Is Dribble Banding Liquid Suspensions Still Relevant?

Jacob Vossenkemper, PhD – Agronomy Lead

FFF Technology Workshop – Council Bluffs, IA Dec 11-12th 2019

FFF Tech Workshop

SCIENCE DRIVEN DECISIONS

Manage Research & Development

Sales Support (grower meetings/key account visit's)

FFF Tech Workshop

SCIENCE DRIVEN DECISIONS

Lead Agronomic Trainings

Agronomic Service Calls

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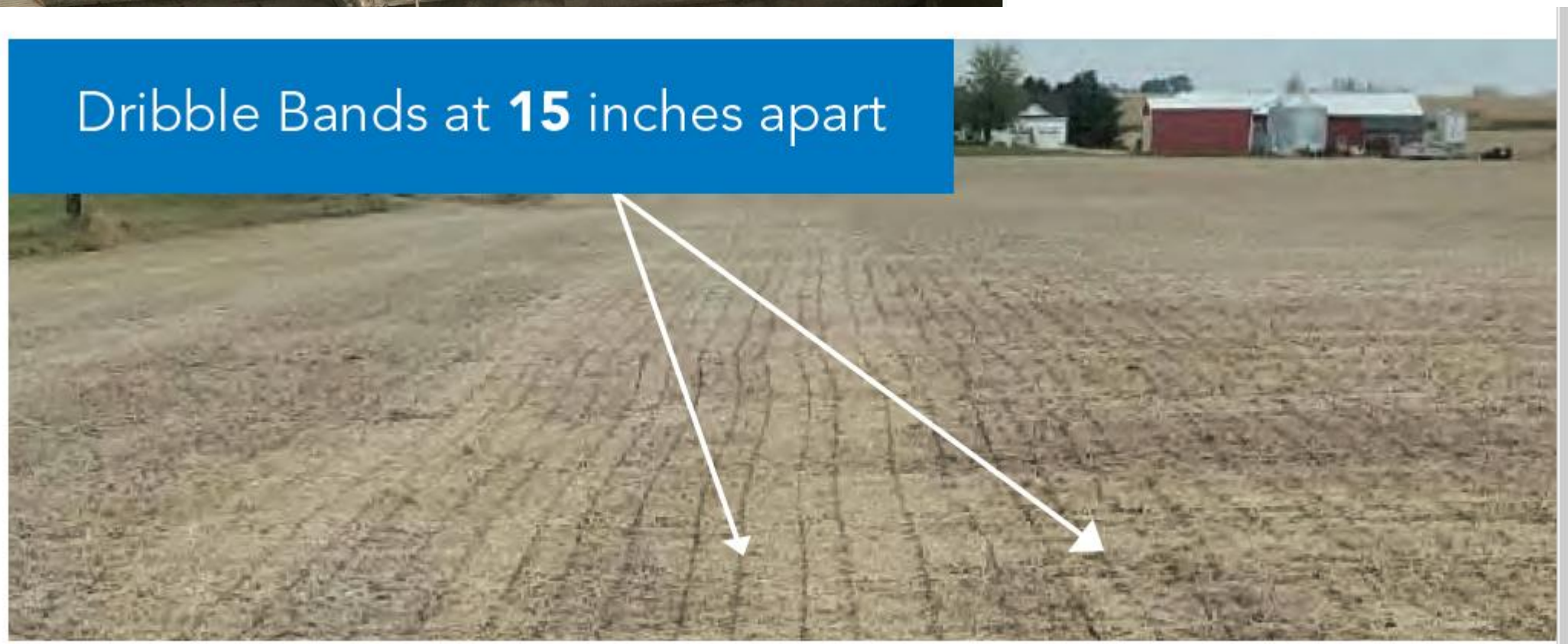
What are Liquid Suspensions?



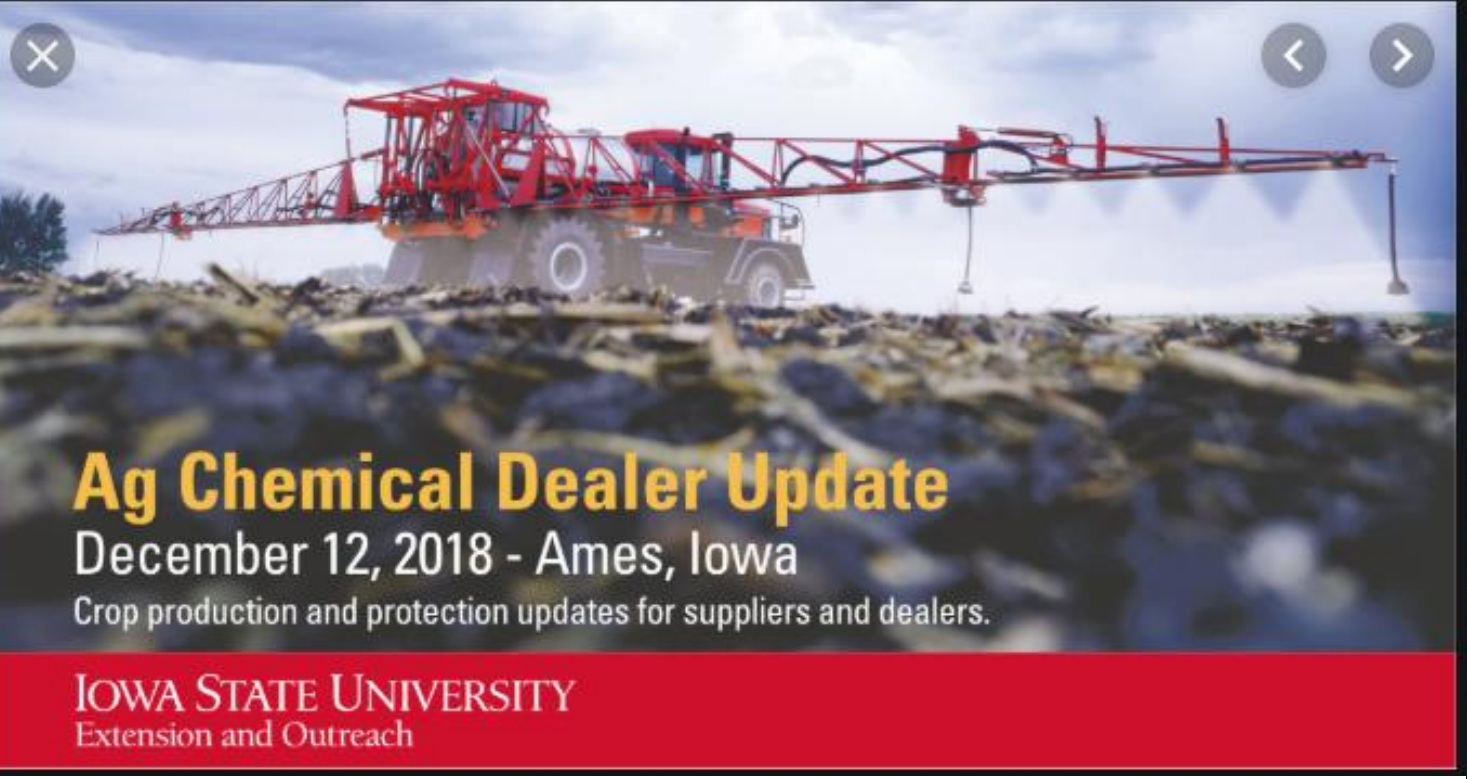
- **Add about 3% clay, 1 gallon of water can now hold about 3 lb of KCL in suspension**

Extremely High Surface Area

What are Liquid Suspensions?

Why might dribble banding liquid suspensions still be relevant?

- Accurate and uniform N, P and K applications – compared to dry broadcast
  - Particularly when it comes to VR P&K applications
- Flexibility to band nutrients – potential for increased agronomic effectiveness
- Co-applied N, P, K, S and micro nutrients – what agronomic advantages may this offer?
- Are fluid sources of phosphorus more plant available than MAP or DAP – long debated

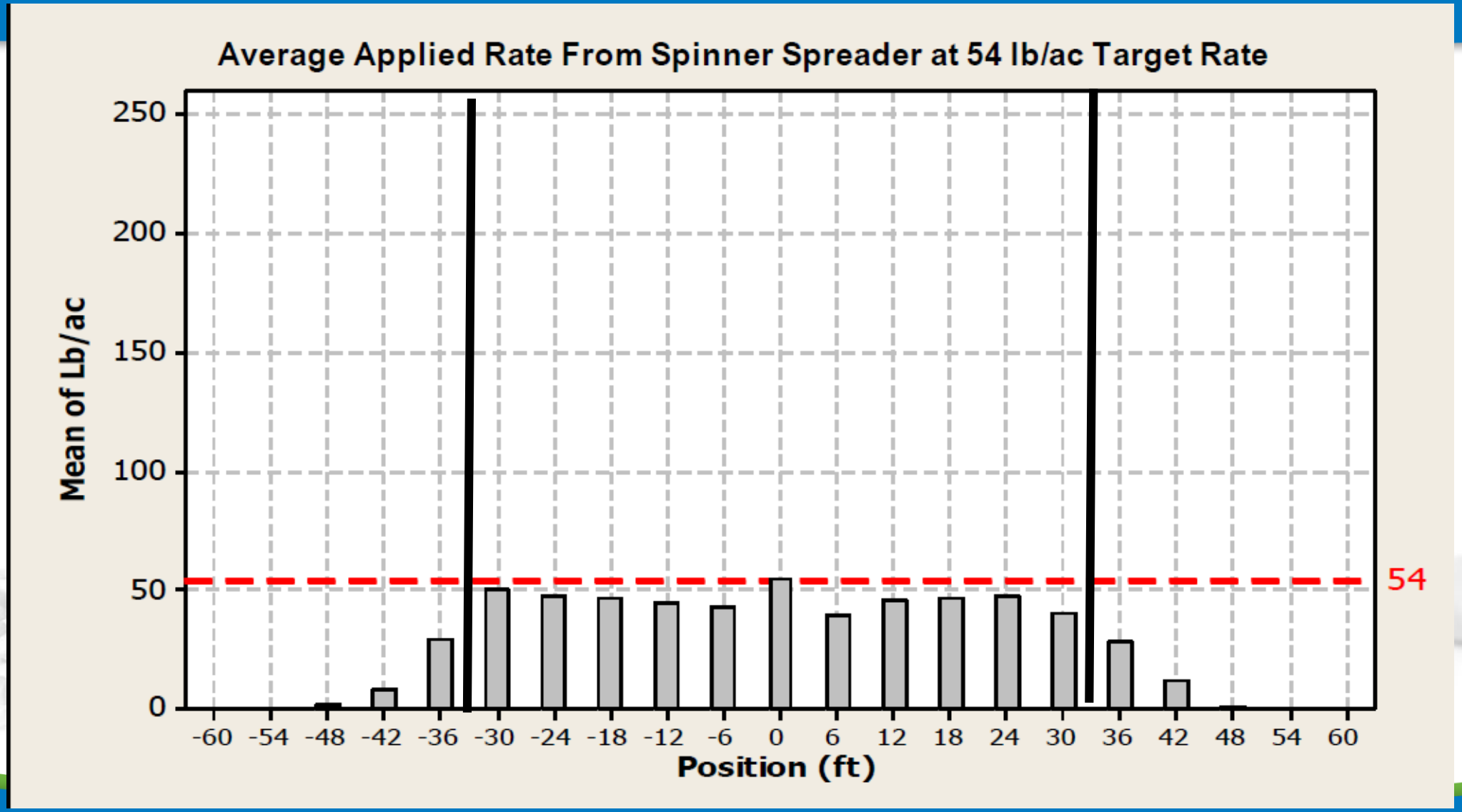


“Recent technology and research updates in fertilizer spreading” Presented by Dr. Matt Darr Professor of Ag Engineering

