J. Plant Production, Mansoura Univ., Vol. 7 (10): 1063 - 1071 ,2016

Estimates of Combining Ability for some Quantitative Traits During Different Sowing Dates in Rice

Okaz, A. M. A[1]; E. I. Zaazaa[1]; E. F. El-Hashash[1]; Y. Z. El-Refaee[2] and A. E. M. Bakr[2]
[1]Department of Agronomy, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.
[2]Rice Research Section, Field Crops Research Institute, A.R.C., Giza, Egypt.

ABSTRACT

Half diallel crosses among six genotypes of rice (*Oryza sativa* L.) as well as their parents were cultivated in a randomized complete block design to investigate general combining ability (GCA) effects of parents and specific combining ability (SCA) effects of crosses during different sowing dates. Analysis of variance in diallel analysis exhibited highly significant ($P < 0.01$) for most studied traits at the four sowing dates. The mean squares due to GCA and SCA were also highly significant for all studied traits during the four sowing dates, indicated that the importance of the both additive and dominance gene actions for these traits. Variances due to GCA were greater than these due to SCA for days to heading, panicle length and panicle weight traits during the second, third and fourth sowing dates and for grain yield/plant during the first and second sowing dates. However, the values of SCA variances were higher than the values of GCA variances for the other studied traits through the other studied sowing dates. Results showed significant differences among all the crosses means and their respective parental values for all examined traits at the four sowing dates. The most of parents and their F_1 crosses were displayed significant or highly significant GCA and SCA effects either negative for days to heading or positive for the other studied traits at the four sowing dates. Concerning the four sowing dates, the variety Giza 179 was the best general combiner for days to heading, grain yield/plant, number of panicles/plant and 1000-grain weight traits while, the genotype CT 9882 was the best general combiner for panicle length and panicle weight traits. The best specific combinations during the four sowing dates were the cross Giza 178 x CT 9882 for days to heading and number of panicles/plant traits, the crosses Giza 178 x Sakha 105, Giza 178 x Sakha 106 and Giza 178 x Giza 179 for grain yield/plant and 1000-grain weight traits and the cross Giza 179 x CT 9882 for panicle weight and panicle length traits. Cluster analysis based on all studied traits resulted into two clusters from genotypes through all sowing dates in rice. The first cluster included the two exotic genotypes (CT9882 and CT 9506). The second cluster containing four genotypes, further divided into two sub clusters. Sub cluster-I containing the most earlier rice genotypes (Sakha105 and Sakha106). The Egyptian indica rice varieties (Giza178 and Giza179) were grouped together. The results of cluster analysis suggested that there is genetic diversity among the six genotypes for all studied traits. Hybridization among these genotypes in the two groups provided more possibility to having more genetic diversity and could be used in breeding programs to achieve maximum heterosis as well as earliness and yield improvement in rice. Generally, the parents involved in the previous combinations and the best crosses could be use in initiated the breeding program for growing at early sowing dates (first and second sowing dates) of rice crop in the north of Egypt.

INTRODUCTION

Rice (*Oryza sativa* L.) belongs to the genus Oryza, of the family poeaceae and is a widely cultivated crop (Syed and Khaliq, 2008). It is the most important staple food crop in the world, and used by more than half of the world population (Kohnaki *et al*., 2013). In Egypt, the available amount of irrigation water from River Nile is not only limited but liable to decrement year after year, due to competition of other water using in the country. So we should breed for early maturing varieties to overcome this problem. Early maturing varieties playing a major role in Egypt to give saving about 30-35 % from irrigation water and allows planting of the following crops (particularly clover) one month earlier than late maturity varieties. This will help to increase the number of clover cuts and help reduce crop exposure to biotic and a biotic stress. So, it is crucial to select short duration varieties without much sacrificing yield. In a successful rice improvement program, breeders provide efforts to accommodate the desirable characters to improve grain yield. Yield is a complex polygenic character where many of yield contributing characters form a complex chain of relationship with grain yield. Those yield contributing characters are highly influenced by environmental conditions (Shahriar *et al*., 2014). Magnitude and nature of variation as well as interrelationship of plant traits in a plant population lead to the progress of breeding. The breeding value of any material is largely determined by its combining ability for important traits related to productivity (Hallauer and Miranda, 1981). The entire genetic variability can be partitioned into general (GCA) and specific (SCA) combining abilities (Sprague and Tatum, 1942). GCA effects represent the fixable component of genetic variance (additive type of gene action) and they are important to develop superior genotypes. SCA effects represents the non-fixable component of genetic variation (non-additive type of gene action) and provides information on hybrid performance. Therefore, the both components play an important role in selecting superior parents for hybrid combinations (Duvick, 1999) and represent a powerful method to measure the nature of gene action involved in quantitative traits (Baker, 1978). Baker (1978) suggested that the calculating of GCA and SCA equivalent variance from the expectations of the components of mean squares for diallel designs. The diallel analysis has been widely used by plant breeders to estimate GCA and SCA effects in the selection of parents and crosses in the early generations (Griffing, 1956). The objective of this study was to estimate GCA of parental genotypes and SCA of hybrids for six traits in rice during the four sowing dates for identifying desirable genotypes for growing at early sowing dates of rice crop in the north of Egypt.

MATERIALS AND METHODS

Plant materials and field procedures:

The genetic materials used in the present investigation included four Egyptian rice commercial varieties i.e, Giza178, Sakha105, Sakha106, Giza179 and two exotic ones (CT9506-44-2-1-1-4-3P-M-10 and CT9882-16-4-2-2-2P-M). The origin, pedigree, types and the main characteristics of these genotypes are presented in Table 1. These six rice genotypes were crossed in a series of hybridization according to half diallel crosses mating design (Griffing, 1956) in 2013 growing season at the Research Farm of Agriculture Research Station, Sakha, Kafr El-Sheikh, Egypt,In 2014 growing season, the six parents and their fifteen F_1 hybrids were planted in a randomized complete block design (RCBD) with three replications during the different four sowing dates viz., 1st March 2014(first sowing date); 20th March (second sowing date); 10th April (third sowing date) and 1st May (fourth sowing date). In each sowing date, 30 days old seedlings were transplanted a spacing of 20×20 cm. Each replication consisted of three rows for each F_1 cross and its parents (each F_1 cross planted between its parents). Each row was five meters long and contained 25 individual plants. Recommended cultural practices were followed to raise agronomically good managed crop. Ten plants (except two border plants) were harvested to determine the studied traits. The data were recorded in the field and laboratory for all selected plants to evaluate the performance of the studied traits.

Table 1. The origin, pedigree, types and the main characteristics of six rice genotypes used as parents in the present study.

