SHORT COMMUNICATION

Development of New Flash Flood Tolerant Genotype of Rice for Coastal Saline Lowlands of Tamil Nadu

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Development of improved cultivars for the vast rainfed lowlands of Asia has lagged far behind that for irrigated areas. This lacuna is not surprising considering the number of traits required for modern rainfed lowland cultivars. In addition to the acceptable grain quality and resistance to insects and diseases that irrigated cultivars require, rainfed lowland cultivars must have sufficient tolerance to abiotic stresses that predominate in their respective environments. From a survey in eastern India, submergence is identified as the third most important of 42 biotic and abiotic stresses that limit rice production in rainfed lowlands (Widawsky and O'Toole, 1990).

Flash flooding and submergence are wide spread in South East Asia, Bangladesh and North-eastern India, and affect at least 22 million hectares (16 per cent of world rice area) including 15 million hectares of potential short duration flash floods in rainfed lowlands and 5 million hectares of deep water rice (Khush, 1984). Submergence for more that 2-3 days kills most rice cultivars (Mishra *et al*., 1996). When rice plants are subjected to flash flood, they should adapt themselves to two drastic environmental changes: the change from aerobic condition to anaerobic condition during complete submergence and the subsequent change from anaerobic to aerobic condition when the flash flood water recedes. Flash flood submergence may occur at any growth stage of rice crop and yield loss in severe cases may be 100 per cent (Mohanty *et al*., 1982). MacKill *et al*. (1996) and Lafitte *et al.* (2006) emphasized on breeding varieties that have intermediate height, stiff and non-lodging culms and moderate submergence tolerance for such growing situations.

Therefore, an attempt was made at the Department of Agricultural Botany, Faculty of Agriculture, Annamalai University, Tamil Nadu to develop saline tolerant high yielding rice variety suitable for *tsunami* affected coastal lowlands of Cuddalore district of Tamil Nadu (Sabesan, 2005). Initially, 26 rice genotypes comprising of 17 mutant cultures, eight high yielding varieties and a traditional variety were evaluated at the Plant Breeding Farm (11º24´N latitude, 79º44´E longitude and + 5.79 msl) for 12 different quantitative and qualitative characters, *viz*., days to first flower, productive tillers per plant, panicle length, number of grains per panicle, thousand grain weight, grain length, grain breadth, grain L/B ratio, kernel length, kernel breadth, kernel L/B ratio and grain yield per plant (Table 1) and were grouped into thirteen clusters using Mahalanobis D^2 statistics (Sabesan, 2008).

Ten lines and three testers representing the thirteen clusters were selected as parents for hybridization programme. They are IR 42, AUR 7, AUR 1, AUR 12, AUR 8, CO 43, AUR 10, ASD 16, AUR 9, Jeeraga samba, ADT 49, PY 5 and Annamalai Mutant Ponmani. The selected 13 genotypes were crossed in Line x Tester mating design to produce 30 hybrids during *Navarai*, 2003 (January–April). All the 30 F_1 hybrids were

Table 1. Composition of D^2 clusters in rice

Cluster	Number of genotypes	Genotypes identity
I	7	CO 43, AUR 5, AUR 13, IR 36, BPT 5204, AUR 6, ADT 43
II	2	AUR 4, Annamalai Mutuant Ponmani (AMP)
III	2	Karnool sona, *Jeeraga samba*
IV	1	AUR 7
V	4	AUR 9, AUR 14, AUR 11, AUR 2
VI	2	IR 42, AUR 3
VII	1	AUR 1
VIII	1	AUR 8
IX	2	ADT 39, AUR 15
X	1	AUR 12
XI	1	AUR 10
XII	1	PY 5
XIII	1	ASD 16

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advanced to F_2 generation during *Samba*, 2003 (August–December).

Out of the 30 F_2 generations evaluated during *Samba*, (August–December) 2004 the F_2 progenies of the cross ASD 16/PY 5 showed appreciable tolerance to salinity under field conditions. The soil pH of the field was 8.01 and the pH of the irrigation water was 8.20. The soil type was clay with clayey loam texture. The parents ASD 16 and PY 5 belong to clusters of intermediate intercluster distance. Single plant selections made in F_2 generation were forwarded to F_3 and F_4 generations during *Samba*, 2004 and *Navarai*, 2005 (January–April), respectively. F_5 generation raised in *Samba*, 2005 remained completely submerged for eight days by flash flooding(DFO, 2005). The short statured lines which tolerated flood were forwarded to succeeding generations (Table 2).

