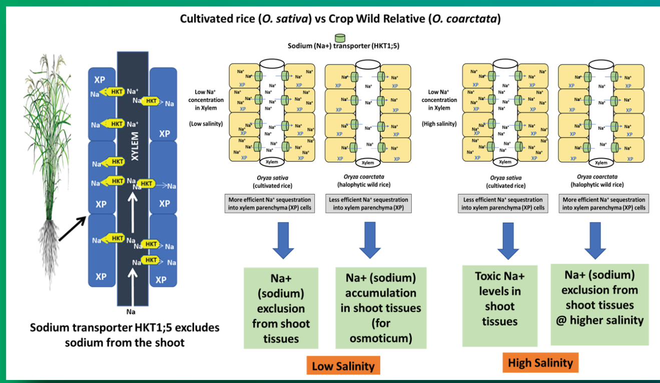
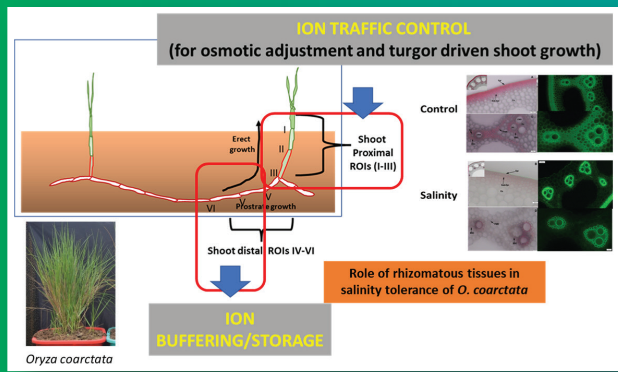
Adaptive traits for salinity tolerance in coastal rice landraces and halophytic rice wild relative

MSSRF established that CWRs and naturally adapted saline tolerant cultivated crop species can be exploited to transfer salinity tolerance traits/genes to saline sensitive crop cultivars





41 Research Dissemination

Context

Soil salinization is identified as a major cause of land degradation, rendering land unsuitable for crop cultivation. Domestication of crops over the past 10,000 years has resulted in the loss of ancestral traits. Crop Wild Relatives (CWRs) can be important sources of salinity tolerance. In the same way, naturally adapted cultivated crops in coastal regions harbour traits for salinity tolerance. Both CWRs and naturally adapted saline tolerant cultivated crop species can be exploited to transfer salinity tolerance traits/genes to sensitive crop cultivars.

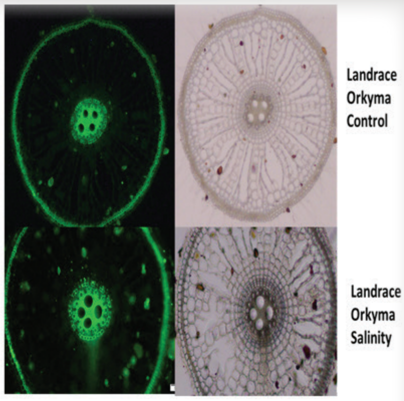
Intervention

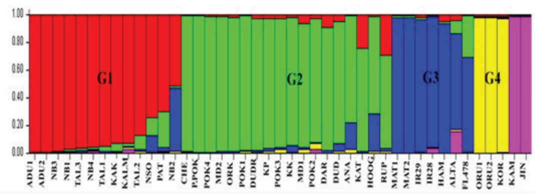
At MSSRF, as a natural extension of mangrove restoration activities, a mangrove associate and a CWR of cultivated rice *(Oryza coarctata)*, was examined for salinity tolerance traits using physiological, cell biological and molecular methods. In a complementary approach, salinity tolerance traits in naturally adapted coastal rice landraces were mapped using morphological and physiological tools.

