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Study of Heterosis and Genetic Parameters for Yield and its Components Traits in Hybrid Rice (*Oryza sativa* L.) using line x tester mating system

El- Mowafi, H. F. ; E. F. A. Arafat ; M. E. Negm*; Mariam T. Wissa and Dalia E. Elsharnobi

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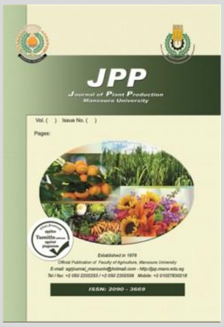
Rice Research Department, Field Crops Research Institute, ARC, Egypt.



ABSTRACT

Heterosis is very important phenomenon where the superior performance can appear in F_1 hybrid because increasing vigorous growth which leads to healthier and faster growing plants compared to its parents. This investigation was carried out at the experimental farm of Sakha Agricultural Research Station, Kafr El-Sheik, Egypt, during 2019 and 2020 rice growing seasons to study heterosis and simple correlation of the yield and its components traits in some hybrid rice combinations, using Line x tester design among six cytoplasmic mail sterility and four restorer genotypes. The results of heterosis over mid parents and heterosis over better parent represents that the best hybrids were IR69625AxPR1, IR68902AxPR78, IR58025AxPR78, IR69625AxPR78 and IR58025AxPR1 could use in breeding program to improve the grain yield dependent on its superiority in many traits. The additive variance (σ^2A) was greater than the dominance variance (σ^2D) for the duration and panicle weight in both seasons and head rice in 2nd growing season. Contrarily, the dominance variance (σ^2D) was the greatest variance for the rest traits, indicating that these traits were largely governed by non-additive genes action. Grain yield exhibited highly significant and positive correlation with total biomass in both seasons and with panicle weight in 1st season, indicating the selection based on these two traits will be more effective to improve the grain yield.

Keywords: Hybrid rice, heterosis, grain yield, heritability, simple correlation

INTRODUCTION

Rice is an important food crop for the world's food security. In Egypt, the rice crop is of further importance to farmers, as it is a high-income source compared with other summer field crops. In addition, rice is one of the major field crops in Egypt for domestic consumption (El-Shahway *et al.*, 2016). Heterosis is the superiority of F_1 offspring over the either parent, a solitary means of harnessing complete hybrid vigor in crop pants. This phenomenon has aided agriculture and captivated geneticists for over centuries for the development of superior cultivar in many crops (Verma *et al.*, 2018). Due to the overpopulation all over the world, it has become crucial to enhance rice production to satisfy the needs for this important crop. On the ways to increase rice yield is the application of hybrid rice. It is easy to obtain 15-20% higher yield just growing hybrid rice instead of the common varieties (Virmani *et al.*, 1993). The presence of non-additive genetic variance is the primary justification for initiating the hybrid program (Pradhan *et al.*, 2006). Although rice is a naturally self-pollinated crop but strong heterosis is observed in their F_1 hybrids. Depending upon the breeding objectives, both positive and negative heterosis is useful for crop improvement. In general, positive heterosis is desired for grain weight, grain yield and negative heterosis for early maturity, spikelets sterility etc. Ample reports are available which concluded the significance of exploiting heterosis commercially by developing F_1 rice hybrids (Raihan and Hasan, 2009). The main objective of the present study was to estimate heterosis values for yield and its components traits and some grain quality traits to know the best hybrid combinations could use in breeding programs.

MATERIALS AND METHODS

The present investigation was conducted during 2019 and 2020 rice growing seasons at the experimental farm of Sakha Agricultural Station, Kafr El-Sheikh, Egypt. The studied experimental materials were six lines and four testers, selected out of the elite germplasm collection maintained at Rice Research Department. Six cytoplasmic mail sterility lines (Wild abortive); IR58025A/B, IR68902A/B, IR69625A/B, IR70368A/B, Pusa3A/B and Pusa13A/B were crossed with four restorer lines i.e. PR1, PR2, PR78 and G.181 according to Line x Tester mating design (Kempthorne, 1957) to produce 24 hybrid, all aforementioned parents are indica long grain. The resulting 24 F_1 hybrid combinations were grown in a randomized complete block design (RCBD) with three replications. Thirty-day old seedlings were transplanted with one seedling hill^{-1} adopting spacing of 20 cm between rows and 20 cm between plants. Each test entry consisted of 14 rows of 5 m length. All agronomical practices were followed as recommended, RRTC (2015). Furthermore, the studied traits were; duration (day), plant height (cm), number of tillers/plant, number of spikelets/panicle, panicle length (cm), panicle weight (g), fertility %= $\frac{\text{No.of filled grains/ panicle}}{\text{Total No.of total grains /panicle}}$x100%, No. of filled grains/ panicle, biomass yield (t ha^{-1}), grain yield (t ha^{-1}), harvest index = $\frac{\text{Economic yield}}{\text{Biological yield}}$x100%, hulling %, milling % and head rice % as recommended by Standard Evaluation System (SES) of IRRI (2008). Heterosis was calculated from

* **Corresponding author.**
E-mail address: mahrousnegm9@gmail.com
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mean values according to Fehr (1987) and analysis of variance (ANOVA) was estimated for all traits.

RESULTS AND DISCUSSION

Analysis of variance:

Results in Table 1 revealed that the significant and highly significant differences among evaluated genotypes for all studied traits except milling % in both seasons and hulling in 2[st] season. The significant differences among genotypes are the first required to complete the study and predict the improvement among these parents and their hybrids in breeding program. The results in Table 1 also revealed that the general mean for fourteen studied traits i.e., duration; all genotypes were 136.79 and 137.78 days for two seasons, respectively. The plants were very high which more than one meter and half in both seasons. Furthermore, the plants recorded 24.19 and 24.74 tiller as a general mean in both seasons respectively. The genotypes represent high yielding in both seasons which more than (10 t ha^{-1}), it's a general rice average grain yield in Egypt returned in the heterosis in hybrid combinations; these results indicated could use these genotypes in breeding program to improve the grain yield. The total biomass for the plants was 43.11 and 44.96, while, harvest index was 33.44 and 33.42% in two growing seasons, respectively. Similar findings reported by Ammar *et al.* (2014), Sedeek (2015) and El-Mowafi *et al.* (2021). The genotypes recorded 3.43 and 3.12 g for the panicle weight in two seasons. Also, the genotypes have long panicles and these panicles have approximately 200 filled grains/ panicle which refer to improve these traits and could using these genotypes in breeding program and expect get high yielding genotypes based on these traits beside the fertility which approximately 90% in both seasons. The results indicated that the quality of grains is good for the genotypes based on the percentages of hulling and milling and the intact rice.

