Preparing for future climate conditions is a necessary consideration for crop breeders, agronomists, and farmers. Depending upon the location, crops and livestock may be facing higher temperatures, increased precipitation, or more frequent droughts. To be proactive rather than reactive, researchers are investigating crop traits, lines, etc. that will make them suited to future conditions now.

Peanut Drought Tolerance

Although climate scientists cannot pinpoint how future precipitation patterns will change, there is agreement that drought will be an increasing problem in many regions. One trait expressed in some plants that can reduce the impact of drought is a decrease in transpiration rate, which helps the plant conserve soil water. Peanut is one example of a crop species that has been found to reduce transpiration under drought conditions.

"Under production conditions in the U.S., water deficit is by far the most restricting factor to achieving high crop yields," notes Thomas Sinclair, Professor of Crop Physiology and Ecology at North Carolina State University, who studies drought tolerance of crop plants including peanut. "Peanut is grown on sandy soils, so the possibility of drought limitation is even more likely for peanut."

Given this combination of high potential for drought stress and the possibility of some genotypes to reduce transpiration, Sinclair and colleagues set out to explore differences in decreased transpiration rate in different Virginia-type peanut germplasm lines. They conducted a series of experiments—first a greenhouse study, followed by a field experiment, and lastly an analysis of yield across environments. Their results were recently published in *Crop Science* (http://doi.org/doi:10.2135/cropsci2018.05.0293).

The research team started with lines from two populations. The initial greenhouse studies provided a controlled environment to measure the daily transpiration rate of genotypes as the soil was allowed to dry. The group ultimately selected lines with...
the desired water conservation trait for field tests, anticipating that the trait would result in increased yield under drought conditions.

Variation in weather during the field tests gave mixed results. While the conditions in the first year were excellent for the study, the second year was not. “The second year was cool and wet, and we eventually abandoned the open-field tests,” Sinclair explains. Ultimately, the researchers determined that one line had a superior drought tolerance and higher yield under drought conditions. This line, N12006ol, is set to be released as a commercial variety. “It is expected farmers will find this line especially attractive for fields that have historically been vulnerable to drying, that is, those fields that are composed of deep, high sand-content soils,” he says.

Although line N12006ol was developed for the Mid-Atlantic region, this approach could be used to identify drought-tolerant peanut lines in other regions. Sinclair points out that this research was a collaborative effort between physiologists and plant breeders, and that this approach could have widespread use for other crop species where there is interest in producing drought-tolerant lines.

Maize Heat Stress

Maize is well known as one of the most widely grown crops, grown for food, livestock feed, and biofuels. Given the importance of maize in global economies and for food security, it is important for breeders and farmers to plan for future climate conditions. While there are some ways to mitigate extreme climate conditions (e.g., irrigation can offset drought and adding tile drains and levees can reduce flood damage), it is more difficult to avoid the effects of heat stress.

Researchers seeking a better understanding of the genes that control heat stress used QTL (quantitative genetic) data to identify specific gene regions that might be associated with heat stress tolerance. This approach can be used to identify breeding lines that will be most useful for developing climate-ready crops.
trait locus) mapping. This approach is useful when dealing with continuous traits, like plant height or, in this case, a stress response that can vary in severity. In an article recently published in *Crop Science* (http://doi.org/10.2135/cropsci2018.05.0291) Junping Chen, Jinming Yu, and colleagues report their findings.

Chen, Molecular Biologist with the USDA-ARS, has a background in crop genetics and stress physiology. Yu, Professor and Pioneer Distinguished Chair in Maize Breeding in the Department of Agronomy at Iowa State University, works on quantitative genetics and maize breeding. Both Chen and Yu recognized that increasing temperatures, and subsequent heat stress on crops, were likely to have a genetic basis that could be identified.

Chen and Yu, who responded to questions via email, say, “[QTL mapping] shows the potential of partitioning the overall stress response into regions of genome that are more relevant than other parts.” Identifying these regions helps determine if they can be targeted when developing new lines.

Field trials were conducted at the USDA-ARS Cropping System Research lab in Lubbock, Texas. Two recombinant inbred lines from Nested Association Mapping populations (B73 × NC350 and B73 × CML103) were planted in three consecutive years starting in 2010.

One of the challenges in this study was trying to separate the effects of drought stress from heat stress, as the two often occur at the same time. The solution was to keep plants well watered as a way to separate the effects of heat from drought. Authors Chen and Yu comment, “Even under well-watered conditions, we may not rule out that some phenotypes observed for some maize lines, such as leaf rolling and leaf bleaching, are caused by transient water deficit stress due to excess transpiration under high heat, high wind, and low relative humidity conditions.” However, having multiple years of data can help reduce the effect of environmental variables out of the control of the research team.

The team measured the heat tolerance of plants based on the foliar and tassel stress response. They chose these characteristics because they are components of yield reduction when maize undergoes heat stress. “The most impactful finding of this study is that... with careful planning and execution, we can pinpoint genomic regions that are underlying the heat stress responses in maize leaf and tassel,” the authors write. Having identified these regions, it may be possible for breeders to improve heat tolerance in maize.

**Dig Deeper**

Check out the two full-length *Crop Science* articles, “Identification of Virginia-Type Peanut Genotypes for Water-Deficit Conditions Based on Early Decrease in Transpiration Rate with Soil Drying” (http://doi.org/10.2135/cropsci2018.05.0293) and “Genetic Mapping of Foliar and Tassel Heat Stress Tolerance in Maize” (http://doi.org/10.2135/cropsci2018.05.0291).

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**Images:**

A. Unstressed phenotype representing a score of 0.
B. Leaf firing (LF).
C. Leaf blotching (LB).
D. Example of the 0-to-5 scale used to score LF starting from 1 (first image from the left) to 5.