Eco. Env. & Cons. 29 (2) : 2023; pp. (681-687)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i02.021

Combining Ability Analysis for Yield and its Component Traits in Rice (*Oryza sativa* L.)

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(Received 7 October, 2022; Accepted 8 December, 2022)

ABSTRACT

The identification of superior parental lines is the pre-requisite for hybrid rice technology. The current study used Line X Tester analysis to evaluate seven lines and three testers (ten parents) along with 21 F_1 hybrids in order to identify good combiners and cross combinations for the development of best high-yielding varieties. The variances due to line x tester differ significantly for all the traits indicating the predominance of inherent variability among all the cross combinations. The GCA/SCA variance ratio was less than one for all the traits studied, suggesting the predominance of dominance (non additive) gene action governing the traits. The estimates of combining ability variances revealed that SCA variance was highly significant than the GCA variance as observed from the GCA/SCA ratios for all the traits studied which indicated the preponderance of non-additive gene action. Among the parents lines based on the mean performance of different parental genotypes, the lines ADT-42, ADT-39 and ADT-45 while the testers ADT-36 and Ilupai poo samba were adjudged as good general combiner for grain yield/plant and several important traits to emerge as superior parents for hybridization programme for obtaining high yielding varieties. Among twenty-one hybrid combinations, three crosses *viz*., ADT-45 x ADT-36, ADT-39 x ADT-36 and ADT-45 x ADT-48 were highly significant and positive specific combiner for grain yield per plant and its component traits and were found suitable for heterosis breeding.

Key words: *Combining ability, SCA effect, GCA effect, Rice, gene action*

Introduction

More than half of the world's population depend on rice for their nourishment as a staple food source (Khush and Jena, 2009). Rice is the predominant food grain crop cultivated in the world (Verma *et al.*, 2017). Asia contributes to more than 90% of world's production and consumption of rice. The world's total rice production during 2020-2021 is estimated to be around 513.6 million tones which is slightly higher (10 million tonnes) than what is actually produced during 2019-2020 *i.e.*, 503.6 million tonnes (FAO, 2021). India is reported to be the second largest producer of rice in the world (FAOSTAT, 2020). Due to limited land and water resources coupled with various biotic and abiotic stresses, the necessity for the sustainable ways to increase rice production remains a crucial challenge. In order to increase rice productivity, the exploitation of heterosis through hybridization offers a great advantage. The identification of superior parental lines is the pre-requisite for hybrid rice technology. The constant challenge faced by rice breeders is the selection for developing potential parental genotypes. For this, the combin-

ing ability is used to determine the ability of parental lines to pass on its genetic information governing desirable characters to its progeny (Aly, 2013). Line X Tester analysis is used for quantifying both the General and Specific Combing Ability and also provides information about the nature of gene action (Kempthorne, 1957). The tests for hybrid purity is very crucial in crop hybridization since the foreign or self-pollen could affect the genetic purity of the F1 seeds (Subashini *et al.,* 2014). The current study used Line X Testers analysis to evaluate seven lines and three testers (ten parents) along with 21 F1 hybrids in order to identify good combiners and cross combinations for the development of best high-yielding varieties.

Materials and Methods

The present study was carried at the Department of Genetics and Plant Breeding farm, Annamalai University, Tamil Nadu located at latitude 11°. 24'N, longitude 79.4'E, and height + 5.79 m. The study material comprises 10 genotypes which include seven lines *viz.,* ADT-39, ADT-42, ADT-52, Sigappu Kuruvikkar, Attur Kichili Samba, ADT-45, White Ponni and three testers *viz.,* ADT-36, ADT-48, Illupai poo samba. To achieve synchronization between the female and male parents staggered sowing of entries were done. Kempthprone's line x tester method (1957) was used to make the crosses and 24 hybrids were synthesized.

During *kharif,* 2021, 21 F_1 hybrids were raised in randomized block design with three replications. Seedlings with 25 days duration were transplanted in the main field with a spacing of 20 x 40 cm in a 2.6 meter single row length. For effective crop growth, all prescribed agronomic procedures and plant protection measures were followed. Ten biometrical and grain quality traits *viz.,* days to fifty percent flowering, plant height, the number of tillers per plant, the number of productive tillers per plant, panicle length, number of grains per panicle, number of filled grains per panicle, flag leaf length, 1000 grain weight and grain yield per plant were recorded. Observations were recorded on five randomly selected plants in each entry and the mean value was calculated. The approach described by Kempthorne (1957) was used to calculate the *gca* and *sca* effects were used to determine good combiners among parental genotypes ad good combiners from crosses. The statistical analysis was carried using the TNAUSTAT.