No.	Genotype	Origin and Pedigree	Type	Main characteristics
1	Giza 178	Egypt (Giza175/Milyang 49)	Indica/Japonica	Medium maturing, short stature, short grain and high yielder.
2	Sakha 105	Egypt (GZ5581-46-3/GZ4316-7-1-1)	Japonica	Early maturing, short stature, short grain and good grain quality.
3	Sakha106	Egypt (Giza177/Hexi 30)	Japonica	Early maturing, short stature, short grain, good grain quality and high yielding.
4	Giza 179	Egypt (GZ6296-12-1-2-1-1/GZ1368-S-5-4)	Indica	Early maturing, short stature, short grain and high yielding.
5	CT 9506-44-2-1-1-4-3P-M-10	IRRI	Indica	Medium maturing, medium stature and medium grain.
6	CT 9882-16-4-2-2-2P-M	IRRI	Indica	Late maturing, medium stature, long grain and high yielding.

Traits measurement and statistical analysis:

Observations were recorded for six traits viz., days to heading (days), grain yield/plant (g), number of panicles/plant, 1000-grain weight (g), panicle length (cm) and panicle weight (g). Data of plot means were subjected to a regular statistical analysis of RCBD as outlined by Steel and Torrie (1980) to test the null hypothesis of no differences between various F_1 hybrids and their parental means. Least significant differences at 5% and 1% levels of probability (LSD at 5% and 1%) were also used for means separation and comparison after significance. The GCA effects of parents and SCA effects of F_1 crosses were calculated according to the method described by Griffing (1956) based on method II model I (fixed model) as outlined by Singh and Chaudhary (1985). Cluster analysis was performed using K-means clustering and tree diagrams based on Euclidian distances was developed by Ward's method using StatistiXL 1.11 software for the six genotypes of the six studied traits in this study.

RESULTS AND DISCUSSION

I- Analysis of variance:

The analysis of variance obtained from diallel analysis for six studied traits during the four sowing dates are presented in Table 2. The mean of squares for the genotypes, parents (P), crosses (C) and P vs C were displayed highly significant differences ($P < 0.01$) for all studied traits during the four sowing dates except the parents variances for number of panicles/plant at the second and third sowing dates, as well as the P vs C variances for days to heading trait at the fourth sowing date and number of panicles/plant at the first and the second sowing dates which were exhibited insignificant. These results indicating presence of sufficient genetic variability among crosses and their parents, hence later analysis for combining ability was possible due to presence of heterosis in these studied traits. The analysis of variance for parents and crosses was highly significant for quantitative traits indicating the existence of sufficient variability in the parents and crosses for all the traits (Prasad *et al*., 2013). Montazeri *et al*. (2014) reported that, the analysis of variance revealed significant differences among genotypes and crosses.

In Table 2, the variance due to general combining ability (GCA) and specific combining ability (SCA) were demonstrated highly significant differences ($P < 0.01$) for all studied traits meantime the four sowing dates, indicated that the importance of the both additive and dominance gene actions for all traits. The GCA variances values greater than SCA variances values for days to heading, panicle length and panicle weight traits during the second, the third and the fourth sowing dates and for grain yield/plant during the first and the second sowing dates. These results indicated that, the additive genes were playing an important role in inheritance of these traits. On the other hand, the values of SCA variances were higher than the values of GCA variances for the other studied traits through the other studied sowing dates, which revealed that non-additive variance played relatively greater role in the inheritance of these traits. Therefore, the selection will be effective using bulk method, not pedigree method. Rahaman (2016) stated that in case of 1000 grain weight, days to flowering and grain yield per hill were found high estimates of SCA variance i.e. non-additive gene action .Montazeri *et al.* (2014) found that the variances of SCA were higher than the GCA variances for panicle length and 1000-grain weight which indicated predominance of non-additive gene action in the inheritance of these traits. Rahimi *et al.* (2010), El-Refaee *et al.* (2016), Rahaman (2016) and Satheeshkumar *et al.* (2016) mentioned that, the analysis of variance for combining ability due to GCA and SCA were highly significant for days to heading, yield and its components traits indicated that both additive and non-additive gene effects contributed to the inheritance of the traits.

Table 2. Mean squares estimates of ordinary analysis and combining ability for various quantitative traits in rice.

S.O.V		Days to heading (day)				Grain yield/plant (g)				No. of panicles/plant			
		SD_1	SD_2	SD_3	SD_4	SD_1	SD_2	SD_3	SD_4	SD_1	SD_2	SD_3	SD_4
Replications	2	0.68	4.11	0.42	0.07	0.06	2.32	0.23	0.28	0.71	0.11	0.12	0.13
Genotypes	20	265.80**	216.90**	124.90**	267.20**	62.08**	79.33**	446.60**	273.2**	11.58**	9.51**	32.45**	57.55**
Parents (P)	5	588.60**	528.80**	416.70**	572.00**	126.20**	58.31**	9.37*	24.75**	4.76**	0.88	1.14	13.32**
Crosses (C)	14	132.20**	120.20**	5.94**	177.20**	42.42**	90.69**	552.20**	270.00**	14.84**	13.09**	38.17**	64.73**
P vs C	1	523.00**	10.16**	331.10**	3.51	16.69**	25.34**	1155.0**	1559.0**	0.10	2.64	108.8**	178.1**
Error	40	0.98	0.81	1.23	1.05	2.05	1.23	3.24	1.30	0.38	0.85	1.88	1.24
G.C.A	5	78.81**	155.40**	65.99**	177.30**	33.05**	51.02**	141.90**	58.25**	2.91**	1.43**	6.57**	8.18**
S.C.A	15	91.88**	44.60**	33.51**	59.68**	16.57**	18.25**	151.20**	102.0**	4.18**	3.75**	12.23**	22.85**
Error	40	0.33	0.27	0.41	0.35	0.68	0.41	1.08	0.43	0.13	0.28	0.63	0.41

*** and ** denote significant at 5% and 1% levels of probability, respectively.**

SD1, first sowing date; SD2, second sowing date; SD3, third sowing date and SD4, fourth sowing date .

Table 2. Continue

S.O.V	d.f	1000-grain weight (g)				Panicle length (cm)				Panicle weight (g)			
		SD_1	SD_2	SD_3	SD_4	SD_1	SD_2	SD_3	SD_4	SD_1	SD_2	SD_3	SD_4
Replications	2	0.25	0.05	0.26	0.79	0.24	0.37	1.33	0.17	0.05	0.04	0.03	0.07
Genotypes	20	28.30**	28.37**	21.79**	35.60**	33.69**	36.20**	27.32**	25.68**	2.53**	1.80**	1.95**	3.45**
Parents	5	22.81**	16.80**	17.27**	28.93**	15.84**	73.23**	58.09**	44.54**	1.00**	1.07**	0.12**	0.49**
Crosses	14	27.66*	27.32**	14.16**	26.22**	39.24**	16.73**	13.26**	11.31**	3.18**	2.18**	2.57**	4.74**
P vs F_1	1	64.64**	100.80**	151.20**	200.2**	45.25**	123.6**	70.38**	132.5**	1.13**	0.16*	2.51**	0.15**
Error	40	0.10	0.21	0.15	0.24	0.25	0.13	0.33	0.25	0.02	0.03	0.01	0.03
G.C.A	5	6.38**	4.21**	5.42**	9.21**	8.57**	21.48**	24.72**	22.30**	0.40**	1.13**	1.17**	1.99**
S.C.A	15	10.45**	11.21**	7.88**	12.75**	12.12**	8.93**	3.90**	3.98**	0.99**	0.42**	0.48**	0.87**
Error	40	0.03	0.07	0.05	0.08	0.09	0.04	0.11	0.08	0.01	0.01	0.01	0.01

*** and ** denote significant at 5% and 1% levels of probability, respectively.**

SD1, first sowing date; SD2, second sowing date; SD3, third sowing date and SD4, fourth sowing date.

