Effects of Elevated Atmospheric Temperature and CO_2 Concentration on Rice Spikelet Fertility in Australian Rice Production Systems

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Abstract

More than 50% of the world's population consumes rice as the staple food while Australia produces 1.2 million tons of rice annually and feeding about 40 million people daily. Future climate change predicts increase temperature and reduced rainfall patterns which could severely affect rice production. As rice yield heavily relies on spikelet fertility factor, this study predicted the spikelet fertility factor with response to different rice varieties in different future climatic scenarios (related to increasing temperature, elevated atmospheric CO_2 concentration and rainfall) using APSIM–Oryza model at two different sites, Griffith in New South Wales and Kununurra in Western Australia. Varieties used at Griffith were Quest, Amaroo, and Langi representing early, mid and late maturity types, respectively. Only single variety (IR72) was used for Kununurra region. Five incremental changes of temperature were 0 (base), +1, +2, +3, +4^oC with amalgamation of five rainfall changes (+10, 0, -10, -20, and -30%) used in the simulation to characterize the variety of projected climatic changes predicted for Australia over the following 60 years. The corresponding CO_2 concentrations connected with the above temperature levels were 380, 435, 535, 640 and 750 ppm. In all varieties of Griffith (Amaroo, Langi, and Quest),spikelet fertility factor showed an increasing trend up to 1-2 ^oC temperature increase which could be due to CO_2 fertilization effect. Further increase in temperature caused a steady decline in spikelet fertility factor, with short-season variety 'Quest' affected least. In contrast to the Griffith Riverina region, in Kununurra, spikelet fertility factor changed negatively with the temperature increase, decreasing from 0.55 to 0.25.These results specify that warmer temperatures are likely to increase spikelet sterility. Adaptations may comprise using shorter season varieties and changing planting dates. Therefore future rice breeding strategies should focus on developing short season varieties with higher spikelet fertility to cope up with higher temperature effects in the future.

Keywords: Climate change, CO_2 Elevation, Elevated temperature, Rice, Spikelet fertility factor

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