Received: 22 Dec 2019 | Revised: 26 Jun 2020 | Accepted: 27 Jun 2020

Electronic Journal of Plant Breeding

Research Article

Rice ADT 51 - A high yielding long duration rice variety suitable for *Samba* season in Cauvery Delta Zone of Tamil Nadu

R. Suresh, R. Parthasarathy, R. Vaithialingam, D. Sassikumar, R. Saraswathi, S. Santha, R. Pushpa, S. Suresh, K. Rajappan, K. Subramanian and V. Ravi.

Tamil Nadu Rice Research Institute, Tamil Nadu Agricultural University, Aduthurai – 612 101, Tamil Nadu, India.
E-Mail: sureshpbg@gmail.com

Abstract
In Tamil Nadu, rice is the predominant crop during *samba* season. In the Cauvery Delta Zone around 2.5 lakh hectares purely depend on water from Cauvery in *Samba* season during the normal years of water release from Cauvery, CR 1009 is predominantly grown variety without any alternate varieties. Mono cropping of CR 1009 leads to susceptibility to pests such as brown plant hoppers (BPH) stem borers and diseases such as blast, bacterial leaf blight (BLB), grain discolouration and false smut. In order to provide a choice variety to farmers' one long duration rice culture, AD 09367 a derivative of the cross BPT 5204 / Improved White ponni was released as Rice ADT 51 during the year 2018. ADT 51 matures in 155 to 160 days with tall, erect and high tillering plant habit and well adapted to single season canal dependent rice growing areas of Cauvery delta for *Samba* season (August-September sowing). ADT 51 has recorded a mean grain yield of 6533 kg/ha which is 9.8 and 12.7 per cent higher than CR 1009 (5947 kg/ha) and ADT 50 (5796 kg/ha) respectively. At Thiruvisanallur, Thanjavur district it manifested highest yield of 10036 kg/ha and the OFT farmer, Mr. Baskar received first prize in the district level crop yield competition for the year 2016. Besides its yield superiority, ADT 51 is resistant to blast and moderately resistant to leaf folder, stem borer, BPH, Sheath blight and sheath rot. The milled rice of this variety is white, medium grade with a 1000 grain weight of 23.9 g. High milling and head rice yield and cooking qualities of ADT 51 are comparable with CR 1009. Opinion from farmers revealed that, vigorous growing nature and tolerance to major pest and diseases of this culture requires less inputs especially nitrogenous fertilizer and plant protection chemicals for cultivation. The characters such as more no. of productive tillers, less chaffiness and quick establishment of seedling are its added advantages.

Key words
ADT 51, long duration, short duration.

INTRODUCTION

Rice is a staple food for over half of the world's population (FAO, 2004). Rice accounts for over 20 per cent of global calorie intake. Over 90 per cent of the world's rice is produced and consumed in the Asian Region comprising 80% of the world's production and consumption. It is grown on 154 million hectares world-wide in a wide range of environments. In India, rice is grown in an area of 45 million ha (23% of gross cropped area) with an annual production of 90 million tonnes (Viraktamath and Sundaram, 2010). In Tamil Nadu, total area under rice is 18.30 lakh hectares, production of 58.39 lakh tonnes and with a productivity of 3190 kg/ha during 2014-15 (INDIASTAT, 2015). Among the Indian states Tamil Nadu has highest productivity of 3.92 t/ha.

On average, rice accounts for nearly half of the food expenses of poor people and a fifth of their total household expenses. It is well established that the rapid productivity growth of rice resulting from the use of improved varieties, fertilizers, and irrigation (popularly known as the Green Revolution) increased the production and led to a long-term decline in rice prices. This has been the major factor

helping to reduce poverty in Asia over the past several decades. Despite the past achievements, rice productivity growth will remain essential in the future for several important reasons. Nearly all rice farmers worldwide depend on rice varieties that have been improved by scientific breeding since the Green Revolution (Sushil Pandey *et al.*, 2010).

Improvement in the yield potential of rice is the major strategy to increase world rice production. Increase in grain yield potential is the major goal of almost all rice breeders' programs. Rice breeders have been very successful in improving the crop. Some milestones are the contribution to the green revolution with the semi-dwarf varieties, the new rice plant type and hybrid rice. In the dynamic rice-breeding programme, genotypes with improvement in grain yields or in other traits of economic value compared to checks are identified through replicated multi-location trials across rice growing environments and released as varieties for commercial cultivation (Muralidharan *et al.,* 2019). During evaluation, yield, grain quality and resistance to biotic and abiotic stresses are ranked; breeding lines that show superiority compared to check cultivars are then selected for release (Lin *et al.,* 1986).