Mean performances:

The mean performances of the six parents and their 15 F_1 crosses for all studied traits at the four sowing dates are illustrated in Table 3. The mean performances values of parents and single crosses demonstrated highly significant differences for all studied traits. Comparative between the parents and 15 F_1 hybrids at the four sowing dates, the values of mean performances detected that, the fourth sowing date was higher than the other sowing dates for most studied traits.

The parent Giza 179 was recorded the desirable lowest values of mean performances at the fourth sowing dates for days to heading (91.32 day). On the other hand, the parent Giza 179 for grain yield/plant (49.55 g), the parent Sakha 106 for number of panicles/plant (21.53), the parent CT 9506 for 1000-grain weight (30.47 g), the parent CT 9886 for panicle weight (4.84 g) were denoted the highest mean performances values during the four sowing dates. While, the maximum mean performances values of the parent CT 9886 for panicle length (31.86 cm) during the second sowing date were found.

With respect to the results from the diallel crosses noticed that, the cross P2 x P6 for days to heading (92.00 day), the cross P2 x P3 for number of panicles/plant (29.73), the cross P1 x P5 for panicle weight (6.46 g), the cross P1 x P2 for 1000-grain weight (35.13 g) were exhibited the better values of mean performances during the fourth sowing date. On the other hand, the crosses P2 x P6 and P4 x P6 for panicle length (32.01) and grain yield/plant (75.58 g) during the first and third sowing dates were displayed the best mean performances values.

Generally, these results indicated that, the superiority of some single crosses, were depended on their corresponding parents. These view points were kept in mind while selecting these single crosses as diverse F_1 base populations for initiating reciprocal selection for combining ability. Consequently, the parents involved in the previous combinations should be used in improving yield and its components and the best crosses should be used in initiated the breeding program.

Table (3): Mean performances of parental varieties and their 15 F1's crosses for six quantitative traits under four sowing dates in rice.

Traits		Days to heading (day				Grain yield/plant (g)				No. of panicles/plant			
Genotypes		**SD_1**	**SD_2**	**SD_3**	**SD_4**	**SD_1**	**SD_2**	**SD_3**	**SD_4**	**SD_1**	**SD_2**	**SD_3**	**SD_4**
Giza 178 (P1)		124.0	116.0	107.4	100.4	22.47	30.22	38.63	45.86	17.33	16.33	16.33	19.37
Sakha 105(P2)		117.0	115.0	100.4	95.80	21.43	28.28	36.64	42.54	15.73	17.40	17.33	20.32
Sakha 106(P3)		115.0	107.0	100.3	96.20	20.82	25.12	34.64	43.54	15.60	16.27	18.19	21.53
Giza 179(P4)		114.0	108.0	95.63	91.32	31.90	38.00	38.51	49.55	16.73	16.07	17.75	19.07
CT 9506 (P5)		122.0	123.0	116.0	117.0	35.88	31.76	36.04	47.95	18.87	17.20	17.33	15.47
CT 9882 (P6)		151.3	143.0	127.0	126.0	31.27	33.26	34.67	48.77	15.87	16.53	17.33	17.80
P1xP2		138.0	120.0	112.0	105.0	29.40	35.07	53.12	54.81	15.67	15.67	21.00	19.60
P1xP3		139.0	128.0	114.0	110.0	27.63	31.79	41.02	51.51	15.07	15.73	19.00	21.33
P1xP4		129.0	124.0	114.0	109.0	32.04	41.37	64.08	63.74	16.23	17.07	28.67	25.93
P1xP5		129.0	114.0	113.0	97.00	22.43	27.50	32.50	54.59	19.07	19.40	21.00	27.13
P1xP6		122.0	121.0	113.0	100.0	23.60	30.73	37.41	59.84	17.93	18.27	21.33	27.20
P2xP3		132.0	112.0	114.0	99.00	26.17	32.08	41.86	68.63	17.27	16.27	21.67	29.73
P2xP4		133.0	113.7	113.0	95.00	30.60	34.97	49.49	65.87	16.20	17.20	20.67	25.47
P2xP5		122.0	110.0	111.0	100.0	21.67	27.83	32.15	58.21	13.60	14.93	25.33	24.93
P2xP6		123.0	111.0	114.0	92.00	22.27	26.95	35.12	39.78	15.60	16.60	20.67	16.80
P3xP4		127.0	113.0	111.0	94.00	23.16	26.56	35.50	46.18	21.67	22.00	14.33	16.93
P3xP5		135.0	119.0	116.0	108.0	21.20	24.52	35.01	50.57	18.07	18.73	16.67	17.60
P3xP6		125.0	125.0	112.0	108.0	25.33	30.65	37.30	45.20	17.40	17.50	16.33	15.73
P4xP5		125.0	109.0	112.0	114.0	32.00	41.46	57.63	68.49	17.07	17.73	16.80	24.00
P4xP6		144.0	121.0	113.0	113.0	28.77	36.53	75.58	71.13	15.87	16.20	20.20	27.67
P5xP6		131.0	126.0	111.0	115.0	26.07	39.67	62.20	62.18	12.33	13.00	20.67	19.67
	0.05	1.42	1.29	1.59	1.46	2.05	1.59	2.57	1.63	0.88	1.32	1.96	1.59
L.S.D.	**0.01**	1.90	1.72	2.12	1.96	2.74	2.12	3.44	2.18	1.17	1.76	2.62	2.13

P1, Giza178; P2, Sakha105; P3, Sakha106; P4, Giza179; P5, CT9506 and P6, CT9882.
SD1, first sowing date; SD2, second sowing date; SD3, third sowing date and SD4, fourth sowing date.