Results and Discussion

The wide range of variability among the genotypes was evident from the highly significant analysis of variance for all traits. The ANOVA revealed significant differences ($p \leq 0.01$) among the parents for all the ten characters studied. However, there was no significant differences across the replications, indicating the minimal effect of environment over the trait expression and the predominance of inherent variability among all the cross combinations. The GCA/SCA variance ratio was less than one for all the traits studied suggesting the predominance of dominance (non additive) gene action governing the traits. The estimates of combining ability variances

Table 1. Analysis of variance of combining ability for grain yield and its related traits

Source of variation	Df	DFF	PH	NTPP	NPTPP	PL	NGP	NFGPP	FLL	TGW	GYP
Replication	2	0.091	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Hybrid	20	164.96**	82.19**	15.20**	8.05**	12.17**	98.74**	162.47**	21.98**	2.86**	21.17**
Lines	6	469.79**	219.73**	12.86**	7.46**	30.10**	312.76**	506.67**	52.61**	4.32*	56.33**
Testers	2	163.69**	60.15**	30.94*	16.93**	6.33**	1.40*	14.06**	19.05**	3.39**	7.25**
L x T	12	12.75**	17.10**	13.75**	6.86**	3.74**	7.96**	15.11**	7.16**	2.04*	5.91**
Error	40	0.46	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
GCA		3.96	1.70	0.04	0.03	0.22	2.36	3.84	0.39	0.02	0.40
SCA		4.10	5.54	4.42	2.13	1.08	2.49	4.87	2.22	0.52	1.81
GCA/SCA		0.97	0.31	0.01	0.01	0.20	0.95	0.79	0.17	0.04	0.22

Where, df – degrees of freedom, * Significant at 5 per cent level; ** Significant at 1 per cent level; DFPF – Days to fifty percent flowering; PH – plant height; PL – panicle length; NTPP- number of tillers per plant; NPTPP – Number of productive tillers per plant; NGPP – Number of grains per panicle; FLL – flag leaf length: TSW – thousand seed weight; SYP – Seed yield per plant

revealed that SCA variance were highly significant than the GCA variance as observed from the GCA/ SCA ratios for all the traits studied which indicated the predominance of non-additive gene action which was in confirmation with the findings of Anandalekshmi *et al*. (2020) (Table 1).

The mean performance of parents is depicted in the Table 2. Among the lines studied, ADT-42 recorded the highest mean for the traits like number of grains per panicle, panicle length and was earlier than other genotypes for days to fifty percent flowering. The line ADT – 52 was highly dwarf while the ADT-39 and ADT-45 recorded the maximum length of panicle and highest grain yield per plant, respectively among the lines. Attur kichili samba recorded the highest number of tillers per plant and number of productive tillers per plant. Among the testers, ADT -36 had taken fewer days to days to fifty percent flowering, was of short stature and produced the longest panicle and recorded highest mean for grain yield per plant. ADT-48 recorded highest mean for number of grains per panicle and thousand grain weight. Illupai poo samba recorded significantly higher mean for number of tillers per plant and number of productive tillers per plant among the testers. Based on the mean performance of different parental genotypes, the lines ADT-42, ADT-39 and ADT-45 while the testers ADT-36 and Ilupai poo samba were adjudged as the superior parents.

General combining ability aids in the identification of superior parents, whereas specific combining ability aids in the identification of superior cross combinations. The results of *gca* effects on parental phenotypes have been depicted in Table 4. The line, ADT-42 showed significant and negative *gca* effect for days to fifty percent flowering and it was highly significant and positive for number of tillers per plant, number of productive tillers per plant, number of grains per panicle and grain yield. ADT-39 showed negative *gca* effect for days to fifty percent flowering, plant height and positive significance for panicle length and grain yield per plant. ADT 45 showed positive and higly significant *gca* effect for thousand grain weight and grain yield per plant. Traditional line Attur Kichili samba was the best general combiner for number of tillers per plant and number of productive tillers per plant. ADT-52 was found to be a good general combiner for reduced plant height. The traditional line Sigappu Kuruikkar was a good general combiner for panicle length. The tester genotype ADT-36 was the best general combiner for reduction in flowering duration, reduction in plant height and it showed positive and signifi-

