ABSTRACT

In the anticipated water scarcity and global warming scenario, it is imperative to identify suitable irrigation and nutrient management strategy in paddy cultivation for maximizing water productivity and minimizing global warming potential (GWP). We conducted two-year field experiments (dry seasons of 2014 and 2015) for (i) investigating the agronomical, physiological and biochemical aspects of four rice varieties (Apo, Annada, Satabdi and Naveen) subjected to different levels of water deficit stress (WDS), (ii) quantifying the temporal and seasonal variation in GHGs emissions and their trade-off relationship under different levels of WDS, (iii) identification of proper nutrient management strategy for arresting yield decline under WDS and (iv) elucidation of the combined effects of elevated CO_2 (ECO_2) and WDS on water productivity and biochemical responses of rice plant. WDS was quantified using tensiometric measurement of soil water potential. Results showed that there was no significant difference in grain yield up to -40 kPa for Apo and Annada, whereas for Naveen and Satabdi the yield difference was insignificant up to -30 kPa as compared to continuous flooding (CF). Reduced electrolyte leakage, root bleeding rate and increased concentration of antioxidant metabolites contributed to tolerate the adverse effect of WDS and resulted in higher grain yield in Apo and Annada varieties. Irrigation scheduling at -30 kPa reduced CH_4 emission by 44%, however, due to increase in CO_2 (27%) and N_2O (22%) emission at -30 kPa, there was no significant reduction in GWP as compared with CF. There was a yield penalty of 32-34% at recommended dose of fertilizer (RDF) under WDS as compared to RDF under well-watered condition, however the application of RDF + P + Fe + Si under WDS condition was able to arrest the yield decline as compared to RDF under well-watered condition. Experiments conducted under ECO_2 elucidated that significant changes in the concentration of antioxidant metabolites and osmoregulants under ECO_2 helped the plant to combat the adverse effects of WDS. Rice genotypes having the inherent capacity to produce higher amount of antioxidant metabolites should be a primary target of breeding high yielding rice varieties under WDS.

Keywords: Tensiometer, Water deficit stress, Greenhouse gas, Direct seeded rice, Soil water potential, Irrigation scheduling, Elevated CO_2, Leaf water potential, Proline, Electrolyte leakage, Open top chamber