Fertilizer Application Uniformity – Iowa State Univ 2018

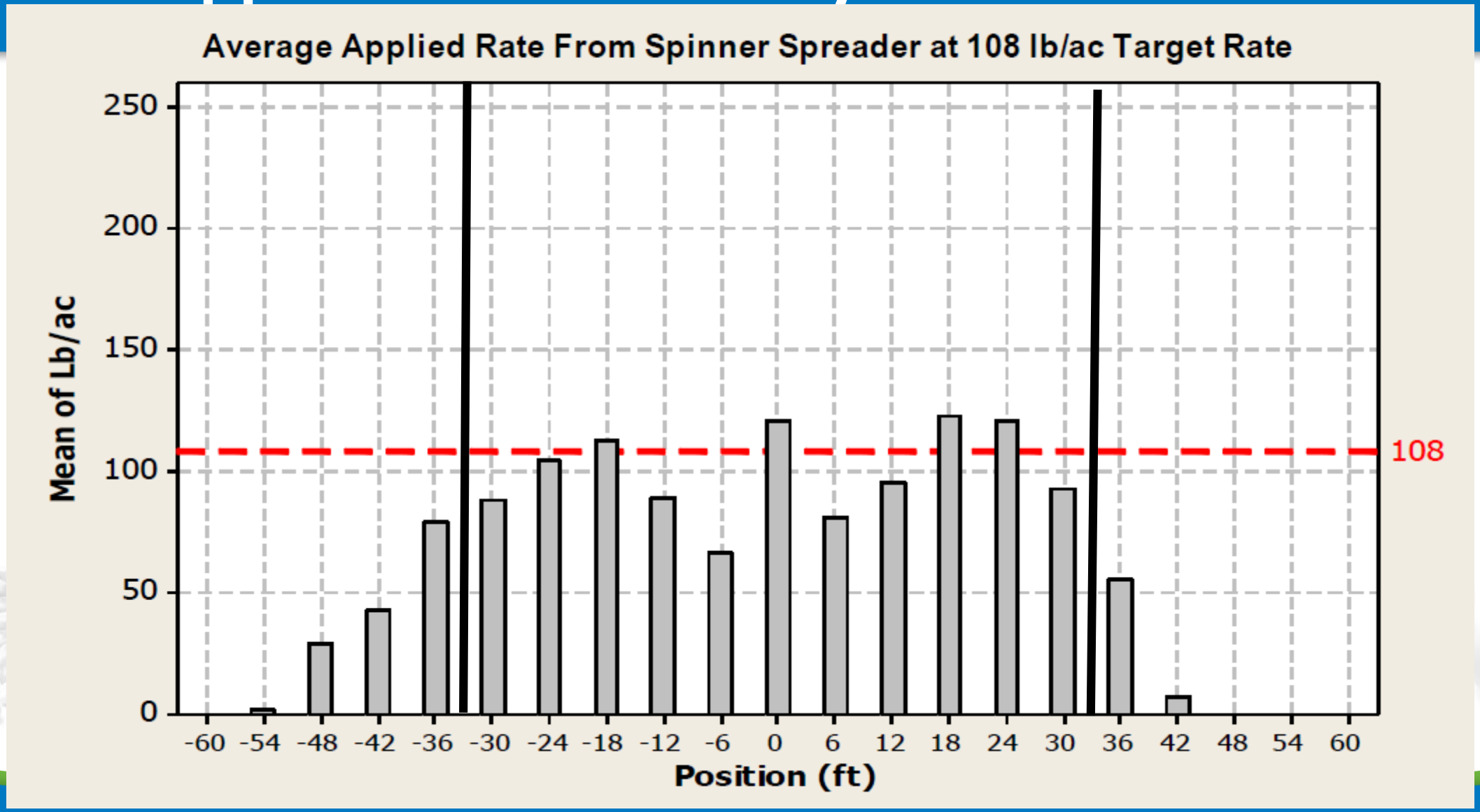
Brand new New Leader L4500G4 spinner bed, just calibrated for a 60 ft swath width

Fertilizer Application Uniformity – Iowa State Univ 2018



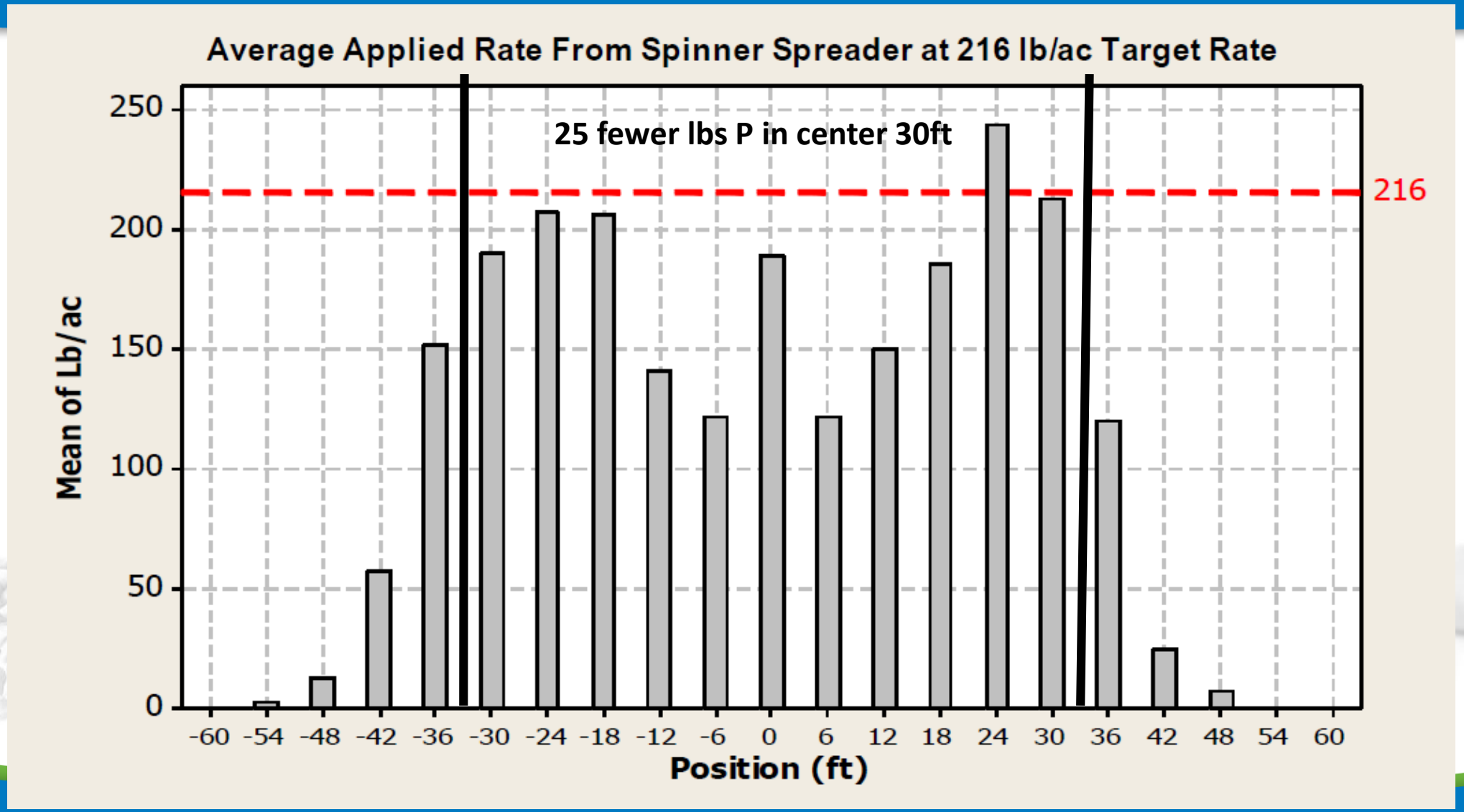
54 lbs of fert material/ac = 24.8 lbs P from DAP

Fertilizer Application Uniformity – Iowa State Univ 2018



108 lbs of fert material/ac = 49.6 lbs P from DAP

Fertilizer Application Uniformity – Iowa State Univ 2018



216 lbs of fert material/ac = 99 lbs P from DAP

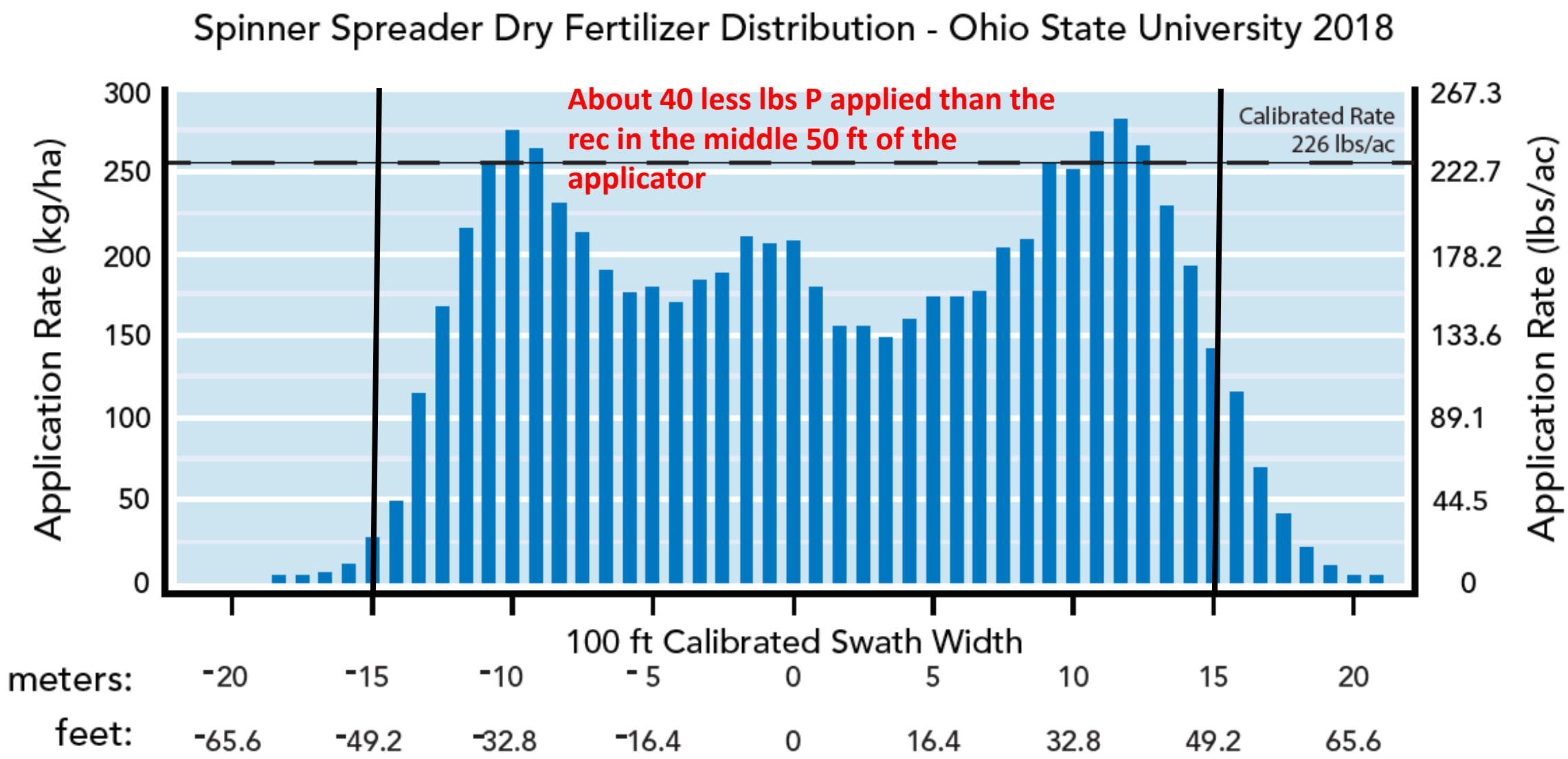
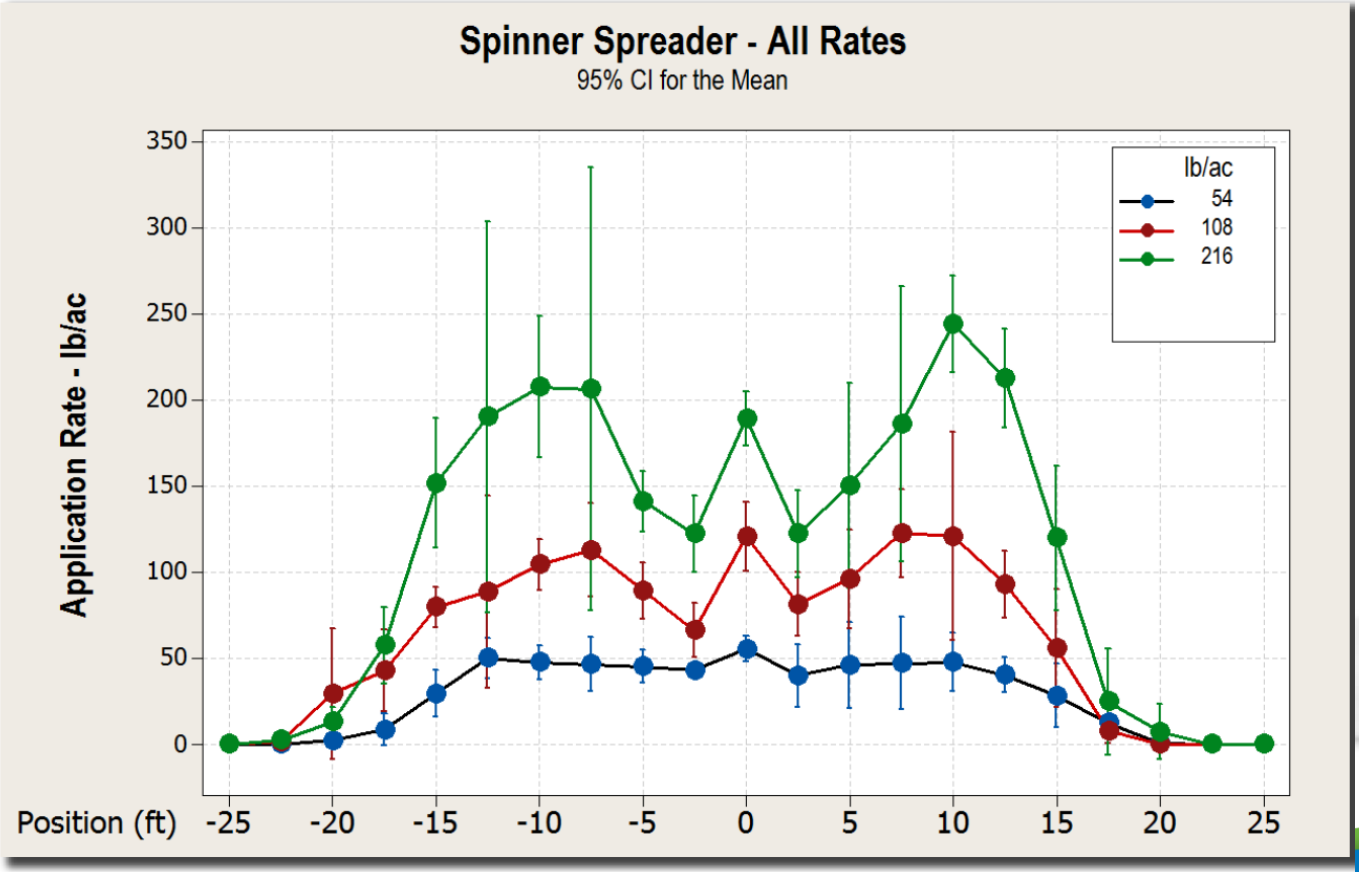


Figure 1. DAP distribution from a modern dry fertilizer spinner spreader calibrated to apply across a 100 ft swath. Figure originated from Colley et al., 2018.

