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Line x tester analysis for combining ability studies in rice (*Oryza Sativa* L.)

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Abstract
An investigation to study the combining ability for eight characters in rice consisted of 36 F_1s involving three cytoplasmic male sterile lines (CMS) and twelve diverse restorers in line x tester mating design in randomized block design (RBD) with three replications. None of the parental lines combined superior GCA for all the traits. However, the hybrids involving parents RTN13-A, IR58025-A, VDN-1425, VDN-1608 and VDN-1606 were found to be better for traits like tillers per plant, tillers per square meter, grains per panicle and yield per plant. In majority of the crosses, high SCA was due to high x high or high x low or low x low GCA status of parents. The parents RTN17-A and IR58025-A were identified as the best general combiners. Among hybrids, IR58025-A x VDN-1336, RTN13-A x VDN-1335, RTN17-A x VDN-1335, RTN13-A x VDN-1608 and RTN17 A x VDEN-1525 was most ideal specific combiner for yield contributing characters for exploitation of hybrids. This indicates that, parents like IR58025-A, RTN13-A, VDN-1336, VDN-1335 and VDN-1608 with high yield and yield contributing characters gives to superior crosses mentioned above. The crosses with significant SCA effects in the desirable direction involved parents with high x high or high x low or low x low gca effects indicating high performance of these crosses due to additive, dominance and epistastic gene interaction.

Keywords: line x tester analysis, combining ability, rice, oryza sativa

Introduction

The concept of heterosis through use of cytoplasmic male sterility hopes to boost the production in rice. Finding new sources of cytoplasmic male sterility is a difficult task. However, the international and national institutes like IRRI, Philippines and CRRI, Cuttack, respectively provided easy access to the availability to different CMS sources in India. The Wild Abortive (WA) CMS source has been used extensively in India. Presently, the other CMS sources viz, Gambia, ARC, Mutant 14 and Dissi are being extensively used by plant breeders. This will avoid the ill effects of monoculturing of rice varieties.

The first step in a successful breeding program is to select appropriate parents. Line x tester analysis provides a systematic approach for selection of appropriate parents and crosses superior in terms of traits. Exploitation of heterosis is primarily dependent on screening and selection of available germplasm that could produce better cross combinations.

Breeding strategies based on selection of hybrids require expected level of the specific combining ability (sca). In breeding high yielding varieties of crop plant, the breeders often face the problem of selecting parents and crosses. Combining ability analysis is one of the powerful tools available to estimate the combining ability effects and aids in selecting the desirable parents and crosses for the exploitation of heterosis (Sarker *et al*. 2002) [8]. The ultimate objective of any crop improvement program is to improve yield, which is a complex character and is dependent on a number of agro-morphological traits. General combining ability is regarded as additive gene action and specific combining ability reflects non- additive gene actions (Sprague and Tatum, 1942). With this background information, the present investigation was taken up to assess combining ability in rice.

Materials and Methods

The experimental material for study includes three CMS lines as female parents and twelve restorers as male parents which were obtained from Agriculture Research Station Vadgaon Maval, Pune those were crossed with CMS to produced 36 hybrids in Line x tester fashion design. Each plot consisted of single row of 4.5 meter length with a spacing of 20 cm. between rows and 15 cm. within plant. The recommended dose of fertilizer was applied @ 100:50:50 kg NPK/ha splits to 50 per cent of N and full dose of P and K at transplanting, 25 per cent of N at 30 DAT and 25 per cent of N at 60 DAT. The recommended cultural practices including weeding, fertigation and plant protection measures were followed as per recommendation.

Combining ability was studied for eight characters in rice *viz.*, days to 50 per cent flowering, days to maturity, plant height at maturity, productive tillers per plant, productive tillers per square meter, grains per panicle, test weight and yield per plant.

Combining ability analysis and the testing of significance of different genotypes was based on the procedure given by Kempthorne (1957) [3] and modified by Arunachalum (1972).

Table 1: Anova for combining Ability analysis for different charecters.

Sr.no.	Source	D.F.	Name of Characters							
			Days to 50% Flowering	Days to Maturity	Plant Height(cm)	Productive tiller/plant	Productive tillers/sq.m	Grains/ panicle	Test Weight(gm)	Grain Yield/ Plant
1	Replication	2	0.84	1.75	111.62**	115.12	1251.27	764.28	1.12	195.76
2	Due to Males	11	108.52**	140.50**	151.10**	1721.82**	11612.34**	8559.51**	208.67**	405.08**
3	Due to Females	2	35.15**	50.36**	30.01*	428.66*	3900.33**	773.13**	4.68**	128.24**
4	Male x Female	22	15.76**	18.22**	96.11**	196.97	2417.30*	459.02	1.90*	41.50
5	Error	70	0.37	1.25	12.41	221.99	1329.47	213.19	0.64	43.34

*,** significant at 5 and 1 % , respectively.

