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Combining ability effects and variances studies in rice (*Oryza sativa* L.) for different metric traits.

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Abstract

Studies on combining ability and variances among ten parents (7 lines and 3 testers) along with their 21 hybrids for eleven yield attributing traits were conducted using line x tester mating design as part of a PhD research programme. The analysis of variance for combining ability revealed significant differences among the genotypes for all the characters except plant height and the GCA/SCA variances revealed the preponderance of non-additive gene action in all the traits analyzed except PI (cm) and UG. Parents such as L3, L6, and L1 exhibited high GCA for yield attributing traits and amongst hybrids, L2xT2, L4xT1, L3xT3, L6xT2, L7xT3, L7xT1, L1xT3, L5xT3 and L6xT1 demonstrated outstanding specific combining ability effect and these crosses were ideal for future breeding approaches to enhance grain yield and most of its attributing traits.

Keywords: Gene effects, combining ability, GCA, SCA, yield attributing traits

Introduction

Rice (*Oryza sativa* L.) is an annual plant of the family Poaceae. It is one of the most important cereal crops in the world forming a staple diet for half of the world's population and is also referred to as "grain of life" (Singh *et al.* 2020). Rice being the most important cereal of the North-East and paddy cultivation occupies a primary position in varied and composite mix of crops. However, the rice production from the region is quite small as compared to the national production which can be attributed to a number of constraints such as extensive use of traditional cultivars, biotic and abiotic stresses and lack of wide scale technological intervention (Kumar *et al.* 2017) ^[3]. However, the existing land races can be utilized for development of area specific high yielding varieties for production and productivity enhancement of rice in the region (Konjengbam *et al.* 2022) ^[2]. The combining ability, a concept proposed by Sprague and Tatum (1942) ^[8] is a powerful tool to identify good combiners and opens up avenues to select suitable parent with good combining ability. The Line x Tester analysis proposed by Kempthorne (1957) ^[1] provides a systematic approach for the assessment of genetic interaction and combining ability of the parents for different quantitative traits which is essential in distinguishing superior performing parents, estimating their hybrid performances and adapting suitable breeding programs for developing new varieties with an improved desired trait.

Materials and Methods

The present research was undertaken at the research farm of Genetics and Plant Breeding, School of Agricultural Sciences, Medziphema Campus, Nagaland University located at 25 degree 45'43" N latitude and 93 degree 53'04" E longitude at an altitude of 310m above mean sea level. The experimental material in the present study comprised of seven lines (female parent), three testers (male parent) procured from SARS, Mokokchung and their 21 crosses (F₁'s). Crossing between parents was carried out during *Kharif* 2023 using Line x Tester mating design and 21 hybrids were planted in randomized block design in three replication along with parents at a spacing of 30 cm x 10 cm during *Kharif* 2024 and observations were recorded for the following 11 parameters; Days to 50% flowering (50%F), Days to 80% maturity (80%M), Plant height (PH), Panicle length (PL), Number of tillers/plant (NOT), Number of panicles/plant (NOP), Number of filled grains/plant (FG), Number of unfilled grains/plant (UG), Total number of grains/plant (TNGPP), Grain yield/plant (GYPP) and 1000 grain weight (TW). Observations

were recorded on 5 randomly selected plants for each genotype except for Days to 50% flowering and Days to 80% maturity which were done on a whole plot basis. Analysis of combining ability effects and variances were computed as per method given by Kempthorne (1957) ^[1].

Results and Discussion

Analysis of variances

The analysis of variance for combining ability (Table 1) revealed that mean squares due to genotypes were significant for all the traits studied except plant height (cm) suggesting the presence of variability among the genotypes for majority of the traits evaluated. Mean squares due to parents were significant for characters such as 50%F, 80%M, PL (cm) and TW (g) indicating variability present among the parents for such traits. Mean squares due to crosses were significant for all the characters except PH (cm) revealing the presence of variability in the crosses studied for majority of the traits. The mean squares due to parents vs. Crosses were significant for all the characters studied except PH (cm) suggest the presence of heterosis for all the traits excluding PH (cm). The comparative variances due to GCA and SCA for different characters (Table 2) revealed that for characters such as 50%F, 80%M, PH (cm), NOT, NOP, FG, TNGPP, GYPP (g) and TW (g) the ratio of variance due to GCA/SCA was less than unity suggesting the significance of non-additive gene action in determining the inheritance of such characters. Whereas, ratio of variance due to GCA/SCA greater than unity was observed in two characters, PL (cm) and UG indicating the greater role of additive gene action in their inheritance than non-additive gene action. Similar findings have been reported by Maring *et al.* (2022) ^[5] and Kushal *et al.* (2023) ^[4].

