Evaluating this year’s cropping systems

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Evaluating this year’s cropping systems

Abstract
Today’s agricultural goals of high yields with low environmental impact are far too complex when combined with dynamic weather conditions. Achieving this complex goal requires agronomy to move beyond single-factor experiments to research that investigates multiple factors or processes. With traditional experimentation, it is nearly impossible to explore the full range of interactions created by different soils, cultivars, management practices and weather conditions.

Disciplines
Agriculture | Agronomy and Crop Sciences | Climate | Soil Science | Statistical Models

Comments
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FACTS: ISU’s Sotirios Archontoulis (left) explains the importance of root depth and soil water buffering capacity for crops at a recent field day. The FACTS project takes in-field measurements and uses computer modeling to provide forecasts for weather, soil, water and yield.

CROPS

Evaluating this year’s cropping systems

Cropping Systems: ISU’s FACTS project helps find out what happened and why.

Sep 13, 2017

By Mark Licht and Sotirios Archontoulis
Today’s agricultural goals of high yields with low environmental impact are far too complex when combined with dynamic weather conditions. Achieving this complex goal requires agronomy to move beyond single-factor experiments to research that investigates multiple factors or processes. With traditional experimentation, it is nearly impossible to explore the full range of interactions created by different soils, cultivars, management practices and weather conditions.

It is unlikely that one management practice can be changed without having an influence on other management practices. Additionally, crop management practices are greatly influenced by spatial and temporal differences. Weather, crop and soil interactions are extremely important in determining the best suite of management practices.

One of the ways to do this is to use cropping system models that integrate the various components of the soil-plant-atmosphere system to forecast and evaluate performance at a systems level, irrespective of location and year. This is exactly what FACTS does. At Iowa State University, a team of researchers involved in FACTS is committed to evaluating complex crop-soil interactions and how management practices can be dynamically optimized.

**Looking back on 2017**

Looking in more depth at the FACTS trials at Ames, the summer was characterized by a dry June through August. Temperatures were warmer than normal in June and parts of July then moderated to cooler than normal for most of August. This surely has impacted crop growth but not to the severity that some were expecting. Abundant soil moisture reserves buffered much of this severity by supplying water for transpiration and canopy cooling.

The Aug. 24 forecast estimated corn yields to be between 178 and 198 bushels per acre at the Ames trial, down 10% from 2016. The big decline in yield is associated with fewer kernels per ear. This year corn ears are averaging 475 kernels per ear, whereas last year it was 620 kernels per ear. Soybean yields are forecast to be 61 to 68 bushels per acre at the Ames trial, down 2% from 2016.
At Ames, shallow spring groundwater tables combined with rapid root growth greatly helped the crops weather the drought conditions. Through June and July, crop roots were growing at a rate of 1.2 inches per day. Corn root growth maxed out at pollination, while soybean root growth continued to the beginning seed fill stage. A big difference between 2016 and 2017 was that in 2016 rainfall was received in mid-July and August, whereas in 2017 substantial rainfall was not received until mid-August.

This delay in rainfall and depleted soil water reserves resulted in much greater kernel abortion and fewer kernels per ear this year. Fortunately, soybeans were able to benefit more from the mid-August rains to fill seeds before going into maturity. Lower-than-normal temperature in the second half of August also helped crops by extending the grain filling period by at least a week.

**Soil water limitations lower yield**

Soil water and nitrogen dynamics are closely linked with plant uptake rates. Plants require water uptake in order to take up nutrients. Drought affects both plant and soil processes. Leaf senescence and rolling are easily observable characteristics of a plant suffering from lack of moisture. Soil N mineralization in the absence of moisture is also reduced substantially. Soil nitrogen supplied through mineralization is extremely important to buffer losses and satisfy plant demand. However, in 2017, soil water limitations resulted in not only lower yield potential but also less nitrogen mineralization and losses.

From April through early June, soil nitrate fluctuated between 60 and 100 pounds N per acre, with the high levels associated with fertilizer application.

What limited corn and soybean yields in 2017? Likely, a three-way interaction between water, high temperatures and nitrogen. One affects the other and the exact reason is site- and management-specific, and cannot be generalized across the state. This complex combination of weather, soil water and soil nitrogen lead to the projected yields being lower in 2017 compared to 2016.
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Get the FACTS

Forecasting and Assessment of Cropping Systems, or FACTS, is an ongoing Iowa State University project to forecast and evaluate crop soil dynamics in real-time across representative locations in Iowa. In-field measurements are combined with a cropping systems model to forecast crop growth, soil dynamics and complex crop-soil interactions based on a combination of actual, forecasted and historical weather information.

The project began in 2015 with two locations, expanded to six locations in 2016, and now encompasses 10 locations in 2017. Each location typically has a cropping system comparison such as date of planting, tile drainage or nitrogen rate.

The overall goal is to develop a widely available cropping systems forecast and evaluation platform to: (1) provide real-time agronomic information and yield predictions during the growing season; (2) benchmark production, economic and environmental performance of representative cropping systems and provide what-if scenario analysis at the end of the season; (3) explore different approaches to accurately forecasting yields, to ground-truth predictions, and to improve the science behind predictive tools.

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