

Agronomic and physiological recovery of Sub1 and non-Sub1 rice (cv. IR64) facing submergence stress: Impact of closer Vs. wider crop spacing

Debarati Bhaduri*, Koushik Chakraborty, Mohammad Shahid, Rahul Tripathi, Rashmita Behera and AK Nayak

ICAR-National Rice Research Institute, Cuttack, Odisha, India

Email: debarati.ssiari@gmail.com

Abstract:

Besides genetic improvement for developing stress-tolerant cultivars, agronomic management may also add considerable tolerance against different abiotic stresses in crop plants. In the present study we evaluated the effect of different spacing treatments (six treatments of closer to wider spacing in sub-plots; (closer, S1: 10×10cm to wider, S6: 20×20 cm) for improving submergence tolerance in rice. A high yielding submergence intolerant rice cultivar IR64 was tested against its Sub1 QTL introgressed counterpart (IR64-Sub1) for 12 days of complete submergence for different spacing treatments in field tanks. Relatively wider spaced plants showed higher individual plant biomass and early seedling vigour, which was particularly helpful for IR64 in increasing plant survival (by 150%) under 12 days of submergence, whereas the improvement was less in IR64Sub1 (13%). Underwater radiation inside the plant canopy, particularly beyond 40 cm water depth, was significantly greater in wider spacing treatments. Leaf senescence pattern captured by SPAD chlorophyll meter reading and chlorophyll fluorescence imaging data (Fm, Fv/Fm) taken at different time interval after stress imposition suggested lesser light penetration inside the canopy of closer spaced plants might hastened leaf senescence and damaged the photosynthetic system. Not only the initial content of total non-structural carbohydrate (NSC) was higher in wider spaced plants of IR64, but also the rate of depletion of NSC was lesser as compared to closer spaced plants. On the contrary, there were not much difference in NSC depletion rate under different spacing in IR64-Sub1. Besides, higher antioxidant enzyme activities in wider spaced plants (both IR64 and IR64-Sub1) after de-submergence indicated better stress recovery and improved tolerance. From this study, we found that wider spacing (20×20 cm) can significantly improve submergence tolerance ability in rice, particularly in submergence intolerant non-Sub1 cultivar like IR64, perhaps due to better underwater light penetration, delayed leaf senescence and slower depletion of NSC reserve. This study shows that intervention of agronomic management like spacing can alter the submergence tolerance ability in rice, particularly in nontolerant cultivar.