

DROUGHTGARD® HYBRIDS CROP WATER USE

TRIAL OVERVIEW

- Drought stress in the Western Great Plains and other regions in the United States can quickly reduce corn yield potential.
- DroughtGard® Hybrids corn products are part of a systems approach that combines best agronomic recommendations, drought-tolerant germplasm, and the industry's only commercial biotech trait for drought tolerance to help reduce the impact of drought stress.

RESEARCH OBJECTIVE

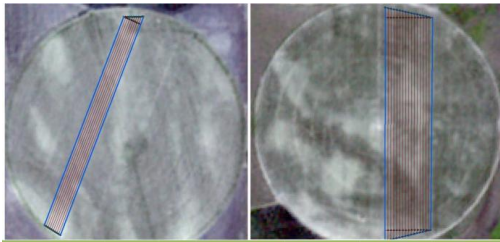
- Information and data are needed to help define the potential water use differences between commercial corn products with and without water saving genetics. In an effort to collect data and evaluate potential differences, the Monsanto Water Utilization Learning Center at Gothenburg, NE partnered with HydroBio Advanced Remote Sensing to evaluate satellite imagery from strip-till corn research plots in Colorado and Nebraska initiated in 2014 and 2015. The goal of the research was to calculate crop water use and derive irrigation crop coefficients (Kc) for each product.

Location	Soil	Previous Crop	Tillage Type	Planting Date	Harvest Date	Potential Yield/Acre	Planting Rate/Acre
NE, CO	Various	Various	Various			140 to 280 bu/acre	Various

SITE NOTES:

- 18 fields with a minimum yield of 140 bu/acre were selected from commercial strip trials such as Market Development trials and side-by-side comparisons from the Colorado and Nebraska region during the 2014 and 2015 growing seasons. Fields had one, two, or three types of the following 26 corn products: A) Monsanto branded products with the DroughtGard® Hybrids corn trait (5); B) Pioneer® branded AQUAmax® products (8); C) Pioneer® brand products not branded AQUAmax® (13).
- Temperature, relative humidity, dew point, solar radiation, and wind speed were collected from May 1 through September 10 for each year using aWhere® computer weather services. The weather information was used to calculate reference evapotranspiration (ET_o). Additionally, latitude, longitude, and elevation readings were collected.
- Pleiades® imagery 1A and 1B, RapidEyeSM telecommunications services complex of 5 satellites and Spot 6 and 7 were utilized to collect NIR, red, green, and blue spectral bands. The images were processed into HydroBio Advanced Remote Sensing specialized vegetation index, which allowed for the pixel data to be clipped to each field's boundaries (Figure 1). HydroBio Advanced Remote Sensing removed any anomalous pixels, which never exceeded 9.6% of the total number of pixels. Removals helped reduce effects of structures, unplanted acres, or edge boundaries where the pixel may have vegetation and bare ground reflectance values. After vegetation indices were derived, all fields were grouped for a given region by HydroBio Advanced Remote Sensing. Advanced mathematical techniques were used to model the change in the vegetative index to produce daily values given the temporal spacing between collected images. Data restricted to dates between emergence and last irrigation (September 10). Fields bundled in the analysis by product and year to smooth any microclimate or minor geographic effects.
- Fields were normalized to crop stage by vegetative index and Growing Degree Days (GDD) from HydroBio's preliminary proprietary Normalized Difference Vegetation Index (NDVI) measurements taken in late May and early June. The daily values for each field were aggregated and the crop water use estimate from HydroBio provided the value for daily ET.
- The k-factor was derived using the equation: $Kc = ET/ET_o$. Values were then aggregated by GDD to provide a usable metric and method for using the provided Kc for future irrigation demand calculations.

UNDERSTANDING THE RESULTS



Product	N	ET	Average NDVI (500 GDD)	Maximum NDVI	Average Yield (bu/acre)	Bu/inch of Water Used
DroughtGard® Hybrids Corn Products	18,027	24.8	0.4507	1.0077	225	9.07
Pioneer® Brand AQUAmax® Corn Products	12,648	26.6	0.4781	1.0546	224	8.42
Pioneer® Brand Corn Products not branded AQUAmax®	36,461	27.3	0.4507	1.1911	227	8.31
LSD (0.05)		0.1	0.002	0.002	NS	

N = Number of satellite pixels analyzed; ET = Evapotranspiration; GDD = Growing Degree Days; NDVI = HydroBio's proprietary Normalized Difference Vegetation Index
Source: Data collected from 18 fields in Colorado and Nebraska during the years of 2014 and 2015.

Figure 1. Unprocessed imagery with trial boundaries (top) and Average seasonal water use by category (bottom).