Table 1. Analysis of variance and general mean for all studied traits.

Traits	Year	M.s. Replications d.f.=2	M.s. Genotypes d.f.=33	M.s. Error d.f.=66	General Mean	Std. Deviation
Duration(day)	2019	0.186ns	42.36**	0.62	136.79	3.76
	2020	3.32*	43.05**	0.99	137.78	3.79
Plant height (cm)	2019	38.48*	292.8**	10.85	162.99	9.88
	2020	8.21ns	212.4**	4.28	164.32	8.41
Number of tillers/plant	2019	3.07ns	18.16*	3.66	24.19	2.46
	2020	11.48*	13.1*	3.48	24.74	2.09
Panicle Length(cm)	2019	0.012ns	6.74**	0.168	25.80	1.50
	2020	0.066ns	10.38**	0.287	26.29	1.86
Panicle Weight(g)	2019	0.002ns	0.53**	0.33	3.43	0.42
	2020	0.004ns	0.11**	0.12	3.12	0.19
Number of spikelets/panicle	2019	509.2**	3808.2**	21.84	220.37	35.63
	2020	505.55**	362.2**	18.24	216.99	29.08
Filled grains/ panicle	2019	662.9**	3503.9**	21.15	200.8	35.8
	2020	446.5**	3065.2**	17.85	198.1	35.88
Fertility %	2019	16.48**	27.65**	2.75	88.76	3.04
	2020	0.80ns	25.02**	2.89	86.68	2.92
Biomass yield (t ha^{-1})	2019	45.17**	398.8**	1.74	43.11	11.53
	2020	102.5**	509.6**	3.97	44.96	13.03
Grain yield (t ha^{-1})	2019	2.83ns	7.30**	1.33	13.76	1.56
	2020	2.14ns	9.20**	0.81	14.15	1.75
Harvest index	2019	14.72ns	111.8**	3.54	33.44	6.11
	2020	10.80ns	159.0**	2.75	33.42	7.28
Hulling %	2019	34.90ns	36.7**	12.8	82.19	3.51
	2020	20.86ns	28.7ns	19.57	81.23	3.09
Milling %	2019	89.9*	26.8ns	19.6	68.39	2.99
	2020	58.8ns	29.4ns	19.58	68.96	3.13
Head rice %	2019	163.5**	46.9*	24.3	60.42	3.95
	2020	75.46ns	56.8*	31.79	60.66	4.35

***, **: Significant at 0.05 and 0.01 probability levels, respectively.**

Estimates of Heterosis Effects

Heterosis over better parent and over mid parents' values are represented in Table 2. The heterosis results for duration indicated that the highly significant negative estimates for better and mid parents in both seasons appeared in the followed hybrids were for Pusa13AxPR1 (-2.70, -3.28, -1.95 and -2.65 %) and Pusa13AxPR2 (-3.92, -4.13, -3.42 and -3.87 %) for better and mid parents in 2019 and 2020 growing seasons, respectively, these two hybrids were the best hybrids for the duration. Regarding plant height, the best hybrids have a good heterosis towards shortness were IR58025AxPR1 (-6.86, -6.01, -6.86 and -6.01 %), IR58025AxG.181 (-8.82, -9.71, -7.95 and -8.83 %) and IR70368AxG.181 (-8.08, -10.34, -9.18 and -11.39 %), where they have significant and highly significant negative heterosis in both seasons over better and mid parents. In general, the estimated values of heterosis over better parent and mid parents showed highly significant and positive values (undesirable) towards tallness and earliness. The negative heterosis found to be desirable for plant height and duration, while positive heterosis was desirable in other yield characters (Jelodar, 2010). Concerning number of tillers/plant, results in Table 2 revealed highly significant positive heterosis over better and mid parents for seven hybrid combinations, IR69625AxPR1, IR58025AxPR2, IR69625AxPR2, IR70368AxPR78, IR68902AxG.181, IR70368AxG.181 and Pusa3AxG.181, indicating that it could use these hybrids to improve the tillers number in breeding program. Out of twenty-four hybrids, eleven hybrids have the best heterotic effects over better parent and mid parents for panicle length, which they exhibited highly significant positive heterosis in both seasons. For panicle weight, results in Table 2 revealed that 15 hybrid combinations showed significant and positive over better parent and mid parents in the two seasons. These findings indicated that panicle weight is one of the most important traits contributing to heterosis and breeders can exploit it to best advantage in hybrid breeding. These results are in general agreement with those reported by Tiwari *et al.* (2010), Abdel-Moneam *et al.* (2016) and El- Mowafi *et al.* (2021). For No. of filled grains/ panicle, results in Table 2 indicated that estimates of heterosis over better and mid parents were highly significant and positive in three hybrids, IR58025AxPR78 (18.07, 26.92, 9.34 and 10.52 %), IR70368AxPR78 (56.88, 65.19, 55.86 and 57.58 %) and Pusa13AxPR78 (11.20, 32.28, 9.71 and 23.61 %) in the two seasons, respectively. Heterosis for filled grains/ panicle has reported by Hammoud (2004) and Dwivedi *et al*. (1998). For number of spikelets/panicle, results in Table 2 revealed significant and highly significant positive heterosis measured as deviation from the better parent and mid parents were observed in the hybrid IR58025AxPR78 in both seasons (11.06, 18.63, 7.20 and 8.66 %), followed by the two hybrids have good results also Pusa13AxPR78 and IR69625AxPR78. Regarding fertility %, data in Table 2 indicated that hybrids showed significant and positive over better parent and over mid parents heterosis. The best values were recorded in the hybrids IR69625AxPR78 followed by Pusa13AxPR78 and then IR58025AxPR78 in first season only, Reddy and Nerkar (1995). These results indicated that there is a big positive relation between Number of spikelet's/plant and fertility may be led to any improvement in one trait its means improving another trait. For biomass yield, the results showed significant and highly significant positive estimates of heterosis over better and mid parents were recorded for 18 hybrid combinations. The highest values were estimate for IR69625AxPR1, Pusa3AxPR1, IR69625AxPR2, IR68902AxPR78 and IR69625AxPR78 in both studied seasons. Concerning grain yield, moreover significant positive heterosis effects were found as deviation from the better and mid parents' values for 15 hybrid combinations. The highest values were estimated for the hybrids IR69625AxPR1, IR58025A xPR2, IR69625AxPR2, IR58025AxPR78 and IR68902AxPR78, Similar findings reported by Sedeek (2015), Abdel-Moneam *et al.* (2016) and El-Mowafi *et al.* (2021). For harvest index, the calculated values of heterosis versus the better and mid parents are shown in Table 2, highly significant and positive heterosis for IR68902AxG.181 (15.02, 19.84, 24.20 and 28.22 %) in two seasons, respectively. For hulling percentage highly significant positive recorded by the hybrid combination IR68902AxPR78 with better and mid parents heterosis values (7.87 and 10.04 %) in first season. Also, this hybrid recorded a significant positive heterosis over mid parents in second season. Negative and positive heterosis for this trait was already reported by Rukminidevi *et al.* (2014) and Krishna *et al.* (2016). For milling percentage and head rice % most hybrids were negative heterosis estimates, indicating the expected improvement in these grain quality traits may be not easy within these hybrids. The hybrids which have a desirable heterosis over mid parents and also over better parent it's could be used in breeding programs and expect the improvement in grain yield. Using the heterosis over mid parents to select more hybrids has a highly significant heterosis in breeding programs. Accordingly, the hybrids with highly significant heterosis over mid parents could use in breeding program also for duration were Pusa3AxPR1 (-5.53 and -5.61 %), Pusa3AxPR2 (-4.96 and -5.16 %) and Pusa3AxPR78 (-2.47 and -2.22 %), in both seasons, respectively. Furthermore, the hybrids Pusa13AxPR78 and Pusa13AxG.181 were significant and highly significant heterosis over mid parents and could use in breeding program to select the short plants. Actually, in the traits of grain quality many hybrids wasn't a significant heterosis over better parent but a few of its hybrids have significant heterosis over mid parents, its gave a breeder an opportunity to improve these traits, however, the best hybrids over mid parents for hulling % were IR68902AxPR1 in 1st season and IR70368AxG.181 in 2st season and for milling % were IR58025AxPR78 and IR70368AxPR78 in 1st season. These results agree with Sreelakshm *et al.* (2019) reported that the heterosis were low for quality traits *viz.*, Hulling %, milling % and head rice %, in addition, none of the crosses exhibited significant positive heterosis over mid and better parents for milling %.

