In-season Prediction of Attainable Maize Yield Using the Hybrid-Maize Model

Achim R. Dobermann
University of Nebraska - Lincoln, adobermann2@unl.edu

Haishun Yang
University of Nebraska - Lincoln, hyang2@unl.edu

Kenneth G. Cassman
University of Nebraska - Lincoln, kcassman1@unl.edu

Daniel T. Walters
University of Nebraska-Lincoln, dwalters1@unl.edu

Follow this and additional works at: http://digitalcommons.unl.edu/agronomyfacpub

Part of the Plant Sciences Commons
The Hybrid-Maize Model

Hybrid-Maize simulates the growth of a maize crop under non-limiting or water-limiting (irrigated or rainfed) conditions based on daily weather data. This new maize model was developed by combining the strengths of two modeling approaches (Yang et al., 2004): (i) growth and development functions in maize used in CERES-Maize (Jones and Kiniry, 1985) and (ii) mechanistic formulations of light interception and photosynthesis in specific crop models such as INTERCOM and WOFOST (van Ittersum et al., 2003).

Hybrid-Maize features temperature-driven maize phenological development, vertical canopy integration of photosynthesis and organ-specific growth respiration, and temperature-sensitive maintenance respiration. The new model requires fewer genotype-specific parameters without sacrificing prediction accuracy. A linear relationship between growing degree-days (GDD) from emergence to silking and GDD from emergence to physiological maturity is used for prediction of day of silking. Field validation under high-yielding growth conditions indicated close agreement between simulated and measured values for leaf area, dry matter accumulation (Fig. 1), final grain and stover yields, and harvest index (Yang et al., 2004).

Real-time Simulation and Yield Forecasting

Hybrid-Maize allows the user to (i) assess the overall site yield potential and its variability, (ii) evaluate changes in attainable yield using different choices of planting date, maize hybrid, and plant density; (iii) analyze maize growth in specific years; (iv) explore options for irrigation water management; and (v) conduct in-season simulations to evaluate actual growth and forecast final yield at different growth stages.

In current season prediction mode, model simulations are based on the up-to-date weather data of the current growing season, supplemented by the previously collected historical weather data for forecasting of all possible outcomes for the remainder of the season. This results in a range of forecasted scenarios, which are ranked based on the predicted final yield (Fig. 2). Management decisions could include adjusting the yield goal in comparison with normal years and making subsequent adjustments in fertilizer and irrigation amounts. During grain filling, yield forecasting can provide additional information to help guide marketing decisions on marketing.

Case Study 1: Irrigated Maize, Lincoln, Nebraska

Maize was grown near yield potential levels, i.e., with full irrigation, optimal nutrient supply, and at a density of 8.6 plants m$^{-2}$. Actual and historical daily weather data were used for yield forecasting in intervals of 5 days. Early in the season, yield forecasts mainly relied on historical weather data so that the median predicted yield was close to the long-term median. As the season progressed, more actual weather data were used, indicating above-normal growth conditions. Shortly after silking, predicted median yield approached the final measured grain yield of 17.9 Mg ha$^{-1}$. With progressing grain filling, the range of predicted yields gradually decreased.

Case Study 2: Rainfed Maize, Oliveros, Argentina

Rainfed maize was grown at 7 plants m$^{-2}$ in a favorable season with no water stress. Shortly after silking, predicted median yield approached the final measured grain yield of 14.4 Mg ha$^{-1}$. With progressing grain filling, the range of predicted yields decreased.

Conclusions

Hybrid-Maize offers promising potential for in-season simulation and forecasting of maize biomass and grain yield. At sites with no water limitations, the final yield was accurately predicted shortly after silking stage. Greater variation in yield predictions may occur at rainfed sites under drought stress, but relative deviations from normal growth were detected early enough in both environments.

References


Acknowledgements: Financial support for developing Hybrid-Maize was provided by the Agricultural Research Division of the University of Nebraska-Lincoln, the Potash and Phosphate Institute through the Foundation for Agronomic Research, the Paul Fertilizer Foundation, the Nebraska Corn Board, and by USDA-CSRS through the Consortium for Agricultural Soil Mitigation of Greenhouse Gases.