General combining ability effects

The estimates of GCA effects (Table 3) of parents revealed that the parent L2, L7 and L3 showed significant GCA effect in the desirable direction *i.e.* negative GCA effect for the character days to 50% flowering and parents such as L2, L4, L7 and T1 for days to 80% maturity. Negative GCA effect is also desirable for the character plant height as dwarf statured plants are considered desirable for the study and among the 10 parents studied; a single line L5 exhibited desirable GCA effect. Amongst the parents studied, the line L3 was observed to be a good general combiner for the characters PL, NOT, NOP, FG, TNGPP and GYPP. The line L1 was also a good general combiner for characters such as PL, UG and TW. The line L2 also exhibited significant GCA effect for PL and TNGPP. For

characters such as FG, TNGPP, GYPP and TW the parent L6 also exhibited significant GCA effect. L4 was also observed to be a good general combiner for UG and TW. The parents L7 and L5 were also found to be good combiners for NOP and FG respectively. Whereas, among the testers involved, T1 was found to be a good combiner for TNGPP and TW, the tester T1 for GYPP and T3 for UG and TW.

Specific combining ability effects

Many hybrids were observed to exhibit significant specific combining ability effect in favourable direction, five for days to 50% flowering, seven for days to 80% maturity, two for plant height (cm), four for panicle length (cm), nine for number of tillers/ plant, nine for number of panicles/ plant, three for number of filled grains/plant, four for number of unfilled grains/plant, five for total number of grains per plant, six for grain yield per plant and eleven for 1000-grain weight (g). The three best performing crosses based on their SCA for different metric traits are described hereafter. For the character days to 50% flowering, L1 x T3, L2 x T2 and L6 x T2 were found to exhibit highly significant SCA effect. For days to 80% maturity, the crosses L2 x T2, L3 x T2 and L5 x T1; for plant height, the crosses L2 x T3 and L7 x T1 were the only hybrids exhibiting significant SCA effect towards desirable direction; for panicle length, the crosses L1 x T3, L2 x T1 and L7 x T3; for number of tillers/plant, the crosses, L2 x T2, L3 x T3 and L4 x T1; for number of panicles per plant, the crosses L3 x T3, L4 x T1 and L5 x T3; for number of filled grains /plant, the crosses L2 x T2, L3 x T3 and L6 x T2; for number of unfilled grains/plant, the crosses L1 x T1, L2 x T1, and L7 x T3; for total number of grains/plant, the crosses L2 x T3, L3 x T3 and L6 x T2; for grain yield/plant, the crosses L2 x T2, L3 x T3 and L4 x T1; for 1000 grain weight, the crosses L3 x T2, L4 x T1 and L7 x T3. Based on Table 4 (a & b) it can be concluded that best specific combination for grain yield per plant would have been obtained from a cross between average x good, good x average and poor x poor parental combinations. Similarly, majority of the cross combinations involved crossing between good x poor, good x average, average x poor and average x average parental combination suggesting the role of non-additive gene action in the expression of the traits studied. The parents L3, L6 and T2 were identified as best combiners for grain yield /plant based on per se performance and combining ability effects and can be extensively utilized for future breeding programmes to enhance grain yield in rice. Cross combinations such as L2 x T2, L4 x T1, L3 x T3, L6 x T2 and L1 x T3 were identified as superior crosses for grain yield and its attributing traits.

Table 1: Analysis of variance for combining ability (Line x Tester) for different characters

Source of variation	DF	Mean square of the character										
		50%F	80%M	PH (cm)	PL (cm)	NOT	NOP	FG	UG	TNGPP	GYPP (g)	TW (g)
Replication	2	1.59	23.88**	182.09	3.307	3.39**	3.61**	126,932.46	5,509.97	105,914.91	67.47	4.051
Genotypes	30	134.08**	278.98**	138.58	22.42**	23.39**	22.35**	862,360.53**	241,126.88**	1,578,802.44**	397.47**	101.72**
Parents	9	32.09**	50.40**	100.06	23.643**	0.28	0.16	53,391.74	6,093.02	52,474.37	17.71	126.18**
Testers	2	84**	147**	141.57	17.08**	0.11	0.11	21,008.33	1,670.11	26,860.11	39.92	241.43**
Lines	6	17.22*	24.33**	93.75	28.13**	0.32	0.21	72,839.49	8,535.27	69,681.33	13.24	104.77**
Lines vs Testers	1	17.5	13.73	54.91	9.831	0.41	0.01	1,472.01	285.36	461.14	0.05	24.17**
Crosses	20	96.49**	77.55**	134.39	19.21**	7.22**	7.18**	687,513.34**	153,077.81**	864,348.75**	250.23**	94.29**
Parents vs. Crosses	1	1,803.59**	6,364.58**	568.98**	75.74**	554.90**	525.63**	11,640,023.43**	4,117,413.17**	29,604,828.81**	6,760.20**	30.27**
Error	60	4.64	4.18	73.99	3.12	0.28	0.46	37,006.72	12,038.18	41,493.21	16.93	1.20