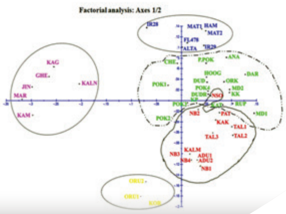
Outputs

Sodium ions are the primary drivers of soil salinity. The function of a major sodium transporter gene, *HKT1;5*, were comparatively mapped in salt tolerant wild rice *O. coarctata* and cultivated rice, *O. sativa* using cloning, biophysical modelling, mutagenesis and heterologous over-expression approaches to identify differential determinants of transporter function in the two species *HKT1;5* gene diversity were mapped in the genus *Oryza* for evolutionary structure-function assessments. This study shows how the sodium transporter *HKT1;5* can function differentially in salt tolerant species such as *O. coarctata* to drive accumulation of sodium in shoot tissues or exclude sodium from shoots in salt sensitive species such as cultivated rice.

Oryza coarctata
Oryza sativa







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This needs to be balanced by the ability to tolerate excess sodium in shoot tissues that can interfere with photosynthesis. The ability to use sodium as an osmoticum to drive growth under salinity instead of potassium or 'tissue tolerance to sodium' is an important trait governing salinity tolerance in *O. coarctata* and in many cultivated rice landraces. One of the unintended consequences of high soil salinity (sodium) is that it interferes with potassium uptake in plants, because both sodium and potassium have many similar chemical properties. Potassium is an important macronutrient for plant growth. The ability to retain potassium in tissues (potassium retention under salinity) was identified as another important component of salinity tolerance in *O. coarctata* leaves and cultivated rice landrace roots. Finally, the role of water impermeable extracellular (apoplastic barriers) in root and rhizome tissues of *O. coarctata*, and cultivated rice landraces in preventing sodium entry into vascular tissues was established.

Outcomes

MSSRF has thus established that CWRs and naturally adapted saline tolerant cultivated crop species can be exploited to transfer salinity tolerance traits/genes to saline sensitive crop cultivars. This knowledge has been disseminated widely through publications to the scientific community. These scientific findings will form the basis to develop saline tolerant crop species in the future.

Research Dissemination

Poster/Oral Presentations	10
Publications (I)	22
Travel/Short term/Independent Fellowships	4
Ph.D Thesis	1
Resource: SRF/Ph.D/Post doctoral Mentored	3

Further Reading

* Somasundaram S, Véry A-A, Vinekar RS, Ishikawa T, Kumari K, Pulipati S, Kumaresan K, Corratgé-Faillie C, Sowdhamini R, Parida A, Shabala L, Shabala S, Venkataraman G* (2020) Homology modeling identifies crucial amino-acid residues that confer higher Na^+ transport capacity of OcHKT1, 5 from Oryza coarctata Roxb. Plant and Cell Physiology.

* Venkataraman G, Shabala S, Véry AA, Hariharan GN, Somasundaram S, Pulipati S, Sellamuthu G, Harikrishnan M, Kumari K, Shabala L, Zhou M (2021). To exclude or to accumulate? Revealing the role of the sodium HKT1, 5 transporter in plant adaptive responses to varying soil salinity. Plant Physiology and Biochemistry.

* Pulipati S, Somasundaram S, Rana N, Kumaresan K, Shafi M, Civáň P, Sellamuthu G, Jaganathan D, Ramaravi PV, Punitha S, Raju K, Mantri SS, Sowdhamini R, Parida A, Venkataraman G* (2022) Sodium transporter HKT1,5 diversity in genus Oryza. Rice Science

* Yong MT, Solis CA, Amatoury S, Sellamuthu G, Rajakani R, Mak M, Venkataraman G, Shabala L, Zhou M, Ghannoum O, Holford P, Huda S, Shabala S, Chen ZH (2021) Proto Kranz-like Leaf Traits and Cellular Ionic Regulation are Associated with Salinity Tolerance in a Halophytic Wild Rice. Stress Biology

* Rajakani R, Sellamuthu, G, Ishikawa T, Ahmed HAI, Bharathan S, Kumari K, Shabala, L, Zhou M, Chen, ZH, Shabala S, Venkataraman G* (2021). Reduced apoplastic barriers in tissues of shoot-proximal rhizomes of Oryza coarctata are associated with Na^+ sequestration. Journal of Experimental Botany

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