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Comparative adaptive responses of improved and indigenous lowland rice to water management under Nigeria's derived-savannah

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Abstract

Lowland rice production in tropical regions is increasingly constrained by water scarcity and climate variability, creating an urgent need for water saving while not compromising yield. Alternate wetting and drying (AWD) irrigation is a promising option, but lowland rice varietal differences in adaptation under Nigeria's derived-Savannah lack under AWD during the vegetative growth stage. This study evaluated the adaptive responses of three improved lowland rice varieties (Africa Rice Centre) (ARICA 3, NERICA® L-19 and WITA 4) and one indigenous landrace (Ofada) under AWD and continuous flooding, focusing on morpho-physiological traits, biomass accumulation, yield performance, and water-use efficiency. A controlled environment pot-experiment was conducted using hydromorphic inland valley soil with a 4 (varieties) × 2 (water regimes) factorial arrangement with three replicates in a Completely Randomised Design under continuous flooding, providing 5 cm depth from transplanting to maturity. AWD pots were irrigated every 5 days during the vegetative growth stage. Data were collected across five developmental stages, including leaf and root biomass, growth rates, yield components, and water-use efficiency (water applied/grain yield). Mixed-effect models and multivariate clustering were used to identify variety-specific responses. AWD reduced water use by 28%-34 % compared to continuous flooding. Grain yield was maintained in ARICA 3 and NERICA® L-19 under AWD, whereas Ofada recorded an 18 % yield reduction. At reproductive stages under AWD, the improved varieties maintained higher leaf chlorophyll (12–15 % higher over landrace) and greater root volume (~22 % higher) than Ofada, indicating stronger adaptation. ARICA 3 exhibited the most stable relative growth rate across water regimes (CV = 8.2 %) whereas Ofada had the greatest variability (CV = 24.7 %). Multiple-index evaluation identified NERICA® L-19 as the most resilient variety, with water productivity 31 % higher than Ofada. The greatest differences were between tillering and flowering growth stages, highlighting this period as the crucial window for water-management. NERICA® L-19 and ARICA 3 exhibit better adaptation to AWD with sustain productivity while conserving water in Nigeria's derived-Savannah lowlands. Prioritizing these varieties in AWD extension packages, include root-traits screening into breeding programmes, and targeting water

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management during tillering to flowering transition offers climate resilience and supports more sustainable lowland rice systems.

Keywords: Alternate wetting and drying (AWD), biomass accumulation, climate resilience, climate variability, lowland-rice varietal adaptation, tillering to flowering transition, water scarcity, water-use efficiency (WUE)