ANALYSING WHEAT BIOMASS AND GRAIN YIELD RESPONSE TO DROUGHT USING AFRCWHEAT2

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Drought can reduce a wheat crop's ability to intercept solar radiation through reductions in leaf area, and production per unit leaf area by slowing photosynthesis. The model AFRCWHEAT2 (1) simulates leaf expansion and loss, and calculates canopy photosynthesis for unit green area index (GAI) layers at hourly intervals during daylight. It is a useful aid for identifying the balance of these processes in determining the nature of response to drought. Grain growth is simulated from an estimates grain number and maximum growth rate per kernel modified by availability of assimilate. Leaf expansion, senescence and photosynthesis are reduced by "drought factors" related to soil moisture deficit. Effects on leaf area begin at smaller deficits than those on photosynthesis.

MATERIALS AND METHODS

In an experiment in a rainshelter, drought was imposed early or late in the season, with durations ranging from three weeks to the entire season (2). Above-ground biomass and its components were measured at regular intervals through the season. Biomass from the seven most contrasting treatments was compared with predictions from AFRCWHEAT2 (1). Simulations included or excluded the influence of drought factors on leaf area and photosynthesis.

RESULTS AND DISCUSSION

Grain yield and final biomass ranged from 3.6 to 9.8 and 15.7 to 23.7 t/ha respectively. Most of the grain yield variation was associated with changes in grain number, although there was a small systematic reduction in kernel mass (2). AFRCWHEAT2 produced good estimates of grain yield, with a root mean square deviation (RMSD) of 0.7 t/ha, without significant bias. In contrast, the model substantially underestimated final biomass; the RMSD was 6.2 t/ ha, made up largely of an average underestimate of 5.8 t?/ha. The model identified slower photosynthesis as a major cause of reduced biomass. However, biomass predictions improved when factors affecting photosynthesis were removed (RMSD = 2.9 t/ha, average underestimate 2.3 t/ha). The remaining underestimates were caused by low estimates of GAI early in the season, and were largest for the least severe drought treatments. However, the modified model substantially overestimated grain yield in the more severe drought treatments, because it substantially overestimated tiller and grain numbers. The model predicted little variation in these, but large variations were observed (2).

We conclude that variation in GAI was the major cause of wheat growth responses to drought. Changes in photosynthesis per unit leaf area had little, if any, influence. The accuracy of AFRCWHEAT2 would be improved by including a response of tiller number to drought, and by reducing the influence of drought on photosynthesis.

REFERENCES

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