Table 2: Estimation of genetic components of variance for grain yield and its attributing characters

	50%F	80%M	PH(cm)	PL(cm)	NOT	NOP	FG	UG	TNGPP	GYPP(g)	TW(g)
Variance due to GCA	-0.28	-0.17	3.07	1.63	-0.46	-0.45	17,761.67	23,912.13	32,252.98	21.06	7.67
Variance due to SCA	27.27	26.94	13.71	0.72	2.97	3.01	137,621.62	15,233.91	158,438.35	43.60	20.99
Variance due to GCA/Variance due to SCA	-0.01	-0.01	0.22	2.26	-0.15	-0.15	0.13	1.57	0.20	0.48	0.37

Table 3: GCA Effects of lines and testers

Parent	Character										
	50%F	80%M	PH (cm)	PL (cm)	NOT	NOP	FG	UG	TNGPP	GYPP (g)	TW (g)
LINES											
L1	3.41**	3.27**	-3.71	1.10**	-0.60**	-0.51*	-206.44**	-255.60**	-462.08**	0.27	4.63**
L2	-6.81**	-3.17**	3.46	3.4**	-0.05	-0.29	32.56	144.95**	177.48**	2.25	-0.42
L3	-1.25*	2.16**	5.49*	0.98*	1.39**	1.38**	790.00**	-4.05	786.14**	9.33**	-4.39**
L4	1.52*	-1.73**	5.68*	-0.08	-0.60**	-0.73**	-339.56**	-79.60*	-419.19**	-5.19**	3.29**
L5	5.19**	-0.95	-6.26**	-4.61**	0.06	0.15	-208.33**	49.17	-159.19*	-5.62**	-2.08**
L6	-0.25	1.71**	-2.18	-1.23**	-0.60**	-0.39*	123.56*	112.51**	236.03**	5.14**	1.65**
L7	-1.81**	-1.29*	-2.48	0.45	0.39	0.38*	-191.78**	32.62	-159.19*	-6.18**	-2.68**
SE	0.71	0.62	2.46	0.44	0.24	0.21	69.33	37.99	72.20	1.45	0.36
Testers											
T1	-1.16**	-2.54**	0.51	0.03	0.03	-0.00	-92.25*	192.86**	100.67*	-5.84**	-4.06**
T2	1.13**	0.51	1.81	0.30	-0.16	-0.19	65.27	-30.95	34.29	4.85**	1.85**
T3	0.03	2.03**	-2.33	-0.33	0.13	0.19	26.99	-161.90**	-134.95**	0.99	2.20**
SE	0.41	0.36	1.42	0.25	0.15	0.12	40.03	21.94	41.69	0.84	0.21

