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Line x tester analysis for yield and its components in scented ri

K. M. HASIB, P. K. GANGULI AND P. C. KOLE
Genetics and Plant Breeding Section, Institute of Agriculture, Visva-Bharati, Sriniketan-731 23

Abstract: Gene action and combining ability for yield and yield components of aromatic rice were studied by line x tester analysis in twelve crosses involving four induced mutants of two traditional cultivars as lines and three 'basmati' varieties as testers. Additive gene action was predominant for days to flower, panicle number/plant, filled grains/panicle, test weight and grain yield/plant, while nonadditive gene action was predominant for plant height, dry matter production/plant and harvest index. Mutants of Tulaipanja 88-8-3 and 33-9-15, were good general combiners for plant height and test weight, while mutants of Gobindabhog, 124-17-4 and 21-6-1, were good general combiners for days to flower and filled grains/panicle. Mutants 88-8-3 and 124-17-4 were best general combiners for grain yield/plant. Difference in combining ability between the mutants originating from same parent was due to radiation induced changes. Among 'basmati' varieties, Pakistan Basmati was good general combiner for most of the important characters including grain yield/plant. The hybrid 21-6-1/Pakistan Bastmati alone, was the best specific combiner for grain yield/ plant.

Key words : Combining ability, Gene action, Agronomic traits, Induced mutants, Aromatic rice.

Introduction

The combining ability analysis provides useful information on selecfion of parents and crosses and also elucidates the type of gene action involved in the expression of metric traits. Estimating combining ability variances and effects of continuously varying quantitative characters through line x tester analysis is quite connnon. Studies on gene action and combining ability through diallel and line x tester analysis are being carried out involving mostly cultivars and cytoplasmic male sterile lines as parents. Reports on combining ability involving induced mutants and that too in aromatic rice are scanty. Classification of induced mutants on the basis of combining ability would help in exploitation of mutant heterosis in F_1 generation and/or selection of superior recombinants in the segregating generations. Hence, an investigation was made to study combining ability and nature of gene action in aromatic rice involving four aromatic induced mutants and three 'Basmati' varieties.

Materials and Methods

Four morphologically distinct true breeding gamma rays induced mutants *viz.* 88-8-3 and 33-9-15 from Tulaipanja (Basak *et al.* 1995) and 124-17-4 and 21-6-1 from Gobindabhog (Ghosh and Ganguli 1990), having the characteristic aroma of their mother cultivars were crossed as lines with three 'Basmati' varieties - Basmati 370, Pakistan Basmati and Pusa Basmati 1 as testers. These seven parents along with their twelve hybrids were grown in a randomised block design with three replications at Agricultural Farm, Visva-Bharati (23° 39' N 87° 42' E, 58.9 msl) during wet season (June - November) of 1995. Single seedling per hill was transplanted by adopting the spacing of 20 x 30 cm. Each treatment consisted of single row of 3 m length. The crop was fertilized with a dose of 60 kg N: 30 kg P_2O_5 : 30 kg K_2O per ha. Ten competitive plants were randomly selected from each treatment in each replication for recording observations on eight quantitative characters *viz.* plant height, days to flower, panicle number/plant, grain number/ panicle, test weight, dry matter production/plant, harvest index and grain yield/plant. The combining ability analysis was carried out as suggested by Kempthorne (1957).

Results and Discussion

The analysis of variance (Table 1) revealed that the variances due to lines, testers and line x tester were significant for almost all the characters indicating genetic variability in the experimental materials. Distinct differences in morphological and agronomic characters of the mutant lines induced from two different traditional aromatic cultivars and 'Basmati' varieties might have

Table 1. Analysis of variance for combining ability of eight quantitative characters in aromatic rice

Source	df	Plant height	Days to flower	Panicle number/ plant	Grain number/ panicle	Test weight	Drymatter production/ plant	Harvest index	Grain yield/ plant
Lines	3	112.52	33.91**	209.23**	7316.61**	48.47**	550.26	28.15	80.07*
Testers	2	215.31	134.56**	6.51	508.87*	0.92	991.94*	10.93	102.32*
Line x Tester	6	45.02**	2.13**	1.71	61.42**	0.57**	131.10**	7.05**	11.63*
Error	36	2.49	0.38	1.43	8.65	0.04	21.67	0.74	3.85
δ^2 GCA		2.13	1.41	2.48	88.86	0.57	11.68	0.28	1.52
δ^2 SCA		14.18	0.58	0.10	17.59	0.18	36.48	2.10	2.59
$2\delta^2$ GCA/ $2\delta^2$ GCA + δ^2 SCA		0.23	0.83	0.98	0.91	0.86	0.39	0.21	0.54