Fertilizer Application Uniformity – Iowa State Univ 2018

Key Conclusion: Spinner Spreader Bare Ground Testing

- Characteristic W pattern is typical of spinner spreader performance particularly across rate changes.
- Agronomically this results in yield limiting situations when used for Nitrogen application and can cause yield reductions in P&K application if fields are near deficiency.
- Pattern shifts across rate make pre-application calibration difficult under variable rate application scenarios.



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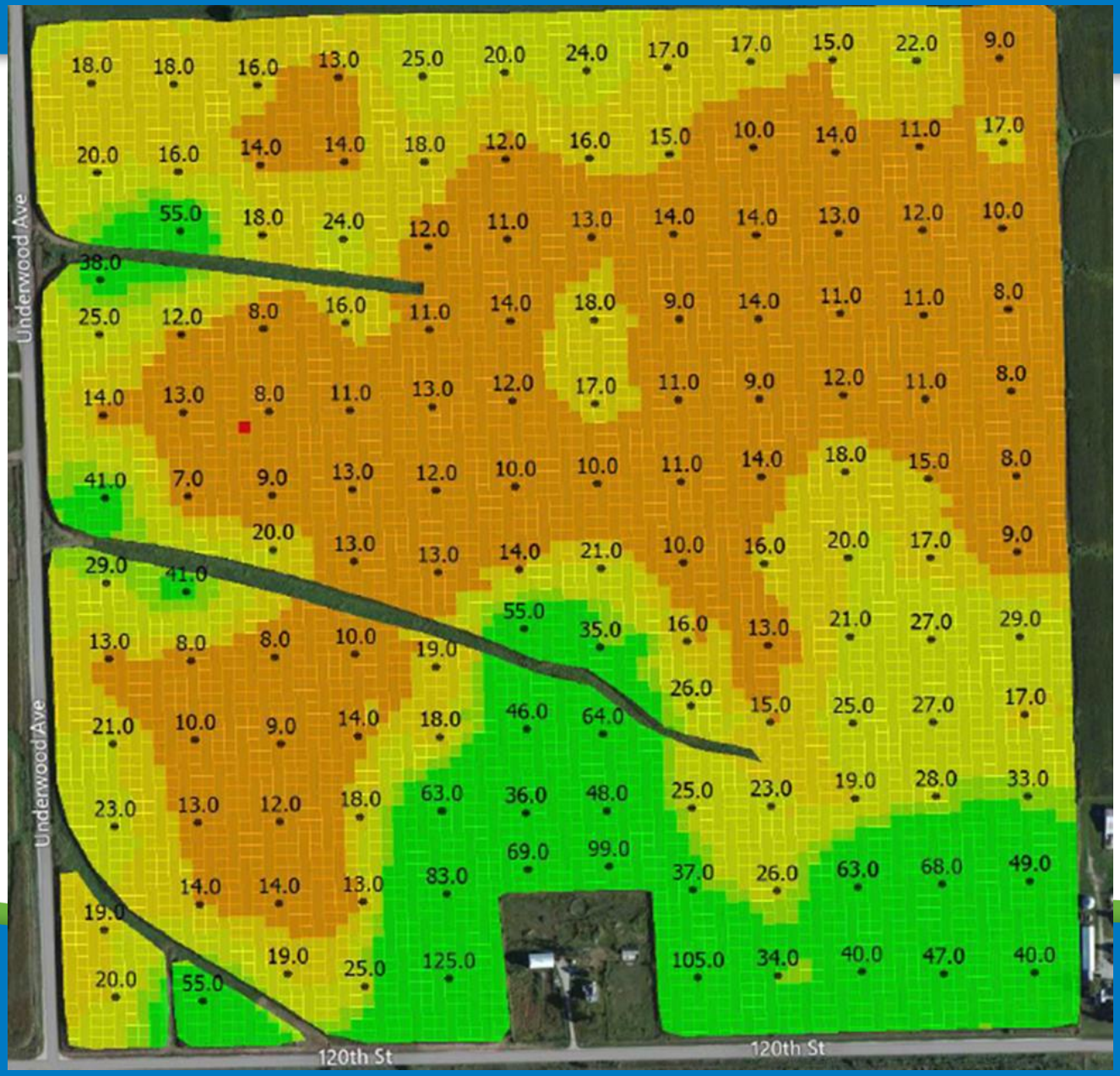
OF SCIENCE AND TECHNOLOGY

Fertilizer Application Uniformity & Variable Rate Technology



- Poorer spread pattern performance for VR applications seems as those it could be a significant concern given large rate changes

SCIENCE DRIVEN DECISIONS

- Corn yield losses of 3% on average have been reported in university studies comparing uniformly and non-uniformly distributed P&K fertilizer (Virk et al., 2013)
- Virk et al., 2013 cited several papers and extension talks from the 70's, only one of which I could find.

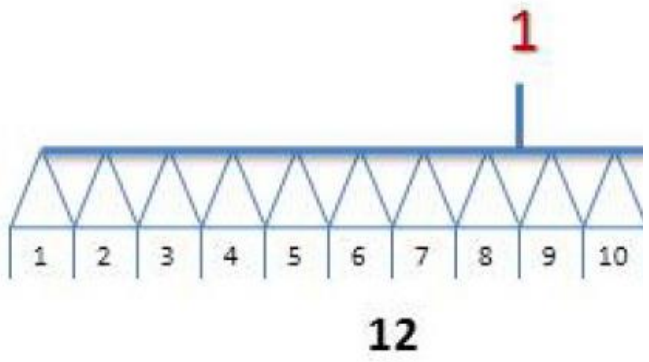
Kansas State Univ

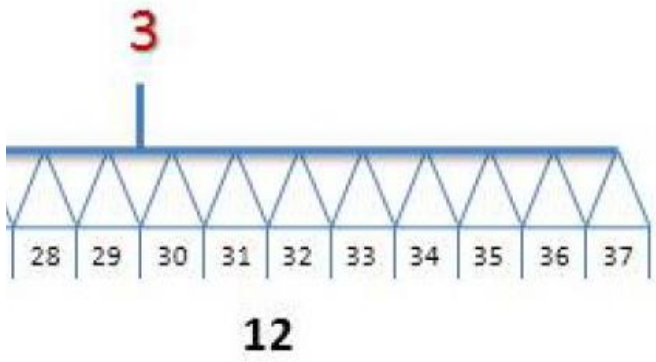
CIENCE DRIVEN DECISIONS

PERFORMANC FOR LIQ

FICE NOZZLES ICATIONS

or





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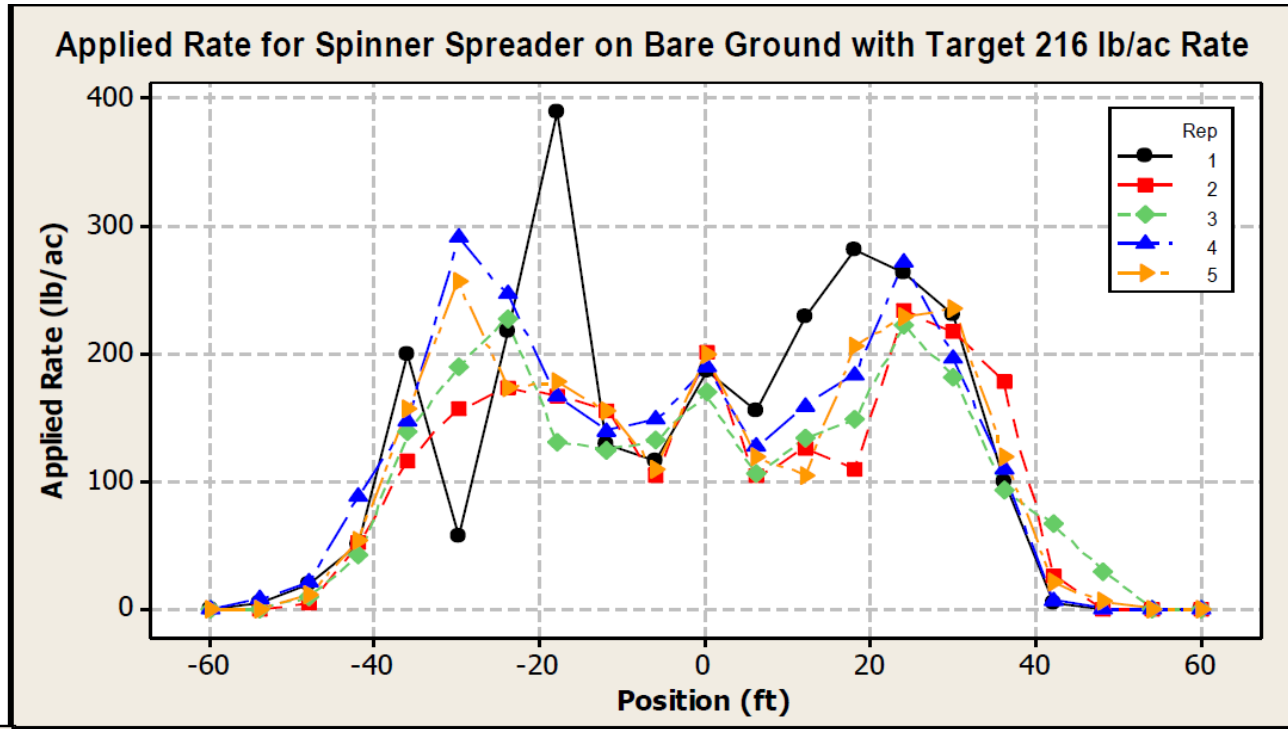
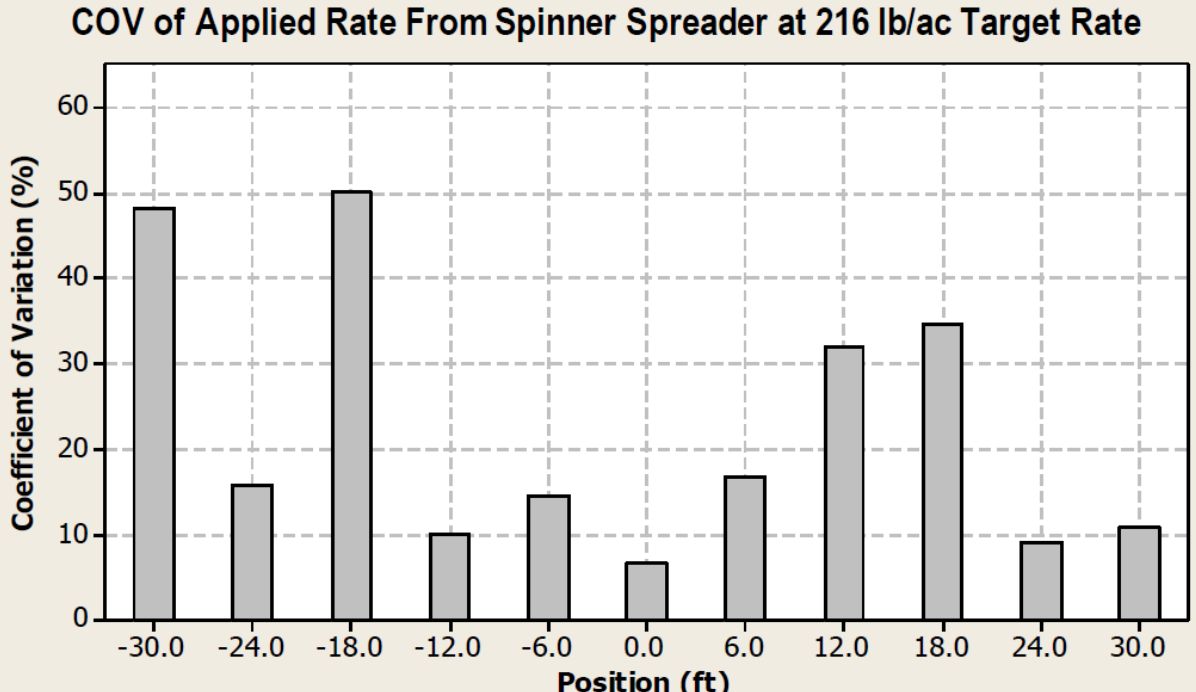
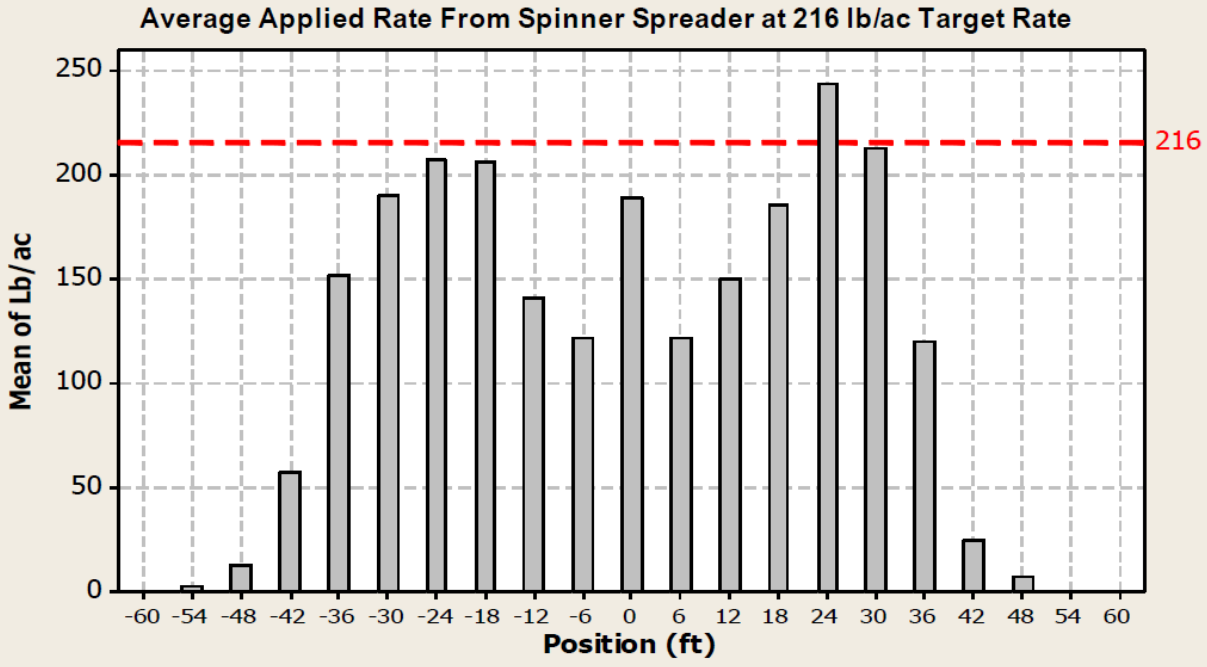
Spinner Spreader Pan Test – 216 lb/ac

