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COMBINING ABILITY FOR GRAIN YIELD AND ITS COMPONENTS IN HYBRID RICE

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ABSTRACT

A total of 51 rice hybrids and their 17 male parents and three isogenic maintainers were studied for their combining ability on eight characters. Based on mean performance and GCA effects, TM 4309 and TKM 6 were identified as the best combining restorer parents followed by IR 64, CO 37, ADT 36, Jaya, ASD 18 and TNAU 88013, while ADT 39 was identified as a potential maintainer for the CMS line V 20A. Based on mean performance and SCA effects, five hybrids viz., IR 62829A/TKM 6, V20A/TNAU 88013, IR 62829A/TM 4309, IR 58025A/TKM 6 and IR58025 A/TM4309 were identified as the best for grain yield and most component traits.

KEY WORDS : Hybrid Rice, Combining Ability, Yield Components

The concept of combining ability plays a significant role in crop improvement, as it helps in determining the nature of gene action involved in the expression of quantitative traits of economic importance. Combining ability studies help in the identification of parents having general combining ability (GCA) effects and specific combining ability (SCA) effects. The present investigation was carried out on hybrids or rice derived by using CMS lines to identify the best combining maintainer parents to transfer the available male sterility systems into them or alternatively the best combining restorer parents to develop new hybrids.

MATERIALS AND METHODS

A total of 51 hybrids was derived by crossing three CMS lines *viz.*, V 20A, IR 58025A and IR 62829A with 17 male parents *viz.*, ADT 36, ASD 17, ASD 18, CO 37, IR 36, IR 50, IR 60, IR 64, IET 1444, TKM 9, TM 4309, TNAU 801793, TNAU 88013, ADT 39 and Jaya, in a line x tester mating system. These 51 F_1s along with their 17 male parents and three isogenic maintainers (B-lines) were studied for their combining ability in randomised block design with two replications during May-September 1991 at the Rice Research Station, Ambasamudram, adopting a plot size of 1.65 m x 0.2m (single row of 11 plants per plot) with 20 cm x 15 cm spacing and single seedling per hill. A manurial schedule of 100:50:50 kg NPK/ha and other cultural operations were followed. Observations were recorded on five random plants, leaving two border plants on either side in each replication for each genotype for eight characters *viz.*, days to flowering, plant height, panicles per plant, grains per panicle, spikelet fertility, grain yield per plant, dry matter production and harvest index. Mean values obtained for each character were analysed statistically as per the design. Combining ability analysis as suggested by Kempthorne (1957) was performed.

RESULTS AND DISCUSSION

Analysis of variance

The genotypic difference were highly significant for all the eight characters. The combining ability analysis(Table 1) indicated the importance of both additive and non-additive gene effects for all characters. The ratio of GCA:SCA variance revealed the predominance of non-additive gene action for seven characters viz., days to flowering, panicles per plant, grains per panicle, spikelet fertility, grain yield per plant, dry matter production and harvest index, while additive

Table 1. Mean squares for combining ability variances for eight characters in rice.

Characters	Source			
	GCA	SCA	Error	GCA/SCA
Days to flowering	5.00**	17.69**	1.08	0.28
Plant height	22.43**	18.60**	2.33	1.21
Panicles per plant	3.73**	7.26**	0.38	0.51
Grains per panicle	354.64**	834.80**	3.08	0.42
Spikelet fertility	44.53**	218.05**	0.95	0.20
Grain yield per plant	13.20**	73.34**	0.92	0.18
Dry matter production	54.92**	245.99**	4.79	0.22
Harvest index	0.0009**	0.0051**	0.0001	0.18

