Does the Corn Rootworm Resistance Trait Affect N Use Efficiency?

Fluid Fertilizer Forum

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NO
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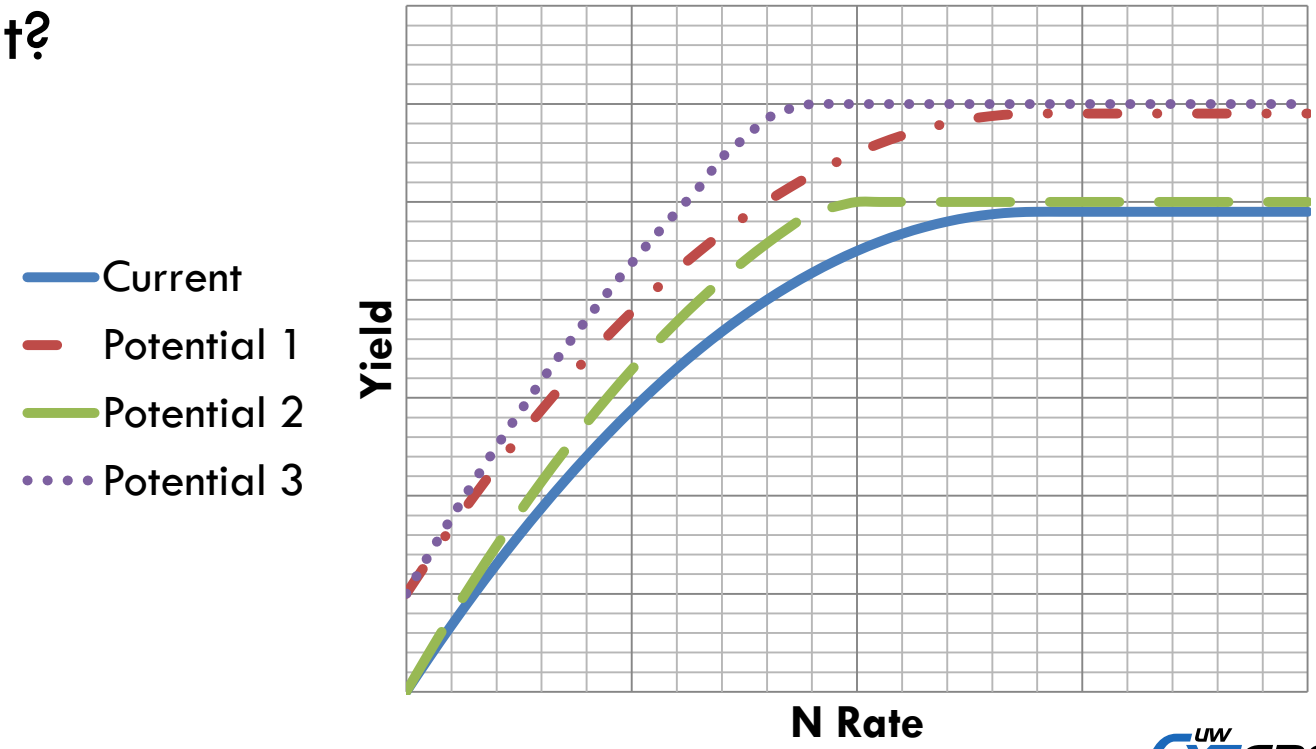
Background

- CRW hybrids have larger root system if not stressed by CRW larval feeding
  - Is more N needed to feed a larger plant, or is less N needed because the root system is more efficient?



Objective:

- To determine if corn hybrids with a transgenic CRW resistant gene vary in their NUE and N need compared to non-resistant hybrids

Methods & Materials

Site background info.

- Previous crop = corn grain
- Spring chisel & soil finisher
- Plano silt loam (Typic Argiudoll)

Soil Test	2008	2009	2010
P, ppm	107 (EH)	33 (EH)	91 (EH)
K, ppm	347 (EH)	163 (VH)	146 (H)
pH	7.1	6.9	7.1
OM, %	4.1	3.2	3.5
PPNT, lb N/a	69 (19 credit)	12 (0 credit)	37 (0 credit)

Experimental design

- N x hybrid in a full factorial – CRD
  - 4 replications
- 6 N rates
  - 0 – 200 lb/a in 40 lb/a increments
  - Applied 11, 23, or 27 day after planting
- 8 Hybrids

Hybrids

Hybrid	Hybrid i.d.	Brand	Hybrid	CRM	Traits
1	Bt-CR 1	Pioneer	P35F44	105	(CB & CRW) Herculex Xtra, Roundup Ready 2, Liberty Link
2	Isoline 1	Pioneer	P35F37	105	Roundup Ready 2
3	Bt-CR 2	DeKalb	DKC52-59	102	(CB & CRW) Yield Guard VT3, Roundup Ready
4	Isoline 2	DeKalb	DKC52-62	102	Roundup Ready 2

