Drought-Tolerant Corn Hybrids: Yield Benefits

The use of drought-tolerant corn hybrids has been increasing. These hybrids have been selected for traits that should allow them to maximize plant productivity per unit of available water.

Currently, two different kinds of drought-tolerant hybrids are commercially available. The first are non-transgenic, conventionally bred, drought-tolerant corn hybrids from Pioneer (Optimum AQUAMAX) and Syngenta (Artesian). The second are transgenic drought-tolerant corn hybrids that combine both traditional breeding aimed at improving traits associated with drought tolerance and a transgenic trait, developed by Monsanto (Genuity DroughtGard). These hybrids are generally targeted for water-limited environments in the central Great Plains. This publication presents information from six research studies (2012 and 2013 seasons) conducted by K-State Research and Extension to evaluate drought-tolerant hybrids in a wide range of production environments.

Results

All sites (located in western, central, and eastern Kansas) compared either one or both types of drought-tolerant hybrids from diverse companies with a standard, non-drought-tolerant counterpart of similar maturity. The tests also evaluated the yield response of the hybrids to varying plant population and irrigation levels. Yield response to changes in plant population was not affected by hybrid selection; thus the current information indicates no need to change plant population when using drought-tolerant hybrids.

Overall, the analysis found a yield benefit for drought-tolerant versus non-drought-tolerant corn hybrids spanning a wide range of diverse environments and stress conditions across Kansas during the 2012-2013 growing seasons (Figure 1). In absolute terms, the yield advantage of using drought-tolerant hybrids was around 6 bushels per acre compared to the non-drought-tolerant material (in nearly 350 corn hybrid comparisons; Figure 1). In low-yielding environments (less than 120 bushels per acre), drought-tolerant out-yielded non-drought-tolerant corn hybrids more often than they did in the higher-yielding environments (between 180 and 260 bushels per acre).

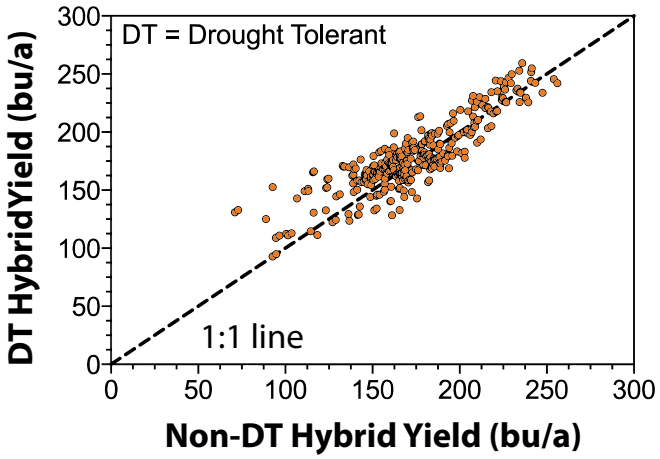

Figure 1. *Yield for the drought-tolerant (DT) hybrids compared to non-drought-tolerant (non-DT) corn hybrids at the same environment and plant density across six studies for 2012 and 2013 growing seasons. Dashed line represents 1:1 ratio. Adapted from Adee et al., 2016.*

Drought-Tolerant versus Non-Drought-Tolerant Corn Hybrids: Yield Environment Analysis

The analysis of information across diverse yield environments allows a more clear understanding where there may be a yield advantage from planting drought-tolerant hybrids. A linear response and plateau function was used to describe the yield advantage for drought-tolerant hybrids across a range of yields for the non-drought-tolerant hybrids (Figure 2). The yield advantage for drought-tolerant hybrids gradually increased as the yield of the regular hybrids decreased from 172 bushels per acre (represented by the vertical dashed line in Figure 2.)

It is important to note that these are generalized relationships, and there are varied responses at each yield level. How individual hybrids respond to a specific environment is influenced by a number of factors, including the type, timing, and duration of the stress.