Table (3): Continue

Traits		1000-grain weight (g)				Panicle length (cm)				Panicle weight (g)			
Genotypes		**SD_1**	**SD_2**	**SD_3**	**SD_4**	**SD_1**	**SD_2**	**SD_3**	**SD_4**	**SD_1**	**SD_2**	**SD_3**	**SD_4**
Giza 178 (P1)		22.23	23.00	22.53	22.13	21.84	19.74	22.22	22.28	2.39	3.73	3.68	4.12
Sakha 105(P2)		25.73	28.00	27.30	29.17	23.66	24.40	22.94	23.04	3.05	3.32	3.68	4.30
Sakha 106(P3)		26.93	26.00	29.47	29.20	24.03	19.24	21.39	21.39	2.92	3.71	3.63	4.09
Giza 179(P4)		28.23	27.00	27.30	29.57	23.79	21.99	19.06	21.39	3.83	3.26	3.80	3.88
CT 9506 (P5)		28.53	30.00	28.60	30.47	26.15	27.93	27.57	27.71	3.80	4.39	4.03	4.82
CT 9882 (P6)		30.13	28.00	27.20	26.37	28.41	31.86	30.97	30.63	3.60	4.76	4.10	4.84
P1xP2		30.53	32.00	32.50	35.13	28.85	27.39	24.85	26.15	3.87	3.13	2.66	2.76
P1xP3		33.83	32.33	32.20	33.47	24.30	27.13	25.63	25.77	3.16	3.09	2.70	3.07
P1xP4		30.73	32.67	32.10	34.33	25.51	23.82	23.87	26.31	3.09	3.19	2.35	4.64
P1xP5		28.23	32.00	32.00	32.27	21.80	24.53	27.59	29.03	3.15	3.95	4.44	6.46
P1xP6		33.83	29.67	29.70	30.63	30.45	28.16	27.83	30.77	5.65	4.32	3.65	5.80
P2xP3		29.93	30.00	28.00	32.33	26.03	24.71	22.47	26.56	4.99	4.01	2.84	3.58
P2xP4		27.53	30.00	31.70	33.40	27.35	28.75	27.35	27.10	2.29	3.19	2.33	3.03
P2xP5		26.33	24.00	27.60	29.33	25.59	28.33	26.23	26.74	2.71	3.41	3.63	4.09
P2xP6		22.13	22.33	25.60	22.77	32.01	29.87	27.75	28.30	3.91	3.82	3.60	4.90
P3xP4		30.93	31.67	31.80	34.73	23.18	27.03	24.31	24.75	2.73	2.45	2.22	2.41
P3xP5		31.93	29.00	33.60	30.93	27.57	24.73	27.39	26.39	2.54	3.01	3.75	3.48
P3xP6		29.53	30.67	30.00	32.33	29.97	30.55	26.87	28.97	2.47	3.91	2.83	4.13
P4xP5		27.63	30.67	31.30	31.80	28.71	29.78	24.15	26.27	4.93	4.51	3.64	3.94
P4xP6		28.13	32.00	29.50	31.23	28.35	30.27	29.61	30.36	4.31	5.99	5.06	6.29
P5xP6		26.87	28.00	29.83	31.73	18.17	24.33	29.55	30.78	3.63	4.30	4.97	4.92
	0.05	0.45	0.66	0.56	0.70	0.72	0.51	0.82	0.71	0.22	0.23	0.17	0.26
L.S.D.	0.01	0.61	0.88	0.75	0.93	0.96	0.68	1.10	0.95	0.29	0.31	0.23	0.35

P1, Giza178; P2, Sakha105; P3, Sakha106; P4, Giza179; P5, CT9506; P6, CT9882.
SD1, first sowing date; SD2, second sowing date; SD3, third sowing date and SD4, fourth sowing date.

Combining ability effects:

1- General combining ability effects:

Estimates of GCA effects for six studied traits during the four sowing dates are shown in Table 4. In respect to days to heading trait, the parents Sakha 105, Saka 106 and Giza 179 during the four sowing dates, the parent Giza 178 during the fourth sowing date and the parent CT 9506 during the first sowing date were exhibited desirable negative and highly significant GCA effects.

Table 4. General combining ability effects of six parental genotypes for six studied traits under sowing dates in rice.

Traits	Days to heading (day)				Grain yield/plant (g)				No. of panicles/plant			
Genotypes	SD_1	SD_2	SD_3	SD_4	SD_1	SD_2	SD_3	SD_4	SD_1	SD_2	SD_3	SD_4
Giza 178	0.74**	1.60**	0.11	-0.85**	-0.67*	0.26	0.29	-0.43*	0.28*	0.01	0.93**	1.11**
Sakha 105	-2.14**	-3.69**	-1.88**	-5.75**	-1.55**	-1.41**	-2.25**	-0.91**	-0.82**	-0.40*	0.98**	0.76**
Sakha 106	-1.39**	-1.90**	-1.54**	-2.15**	-2.53**	-3.62**	-5.38**	-3.81**	0.54**	0.51**	-1.48**	-0.84**
Giza 179	-1.64**	-3.69**	-3.21**	-2.62**	3.13**	4.02**	7.03**	4.36**	0.51**	0.45*	0.00	0.88**
CT 9506	-1.64**	-0.28	1.89**	4.93**	1.22**	-0.04	-1.43**	1.29**	0.19	-0.06	-0.13	-0.85**
CT 9882	6.07**	7.97**	4.64**	6.43**	0.40	0.78**	1.74**	-0.50*	-0.69**	-0.51**	-0.29	-1.05**
0.05	0.37	0.34	0.42	0.39	0.54	0.42	0.68	0.43	0.23	0.35	0.52	0.42
L.S.D. 0.01	0.50	0.45	0.56	0.52	0.72	0.56	0.91	0.67	0.31	0.47	0.69	0.53

*** and ** denote significant at 5% and 1% levels of probability, respectively.**

SD1, first sowing date; SD2, second sowing date; SD3, third sowing date and SD4, fourth sowing date.

Table 4. Continue

Traits	1000-grain weight (g)				Panicle length (cm)				Panicle weight (g)			
Genotypes	SD_1	SD_2	SD_3	SD_4	SD_1	SD_2	SD_3	SD_4	SD_1	SD_2	SD_3	SD_4
Giza 178	0.21**	0.21*	-0.38**	-0.54**	-0.91**	-1.79**	-0.71**	-0.54**	-0.08**	-0.17**	-0.17**	0.14**
Sakha 105	-1.51**	-1.08**	-0.83**	-0.39**	0.66**	0.38**	-0.67**	-0.75**	-0.06*	-0.29**	-0.27**	-0.36**
Sakha 106	1.26**	0.33**	0.99**	0.97**	-0.35**	-1.53**	-1.30**	-1.46**	-0.33**	-0.33**	-0.37**	-0.62**
Giza 179	0.18**	1.00**	0.55**	1.27**	-0.15	-0.15*	-1.56**	-1.17**	0.08**	-0.08**	-0.17**	-0.22**
CT 9506	-0.24**	0.08	0.62**	0.32**	-0.97**	0.34**	1.28**	0.97**	0.03	0.19**	0.50**	0.34**
CT 9882	0.10	-0.54**	-0.95**	-1.63**	1.73**	2.76**	2.96**	2.94**	0.35**	0.67**	0.47**	0.73**
0.05	0.12	0.17	0.15	0.18	0.19	0.13	0.22	0.19	0.06	0.06	0.04	0.07
L.S.D. 0.01	0.16	0.23	0.20	0.25	0.25	0.18	0.29	0.25	0.08	0.08	0.06	0.09

*** and ** denote significant at 5% and 1% levels of probability, respectively.**

SD1, first sowing date; SD2, second sowing date; SD3, third sowing date and SD4, fourth sowing date.