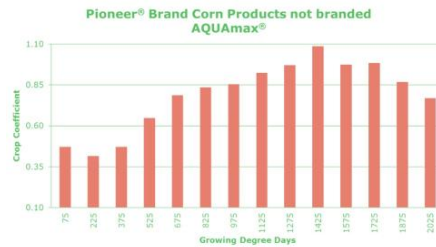
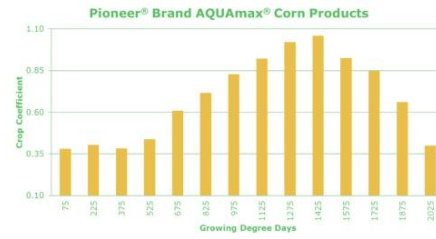


Figure 2. Crop Coefficient (Kc) vs Growing Degree Days (GDD) for Pioneer® Brand AQUAmax® corn products (top) and Pioneer® Brand Corn Products not branded AQUAmax® (bottom).

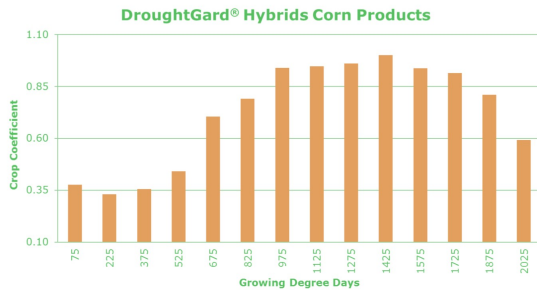


Figure 3. Crop Coefficient (Kc) vs Growing Degree Days (GDD) for DroughtGard® Hybrids Corn Products.

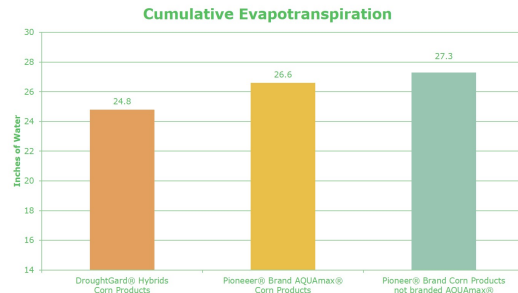


Figure 4. Cumulative Evapotranspiration for Each Category

- Data were categorized by water saving traits and company and crop coefficients (Kc) were generated based on alfalfa reference water use: A) Maximum Kc for DroughtGard® Hybrids corn products types was 1.00 (Figure 3); B) Other types exceeded 1.00 Kc including Pioneer® brand AQUAmax® corn products which peaked at 1.08 (Figure 2); C) Pioneer® brand AQUAmax® products had a slightly higher peak and steeper rise and used more water over the season on average.
- DroughtGard® Hybrids corn products consumed 1.8 inches less water than Pioneer® brand AQUAmax® corn products and 2.5 inches less than Pioneer® brand products not branded AQUAmax® (Figure 4). This translates into a potential water savings of 7% on average for DroughtGard® Hybrids corn products.

WHAT DOES THIS MEAN FOR YOUR FARM?

- DroughtGard® Hybrids corn products are the foundation of a systems approach designed to help minimize yield loss from drought by combining a drought-tolerant biotech trait with top-performing drought-tolerant germplasm and agronomic best practice recommendations for water conservation.

LEGAL STATEMENT

For additional agronomic information, please contact your local brand representative. Developed in partnership with Technology, Development & Agronomy by Monsanto. The information discussed in this report is from an 18 site, non-replicated demonstration. This informational piece is designed to report the results of this demonstration and is not intended to infer any confirmed trends. Please use this information accordingly. Monsanto Company is a member of Excellence Through Stewardship® (ETS). Monsanto products are commercialized in accordance with ETS Product Launch Stewardship Guidance, and in compliance with Monsanto's Policy for Commercialization of Biotechnology-Derived Plant Products in Commodity Crops. This product has been approved for import into key export markets with functioning regulatory systems. Any crop or material produced from this product can only be exported to, or used, processed or sold in countries where all necessary regulatory approvals have been granted. It is a violation of national and international law to move material containing biotech traits across boundaries into nations where import is not permitted. Growers should talk to their grain handler or product purchaser to confirm their buying position for this product. IMPORTANT IRM INFORMATION: RIB Complete® corn blend products do not require the planting of a structured refuge except in the Cotton-Growing Area where corn earworm is a significant pest. See the IRM/Grower Guide for additional information. Always read and follow IRM requirements. Excellence Through Stewardship® is a registered trademark of Excellence Through Stewardship. Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible. Always read and follow IRM, where applicable, grain marketing and all other stewardship practices and pesticide label directions. DroughtGard®, Monsanto and Vine Design® and RIB Complete® are trademarks of Monsanto Technology LLC. All other trademarks are the property of their respective owners. ©2016 Monsanto Company. 160721103639 081216LGM