Hybrid	Hybrid i.d.	Brand	Hybrid	CRM	Traits
5	Standard Bt-CB	Northrup King (08/09)	N58-D1	107	(CB) Yield Guard
		Renk (10)	RK670	103	(CB) Yield Guard
6	Standard nontransgenic	Pioneer (08)	35A30	106	None
		Pioneer(09/10)	35F38	105	None
7	Bt-CR (Mon863) 1	Renk (08)	R698RRYGRW	104	(CRW) Yield Guard Roundup Ready
		DeKalb (09/10)	DKC55-4 (VT3)	105	(CB & CRW) Yield Guard VT3, Roundup Ready
8	Bt-CR (Mon863) 2	Dairyland	ST400	106	Roundup Ready, CRW

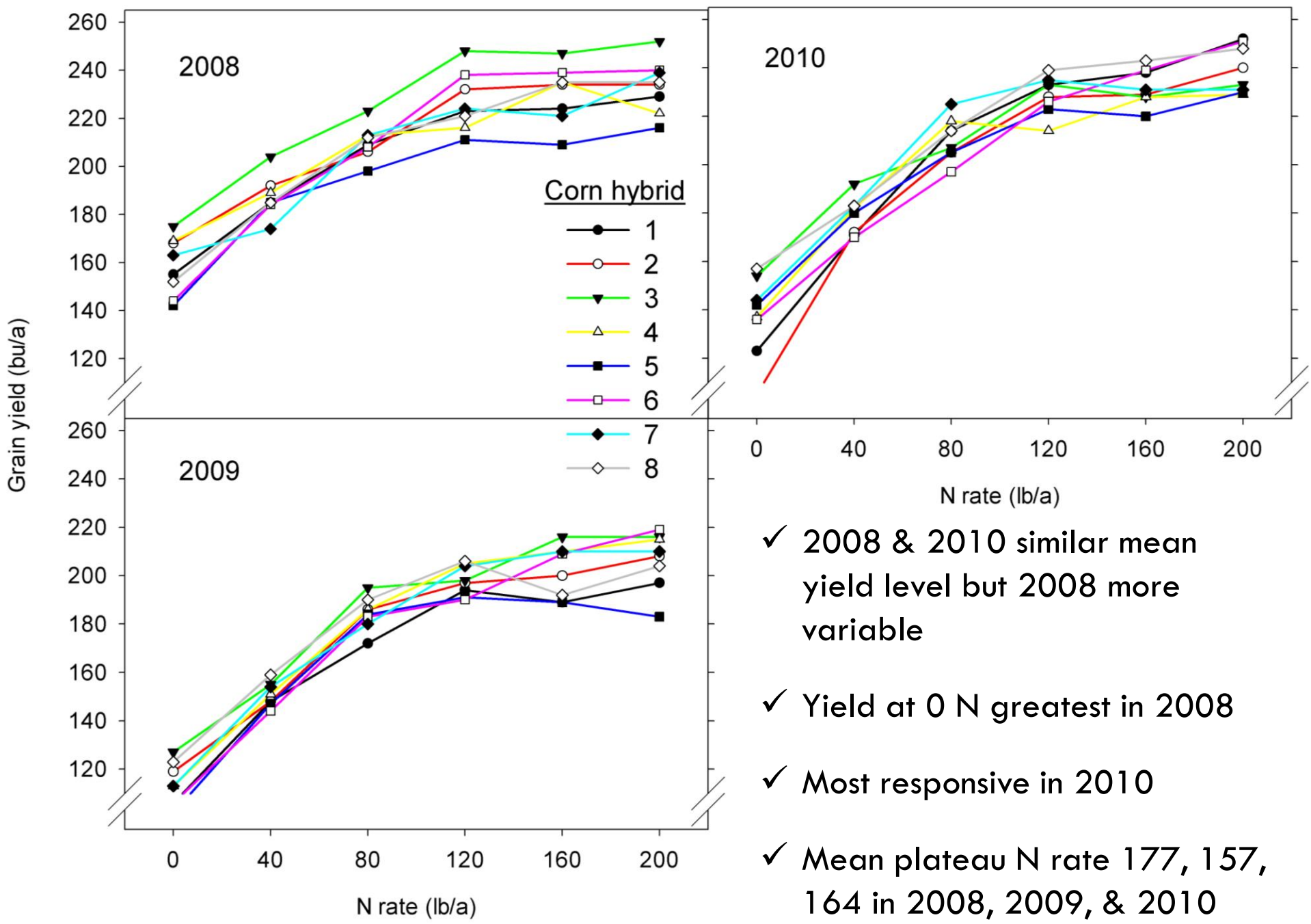
Plot details

- Planting
  - May 5, 2008; May 12, 2009; May 5, 2010
  - 33,600 seeds/a or 36,670 seeds/a
    - Thinned to 30,500 or 34,294 at V4-V5
  - 3 gal/a 10-34-0 in furrow in 20
  - 4.4 lb/a insecticide in T-band (Fo
    - To all plots
    - Border area - no insecticide