Table 4: SCA effects of crosses

Crosses	Character										
	50%F	80%M	PH (cm)	PL (cm)	NOT	NOP	FG	UG	TNGPP	GYPP(g)	TW(g)
L1XT1	2.49**	2.54**	4.93	-0.21	-1.25**	-1.11**	-25.75	-191.63**	-217.44*	-4.58*	-4.74**
L1T2	8.87**	1.49*	-3.34	-1.09*	0.27	0.41	123.73	21.84	145.60	5.11**	3.00**
L1T3	-11.36**	-4.03**	-1.59	1.31*	0.98**	0.69*	-97.98	169.79**	71.84	-0.53	1.73**
L2T1	0.38	2.65**	0.53	1.31*	-1.48**	-1.33**	-319.75**	-110.19*	-430**	-7.69**	0.00
L2T2	-4.57**	-4.73**	8.89**	0.11	1.05**	1.19**	215.73*	-76.05	139.71	7.21**	2.65**
L2T3	4.19**	2.08*	-9.43**	-1.42*	0.43	0.14	104.02	186.24**	290.29**	0.48	-2.66**
L3T1	2.49**	2.65**	0.59	-0.03	-0.59*	-0.67*	-1.86	-34.52	-36	1.67	2.17**
L3T2	-0.79	-7.39**	-4.70	-0.55	-2.06**	-2.14**	-786.38**	104.95*	-681.62**	-10.75**	3.35**
L3T3	-1.69*	4.75**	4.11	0.58	2.65**	2.81**	788.24**	-70.43	717.62**	9.08**	-5.52**
L4T1	-2.62**	-3.13**	1.71	1.22*	2.75**	2.78**	51.03	31.36	82.33	6.19**	6.18**
L4T2	-0.24	7.82**	-4.12	-0.02	-0.39	-0.69*	136.51	29.17	165.71	-0.72	-3.63**
L4T3	2.86**	-4.69**	2.42	-1.19*	-2.35**	-2.08**	-187.54*	-60.54	-248.05**	-5.47**	-2.56**
L5T1	0.38	-6.24**	-0.19	-0.08	-0.92**	-1.11**	145.81	82.92	228.67*	3.35	0.33
L5T2	-0.24	3.38**	1.71	0.57	-0.06	0.08	-132.71	-101.94*	-234.62*	-6.99**	-3.61**
L5T3	-0.14	2.86**	-1.52	-0.49	0.98*	1.03**	-13.09	19.03	5.95	3.65*	3.28**
L6T1	-1.51	-0.24	-0.27	-0.63	0.75*	0.78**	92.92	15.59	108.44	4.38*	2.28**
L6T2	-4.79**	-2.95**	2.79	0.87	0.60*	0.63*	320.39**	33.73	354.16**	3.39	-3.36**
L6T3	6.30**	3.19**	-2.53	-0.23	-1.35**	-1.41**	-413.32**	-49.32	-462.60**	-7.78**	1.08*
L7T1	-1.62	1.76*	-7.30*	-1.57**	0.75*	0.67*	57.59	206.48**	264**	-3.31	-6.23**
L7T2	1.76*	2.38**	-1.24	0.12	0.60*	0.52*	122.73	-11.71	111.05	2.74	1.59**
L7T3	-0.14	-4.14**	8.54**	1.45*	-1.35**	-1.19**	-180.32*	-194.76**	-375.05**	0.57	4.64**
SE	1.00	0.88	3.48	0.62	0.35	0.30	98.05	53.74	102.11	2.06	0.51

Table 5: List of parents and place of collection

Lines		Sources
L1	Meyatsuk	SARS, Mokokchung
L2	Sulijak	SARS, Mokokchung
L3	RoshoLha	SARS, Mokokchung
L4	Tungo	SARS, Mokokchung
L5	Thangmo Red	SARS, Mokokchung
L6	Sungmangtsuk	SARS, Mokokchung
L7	Apuapa	SARS, Mokokchung
Testers		Sources
T1	Amusu	SARS, Mokokchung
T2	Tsuvhuri	SARS, Mokokchung
T3	Ongpangsuk	SARS, Mokokchung

References

- Kempthorne O. *An introduction to genetic statistics*. New York: John Wiley and Sons Inc.; 1957. p. 222–240.
- Konjengbam NS, Mahanta M, Lyngdoh AA. Rice cultivation – a way of life for the people of North Eastern Hill Region of India. IntechOpen; 2022. Available from: <https://www.intechopen.com> (Accessed 2023 Jun 23).
- Kumar S, Devi EL, Sharma SK, Ansari MA, Phurailatpam S, Chanu TN, et al. Rice breeding strategies of North Eastern India for resilience to biotic and abiotic stresses: A review. *Oryza*. 2017;54(1):1–12.
- Kushal G, Suresh J, Sreedhar S, Hari Y. Study of combining ability in association with heterosis in rice (*Oryza sativa* L.). *Int J Environ Clim Change*. 2023;13(9):2829–2847.
- Maring KM, Bala M, Patel PB. Line × tester analysis for deducing heterosis in rice (*Oryza sativa* L.). *J Rice Res*. 2022;15(1):9–16.
- Singh TVJ, Raju CD, Mohan YC, Jagadeeshwar R, Balram M, Krishna L. Combining ability and heterosis studies for

- grain yield and its components in rice (*Oryza sativa* L.). *Int J Ecol Environ Sci.* 2020;2(3):67–75.
7. Soni RK, Koli NR, Kumar M, Tak Y, Aarif M, Meena CB, et al. Studies on combining ability for grain yield and its quality characteristics in rice (*Oryza sativa* L.). *Pharma Innov J.* 2021;10(12):1468–1473.
 8. Sprague GF, Tatum LA. General vs specific combining ability in single crosses of corn. *J Am Soc Agron.* 1942;34:923–932.