*P = 0.05, **P = 0.01

Table 2. Mean performance of parents for eight characters in rice

Parents	Days to flowering (no.)	Plant height (cm)	Panicles / plant (no.)	Grains/panicle (no.)	Spikelet fertility (%)	Grain yield / plant (g)	Dry matter production (g)	Harvest Index
B-Lines :								
V20 B	62	72	14.8	83	80	9.7	34.8	0.28
IR58025 B	83	90	10.4	157	82	18.7	50.9	0.37
IR62829 B	77	90	15.4	77	81	18.9	50.2	0.38
Males :								
ADT 36	77	93	11.2	99	81	26.3	59.7	0.44
ASD 16	74	104	8.8	172	87	34.9	67.3	0.52
ASD 17	65	102	11.5	110	87	10.2	36.2	0.28
ASD 18	76	99	8.7	89	85	19.5	46.2	0.42
CO 37	78	103	9.9	125	87	22.4	56.2	0.40
IR 36	78	93	14.5	102	82	23.4	56.4	0.41
IR 50	75	91	11.6	84	87	16.6	35.2	0.47
IR 60	74	87	13.4	78	87	15.6	36.9	0.42
IR 64	82	88	12.4	94	91	25.1	57.4	0.44
IET 1444	78	99	8.5	123	92	26.5	58.0	0.46
TKM 6	78	152	21.9	148	92	39.8	123.2	0.32
TKM 9	74	87	8.9	79	81	18.4	41.7	0.44
TM 4309	74	119	15.2	163	84	34.0	85.2	0.40
TNAU 801793	75	89	11.5	79	85	17.8	38.9	0.46
TNAU 88013	79	96	12.5	100	90	19.6	50.5	0.39
ADT 39	99	91	–	–	–	–	–	–
Jaya	88	81	12.2	94	83	24.9	59.8	0.42
General mean	78	92	14.7	100	71	22.3	58.2	0.38
CD (P=0.05)	1.9	3.0	1.2	3.4	1.9	1.9	4.3	0.01

Table 3. Mean performance of promising hybrids for eight characters in rice

Hybrids	Days to flowering (No.)	Plant height (cm)	Panicles/ plant (No.)	Grains/ panicle (No.)	Spikelet fertility (%)	Grain yield/ plant (g)	Dry matter production (g)	Harvest index
V20A/ADT 36	88	81	16.1	124	77	31.8	71.1	0.45
V20A/IR 64	89	89	17.0	125	86	35.4	82.7	0.43
V20A/TNAU 88013	86	88	16.9	144	81	44.2	95.4	0.46
V20A/ADT 39	97	82	21.9	6	4	4.4	69.6	0.06
IR58025A/ASD 18	79	90	9.3	144	83	26.4	61.2	0.43
IR58025A/CO 37	77	91	11.8	142	81	31.6	72.2	0.44
IR58025A/IR 50	75	93	16.1	131	86	30.0	58.0	0.52
IR58025A/TKM 6	92	127	29.8	164	81	41.7	134.9	0.31
IR58025A/TM 4309	71	118	13.5	147	95	40.0	74.5	0.54
IR58025A/TNAU 88013	86	89	15.5	123	82	36.2	75.9	0.48
IR58025A/Jaya	88	86	15.5	143	81	34.7	80.3	0.43
IR62829A/ADT 36	80	87	14.2	144	82	28.6	66.3	0.43
IR62829A/ASD 18	79	91	16.5	142	85	29.5	81.0	0.37
IR62829A/CO 37	75	97	22.5	147	76	33.0	77.0	0.43
IR62829A/IR 64	81	89	13.0	121	84	26.2	60.6	0.43
IR62829A/TKM 6	91	116	35.0	157	82	60.2	156.7	0.38
IR62829A/TM 4309	74	122	21.0	153	84	42.8	94.1	0.46
General mean	78	92	14.7	100	71	22.3	58.2	0.38
CD (P=0.05)	1.9	3.0	1.2	3.4	1.9	1.9	4.3	0.01