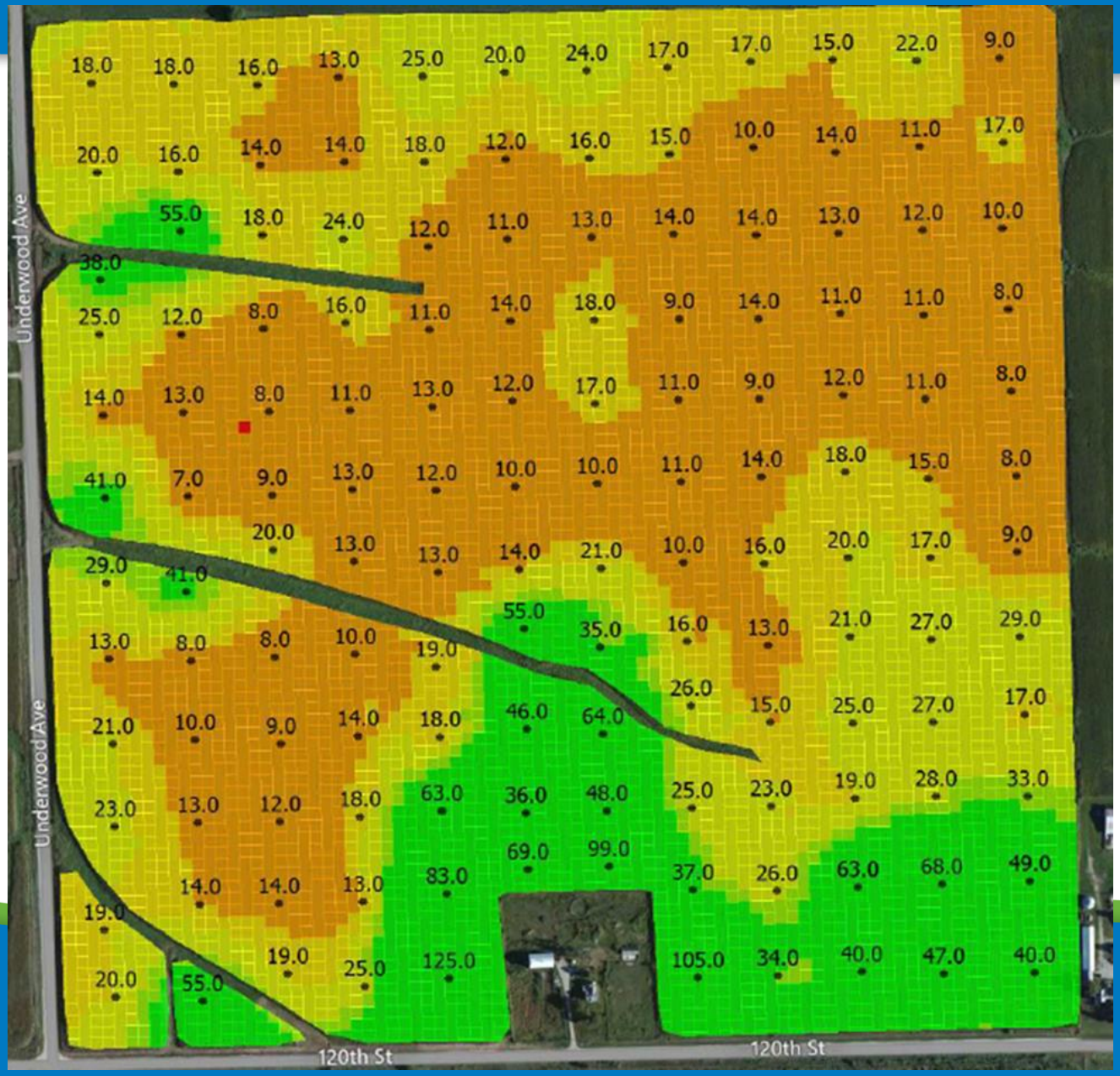
Comments: COV of 33% across the width.
Average COV of 22% at a single position.







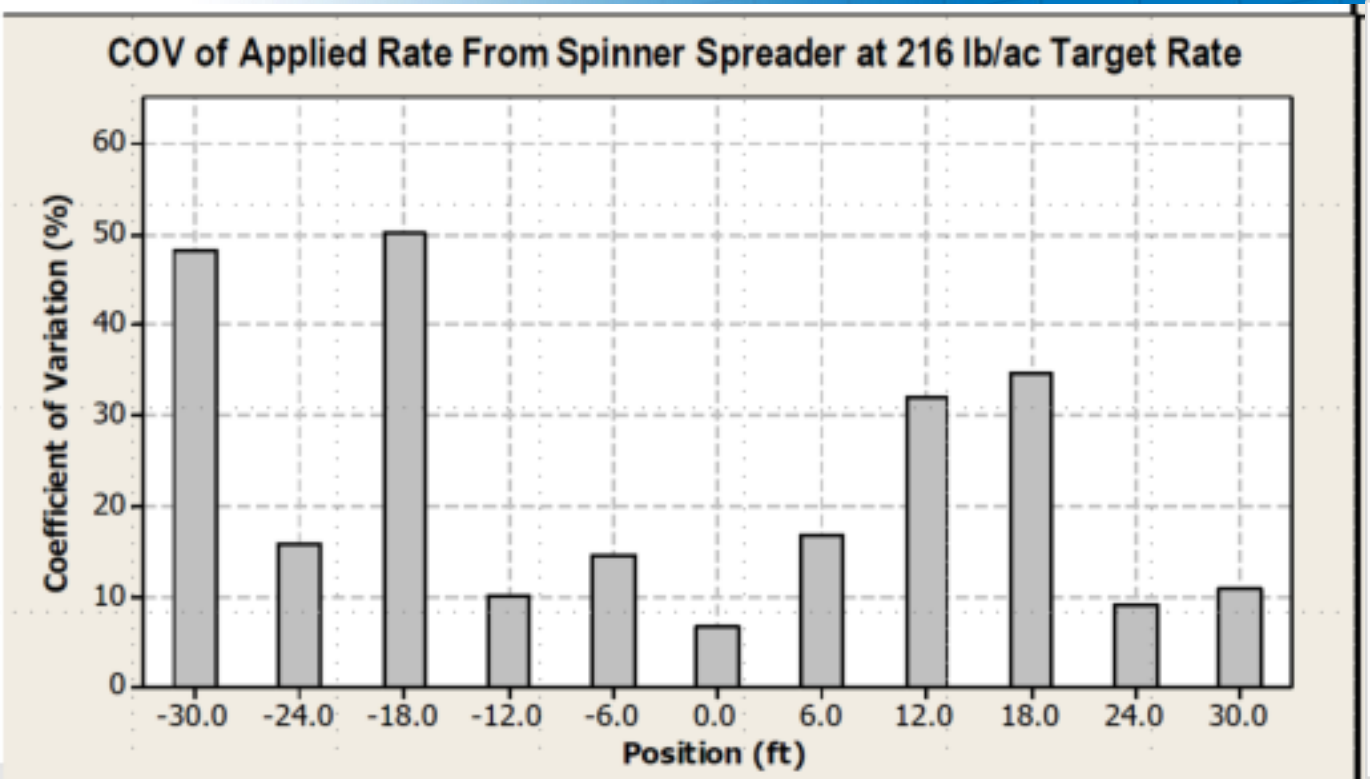
Fertilizer Application Uniformity & Variable Rate Technology

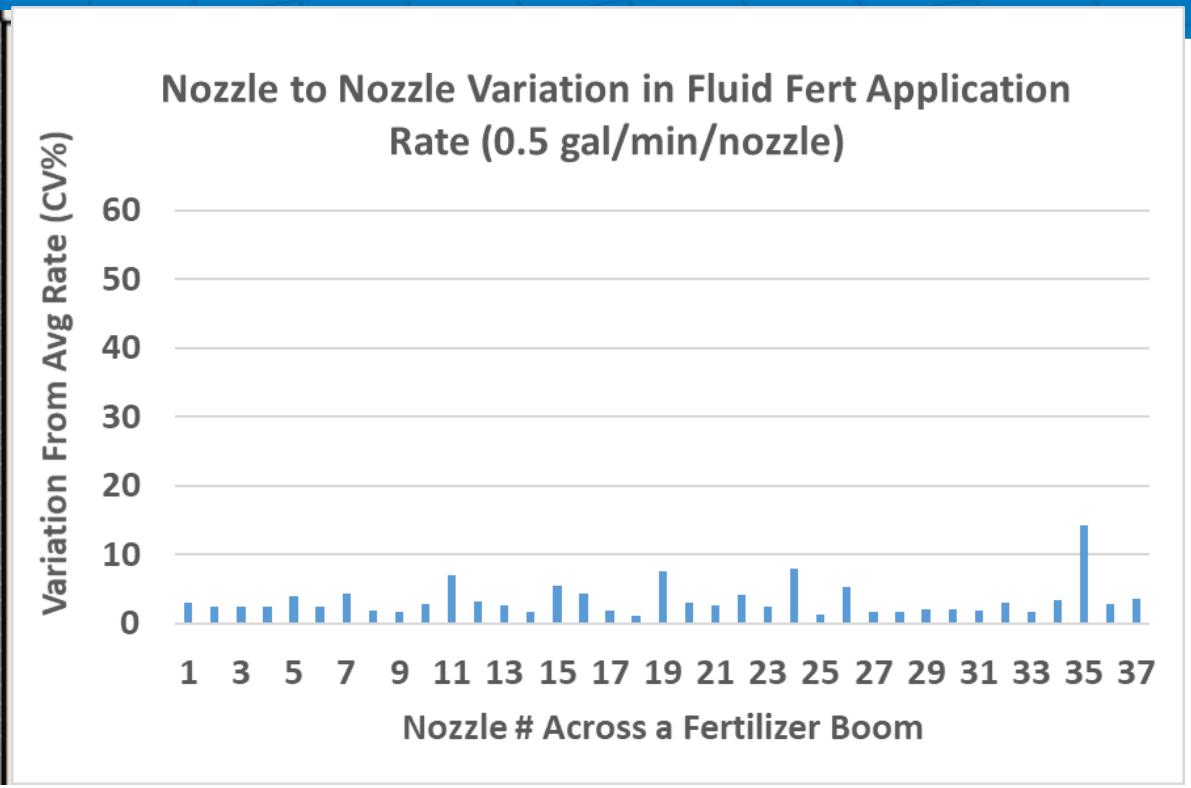


- Not confident that recommend rate is being applied in area's of the field that will maximize crop response and profitability

Kansas State Univ - 2016

SCIENCE DRIVEN DECISIONS





Dry Spinner = 33% variation from target rate across the swath width

Fuid Fert = 3.4% variation from target rate across the boom

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Fertilizer Application Uniformity & Variable Rate Technology

Table 4.4. Summary information for the "as-applied" surface for field A.

