

Research Article**Genetic Analysis Of Grain Quality Characteristics Of Two Line Rice Hybrids**

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Abstract

The experiment was laid out at Agricultural College and Research Institute Madurai, Tamil Nadu, India and the materials for this study consisted of three TGMS lines *viz.*, TS 29, TS 6 and 11 testers *viz.*, ADT 39, ADT41, Pusa Basmati 1, Basmati 370, Improved White Ponni, AD 98028, GEB 24, ADT 43, ADT 45, Taroari Basmati and Jeeraga samba. Crossing was done according to clipping and churning method in L x T fashion. The 33 hybrids obtained by crossing three lines and eleven testers were raised in randomized block design with two replications during 2004-2005. The parents were also raised in similar design in an adjacent plot with two replications as suggested by Arunachalam (1974). Observations were made on KL, KB, KLAC, LER, VER, ASV, GC and AC. Based on the nature of combining ability inferred from line x tester analysis, three cross combinations *viz.*, TS29/ADT41, TS29/Pusa Basmati 1 and TS29 / Basmati 370 were selected for generation mean analysis study. The scaling tests indicated the presence of epistasis for all the characters and therefore six parameters mode was followed to estimate the various gene action. In TS29/Basmati 370 cross combination all the three scales are positively significant. The mean effect *m* was significantly positive and greater than all other effects in all the three crosses for kernel breadth, kernel length after cooking, volume expansion ratio, alkali spreading value, gel consistency and amylose content. The additive x dominance effect (*j*) was positive and significant for kernel length after cooking, linear elongation ratio, gel consistency and amylose content in the crosses TS29/ADT41, TS29/Pusa Basmati 1 and TS29/Basmati 370. In general, both additive and non-additive gene effects appear to all eight characters studied. Therefore, improvement of these traits appears to beset with difficulties as simple selection techniques will not be able to fix superior lines in the early segregating generations. Postponement of selection of superior lines to later generations in pedigree breeding will be effective.

Key words: Combining ability, pedigree breeding, epistasis, additive effect, dominance effect

Introduction

Rice has always been one of the most important food crops in the world. It is estimated that 40 per cent of the world's population take rice as their major source of food. The advent of higher yielding semi dwarf varieties has been instrumental in achieving consistent progress in rice production in the past three decades and attaining self sufficiency. This has enabled the country to become the world's second largest producer of rice after China with a dramatic increase in rice production. China was the first country where yield barrier in semi-dwarf rice was broken by successful development of hybrid rice, which yielded about 20 per cent more than the conventional varieties (Virmani *et al.*, 1992).

Though the three line system involving cytoplasmic male sterility-fertility restoration system to a large extent is quite effective for the development of commercial rice hybrids, this system cumbersome and tedious as it involves three lines (A, B and R) and has negative effects of cytoplasm.

A new vista in hybrid rice breeding has been opened by successful development of two line hybrids using Thermo Sensitive Genetic Male Sterile (TGMS) lines. It further enhances the hopes of exploiting the additional heterotic potential, which can outyield the inter-varietal hybrids by 20 – 30 per cent (Virmani, 1994). Immense efforts of rice breeders made during the last ten years have enabled the country to become the second largest in the world to develop and commercialize hybrid and its technology.

Though 16 rice hybrids have been released all over India for cultivation, their spread is not commensurate with expectations. Along with other reasons, lack of consumer acceptance also added the cause for slow spread. Since rice hybrids have entered the country recently, there is a need to look in to the quality aspects so that hybrid rice can be developed coupled with improved quality characteristics. Research work on quality on rice hybrids are scanty. Even though many studies have indicated the nature of gene action conditioning the quality traits are limited. But most of the quality traits are quantitatively inherited and need continuous efforts to combine. Hence an attempt was made in the present study to unravel the genetic architecture of grain quality traits by involving basmati rice varieties.

Materials and Methods

The experiment was laid out at Agricultural College and Research Institute, Madurai, Tamil Nadu, India and the materials for this study consisted of three TGMS lines viz., TS 6, TS 29 and GD 98013 and 11 testers viz., ADT 39, ADT 41, Pusa Basmati 1, Basmati 370, Improved White Ponni, AD 98028, GEB 24, ADT 43, ADT 45, Tarori Basmati and Jeeragasamba. Each of the lines and testers in three rows of 3 m length were raised during Kharif 2002. Three staggered sowings were taken up to have synchronisation of flowering. Crossing was done according to clipping and churning method in L X T fashion. Three panicles of male parent were used to dust one female panicle. After 20-25 days the crossed seeds were harvested. The seeds of the testers were also collected separately.

