ABSTRACT

Climate change and climate variability pose a great challenge to sustain food production and productivity. Specifically, the occurrence of extreme weather conditions in form of prolonged and poorly predictable dry-spells during monsoon seasons are affecting lowland rice production. A vast body of literature on water stress research in different crops suggests that plants also have inherent capability to adjust to the stress if engineered and managed properly. The main objective of this study was to study the effects of recoverable water stress in rice using soil water potential as a robust descriptor of soil water regime. Two years of intensive field experiment was conducted using a split-plot experimental design during the winter seasons of 2011 and 2012. Water stress was imposed in the water sensitive growth stages on three drought susceptible and one drought tolerant rice varieties followed by several on-field and laboratory measurements and samplings. Soil water stress was quantified using a combination of tensiometric measurement and mechanistic water flow model to obtain terminal soil water potential at the end of stress period, otherwise not measurable by tensiometer. The CERES-Rice model was used to study the effects of crops, soils and environmental factors on plant growth and development under water stress condition. Results showed that water stress at the active tillering stage had a positive effect on the expression of some of the plant parameters such as aboveground biomass, productive tillers and number of spikelets. Most importantly, yield and water productivity also increased in both drought susceptible and tolerant rice varieties. This indicated that if irrigation is deliberately checked at a particular window of the vegetative stage of rice, water stress may be advantageous to the crop in terms of its growth and economic yield. This approach may lead to water saving in rice. Strong positive correlation of terminal soil water potential with yield, root biomass and relative water content in leaves suggested that the active tillering stage was the most rewarding in terms of drought recovery. The concept led to widening of the operational range of the tensiometers, which may be used to quantify intense water stress in field experiments. Results obtained from the crop simulation model suggested that genetic coefficients of rice under water stress differ with respect to level to stress. Genetic coefficient P1, representing the basic vegetative phase of rice, increases during vegetative stage stress. Contribution and future scope of the study are: 1) terminal soil water potential may be used as a new drought recovery attribute in water stress studies, 2) detailed studies should be conducted to identify variety-specific terminal soil water potential, such that water saving strategies may be designed to save water while maintaining yield and 3) crop growth models may be modified to express genetic coefficients as functions of changing environmental condition.

Keywords: climate change, lowland rice, vegetative stage, soil water potential, recoverable water stress, water flow model, crop simulation model, genetic coefficient, water saving, drought recovery.