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ABIOTIC STRESS TOLERANCE - A SEARCH IN TRADITIONAL RICE GERMPLASM

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To cater the need of identifying suitable variety for wide range of biotic and abiotic stresses as prevailed in Bay Islands, a massive screening programme were undertaken during 1986-1992 adopting diverse screening strategies. Computing results across years and localities, a set of varieties tolerant to important abiotic stresses viz., excess salt, phosphorous deficiency, aluminium and Iron toxicity were identified from traditional rice germplasm collected from diverse agroclimatic zones.

Key words : Rice, germplasm, abiotic stress, tolerance

Identifying suitable germplasm resources tolerant to various biotic and abiotic stresses have been a major concern in the national as well as international rice research strategy since long back. Day by day the magnitude of such stresses are concentrating due to intensive cropping, cultivation of improved varieties with narrow genetic base, monoculture of variety in specific areas, breakdown of established tolerance level, natural calamities and due to ecological mismanagement. The Andaman and Nicobar group of Islands - a far flung union territory of Indian subcontinent is a potential rice growing area. Being humid tropics and endeavour with unique climatic conditions, the islands are having specific constraints in rice cultivation. Among the abiotic stresses, excess salt stress and phosphorus deficiency in the acid sulphate soils, excess iron and aluminium in the low lying areas were found to be major problem. The present paper deals with the achievements of a study aims at identifying suitable tolerant germplasm for important abiotic stresses in Andamans are detailed below.

MATERIALS AND METHODS

Two hundred seventy five traditional rice germplasm including landraces were collected from Chhotanagpur plateau of Bihar and Maharashtra, Indo-gangetic plains of West Bengal and Uttar Pradesh, hilly terrain of North

Eastern Region, coastal south Bengal and Kerala, were used in this study. Since 1986, the collected materials were recurrently screened across different localities till 1992 with a view to pinpoint suitable donor sources tolerant to prevailing biotic and abiotic stresses in Andamans. Regarding abiotic stress tolerance for screening of the genotypes following strategies were adopted.

A. Screening for excess salt tolerance

1. Under hydroponics

Pre-germinated seeds of the traditional rice germplasm were kept on furrous made on a square styrofoam sheet with a nylon net underneath. In such a way 20 number of entries accommodated on each styrofoam sheet which was kept floated on Hogland solution in a plastic tray (42 × 30 × 6 cm). The pH of the solution maintained at 5.0 regularly. At 3-4 leaf stage, salt stress was given in the form of NaCl: $CaCl_2$ (1:1). After salinazation at the 7th day, leaf injury symptoms were scored in 0-9 scale and the entries were grouped as tolerant, moderately tolerant and susceptible.

2. *In vivo* screening in cement tanks

Large narrow cement chambers filled with acid sulphate soils in experimental net house were employed in this study. Desired salinity level was maintained regularly with sea water, pH was maintained at 5.0. Observations were recorded at different stages of the crop and finally completed to detect tolerance norms.

3. Field screening

The germplasm were recurrently evaluated in a field adjacent to creek which was frequently inundated with sea water. The average EC and pH varied from 3.0 to 9.0 and 3.0 to 4.8 respectively. Observations were taken at various stages of the crop. In all the approaches, **Pokkali, Nona Bokra** and IR 26 were used as tolerant and susceptible checks.

B. Screening for phosphorous deficiency tolerance

1. Under hydroponics

Hogland solution was used in the same manner as for salt stress. In control set 10 ppm and in phosphorous deficient set 0.5 ppm of phosphorus were used, pH was maintained regularly at 6.5.

2. *In vivo* screening in wooden tanks

Varieties were directly sown on red lateritic soil (pH 4.5, soil: water = 1:2.5; p = 60 ppm) in narrow long wooden tanks where phosphatic fertilizer was withdrawn and in the control set phosphorous was applied @ 50kg/ha. Observation were recorded and entries were grouped as tolerant and susceptible. In both the approaches Rasi and IR-28 were used as biological check.

C. Screening of excess Aluminium tolerance

A. Under hydroponics

Hogland solution with 0, 30 and 60 ppm aluminium in the form of $AlCl_3$ were employed in this study. pH was adjusted regularly at 4.0. On the basis of relative root length in treated and control set, tolerance level were detected. MW 10 was used as biological check.

D. Screening for excess iron tolerance

1. *In vivo* screening

Germplasm were screened in fibre glass tanks filled with soil. Iron toxicity created artifically with the addition of $FeCl_3$ and citric acid to attain a level of 400 ppm. pH at 5.0 and Fe stress level were maintained throughout the experiment. Twenty one days old seedlings were transplanted in such tanks in experimental net house. Observations were recorded at maturity.

2. Field screening

Germplasm were evaluated in a field with acid sulphate soil stressed with iron toxicity. Materials were screened recurrently across years and average data used in computing tolerance norms. Mashuri and IR-24 were used as tolerant and susceptible checks. In the aforementioned approaches for observations and interpretations were made as per IRRI standard Evaluation system 1988.

RESULTS AND DISCUSSION

Two hundred and seventy five varieties were screened for mineral stresses (excess salt, iron, aluminium and phosphorous deficiency) related to acid surface soil. Among the varieties tested 20 varieties were found to be tolerant to excess slat (Table 1) and out of those varieties 5 varieties viz., **Pokkali, Chettipokkali, Chettivirippu, Cheriopandy** and **Hamilton** were normally grown in salt affected areas.