Total number of points	952
Application rate (kg/ha)	
Minimum	0.0
Maximum	557.3

		Percent Correct (%)	
Range (kg/ha)	**Percent of Points**	**Within 5 kg/ha**	**Within 10 kg/ha**
0.0	40.0	72.0	80.0
78.3 - 80.0	11.8	8.0	18.8
80.1 - 90.0	21.6	16.5	27.7
90.1 - 100.0	7.1	13.2	23.5
100.1 - 110.0	3.9	10.8	27.0
110.1 - 120.0	6.4	14.8	29.5
120.1 - 166.2	9.6	6.6	12.1

9 lb/ac

Fulton, 2003 – Univ of Kentucky

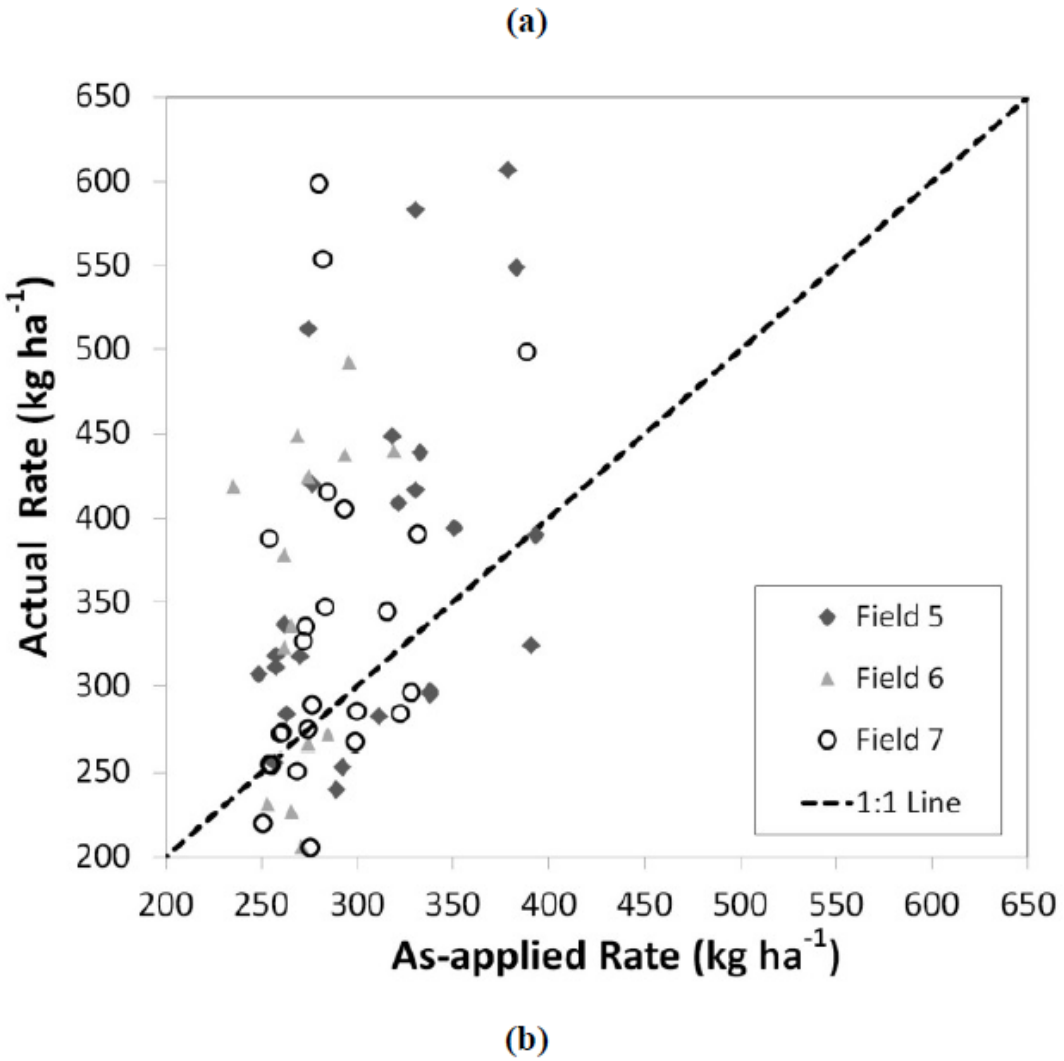
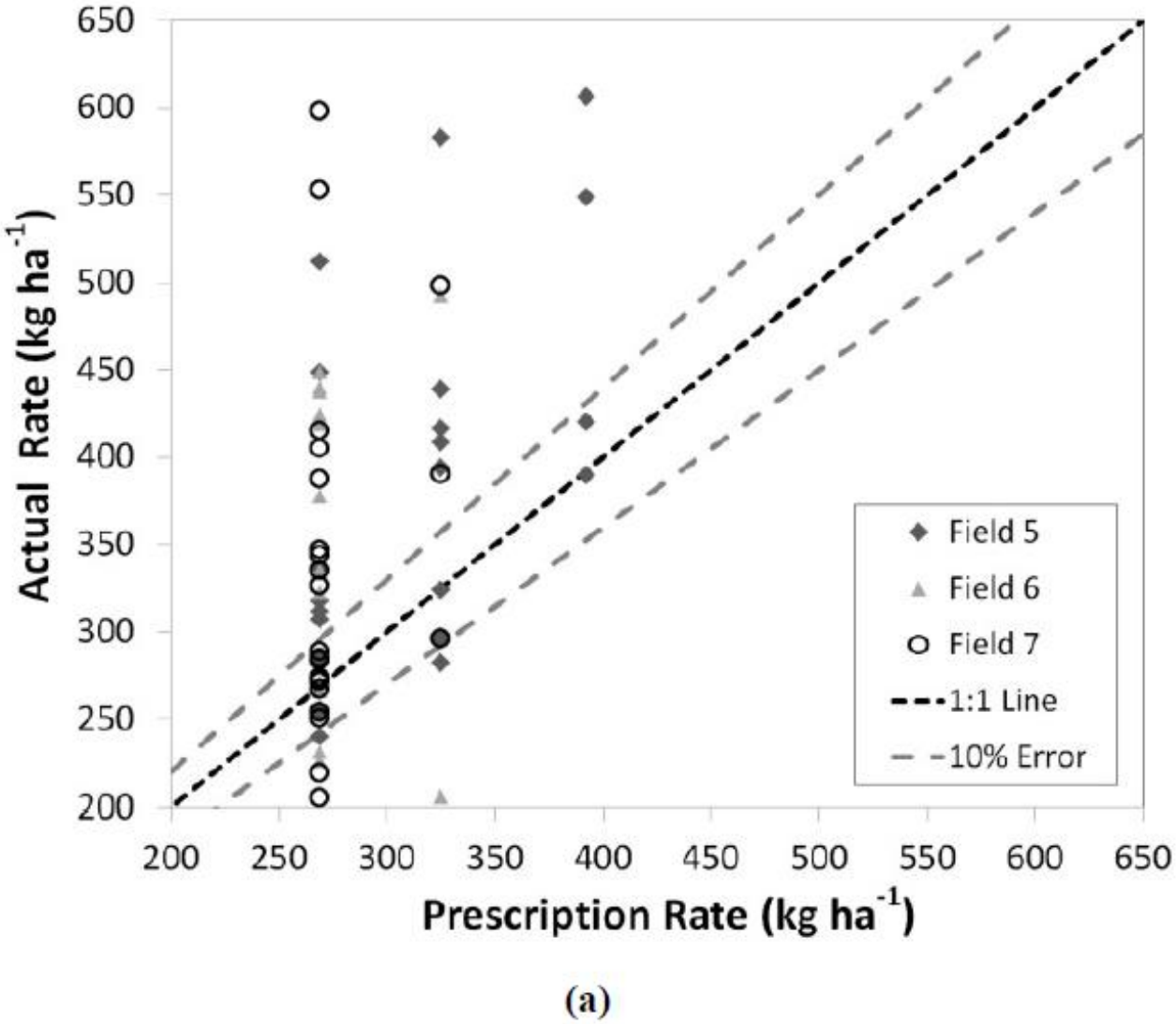
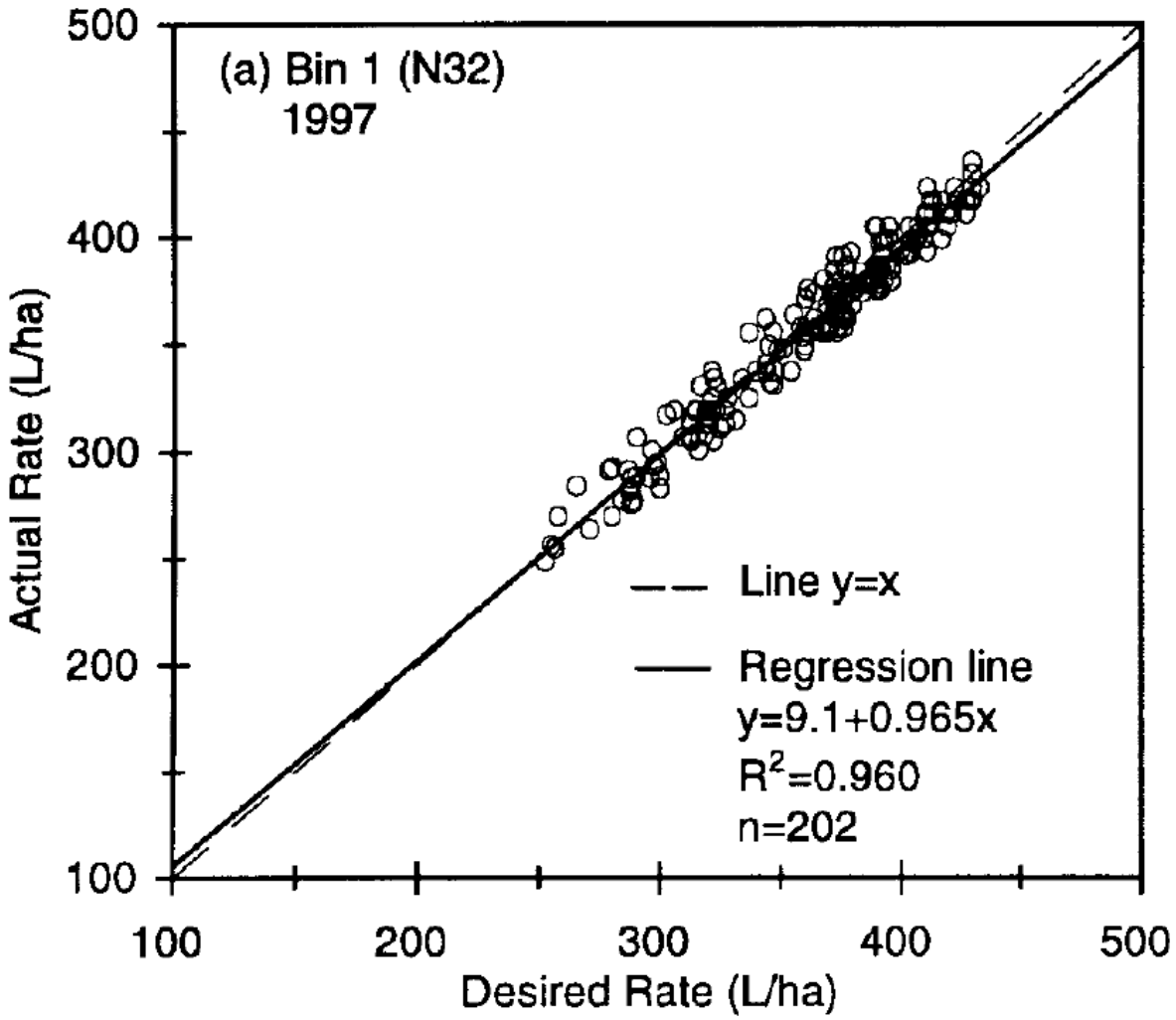