Table 4. GCA effects of parents for eight characters in rice

Hybrids	Days to flowering	Plant height	Panicles/ plant	Grains/ panicle	Spikelet fertility	Grain yield/plant	Dry matter production	Harvest index
CMS lines :								
V20A	-1.5**	-2.5**	0.8**	-22.6**	-8.6**	-3.8**	-4.7**	-0.04**
IR 58025A	1.5**	0.9**	-1.6**	16.3**	4.9**	2.1**	2.8**	0.02**
IR 62829A	0.1	1.6**	0.8**	6.4**	3.7**	1.7**	1.9**	0.02**
Males :								
ADT 36	4.3**	-5.1**	-1.7**	25.7**	7.8**	4.8**	5.5**	0.04**
ASD 16	-6.1**	0.02	-2.6**	-14.4**	-15.4**	-5.0**	-6.2**	-0.06**
ASD 17	-4.8**	-6.8**	-2.3**	-23.2**	-10.0	-10.3**	-22.1**	-0.05**
ASD 18	1.5	-1.9**	-2.4**	28.1**	10.8**	1.9**	4.1**	0.01**
CO 37	-4.0**	-1.3*	1.1**	22.7**	7.4**	4.0**	6.7**	0.02**
IR 36	-4.3**	-6.8**	-3.7**	-15.6**	-4.3**	-8.9**	-22.6**	-0.01**
IR 50	-4.8**	-0.3	-0.1	-6.3**	9.0**	-1.7**	-11.3**	0.05**
IR 60	-2.5**	-4.3**	-2.8**	-26.7**	-2.1**	-6.2**	-17.7**	0.02**
IR 64	5.0**	-1.1	-1.2**	19.1**	14.2**	5.1**	7.0**	0.04**
IET 1444	-2.4**	-0.2	1.5**	-12.5**	-1.7**	-2.1**	-3.3**	-0.01**
TKM 6	6.9**	30.9**	15.7**	39.8**	7.2**	19.8**	66.1**	-0.04**
TKM 9	-1.8**	-6.5**	-1.9**	-28.5**	-13.3**	-8.6**	-18.5**	-0.04**
TM 4309	-6.5**	28.7**	1.0**	32.7**	15.8**	13.1**	15.1**	0.10**
TNAU 801793	-3.8**	-5.0**	-1.5**	-17.6**	-2.9**	-6.9**	-18.2**	0.01**
TNAU 88013	5.9**	-7.1**	-0.8**	9.8**	3.5**	8.4**	8.8**	0.06**
ADT 39	14.0**	-9.7**	2.1**	-39.1**	-24.5**	-10.5**	1.4	-0.17**
Jaya	3.2**	-6.3**	-0.5*	5.9**	-1.7**	3.2**	5.4**	0.02**
SE (females)	0.18	0.26	0.11	0.30	0.17	0.16	0.38	0.001
SE (males)	0.42	0.62	0.25	0.71	0.40	0.39	0.89	0.003

*P = 0.05, **P = 0.01.

gene action for the character plant height. Mohanty and Mahapatra (1973),Singh *et al* (1980), Srivastava and Seshu (1983) and Dhaliwal and Sharma (1990) also reported that non-additive gene effects were greater than additive gene effects for yield and most of its component characters. The presence of greater non-additive genetic variance offers scope for exploitation of hybrid vigour in the materials studied.

Mean performance

A total of seven male parents *viz.*, ADT 16, ASD 16, IR 64, IET 1444, TKM 6, TM 4309, and Jaya recorded superior performance for grain yield (Table 2), the characters for which these parents have performed well in addition on to grain yield are given below:

ADT 36 : Spikelet fertility and harvest index
ASD 16 : Earliness, grains per panicle, spikelet fertility, dry matter production and harvest index
IR 64 : Dwarfness, spikelet fertility and harvest index
IET 1444 : Grains per panicle, spikelet fertility and harvest index
TKM 6 : Panicles per plant, grains per panicle, spikelet fertility and dry matter production
TM 4309 : Earliness, grains per panicle, spikelet fertility, dry matter production and harvest index
Jaya : Dwarfness, spikelet fertility and harvest index