Table 1. Donors tolerant to different abiotic stress conditions identified in traditional rice varieties

Stress	Traditional variety
Excess Salt[1]	Pokkali, Chettipokkali, Chettivirippu, Cheriopandy, Hamilton
Excess Salt[2]	Changpai, Ratirali, Ramsail, Mahajang, Radhunipagal, Phouren, Churnakati, Mirgolo, Mohishadhan, Seetabhog
Iron toxicity (Avoiding type)	Chakhau Amubi, Seetabhog, Ramsail, Ngoba, Black Jonga, Meetmuri, Digio, Sendurjoba, Nania, Chipti, Chinadhan, Basmati.
Iron toxicity	Sirsoria, Thaothabi, Iaphoe, Phourem, Kalma, Framdhan, Charaimukhi
Iron toxicity and excess salt	Pokkali, Damodar, Vatnama, Kurunthakuruka, Maltu, Hamiltom, Dhudrice.
Aluminium toxicity	Khailal Kucho, Digio, Haskalma, Gora, Karjat 23, Ajan 146, Mohishadhan, Maltu, Sangsangba, Panvel, Sendursail, Pawana, Nania, Karjat 18, Indrayani, Karhani, Kataribhog, Seetabhog, Kalokeri.
Aluminium toxicity and excess salt	Dhudrice, Seetabhog, Mohishadhan
Phosphorus deficiency	Indrayani, Charaimukhi, Nania, Chindhan, Lalki, Digio, Laloo 14, Punadhan, Daldadhan, Malkujiddhan, Barajapani.
Phosphorus deficiency (Efficient for high P-uptake)	Karjat 23, Jonga, Black gora, Badhkaamkati, White/gora, Sathi, Maltu, Kataribhog, Ratiarali.
Phosphorus deficiency and excess salt	Pokkali

1. Normally grow in salt affected areas.
2. Normally grow in normal soils.

It is logical to assume that these varieties were tuned with salt stress due to their cultivation over years, whereas other 15 varieties collected from places not affected with salt stress. This observation indicates null relationship between the tolerant norms and of the geographical origin. For Iron toxicity, 19 varieties were found to be very promising (Table 1). Out of them 12 varieties were of avoiding type i.e. either they escape the critical injury period i.e the flowering phase due to shorter life cycle or could inhibit the diffusion of excess iron through the root system, thereby injurious level of iron could never be achieved. Seven varieties viz., **Sirsoria, Thaothabi, Laiphoe, Phouren, Kalma, Framdhan** and **Charaimukhi** were found true tolerant type. Inspite of high iron uptake neither yield was affected nor the extent of bronzing symptoms which reflect physiological injury. Seven varieties viz., **Pokkali,**

Damodar, Vatnama, Kurunthakuruka, Maltu, Hamilton and **Dhudrice** were found to be tolerant for both iron toxicity and excess salt. (Table 1).

Nineteen varieties were identified as tolerant to aluminium toxicity (Table 1). Furthermore 3 varieties viz., **Dhudrice, Seetabhog** and **Mohishadhan** were found to be tolerant for both aluminium toxicity and excess salt. In respect of phosphorous deficiency, 11 varieties were found to sustain the yield level with minimum phosphorus while, 9 varieties viz., Karhat 23, **Jonga,** Black gora, **Badhkalamkati, Whitegora, Sathi, Maltu, Kataribhog, Ratiarali** had the capacity for high uptake of phosphorous indicating their strong efficiency in this aspect. Variety **Pokkali** was identified as tolerant to both phosphorous deficiency and excess salt. (Table 1).

Thirteen varieties were identified for multitolerance and among them 3 varieties viz., **Pokkali, Seetabjog** and **Digio** (Table 2) had tolerance for three

Table 2. Rice varieties with multi tolerance for abiotic stresses

Variety	Excess Salt stress	Iron toxicity	Aluminium toxicity	Phosphorus deficiency
Indrayani			+	+
Charaimukhi		+		+
Nania		+		+
Chinadhan		+		+
Digio		+	+	+
Kataribhog				
Seetabhog	+	+	+	
Ramsail	+	+		
Ngoba	+	+		
Phouren	+	+		
Ajan 146	+		+	
Mohishadhan	+		+	
Pokkali	+	+		+

+ = Tolerant

stresses and other 10 varieties possessed tolerance for two stresses germplasm were screened for tolerance in respect of excess salt at various growth stages. At 8 ds^{-m} salt stress three different kinds of varieties were identified which

exhibited their tolerance at seedling, vegetative and ripening stage. Varieties mostly failed to show the tolerance at reproductive stage which was also found to be most crucial. With the increment of salt stress such as 12 ds^{-m}, 6 varieties viz., Frow, Ranga Gellong, Kbathangmew, Napdoi, Lyngri and Adamchini were found to be tolerant at seedling stage and 3 varieties viz. Pokkali, Mahajang and C 14-8 were found tolerant at flowering stage while increasing the stress level to 16 ds^{-m}, 3 varieties viz. Nonabokra, Pokkali and Sendursail were found to be tolerant at seedling stage and 2 varieties viz. Pokkali and C 14-8 showed their tolerance at flowering stage.

It is concluded that the present set of germplasm offered considerable amount of variability in respect of biotic and abiotic stresses. The identified donors may be used in future breeding programmes to recombine resistance/tolerance characters in high yielding varieties which are well adaptive to the agroclimates of Andamans.