Identification of Nitrogen Management Strategies in Indiana, USA that Impact Corn Stalk Nitrate Concentrations

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Introduction

Nitrogen management in corn production systems is challenging due to the many factors that affect N availability, including soil properties, weather, fertilizer application timing, rate, and placement, previous crop grown, cover crops, etc. The stalk nitrate test, which measures nitrate concentration in the lower corn stalk around the time of physiological maturity, can be used to estimate corn N status and also determine management factors that influence N availability.

Materials & Methods

1. Collect producer feedback and stalk nitrate sampling of fields in Indiana, USA

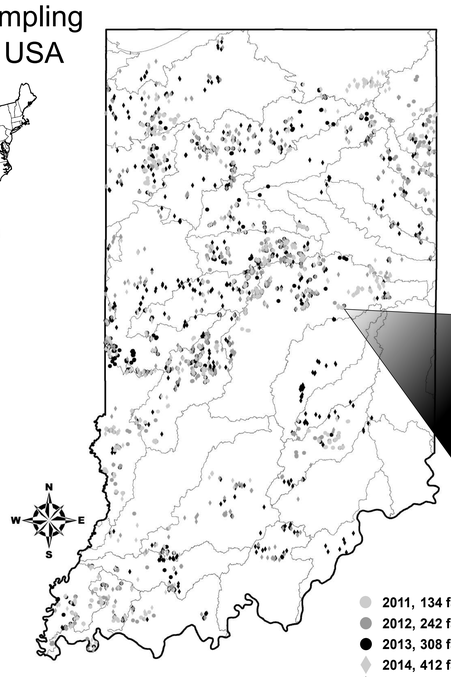
Management Practices
(> 5% of fields each year (2,105 total farms)

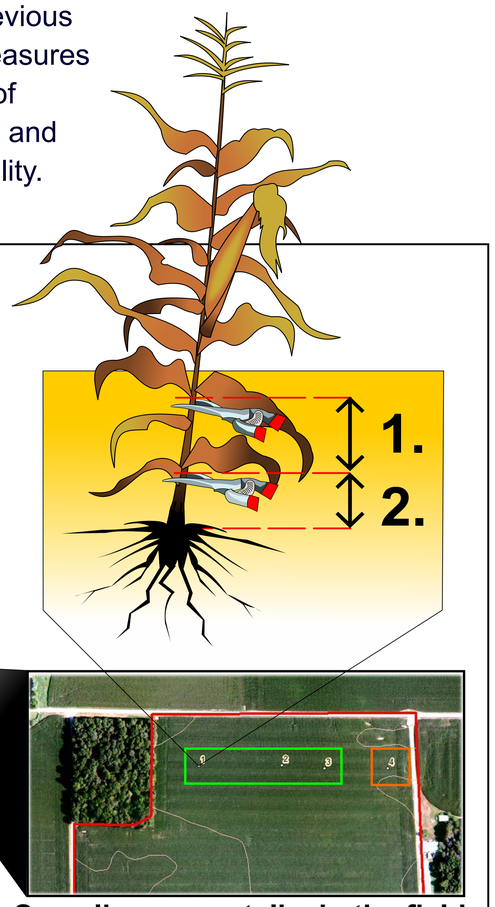
Cover Crop
Grass
2 part mix
3 part mix
None

N form and timing
NH_3 in season
NH_3 spring
NH_3 fall
Starter in season
UAN in season
Urea in season

Previous crop
Corn
Soybeans

Tillage
Fall
Spring
Fall and Spring
Strip Till
No till





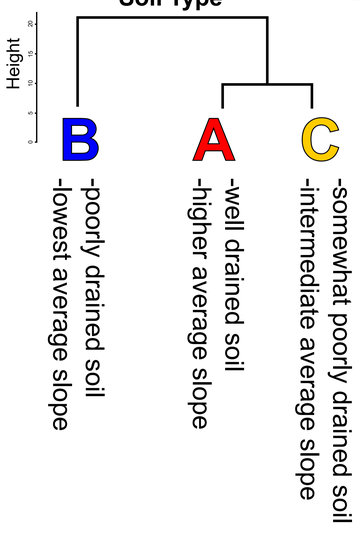
Sampling corn stalks in the field:

1. **Test segment 8" in length**
2. **Bottom of segment 6" above ground**

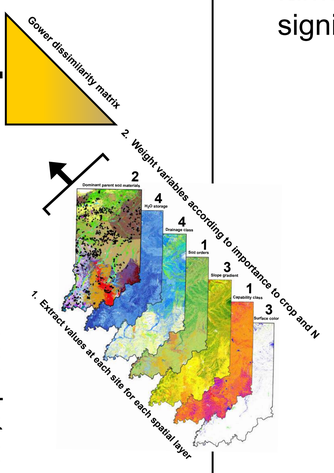
Corn stalks were sampled after physiological maturity (blacklayer). Three locations were selected as **"typical"** based on aerial imagery. A fourth location was selected based on **"stressed"** appearance.

