Understanding the historical probability of drought

January 30 2013

Droughts can severely limit crop growth, causing yearly losses of around $8 billion in the United States. But it may be possible to minimize those losses if farmers can synchronize the growth of crops with periods of time when drought is less likely to occur. Researchers from Oklahoma State University are working to create a reliable "calendar" of seasonal drought patterns that could help farmers optimize crop production by avoiding days prone to drought.

Historical probabilities of drought, which can point to days on which crop water stress is likely, are often calculated using atmospheric data such as rainfall and temperatures. However, those measurements do not consider the soil properties of individual fields or sites.

"Atmospheric variables do not take into account soil moisture," explains Tyson Ochsner, lead author of the study. "And soil moisture can provide an important buffer against short-term precipitation deficits."

In an attempt to more accurately assess drought probabilities, Ochsner and co-authors, Guilherme Torres and Romulo Lollato, used 15 years of soil moisture measurements from eight locations across Oklahoma to calculate soil water deficits and determine the days on which dry conditions would be likely. Results of the study, which began as a student-led class research project, were published online Jan. 29 in Agronomy Journal. The researchers found that soil water deficits more successfully identified periods during which plants were likely to be water stressed than did traditional atmospheric measurements when used

as proposed by previous research.

Soil water deficit is defined in the study as the difference between the capacity of the soil to hold water and the actual water content calculated from long-term soil moisture measurements. Researchers then compared that soil water deficit to a threshold at which plants would experience water stress and, therefore, drought conditions. The threshold was determined for each study site since available water, a factor used to calculate threshold, is affected by specific soil characteristics.

"The soil water contents differ across sites and depths depending on the sand, silt, and clay contents," says Ochsner. "Readily available water is a site- and depth-specific parameter."

Upon calculating soil water deficits and stress thresholds for the study sites, the research team compared their assessment of drought probability to assessments made using atmospheric data. They found that a previously developed method using atmospheric data often underestimated drought conditions, while soil water deficits measurements more accurately and consistently assessed drought probabilities. Therefore, the researchers suggest that soil water data be used whenever it is available to create a picture of the days on which drought conditions are likely.

If soil measurements are not available, however, the researchers recommend that the calculations used for atmospheric assessments be reconfigured to be more accurate. The authors made two such changes in their study. First, they decreased the threshold at which plants were deemed stressed, thus allowing a smaller deficit to be considered a drought condition. They also increased the number of days over which atmospheric deficits were summed. Those two changes provided estimates that better agreed with soil water deficit probabilities.

Further research is needed, says Ochsner, to optimize atmospheric calculations and provide accurate estimations for those without soil water data. "We are in a time of rapid increase in the availability of soil moisture data, but many users will still have to rely on the atmospheric water deficit method for locations where soil moisture data are insufficient."

Regardless of the method used, Ochsner and his team hope that their research will help farmers better plan the cultivation of their crops and avoid costly losses to drought conditions.

More information: dl.sciencesocieties.org/public …/0/0/agronj2012.0295

Provided by American Society of Agronomy