Date	Root injury rating in border; 0-3 node-injury scale
7/24/08	1.12
7/27/09	0.19
7/26/10	1.50

- Weather
  - 2008: Wet June; cool all-season
  - 2009: somewhat dry; cold
  - 2010: June & July wet; somewhat warmer July & Aug.

Results



- ✓ 2008 & 2010 similar mean yield level but 2008 more variable
- ✓ Yield at 0 N greatest in 2008
- ✓ Most responsive in 2010
- ✓ Mean plateau N rate 177, 157, 164 in 2008, 2009, & 2010

N use efficiency definitions

- Relative yield (RY)
  - (Yield at 0 lb/a ÷ Yield at 200 lb/a) x 100
- Partial factor productivity (PFP)
  - bu/a ÷ lb/a N fertilizer
- Agronomic N fertilizer efficiency (ANFE)
  - Δ bu/a ÷ lb/a N fertilizer

N use efficiency definitions

- Internal N Use Efficiency (INUE)
  - bu/a ÷ lb/a N uptake
- Physiological Efficiency (PE)
  - Δ bu/a ÷ Δ lb/a N uptake
- Fertilizer N Recovery Efficiency (FNRE)
  - Δ lb/a N uptake ÷ lb/a N fertilizer

Effect of isoline on RY, PFP, and ANFE

Hybrid	Relative Yield$_{200}$		
	2008	2009	2010
	-------- % --------		
1	68a	54b	49b
2	72a	56b	44c
p	ns	ns	ns
3	70	60	66
4	74a	53b	60b
p	ns	ns	ns

For a given measure of NUE, values in each row followed by the same letter are not significantly different at the 0.10 probability level.

p values compare an isoline pair in each year. ns = not significant; * = p<0.10.

Effect of isoline on RY, PFP, and ANFE

Hybrid	Relative Yield$_{200}$			Partial Factor Productivity$_{160}$		
	2008	2009	2010	2008	2009	2010
	-------- % --------			----- bu/lb N fert. -----		
1	68a	54b	49b	1.40a	1.18b	1.49a
2	72a	56b	44c	1.47a	1.25b	1.44a
p	ns	ns	ns	ns	*	*
3	70	60	66	1.54a	1.35b	1.42a
4	74a	53b	60b	1.47a	1.32c	1.43b
p	ns	ns	ns	ns	ns	ns

For a given measure of NUE, values in each row followed by the same letter are not significantly different at the 0.10 probability level.

p values compare an isoline pair in each year. ns = not significant; * = $p<0.10$.

Effect of isoline on RY, PFP, and ANFE

Hybrid	Relative Yield$_{200}$			Partial Factor Productivity$_{160}$			Agronomic N Fertilizer Efficiency$_{160}$		
	2008	2009	2010	2008	2009	2010	2008	2009	2010
	-------- % --------			----- bu/lb N fert. -----			--- Δbu/ lb N fert. ---		
1	68a	54b	49b	1.40a	1.18b	1.49a	0.43b	0.52ab	0.72a
2	72a	56b	44c	1.47a	1.25b	1.44a	0.41b	0.53b	0.78a
p	ns	ns	ns	ns	*	*	ns	ns	ns
3	70	60	66	1.54a	1.35b	1.42a	0.45	0.55	0.46
4	74a	53b	60b	1.47a	1.32c	1.43b	0.42b	0.61a	0.57a
p	ns	ns	ns	ns	ns	ns	ns	ns	ns

For a given measure of NUE, values in each row followed by the same letter are not significantly different at the 0.10 probability level.

p values compare an isoline pair in each year. ns = not significant; * = $p<0.10$.

Effect of isoline on INUE, PE, and FNRE

Hybrid	Internal N Use Efficiency$_{160}$		
	2008	2009	2010
	--- bu/lb N uptake ---		
1	0.97	1.03	0.94
2	1.00b	1.10a	0.94c
p	ns	ns	ns
3	1.02a	1.05a	0.91b
4	1.01b	1.09a	0.91c
p	ns	ns	ns

For a given measure of NUE, values in each row followed by the same letter are not significantly different at the 0.10 probability level.

p values compare an isoline pair in each year. ns = not significant; * = $p<0.10$.

