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Hydrology and Management Effects on Rainfed Lowland Rice in the Kilombero Floodplain, Tanzania

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Abstract

Lowland rice farmers in East Africa are confronted with a growing risk of low or variable rice yields due to increasingly unpredictable precipitation patterns. Variable hydrological field conditions are particularly critical in the floodplain environments of Central Tanzania, where yields are affected by both drought and submerging events, depending on annual precipitation and the physical location of the fields within the floodplain (potentially drought-prone fringe and potentially submergence-prone center positions). Low and variable yields affect food security on the household level, as well as the food supply of the entire region. Farmers attempt to minimize the risk of low and variable yields by using drought- or submergence-resistant genotypes, by building field bunds for water retention and by improving the soil water holding capacity through organic amendments. We investigated the effects of physical field positions (fringe, middle, center), of land management (bunding) and of soil organic carbon contents on the occurrence of water related stress and concomitant effects on rice grain yields. To this effect, a novel water stress index was developed and its relation to grain yield and yield variability was assessed in the Kilombero floodplain, in Ifakara, Tanzania in 2018. The developed hydric stress index was based on volumetric soil water contents (TDR) and the duration and depth of soil submergence measured twice per week during the rice cropping season. Days with deviations from "normal" (soil saturation of <30% or floodwater depths of > 50 cm) were summed up and related to the total crop growth duration, yielding hydric stress indices from 0 (no stress) to 1 (severe or permanent stress). Stress indices showed trends in relation with grain yields in the 72 field observation plots. They differed by position with low indices and high grain yields in the center position and high variability in yield and indices at the middle position. The building of field bunds generally reduced the stress index, thus increasing grain yields at all positions. Finally, drought-related stress was reduced by increasing soil organic carbon contents, irrespective of the fields' position. The stress index is seen as a potentially useful tool for predicting expected yield levels in hydrologically variable floodplain environments and for the site-specific targeting water stress-alleviating technology options. However, further evaluations are required before transferring the application of the hydric stress index to other floodplains.