On the other hand, based on the performance of the varieties and also based on the emerging needs of the farmers, traders and end users, the old varieties are to be replaced time to time. Such a breeding effort was made at Tamil Nadu Rice Research Institute, Aduthurai to develop a long duration rice variety suitable for Cauvery Delta Zone of Tamil Nadu as a choice variety to CR 1009.

In Cauvery Delta Zone, during *Samba* season rice cultivation in an area of 2.5 lakh hectares purely depends on water from Cauvery and rice is cultivated in single season. In these areas during the normal years of water release from Cauvery CR 1009 is predominantly grown without any alternate varieties. Mono cropping of CR 1009 leads to susceptibility to pests such as brown plant hoppers (BPH), stem borers and diseases such as blast, bacterial leaf blight (BLB), grain discoloration and false smut.

From 1980 to 2016, 14 rice varieties were released by Tamil Nadu Rice Research Institute, out of which only three (ADT 40, ADT 44 and ADT 50) were released for *Samba* season with the duration of more than 145 days. Among the long duration varieties, the most popular one is CR 1009 and other varieties are less popular among the farmers.

In order to offer the farmers to have wider choice of varieties for cultivation during single crop *Samba* season, research efforts were undertaken at this institute with an objective to develop a rice variety suitable for *Samba* season which resulted in the development of a medium slender high yielding long duration rice culture AD 09367 and released as ADT 51 during, 2018. ADT 51, a cross derivative of BPT 5204 / Improved White Ponni has the maturity duration of 155 to 160 days with tall, erect and high tillering plant habit. It has long panicles with more filled grains and angular boot leaf and best suited for *Samba* season (August-September sowing).

MATERIALS AND METHODS

ADT 51 is a derivative of the cross BPT 5204 / I. W. Ponni effected during 2004 and advanced upto F_4 in Tamil Nadu Rice Research Institute, Aduthurai. Homozygous culture was identified in F_4 generation during *Samba*, 2008-09 and tested in various yield trials as AD 09367 from *Samba*, 2009-10 to 2016-17 (**Fig 1**). Based on the yield performance of this culture in station trials it was nominated for testing in Multi-Location trials during 2012 to 2014. As the performance of this culture was satisfactory in the MLT trials it was recommended for testing in Adaptive Research Trial (ART) for a period of two years (2014-15 to 2015-16). Under ART this culture was tested in 10 locations each in eight districts *viz*., Trichy, Thanjavur, Nagapattinam, Tiruvarur, Cuddalor, Pudukkottai, Karur and Perambalur. ARTs were also conducted in three locations each in five Krishi Vigyan Kendras *viz.,* Nagapattinam, Thiruvarur, Pudukkottai, Trichirapalli and Cuddalore during 2014-15 and 2015-16. AD 09367 was also evaluated in All India Coordinated Rice Improvement Programme (AICRIP) trials as IET 23617 in Initial Varietal Trial – Late (IVT-L) during Kharif, 2013. Besides various trials conducted in research stations, large no. of On Farm Trials (OFTs) were also conducted in farmer's field at 107 locations. Pest and disease performance was tested under artificial and field conditions at Aduthurai, Coimbatore and Madurai. Quality parameters viz., Physical, cooking and biochemical properties of this culture was tested along with CR 1009 at TRRI, Aduthurai and Department of Rice, TNAU, Coimbatore.

RESULTS AND DISCUSSION

The culture AD 09367 recorded a mean grain yield of 6796 kg / ha in the yield evaluation trials at Tamil Nadu Rice Research Institute, Aduthurai from 2009 to 2015. The yield increase was 15.2 and 9.1 per cent respectively over the checks CR 1009 (5897 kg / ha) and ADT 50 (6229 kg / ha). In Multi Location Trials conducted during 2012-13 and 2013-14 at different research stations the mean grain of 7242 kg / ha was recorded in the AD 09367 with yield increase of 6.8 and 10.0 per cent over CR 1009 (6778 kg / ha) and ADT 50 (6584 kg / ha) respectively. AD 09367 was evaluated as IET 23617 under All India Coordinated Rice Improvement Programme during 2013 under Initial Varietal Trial – Late, in which the culture registered superior performance in Shirgaon, Nellore and Karaikal locations than the national check Swarna.

