

THE STRENGTH OF CORTEVA AGRISCIENCE CORN ROOTWORM PROTECTION RESEARCH



Pioneer has been creating industry-leading corn genetics since the first inbred development program established in 1920. Throughout our brand's history, we've strived to create high performance products, along with the associated management practices for their success, to maximize farmers' productivity and profitability.

Through the introduction of new breeding technologies and predictive tools, we continue to revolutionize corn hybrid genetics, and incorporate new traits and technologies to bring forward new products that address challenges farmers face today and in the future, including pressures from corn rootworm (CRW).

Pioneer® brand Qrome® products: Optimized balance of yield, agronomics, and CRW protection

The most recent introduction from the Corteva Agriscience trait pipeline, Qrome® technology, unlocks the full potential of the Pioneer germplasm library. Qrome products have two modes of action for above- and below-ground protection, as well as two modes of action herbicide tolerance. Qrome technology includes a proprietary molecular stack of the proven Bt proteins in the Herculex® XTRA trait and works with more genetics than previous technology. This means more unique genetic options to select from, leading to enhanced yield and agronomics across our triple-stack portfolio.

With more than 3,000 IMPACT™ plot and on-farm trials since 2015, and more than 34,000 root observations under moderate to heavy CRW pressure in efficacy trials, Qrome products are some of the most extensively tested products in the Pioneer lineup.

Pioneer brand Qrome products by the numbers:

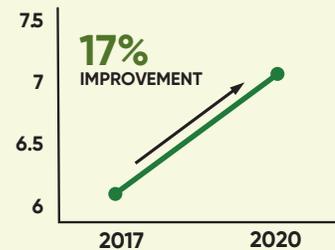
ENHANCED YIELD

Yield Advantage Over Competition in 2019 On-Farm Trials¹



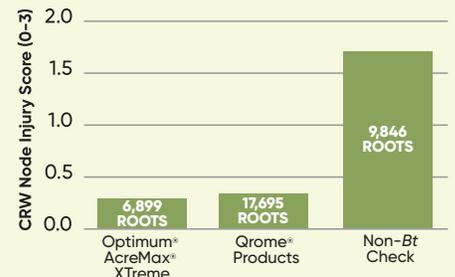
IMPROVED AGRONOMICS

Weighted Average Root Strength Triple-stack segment, Corn Belt



CRW PROTECTION PROVEN IN THE FIELD

Proven Insect Protection



CRW Efficacy Under Moderate and Heavy Pressure^{2,3}

64 locations over 6 years: Average CRW node injury by insect protection technology at moderate and high CRW pressure locations.

“The level of CRW pressure in a field has a significant impact on what level of damage can be expected, and all current commercial CRW trait technologies can incur unexpected damage under high pressure. Through our six years of testing Qrome® technology in CRW efficacy trials, we’ve continued to see consistent results in moderate and heavy CRW pressure environments. Node injury scores are an important measure for us in determining what farmers are going to experience in their fields at different CRW pressures.”

-Tim Nowatzki, Sr. Research Scientist, Corteva Agriscience

Backed by an R&D Powerhouse

Insects and other pests can naturally evolve over time to overcome pest management practices used against them. We continue to study and learn more about insect resistance every year through our research and agronomy efforts.

Corteva Agriscience has a robust and leading insect management research program to understand resistance, predict trait durability, and develop management strategies. This is important to developing new, effective, and durable insect protection traits for farmers, as well as providing guidance on management practices for technologies to remain successful.

Our investments in generating robust empirical data, studying different components of insect management like insect biology and genetics, trait efficacy, insect survivability, and resistance characterization fuel our modeling expertise and help us understand resistance development. This has resulted in more knowledge on insect management than ever before.

Insect Trait Development and Management Leadership

- State-of-the-art greenhouse facilities and insectary facility producing ~600 million insects for research annually
- 20 Corteva Agriscience Research Centers across U.S. with insect trait efficacy and agronomy testing
- 300+ Insect trait efficacy and agronomy trials across the U.S. annually
- 100+ Laboratory, greenhouse and field studies to better understand trait durability annually
- Modeling expertise to better understand product performance over time

Technology stewardship and Best Management Practices

Bt traits for CRW management have been effective for more than a decade. Through our insect management research, we know the value of these traits can be extended by 30–50% if CRW population management Best Management Practices (BMPs) are implemented.

Farmers investing in a diverse set of CRW management practices strengthens Corteva's R&D engine, enabling us to deliver the most technically-advanced and optimized profitable products available today.

Implementing the recommended BMPs maintains CRW populations at levels where the traits can perform optimally to protect yield in a durable manner. Continuous corn production of the same Bt traits being grown in the same fields significantly decreases trait effectiveness. All Bt traits on the marketplace are subject to similar lifecycle outcomes if managed inappropriately.

Our research demonstrates that Qrome® technology has a similar durability profile to Optimum® AcreMax® XTreme insect protection. Management of CRW population densities field by field far outweighs any differences among the technologies regarding efficacy and long-term profitability. Follow these BMPs:

1) Proactively Lower Corn Rootworm Populations:

- a. Build in a crop rotation every 3 years

- b. Use an adult beetle control program (using appropriate thresholds and timing)
- c. Plant corn containing pyramided CRW traits, especially in fields planted corn the previous year

2) Use of non-Bt corn with a soil-applied insecticide can be very effective (especially if CRW populations are at low to moderate levels)

3) In situations with high CRW pressure, consult with a local expert regarding these options in combination with Bt corn

- a. Use a high rate insecticidal seed treatment (@ 1250 rate)
- b. Use of a soil-applied insecticide is not recommended for control except in limited circumstances. Consult with your Pioneer agronomist, extension service, crop consultant or other local experts for further guidance.

The above BMPs continue to be the most effective options. These BMPs focus on 1) breaking the cycle (both CRW and cropping cycle), 2) managing CRW populations, and 3) protecting yield potential.

Appropriate management of technologies today is important for the future. The next generation of below-ground protection products will build on the technologies and knowledge currently available today, including Next Gen CRW + Enlist® corn in the near-term, and new CRW traits in the long-term product pipeline.



¹ 2019 comparison data is based on the average of comparisons made in the U.S. through Nov. 1, 2019. Comparisons are against all competitors, technology segment matched, unless otherwise stated, and within +/- 3 CRM of the competitive brand. Product performance is variable and subject to any number of environmental, disease and pest pressures. Individual results may vary and from year to year. Product label instructions must be followed at all times. No offer for sale, sale or use of these products are permitted prior to issuance of the required country, region or state registrations.

² Efficacy from multiple trials with moderate & high CRW pressure at 8 locations in 2014, 6 locations in 2015, 8 locations in 2016, 8 locations in 2017, 10 locations in 2018, 9 locations in 2019, and 15 locations in 2020. Qrome® products (Qrome), Optimum® AcreMax® XTreme products (AMXT).

³ Standard for assigning pressure is based on average NIS score of negative control hybrid at a location. Low pressure <0.75 NIS; Moderate pressure 0.75-1.50; High pressure >1.50 U. Schellenberger et al., Science 634-637.

Qrome® products are approved for cultivation in the U.S. and Canada. They have also received approval in a number of importing countries, most recently China. For additional information about the status of regulatory authorizations, visit <http://www.biotradestatus.com/>

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