Effect of isoline on INUE, PE, and FNRE

Hybrid	Internal N Use Efficiency$_{160}$			Physiological Efficiency$_{160}$		
	2008	2009	2010	2008	2009	2010
	--- bu/lb N uptake ---			--- Δbu/Δlb N uptake ---		
1	0.97	1.03	0.94	0.86	0.85	1.09
2	1.00b	1.10a	0.94c	0.91	0.95	0.89
p	ns	ns	ns	ns	ns	*
3	1.02a	1.05a	0.91b	0.76	0.91	0.68
4	1.01b	1.09a	0.91c	0.66c	1.01a	0.85b
p	ns	ns	ns	ns	ns	*

For a given measure of NUE, values in each row followed by the same letter are not significantly different at the 0.10 probability level.

p values compare an isoline pair in each year. ns = not significant; * = $p<0.10$.

Effect of isoline on INUE, PE, and FNRE

Hybrid	Internal N Use Efficiency$_{160}$			Physiological Efficiency$_{160}$			Fertilizer N Recovery Efficiency$_{160}$		
	2008	2009	2010	2008	2009	2010	2008	2009	2010
	--- bu/lb N uptake ---			--- Δbu/Δlb N uptake ---			Δlb N uptake/ lb N fert.		
1	0.97	1.03	0.94	0.86	0.85	1.09	0.57	0.60	0.67
2	1.00b	1.10a	0.94c	0.91	0.95	0.89	0.47b	0.54b	0.87a
p	ns	ns	ns	ns	ns	*	ns	*	*
3	1.02a	1.05a	0.91b	0.76	0.91	0.68	0.57	0.64	0.66
4	1.01b	1.09a	0.91c	0.66c	1.01a	0.85b	0.66	0.60	0.70
p	ns	ns	ns	ns	ns	*	ns	ns	ns

For a given measure of NUE, values in each row followed by the same letter are not significantly different at the 0.10 probability level.

p values compare an isoline pair in each year. ns = not significant; * = $p<0.10$.

Effect of CRW trait on RY, PFP, and ANFE

Hybrid	Relative Yield$_{200}$			Partial Factor Productivity$_{160}$			Agronomic N Fertilizer Efficiency$_{160}$		
	2008	2009	2010	2008	2009	2010	2008	2009	2010
	-------- % --------			----- bu/lb N fert. -----			--- Δbu/ lb N fert. ---		
CRW	68a	57b	60b	1.45a	1.26b	1.47a	0.44b	0.53a	0.57a
Non-CRW	67a	53b	54b	1.44a	1.27b	1.43a	0.47b	0.58a	0.62a
p	ns	ns	ns	ns	ns	ns	ns	ns	ns

For a given measure of NUE, values in each row followed by the same letter are not significantly different at the 0.10 probability level.

p values compare an isoline pair in each year. ns = not significant; * = $p<0.10$.

Effect of CRW trait on INUE, PE, and FNRE

Hybrid	Internal N Use Efficiency$_{160}$			Physiological Efficiency$_{160}$			Fertilizer N Recovery Efficiency$_{160}$		
	2008	2009	2010	2008	2009	2010	2008	2009	2010
	--- bu/lb N uptake ---			-- Δbu/Δlb N uptake --			Δlb N uptake/ lb N fert.		
1	1.01b	1.06a	0.94c	0.81	0.92	0.87	0.58	0.59	0.66
2	1.03b	1.07a	0.92c	0.95	0.95	0.87	0.52b	0.61b	0.74a
p	ns	ns	ns	ns	ns	ns	ns	ns	ns

For a given measure of NUE, values in each row followed by the same letter are not significantly different at the 0.10 probability level.

p values compare an isoline pair in each year. ns = not significant; * = $p<0.10$.

N response CRW vs non-CRW hybrids

Year	Yield at 0 N		Yield at plateau N rate		Plateau N rate	
	CRW	non-CRW	CRW	non-CRW	CRW	non-CRW
	bu/a		bu/a		lb N/a	
2008	161	154	235	228	152	139
2009	115	110	206	206	160	164
2010	145*	130*	240	234	165	154

* CRW and non-CRW hybrids are significantly different for Yield at 0 N in 2010.

When averaged overall years, Yield at 0 N for non-CRW hybrids is significantly less than CRW hybrids.

Summary

- CRW traited hybrids are more efficient in using mineralized soil N in 0 N plots

- However, this does not translate to significantly greater yield levels when fertilized or different N needs

Questions?

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- Fluid Fertilizer Foundation
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