Meanwhile the first sowing date, the parents Giza 178 and Sakha 106 for number of panicles/plant and 1000-grain weight traits; the parent Sakha 105 for panicle length trait; the parent Giza 179 for grain yield/plant, number of panicles/plant, 1000-grain weight and panicle weight traits; the parent CT 9506 for grain yield/plant and lastly the parent CT 9882 for panicle length and weight traits were exhibited positive and significant or highly significant GCA effects. Meantime the second sowing date, highly significant positive GCA effects exhibited for the parent Sakha 105 of panicle length trait; the parent Sakha 106 for number of panicles/plant and 1000-grain weight traits; the parent Giza 179 for grain yield/plant and 1000-grain weight traits; the parent CT 9506 for panicle length and panicle weight traits and finely the parent CT 9882 for grain yield/plant, panicle length and panicle weight traits. However, the parents Giza 178 and Giza 179 were exhibited significant positive estimates of GCA for 1000-grain weight and number of panicle/plant, respectively.

In respect to the third sowing date, the parents, Giza 178 and Sakha 105 for number of panicles/plant, the parent, Giza 179 for grain yield/plant and 1000-grain weight traits, the parents Sakha 106 and CT 9506 for 1000-grain weight trait, the parent CT 9882 for grain yield/plant and the two parents CT 9506 and CT 9882 for panicle length and panicle weight traits were displayed positive and highly significant of GCA effects. Concerning the fourth sowing date, the parent Giza 178 for number of panicles/plant and panicle weight traits, the parent Sakha 105 for number of panicles/plant, the parent Sakha 106 for 1000-grain weight, the parent Giza 179 for grain yield/plant, number of panicles/plant and 1000-grain weight traits as well as both of parents CT 9506 and CT 9882 for panicle length and panicle weight traits while each one of them were revealed positive and high significantly GCA effects for grain yield/plant and 1000-grain weight traits and panicle weight. Other estimates of GCA effects were displayed undesirable insignificant positive and significant or highly significant negative for the parents during the four sowing dates.

The results detected that, the best general combiner were the parent Giza 179 for days to heading, grain yield/plant and 1000-grain weight traits through the four sowing; the parent Giza 178 for number of panicles/plant at first, third and fourth sowing dates; the parent CT 9882 for panicle length and panicle weight traits at the four sowing dates; the parent Sakha 105 for days to heading during the four sowing dates; and the parent Sakha 106 for days to heading and 1000-grain weight traits through the four sowing dates. The parents were found to be good general combiners as they could contribute alleles with positive effect for improving the important quantitative traits. With regard to GCA effects of parents, it could be suggested that these parents may be preferred for hybridization and selection programs to extract desirable plants from segregating populations to improve majority of the studied traits. Montazeri *et al*., (2014), Rahaman (2016), Satheeshkumar *et al*., (2016) also concluded that parents with maximum GCA effects were found better responsive to produce high yielding hybrids.

2- Specific combining ability effects:

Estimates of SCA effects based on mean performance of the best crosses for studied traits at the four sowing dates is illustrated in Table (5). Significant or highly significant and positive or negative SCA effects were noticed by some crosses for six studied traits.

Table 5. Specific combining ability effects of each cross for six studied traits during the four sowing dates in rice.

Traits	Days to heading (da				Grain yield/plant (g)				No. of panicles/plant			
Genotypes	SD_1	SD_2	SD_3	SD_4	SD_1	SD_2	SD_3	SD_4	SD_1	SD_2	SD_3	SD_4
P1xP2	10.96**	4.07**	2.36**	7.51**	5.14**	4.11**	11.78**	1.92**	-0.42	-0.90	-0.37	-3.85**
P1xP3	11.21**	10.27**	4.01**	8.91**	4.35**	3.03**	2.82**	1.51*	-2.38**	-1.75**	0.09	-0.52
P1xP4	1.46**	8.07**	5.69**	8.38**	3.10**	4.98**	13.46**	5.58**	-1.19**	-0.36	8.28**	2.36**
P1xP5	1.46**	-5.35**	-0.41	-11.17**	-4.60**	-4.84**	-9.65**	-0.50	1.97**	2.49**	0.74	5.30**
P1xP6	-13.25**	-6.60**	-3.16**	-9.67**	-2.62**	-2.43**	-7.92**	6.53**	1.72**	1.81**	1.24	5.56**
P2xP3	7.08**	-0.44	6.00**	2.81**	3.77**	5.00**	6.20**	19.11**	0.93**	-0.80	2.71**	8.23**
P2xP4	8.33**	3.02**	6.67**	-0.72	2.54**	0.26	1.42	8.18**	-0.12	0.19	0.24	2.24**
P2xP5	-2.67**	-4.06**	-0.42	-3.26**	-4.49**	-2.83**	-7.45**	3.60**	-2.39**	-1.56**	5.04**	3.44**
P2xP6	-9.38**	-11.31**	-0.17	-12.76**	-3.07**	-4.53**	-7.66**	-13.05**	0.49	0.56	0.53	-4.49**
P3xP4	1.58**	0.57	4.33**	-5.32**	-3.92**	-5.95**	-9.44**	-8.60**	3.99**	4.08**	-3.64**	-4.69**
P3xP5	9.58**	3.15**	4.23**	1.14*	-3.97**	-3.94**	-1.47	-1.14	0.72*	1.33**	-1.18	-2.29**
P3xP6	-8.13**	0.90	-2.52**	-0.36	0.98	1.37*	-2.34*	-4.73**	0.93**	0.54	-1.35	-3.96**
P4xP5	-0.17	-5.06**	1.91**	7.61**	1.17	5.37**	8.74**	8.61**	-0.26	0.39	-2.52**	2.39**
P4xP6	11.13**	-1.31**	0.16	5.11**	-1.24	-0.38	23.52**	13.04**	-0.58	-0.70	1.04	6.26**
P5xP6	-1.88**	0.27	-6.94**	-0.44	-2.03**	6.81**	18.60**	7.16**	-3.79**	-3.39**	1.64*	-0.01
0.05	1.03	0.93	1.15	1.06	1.48	1.15	1.86	1.18	0.64	0.96	1.42	1.15
L.S.D. 0.01	1.37	1.25	1.54	1.42	1.98	1.54	2.49	1.58	0.85	1.28	1.90	1.54

*** and ** denote significant at 5% and 1% levels of probability, respectively.**
SD1, first sowing date; SD2, second sowing date; SD3, third sowing date and SD4, fourth sowing date.
P1, Giza178; P2, Sakha105; P3, Sakha106; P4, Giza179; P5, CT9506; P6, CT9882.

