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Abstract

Recent Trends in Drought, Heat and Frost-Induced Yield Losses Across the Australian Wheatbelt †

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Abstract: While global food demand is projected to grow by 50–80% by 2050, Australia is expected to continue its significant contribution to global food security. We quantified how recent climatic changes have affected wheat crops in Australia over the last 38 years. Changes in drought, heat and frost stresses affecting a mid-maturing cultivar sown on May 15 were quantified over 1981–2018 using an improved version of the Agricultural Production Systems sIMulator (APSIM). Modifications to APSIM-wheat module included the addition of two calculation subroutines for estimating direct impact of frost events and heat shocks on grain setting and grain filling. National drought-induced yield loss exceeded 40%, significantly increasing by 3.6% per decade ($P < 0.1$), part of which being compensated for by rising atmospheric CO_2 concentration. The national average impact of hot days ($T_{max} > 26$ °C) on grain yield have significantly increased mostly due to a significant trend in the impact on individual grain weight. At the national level, frost damage has reached 14% of wheat yield and has been significantly increasing since 1981. Overall, wheat yield has decreased at a significant rate of 180 kg ha^{-1} per decade ($P < 0.01$) with the largest decreasing rate in the South-East and East. As heat and drought are expected to remain predominant yield-limiting factors in the future, adaptation of wheat germplasm to warmer and drier environments appears to be a priority to enhance grain yield in Australia.

Keywords: abiotic stresses; adaptation; APSIM-wheat; breeding; climate trends