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Salt tolerant rice cv Nona Bokra chromosome segments introgressed into cv Koshihikari improved its yield under salinity through retained grain filling

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Abstract

Salt stress is one of the deteriorating abiotic stresses due to the climate change, which causes over-accumulation of Na^+ and Cl^- ions in plants and inhibits the growth and yield of rice especially in coastal Southeastern Asia. The yield components of rice plant (panicle number, spikelet number per panicle, 1000-grain weight, % of ripened grains) that are majorly affected by salt stress vary with growth stages at which the plant is subjected to the stress. In addition, the salt sensitivity of each yield component differs among rice varieties even when the salt-affected growth stage was same, which indicates that the physiological mechanism to maintain each yield component is different from each other. Therefore, we hypothesized that rice plant has different genes/QTLs that contribute to the maintenance of each yield component. Using a Japanese leading rice cultivar, Koshihikari, and salt-tolerant Nona bokra's chromosome segment substitution lines (CSSLs) with the genetic background of Koshihikari (44 lines in total) (Takai et al. 2007), we screened higher yielding CSSLs under salinity in comparison to Koshihikari and identified the yield components that were improved by the introgression of chromosome segment(s) of Nona bokra. The experiment was conducted in a salinized paddy field. One-month-old seedlings were transplanted into a paddy field without salinity. These were allowed to establish for one month, and then the field was salinized by introducing saline water to maintain the surface water at 0.4% salinity until harvest. The experiments were done twice in 2015 and 2016. Although all the CSSLs and Koshihikari decreased their yield under salinity, some CSSLs showed relatively higher yield compared with Koshihikari. In Koshihikari, all the yield components except panicle number were decreased by salinity and % of ripened grains was mostly reduced, followed by spikelet number per panicle and 1000-grain weight. When compared with Koshihikari, keeping a higher % of ripened grains under salinity attributed to the significantly greater yield in one CSSL. This indicated that the % of ripened grains is the most sensitive to salt stress among the yield components of Koshihikari and that the Nona bokra chromosome segments that maintained it contributed to increased yield under salt stress. In addition, growth analyses showed that maintaining relative growth rate in the late grain filling stage led to the increased yield under salt stress but not in earlier stages.

Keywords: rice, salt stress, salt tolerance, yield, yield components

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