Table 5. Continue

Traits	1000-grain weight (g)				Panicle length (cm)				Panicle weight (g)			
Genotypes	SD_1	SD_2	SD_3	SD_4	SD_1	SD_2	SD_3	SD_4	SD_1	SD_2	SD_3	SD_4
P1xP2	3.26**	3.88**	4.19**	5.44**	3.13**	2.40**	0.53	0.74**	0.53**	-0.20*	-0.41**	-1.28**
P1xP3	3.80**	2.79**	2.07**	2.41**	-0.42	4.04**	1.94**	1.07**	0.09	-0.20*	-0.26**	-0.71**
P1xP4	1.78**	2.46**	2.42***	2.97**	0.59*	-0.64**	0.44	1.32**	-0.39**	-0.35**	-0.82**	0.46**
P1xP5	-0.30	2.71**	2.25**	1.86**	-2.30**	-0.42*	1.33**	1.90**	-0.28**	0.15	0.61**	1.72**
P1xP6	4.96**	1.00**	1.51**	2.17**	3.64**	0.79**	-0.12	1.67**	1.90**	0.03	-0.16**	0.66**
P2xP3	1.61**	1.75**	-1.68**	1.12**	-0.27	-0.54**	-1.26**	2.07**	1.90**	0.84**	-0.03	0.30**
P2xP4	0.29	1.08**	2.46**	1.89**	0.86**	2.12**	3.88**	2.31**	-1.21**	-0.23**	-0.75**	-0.65**
P2xP5	-0.49**	-4.00**	-1.71**	-1.23**	-0.08	1.21**	-0.07	-0.18	-0.73**	-0.27**	-0.11	-0.15
P2xP6	-5.03**	-5.04**	-2.14**	-5.85**	3.64**	0.33	-0.24	-0.60*	0.14	-0.35**	-0.11	0.26**
P3xP4	0.93**	1.33**	0.75**	1.86**	-2.30**	2.31**	1.48**	0.67*	-0.51**	-0.93**	-0.75**	-1.01**
P3xP5	2.35**	-0.42	2.48**	-0.99**	2.91**	-0.49**	1.73**	0.18	-0.64**	-0.64**	0.12*	-0.49**
P3xP6	-0.39*	1.88**	0.44*	2.36**	2.60**	2.92**	-0.48	0.79**	-1.04**	-0.22**	-0.78**	-0.24*
P4xP5	-0.88**	0.58*	0.62**	-0.43	3.85**	3.19**	-1.26**	-0.23	1.34**	0.62**	-0.19**	-0.44**
P4xP6	-0.72**	2.54**	0.38	0.95**	0.78**	1.26**	2.51**	1.88**	0.39**	1.61**	1.26**	1.51**
P5xP6	-1.56**	-0.54*	0.65**	2.41**	-8.58**	-5.17**	-0.38	0.17	-0.23**	-0.34**	0.50**	-0.42**
0.05	0.33	0.48	0.41	0.50	0.52	0.37	0.60	0.51	0.16	0.17	0.12	0.19
L.S.D. 0.01	0.44	0.64	0.54	0.67	0.70	0.49	0.80	0.69	0.21	0.22	0.16	0.25

*** and ** denote significant at 5% and 1% levels of probability, respectively.**
SD1, first sowing date; SD2, second sowing date; SD3, third sowing date and SD4, fourth sowing date.
P1, Giza178; P2, Sakha105; P3, Sakha106; P4, Giza179; P5, CT9506; P6, CT9882.

In relation to days to heading, five crosses during both of first and fourth sowing dates were displayed desirable negative highly significant SCA effects values and ranged from -1.88 to -13.25 for the first sowing date (P1×P6, P2×P6, P3×P6, P2×P5, and P5×P6) while, for the fourth sowing date ranged from -3.26 to -12.76(P2×P6, P1×P5, P1×P6, P3×P4 and P2×P5), respectively. Six crosses during the second sowing date were displayed desirable negative highly significant SCA effects values and ranged from -1.31 to -11.31 (P2×P6, P1×P6, P1×P5, P4×P5, P2×P5 and P4×P6) and three crosses during the third sowing date exhibited desirable negative highly significant SCA effects values and ranged from -2.52 to -6.94(P5×P6, P1×P6, and P3×P6), respectively.

Concerning to grain yield/plant, five crosses during all the four sowing dates were displayed desirable positive and highly significant SCA effects values (P1×P2, P1×P3, P1×P4, P2×P3, and P5×P6) except the last cross (P5×P6) showed negative SCA effects value, and ranged from 1.51 to 19.11.

Regarding to no. of panicles/plant, cross P3×P4 gave the highest positive highly significant SCA effects during the first and the second sowing dates (3.99 and 4.08), while during the third sowing date, cross P1×P4 gave the highest positive highly significant SCA effects (8.28). During the fourth sowing date, the crosses P2×P3 followed by P4×P6 and P1×P6 showed the highest positive highly significant SCA effects (8.23, 6.26 and 5.56), respectively.

For 1000 grain weight, six crosses during all the four sowing dates were displayed desirable positive and highly significant SCA effects values (P1×P2, P1×P3, P1×P4, P1×P6, P2×P3 and P3×P4) and generally, ranged from 0.93 to 5.44.

Regarding to panicle length, three crosses during all the four sowing dates were displayed desirable positive and highly significant SCA effects values (P1×P2, P2×P4 and P4×P6) and ranged from 0.53 to 3.88.

Concerning to panicle weight, crosses P1×P6 and P2×P3 gave the highest positive highly significant SCA effects during the first sowing dates (1.90). And cross P4×P6 gave the highest positive highly significant SCA effects during the second and the third sowing dates (1.61 and 1.26) respectively, while during the fourth sowing date, cross P1×P5 gave the highest positive highly significant SCA effects (1.72).

Finally, concerning among the four sowing dates, the results showed that, the cross P1 x P6 at the fourth sowing dates and the cross P2 x P6 at the first, second and fourth sowing dates for days to heading, the crosses P1 x P2, P1 x P3 and P1 x P4 for grain yield/plant and 1000-grain weight traits during the all four sowing dates, the crosses P1 x P4 and P2 x P3 for number of panicles/plant at the third and fourth sowing dates, respectively, the cross P3 x P4 for number of panicles/plant at the first and second sowing dates, the cross P2 x P4 for panicle length at the four sowing sates and the cross P4 x P6 for panicle length and panicle weight traits at the four sowing dates were found to be the best specific combinations.