From the data collected it can be concluded many management factors affect yield results, which makes it difficult to separate out the effect of hybrid alone.

Potential research-based interpretations of the drought-tolerant yield advantage are:

- Slower vegetative growth, saving water for reproductive stages (water conservation),
- Greater root biomass with superior water uptake,
- Differential regulation in the stomata opening, controlling water and carbon dioxide exchange processes, and
- Other potential physiological modifications.

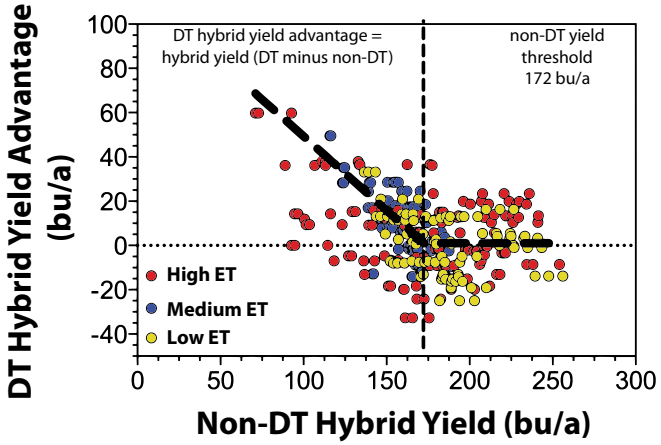

Figure 2. *Yield advantage for drought-tolerant (DT) compared to non-drought-tolerant (non-DT) corn hybrids at the same environment and plant density, ranging from low- to high-yielding environments and identifying diverse evapotranspiration (ET) conditions (from low – reduced water stress, to high ET – drought conditions). The dashed vertical line represents the non-DT yield threshold, 172 bushels per acre, with a likelihood of positive yield responses for DT as yields of non-DT are to the left of this line. Each data point represents the DT hybrid yield advantage (bu/acre) in a specific environment, with positive values representing a yield benefit of DT hybrid vs non-DT hybrid counterpart. Adapted from Adee et al., 2016.*

Summary

The main points of these studies are:

- Advantage of the drought-tolerant hybrids became more evident under water stress,
- As to the range explored in our database (from 70 to 260 bu/a), drought-tolerant hybrids have the potential to yield with regular hybrids when water is not an environmentally limiting factor,
- Yield benefit was variable for drought-tolerant vs. non-drought-tolerant hybrids under diverse environments (5 to 15 bushels per acre), and
- Drought-tolerant corn hybrid yield advantage was more evident when the non-drought-tolerant yield was less than 170 bushels per acre (Figure 2), often associated with a greater likelihood of limited water supply, high ET, and leaves rolling most days.

It is reasonable to expect drought-tolerant hybrids to serve as a risk-management tool to sustain yield potential in water-limited environments. Based on the database obtained from these studies (yield data ranging from 70 to 260 bushels per acre), it appears there is no yield penalty associated with drought-tolerant hybrids if water-limiting conditions do not occur.

It is crucial to understand that drought-tolerant hybrids will not produce if subjected to terminal drought. They will not thrive when moisture is severely limited, especially in dryland systems.

When selecting a hybrid keep in mind not only the tolerance to drought or other stresses, but also consider traits such as specific herbicide tolerance, disease and insect resistance, maturity, lodging, and overall hybrid performance. K-State Research and Extension performs corn hybrid tests across the state and the information from these tests is summarized in a report of progress available at: *www.agronomy.k-state.edu/services/crop-performance-tests/corn/2016-corn-performance-test.html*

Reference

Adee, E., K. Roozeboom, G.R. Balboa, A. Schlegel, and I.A. Ciampitti. 2016. *Drought-Tolerant Corn Hybrids Yield More in Drought-Stressed Environments with No Penalty in Non-stressed Environments.* Frontiers in Plant Science 7:1534. doi: 10.3389/fpls.2016.01534

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