Table 2. Mean performance of parents for yield and yield related traits

Parents LINES	DFF	PH	NTPP	NPTPP	PL	NGP	NFGPP	FLL	TGW	GYP
ADT 39	80.40	98.78	29.19	23.13	22.52	142.50	131.46	18.41	23.27	29.47
ADT 42	72.60	108.90	28.65	23.75	21.56	158.47	149.87	25.02	23.20	31.14
ADT 52	85.34	95.13	29.89	24.59	20.43	124.97	118.56	20.46	23.31	28.47
SK	80.20	112.64	27.82	21.62	19.42	125.64	116.85	34.26	23.90	25.51
AKS	88.65	112.98	30.30	26.28	21.18	142.62	130.74	17.35	21.77	22.85
ADT 45	76.80	97.82	24.47	19.44	18.40	141.41	133.25	17.78	23.28	32.14
WP	92.60	99.64	26.26	21.89	19.37	134.05	128.01	16.67	22.66	30.11
Mean (Lines)	82.37	103.70	28.08	22.95	20.39	138.52	129.82	21.42	23.06	28.53
TESTERS										
ADT 36	76.20	101.40	27.64	22.54	19.42	131.50	123.97	20.83	22.64	29.24
ADT 48	76.20	106.48	27.90	23.70	19.06	146.22	135.62	22.25	23.71	29.81
IPS	74.40	117.88	30.72	24.62	18.76	133.05	126.45	19.18	22.86	28.74
Mean (Testers)	75.60	108.59	28.75	23.62	19.08	136.92	128.68	20.75	23.07	29.26
Mean (Parents)	80.34	105.16	28.28	23.16	19.99	138.04	129.48	21.22	23.06	28.75
General mean	78.82	103.66	28.84	23.97	21.02	145.48	131.50	21.13	23.39	29.93
CV (%)	0.72	0.56	2.03	2.44	2.79	0.40	0.51	2.80	2.50	1.96

Where, ADT- Aduthurai; SK- Sigappu Kuruvikkar; AKS- Attur Kichili Samba; WP- White Ponni; IPS- Ilupai poo samba; CV – coefficient of variation; DFPF – Days to fifty percent flowering; PH – plant height; PL – panicle length; NTPP- number of tillers per plant; NPTPP – Number of productive tillers per plant; NGPP – Number of grains per panicle; FLL – flag leaf length: TSW – thousand seed weight; SYP – Seed yield per plant

cant general combining effect for panicle length, number of grains per panicle and grain yield per plant. Ilupai poo samba, a traditional genotype showed positive and significant *gca* effect for number of tillers per plant and number of productive tillers per plant among the testers. The tester, ADT-48 was a good general combiner for thousand grain weight and grain yield per plant (Table 4). Based on the *gca* effects of the parents, the lines ADT-42, ADT-39and ADT-45 were good general combiners and the testers ADT-36 and Ilupai poo samba were better testers with good *gca* effects. Hence, in the present study, the lines (ADT-42, ADT-39, ADT-45) and the testers (ADT-36 and Ilupai poo samba) have been selected for hybridization as they possess high mean and significant *gca* effects for most of the traits under study. The present findings are also in accordance with the results of Alok Kumar Singh and Sujeet Kumar (2020) and Rasheed *et al*. (2021).

In the present study, the F1 combination ADT-39 x ADT-36 recorded the significant mean values for the traits *viz*., number of productive tillers per plant, grain yield per plant and produced panicles in short duration and are short duration and were of short stature. The hybrid combination ADT-42 x Ilupai poo samba recorded lower mean value for days to 50 percent flowering and have exhibited high mean for tillers number per panicle and grain yield per plant. ADT-45 x ADT-48 and ADT-45 x ADT-36 cross combinations exhibited high mean for thousand grain weight and grain yield per plant among other hybrids. The hybrid, ADT-53 x ADT-36 produced considerably dwarf plants with low mean for plant height. Attur kichili samba x Ilupai poo samba produced high mean number of tillers per plant and number of productive tillers per plant. The cross white ponni x Ilupai poo samba recorded high mean for number of productive tillers but exhibited in-significant mean for other traits (Table 3).