These results indicated the possibility of utilizing these genotypes for further exploitation. The results obtained here concerning general and specific combining ability effects indicated that, the excellent hybrids combination were obtained from crossing good by good, good by low and low by low combiners. The attained results may be due to the presence of a considerable non-allelic gene action. On the other hand, the significant negative estimates at SCA revealed the presence of undesirable types in these combinations. These results as well as general combining ability confirm that the parental general combining ability effects were generally unrelated to specific combining ability effects estimates for their respective crosses. Most of the crosses with high SCA have at least the highest one GCA parent. Therefore, high × low, low × high and in some cases high × high GCA parents performed well in SCA determination and revealed also the best mean performance. Therefore, after analyzing the F_1 hybrids through combining ability with reasonable SCA variance, the medium type of heterosis in such specific cross combinations may have some stability and such promising F_1 hybrids can also be used for hybrid rice productions. Among the crosses the best hybrids exhibited significant SCA effect for grain yield/plant, indicating the preponderance of non-additive gene action for yield and its contributing traits (Prasad *et al*., 2013). Rahaman (2016) declared that cross combinations were observed to be good specific cross combinations for magnitude of gene action. The two crosses exhibited good SCA effects for major yield and more than seven yield contributing characters (Satheeshkumar *et al*., 2016).

Generally, the parents involved in the above combinations and the best crosses could be used in initiated the breeding program for growing at early sowing dates (first and second sowing dates) of rice crop at the north of Egypt in future improvement programs. Thus hybrid varieties have positive potential for rice breeding.

Genetic diversity by cluster analysis:

The diversity analysis by cluster analysis was used as a tool to classify six genotypes for six traits in rice during the four studied sowing dates Figure 1. Cluster analysis based on all studied traits resulted into two clusters from genotypes through all sowing date in rice.

The first cluster included the two exotic genotypes (CT9882 and CT 9506). These genotypes belong to indica type variety (adapted in sub-tropical regions). The remain parental genotypes (four genotypes) were grouped into the second cluster. The two genotypes (CT9882 and CT 9506) were the latest maturity genotypes as well as they had low no. of panicles per plant. The second cluster containing four genotypes, further divided into two sub clusters. Sub cluster-I containing the most earlier rice genotypes (Sakha105 and Sakha106). The Egyptian japonica rice varieties (Sakha105 and Sakha106) grouped together due to they have the same genetic background and also, they have high 1000 grain weight and no. of panicles per plant. Sub cluster-I I containing two genotypes, further divided into two sub- sub clusters.

The Egyptian indica rice varieties (Giza178 and Giza179) grouped together due to they have the same genetic background and also, they have the highest grain yield as well as high no. of panicles per plant. However, the distribution of genotypes in this study indicated that the geographical origin has bearing on clustering pattern. Classifying the results of the cluster analysis identified majority genotypes suitable for sown and which confirm the results of the compared means performance for all studied traits.

The results of cluster analysis suggested that there is genetic diversity among the six genotypes for all studied traits. Hybridization among these genotypes in the two groups provided more possibility to having more genetic diversity and could be used in breeding programs to achieve maximum heterosis as well as earliness and yield improvement in rice. Sala *et al*. (2016) stated that, the dendrogram of cluster analysis revealed that the thirteen genotypes were grouped in to six clusters. The cluster II is the biggest cluster consisting of six genotypes followed by cluster I with three genotypes and Cluster II with six genotypes and cluster III, IV, V and VI are mono-clusters. Multivariate analysis based on 10 agronomic characters indicated that the 15 varieties in rice were grouped into four distant clusters (Biswash *et al*. 2016). Nurhasanah *et al*. (2016) mentioned that genetic diversity analysis based on Agro-morphological characters clustered the cultivars in nine and four classes for rice populations in PPU and Paser districts, respectively.

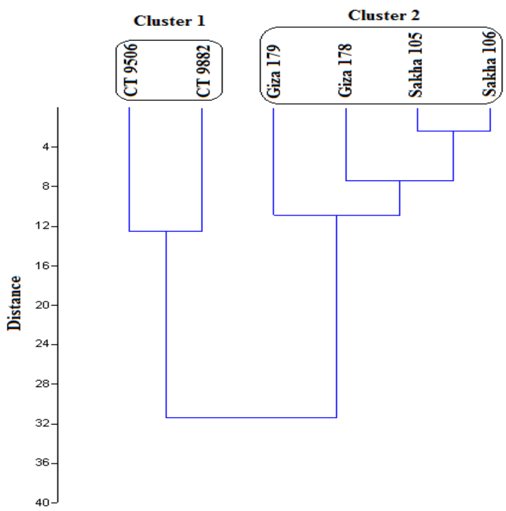

Figure 1. Tree diagram for six genotypes of six studied traits during four different sowing dates using hierarchical cluster analysis (ward's method).

REFERENCES

Baker, R. J. (1978). Issues in diallel analysis. Crop Sci. 18: 533-536.

Basal, H. and I. Turgut (2003). Heterosis and combining ability for yield components and fiber quality parameters in a half diallel cotton (*G. hirsutum*) population. Turk. J. Agric. & For. 27: 207-212.

Biswash, M. R.; M. Sharmin; N. M. F. Rahman; T. Farhat and M. A. Siddique (2016). Genetic Diversity in Modern T. Aman Rice Varieties of Bangladesh (*Oryza sativa* L.). Sains Malaysiana 45(5): 709–716.

Duvick, D. N. (1999). Commercial strategies for exploitation of heterosis: The Genetics and Exploitation of Heterosis in Crops. Wisconsin, U.S.A. Falconer, D.S. (1989). Introduction to Quantitative Genetics. (Second edition). Longman, New York, USA.

EL-Refaee Y. Z.; A. M. Reda; M. M. Shehab and A. E. Draz (2016). Heterosis for Yield and some Morphological Traits in Inter and Intra Sub-Specific crosses of Rice. Egypt. J. Agric. Res., 91(1): 88-106.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol. Sci. 9:463-493.

Hallauer, A. R. and J. B. Miranda (1981). Quantitative Genetics in Maize Breeding. Iowa State Univ. press, Ames Iowa, U.S.A.

Kohnaki, M. E., G. Kiani and G. Nematzadeh (2013). Relationship between morphological traits in rice restorer lines at F3 generation using multivariate analysis. *Int. J. Adv. Biol. Biomed. Res.* 1(6): 572-577.

Montazeri, Z.; N.B. Jelodar and N. Bagheri (2014). Genetic Dissection of Some Important Agronomic Traits in Rice Using Line × Tester Method. Int J Adv Biol Biom Res. 2014; 2(1):181-191.

Nurhasanah; Sadaruddin and W. Sunaryo (2016). Diversity analysis and genetic potency identification of local rice cultivars in Penajam Paser Utara and Paser Districts, East Kalimantan. BIODIVERSITAS, 17 (2): 401-408.

Prasad, S.; O. P. Verma; N. Treepathi; Ashish, and P.K. Yadav (2013). Combining Ability for Yield and its Contributing Traits in Rice (Oryza sativa L.) Under Salt Affected Soil. International Journal of Science and Research. 6.14: 1050 – 1054.