Adoptive Research Trial (ART) was conducted during 2014-15 and 2015-16 in 10 locations each in 8 districts namely Thanjavur, Tiruvarur, Nagapattinam, Cuddalore, Pudukkottai, Trichy, Perambalur and Karur. Over two years of ART in 77 locations, this culture recorded mean grain yield of 6444 kg / ha which is 3.9 per cent higher than CR

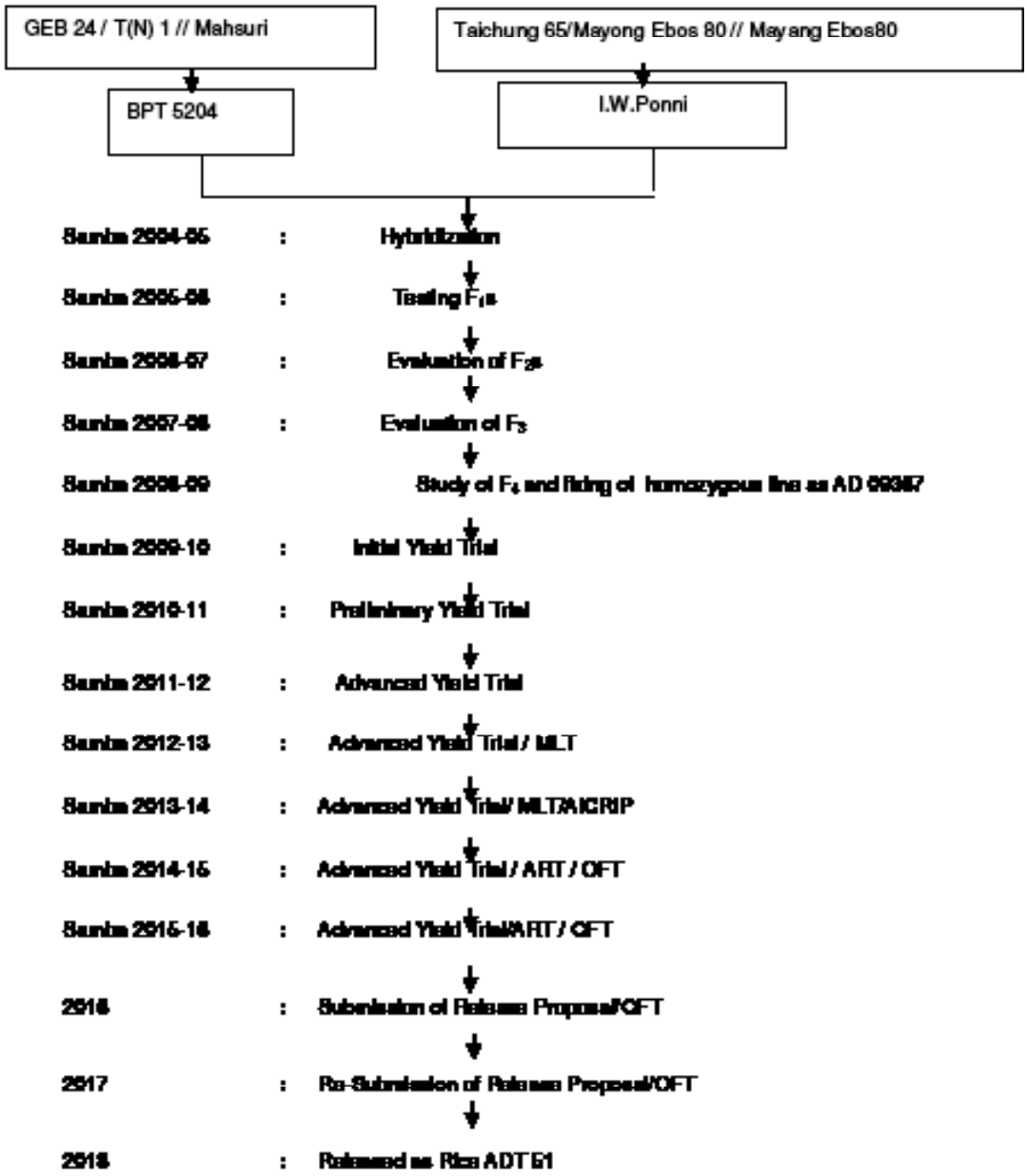

Fig.1. Pedigree of AD 09367 (IET 23617)

1009 (6202 kg / ha) and 11.1 per cent higher than ADT 50 (5798 kg / ha). In ART Trials conducted through Krishi Vigyan Kendras it recorded a mean grain yield of 6206 kg / ha which was 8.6 and 8.0 per cent higher than CR 1009 (5713 kg / ha) and ADT 50 (5741 kg / ha) respectively.

