Technology Approaches to Drought Tolerance at Pioneer

Dave Warner
DuPont Pioneer Agricultural Biotechnology
Johnston, Iowa

dave.warner@pioneer.com

Research focused on the improvement of drought tolerance in crop plants has received increased attention in the past ten years. The development of drought-tolerance technologies is one of the most important initiatives for the seed industry in this decade. Increasing worldwide demands for food and agricultural products, combined with fixed amounts of arable land, brought on by increasing global population is driving a need for increased productivity. At the same time, we continue to see evidence of declines in freshwater resources. Public efforts to restrict water usage focus on ways to maintain sustainable water levels in major aquifers and reservoirs. Agriculture, in general, is a major user of freshwater. Approximately 70% of the world's freshwater is used for agricultural purposes.

DuPont Pioneer was the first company to commercialize hybrid maize in 1926. The company has had a dedicated drought-research program since 1957. Due to the company's significant knowledge of maize germplasm, Pioneer focuses drought-tolerance research on maize. Pioneer scientists leverage this research to other crops.

Multiple Product Options

Drought affects crops differently depending on the geography and stress factors of each unique environment. Depending on the timing and severity of drought episodes, yield losses due to drought in maize can be quite severe. Pioneer has been a leader in the development of drought-tolerant corn hybrids and utilizes a multi-phase research approach that delivers total product performance minimizing risk and maximizing productivity. Growers today are already experiencing the benefits of DuPont Pioneer hybrids, which deliver a yield advantage in water-limited environments, and offer top-end yield potential under optimal growing conditions, allowing growers to help minimize risk and maximize productivity on every acre.

In the past decade, many new technology opportunities have emerged to aid researchers in the improvement of drought tolerance, including marker-assisted breeding tools, transgenic solutions and new agronomic practices. The successful approach to improvement of drought tolerance in maize involves an integrated approach that couples strong base genetics, developed from years of success in conventional breeding, with leading-edge technologies and state-of-the-art agronomic practices. Farmers need multiple product options that are best adapted to their specific environments coupled with advice on the latest agronomic practices to maximize performance.

Resource Integration

Drought tolerance is a complex trait that is influenced by many plant processes. A simple diagram of how water cycles through the environment and how the plant integrates resources that contribute to productivity is shown in Figure 1. Plant productivity, under drought stress, is determined by the interaction of water capture, water-use efficiency and water partitioning within the plant. Research strategies focused on improvement of drought tolerance need to integrate all of these factors.

Optimum AQUAmax

Drought-tolerance research at Pioneer focuses on a multi-pronged approach that involves conventional plant breeding, and native- and transgenic-trait technologies. For over 50 years, our conventional breeding programs have been improving drought tolerance. More recently, we've taken advantage of molecular-marker tools and whole-genome models to select native maize traits that are important for drought tolerance. Using this technology, we have launched a product line under the brand Optimum® AQUAmax™. When evaluated in 680 water-limited environments in 2011, Optimum AQUAmax hybrids demonstrated greater than 7% yield advantages on-farm when compared to grower-selected competitor hybrids. In 7,258 on-farm comparisons under more favorable growing conditions, Optimum AQUAmax hybrids demonstrated a 3.4% yield advantage over commercially available competitor hybrids. This indicates Optimum AQUAmax products help minimize risk and maximize productivity on every acre.

Robust Research

As we look into the next decade, we have a very strong and robust research pipeline of transgenic traits that will provide additional levels of tolerance to our conventional and native approaches. Discovery approaches start with thousands of different lead genes that come from many different sources. In most cases, lead discovery screening is accomplished with high-throughput assays, using model systems in controlled environments. A subset of these gene leads are transformed into the target crop for advanced product testing. Field testing under both drought-stressed and non-stressed conditions is conducted over multiple seasons to evaluate candidate genes for yield and other important agronomic traits.