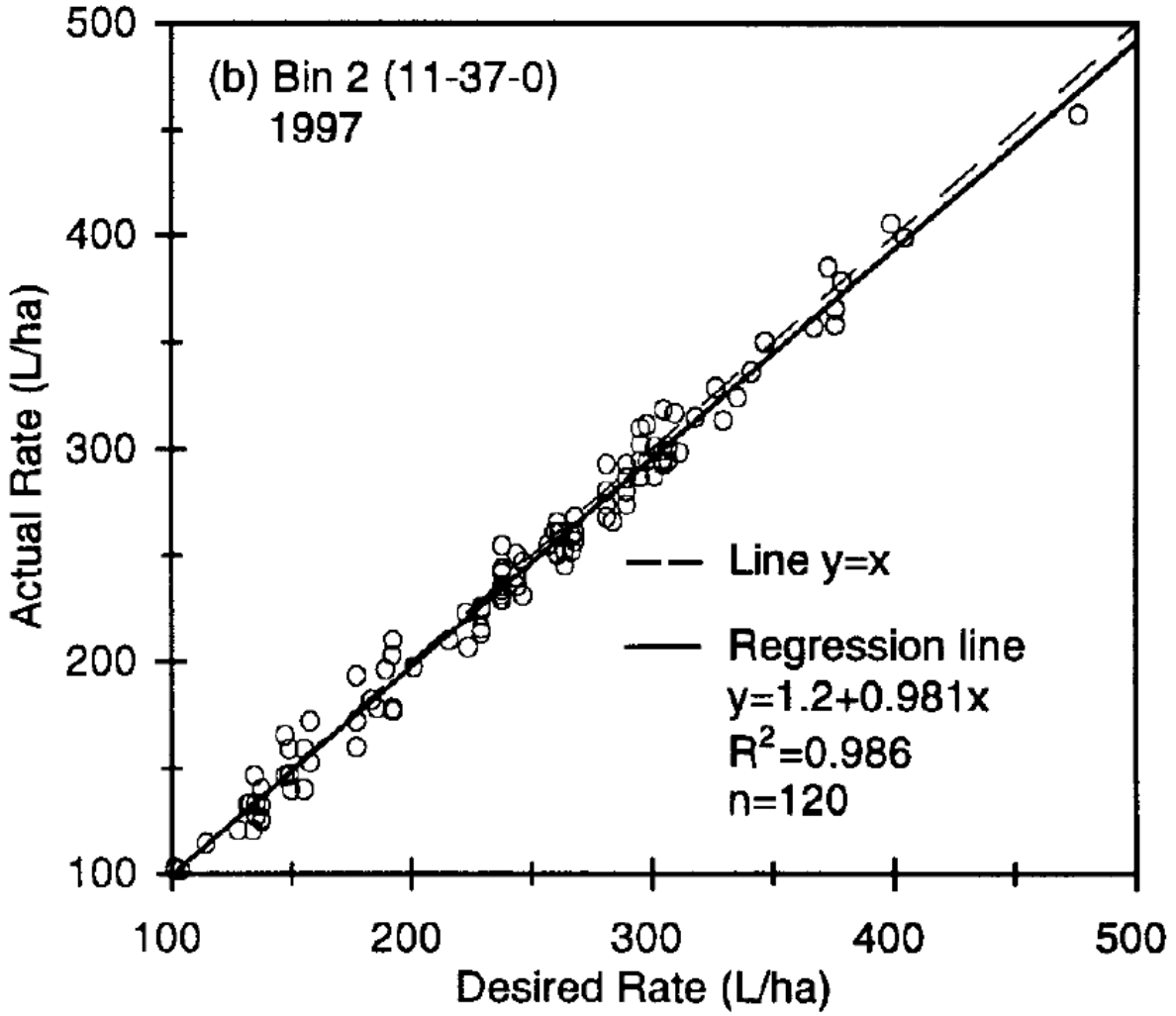
Figure 3. Comparison between actual and prescription (a) and actual vs. as-applied map rates (b) for the three fields.



Virk et al., 2013 – Univ of Auburn

Fertilizer Application Uniformity & Variable Rate Technology





Yang, 2001 – USDA-ARS

Does Banding Nutrients Increase Crop Yield vs Broadcasting?

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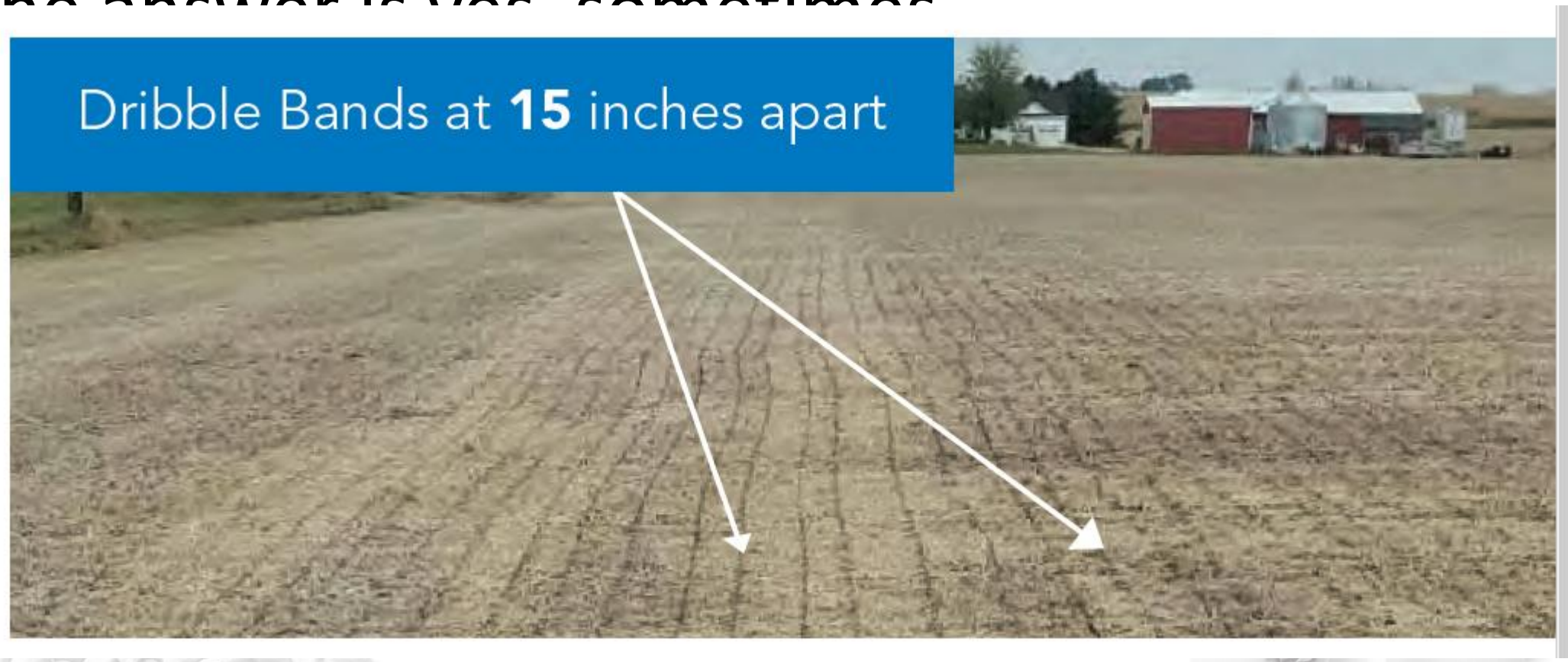
- F ot support the use of banding



Does Banding Nutrients Increase Crop Yield vs Brodcasting?

- Why a meta-analyses? – attempt to summarize many know experiments to give a general answer to an applied question
- Nkebiwe et al., 2018 summarized the results from 40 published experiments (many different crops)
- 1968 to 2012
- Priority was given to papers published in international journals and that included measurements of above ground mineral nutrient accumulation

Does Banding Nutrients Increase Crop Yield vs Brodcasting?

- In the meta-analysis corn yield was increase 4.5% (n=408, CI95% 3.6 to 5.5) by banding vs broadcasting equivalent rates of fert nutrients
- The sum of N+P+K+S above ground mineral nutrient accumulation for corn was increased by 12.2% (n=112, CI95% 8.7 to 16.1)

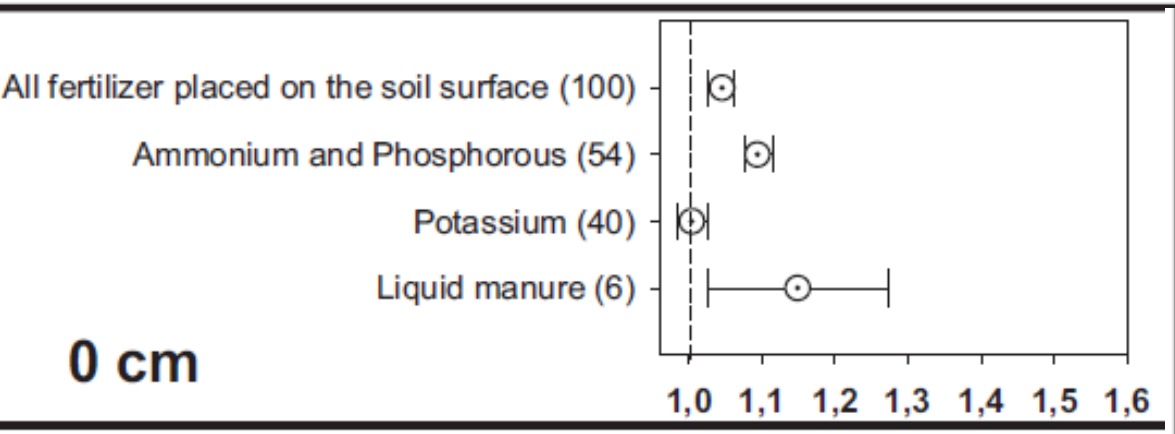
Nkebiwe et al., 2018

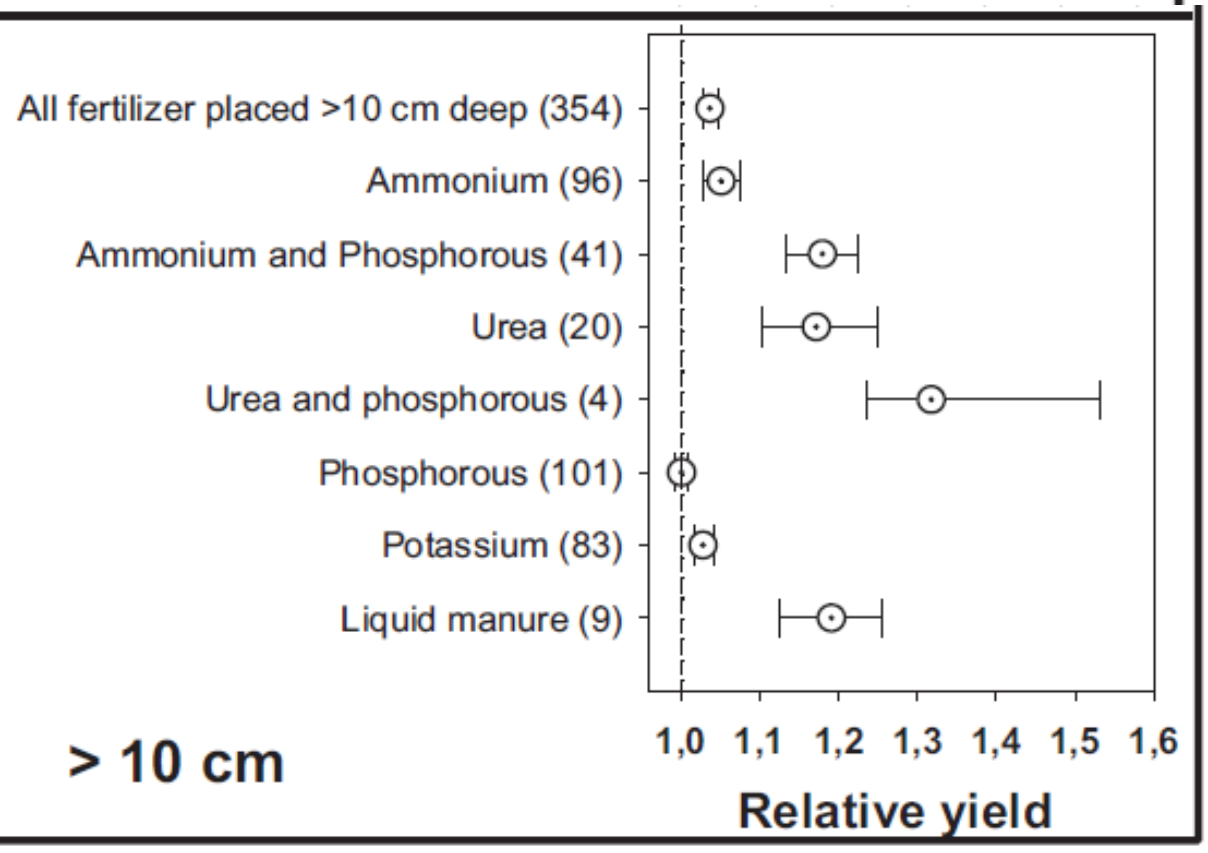
Does Banding Nutrients Increase Crop Yield vs Brodcasting?