Table 2. Estimates of heterosis over better (BP) and mid parents (MP) of each hybrid for all studied traits.

Hybrids	Duration (day)				Plant height (cm)				Number of tillers/plant			
	2019		2020		2019		2020		2019		2020	
	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)
IR58025A×PR1	2.23**	1.12*	2.45**	1.47*	-6.86*	-6.86**	-6.01**	-6.01**	26.47**	26.47**	0.00ns	0.69ns
IR68902A×PR1	-1.42*	-1.80**	-1.18ns	-1.78*	4.50ns	-2.62ns	4.45*	-2.69ns	10.28**	13.64**	-6.77**	-4.17**
IR69625A×PR1	-1.46*	-1.81**	-1.45ns	-1.56*	19.51**	6.52**	16.59**	4.08**	17.15**	18.83**	7.90**	9.32**
IR70368A×PR1	0.25ns	-0.59ns	0.25ns	-0.47ns	3.03ns	1.49ns	-1.20ns	-2.65ns	8.82**	8.82**	0.00ns	0.00ns
Pusa3A×PR1	-0.94ns	-5.53**	-0.94ns	-5.61**	-3.96ns	-4.43ns	-4.90**	-5.46**	0.00ns	3.82*	2.68ns	6.27**
Pusa13A×PR1	-2.70**	-3.28**	-1.95*	-2.65**	0.99ns	0.49ns	0.98ns	0.39ns	-7.41**	0.66ns	-16.29**	-10.01**
IR58025A×PR2	1.49*	0.76ns	1.47ns	0.76ns	16.67**	9.38**	14.28**	7.10**	12.50**	15.71**	5.12**	8.60**
IR68902A×PR2	-0.68ns	-1.43*	-0.92ns	-1.78*	14.61**	13.97**	12.22**	11.60**	-4.17**	1.48ns	-11.54**	-6.75**
IR69625A×PR2	-1.41*	-1.44*	-1.16ns	-1.31ns	23.17**	17.44**	23.80**	18.25**	25.00**	26.77**	15.38**	16.89**
IR70368A×PR2	0.25ns	-0.22ns	0.25ns	-0.22ns	11.11**	5.82*	9.89**	4.60**	-2.79ns	-0.02ns	-10.27**	-7.91**
Pusa3A×PR2	0.05ns	-4.96**	-0.20ns	-5.16**	8.89**	2.62ns	8.79**	2.59ns	4.17**	11.11**	-3.85*	2.04ns
Pusa13A×PR2	-3.92**	-4.13**	-3.42**	-3.87**	15.55**	8.90**	13.19**	6.74**	-6.19**	-0.67ns	-11.65**	-7.33**
IR58025A×PR78	3.01**	2.24**	3.76**	2.73**	-3.72ns	-20.0**	-2.13ns	-2.61ns	-8.57**	-7.26**	-14.68**	-13.52**
IR68902A×PR78	1.51*	-0.74ns	2.01*	-0.61ns	11.24**	3.13ns	10.00**	1.96ns	-4.29**	0.00ns	-10.68**	-7.59**
IR69625A×PR78	1.51*	0.00ns	2.01*	0.13ns	21.95**	8.11**	18.99**	5.65**	-7.12**	-7.12**	-14.45**	-13.9**
IR70368A×PR78	3.01**	1.99**	3.76**	2.48**	4.04ns	1.98ns	0.80ns	-1.18ns	11.44**	13.04**	9.32**	10.05**
Pusa3A×PR78	4.27**	-2.47**	4.76**	-2.22**	0.99ns	0.00ns	0.00ns	-1.07ns	10.03**	15.81**	2.68ns	6.96**
Pusa13A×PR78	0.50ns	-0.75ns	1.00ns	-0.25ns	-3.96ns	-4.90*	-3.92*	-4.95**	-28.41**	23.19**	-25.60**	20.51**
IR58025A×G.181	6.73**	6.34**	6.95**	6.42**	-8.82**	-9.71**	-7.95**	-8.83**	2.91ns	10.20**	-4.11**	1.43ns
IR68902A×G.181	7.48**	5.51**	7.44**	5.22**	15.74**	6.74**	13.33**	4.51**	31.27**	36.59**	20.02**	24.44**
IR69625A×G.181	2.24**	1.11*	2.49**	1.11ns	9.75**	-3.23ns	6.97**	-5.52**	7.16**	16.28**	0.00ns	7.79**
IR70368A×G.181	2.49**	1.86**	2.73**	1.97**	-8.08**	-10.34**	-9.18**	-11.39**	11.73**	19.65**	6.73**	13.64**
Pusa3A×G.181	7.48**	0.94ns	7.94**	1.28ns	-2.97ns	-4.39ns	-3.92*	-5.41**	19.05**	22.94**	5.78**	9.93**
Pusa13A×G.181	2.99**	2.10**	3.23**	2.47**	-3.96ns	-5.36*	-5.88**	-7.34**	-8.63**	5.72**	-13.95**	-1.99ns
LSD 0.05	1.28	1.11	1.62	1.41	5.37	4.65	3.37	2.92	3.12	2.70	3.04	2.63
LSD 0.01	1.71	1.48	2.15	1.87	7.13	6.18	4.48	3.88	4.14	3.59	4.04	3.50