The *sca* effect should be given much importance

Table 3. Mean performance of hybrids for yield and yield related traits

Hybrids	DFF	PH	NTPP	NPTPP	PL	NGP	NFGPP	FLL	TGW	GYP
ADT 39 X ADT 36	65.40	92.36	27.80	22.80	25.58	151.64	129.20	22.18	25.06	33.99
ADT 39 X ADT 48	73.09	99.72	28.85	23.78	22.75	146.23	131.65	18.99	23.73	30.90
ADT 39 X IPS	76.03	104.35	30.62	23.93	21.99	146.91	129.50	19.20	22.92	30.21
ADT 42 X ADT 36	69.04	106.24	28.45	24.05	19.78	159.42	146.87	24.99	23.16	30.59
ADT 42 X ADT 48	70.76	107.52	28.62	24.29	21.04	160.23	141.35	23.62	24.33	30.89
ADT 42 X IPS	68.07	107.62	33.60	27.73	19.92	163.32	144.84	26.86	24.47	32.92
ADT 52 X ADT 36	84.26	96.05	26.93	24.40	20.57	144.76	123.81	21.12	23.19	29.20
ADT 52 X ADT 48	85.50	96.24	26.67	23.60	19.92	145.29	129.35	20.52	23.65	28.47
ADT 52 X IPS	89.59	99.06	29.79	24.63	19.83	144.23	126.45	19.22	23.32	28.51
SK X ADT 36	75.67	108.96	30.29	21.96	24.62	148.95	123.72	25.24	23.70	27.50
SK X ADT 48	78.66	108.18	27.28	23.20	23.94	148.63	124.12	23.75	23.72	28.89
SK X IPS	80.59	112.01	27.97	25.02	24.76	146.89	123.56	21.56	22.92	26.24
AKS X ADT 36	86.19	103.94	29.87	23.79	22.48	148.95	131.21	18.99	21.74	29.01
AKS X ADT 48	89.03	107.58	30.26	25.69	22.05	149.71	132.74	17.95	23.92	29.83
AKS X IPS	90.24	109.78	32.04	26.33	21.98	149.63	130.74	19.29	22.76	28.75
ADT 45 X ADT 36	68.90	100.76	30.38	25.59	21.60	149.44	143.93	24.61	25.26	36.43
ADT 45 X ADT 48	76.40	98.46	27.23	23.20	20.01	150.20	141.11	19.67	25.68	36.60
ADT 45 X IPS	77.60	99.42	25.22	21.85	17.44	148.04	138.01	18.98	23.00	32.22
WP X ADT 36	75.70	101.17	27.25	23.61	20.21	141.59	127.75	18.21	22.65	29.26
WP X ADT 48	78.12	111.45	27.99	23.90	19.85	143.09	133.01	19.57	22.68	30.09
WP X IPS	81.20	100.80	33.98	28.25	21.44	142.14	128.85	18.42	22.69	29.85
Mean (Hybrids)	78.10	102.94	29.10	24.36	21.51	149.01	132.47	21.09	23.55	30.49
General mean	78.82	103.66	28.84	23.97	21.02	145.48	131.50	21.13	23.39	29.93
CV (%)	0.72	0.56	2.03	2.44	2.79	0.40	0.51	2.80	2.50	1.96

Where, ADT- Aduthurai; SK- Sigappu Kuruvikkar; AKS- Attur Kichili Samba;WP- White Ponni; IPS- Ilupai poo samba
CV – coefficient of variation; * Significant at 5 per cent level ;** Significant at 1 per cent level; DFPF – Days to fifty percent flowering; PH – plant height; PL – panicle length; NTPP- number of tillers per plant; NPTPP – Number of productive tillers per plant; NGPP – Number of grains per panicle; FLL – flag leaf length: TSW – thousand seed weight; SYP – Seed yield per plant