Among them, ASD 16 and IET 1444 when crossed with the three CMS lines, could not produce superior hybrids even with more than 80 per cent spikelet fertility. Based on spikelet fertility, nine male parents viz., ADT 36, ASD 18, Co 37, IR 50, IR 64, TKM 6, TM 4309, TNAU 88013 and Jaya that involved in 14 hybrid combi nations were identified as effective restorers which can be reconfirmed by involving in re-test crosses

Table 5. SCA effect of promising hybrids for eight characters in rice

Hybrids	Days to flowering	Plant height	Panicles/ plant	Grains/ panicle	Spikelet fertility	Grain yield/plant	Dry matter production	Harvest index
V20A/ADT 36	6.9**	-1.7	1.4**	25.5**	12.3**	8.5**	10.6**	0.07**
V20A/IR 64	7.3**	1.4	1.8**	33.0**	14.8**	11.7**	20.7**	0.06**
V20A/TNAU 88013	3.5**	6.7**	1.2**	61.0**	21.0**	17.3**	31.6**	0.07**
IR58025A/ASD 18	-2.4**	0.4	-2.4**	3.3*	2.4**	-0.04	-5.3**	0.03**
IR58025A/CO 37	0.9	-1.6	-3.4**	7.0**	3.6**	3.0**	3.0	0.03**
IR58025A/IR 50	-0.2	1.8	2.2**	25.4**	6.3**	7.2**	6.9**	0.08**
IR58025A/TKM 6	4.9**	4.1**	0.01	11.8**	3.3**	-2.7**	6.3**	-0.04**
IR58025A/TM 4309	-2.2**	-2.2*	-1.5**	2.2	9.1**	2.4**	-3.1	0.04**
IR58025A/TNAU 88013	0.01	5.1**	2.2**	1.0	8.3**	3.3**	4.6**	0.03**
IR58025A/Jaya	5.5**	0.8	2.0**	24.7**	12.0**	7.0**	12.4**	0.03**
IR62829A/ADT 36	-2.6**	0.01	-0.6	16.0**	4.8**	-0.3	-0.8	-0.001
IR62829A/ASD 18	-0.8	0.6	2.4**	11.3**	5.1**	3.5**	15.4**	-0.03**
IR62829A/CO 37	0.2	3.5**	4.9**	22.4**	-0.2	4.9**	8.8**	0.03**
IR62829A/IR 64	-2.7**	-2.5*	-2.3**	-0.4	0.2	-3.1**	-7.9**	0.01
IR62829A/TKM 6	5.5**	-7.0**	2.8**	14.5**	5.9**	16.2**	29.0**	0.04**
IR62829A/TM 4309	2.4**	0.5	3.6**	17.8**	-1.3	5.5**	17.4**	-0.04**
SE	0.73	1.08	0.44	1.24	0.69	0.68	1.55	0.005

*p = 0.05, **p = 0.01

with CMS lines; one male parent ADT 39 was identified as a potential maintainer for the CMS line V2OA and this can be involved in the back crossing programme to develop a new CMS line.

Among the hybrids (Table 3) the top five hybrids viz., V2OA/TNAU 88013, IR 58025A/ TKM 6, IR 58025A/TM4309, IR 62829A/TKM 6 and IR 62829A/TM 4309, exhibited superior perfor mance for grain yield per plant, spikelet fertility and most of the yield contributing characters and these can be exploited commercially.

General combining ability

Among the parents, two CMS lines viz., IR 58025A and IR 62829A, and eight males viz., ADT 36, ASD 18, CO 37, IR 64, TKM 6, TM 4309, TNAU 88013 and Jaya recorded significant posi tive GCA effects for grain yield and also significantly desired GCA effects for most component traits (Table 4). Several workers reported on the association of high GCA effects in the parents with maximum SCA effects and heterosis for yield in the resulting hybrids (Ranganathan *et al.*, 1973; Maurya and Singh 1977; Rahman *et al.*, 1981; Sarathe and Perraju 1990). Accordingly, crosses involving these parents with significant positive GCA effects could produ: superior hybrids.