Table 2. continue…

Hybrids	Panicle length (cm)				Panicle weight (g)				No. of filled grains/ panicle			
	2019		2020		2019		2020		2019		2020	
	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)
IR58025A×PR1	0.23ns	3.69**	5.78**	8.57**	23.55**	23.97**	20.72**	21.12**	-21.25**	-6.02ns	-17.87**	-1.96ns
IR68902A×PR1	-6.01**	-1.50**	4.06**	10.28**	33.33**	35.9**	8.94**	11.15**	5.31ns	16.19**	-30.22**	-28.58**
IR69625A×PR1	-0.47ns	5.90**	-1.33**	5.14**	30.03**	32.66**	11.18**	13.17**	-30.55**	-19.60**	-24.18**	-12.25**
IR70368A×PR1	9.11**	12.97**	6.05**	9.56**	6.10**	6.83**	6.54**	7.24**	-32.67**	-18.23**	-15.77**	2.32ns
Pusa3A×PR1	1.20**	5.73**	15.38**	21.02**	15.65**	16.24**	11.48**	12.03**	-42.56**	-42.33**	-10.20**	-9.96**
Pusa13A×PR1	-0.39ns	2.78**	7.34**	11.09**	21.58**	21.9**	9.90**	10.08**	-35.99**	-30.94**	-41.79**	-37.16**
IR58025A×PR2	3.60**	8.31**	6.02**	9.05**	47.78**	48.8**	12.50**	13.25**	-7.05ns	-3.20ns	-30.82**	-27.98**
IR68902A×PR2	2.43**	8.46**	7.97**	14.65**	21.11**	23.02**	-5.00**	-3.39**	-20.59**	-16.57**	-31.40**	-22.43**
IR69625A×PR2	0.08ns	7.56**	-3.69**	2.82**	31.02**	34.12**	-6.71**	-4.73**	11.03**	11.54**	-1.08ns	-0.72ns
IR70368A×PR2	-4.67**	-0.26ns	5.83**	9.56**	29.49**	30.82**	-5.88**	-4.95**	7.05ns	13.85**	-6.09ns	-0.19ns
Pusa3A×PR2	-2.16**	3.28**	7.81**	13.32**	4.76**	5.66**	-1.31**	-0.50*	-23.45**	-11.43**	-32.42**	-21.85**
Pusa13A×PR2	0.23ns	4.51**	4.94**	8.83**	16.78**	17.38*	1.32**	1.82**	-13.37**	-6.85*	4.01ns	11.85**
IR58025A×PR78	-1.31**	2.30**	13.78**	16.28**	15.36**	16.75*	-2.63**	-1.33**	18.07**	26.92**	9.34**	10.52**
IR68902A×PR78	2.32**	7.44**	11.58**	17.75**	31.12**	32.51**	0.68*	1.71**	9.31*	27.43**	-23.00**	-9.03**
IR69625A×PR78	-2.63**	3.81**	11.34**	18.14**	14.52**	17.83**	-3.83**	-1.15**	14.23**	26.98**	-2.71**	1.99ns
IR70368A×PR78	-10.35**	-6.99**	8.86**	11.97**	9.49**	11.19**	0.98**	2.66**	56.88**	65.19**	55.86**	57.58**
Pusa3A×PR78	7.03**	12.05**	9.33**	14.19**	34.01**	35.86**	-0.98**	0.50*	6.45ns	35.00**	11.50**	34.54**
Pusa13A×PR78	7.68**	11.34**	8.43**	11.73**	20.55**	21.80**	-2.64**	-1.50**	11.20**	32.28**	9.71**	23.61**
IR58025A×G.181	7.68**	8.87**	15.91**	17.44**	22.64**	27.66**	-7.93**	-4.43**	-27.92**	-16.43**	-35.88**	-25.70**
IR68902A×G.181	10.16**	12.86**	11.82**	17.03**	9.12**	16.05**	-3.96**	1.94**	-28.63**	-23.74**	-29.20**	-28.31**
IR69625A×G.181	14.63**	19.28**	-1.80**	3.33**	28.62**	31.72**	-3.96**	-1.72**	-25.35**	-16.16**	-12.85**	-2.22ns
IR70368A×G.181	5.69**	6.95**	-0.24ns	1.74**	18.24**	22.68**	-1.52**	1.89**	10.97**	31.04**	-16.10**	-1.00ns
Pusa3A×G.181	7.68**	9.98**	4.21**	7.93**	17.61**	22.22**	-0.61*	3.00**	-16.73**	-13.48**	-21.05**	-17.99**
Pusa13A×G.181	15.08**	16.04**	3.05**	5.28**	1.89**	6.23**	-0.91**	3.01**	-3.85ns	0.37ns	-25.42**	-22.18**
LSD 0.05	0.67	0.58	0.87	0.76	0.94	0.81	0.56	0.49	7.50	6.49	6.89	5.97
LSD 0.01	0.89	0.77	1.16	1.00	1.24	1.08	0.75	0.65	9.96	8.63	9.15	7.92