All potential Pioneer products developed from the drought-tolerance program are evaluated in an extensive network of field-testing sites that include both managed-stress and target-market locations. Managed-stress locations are located in environments with very

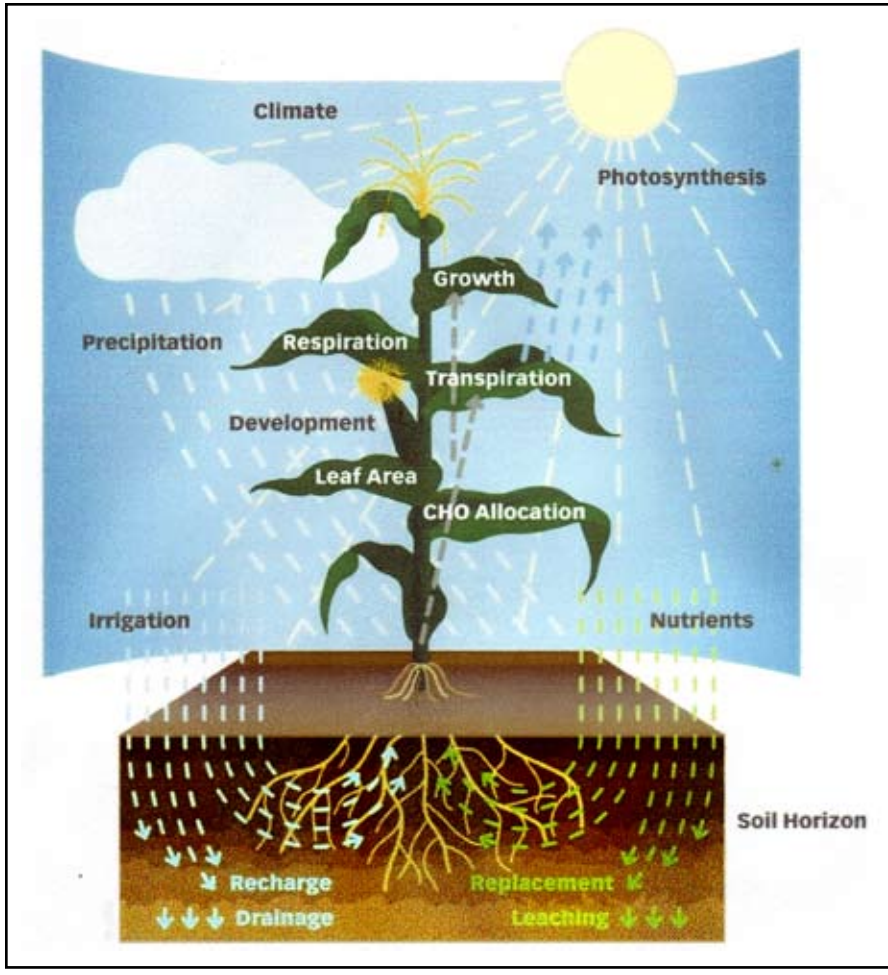


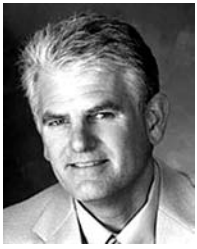
Figure 1. Environmental resource cycles and their involvement in plant productivity.

low rainfall and use precision-irrigation technologies to control the intensity, duration and timing of stress episodes. Target-market locations are used to evaluate the performance of lead products in the environments where they will be sold. Our Enclass® environmental modeling system assists in the placement of the right hybrid product on the right acre.

Many factors contribute to increased productivity. In light of this, Pioneer extensively evaluates the performance of our products using many different agronomic practices, including plant populations, soil fertility and water management. We use this information to support our customers with the best agronomic recommendations for use with our drought-tolerance technologies. The best combination of products and agronomic practices leads to the best real improvements under drought stress.

Committed to Collaboration

To advance the best innovations, we are committed to collaborating with both public and private organizations. We leverage these relationships to discover new approaches to drought tolerance and to test our existing technologies, globally, to make sure we make the best possible product-advancement decisions. The application and development of these innovative drought technologies have already addressed, and will continue to address, the wide range of water-supply environments around the world and will continue to improve productivity across crops and regions to ensure we meet the demands of a growing world population.



DAVE WARNER is currently Agronomic Traits program leader within the Agricultural Biotechnology Division of Pioneer Hi-Bred International. He is responsible for cross-functional program management and research strategy for all Pioneer drought-tolerance and nitrogen-use efficiency technology programs. He joined Pioneer in May 2010 with extensive experience in maize drought-stress tolerance, crop physiology, genetics and remote sensing. Prior to joining Pioneer, he held various research leadership positions within Monsanto and Dekalb Genetics, most recently as a science fellow. His work led to the discovery and development of several transgenic and native-trait technology solutions to water sustainability in maize production.

Warner, who holds degrees from the University of Massachusetts and the University of Illinois, is an inventor on several patents, and an author of many publications and presentations on drought-tolerance and remote-sensing technologies. He has worked with academic, industry and NGO collaborators in North and South America, India and Africa.