In the On Farm Testing (OFTs) conducted in 107 farmer holdings in three delta districts during 2014-15 to 2016-17, the AD 09367 recorded the mean grain yield of 6709 kg / ha which is 15.7 per cent higher than the check variety CR 1009 (5797 kg / ha). The overall mean performance of AD 09367 against the checks *viz.,* CR 1009 and ADT 50 in different yield trials is given in **Table 1.** The culture has recorded a mean grain yield of 6533 kg / ha at 191 locations which was 9.8 and 12.7 per cent increased grain yield over CR 1009 (5947 kg / ha) and ADT 50 (5796 kg / ha) respectively. Highest yield of this culture was realized at Thiruvisanallur in Thanjavur district, where it manifested 10035 kg / ha. The OFT farmer, Mr. Baskar received first prize in the crop yield competition for the year 2015-16.

AD 09367 was screened against the important diseases *viz.,* blast, bacterial Sblight, sheath rot, sheath blight and brown spot under artificially inoculated conditions

Table 1. Overall yield performance of ADT 51 (AD 09367) in different yield trials

S. No	Name of the Trials	No. of Locations	Grain yield (kg/ha)			Duration (days)		
			AD 09367	CR 1009	ADT 50	AD 09367	CR 1009	ADT 50
1	Station trials (2009 - 2011)	3	5682	5260	5682	151	152	-
2	Multi location trials (2012-14)	9	7242	6778	6609	152	154	148
3	Adaptive Research Trials (2014-16)	84	6357	6140	5725	146	150	146
4	KVKs (2014 -16)	24	6206	5713	5741	152	157	148
5	OFT (2014 -17)	107	6709	5797	-	159	158	-
	Overall Weighted Mean	222	6533	5947	5796	154	155	148
	% increase over the checks		9.8	12.7				

Table 2. Distinguishing morphological characters of Rice ADT 51

1.	Early plant vigour	:	Very Good
2.	Coleoptile	:	Green
3.	Basal leaf sheath colour	:	Green
4.	Leaf blade colour	:	Green
5.	Leaf pubescence	:	Glabrous
6.	Auricle	:	Present, light green
7.	Anthocyanin pigment	:	Absent
8.	Collar	:	Light green
9.	Ligule	:	White
10.	Septum	:	Cream
11.	Flag leaf angle	:	Semi erect
12.	Days to 50% flowering	:	124 (120-128 days)
13.	Panicle exsertion	:	Well exerted
14.	Stigma color	:	White
15.	Apiculus color	:	Straw
16.	Panicle length	:	27.3 cm (25.6-28.5 cm)
17.	Filled grains/panicle	:	~187 - 225 nos. (in primary tillers)
18.	Average single plant yield	:	43.5 g
19.	Panicle type	:	Compact
20.	Awns	:	Absent
21.	Hull colour	:	Straw
22.	Seed coat (kernel) colour	:	Light brown
23.	Threshability	:	Easy
24.	Aroma	:	Absent
25.	Grain / Paddy		
	L x B x T (mm)	:	8.5 x 2.6 x 1.69
26.	Brown rice		
	L x B x T (mm)	:	6.3 x 2.3 x 1.56
	L/B ratio	:	2.74
27.	1000 grain weight (g)	:	23.9
28.	Rice grade	:	Medium (length) and Medium slender
29.	Milled Rice colour	:	White
30.	Abdominal white	:	Absent
31.	Translucency	:	Translucent

during 2014-15 and 2015-16 at Aduthurai, Coimbatore and Madurai. It is found to be resistant to Blast (scale 3), in 1 to 9 scale. This culture was found to be moderately resistant to bacterial leaf blight, sheath rot and brown spot (**Table 3**). It was also screened for major pests *viz*., brown plant hopper, stem borer, leaffolder and gal midge at Aduthurai, Coimbatore and Madurai. It shows moderate resistance to all the four pests for which it was screened (**Table 4**).