Table 2. continue…

Hybrids	Number of spikelets/panicle				Fertility %				Hulling %			
	2019		2020		2019		2020		2019		2020	
	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)
IR58025A×PR1	-18.06**	-3.97ns	-14.13**	0.49ns	-4.00**	-1.90ns	-4.34**	-2.06ns	-7.57*	-7.20**	-8.53*	-8.16*
IR68902A×PR1	5.02ns	5.24ns	-25.18**	-9.09**	-0.20ns	2.13ns	-6.63**	-4.46**	5.63ns	7.14**	-3.56ns	-2.25ns
IR69625A×PR1	-24.65**	-17.19**	-21.38**	-13.69**	-7.97**	-2.49*	-3.49*	2.31ns	1.83ns	3.94ns	3.60ns	5.78ns
IR70368A×PR1	-30.51**	-15.88**	-12.47**	5.74ns	-3.19*	-2.65*	-3.66*	-2.91*	-4.11ns	-2.91ns	-5.78ns	-4.68ns
Pusa3A×PR1	-36.94**	-36.00**	-8.32*	13.69**	-11.72**	-10.03**	-5.11**	-3.34**	-7.48*	-6.70*	-3.16ns	-1.93ns
Pusa13A×PR1	-35.66**	-31.21**	-36.70**	16.38**	-0.30ns	0.66ns	-8.08**	-7.10**	-1.25ns	-0.50ns	1.31ns	1.99ns
IR58025A×PR2	-11.18**	-7.96*	-23.56**	-20.84**	4.73**	5.21**	-9.53**	-9.09**	-5.61ns	-3.59ns	-3.98ns	-1.79ns
IR68902A×PR2	-34.91**	-25.88**	-8.12*	-0.59ns	2.16ns	2.77*	-2.72ns	-2.3ns	-8.01**	-5.10*	-9.28*	-6.35*
IR69625A×PR2	-0.74ns	3.05ns	-7.08*	-3.53ns	3.81**	8.20**	-1.22ns	2.86*	-7.63*	-4.12ns	-6.40ns	-2.68*
IR70368A×PR2	2.54ns	10.33**	-4.21ns	2.93ns	2.04ns	3.23**	-3.96**	-2.89*	-4.56ns	-1.72ns	-5.09ns	-2.21*
Pusa3A×PR2	-19.58**	-9.77**	-5.46ns	4.75ns	-5.00**	-1.55ns	-9.19**	-5.78**	-16.27**	-14.10**	-14.52**	-11.90**
Pusa13A×PR2	-16.07**	-10.36**	21.06**	117.1**	2.64ns	3.43**	0.62ns	1.45ns	-6.37*	-4.03ns	-4.53ns	-2.10ns
IR58025A×PR78	11.06**	18.63**	7.20*	8.66**	6.20**	7.17**	1.35ns	1.54ns	-3.25ns	-2.30ns	0.12ns	1.12ns
IR68902A×PR78	-11.52**	9.66**	13.94**	17.69**	4.77**	5.57*	3.45*	3.58**	7.87**	10.04**	2.02ns	8.01*
IR69625A×PR78	4.56ns	19.37**	8.67*	18.15**	3.21*	6.17**	1.05ns	4.91**	-3.60ns	-1.05ns	-5.32ns	-2.76ns
IR70368A×PR78	0.47ns	3.31ns	2.41ns	5.03ns	-4.99**	-2.58*	-0.12ns	1.29ns	-4.59ns	-2.85ns	0.12ns	1.89ns
Pusa3A×PR78	-31.49**	-16.20**	2.07ns	8.11**	-2.53ns	2.34*	-4.54**	-0.67ns	-5.21ns	-3.87ns	-1.01ns	0.84ns
Pusa13A×PR78	6.07ns	24.20**	30.80**	132.1**	4.82**	7.06**	1.32ns	2.46*	-9.03**	-7.81**	-7.67*	-6.50*
IR58025A×G.181	-26.83**	-16.48**	-31.10**	-21.47**	-1.25ns	0.44ns	-6.75**	-5.04ns	-0.48ns	-0.06ns	0.89ns	1.54ns
IR68902A×G.181	-31.19**	-28.88**	-22.00**	-7.56*	-2.70*	-0.90ns	-6.85**	-5.19**	1.48ns	2.09ns	-3.26ns	-2.96ns
IR69625A×G.181	-20.80**	-15.42**	-10.49**	-4.52ns	-5.56**	-0.39ns	-2.48ns	2.84*	3.23ns	4.52ns	5.28ns	6.41*
IR70368A×G.181	10.99**	31.00**	-13.40**	2.01ns	0.22ns	0.30ns	-3.07*	-2.84*	-7.83**	-7.44**	6.78ns	6.92*
Pusa3A×G.181	-10.08**	-8.61*	-12.27**	6.20*	-7.42**	-5.21**	-7.36**	-5.12**	1.65ns	1.66ns	5.56ns	5.79ns
Pusa13A×G.181	-1.93ns	1.80ns	-22.00**	42.66**	-1.69ns	-1.22ns	-4.43**	-3.94**	0.82ns	0.88ns	4.19ns	4.57ns
LSD 0.05	7.62	6.60	6.96	6.03	2.70	2.34	2.77	2.40	5.83	5.05	7.21	6.25
LSD 0.01	10.12	8.76	9.25	8.01	3.59	3.11	3.68	3.19	7.75	6.71	9.58	8.30