The F_8 generation grown is *Samba*, 2007 remained completely submerged for 12 days because of flash flooding (Table 3) from 7 DAT to 19 DAT (DFO, 2007). It remained partially submerged for another three days (Fig. 1). No lodging was observed after desubmergence. The leaves were erect and dark green before submergence and after desubmergence. The plant height at maturity was 80 cm (Fig. 1).

Submergence tolerance can be defined as 'the ability of rice plant to survive 10-14 days of complete submergence and renew its growth when the water subsides' (Catling, 1992). The importance of low shoot elongation during submergence and lodging resistance was reported by Kawano *et al*. (2008). Most of the existing rice cultivars are seriously damaged by flash flooding. Extensive shoot elongation is detrimental under flash flood conditions as it exhausts energy storage and when water recedes, the plants tend to lodge. This reduces both productivity, grain quality, and renders the crop susceptible to pest and disease. Positive association between survival and limited stem elongation was reported by Setter and Laureles (1996), Singh *et al*. (2001) and Lafitte *et al.* (2006).

The progress made so far in developing improved cultivars for the rainfed lowland that combine ample submergence tolerance with good agronomic traits is still far from excellent. Although FR 13A has long been known as lowland rice most tolerant to flash flooding, its direct utilization as a tolerant donor is limited by its poor agronomic traits such as the presence of long awn, short and thick grains, photoperiod sensitivity and low productivity (Setter and Laureles, 1996).

The newly developed short statured rice culture AURC 02-05-2 exhibited excellent tolerance to flash flooding besides tolerance to salinity. Association of submergence stress with salinity, cold, nutrient and drought stresses is also reported by Ito *et al.* (1999). This might be because one of the parents ASD 16 is a saline resistant variety.

Table 2. Rainfall and weather data for the year 2005

Week no.	Period	Temperature (ºC)		RH (%)	HBSS (hrs)	Rainfall (mm)	WV (km/hr)
		Max.	Min.				
42	Oct. 15-21	32.2	23.6	93	6.5	109.4	1.4
43	Oct. 22-28	29.9	22.5	95	3.7	103.4	0.8
44	Oct. 29-Nov. 4	32.5	24.2	90	5.8	022.2	2.1
45	Nov. 5-11	26.6	22.0	97	0.0	**591.0**	2.4
46	Nov. 12-18	29.0	20.3	91	5.7	002.8	2.2
47	Nov. 19-25	27.5	21.1	95	2.7	**331.1**	3.3

RH- Relative humidity, HBSS-Hours of bright sunshine, WV-Wind velocity
Source: Meteorology Data, Faculty of Agriculture, Annamalai University

Table 3. Rainfall and weather data for the year 2007

Week no.	Period	Temperature (ºC)		R.H (%)	HBSS (hrs)	Rainfall (mm)	WV (km/hr)
		Max.	Min.				
39	Sept. 24-30	34.6	24.7	79	8.0	0.8	5.9
40	Oct. 01-7	34.6	24.4	82	6.6	14.6	5.6
41	Oct. 8-14	34.6	24.7	84	8.4	22.4	2.4
42	Oct. 15-21	30.7	24.1	88	5.4	40.3	0.4
43	Oct. 22-28	28.1	23.3	97	2.8	**599.4**	0.6
44	Oct. 29-Nov. 4	30.1	23.7	91	6.2	63.2	1.3

RH-Relative humidity, HBSS-Hours of bright sunshine, WV-Wind velocity
Source: Meteorology Data, Faculty of Agriculture, Annamalai University

Fig. 1: Flash flood tolerant rice genotype AURC 02-05-2

The culture AURC 02-05-2 produced 12 tillers, all of them productive. The panicle length was 21.9 cm with 245 grains per panicle. One thousand grains weight was 21 g. Days to 50% flowering was 110-115 and days to maturity was 135-150 days. Grain length was 8 mm and breadth was 2.7 mm. Kernel color was white. Kernel length was 6.1 mm and breadth was 2.4 mm with kernel L/B ratio of 2.54. Kernel length after cooking was 10.2 mm and breadth after cooking was 3.4 mm. Boot leaf length was 32 cm and boot leaf width was 1.8 cm. The yield performance of this line was 5.52 t/hectare. While, rice yields in the rainfed lowlands of eastern India are generally low, averaging 2.4 t/hectare (IRRI, 2002). One peculiar character of this newly identified rice ideotype was the persistence of dark green colour of leaves even during submergence. Erect stature with non-lodging character was another peculiarity of this culture. This culture showed field tolerance to pests and diseases. This culture is in the pipe line of variety release.

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