forestry. 7(6): 134-139.

Astarini, I. A., J.A. Plummer, R. A. Lancaster and G. Yan (2004). Finger printing of cauliflower cultivars using RAPD markers. Australian Journal of agricultural research, Vol. 55(2):117-124.

Astif, M., M. Ur-Rahman and Y. Zafar (2005). DNA finger printing studies of some wheat (*Triticum aestivum* L.) genotypes using Random Amplified Polymorphic DNA (RAPD) analysis. Pakistan Journal of Botany Vol. 37: 271-277.

Bartlett, M. S. (1937). Properties of sufficiency and statistical tests. Proc. Roy Soc. London, Series A. (160):268-282.

Burton, G. and E. De vane (1953). Estimating heritability in tall Fescue (*Festuca Arundinacea*) from replicated Clonal material. Agronomy Journal 45:478-481.

Burton, G. W. (1951). Quantitative inheritance in Pearl millet (*Pennisetum glaucum*). Agronomy Journal 43: 409-417.

Chakravarthi, B. K. and R. Naravaneni (2006). SSR marker based DNA fingerprinting and diversity study in rice (*Oryza sativa* L.). African Journal of Biotechnology Vol.5(9):684-688.

Devi, C. B., G. M. Lal, C. M. Singh, and P. Yadav. (2012). Genetic architecture, interrelationship and path analysis for yield improvement in exotic rice (*Oryza sativa* L.).IJAEB 5(4): 387-392.

Dhakal, A., S. Sharma, A. Pokrel and A. Poudel (2020). Variability and heritability estimate of 30 rice landraces of lamjung and Tanahun districts Nepal. Indonesian J. of Agric., Sci., 21(1):1-10.

El-Refaee I. S., A. E. Abd-El-Wahab and S. A. Ghanem (2005). Physiological performance and yield of some rice cultivars as affected by different irrigation intervals. Egypt J. Agric. Res., 83(58): 393-410.

El-Refaee, I. S., R. N. Gorgy and T. F. Metwally (2012). Response of some rice cultivars to plant spacing for improving grain yield and productivity under different irrigation intervals. Alex. J. Agric. Res., 57(1): 1-15.

Gaballah, M.M. (2009). Studies on physiological and morphological traits associated with drought resistance in rice (*Oryza sativa* L.). PhD Thesis. Kafrelsheikh University.

Gewaily E. E., H. Sh. Hamad, B. B. Mikhael and E. F. Arafat (2021). Performance of promising hybrid rice genotypes under different irrigation intervals. Menoufia J. Plant Prod., 6: 19 –33

Gewaily, E. E., Amera, T. Mohammed and W. T. Abd El-Rahem (2019). Effect of different irrigation regimes on productivity and cooking quality of some rice varieties. W JA S 15 (5): 341-354.

Gyawali, S., A. Poudel and S. Poudel 2018. Genetic variability and association analysis in different rice genotypes mid-hill of western Napal.Acta Scientific Agriculture, 2(1): 6-76.

Hashem, E. M., E. S. Naeem, T. F. Metwally and H. M. El Sharkawi (2016). Enhancement of lodging resistance and productivity of rice using growth regulators at different nitrogen levels", Journal of Plant Breeding and Crop Science.

IRRI (1996). International Rice Research Institute Descriptors for Rice. Los Banos, Laguna, Philippines.52p.

Johnson,H.W.H.F.Robinson and R.E.Constock(1955). Estimates of genetic and environmental variability in soybean .Agron. J. 47:314-318.

Joseph, M., S. Gopalakrishnan, R.K. Sharma (2004). Combining bacterial blight resistance and basmati quality characteristics by phenotypic and molecular markers-assisted selection in rice. Molecular Breeding, Vol.13(4):377-387.

Kondhia, A., R. E. Tabien and A. Ibrahim (2015). Evaluation and selection of high biomass rice (*Oryza sativa* L.) for drought tolerance. Amer. J. of Plant Sci., 6: 1962-1972.

Lafitte H. R., A. Ismail and J. Bennett (2004). Abiotic stress tolerance in rice for Asia: progress and the future. In Proceeding of 4th International Crop Science Congress, Brisbane, Australia. 26: 1137.

Mohamed A., S. Sedeek, A. Galal and M. Alsakka (2019). Effect of water deficiency as abiotic stress on the reproductive and ripening stage of rice genotypes. Int. J. Plant Sci. Agric. 2(1):13-19.

Muhammad, A., Z. Ahmad, M. I. Jalil, M. F. Nawaz, *et al*. (2021). Exogenous Application of Silicon Can Help Augment Drought Tolerance in Wheat (*Triticum aestivum* L.) by Enhancing Morpho-physiological and Antioxidant Potential",Research Square Platform LLC.

Murray, A. A. and W. F. Thompson (1988). Rapid isolation of high molecular weight plant DNA. Nucleic Acid Res, 8: 4321-4325.

Nagy, S., P. Poczai., I. Cernák and A. M. Gorji (2012). PICcalc: an online program to calculate polymorphic information content for molecular genetic studies. Biochem Genet, 50: 670-672.

Nguyen L.oc H., T. Yoshihahi, W. Sarhadi, V. Cong THANH, Yosei OIKAWA,Yutaka HIRATA (2006). Evaluation of Aroma in Rice (*Oryza sativa* L.)using KOH Method, Molecular Markers and Measurement of 2-Acetyl-1-Pyrroline Concentration", Japanese Journal of Tropical Agriculture.