Table 2. continue…

Hybrids	Biomass yield (t ha^{-1})				Grain yield (t ha^{-1})				Harvest index			
	2019		2020		2019		2020		2019		2020	
	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)
IR58025A×PR1	32.70**	34.60**	25.54**	28.36**	20.89**	23.87**	21.44**	24.80**	-8.88**	-7.96**	-3.29*	-2.89*
IR68902A×PR1	25.37**	25.54**	16.77**	17.06**	14.74**	14.89**	17.85**	20.12**	-7.61**	-7.56**	0.12ns	2.25ns
IR69625A×PR1	79.82**	82.48**	108.60**	112.42**	38.05**	38.67**	34.47**	34.59**	-24.68**	-23.96**	-37.43**	-36.43**
IR70368A×PR1	27.79**	28.15**	17.04**	17.31**	10.57**	12.64**	17.00**	19.55**	-13.32**	-11.47**	-0.59ns	1.71ns
Pusa3A×PR1	79.84**	90.95**	71.25**	81.45**	4.63**	12.63**	-3.07**	5.69**	-41.84**	-41.04**	-43.52**	-41.80**
Pusa13A×PR1	41.58**	56.11**	52.61**	67.17**	11.46**	17.75**	11.74**	18.32**	-28.36**	-24.93**	-26.65**	-29.50**
IR58025A×PR2	64.23**	70.27**	94.09**	103.40**	27.80**	31.97**	23.59**	27.44**	-22.75**	-22.46**	-38.27**	-37.22**
IR68902A×PR2	60.36**	64.18**	52.25**	55.74**	29.13**	30.33**	17.26**	19.93**	-21.99**	-20.87**	-23.14**	-23.15**
IR69625A×PR2	90.64**	92.10**	81.84**	83.15**	32.32**	32.80**	28.83**	29.17**	-31.08**	-30.78**	-29.91**	-29.55**
IR70368A×PR2	72.30**	75.68**	65.43**	69.26**	19.78**	22.98**	30.90**	34.22**	-30.69**	-30.18**	-20.60**	-20.77**
Pusa3A×PR2	42.11**	54.05**	35.70**	47.23**	1.59ns	10.17**	-1.31ns	7.94**	-28.36**	-28.35**	-26.18**	-26.87**
Pusa13A×PR2	65.13**	85.74**	62.79**	82.43**	21.98**	29.83**	17.65**	24.99**	-34.61**	-30.58**	35.78**	-31.94**
IR58025A×PR78	74.44**	93.44**	71.60**	88.16**	37.91**	39.08**	37.95**	38.63**	-36.57**	-29.09**	-33.15**	-27.02**
IR68902A×PR78	58.68**	78.00**	100.71**	125.05**	33.25**	35.22**	37.30**	39.12**	-32.11**	-24.82**	-45.02**	-39.08**
IR69625A×PR78	86.77**	112.47**	87.93**	113.63**	26.82**	29.43**	10.66**	14.36**	-46.37**	-40.07**	-50.33**	-45.19**
IR70368A×PR78	67.81**	88.93**	62.57**	82.26**	24.72**	25.04**	27.05**	28.42**	-42.30**	-34.86**	-37.41**	-30.49**
Pusa3A×PR78	13.01**	20.00**	10.30**	16.87**	2.66**	8.86**	11.82**	18.30**	-19.77**	-10.02**	-10.30**	0.40ns
Pusa13A×PR78	34.03**	36.80**	26.60**	29.59**	12.25**	16.78**	0.08ns	2.71**	-19.45**	-14.58**	-24.68**	-20.99**
IR58025A×G.181	-25.65**	-7.40**	-23.05**	-6.25**	-23.43**	-8.40**	-20.80**	-4.65**	-7.16**	-2.29ns	-0.03ns	1.50ns
IR68902A×G.181	-32.88**	-15.58**	-30.43**	-13.59**	-16.24**	4.07**	-7.88**	11.64*	15.02**	19.84**	24.20**	28.22**
IR69625A×G.181	8.43**	37.99**	-17.71**	3.42*	-18.11**	0.24ns	-25.94**	-8.83**	-32.02**	-28.5**	-14.76**	-12.45**
IR70368A×G.181	-21.87**	-1.43ns	2.21ns	26.92**	-23.49**	-8.03**	-25.73**	-10.16**	-13.71**	-8.21**	-26.41**	-23.89**
Pusa3A×G.181	-22.55**	-7.03**	-19.60**	-4.92**	-19.75**	-8.04**	-7.88**	5.29**	-6.96**	-1.73ns	5.45**	9.83**
Pusa13A×G.181	-23.07**	-10.71**	-18.22**	-6.16**	-24.00**	-11.41**	-21.57**	-7.93**	-1.01	-0.48ns	1.46ns	-1.35ns
LSD 0.05	2.15	1.86	3.25	2.81	1.88	1.63	1.47	1.27	3.07	2.66	2.70	2.34
LSD 0.01	2.86	2.47	4.31	3.74	2.50	2.16	1.95	1.69	4.07	3.53	3.59	3.11

Table 2. continue…

Hybrids	Milling %				Head rice %			
	2019		2020		2019		2020	
	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)	(BP)	(MP)
IR58025A×PR1	0.27ns	4.72ns	-8.49*	-4.76ns	-8.01ns	-3.25ns	-10.03*	-5.29ns
IR68902A×PR1	-7.61*	-7.41*	-9.75**	-9.57**	-17.05**	-16.65**	-19.12**	-18.74**
IR69625A×PR1	-6.05ns	-4.07ns	-7.94*	-6.14ns	-11.74**	-10.06**	-13.52**	-12.08**
IR70368A×PR1	-3.77ns	-0.90ns	-7.86*	-5.18ns	-13.05**	-9.39**	-15.90**	-12.50**
Pusa3A×PR1	-6.20ns	-4.44ns	-10.39**	-8.74**	-18.46**	-16.10**	-15.56**	-13.11**
Pusa13A×PR1	-6.76ns	-6.19ns	-8.27*	-7.83*	2.96ns	3.86ns	-7.17ns	-6.19ns
IR58025A×PR2	-10.75**	-7.09*	-0.34ns	3.29ns	-13.93**	-11.30**	-6.81ns	-4.00ns
IR68902A×PR2	-0.97ns	-0.86ns	-3.50ns	-3.28ns	-12.76**	-11.40**	-17.03**	-15.55**
IR69625A×PR2	-3.33ns	-0.97ns	-6.90ns	-4.67ns	-5.81ns	-2.05ns	-10.95*	-7.47ns
IR70368A×PR2	-5.41ns	-2.90ns	-6.55ns	-4.24ns	-3.15ns	-1.11ns	-11.55*	-9.96*
Pusa3A×PR2	-12.63**	-11.30**	-14.96**	-13.80**	-11.63**	-10.90**	-17.71**	-17.2**
Pusa13A×PR2	-0.21ns	0.73ns	-4.03ns	-3.15ns	-3.98ns	-2.81ns	-6.22ns	-5.11ns
IR58025A×PR78	2.39ns	6.55*	-2.00ns	1.63ns	-1.29ns	2.24ns	-2.63ns	0.97ns
IR68902A×PR78	0.40ns	0.57ns	-0.39ns	-0.22ns	-3.90ns	-2.83ns	-10.17*	-9.18*
IR69625A×PR78	-4.35ns	-1.97ns	-7.94*	-5.80ns	-9.37*	-6.20ns	-15.12**	-12.40**
IR70368A×PR78	4.26ns	6.97*	-3.56ns	-1.11ns	-14.85**	-12.60**	-7.75ns	-5.47ns
Pusa3A×PR78	-6.46ns	-5.06ns	-4.40ns	-3.00ns	-8.79*	-7.54*	-7.49ns	-6.26ns
Pusa13A×PR78	-5.14ns	-4.20ns	-9.03*	-8.24*	-5.94ns	-5.25ns	-8.77ns	-8.30*
IR58025A×G.181	-8.05*	-2.77ns	-4.78ns	0.21ns	-7.09ns	-3.29s	-5.01ns	-1.22ns
IR68902A×G.181	-5.64ns	-4.20ns	-9.05*	-7.80*	-4.92ns	-4.35ns	-23.29**	-22.70**
IR69625A×G.181	-1.55ns	-0.77ns	-4.38ns	-3.64ns	-12.22**	-9.60**	-14.00**	-11.50**
IR70368A×G.181	-5.29ns	-1.23ns	1.66ns	5.80ns	-0.25ns	2.86ns	3.59ns	6.46ns
Pusa3A×G.181	-4.93ns	-1.90ns	-9.47*	-6.75*	-7.18ns	-5.44ns	-14.24**	-12.85**
Pusa13A×G.181	-10.54**	-9.92**	-10.99**	-10.39**	-17.07**	-16.9**	-13.88**	-13.70**
LSD 0.05	7.22	6.25	7.22	6.25	8.04	6.96	9.19	7.96
LSD 0.01	9.59	8.30	9.58	8.30	10.68	9.25	12.21	10.57

Estimation of the Genetic Parameters and Gene Action

The estimates of genetic parameters for all studied traits are shown in Table 3. The results demonstrated that the additive variance (σ^2A) due to the relative importance of the GCA% for the duration and panicle weight in both seasons and head rice in 2nd growing season traits was greater than the dominance variance (σ^2D) due to the relative importance of the SCA% for those traits, indicating that these traits were largely governed by additive gene action. On the other hand, the dominance variance (σ^2D) due to the relative importance of the SCA% for the rest traits were higher than the additive variance (σ^2A) due to the relative importance of the GCA%, indicating that these traits were largely governed by non-additive genes action.

