SHORT COMMUNICATION

Rice Donors Tolerant to Complete Submergence

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Rice is grown in varied ecological regions ranging from irrigated to upland, rainfed lowland, deep water and tidal wetland. About 29% of India's total rice area i.e. about 13 million ha is rainfed lowland, which contributes only 19% to national rice production. In a normal year about 4 million ha remains drought prone while 3 million ha is favourable. Another 3 million ha is medium deep waterlogged with water standing up to 50 cm for about a week or so. The remaining 3 million hectare of submergence or flood prone area. The rice crop in this area remains submerged for 1-2 weeks or so giving little or no return at all. Rainfed lowland constitutes a highly fragile ecosystem, which is always prone to flash floods and submergence with an average productivity of 1.2 tonnes/ha in normal years and hardly 0.5 tonnes/ha in case of submergence. Among the 42 biotic and abiotic stresses, submergence has been identified as the third most important constraint in the way of higher rice productivity in eastern India (Hossain and Laborte 1996), which sometimes results in near total yield loss. Besides India, flooding is widespread in other South and South-east Asian countries and affects approximately 22 million ha of rice lands. Therefore better varieties are needed to enhance the productivity of such areas.

The genetic pool of submergence tolerant rice cultivars is limited. Some submergence tolerant rice cultivars like FR 13A, FR 43B, 'Goda Heenati' etc. were identified long back and they are similar in the sense that all the cultivars possess the same submergence tolerant gene (*Sub 1*) in chromosome number 9 (Xu *et al.* 2004). Moreover, the existing tolerant cultivars have very poor combining ability and agronomic characters. Hence, development of high yielding submergence tolerant cultivars using these cultures as one of the parents was successful (Mallik 2000). Identification of new donors (gene resources) thus is highly desirable to achieve success in this field.

The germplasm were grown under normal condition with recommended package of practices to characterize and document the agro-morphological traits. For screening against submergence tolerance, the seeds were direct seeded in specially designed field cemented tanks (40 x 8 m) with known submergence tolerant (cultivar FR 13A) and susceptible cultivar (cultivar IR 42) as checks. Twenty-one-day-old seedlings were submerged for 12 days under 80 cm of water. Survival count was taken visually on 10^{th} day of de-submergence. The characteristics of the floodwater in terms of light transmission (%) were measured at 1200 h (LI COR, Lincoln, USA), and water temperature and oxygen concentration were determined at 0600 and 1630 h (Syland, Heppenheim, Germany). Light intensity at 60 cm water depth varied between 37.6 and 41.2 % of the incident irradiance above the floodwater. The oxygen concentration at the same water depth was 4.4-7.4 mg l^{-1} at 0600 h and 6.2-11.6 mg l^{-1} at 1630 h. The temperature did not vary greatly, being 29.1-33.3°C throughout the period of experiment.

Identification of diverse gene sources for desired traits and their incorporation into the promising cultivars are the most effective way to tackle the adverse situations. These two germplasm namely 'Kalaputia' and 'Kusuma' were screened for their valuable traits like submergence tolerance in the experimental fields of the institute. They withstood complete submergence even if their leaf tips remained below the water surface for more than 12 days (Table 1). The elongation ability of these two landraces was as good as the international submergence tolerant check 'FR 13A'. Accumulation of non-structural carbohydrate (NSC) content before submergence was found to be more in 'Kalaputia', followed by 'FR 13A' and 'Kusuma'. Tolerant cultivars accumulate greater quantities of NSC before submergence compared to the susceptible cultivar (Table 1). This is in conformity with earlier findings (Das *et al.* 2005, Sarkar 1998). Submergence reduced the chlorophyll content (Table 1). The percentage of decrease was maximum in susceptible cultivar 'IR 42' (70.8 %), followed by 'Kusuma' (40.7 %), 'FR 13A' (15.9 %) and 'Kalaputia' (13.6 %). Lower elongation and maintenance of higher quantities of chlorophyll content during submergence is associated with submergence tolerance (Sarkar and Bera 1997, Sarkar *et al.* 2001). Though the survival percentage of 'Kusuma'

Table 1. Total non-structural carbohydrate (NSC) content before submergence and elongation capacity, chlorophyll content and survival capacity due to complete submergence

Cultivar	NSC (%)	Plant Height (cm)			Chlorophyll (mg g^{-1} FW)		Survival (%)
		BS	AS	Elongation	BS	AS	
'Kalaputia'	11.5	27	50	23	2.80	2.42	88
'Kusuma'	10.1	34	66	32	2.95	1.77	75
'FR 13A' (T-check)	10.2	33	64	31	2.20	1.85	82
'IR 42' (S-check)	6.2	28	65	37	2.19	0.64	0

BS. AS = before and after submergence; Elongation = AS-BS; T= tolerant; S= susceptible; FW=fresh weight

Table 2. Agro-morphological traits of the landraces

Characteristics	Kalaputia (PCP-01)	Kusuma (PD-75)	FR 13A
Blade colour	Light green	Dark green	Light green
Apiculus & stigma colour	Purple	Straw white	Straw white
Ligule shape	2-cleft	2-cleft	2-cleft
Basal leaf sheath colour	Purple	Purple	Green
Culm angle & flag leaf angle	Erect	Erect	Erect
Culm strength & panicle type	Intermediate	Intermediate	Intermediate
Panicle exsertion	Well exserted	Well exserted	Well exserted
Secondary branching	Absent	Absent	Absent
Leaf length (cm)	50.5	31.4	58.2
Leaf width (cm)	1.54	0.6	1.49
Plant Height (cm)	105.7	140	149.2
Number of EBT	10.6	9.5	13.6
Panicle length (cm)	21.7	17.9	23.6
Awning	Completely awned	Awn less	Completely awned
Husk colour	Black	Dark purple	Straw white
Kernel colour	Red	Red	Red
Grain length (mm)	8.3	8.0	9.0
Grain breadth (mm)	3.2	2.8	3.4
l/b ratio	2.59	2.86	2.6
Brown rice length (mm)	6.5	7.5	6.0
Brown rice breadth (mm)	2.25	2.75	2.0
l/b ratio	2.8	2.72	3.0
Brown rice shape	Long bold	Long bold	Long bold
Maturity duration (days)	155	165	160

was low compared to the 'FR 13A', yet the cultivar was better than FR 13A due to its awn less characteristics. Awning is undesirable in rice as it creates problems in post harvest handling of the produce. In general, submergence tolerant cultivars possess awn (Mallik 2000). 'Kalaputia' possesses black husk with reduced elongation under submergence and can be easily distinguished from 'FR 13A'. Identification of these two lines is given us hope and extended the scope for further research to develop high yielding submergence tolerant rice varieties.

All the submergence tolerant cultivars namely 'Kalaputia', 'Kusuma' and 'FR 13A' were characterized morpho-agronomically in accordance with IRRI-IPGRI descriptor (Table 2). They were different in respect of apiculus and stigma colour, leaf length and breadth, plant height, awning characteristics. The mean quantitative characters of both the genotypes also showed that they were different. These two newly identified, valued cultivars would be submitted to the Germplasm Registration Committee of NBPGR for registration.

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