Rahaman, A. (2016). Study of nature and magnitude of gene action in hybrid rice (*Oryza sativa* L.) through experiment of line x tester mating design. International J. of Appl. Res., 2016; 2(2): 405-410.

Rahimi, M.; B. Rabiei, H. Samizadeh and A. Kafi Ghasemi1 (2010). Combining Ability and Heterosis in Rice (Oryza sativa L.) Cultivars. J. Agr. Sci. Tech. (2010) Vol. 12: 223-231.

Sala M; P. Shanthi; B. Selvi and V. Ravi (2016). Marker based genetic diversity of rice genotypes for salinity tolerance at panicle initiation stage. Vegetos- An Inter. J. of Plant Res., 29(1). 1 – 6.

Satheeshkumar, P.; K. Saravanan and T. Sabesan. (2016). Selection of superior genotypes in rice (*Oryza sativa* L.) through combining ability analysis. Internat. J. agric. Sci., 12(1): 15 – 21.

Singh, R. K. and B. D. Chaudhary (1985). Biometrical Methods in Quantitative Genetic Analysis. Kalyani publishers, New Delhi.

Shahriar, M. d., A. H. Khan Robin and Ahasanul Hoque. (2014). Diversity Assessment of Yield, Yield Contributing Traits, and Earliness of Advanced T-aman Rice (*Oryza sativa* L.) Lines. Journal of Bioscience and Agriculture Research. Vol. 01(02): 102-112.

Sprague, G. F. and L. A. Tatum (1942). General versus specific combining ability in single crosses of corn. J. Amer. Soc.Agron. 34:923-952.

Steel, R. G. D. and J. H. Torrie (1980). Principles and Procedures of Statistics. Second Edition, Mc.Graw Hill Book Company Inc., New York.

Syed, E and I. Khaliq (2008). Quantitative inheritance of some physiological traits for spring wheat under two different population densities. *Pak. J. Bot*., 40(2): 581- 587.

تقدير القدرة على التالف لبعض الصفات الكمية خلال مواعيد الزراعة المختلفة فى الارز

عبدالحميد محمد على عكاز[١]، عزالدين ابراهيم حسن زعزع[١] ، عصام فتحى الحشاش[١] ، ياسر زين العابدين الرفاعى[٢] و أحمد اليمنى محمد مصطفى بكر[٢]

[١]قسم المحاصيل – كلية الزراعة – جامعة الازهر – القاهرة – مصر.

[٢]مركز بحوث وتدريب الارز - سخا – كفرالشيخ - مركز البحوث الزراعية.

لقد تم زراعة ستة تركيب وراثية ابوية من الارز ثم تم التهجين بينهم بطريقة التزاوج التبادلي النصف دائري Half diallel fashion في موسم ٢٠١٣ للحصول على بذور ١٥ هجين فردى. وفي موسم ٢٠١٤ تم زراعة ٦ آباء و١٥ هجين فردى وتقييمها باستخدام تصميم القطاعات الكاملة العشوائية وذلك بهدف تقدير تاثيرات القدرة العامة على التالف للاباء والقدرة الخاصة على التالف للهجن تحت اربع مواعيد للزراعة لصفات تاريخ التزهير – محصول الحبوب (جم) – عدد الفروع الحاملة لسنابل/نبات – وزن الـ ١٠٠٠ حبة (جم) – طول السنبلة (سم) – وزن السنبلة (جم).وكانت أهم النتائج المتحصل عليها كالتالى:أظهر تحليل التباين الخاص بتحليل الدايليل وجود اختلافات معنوية عالية فى معظم الصفات المدروسة خلال مواعيد الزراعة الاربعة. أشارت النتائج ايضا ان تباينات القدرة العامة والخاصة على التالف كانت عالية المعنوية لكل الصفات المدروسة خلال الاربع مواعيد للزراعة، وهذه النتائج تشير الى ان اهمية كلاً من التباين الاضافى والسيادى فى وراثة هذه الصفات. كما بينت النتائج ان قيم تباينات القدرة العامة على التالف كانت أكبر من قيم تباينات القدرة الخاصة على التالف لصفات التزهير وطول ووزن السنبلة خلال مواعيد الزراعة الثانى والثالث والرابع ولصفة محصول الحبوب/نبات خلال ميعادى الزراعة الاول والثانى، بينما كانت قيم تباينات القدرة الخاصة على التالف كانت أكبر من قيم تباينات القدرة العامة على التالف لباقى الصفات المدروسة خلال باقى مواعيد الزراعة محل الدراسة.اوضحت النتائج انه كان هناك اختلافات معنوية بين متوسطات الاباء والهجن الناتجة منها فى كل الصفات المدروسة تحت مواعيد الزراعة الاربعة محل الدراسة. وكانت متوسطات الاداء لميعاد الزراعة الرابع أعلى عن متوسطات الاداء للثلاث مواعيد زراعة الاخرى لمعظم الصفات المدروسة.وأوضحت النتائج أن معظم التراكيب الوراثية (الاباء و الهجن) كانت معنوية او عالية المعنوية وسالبة لصفة التزهير وموجبة لباقى الصفات محل الدراسة لتاثيرات القدرة العامة والخاصة على التالف تحت مواعيد الزراعة الاربعة. كما بينت النتائج ان خلال كل مواعيد الزراعة المدروسة ان التركيب الوراثى جيزة ١٧٩ لصفات التزهير و محصول الحبوب/نبات وعدد الفروع الحاملة لسنابل/نبات و وزن الـ ١٠٠٠ حبة والتركيب الوراثى CT 9882 لصفتى طول ووزن السنبلة كانا قد أظهرا أفضل قدرة عامة على التالف والذى يمكن استخدام الهجن القيمة الناتجة منهما مع تاثيرات القدرة الخاصة على التالف وبصفة خاصة مع صفات المحصول.واوضحت النتائج الى ان الهجين P1 x P6 لصفتى التزهير وعدد الفروع الحاملة لسنابل/نبات والهجن P1 x P2 و P1 x P3 و P1 x P4 لصفتى محصول الحبوب/نبات ووزن الـ ١٠٠٠ حبة والهجين P4 x P6 لصفتى طول ووزن السنبلة قد أظهروا افضل قدرة خاصة على التالف خلال مواعيد الزراعة الاربعة محل الدراسة.اشارت نتائج التنوع الوراثى باستخدام التحليل العنقودى ان الستة تراكيب وراثية قسمت الى مجموعتين اشتملت المجموعة الاولى على اثنين والثانية على اربعة تراكيب وراثية، وهذا يشير الى وجود درجة من التنوع الوراثى الواسع بين هذه التراكيب الوراثية.عموماً، فإن الآباء المشاركة في الهجن السابقة وأفضل الهجن ينبغي أن تستخدم للابتداء في برنامج تربية لتحمل البرودة بحيث يزرع محصول الارز بشمال مصر في مواعيد الزراعة المبكرة (ميعادى الزراعة الاول والثانى).

1-