Table 2: GCA effects for combing ability analysis for different charecters.

Name of Characters								
Name of parent varieties	50% Flowering	Days to Maturity	Plant Height	Productive tiller/plant	Productive tillers/sq.m	Seeds/plant	Test Weight	Yield/ Plant
IR 58525A	1.13	-1.139	-0.785	3.983**	11.421**	4.206	0.332	0.549
RTN 13A	-0.426*	1.222	-0.219	-1.912*	-2.47	0.765	0.05	0.472
RTN17 A	-0.704**	-0.083	1.005*	-2.072**	-8.952**	-4.971	-0.383	-1.021
VDN1325	-4.426*	-6.389**	0.329	-1.625*	4.938	-3.715	1.732**	4.567**
VDN1336	2.907*	-0.833	6.444**	4.486**	-6.173**	-22.216**	1.89**	-4.004**
VDN 1424	2.019*	1.167	-4.722**	0.463	75.304**	42.796**	-8.381**	5.282**
VDN 1425	3.13*	5.056**	-1.514*	-0.234	49.386**	37.977**	-7.803**	8.595**
VDN1335	-6.093**	-7.278**	8.94**	-1.836*	16.054**	13.301**	1.157*	-0.683
VDN1604	-5.093**	1.611	1.228*	-2.367**	-20.986**	-24.188**	3.557**	-1.016
VDN1606	-0.87	-0.167	0.616	12.346**	-43.216**	-35.366**	5.272**	5.334**
VDN1608	0.13	-0.5	0.206	-1.195*	23.458**	-3.728	4.572**	8.919**
VDN1525	2.574*	1.611	-3.452**	-2.56**	-28.399**	57.079**	-6.798**	-2.839*
VDN1520	0.241	0.167	-4.03**	-2.36**	-20.986**	-27.897**	1.537*	-8.915**
VDN1510	1.13	-1.056	-1.648*	-2.315**	-9.875*	-21.398**	1.024	-12.271**
VDN1621	4.352**	6.611**	-2.397*	-2.806**	-39.504**	-12.646**	2.241**	-2.969*

*,** significant at 5 and 1 % , respectively.