* Significant at P=0.05 and **Significant P=0.01

Table 2. Estimates of GCA effects of parents for eight quantitative characters in aromatic rice

Parents	Plant height (cm)	Days to flower	Panicle number/ plant	Grain number/ panicle	Test weight/ (gm)	Dry matter production/ plant (gm)	Harvest index (%)	Grain yield/ plant(gm)
Lines								
38-8-3	-2.38** (110.20)	1.26** (127.40)	-2.04** (18.03)	-4.40** (111.03)	2.21 (12.81)	-5.26** (80.70)	2.20** (29.48)	1.35* (23.79)
33-9-15	-1.83** (103.58)	2.05** (127.53)	7.22** (25.73)	-38.12** (75.21)	1.63** (12.60)	5.76** (99.95)	-1,03** (22.98)	0.17 (22.97)
124-17-4	5.24** (141.93)	-1.53** (122.97)	-2.60** (13.60)	26.83** (206.51)	-1.12** (9.76)	7.57** (87.22)	0.59* (29,22)	2.68** (25.48)
21-6-1	-1.03 (110.73)	-1.79** (122.13)	-2.58** (17.93)	15.69** (117.88)	-2.72** (8.42)	-8.07** (57.03)	-1.76** (28.46)	-4.20** (16.34)
S.E.(g_i)±	0.53	0.21	0.40	0.98	0.06	1.55	0.29	0.65
S.E.(g_i-g_j) ±	0.74	0.29	0.56	1.39	0.09	2.19	0.41	0.92
Testers								
Basmati-370	1.18* (148.52)	-3.83** (99.43)	-0.23 (13.27)	-7.26** (52.95)	0,15* (23.12)	-3.27* (65.64)	-1.09** (21.97)	-2.31 (14.42)
Pakistan Basmati	3.52** (153.38)	2.37** (114.37)	0.82* (11.30)	5.33** (74.34)	0.17** (21.26)	10.27** (79.56)	0.38 (20.12)	3.28** (16.03)
Pusa Basmati I	4.70** (112.78)	1.46** (109.30)	-0.59 (10.07)	1.92* (73.95)	-0.32** (21.47)	-7.01 ** (49.77)	0.71** (28.54)	-0.97 (14.22)
S.E (g_i)±	0.46	0.18	0.34	0.85	0.06	1.34	0.25	0.57
S.E.(g_i-g_j)±	0.64	0.25	0.49	1.20	0.08	1.90	0.35	0.80

* Significant at P = 0.05 and ** Significant at P = 0.01 Figures in parenthesis indicate per se performance

Table 3. Estimates of SCA effects of hybrids for eight quantitative characters in aromatic rice

Crosses	Plant height	Days to flower	Panicle munber/ plant	Grain number/ particle	Tea weight	Dry matter production/ plant	Harvest index	Grain yield/ plant
88-8-3 x Basmati-370	1.95*	0.35	0.08	3.66*	0.31**	-2.52	1.66**	1.31
88-8-3 x Paidstan Basmati	2.99**	-0.54	-0.78	2.70	0.19	3.15	-0.55	0.37
88-8-3 x Ptisa Basmati 1	4.84**	0.19	0.70	-6.36**	-0.50**	-0.63	-1.11*	-1.68
33-9-15 x Basmati-370	-2.47*	-0.30	0.28	0.63	-0.45**	-4.25	0.12	-0.90
33-9-15 x Paidstan Basmati	0.66	0.49	-0.45	-2.77	0.03	-2.38	-0.45	-1.36
33-9-15 x Pusa Basimati 1	1.81	-0.19	0.17	2.14	0.42**	6.63*	0.33	2.26
124-17-4 x Basmati-370	0.77	-1.04**	-0.03	-0.31	0.40**	10.13**	-1.47**	0.66
124-17-4 x Pakistan Basmati	4.90**	0.26	0.11	-3.17	-0.28*	-3.51	-0@44	-1.34
124-17-4 x Pusa Basmati 1	4,13**	0.78*	-0.07	3.48*	-0.12	-6.62*	1.91 **	0.67
21-6-1 x Basmati-370	-0.15	1.00**	-0.32	-3,98*	-0.27*	-3.36	-0.30	-1.08
21-6-1 x Pakistan Basmati	1.26	-0.21	1.12	3.24	0.06	2.74	1.44**	2,33*
21-6-1 x Pusa Basmati 1	-1.10	-0.79*	-0.80	0.74	0.21	0.62	-1.14*	-1.25
S.E. (S_{ij})±	0.91	0.36	0.69	1.70	0.11	2.69	0.50	1.13
S.E. (S_{ij}-S_{kl})±	1.29	0.50	0.98	2.40	0.16	3.80	0.70	1.60