Table 3. Estimates of genetic parameters for studied traits.

SOV		(σ^2A)	(σ^2D)	(σ^2G)	(σ^2P)	(h^2_b)%	(h^2_n)%	σ^2GCA	σ^2SCA
DUR	2019	3.35	2.17	5.53	6.15	89.92	54.56	60.68	39.32
	2020	3.22	2.24	5.46	6.45	84.64	49.9	58.95	41.05
PH	2019	0.44	73.68	74.12	84.97	87.23	0.52	0.60	99.40
	2020	4.34	28.79	33.13	37.41	88.56	11.6	13.10	86.90
NTP	2019	0.00	4.76	4.73	8.39	56.4	0.00	0.00	100.5
	2020	0.00	3.91	3.82	7.3	52.3	0.00	0.00	102.4
P L	2019	0.13	1.22	1.35	1.52	88.94	8.77	9.86	90.14
	2020	0.40	0.83	1.23	1.52	80.96	26.47	32.7	67.30
PW	2019	0.003	0.088	0.09	0.11	82.82	2.93	3.53	96.47
	2020	0.006	0.015	0.02	0.03	63.25	18.33	28.99	71.01
FGP	2019	0.00	1360	1201	1228	98.28	0.00	0.00	112.7
	2020	0.00	780.4	741.6	759.4	97.65	0.00	0.00	105.2
SPK	2019	0.00	1466	1308	1330	98.36	0.00	0.00	112.1
	2020	0.00	828.4	792.69	810.9	97.75	0.00	0.00	104.5
FER	2019	1.19	4.16	5.35	8.10	66.06	14.68	22.22	77.78
	2020	0.00	5.13	4.90	7.79	62.9	0.00	0.00	104.8
BIO	2019	19.40	57.15	76.55	78.29	97.78	24.78	25.34	74.66
	2020	13.21	114.2	127.4	131.4	96.98	10.06	10.37	89.63
GYP	2019	0.08	0.16	0.24	1.57	15.26	4.86	31.83	68.17
	2020	0.00	1.46	1.33	2.14	62.12	0.00	0.00	109.9
HI	2019	7.00	15.65	22.65	26.19	86.48	26.71	30.89	69.11
	2020	8.40	38.08	46.48	49.23	94.41	17.06	18.07	81.93
HUL	2019	0.98	9.37	10.35	23.15	44.71	4.25	9.51	90.49
	2020	0.00	6.74	6.29	25.86	24.34	0.00	0.00	107.1
MIL	2019	0.40	1.77	2.17	21.77	9.96	1.84	18.51	81.49
	2020	0.90	0.11	1.00	20.58	4.87	4.35	89.36	10.64
HDR	2019	0.00	9.8	8.23	32.53	25.3	0.00	0.00	119.1
	2020	1.20	0.2	1.4	33.19	4.23	3.62	85.52	14.48

Where, DUR=duration, PH=plant height, GYP=Grain yield (t ha^{-1}), HI=harvest index%, BIO=total biomass (t ha^{-1}), PW=panicle weight, PL=panicle length, FGP=filled grains/ panicle, SPK=number of spikelet's/ panicle, FRT=fertility percentage, HUL=Hulling percentage, MIL=milling percentage, HDR= head rice and NTP=number of tiller /plant, Additive variance (σ^2A), Dominant variance (σ^2D), Genotypic variance (σ^2G), Phenotypic variance (σ^2P), Broad sense heritability (h^2_b) %, Narrow sense heritability (h^2_n) %, General combining ability variance (σ^2GCA) and specific combining ability variance (σ^2SCA).

A similar finding was reported by Bhutta *et al.* (2018). Furthermore, Anis *et al*. (2019) reported the significance of non-additive gene action in controlling the inheritance of most studied traits. Contrarily, Gaballah *et al.* (2022) reported that the additive variance was the main component of the total genotypic variance. Regarding heritability estimation, in a broad sense (h^2_b%), the results indicated that the heritability values were high for duration, plant height, no. of filled grains/ panicle, number of spikelets/ panicle, fertility percentage, total biomass yield, harvest index, panicle length, hulling and milling percentages in both seasons, besides grain yield and head rice % in the 2nd season only, the heritability more than sixty percentage. However, the heritability values are moderate for number of tillers/plant and panicle length in both seasons, besides hulling % in the 2nd season. The heritability in broad sense is low 30 percent for panicle weight in both seasons and grain yield and head rice % in the 2nd season. Knowledge of heterosis, heritability, and genetic components for any crop will give breeders the information needed to select optimal breeding strategies for hybrid variety creation programs (Ammar *et al*. 2014).

Traits with high heritability is very important in breeding program because capability of its genotype to transform of its superiority to its offspring. Heritability of narrow sense (h^2_n%) was high for duration and moderate for plant height, fertility % and hulling % in only one season and moderate for panicle length in both seasons. Contrarily, most of the studied traits were low narrow sense heritability, indicating that a major part of the total genotypic variance was the dominance variance. These results agree with Al-Daej, (2022) who reported that the lowest narrow sense heritability values were noted for duration and panicle length.

Estimates of simple phenotypic correlation:

Plant breeding progressed due to an effective selection scheme based on correlated and non-correlated responses. In almost all crops, grain yield is referred to as a super character those results from the multiplicative interactions of several other characters known as yield components. Thus, identifying important yield components and learning about their relationships with grain yield and with one another is extremely useful for selecting efficient genotypes for evolving high yielding varieties. In this regard, the correlation coefficient, which provides a symmetrical measurement of the degree of association between two variables or characteristics, aids us in comprehending the nature and magnitude of association between yield and yield components. El-Mowafi *et al.* (2021) and Al-Daej, (2022) they studied the simple correlation among traits in F_1 hybrids. Table 4 shows the phenotypic correlation coefficients. Grain yield exhibited highly significant and positive correlation with total Biomass in both seasons and with panicle weight in 1st season, indicating the selection based on these two traits will be more effective to improve the grain yield. And also, the grain yield was a significant positive with plant height in 2nd growing season. Also, the grain yield was significant and highly significant with plant height and panicle length in 2nd season. Similar findings found by El-Mowafi *et al.* (2021) and Al-Daej, (2022).