The 33 hybrids obtained by crossing three lines and 11 testers were raised in a randomized block design with two replications during Rabi 2002-2003. Each hybrid was accommodated in a single row of 3m length. A spacing of 20cm between rows and 15cm between plants in row was adopted. The parents were also raised in similar design in an adjacent plot with two replications as suggested by Arunachalam (1974). Observations were recorded individually on ten plants in each replication for each hybrid and parent for combining ability analysis.

Based on the nature of combining ability inferred from line x tester analysis, three cross combinations viz., TS 29 /ADT41 (Cross 1), TS 29 / Pusa Basmati 1 (Cross 2) and TS29/ Basmati 370 (Cross 3) were selected for generation mean analysis study. The female parent viz., TS 29 and the three testers viz.,

ADT 41, Pusa Basmati 1 and Basmati 370 and their corresponding F₁s were raised during summer 2003 in a crossing block with four rows of female parent and three testers and two rows of F₁s of 3m length. The parents were used as females and pollen from F₁s was dusted to obtain the two back crosses B₁(back cross to P₁) B₂ (back cross to P₂ after emasculation). Fresh crosses were effected simultaneously to obtain all cross combinations (F₁s). Parental lines and F₁ were raised separately to obtain the generations P₁, P₂ and F₂. Thus, the six generations viz., P₁, P₂, F₁, F₂, B₁ and B₂ for all the three crosses were constituted. During Rabi 2003-04, the six generations of three selected crosses were raised in a row of 3 meter length spaced 20cm apart. Observations were recorded randomly on 20 plants each in P₁, P₂ and F₁ and 200 plants in F₂ and 80 plants in B₁ and B₂.

Results and Discussion

The scaling tests (Table 1.) indicated the presence of epistasis for all the characters and therefore six parameters model (Hayman, 1985) was followed to estimate the various gene action. In TS 29/Basmati 370 cross combination all the three scales are positively significant and in TS 29/Pusa Basmati 1 cross the scales viz., A, B and C are negatively significant for kernel length trait. The two scales B and C are negatively significant in TS29/ADT 41 cross combination. The TS29/Pusa Basmati 1 cross had shown the non significant for all the three scales for kernel breadth character. The scale B in TS29/ADT 41, TS29/Pusa Basmati 1 and TS29/Basmati 370 crosses are positively significant for kernel length after cooking whereas the scales B and C are negatively significant in TS29/ADT41, TS29/Pusa Basmati 1 and TS29/Basmati 370 crosses. In TS29/ADT 41 and TS29/Basmati 370 the scale A is positively significant and the scales B and C are negatively significant in TS29/Pusa Basmati 1 and TS29/Basmati 370 for linear elongation ratio. The scale A only in TS29/Pusa Basmati 1 showed positive value and all the three scales in all the crosses showed negative value. All the three scales viz., A, B and C are negatively significant in TS29/ADT 41, TS29/Pusa Basmati 1 and TS29/ Basmati 370 for gel consistency.

The mean effect m was significantly positive and greater than all other effects in all the three crosses viz., TS29/ADT 41, TS29/Pusa Basmati 1 and TS29/Basmati 370 for kernel breadth, kernel length after cooking, volume expansion ratio, alkali spreading value, gel consistency and amylose content

whereas in TS29/Basmati 370 cross the mean effect m value is lesser than (h) for kernel length and linear elongation ratio. The additive effect (d) was positive and non significant for kernel breadth only in TS 29 / ADT 41, TS 29 / Pusa Basmati 1 and TS 29 / Basmati 370 crosses. A positive and significant additive effect (d) was observed for alkali spreading value in TS 29 / Basmati 370 cross. In all the crosses viz., TS29/ADT 41, TS29/Pusa Basmati 1 and TS 29 / Basmati 370 negative and significant additive effect (d) was noticed for kernel length after cooking, linear elongation ratio, volume expansion ratio, gel consistency and amylose content.