Table 4. General Combining ability effects of parents for ten characters in rice

Parents LINES	DFF	PH	NTPP	NPTPP	PL	NGP	NFGPP	FLL	TSW	GYP
ADT 39	-6.59**	-4.13**	-0.01	-0.86**	1.93**	-0.75**	-2.35**	-0.97**	0.35	1.21**
ADT 42	-8.81**	4.19**	1.12**	1.00**	-1.26**	11.98**	11.89**	4.07**	0.44	0.97**
ADT 52	8.35**	-5.82**	-1.30**	-0.15	-1.41**	-4.25**	-5.93**	-0.81**	-0.16	-1.77**
SK	0.21	6.78**	-0.59*	-0.97**	2.93**	-0.86**	-8.67**	2.42**	-0.10	-2.95**
AKS	10.39**	4.16**	1.62**	0.91**	0.66**	0.42	-0.90**	-2.35**	-0.74**	-1.30**
ADT 45	-3.80**	-3.39**	-1.49**	-0.82**	-1.83**	0.21	8.55**	-0.01	1.10**	4.59**
WP	0.24	-1.80	0.64**	0.89**	-1.01**	-6.74**	-2.60**	-2.36**	-0.88**	-0.76**
SE for Lines	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
TESTERS										
ADT 36	-3.07**	-1.58**	-0.39*	-0.62**	0.61**	0.24	-0.11	1.10**	-0.01	0.36*
ADT 48	0.70**	-0.20	-0.97**	-0.41**	-0.15	0.04	0.87**	-0.51**	0.41**	0.32*
IPS	2.38**	1.78**	1.36**	1.03**	-0.46**	-0.28	-0.76**	-0.59**	-0.40*	-0.68**
SE for Testers	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15

Where, ADT- Aduthurai; SK- Sigappu Kuruvikkar; AKS- Attur Kichili Samba; WP- White Ponni; IPS- Ilupai poo samba SE – standard error; * Significant at 5 per cent level **; Significant at 1 per cent level; DFPF – Days to fifty percent flowering; PH – plant height; PL – panicle length; NTPP- number of tillers per plant; NPTPP – Number of productive tillers per plant; NGPP – Number of grains per panicle; FLL – flag leaf length: TSW – thousand seed weight; SYP – Seed yield per plant

Table 5. Specific combining ability effects of parents for ten characters in rice

Hybrids	DFF	PH	NTPP	NPTPP	PL	NGP	NFGPP	FLL	TGW	GYP
ADT 39 X ADT 36	-3.03**	-4.87**	-0.90*	-0.08	1.53**	3.14**	-0.81	0.96*	1.17**	1.93**
ADT 39 X ADT 48	0.89*	1.11**	0.73	0.69	-0.54	-2.07**	0.67	-0.62	-0.58	-1.12**
ADT 39 X IPS	2.15**	3.76**	0.17	-0.60	-0.99*	-1.07*	0.14	-0.34	-0.59	-0.81*
ADT 42 X ADT 36	2.82**	0.69	-1.38**	-0.69	-1.08*	-1.81**	2.63**	-1.27**	-0.81*	-1.24**
ADT 42 X ADT 48	0.77	0.59	-0.63	-0.66	0.94*	-0.80	-3.87**	-1.03*	-0.07	-0.89*
ADT 42 X IPS	-3.60**	-1.29**	2.02**	1.35**	0.14	2.61**	1.25**	2.29**	0.88*	2.13**
ADT 52 X ADT 36	0.89*	0.52	-0.48	0.81*	-0.14	-0.24	-2.62**	-0.27	-0.18	0.11
ADT 52 X ADT 48	-1.65**	-0.68	-0.16	-0.20	-0.04	0.49	1.95**	0.74	-0.15	-0.57
ADT 52 X IPS	0.76	0.16	0.63	-0.61	0.18	-0.25	0.67	-0.48	0.33	0.46
SK X ADT 36	0.44	0.83*	2.17**	-0.81*	-0.43	0.56	0.03	0.62	0.27	-0.40
SK X ADT 48	-0.34	-1.34**	-0.26	0.22	-0.35	0.43	-0.55	0.74	-0.14	1.03*
SK X IPS	-0.09	0.51	-1.90**	0.60	0.78	-0.99*	0.52	-1.37**	-0.13	-0.63
AKS X ADT 36	0.78	-1.58**	-0.46	-0.86*	-0.30	-0.72	-0.24	-0.85*	-1.05*	-0.55
AKS X ADT 48	-0.15	0.68	0.51	0.83*	0.03	0.24	0.31	-0.28	0.70	0.32
AKS X IPS	-0.62	0.90*	-0.04	0.03	0.27	0.48	-0.07	1.13**	0.35	0.23
ADT 45 X ADT 36	2.33**	2.80**	3.16**	2.66**	1.31**	-0.02	3.02**	2.42**	0.63	0.99*
ADT 45 X ADT 48	1.40**	-0.89*	0.59	0.06	0.47	0.93*	-0.77	-0.91*	0.62	1.20**
ADT 45 X IPS	0.92*	-1.91**	-3.75**	-2.73**	-1.78**	-0.91*	-2.25**	-1.52**	-1.25**	-2.19**
WP X ADT 36	0.43	1.61**	-2.10**	-1.02*	-0.90*	-0.92*	-2.01**	-1.62**	-0.01	-0.83*
WP X ADT 48	-0.92*	0.51	-0.78	-0.94*	-0.50	0.78	2.27**	1.35**	-0.40	0.04
WP X IPS	0.48	-2.12**	2.88**	1.97**	1.40**	0.14	-0.26	0.27	0.41	0.79
SE (*sca* effect)	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40