Table 4. Estimates of the Pearson correlation coefficient for all studied traits in 2019 and 2020 growing seasons.

Traits		DUR	PH	NTP	SPK	PL	PW	FGP	FRT	BIO	GYP	HI	HUL	MIL
NTP	2019	0.001	0.184											
	2020	0.008	0.038											
SPK	2019	0.207	-0.290	-0.248										
	2020	-0.324	-0.065	-0.082										
PL	2019	-0.082	0.175	0.217	-0.223									
	2020	-0.132	0.298	-0.224	0.063									
PW	2019	-0.031	0.029	0.419^{*}	-0.094	0.482^{**}								
	2020	0.030	-0.087	0.192	0.157	0.077								
FGP	2019	0.220	-0.017	-0.108	0.709^{**}	-0.151	0.054							
	2020	0.183	0.028	-0.037	0.420^{*}	-0.143	-0.074							
FRT	2019	0.097	0.295	-0.170	0.278	0.202	0.175	0.444^{**}						
	2020	0.111	0.270	-0.227	0.372^{*}	-0.074	-0.207	0.735^{**}						
BIO	2019	-0.389^{*}	0.129	-0.010	-0.204	0.194	0.448^{**}	0.002	0.111					
	2020	-0.356^{*}	0.282	-0.107	0.108	0.563^{**}	0.088	-0.083	0.067					
GYP	2019	-0.140	0.221	0.084	-0.061	0.280	0.561^{**}	0.076	0.259	0.762^{**}				
	2020	0.110	0.383^{*}	-0.086	0.020	0.448^{**}	0.231	0.016	0.029	0.538^{**}				
HI	2019	0.496^{**}	-0.102	0.012	0.249	-0.199	-0.384^{*}	0.033	-0.057	-0.935^{**}	-0.530^{**}			
	2020	0.535^{**}	-0.188	0.066	-0.113	-0.441^{**}	0.007	0.086	-0.060	-0.891^{**}	-0.150			
HUL	2019	0.014	0.013	-0.057	0.091	-0.034	0.093	0.013	-0.030	-0.079	-0.001	0.144		
	2020	0.001	-0.092	0.139	-0.101	-0.145	0.021	-0.011	0.107	0.183	0.135	-0.123		
MIL	2019	-0.116	-0.254	-0.052	0.151	-0.248	-0.181	0.099	-0.295	0.175	0.154	-0.091	0.207	
	2020	-0.041	-0.209	0.112	0.121	-0.467^{**}	-0.187	0.125	0.012	-0.016	-0.094	0.013	0.477^{**}	
HDR	2019	-0.083	-0.226	-0.150	0.258	-0.321	-0.281	-0.002	0.017	-0.201	-0.151	0.224	0.138	0.561^{**}
	2020	-0.101	-0.193	0.014	0.117	-0.570^{**}	-0.138	0.247	0.161	-0.155	-0.374^{*}	0.000	0.354^{*}	0.799^{**}

Where, DUR=duration, PH=plant height, GYP=Grain yield (t ha^{-1}), HI=harvest index%, BIO=total biomass (t ha^{-1}), PW=panicle weight, PL=panicle length, FGP=filled grains/ panicle, SPK=number of spikelets/ panicle, FRT=fertility percentage, HUL=Hulling percentage, MIL=milling percentage, HDR= head rice and NTP=number of tiller /plant, *. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

The grain yield was significant and highly significant negative with harvest index in 2019 and head rice in 2020. The correlation coefficients of grain yield with remaining nine characters were non-significant, similar findings found by Fahmi *et al.* (2017) and Singh *et al*. (2018). Results in Table 4 also, were represents the other correlation between the other traits; the duration was highly significant positive and negative for harvest index and Biomass respectively in both seasons. Total biomass yield was highly significant positive correlation with panicle weight in 1st season, indicating the improvement in biomass yield will be increasing the weight of panicle. The No. of filled grains/ panicle will be improved together with number of spikelets/ panicle and fertility. The grain quality traits have a positive correlation with each other, since the good hulling % will be led to good milling % and also the intact grain % will be improved.

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دراسة قوه الهجين والمقاييس الوراثيه بين صفات المحصول ومكوناته في الأرز الهجين باستخدام نظام تزاوج السلالة في الكشاف

حمدي فتوح الموافي، السيد فاروق عرفات ، محروس السيد نجم ، مريم طلعت ويصا وداليا السيد الشرنوبي

قسم بحوث الأرز، معهد بحوث المحاصيل الحقلية، مركز البحوث الزراعية، مصر

الملخص

تعتبر قوة الهجين مهمة للغاية لأن الأداء المتفوق يمكن أن يظهر في هجن الجيل الأول نظرًا لزيادة النمو الخضري الذي يؤدي إلى نباتات أكثر صحة وأسرع نموًا مقارنة بأبويها. تم إجراء هذا البحث في المزرعة التجريبية بمحطة البحوث الزراعية بسخا، كفر الشيخ، مصر، خلال موسمي زراعة الأرز 2019 و 2020 لدراسة قوه الهجين والارتباط البسيط لصفات المحصول ومكوناته في بعض توليفات الأرز الهجين، باستخدام نظام تزاوج السلالة في الكشاف بين ست سلالات عقيمة ذكريًا وأربعه تراكيب وراثية معيدة للخصوبة. كانت نتائج قوة الهجين متفوقة عن متوسط الأبوين وكذلك قوة الهجين مقارنة بالأب الأفضل وكانت أفضل الهجن هى IR69625AxPR1, IR68902AxPR78, IR58025AxPR78, IR69625AxPR78 وIR58025AxPR1 حيث يمكن استخدامها في برنامج التربية لتحسين محصول الحبوب الذي يعتمد على تفوقها في العديد من الصفات. كان التباين الإضافي (σ^2A) أكبر من التباين السائد (σ^2D) لصفتى عمر النبات ووزن الدالية في كلا الموسمين والتدريج فى موسم النمو الثاني وعلى النقيض من ذلك ، كان التباين السائد (σ^2D) هو التباين الأكبر في باقي الصفات ، مما يشير إلى أن هذه الصفات كانت تخضع إلى حد كبير لعمل الجينات غير المضيفة. وكذلك أظهر محصول الحبوب ارتباطًا معنويًا وإيجابيًا للغاية مع المحصول البيولوجى في كلا الموسمين ومع وزن الدالية في موسم الزراعه الاول، مما يشير إلى أن الاختيار بناءً على هاتين الصفتين سيكون أكثر فاعلية في تحسين محصول الحبوب.