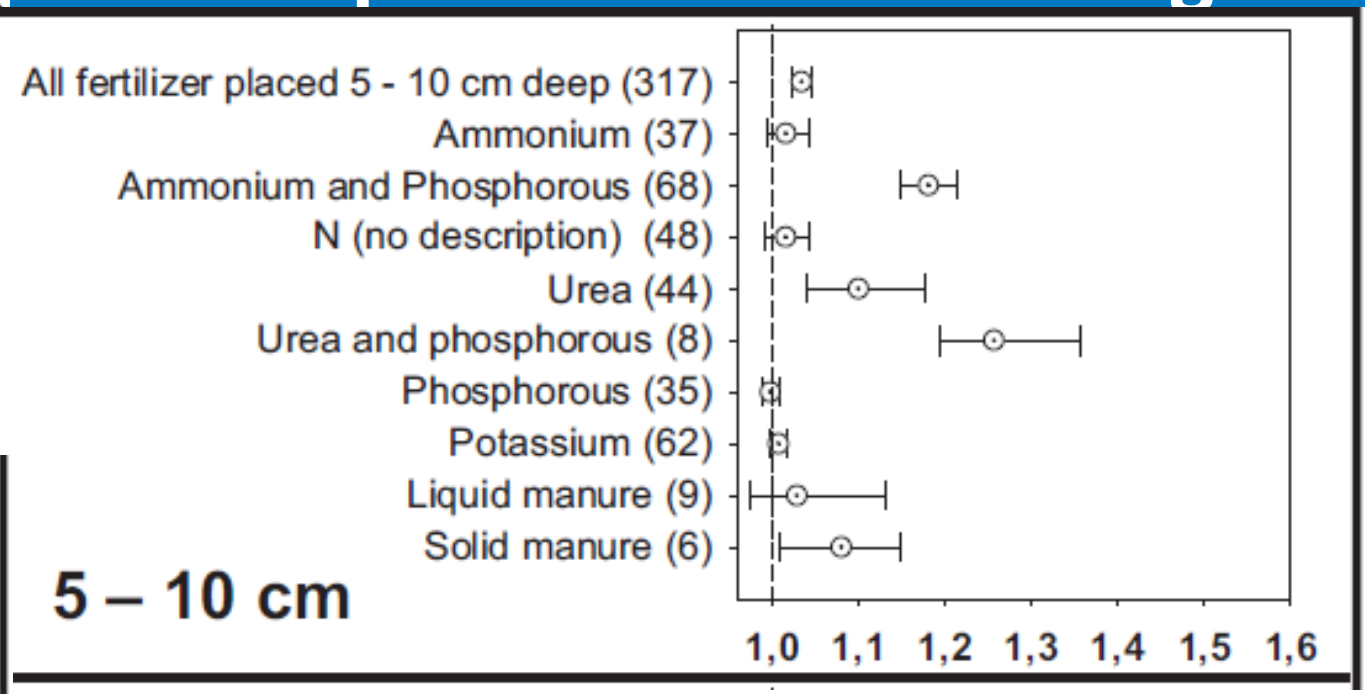
- Averaged over all crops (mostly corn, winter wheat, soybean, rape or canola)
- Surface, 2x2 and subsurface band placement increased yields vs broadcasting
- Surface 3.9% (n=101 CI95% 1.9 to 5.6)
- 2x2 3.4% (n=317 CI95% 2.4 to 4.6)
- Subsurface 4.1% (n=354 CI95% 3.5 to 5)

Nkebiwe et al., 2018

Does Banding Nutrients Increase Crop Yield vs Brodcasting?





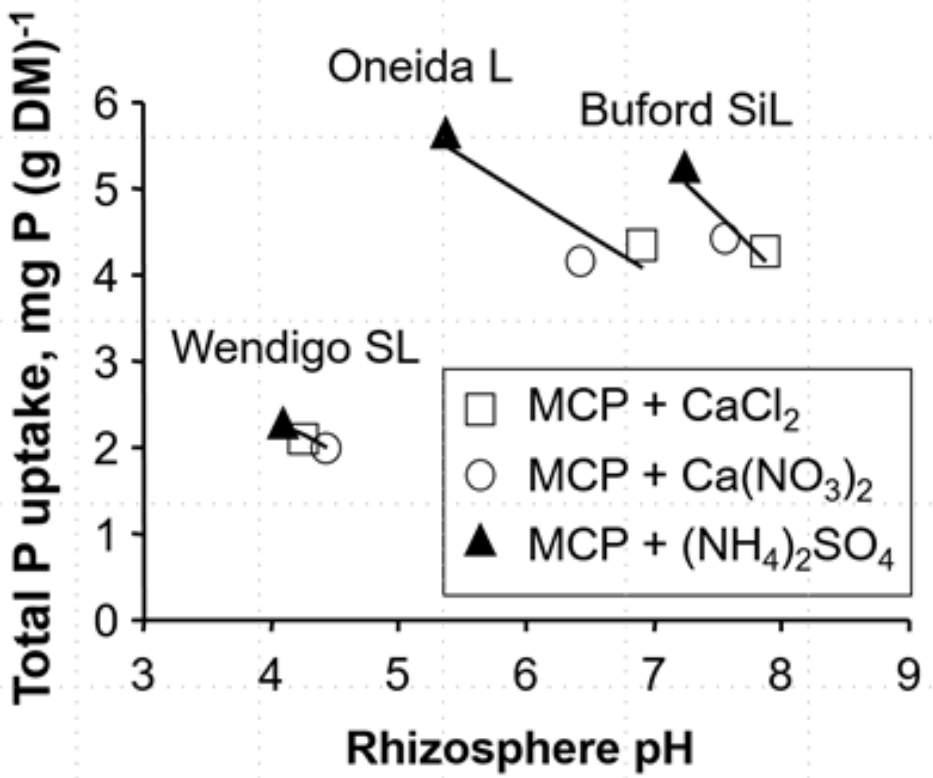


Nkebiwe et al., 2018

Does Ba ting?

Rhizosphere pH affects P uptake by corn

- 11 day old corn
- Ammonium source reduced rhizosphere pH and increased P uptake



Soon and Miller, 1977

Co-Applied Nutrients & Agronomic Importance

3 Year Experiment Walcott, IA – ST Zn 2.6 ppm

Table 2. Corn yield from the addition of .5 lb/ac of ammoniated zinc or the addition of .5 lb/ac of ammoniated zinc plus 10 lb/ac of sulfur as ATS at the Walcott research farm from 2004 to 2006. Plots were replicated 4 times each year. The price received for a bu of corn was assumed to be $3.80/bu. LSD at alpha level of 0.10 = 5 bu/ac.

Fertilizer NPKSZn (lb/ac)	Yield (bu/ac)	Yield Increase (bu/ac)
24-45-65	210.1	-
24-45-65-0.5Zn	212.9	2.8
24-45-65-10s	212.7	2.6
24-45-65-10s-0.5Zn	218.1	8.0
LSD at 0.10 = 5.1		

December 2012

Soil Chemistry

Speciation of Phosphorus in a Fertilized, Reduced-Till Soil System: In-Field Treatment Incubation Study

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Phosphorus management in reduced-tillage systems is a great concern for farmers. Conclusive positive results of deep-banding P fertilizers compared with broadcast application and the chemistry of reduced-tillage systems remain unclear. Knowledge of the dominant solid P species present in soil following application of P fertilizers and the resulting potential P availability would help us understand and efficiently manage P in reduced-tillage systems. The objective of this research was to study the influence of placement (broadcast vs. deep-band P), fertilizer source (granular vs. liquid P), and time on the reaction products of P under field conditions. Changes in soil pH, resin-extractable P, total P, and speciation of P were determined at different distances from the point of fertilizer application at 5 wk and 6 mo after P application at a rate of 75 kg ha^{-1} to a soil system that was under long-term reduced tillage. Resin-extractable P was lower for broadcast treatments compared with deep-band treatments for both time periods.

Table 1. Basic properties of North Farm soil.

Sample depth	pH	CEC†	Extractable					Total N	Total P	OM	Textural class
			M3P	Ca_{ac}	Fe_{dtpa}	Mn_{dtpa}	$Al^{3+}{}_{KC}$				
cm		$cmol_c\ kg^{-1}$	mg kg^{-1}							%	
0–7	5.9	16.1	45.4	2426.0	7.9	58.3	0.0	1598.0	423.0	3.2	SiL
7–15	5.7	20.3	19.6	2540.0	8.2	57.8	0.4	1114.0	329.0	2.3	SiCL
15–30	6.1	18.8	5.9	3174.0	27.8	25.0	0.1	1119.0	278.0	2.2	SiCL

† CEC, cation exchange capacity; M3P, Mehlich III-extractable phosphorus; Ca_{ac}, ammonium acetate-extractable calcium; Fe_{dtpa} and Mn_{dtpa}, diethylene triamine pentaaceticacid-extractable iron and manganese; Al_{KCl}, potassium chloride extractable aluminum; OM, organic matter content; SiL, silty loam; SiCL, silty clay loam.

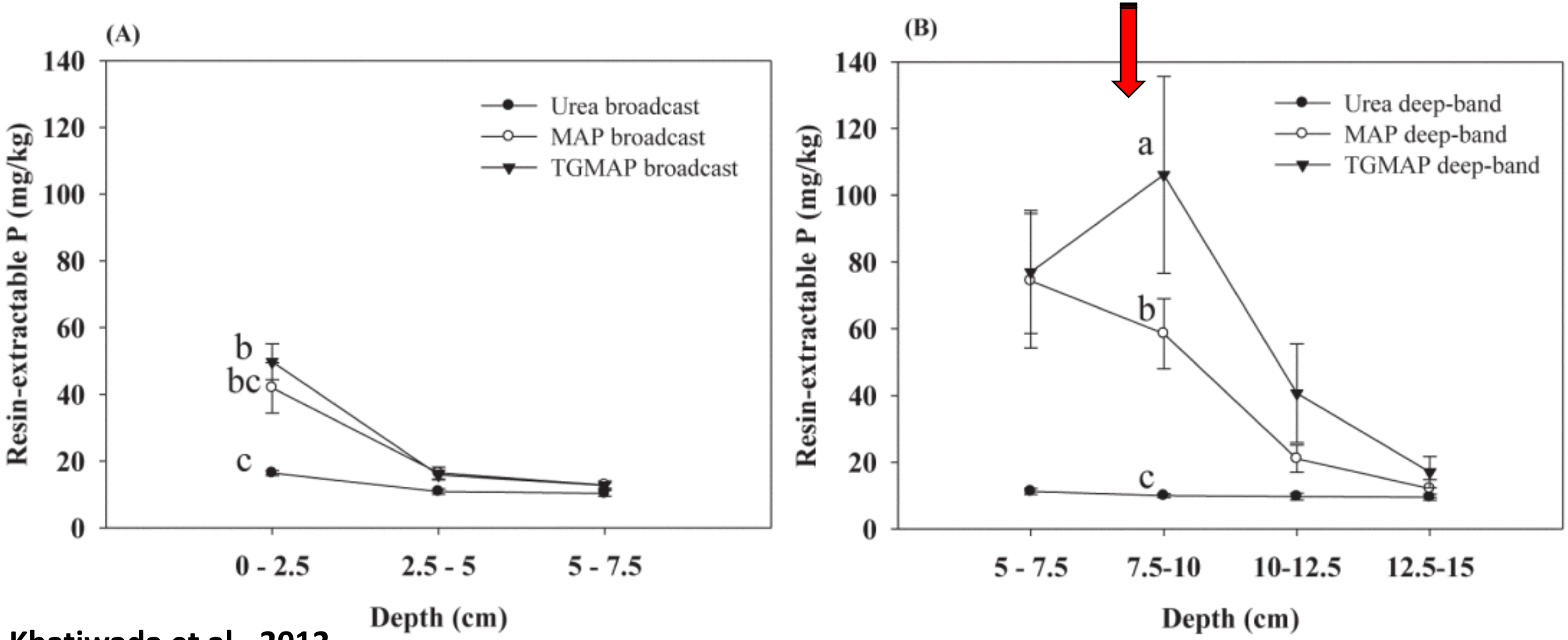
4 Treatments

1. Broadcast Granular MAP
2. “Deep Band” Granular MAP
3. Broadcast fluid MAP
4. “Deep Band” Fluid Map

Objective

How do these treatments effect potentially plant available P?