Table 3. Reaction of AD 09367 to major Diseases (Average of two years 2013-14 & 2014-15)

S. No.	Diseases	Centre	AD 09367	CR 1009	ADT 50
1.	Blast	CBE	2	2	5
2.	Sheath rot	ADT	3	3	3
		MDU	5	7	9
3.	Sheath blight	ADT*	5	7	5
		MDU	7	7	7
4.	BLB	ADT*	3	7	7
5.	Brown spot	ADT	5	3	5

* Artificial Screening

Source: TNAU Crop Scientists' Meet on Rice, 2014 & 2015)

Table 4. Reaction to major Pests (Average of two years 2013-14 & 2014-15)

S.No	Pests	Centre	AD 09367	CR 1009	ADT 50
1.	**Stem borer**	Aduthurai (Dead Hearts)	6.4 (1)	6.3 (1)	8.3 (1)
		Madurai (Dead Hearts)	0.00 (0)	0.00 (0)	0.00 (0)
		Aduthurai (White ears)	0.00 (0)	0.00 (0)	0.00 (0)
		Madurai (White ears)	8.42 (1)	9.13	5.32
		Thirupathisaram (White ears)	2.90	1.13	3.40
2.	**BPH***	Coimbatore	5	5	5
		Madurai	5	3	7
		Aduthurai	3	5	5
3.	**WBPH***	Coimbatore	5	5	7
4.	**GLH***	Coimbatore	5	5	5
5.	**Leaf folder (%)**	Madurai	5.98 (1)	7.31 (1)	7.56 (1)
6.	**Gall midge (%)**	Madurai	21.59 (7)	16.27 (7)	31.25 (9)

* Artificial Screening

Source: TNAU Crop Scientists' Meet on Rice, (2014 & 2015)

Table 5. Physical quality characteristics (Average of two years 2013-14 & 2014-15)

Variety	Milling Yield (%)	Head rice Recovery (%)	1000 grain wt (g)	Kernel length (mm)	Kernel breadth (mm)	L/B ratio	*Grain Type
AD 09367	70.3	60.5	23.90	6.3	2.3	2.74	MS
CR 1009	69.85	58.25	23.85	5.55	2.67	2.00	SB
ADT 50	68.20	56.0	16.00	5.45	2.05	2.62	MS

*MS - Medium slender, SB - Short bold

Source: TNAU Crop Scientists' Meet on Rice, (2014 & 2015)

Table 6. Cooking quality characteristics

Parameters	AD 09367	CR 1009	ADT 50
Kernel length after cooking (mm)	9.45	9.35	8.80
Kernel breadth after cooking (mm)	3.2	3.0	3.0
Linear elongation ratio	1.56	1.55	1.73
Breadthwise expansion ratio	1.42	1.32	1.39
Volume expansion (ml)	3.85	3.85	3.45

Source: TNAU Crop Scientists' Meet on Rice, (2014 & 2015)

Table 7. Organoleptic evaluation of cooked rice

Characteristics	AD 09367	CR 1009	ADT 50
Appearance	9.0	8.5	9.0
Cohesiveness	9.0	8.0	9.5
Tenderness on touching	7.8	7.0	9.0
Tenderness on chewing	8.2	7.8	8.5
Taste	7.5	7.5	8.0
Elongation	7.3	6.0	8.5
Overall acceptability	7.5	7.0	8.0

Maximum score 10

The grain type of ADT 51 is medium slender with 1000 grain weight of 23.9 g. Cooked rice is non sticky, soft with good taste and suitable for tiffin and savories preparation. The milling yield (70.3%) and head rice recovery (60.5%) of this culture are high and on par with CR 1009. Cooking quality and organoleptic characters are also similar to CR 1009 (**Table 5, 6 & 7**)

Besides its yield superiority, AD 09367 was found to be resistant to blast and moderately resistant to insects like leaf folder, stem borer and BPH and diseases like sheath blight and sheath rot and field tolerance to all other major pests and diseases. Opinion from farmers revealed that, this culture fetches higher returns when compared to CR 1009 due its high yield potential with medium slender grain type. In addition, farmers also express that vigorous growing nature of this culture along with its field tolerance to major pest and diseases paves way to incur less expenditure for cultivation by applying less inputs especially nitrogenous fertilizer and plant protection chemicals. The characters such as quick seedling establishment, more number of productive tillers, less chaffiness are its added advantages. As a result, new rice variety “ADT 51” with higher yield, pest and disease resistance with superior cooking quality in comparison to the check CR 1009 was released during 2018 and it can be cultivated as a transplanted/direct seeded semidry crop during *Samba* season in the Cauvery Delta districts.

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