RADIATION-BASED AND TRANSPIRATION-BASED MODELING OF BARLEY AND WHEAT GROWTH

Abstract

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Process-oriented crop simulation models are ideal tools to dynamically account for the impact of factors that vary spatially and temporally and affect crop growth. The objective of this dissertation was to analyze radiation and transpiration-based modeling barley and wheat growth. A preliminary evaluation of the effectiveness of the CropSyst model at simulating wheat response to nitrogen fertilization was also performed. Biomass, intercepted radiation, and cumulative transpiration were monitored in field experiments over two years. Maximum barley radiation-use efficiency (e) at Pullman was 1.2 g MJ^{-1}, while maximum values of e reported for barley and wheat are near 1.6 g MJ^{-1}. The e of barley and wheat reported in the literature and those obtained in this study were linearly related to the vapor pressure deficit of the air (D, kPa): $e = 1.89 - 0.55D$ ($r^2 = 0.82$, n = 21). This research suggests that high values of e can only be achieved in low D environments. Transpiration-use efficiency (Y/T, g biomass kg^{-1} water) of barley and wheat also shown to be inversely related to D; maximum efficiencies obtained with varying D were well approximated by $Y/T = 5.2D^{-2/3}$. This empirical function is well explained by the response of the ratio of leaf-to-ambient CO_2 concentration to D. Modeling the response of wheat to nitrogen fertilization showed that while the model explained 65% of the observed variability in biomass production, it overestimated nitrogen uptake. That overestimation was

linked to an underestimation of the rate of residues decomposition, which favored nitrogen uptake by the crop over microbial immobilization of mineral nitrogen. This preliminary results suggest that a thorough reassessment of crop and soil processes related to nitrogen dynamics is needed before further exploring the use of the CropSyst model to analyze spatial variability of grain yield and particularly grain nitrogen concentration.