Table 3: SCA effects for combing ability analysis for different charecters

Name of Characters								
Crosses	Days to 50% Flowering	Days to Maturity	Plant Height(cm)	Productive tiller/plant	Productive tillers/sq.m	Seeds/plant	Test Weight(gm)	Yield/ Plant
IR 58525A *VDN1325	2.093**	3.806**	-1.11	-1.946	51.54**	8.847**	0.933**	1.566*
IR 58525A*VDN1336	6.093**	1.583*	6.431**	10.52**	29.317*	17.375**	-0.491*	7.417**
IR 58525A*VDN1424	1.648*	-2.417**	-3.069**	-3.07**	14.497	4.546*	0.51*	1.11*
IR 58525A*VDN1425	-0.463	-2.306**	-3.428**	-4.22**	-15.108	0.528	0.504*	1.441*
IR 58525A*VDN1335	0.759	0.361	-4.088**	-3.448**	7.104	8.545**	-0.199	-9.571**
IR 58525A*VDN1604	0.759	1.472*	-1.146	-4.003**	-11.423	7.21**	-0.682*	-1.454*
IR 58525A*VDN1606	-1.13*	-2.417*	-0.701	26.567**	-33.636**	4.338*	-0.797*	1.879***
IR 58525A*VDN1608	-2.463**	-0.75	1.195	-4.042**	-11.42	-10.616**	0.553*	-2.34*
IR 58525A*VDN1525	-1.574*	1.139*	4.044**	-4.427**	-26.234*	-1.356	1.04**	-2.632*
IR 58525A*VDN1520	-2.574**	-1.75*	0.462	-4.113**	-11.423	-35.097**	-0.556*	0.854
IR 58525A*VDN1510	-2.463**	0.472	1.963*	-3.386**	33.02**	-4.78*	-0.382	-0.033
IR 58525A*VDN1621	-0.685	0.806	-0.555	-4.431**	-26.235*	0.461	-0.432	1.764*
RTN 13A*VDN1325	-1.352*	-1.889*	5.897**	0.276	-45.676**	-9.928**	-1.108**	-0.741
RTN 13A*VDN1336	-2.685**	1.222*	-15.012**	-5.828**	-34.565**	-6.844**	0.857**	-5.537**
RTN 13A*VDN1424	-2.13**	-1.111*	-2.979*	2.162	17.289	9.101**	-0.678*	-1.51
RTN 13A*VDN1425	-0.574	0.667	0.839	2.392	20.976*	2.966	-0.364	0.244
RTN 13A*VDN1335	-0.019	0.667	8.242**	1.927	-12.348	-5.56**	0.333	5.075**
RTN 13A*VDN1604	-0.019	-1.556*	1.038	2.142	13.582	-1.765	-0.234	-0.528
RTN 13A*VDN1606	0.759	0.556	1.826*	-13.405**	13.579	-5.02**	1.118**	-0.061
RTN 13A*VDN1608	2.426**	3.889**	2.436**	3.013**	35.804**	8.729**	-0.732**	4.12**
RTN 13A*VDN1525	0.315	-0.889	0.928	1.669	-1.239	-4.198*	0.488*	-0.739
RTN 13A*VDN1520	0.648	0.556	-3.868**	1.835	2.472	17.228**	-0.097	0.464
RTN 13A*VDN1510	1.093*	-3.222**	-2.786**	1.57	-19.749*	-1.835	0.433*	-0.187
RTN 13A*VDN1621	1.537*	1.111*	3.439**	2.247*	9.876	-2.874	-0.017	-0.599
RTN17 A*VDN1325	-0.741	-1.917*	-4.787**	1.669	-5.864	1.081	0.175	-0.824
RTN17 A*VDN1336	-3.407**	-2.806**	8.581**	-4.692**	5.247	-10.531**	-0.366*	-1.88*
RTN17 A*VDN1424	0.481	3.528**	6.048**	0.908	-31.786**	-13.647**	0.168	0.4
RTN17 A*VDN1425	1.037*	1.639*	2.589*	1.828	-5.868	-3.494	-0.14	-1.685*

RTN17 A*VDN1335	-0.741	-1.028*	-4.155**	1.52	5.244	-2.984	-0.134	4.496**
RTN17 A*VDN1604	-0.741	0.083	0.108	1.862	-2.159	-5.446**	0.916**	1.983*
RTN17 A*VDN1606	0.37	1.861*	-1.125	-13.162**	20.057*	0.682	-0.322	-1.818*
RTN17 A*VDN1608	0.037	-3.139**	-3.631**	1.029	-24.384*	1.888	0.178	-1.78*
RTN17 A*VDN1525	1.259*	-0.25	-4.972**	2.758*	27.473**	5.554**	-1.528**	3.371**
RTN17 A*VDN1520	1.926*	1.194*	3.405**	2.278*	8.951	17.87**	0.653*	-1.319*
RTN17 A*VDN1510	1.37*	2.75**	0.823	1.816	-13.27	6.614**	-0.05	0.22
RTN17 A*VDN1621	-0.852	-1.917*	-2.885**	2.184*	16.359	2.412	0.45*	-1.165*

*, ** significant at 5 and 1 %, respectively.

Results and Discussions

Days to 50 per cent flowering (No.)

For days to 50 per cent flowering negative gca effects are desirable in view for developing early hybrids. Among the lines two lines RTN-13A (-0.42) and RTN-17A (-0.70) recorded significant negative gca effect. While among the testers VDN-1335 (-6.09) negative gca effect followed by VDN-1604 (-5.09), VDN-1325 (-4.42) and VDN-1606 (-0.87) showed negative gca effect which were good combiner for earliness.

Days to maturity (No.)

Negative gca effects for days to maturity are desirable in view of developing early hybrids. Out of the three lines, IR58525-A (-1.139) recorded significant negative gca effect, while RTN-17A (-0.083) recorded non-significant negative gca effects for days to maturity. Amongst testers VDN-1335 (-7.278) and VDN-1325 (-6.38) showed significant negative gca effects.

Plant height (cm)

Significant positive gca effects was recorded by only one line, RTN-17A (1.005) and among the testers VDN-1335 (8.94) and VDN-1336 (6.44). Among the lines IR58525A (-0.78) and RTN-13A (-0.219), while six tester VDN-1424 (-4.72), VDN-1520 (-4.03), VDN-1525 (-3.45), VDN-1621 (-2.397), VDN-1510 (-1.648) and VDN-1425 (-1.514) recorded negative gca effect which were good combiner for dwarfness.

