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Salinity stress: a threat to rice cultivation in coastal agro-ecosystem

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Abstract:

Salinity, recognized as major threat in agriculture causes 4.0-6.3% yield loss annually across the world. The problem is aggravated due to increasing irrigation with sub-optimal quality of irrigation water and more salinization of coastal area due to rise in sea level because of climate change. Rice cultivation in coastal area possesses inherent risk of sea water intrusion subjecting the standing crop to concomitant stresses of flooding and salinity. In saline soil, excessive concentrations of Na+ and Cl− impairs absorption of other beneficial ions such as K+, Ca2+ that in turn inhibit plant growth and productivity. Maintenance of cellular K+ level and K+/Na+ ratio is still considered the most important factor for salt-tolerance. Under high Na+ environment, excess Na+ competes with K+ thereby hindering its uptake. Tolerant plants by employing number of stategies restricts Na+ movement to young meristematic tissues and allow greater movement and/or tissue retention of K+ to physiologically more active tissues. Under salt stress different K+ and Na+ specific transporter viz. SOS, NHX, HKT family transporters (regulate cellular Na+ movement) and HAK, AKT, KT, KUP (regulate K+ movement) either by up-regulation or down-regulation controls cellular ion homeostasis and salt-tolerance in plants. SOS1, a plasma membrane bound Na+/H+ antiporter, mostly active in root tissue, removes the excess salt from the plant body by pumping them back to rhizosphere in an energy dependent process. Tonoplast bound vacuolar Na+/H+ antiporters (NHX family transporters) play crucial role in Na+-compartmentalization inside vacuole in mature cell in both root and leaf tissues. Storing excess salts in vacuole imparts tolerance in multifaceted manner viz. imparting tissue- and osmo-tolerance. Biosynthesis of organic osmolyte, a more energy expensive process sometimes substituted by the accumulation of excess Na+ in non-active tissues under salt stress. Improved Ca2+ status inside plant tissue is another important factor for salt-tolerance as it acts as a key signalling molecule to initiate Na+-exclusion. Several QTLs and miRNAs were also reported to impart salt-tolerance in rice and other crops.