The TS29/ADT41 showed positive dominance effect (h) for all the characters except amylose content A positive and significant dominance effect (h) was recorded for kernel length and linear elongation ratio in TS29/ADT 41 cross. A positive and significant additive x additive effect (i) was recorded in TS29/Basmati 370 (linear elongation ratio and TS29/ADT 41 (alkali spreading value and gel consistency. A positive and non significant additive x additive effect (i) was recorded in all the three crosses viz., TS29/Pusa Basmati1, TS29/ ADT 41 and TS29/Basmati 370 for kernel length and volume expansion ratio.

The additive x dominance effect (j) was positive and significant for kernel length after cooking, linear elongation ratio, gel consistency and amylose content in the crosses TS29/ADT 41, TS29/Pusa Basmati 1 and TS29/ Basmati 370. The crosses TS29/Pusa Basmati 1(kernel length after cooking and linear elongation ratio), TS29/Basmati 370(volume expansion ratio and gel consistency) and TS29/ADT 41(amylose content) showed positive and significant dominance x dominance (l) effect (Table.2)

The (h) and (l) showed opposite sign in TS29/Pusa Basmati 1 and TS 29 / Basmati 370 and similar sign in TS 29 / ADT 41 indicating the presence of duplicate gene interaction for kernel length after cooking and linear elongation ratio. Vivekanandan and Giridharan (1995) and Mohan and Ganesan (2003) reported that kernel length after cooking was controlled by non additive gene action. The (h) and (l) signs were same in crosses TS 29/ADT 41 and TS29/Pusa Basmati 1 confirming the presence of complementary type of gene action for volume expansion ratio. Tomar and Nanda (1982) and Shivani (2002) reported additive gene action for this trait. Sarathe *et al.*, (1986) and Sharma and Mani

(1999) reported both additive and non additive genetic variance for volume expansion ratio.

The (h) and (l) took opposite sign indicating the duplicate type of gene action in the crosses TS29/ADT41, TS29 / Pusa Basmati and TS29/Basmati 370 for gel consistency and amylose content. Bu and Tao (1992) suggested the influence of dominance and epistatic interaction mainly of additive x additive, dominance x dominance and duplicate gene effect for amylose content. Zaman *et al.*, (1985) and Shivani (2002) reported additive gene action for gel consistency.

In general, both additive and non-additive gene effects appear to all eight characters studied. Therefore, improvement of these traits appears to beset with difficulties as simple selection techniques will not be able to fix superior lines in the early segregating generations. Postponement of selection of superior lines to later generations in pedigree breeding will be effective. However, one or two cycles of recurrent selection followed by pedigree breeding will be effective and useful to utilize both additive and non additive gene effects.

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Table 1. Scaling tests for grain quality characters

Cross	KL	KB	LBR	KLAC	LER	ASV	AC	GC
TS29/ADT41								
A	0.40±0.63	0.61 ±0.31*	0.570.39	2.19±1.40	0.27±0.09*	-1.00±0.71	-2.19±0.63*	-6.56±3.27*
B	-2.09±0.40*	0.09±0.07	-0.410.32	-7.40±1.42*	-0.54±0.14*	-1.80±0.68*	-8.05±1.03*	-20.71±3.51*
C	-2.50±0.63*	0.93±0.24*	-1.70±0.58*	-7.20±1.41*	-0.45±0.12*	-1.34±0.61*	-6.39±0.89*	-55.88±10.38*
TS29/Pusa Basmati 1								
A	-1.50± 0.59*	-0.11± 0.10	-0.80±0.39*	-3.30±2.00	-0.23±0.22	-0.80±0.73	1.50±0.85	-18.34±2.04*
B	-1.79±0.56*	0.22±0.20	-1.63±10.52*	-10.50±1.74*	-1.16±0.21*	0.30±0.63	-3.21±0.40*	-43.31±2.06*
C	-3.86±0.57*	0.97±0.27*	-2.80±0.38*	-10.50±1.67*	-0.69±0.23*	-1.50±0.72*	-0.93±1.51	-39.22±8.80*
TS29/Basmati 370								
A	3.03±0.89*	1.21±0.33*	-0.52±0.30	2.19±1.40	0.52±0.51*	-1.00±0.67	2.00±0.96*	-16.90±4.85*
B	3.63±0.80*	-0.583±0.60	1.020.29*	-7.39±1.42*	0.14±0.08	2.87±0.82*	-2.41±1.06*	-53.29±3.85*
C	5.18±1.62*	1.35±0.31*	0.20±0.40	-7.19±1.40*	0.08±0.13	0.40±0.42	2.64±1.75	-48.09±8.27*