Productive tillers per plant (No)

All the three lines recorded significant gca effect. The maximum gca effect was observed by the line IR58525A (3.983). Among the tester gca significant positive gca effects present in VDN-1336 (4.486) and maximum 12.346 (VDN-1606). Only three testers recorded positive significant gca effect for this character.

Tillers per square meter (No.)

The maximum positive gca effect was observed by IR58525A (11.42) Among the testers five testers recorded positive gca effect. Maximum positive gca effect was observed in VDN 1424 (75.30) followed by VDN-1425 (49.38), VDN-1608 (23.45), VDN-1335 (16.05) and VDN-1325 (4.93) which were good combiner for tillers per square meter.

Test weight (g)

Among the lines two lines viz. IR58525-A (0.332) and RTN-13A (0.05) exhibited positive gca effect. Whereas VDN-1606 (5.27) showed maximum gca effect followed by VDN-1608 (4.57), VDN-1604 (3.55) appears good combiners for thousand seed weight.

Number of Seeds per plant (No.)

The maximum positive gca effect was observed by IR58525-A (4.20). Among the testers the positive significant gca effect was recorded by four testers viz. VDN-1525 (57.07), followed by VDN-1424 (42.79), VDN-1425 (37.97), VDN-1335 (13.30) and appears to be good general combiners.

Yield per plant (g)

The maximum gca effect was recorded by IR58525-A (0.54), followed by RTN-13A (0.47). Among the tester only, VDN 1608(8.91), VDN-1425 (8.59), VDN-1606 (5.33) and VDN-1424 (5.28) were recorded significant positive gca effects were the good combiner for yield per plant.

It is quite evident that none of the female and male parents exhibited significant gca effect for all characters. The line IR58525-A had the highest gca effect for the tillers per plant, tillers per square meter, seeds per plant test weight, yield per plant and days to 50 per cent flowering The line RTN17-A had the highest gca effect for plant height, panicle length.

Among the restorers VDN1425 was the best combiner, with higher gca effect for five characters *viz.*, days to 50 per cent flowering, days to maturity, panicle length, tillers per square meter, and seed yield per plant. The tester VDN1335 for plant height at maturity, VDN1606 for productive tiller per plant and VDN1525 for seeds per plant from the above studies VDN1608 were found to be best general combiner for yield and most important yield contributing characters.

The above results are in agreement with reports of Shanti *et al.* (1996), Singh *et al.* (1996) [10], Sreedhar and Kulkarni (1997) [13], Lavanya (2000) [4], Munhot *et al.* (2000) [5], Savery and Ganesan (2003) [9] Panwar (2005) [6] and Dhakar and Vyas (2006) [2].

Specific combining ability

Days to 50 % flowering (No.)

Among the 36 hybrids, only six hybrids viz. RTN-17A x VDN-1336(-3.407), RTN-13A x VDN-1336 (-2.685), IR58525-A x VDN-1520 (-2.574), IT-58525A x VDN-1510 and IR58525-AxVDN-1608 (-2.463), and RTN-13A x VDN-1424 (-2.13), recorded significant negative SCA effects which is considered to be desirable for earliness.

Days to maturity (No.)

Thirteen hybrids recorded significant negative sca effect viz. RTN-13A x VDN-1510 (-3.22),RTN-17A x VDN-1608 (-3.13), RTN-17A x VDN-1336 (-2.806), IR58525 xVDN-1606 and IR58525A x VDN-1424 (-2.41), IR58525A x VDN-1425 (-2.306), RTN-17 AxVDN-1325 and RTN-17A x VDN-1621 (-1.917), RTN-13A x VDN-1325 (-1.889), RTN-13A x VDN-1604 (-1.556) recorded significant negative sca effects considered to be desirable for earliness.

Plant height (cm)
The negative sca effect is considered to be desirable for plant height. Out of 36 hybrids, RTN-13A x VDN-1424 (-15.01), RTN-17A x VDN-1525 (-4.97), RTN-17A x VDN-1325 (-4.78), RTN-17A x VDN-1325 (-4.15), IR58525A x VDN-1335 (-4.08) recorded significant negative sca effects desirable for dwarfness of hybrids.

Productive tillers per plant (No.)
Positive sca effect is desirable for productive tillers per square meter. Among the 36 hybrids, only two hybrids were recorded significant sca effect IR58525-A x VDN-1608 (26.57) and IR-58525A x VDN-1336 (10.52) showed highly significant sca effect.

Productive tillers per square meter (No.)
Among the 36 hybrids, only two were recorded significant sca effect IR58525-A x VDN-1325 (51.54) and RTN-13A x VDN-1608 (35.80) showed highly significant sca effect.