Where, ADT- Aduthurai; SK- Sigappu Kuruvikkar; AKS- Attur Kichili Samba; WP- White Ponni; IPS- Ilupai poo samba SE – standard error; *sca*-specific combining ability* Significant at 5 per cent level; ** Significant at 1 per cent level; DFPF – Days to fifty percent flowering; PH – plant height; PL – panicle length; NTPP- number of tillers per plant; NPTPP – Number of productive tillers per plant; NGPP – Number of grains per panicle; FLL – flag leaf length: TSW – thousand seed weight; SYP – Seed yield per plant

for the evaluation of a hybrid. Among the twenty-one hybrid combinations, ADT-39 x ADT-36 was the best specific combiner for reduction in days to 50 percent flowering and reduction in plant height. Also, this combination exhibited the maximum *sca* effect for panicle length, thousand grain weight, grain number per panicle and grain yield per plant. Another cross combination, ADT-42 x Ilupai poo samba was a good specific combiner for early flowering, number of productive tillers per plant, number of grains per panicle and grain yield per plant. ADT-45 x ADT-36 exhibited better *sca* effect for early anthesis, number of tillers and productive tillers per plant and grain yield. ADT-45 x ADT-48 exhibited significant and positive *sca* effect for grain yield per plant (Table 5). In the present study, the hybrids ADT-39 x ADT-36, ADT-45 x ADT-48 and ADT-45 x ADT-36 exhibited high mean performance and significant *sca* effects with high x high *gca* combinations for grain yield and yield related traits. These cross combinations exhibited superior mean performance for grain yield and other traits studied. Hence, these three hybrids could be exploited for heterosis breeding. This indicated that additive gene action played a predominant role and these crosses are found suitable for recombination breeding. The other hybrids *viz*., ADT-39 x ADT-48 and ADT-45 x Ilupai poo samba recorded non-significant *sca* effects for almost all the traits studied. The present findings are also in accordance with the results of Singh *et al*. (2020) and Suvi *et al*. (2021)

Conclusion

Based on the *per se* performance of different traits of parents, the lines ADT-45, ADT-42 and tester genotype ADT-48, ADT-36 were found to be best performers for grain yield and its component traits. Thus, based on *per se* mean performance and *gca* effects, the lines ADT-45, ADT-42 and tester genotype ADT-48, ADT-36 was adjudged as superior for grain yield and other related traits. The recorded mean grain yield was highest for ADT- 45 x ADT- 48 which was closely followed by ADT-45 x ADT-36 and ADT-39 x ADT-36. ADT-45, ADT-39 and ADT-42 are good general combiner liners for grain yield per plant and other related traits. Among the tester genotypes, ADT- 36 and ADT- 48 have shown good general combining ability for most of the economic traits. Among twenty-one hybrid combinations, three crosses *viz*., ADT-45 x ADT-36, ADT-39 x ADT-36 and ADT-45 x ADT-48 were highly significant and positive specific combiner for grain yield per plant and its component traits. Thus, it is concluded based on the mean performance and *sca* effect, the hybrids ADT-45 x ADT-48, ADT-45 x ADT-36 and ADT-39 x ADT-36 were the most promising and were found suitable for heterosis breeding.

Acknowledgement

The authors are grateful to the Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Tamil Nadu for supporting and providing all the necessary facilities to conduct this research.

Abbreviation

df – degrees of freedom
* Significant at 5 per cent level
** Significant at 1 per cent level
GCA - General combining ability
SCA – Specific combining ability
ADT - Aduthurai
SK - Sigappu Kuruvikkar
AKS - Attur Kichili Samba
WP - White Ponni
IPS - Ilupai poo samba
SE – Standard error
CV – Coefficient of variation
DFPF – Days to fifty percent flowering
PH – Plant height
PL – Panicle length
NTPP - Number of tillers per plant
NPTPP – Number of productive tillers per plant
NGPP – Number of grains per panicle
FLL – Flag leaf length
TSW – Thousand seed weight
SYP – Seed yield per plant

Conflict of Interest

The authors declare that there is no conflict of interest.

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