Pantuwan, G.; S. Fukai, M. Cooper, S. Rajatasereekul and J. C. OToole (2002). Yield response of rice (*Oryza sativa* L.) genotypes to different types of drought under rainfed lowlands.3- Plant factors contributing to drought resistance. Field Crops Res.73:181-200.

Pennisi, E. (2008). The Blue Revolution, drop by drop, gene by gene. Science 320: 171-173.

Pratap, A., P. Bisen, B. Lotongbam and P.K. Singh (2018). Assessment of genetic variability for yield and yield components in rice (*Oryza sativa* L.) germplasms. International J. of Bio-resource and stress management,.9(1):087-092

Ramesh K., S. Kaushal and Y. R. Shukla (2010). Variability, Correlation, and Path Analysis Studies in Lettuce", International Journal of Vegetable Science.

Rashid, M. M., M. Muruzzaman, L. Hassan and S. N. Begum (2017). Genetic variability analysis for various yield attributing traits in rice genotypes. Journal of the Bangladesh Agricultural University, 15(1): 15-1.

Rohlf, F. J. (1988). NTSYS-pc: Numerical Taxonomy and Multivariate Analysis System. Exeter Publishing.

Saba, J. A., M. Y. Rafii, M. A. Latif, S. Z. Sakimin, I. W. Arolu and G. Miah (2018). Genetic Diversity of Aromatic Rice GermplasmRevealed by SSR Markers. BioMed Research International 1-11.

Santhanakshmi, S., S. Saikumar, S. Roa, A. Saiharini, P. Khera, H.E. Shashidar (2010). Mapping genetic locus linked to brown plant hopper resistance in rice Oryza Sativa L. International Journal of Plant Breed and Genet. 4:13-22.

Sarvestani, Z. T., H. Pirdashti, S. A. M. M. Sanavy, and H. Balouchi (2008). Study of water stress effects in different growth stages on yield and yield components of different rice (*Oryza sativa* L.) cultivars, Pak. J. Biol. Sci. PJBS, 11(10): 1303–1309.

Schulman, A.H. 2007. Molecular markers to assess genetic diversity. Euphytica Vol.58(3): 313-321.

Sedeek, S.E.M., S.A.A. Hammoud, M.H. Ammar and T.F. Metwally (2009). Genetic variability, heritability, genetic advance and cluster analysis for some physiological traits and yield and its components in rice (*Oryza Sativa* L.).J.Agric.Res,.Kafer EL-Sheikh Univ., 35(3):858-878.

Sendecor, G.W. and W.G. Cochran (1967). Statistical methods. lowa State Univ., Press, USA.

Sivasubramanian, S. and P. Madhavamenon (1973). Genotypic variability in rice. Madras Agriculture Journal 60(9-13), 1093-1096.

Sood, B. C. and E. A. Siddiq (1978). A rapid technique for scent determination in rice. Indian J. Genet. Plant Breed.38:268-271.

USDA (2019). World Agricultural Production United States Department of Agriculture, Foreign Agricultural Service. Circular Series WAP 3-19.

Yang, T. (2007). Investigation of multi-modal high-salt binding ion-exchange chromatography using quantitative structure-property relationship modeling", Journal of Chromatography.

Zaman, N. K., M. Y. Bdullah and S. Othman (2018). Growth and physiological performance of aerobic and lowland rice as affected by water stress at selected growth stages. Rice Science, 25 (2): 82-93.

Zeng, L., T. R. Kwon, X. Liu, C. Wilson, C. M. Grieve and G. B. Gregorio (2004). Genetic diversity analyzed by microsatellite markers among rice (*Oryza sativa* L.) genotypes with different adaptations to saline soils. Journal of Plant Science Vol.166 (5): 1275-285.

Zubaer, M. A., A. K. B. Chowdhury, M. Z. Islam, T. Ahmed and M. A. Hasan (2007). Effects of water stress on growth and yield attributes of Aman rice genotypes. Int. J. Sustain. Crop Prod. 2(6): 25-30.

التنوع الوراثي بين بعض التراكيب الوراثية من الارز تحت ظروف نقص المياه

صابر السيد محمد صديق، تهانى محمد مظال، مرفت محمد عوض الله عثمان، احمد جمال حفينه، وائل حمدى الكلاوى و ايمان محمد بليح

مركز البحوث والتدريب فى الأرز – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية - مصر

الملخص

لدراسة التنوع الوراثى لبعض التراكيب الوراثية للارز وابائها لبعض الصفات المحصولية والمعلمات الجزئيية. اجريت تجربة حقلية في تصميم الشرائح المتعامدة في ثلاث كمرارات بمزرعة ومعمل البيوتكنولوجيا بمركز البحوث والتدريب في الارز – سخا كفرالشيخ- مصر. تم زراعة 14 تركيب وراثى من الارز في شهر مايو موسمى 2021 و 2022. اظهرت النتائج وجود تباين بين التراكيب الوراثية وابائها للصفات المحصولية والمعلمات الجزئيية. تأثرت كل الفات المدروسة سلبا ومعنوي بتعريض الاصناف لنقص المياه. اعطى الصنف الياسمين المصرى اعلى محصول حبوب واقل نسبة فقد في المحصول تحت ظروف الاجهاد المائي. اظهرت المعلمات الجزئيية المستخدمه اختلافات واضحة بين التراكيب الوراثية المستخدمة في الدراسة. اظهرت النتائج ايضا فان معامل التباين المظهرى اكبر من معامل التباين الوراثى مما يدل على تأثير البيئة في الصفات المدروسة.