Specific combining ability

Of the hybrids derived between the best eigh male parents and three CMS lines, only 12 hybrid recorded significant positive SCA effects for grai yield (Table 5), indicating that the best parent were not always the best combiners (Rao *et al* 1980). Among the 12 hybrids, V2OA/Jaya wa found to record less than 80 per cent spikele fertility, indicating that Jaya is not an effectiv restorer for V 20A; the remaining hybrids wer found to perform well for most characters i addition to grain yield. Some of the above hybrid exhibited good performance for certain character for which their parents were found to be eithe average or poor combiners, indicating interactio effects of genes in the positive direction. The hig SCA effects for grain yield, dry matter productio and harvest index by most hybrids revealed that th yield superiority of heterotic F_1s is due t increased dry matter production and/or harve index.

The study of relation between GCA and SC effects showed that almost all kinds of SCA effect

ould be obtained from any type of parental ombinations. But majority of the high SCA ombinations involved at least one parent ossessing high GCA effect; the other parent could ave high, average or low GCA effects (Yuan and irmani 1988). This suggested that either additive additive and/or additive x non-additive genetic nteraction was predominant in the materials tudied. In some other high SCA combinations, the arental combinations were either average x verage, average x poor or poor x poor, and the uperiority of these crosses may be due to omplementary type of gene interaction.

On the whole based on mean performance and CA effects, TM 4309 and TKM 6 were the best ale parents, followed by IR 64, CO 37, ADT 36, ya, ASD 18 and TNAU 88013, and these parents an be used advantageously in the crossing rogramme with CMS lines for the development of uperior rice hybrids. Based on mean performance nd SCA effects, five hybrids *viz.*, IR 2829A/TKM 6, V20A/TNAU 88013, IR 2829A/TM 4309, IR 58025A.TKM 6 and IR 8025A/TM 4309 were found to be the best ombinations for grain yield and most component raits, and can be exploited further to fix stable erforming heterotic hybrids.

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IMPACT OF IRRIGATION AND MANAGEMENT PRACTICES ON PHYSIOLOGY OF WATER RELATION AND PRODUCTIVITY IN SOYBEAN

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ABSTRACT

Investigations were carried out in the field in *kharif* 89 and *rabi* 90 employing the variety Co.1 with three irrigation scheduling *viz.*, 60, 80 and 100 mm of cumulative pan value and six management (ameliorative) practices comprising, incorporation of decomposed coir pith (coconut fibre waste) at 12.5 t ha^{-1}, split application of potassium at 40 kg ha^{-1} (50 per cent basal and 50 per cent top dressed at 30 and 60 DAS), spraying cycocel (250 ppm) at peak flowering stage, spraying 0.5 per cent Kcl at peak flowering stage, incorporation of crystal rain (Soil moisturiser) at 12 kg ha^{-1} and a control. The crop growth and yield was better in *kharif* than in *rabi*. Irrigation at 60 mm pan value improved the crop growth by recording more LAI, RGR, CGR, lower canopy temperature, transpiration rate higher RLWC and SDR which resulted in higher seed yield. Among the management practices, the foliar application of cycocel, and Kcl, separately maintained higher tissue water content, followed by split application of potassium and other treatments. Irrigation at 60 mm pan vale in combination with cycocel at 250 ppm recorded maximum seed yield in both the season, followed by split application of potassium in *kharif* and coirpith in *rabi* seasons respectively.

The water management for augmenting the rop productivity has become a most indispensable actor especially in a crop like soybean because of ts high susceptibility to water stress at various growth stages. This can be achieved by proper crop management *viz.*, regulation of transpiration, improved water use efficiency and better root penetration. The water demand of the crop at