Does the rootworm Bt trait improve N use and productivity of corn?

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Introduction:

- Traits conferring resistance to corn rootworm (*Diabrotica* spp.) protect corn grain yield potential and are becoming standard practice where corn rootworm pressure is present.
- Because the grain yields of rootworm protected (RW) hybrids are often higher than their non-RW counterparts, understanding the processes (i.e. nutrient or water uptake) that are protected by rootworm feeding might result in added value to a corn producer.
- **Our hypothesis is that rootworm protected hybrids exhibit increased nitrogen (N) uptake, resulting in higher grain yield and improved N use efficiency (NUE) relative to their non-protected counterparts.**

Research approach:

- Two commercial RW hybrids, DKC61-69 VT3 (hybrid pair 1) and DKC63-42 VT3 (hybrid pair 2), were grown along with their near-isogenic non-RW counterparts (DKC61-72 RR2 and DKC63-46 RR2/YGCB) at Champaign, IL in 2008. The non-RW hybrids received an in-furrow application of tefluthrin.
- Plots were thinned to a final population of 76,600 plants ha^{-1}. N was applied as ($(NH_4)_2SO_4$) in a diffuse band and incorporated between V2 and V3. N rates of 0, 67, 135, 202, and 270 kg ha^{-1} were used.
- Four representative plants per plot were harvested at R1 and R6 for dry weight and NUE measurements.
- The plots were harvested with a plot combine and a subsample of the grain was analyzed for protein concentration and kernel weight.

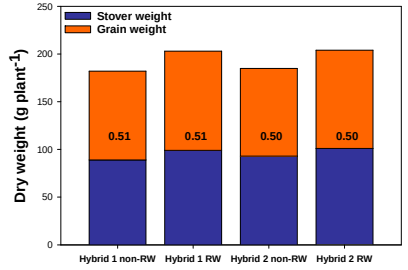

Figure 1. Stover, grain, and total above-ground weight (g $plant^{-1}$) of RW hybrids and their non-RW counterparts measured at physiological maturity (R6). Values averaged across N rates. Harvest indices shown within each bar.

- **The grain yield increases in RW hybrids relative to their non-RW counterparts resulted from increased whole shoot biomass, while harvest index remained similar in non-RW and RW hybrids.**
- **Whole shoot biomass at R1 was also increased by an average of 12% in RW hybrids (data not shown).**

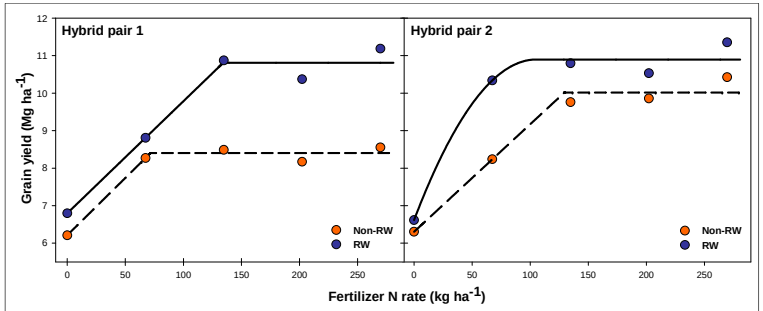

Figure 2. Grain yield of RW hybrids and their non-RW counterparts at five rates of N fertilization.

- **Although not statistically significant, grain yield under unfertilized conditions (0 kg N ha^{-1}) trended higher in RW hybrids (average of 0.4 Mg ha^{-1}).**
- **Hybrid pair 1 exhibited similar grain yield response patterns to N, but RW protection increased the maximum yield by 2.4 Mg ha^{-1}.**
- **In contrast, RW protection in hybrid pair 2 increased the initial response of grain yield to N fertilizer (slope of regression line) and the maximum grain yield (+ 0.9 Mg ha^{-1}).**

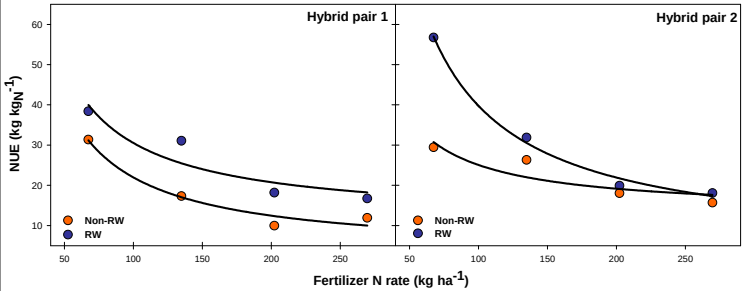

Figure 3. Nitrogen use efficiency (NUE) of RW hybrids and their non-RW counterparts at four rates of N fertilization.

- **When compared to their non-RW counterparts, RW hybrids had similar or higher levels of N use efficiency (NUE) at all rates of N fertilizer.**
- **Averaged across N rates, hybrid pair 1 had lower overall NUE values relative to hybrid pair 2. RW protection in hybrid pair 1 increased NUE at all levels of N but did not alter the general response pattern.**
- **At the N rates that optimized grain yield (Fig. 2), NUE values were similar for the hybrids in pair 1, while the RW hybrid in pair 2 had a higher NUE at the rate that optimized grain yield (Fig. 3).**

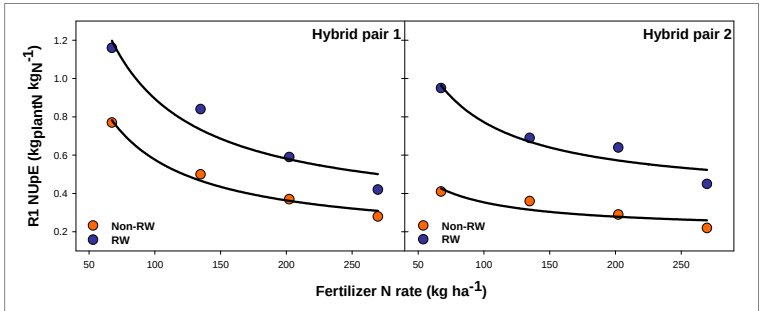

Figure 4. N uptake efficiency (NUpE) of RW hybrids and their non-RW counterparts at four rates of N fertilization.

- **RW hybrids had greater NUpE at flowering (Fig. 4) and at physiological maturity (data not shown).**
- **At flowering, RW hybrids had average NUpE values of 0.75 (pair 1) and 0.68 (pair 2), compared to 0.48 and 0.32 for their non-RW counterparts.**
- **At physiological maturity, RW hybrids had average NUpE values of 0.71 (both hybrid pairs), compared to 0.53 (pair 1) and 0.56 (pair 2) for their non-RW counterparts.**

Conclusions:

- **N use efficiency is a current target of corn germplasm improvement programs, and RW resistance traits represent the first generation of NUE traits as a result of their indirect effect on N uptake.**
- **Although only two hybrid pairs were evaluated in this experiment, it appears that RW hybrids use two strategies to improve N use and yield:**
  - **Strategy 1 increases yield at N rates typical of current agronomic recommendations (hybrid pair 1).**
  - **Strategy 2 increases yield while reducing the N required for maximum yield (hybrid pair 2).**
- **This study indicates that RW hybrids are more efficient at N uptake throughout their growth and development, and this increase in N acquisition likely results in improved grain yields.**
- **Further experimentation in 2009 is addressing the strategies by which RW hybrids protect yield and improve N use in a broader panel of hybrids.**