2. Constructed a new composite variable based on:

Ward's Clustering



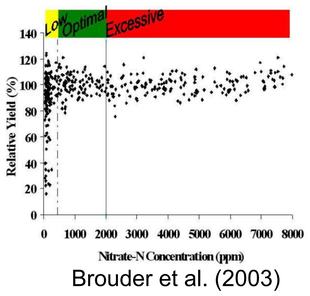
(Some predominant features)



3. Use continuation ratio logit models to determine management factors commonly used by IN farmers and soil property variable levels that have significant influence on stalk nitrate status

Stalk [NO_3-N] ppm (continuous)

Reclassified to:
"Low"
"Optimal"
"Excess"



Brouder et al. (2003)

Continuation ratio logit model
(with proportional odds or nonproportional odds)

"Low" < 450 ppm
"450 ppm ≤ **"Optimal"** < 2000 ppm
"Excess" ≥ 2000 ppm

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Tillage
Previous crop
Cover crop
N form and timing
Total N
Soil type
Precipitation
(Spring or Season cumulative)

Results and Discussion

Significant results of continuation ratio logit models (2011 - 2016)

Interpreting the model

Nonproportional vs. Proportional

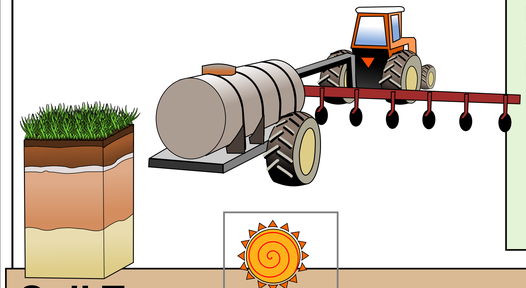
When the odds ratio is > 1: there is a greater chance to test in higher categories vs. "low" when compared to the reference category

When the odds ratio is > 1: there is a greater chance to test in "excess" vs. "optimal" when compared to the reference category

When the odds ratio is > 1: there is a greater chance to test in a higher category vs. staying in a category when compared to the reference category

Note: When odds ratio is < 1, there is a smaller chance...
When odds ratio is = 1, there is an equal chance...

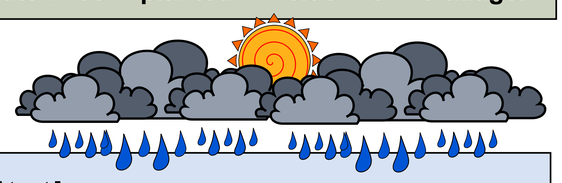
* Significant at p < 0.05 level
** Significant at p < 0.01 level
*** Significant at p < 0.001 level
Italic inidicates reference factor level
UAN: Urea-ammonium nitrate sol'n



Tillage

	2011		2013		2014	2015		2016	
	1	2	1	2		1	2	1	2
None									
Fall		2.8*	0.3**						
Spring				1.7*	1.3*		1.5*	2.4***	1.8***
Fall & Spring				2.6***			2.8***	2.1***	2.0***
Strip till	0.4*								
Vertical								1.7**	2.1***

Generally, nitrate in corn planted in fields with either "Spring" or "Fall & Spring" tillage is more likely to be in a higher stalk nitrate category than nitrate in corn planted in fields with no tillage.



Precipitation

(Spring or Season cumulative)

	2012		2013		2014	2015, 2016	
	1	2	1	2		1	2
Rainfall (cm)	1.0*	1.1**		0.9***	1.0***		1.0***

As precipitation increases by 1 cm, there is an approximately equal chance that nitrate in corn test in a higher category or remain in the current category.

N form, timing

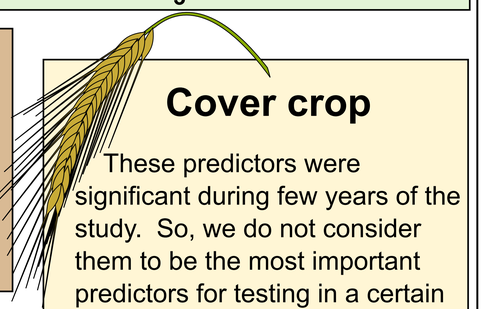
	2011		2013		2014	2015		2016	
	1	2	1	2		1	2	1	2
NH_3 in season									
NH_3 spring	0.4**				0.7**			0.6**	0.8*
NH_3 fall			0.4***	0.5*					
Starter in season	0.5**					0.3***			
UAN in season			0.6**	0.7*	0.5***		1.6*	0.5***	0.6***
Urea in season							2.8***		

The odds of being in a higher stalk nitrate category for nitrate in corn fertilized with other N forms were generally lower than the odds for nitrate in corn fertilized with "NH_3 in season".

Soil Type

	2012		2013		2014	2015		2016	
	1	2	1	2		1	2	1	2
A (well drained)									
B (poorly drained)	1.6*	3.0***	0.7*	0.6**	0.7***	0.6***	0.5***	0.9**	
C (somewhat poorly drained)	1.9**					0.6**	0.5***		

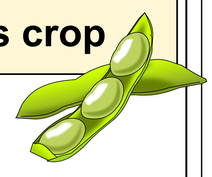
During non-drought years, nitrate in corn planted in poorly drained soil is less likely to test in "optimal" or "excess" than nitrate in corn planted in well drained soil.



Cover crop

These predictors were significant during few years of the study. So, we do not consider them to be the most important predictors for testing in a certain stalk nitrate test categroy.

Previous crop



Total N

	2011		2013		2014	2015		2016	
	1	2	1	2		1	2	1	2
Total N, kg/ha	1.0*			1.0***	1.0***	1.0***	1.0***		1.0***

As total N applied increases by 1 kg/ha, there is an equal chance that nitrate in corn test in a higher category or remain in the current category.

Most important predictors included tillage type and N form and application timing, followed by total N applied, precipitation, previous crop and cover crop planted. Furthermore, our soil property variable also had a significant influence on stalk nitrate status. This study further demonstrates the value of growers to provide important field information to determine important variables impacting N availability across a given farming region.

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Questions?
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