* Significant at P = 0.05 and ** Significant at P = 0.01

contributed to the variability. The estimates of predictability ratio (282 GCA/282 GCA + 52 SCA) as proposed by Baker (1978) were higher dm 0.50 for the traits days to flower, panicle number/plant filled grains/panicle, test weight and grain yield/plant indicating the preponderance of additive gene action in the expression of these traits. Therefore, single plant selection based on pedigree method would be useful for improving these traits. However, nonadditive gene action was important for the expression of plant height, dry matter production/plant and harvest index, which offers scope for exploitation of heterosis. Nature of gene action in induced mutants of rice has been reported by Awan *et al.* (1986) for plant height and days to heading, Kumar and Sree Rangasamy (1986) for plant height and Cheema *et al.* (1988) for plant height, days to flower and spikelet number/panicle.

The general combining ability (GCA) effects of lines (Table 2) revealed that mutants of Tulaipanja, 88-8-3 was good general combiner for grain yield/plant and harvest index, while 33-9-15 was good general combiner for panicle number/plant and dry matter production/plant. Both mutants were identified as good combiners for plant height and test weight. Mutants of Gobindabhog *viz.* 124-17-4 and 21-6-1 were superior general combiners for days to flower and filled grains/panicle. The GCA effects of 124-17-4 for grain yield/plant dry matter production/plant and harvest index were also found significant. The differences in combining ability effects between the mutants of same parent is probably due to non-allelic genes controlling the mutant characters induced by y-irradiation. Radiation induced changes in combining ability have been reported in maize (Palenzona and Scossiroli 1963), *Melilotus albus* (Romer and Micke 1974) and rice (Cheema *et al.* 1988; Xiang and Gao 1991). The superior combining ability effects for plant height and test weight in the mutants of Tulaipanja and days to flower and filled grains/panicle in the mutants of Gobindabhog are related to their *per se* performance.

Among the 'Basmati' varieties used as testers, Pakistan Basmati was good general combiner for grain yield/plant, panicle number/plant filled grains/panicle and test weight. Basmati 370 was good general combiner for days to flower and test weight and Pusa Basmati 1 for plant height and filled grains/panicle.

The specific combining ability (SCA) effects of hybrids (Table 3) revealed that only the hybrid 21-6-1/Pakistan Basmati was the best specific

.ombiner for grain yield/plant. The hybrid 88-:3/Basmati 370 showed significant and desirable CA effects for filled grains/panicle, test weight nd harvest index and 124-17-4/Basmati 370 and 3-9-15/Pusa Basmati 1 for test weight and dry iatter production/plant. Three cross combina-.ons, *viz.* 88-8-3/Pusa Basmati 1, 33-9-15/Basmati '70 and 124-17-4/Pakistan Basmati showed ignificant and negative SCA effects for plant ieight which is desirable. The hybrid 124-17-I/ Pusa Basmati 1 displayed significant and lesirable SCA effects for filled grains/panicle ind harvest index.

The crosses 88-8-3/Basmati 370 for test weight and 124-17-4/Pusa Basmati 1 for filled rains/panicle and harvest index showing high SCA effects were in the category of high x high combination of general combiners. This night be due to additive and/or additive x additive ype of gene effects, which are fixable in nature Singh *et al.* 1971). Therefore, there is high probability of obtaining good transgressive segregants n the progeny of these crosses for the improvement of particular character as mentioned. The high SCA effects in the crosses 124-17-4/Basmati 370 ind 33-9-15/Pusa Basmati I for test weight and dry matter producfion/plant 88-8-3/Basmati 370 for harvest index, 33-9-15/ Basmati 370 for plant height and 21-6-1/Pakistan Basmati for grain yield/ plant involved one parent with high GCA effect while the other parent was a poor general combiner. Such crosses could produce good segregants only, if the addifive genetic effects are present in the good general combiner and the complementary epistafic effects in the other act in the same direction to maximise the desirable plant attributes (Singh and Chaudhary 1995).

The non significant SCA effects with parents possessing significant GCA effects in the hybrids 124-17-4/Pakistan Basmati for filled grains/panicle, dry matter production/plant and grain yield/ plant 33-9-15/Paidstan Basmati for panicle number/ plant, test weight and dry matter production/ plant 88-8-3/ Pakistan Basmati for test weight and grain yield/plant, 21-6-1/Pakistan Basmati for filled grains/panicle, 33-9-15/Pusa Basmati I for plant height and 21-6-1/Plusa Basmati 1 for filled grains/spanicle would be expected to produce desirable superior recombinants in the advanced generation of inbreeding (Devraj and Nadarajan 1996). Such recombinants will have a higher chance of producing plants with aromatic grains as all the parents were aromatic.

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