Table 2. Estimates of gene effects for grain quality characters

	Cross	m	d	h	i	j	l
KL	TS29/ADT41	6.15±0.85*	-0.65±0.11*	0.25±2.30	0.80±0.84	1.25±0.35*	0.90±1.50
	TS29/PB1	5.99±0.88*	-0.35±0.08*	-1.23±2.45	0.56±0.88	0.15±0.39	2.74±1.62
	TS29/B 370	4.91±0.77*	-0.20±0.10	6.59±2.04*	1.48±0.76	-0.30±0.31	-8.14±2.00*
KB	TS29/ADT41	2.16±0.38*	0.05±0.03	0.31±1.03	-0.22±0.38	0.26±0.16	-0.49±0.66
	TS29/PB1	2.90±0.32*	0.05±0.05	-1.56±0.05*	-0.86±0.32*	-0.16±0.11	0.75±0.48
	TS29/B 370	2.81±0.73*	0.11±0.07	-0.91±2.10	-0.72±0.73	0.90±0.34*	0.09±1.38
LBR	TS29/ADT41	1.57±0.40*	-0.64±0.07*	3.28±1.09*	1.86±0.40*	0.49±0.18*	-2.02±0.87*
	TS29/PB1	2.79±0.71*	-0.18±0.07*	-1.09±2.01	0.38±0.71	0.41±0.33	2.05±1.32
	TS29/B 370	2.49±0.44*	0.19±0.07*	1.45±1.18	0.30±0.43	-0.78±0.19*	-0.80±0.80
KLAC	TS29/ADT41	9.70±2.35*	-3.20±0.12*	1.20±6.42	1.99±2.35	4.79±0.98*	3.20±4.15
	TS29/PB1	14.35±3.08*	-2.85±0.16*	-17.35±8.53*	-3.60±3.08	3.45±1.32*	17.70±5.51*
	TS29/B 370	9.70±2.53*	-3.19±0.12*	1.19±6.42	1.99±2.35	1.79±0.98*	-3.20±4.15
LER	TS29/ADT41	1.456±0.20*	-0.28±0.20*	0.39±0.54	0.18±0.20	0.40±0.08*	0.09±0.35
	TS29/PB1	2.35±0.35*	-0.36±0.03*	-2.44±0.96*	-0.70±0.34*	0.46±0.15*	2.09±0.63*
	TS29/B 370	1.01±0.19*	-0.32±0.03*	1.99±0.54*	0.59±0.19*	0.19±0.08*	-1.25±0.35*
ASV	TS29/ADT41	4.11±1.23*	-0.15±0.14	2.52±3.24	2.63±1.23*	0.35±0.48	0.25±2.06
	TS29/PB1	6.24±0.99*	-0.15±0.18	-0.45±2.74	0.40±0.97	-0.25±0.44	0.70±1.84
	TS29/B 370	3.00±1.22*	1.80±0.24*	5.39±3.26	1.39±1.20	-1.90±0.52*	-3.20±2.09
AC	TS29/ADT41	24.78±1.35*	-2.11±0.22*	-14.084±16.50	-3.85±1.33*	2.93±0.60*	14.09±2.39*
	TS29/PB1	70.61±4.24*	-2.82±0.09*	-1.50±3.71	-0.76±1.56	2.35±0.46*	2.46±2.22
	TS29/B 370	24.17±1.71*	-2.37±0.21*	-6.00±4.27	-3.04±1.70	2.01±0.60*	3.44±2.84
GC	TS29/ADT41	33.89±11.41*	-19.18±0.17*	47.32±25.21	28.61±11.41*	7.07±2.39*	-1.33±14.11
	TS29/PB1	85.92±9.27*	-20.12±0.09*	-87.57±19.64*	-22.44±9.27*	12.49±1.45*	84.09±10.54*
	TS29/B 370	78.98±8.08*	-13.52±0.49*	-99.38±19.42*	-22.09±8.06*	18.19±2.44*	26.23±11.09*