Heat, not drought, will drive lower crop yields, researchers say

June 3 2019, by Amanda Garris

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Climate change-induced heat stress will play a larger role than drought stress in reducing the yields of several major U.S. crops later this century, according to Cornell University researchers who weighed in on a high-stakes debate between crop experts and scientists.

"There is a big divide in this field, and we thought there must be some way to resolve this puzzle," said Ariel Ortiz-Bobea, assistant professor of applied economics and management.

That has major implications for crop management as well as plant breeding.

The researchers used decades' worth of data from government and other sources, and their findings are reported in "Unpacking the Climatic Drivers of U.S. Agricultural Yields," published in *Environmental Research Letters*. Contributors included Toby Ault, assistant professor of earth and atmospheric sciences; postdoctoral associate Carlos Carrillo; and Haoying Wang, assistant professor of management at New Mexico Tech.

Ortiz-Bobea and his team incorporated information from three sources to develop a statistical crop yield model for six crops: maize, cotton, sorghum, soybeans, spring wheat and winter wheat.

The researchers' analysis revealed that soil moisture alone was the best predictor of year-to-year variations in yield across the past four decades. Harvests were particularly sensitive to drought stress in the middle portion of the growing season.

The team then applied its statistical model to climate change scenarios ranging from mild to severe. The analysis projects that temperature, which the authors interpret as heat stress, will be the primary climatic driver of crop yields in 2050 and 2100. Under the mildest scenario, yields for the six crops are predicted to decrease by 8% to 19%, relative to a world without climate change. Under the most severe scenario, the projected yield reductions range from 20% to 48%.

The greatest losses are forecasted for maize and spring wheat, but more

resilient crops such as sorghum, which is half as sensitive to high temperature as maize, will experience less damage.

Co-author Ault noted climate change projections show that many of the food-producing counties in the United States could become drier in the summer even if rainfall increases. In a changing climate, this could motivate farmers to plant earlier, but that approach to adaptation can be thwarted by heavy rains during the late spring, as many regions are experiencing this year.

"The work highlights two major challenges for adapting to a changing climate," Ault said. "First, how do we deal with increases in temperature that through higher evaporation rates could surpass increases in precipitation? And second, how can we start to envision an agricultural system of the 21st century that is equipped to handle the remarkable shifts in seasonality that might occur?"

More information: DOI: 10.1088/1748-9326 Ariel Ortiz-Bobea et al. Unpacking the climatic drivers of US agricultural yields, *Environmental Research Letters* (2019). DOI: 10.1088/1748-9326/ab1e75

Provided by Cornell University