Test weight (g)
Two hybrids recorded significant positive sca effect. Viz, RTN-13A x VDN-1606 (1.18) followed by IR58525-A x VDN-1525 (1.04).

Number Seeds per plant (No.)
In case of seeds per plant, ten hybrids recorded significant positive sca effect while hybrids RTN-17A x VDN-1520 (17.87) recorded maximum positive sca effect.

Yield per plant (g)
Among 36 hybrids, two hybrids recorded significant positive sca effect IR58525A x VDN-1336 (7.41) and RTN-13A x VDN-1335 (5.07).
For days to 50% flowering, six hybrids viz. RTN17A x VDN-1336 (-3.407), RTN13-A x VDN-1336 (-2.685), IR58525-A x VDN-1520 (-2.574), IT-58525A x VDN-1510 and IR58525-A x VDN-1608 (-2.463), and RTN13-A x VDN-1424 (-2.13) recorded significant negative SCA effects which is considered to be desirable for earliness, Out of 36 hybrids, two hybrids recorded significant negative sca effect viz. RTN13A x VDN1510, RTN17A x VDN-1608 for days to maturity, RTN13A x VDN-1424 for plant height at maturity, IR58525-A x VDN-1608 for productive tillers per plant and IR58525-A x VDN-1325 for productive tillers per square meter RTN-17A x VDN-1520 for seeds per plant, RTN13A x VDN-1606 for thousand seeds weight and IR58525-A x VDN-1336, RTN13-A x VDN-1335 for yield per plant with highest SCA effects.
For all the character studied, the crosses with significant SCA effects in the desirable direction involved parents with high x high or high x low or low x low gca effects indicating high performance of these crosses due to additive, dominance and epistastic gene interaction. The ideal cross combination to be exploited is one having high magnitude of sca, in addition to gca in both or at least in one of the parents. Therefore, the hybrid RTN13AxVDN1510 RTN17AxVDN-1608, RTN17AxVDN1336 for early maturity and IR58525-A x VDN-1336, RTN13A x VDN-1606, IR58525-A x VDN-1608 for yield and yield contributing characters can be exploited through heterosis breeding.

These findings are in agreement to those of Singh *et al.* (1996) [10], Singh *et al.* (1998) [11], Munhot *et al.* (2000) [5], Panwar (2005) [6], Savery and Ganeshan *et al*. (2003) [9] reveals that the hybrids with high sca effects were produced.

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References
1. Arunachalam V, Bandopadhyay A. Limits to genetic divergence for occurrence of heterosis experimental evidence from crop plants. Indian J Genet,1974:44(3):548-554.
2. Dhakar JN, Vyas V. Combining ability analysis in rice. *Crop res.*,2006:31(3):378-379.
3. Kempthorne O. An introduction to genetic statistics. John Wiley and Sons. Inc, New York,1957.
4. Lavanya C. Combining ability for yield and its components and its hybrid rice. *Oryza*,2000:37(1):11-14.
5. Munhot MK, Sarawgi AK, Rastogi NK. Gene action and combining ability for yield grain quality and other related characters rice. *Oryza*,2000:37(1):1-6.
6. Panwar LL. Line x tester analysis of combining ability in rice (*Oryza sativa* L.). Indian J Genet,2005:65(1):51-52.
7. Sampath N, Rajeshekharan S, Vivekanandan P. Heterosis in intervarital hybrids of rice (*Oryza sativa* L.). Madras Agric J,1989:76(9):507-511.
8. Sarker U, Biswas PS, Prasad B, Khaleque Main MA. Heterosis and genetic analysis in rice hybrids. Pakistan J Bio Sci,2002:5:1-5.
9. Savery MA, Ganesan J. Combining ability for yield and different traits in rice. Madras Agric J,2003:90(1-30):37-40.
10. Singh R, Singh A, Panwar DVS. Line X tester analysis for grain yield and related characters in rice. *Oryza*,1996:33:1-5.
11. Singh AK, Singh SB, Payasi SK. Combining ability for grain yield and its attributing characters in rice (*Oryza sativa* L.) Ann agric Res,1998:19(3):254-259.
12. Sprague GF, Tatum LA. Genetic and specific combining ability in single crosses of corn. J American Soc Agron,1942:34:923-932.
13. Sreedhar M, Kulkarni N. Combining ability analysis using cytoplasmic genetic mail sterile line in rice (*Oryza sativa* L.). J Res angrau,1997:25(3):5-9.