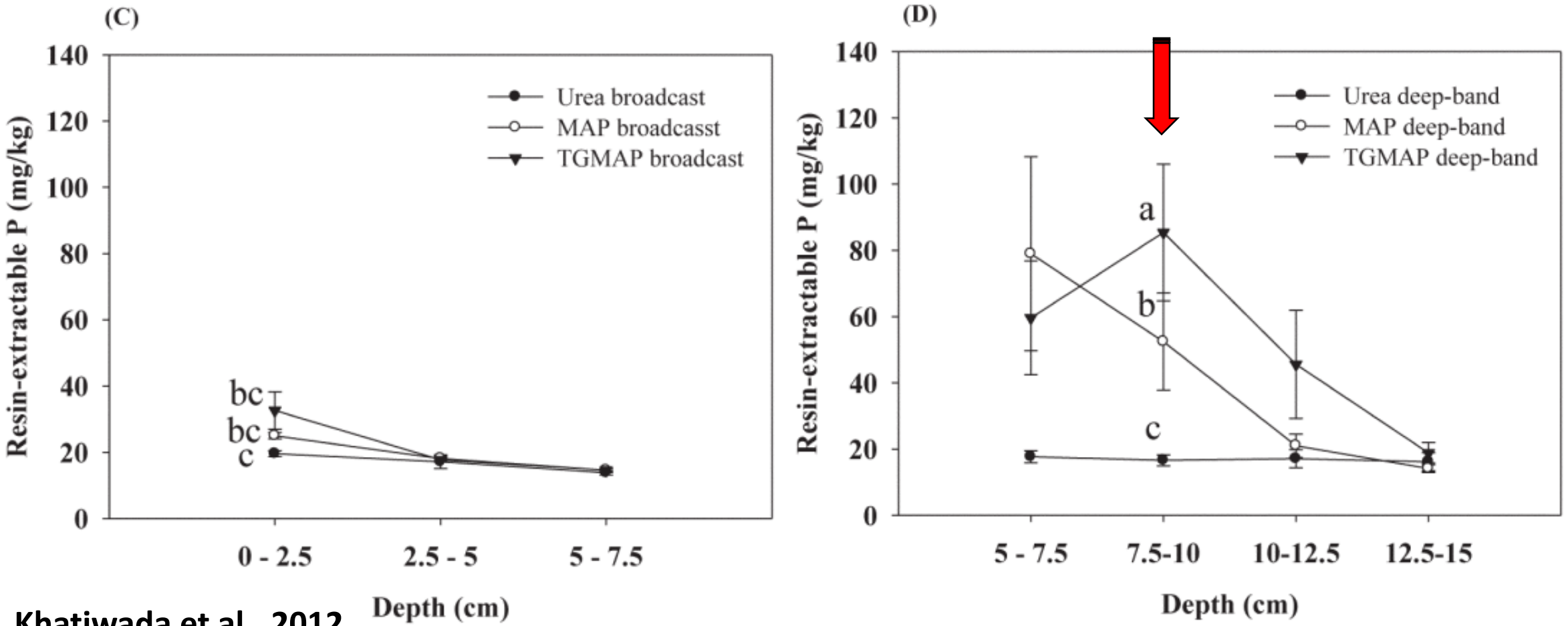
Plant Available Phosphorus – 5 Weeks After Application



Khatiwada et al., 2012

5 weeks after application about 50% more P in the plant available form with fluid MAP

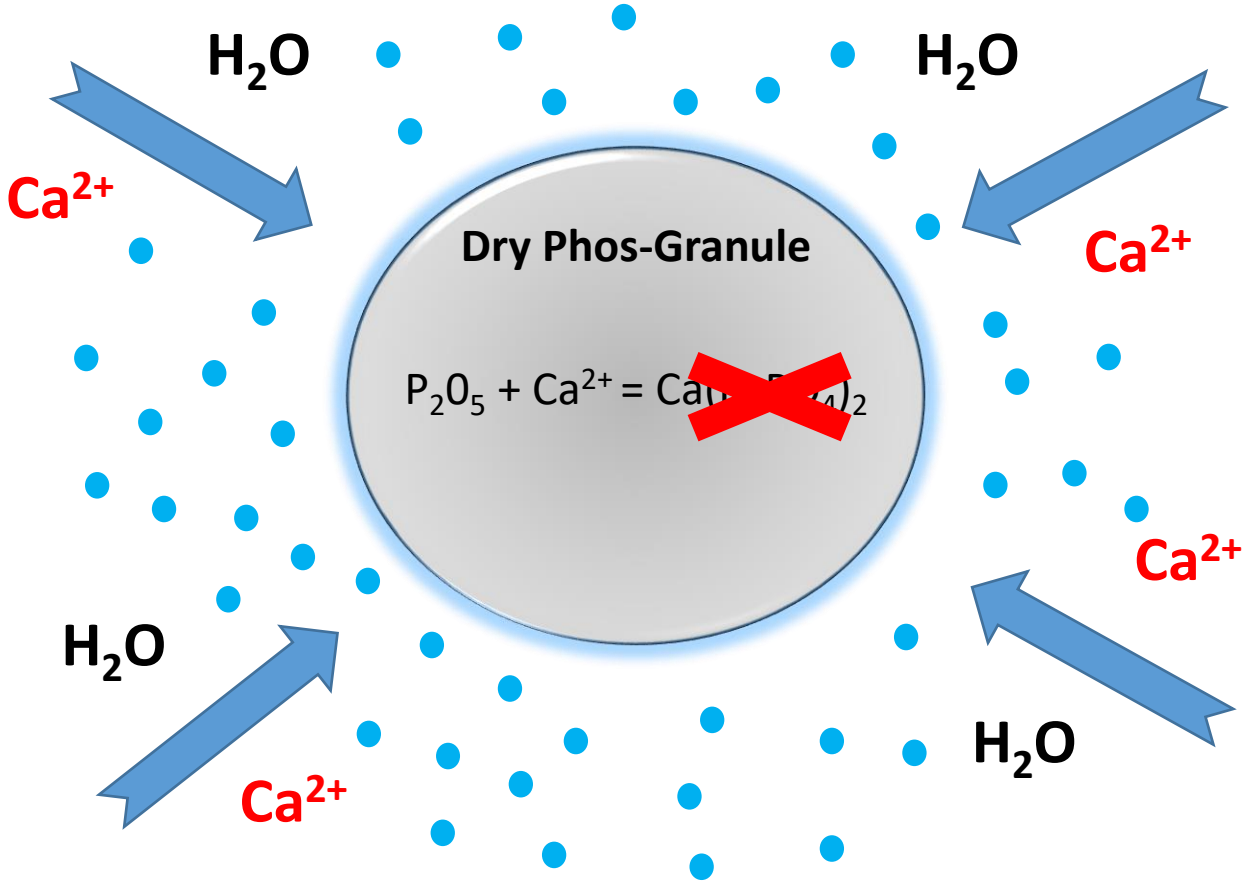
Plant Available Phosphorus – 6 Months After Application



Khatiwada et al., 2012

6 months after application still about 50% more P in the plant available form with fluid MAP

Water Gradient Carries Dissolved Minerals that Fix Phos Fertilizer



Khatiwada et al., 2012

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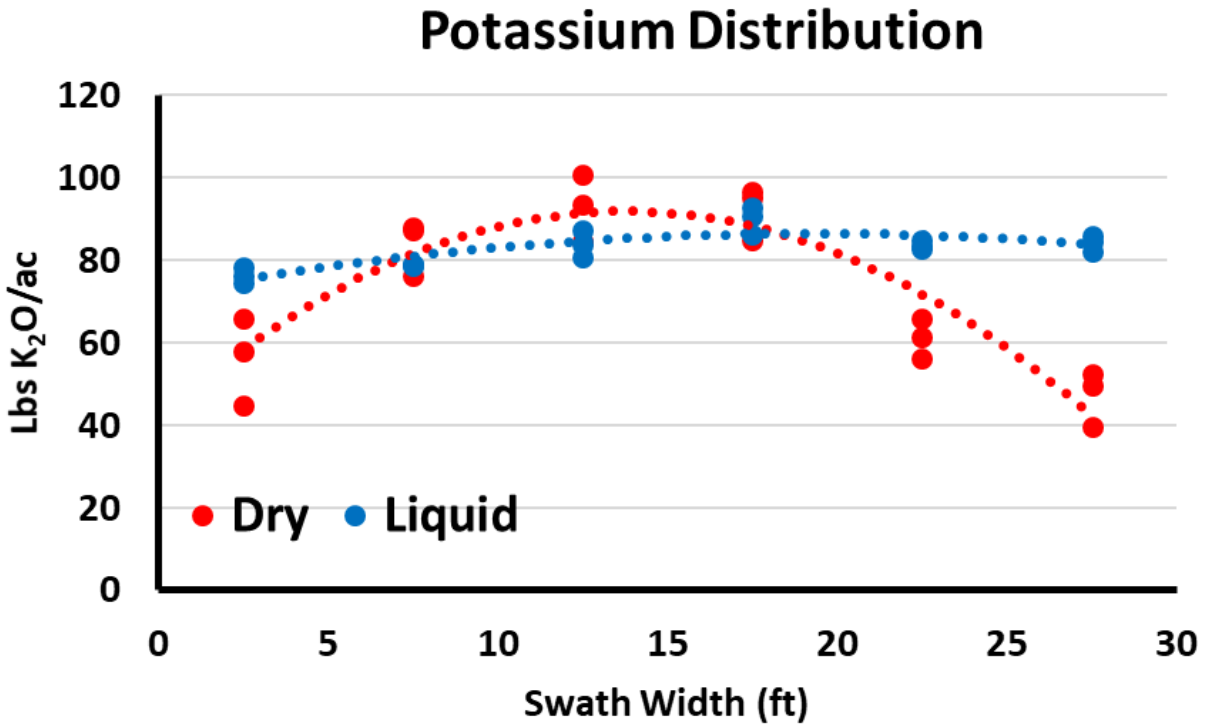
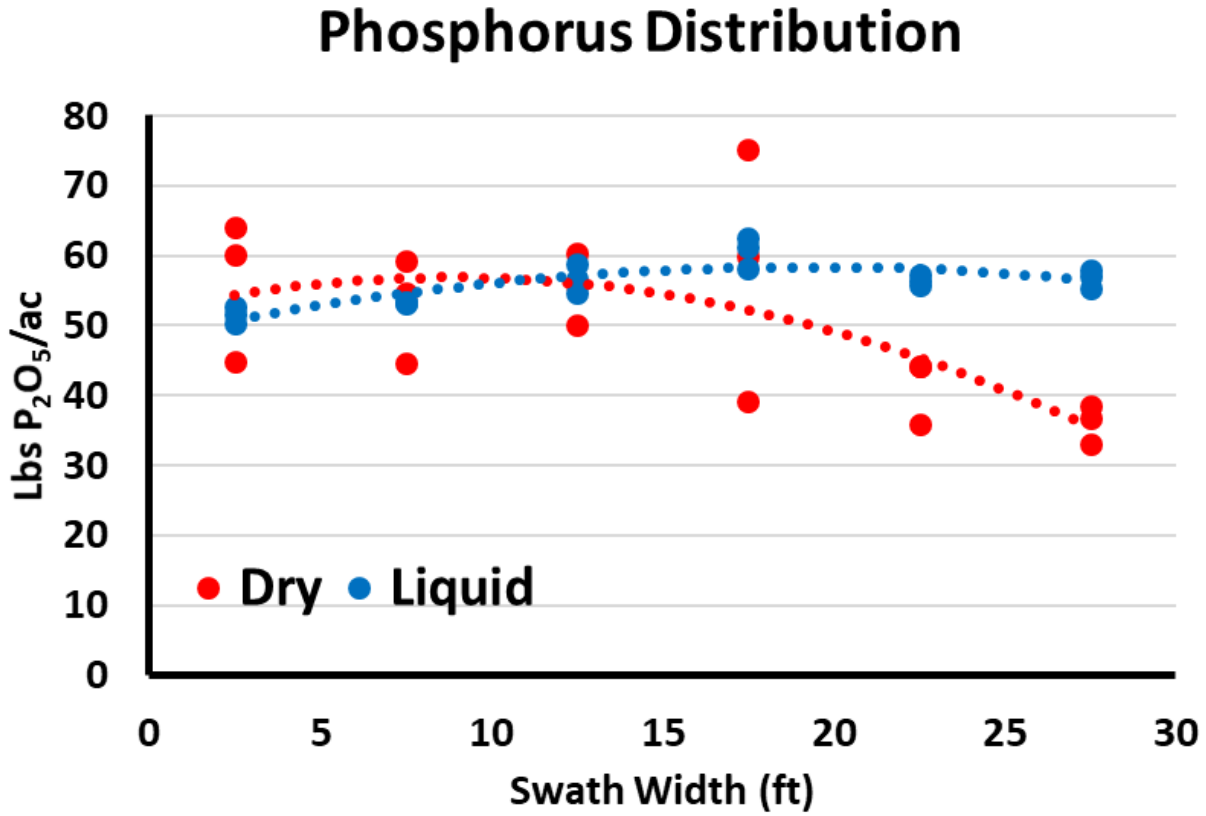
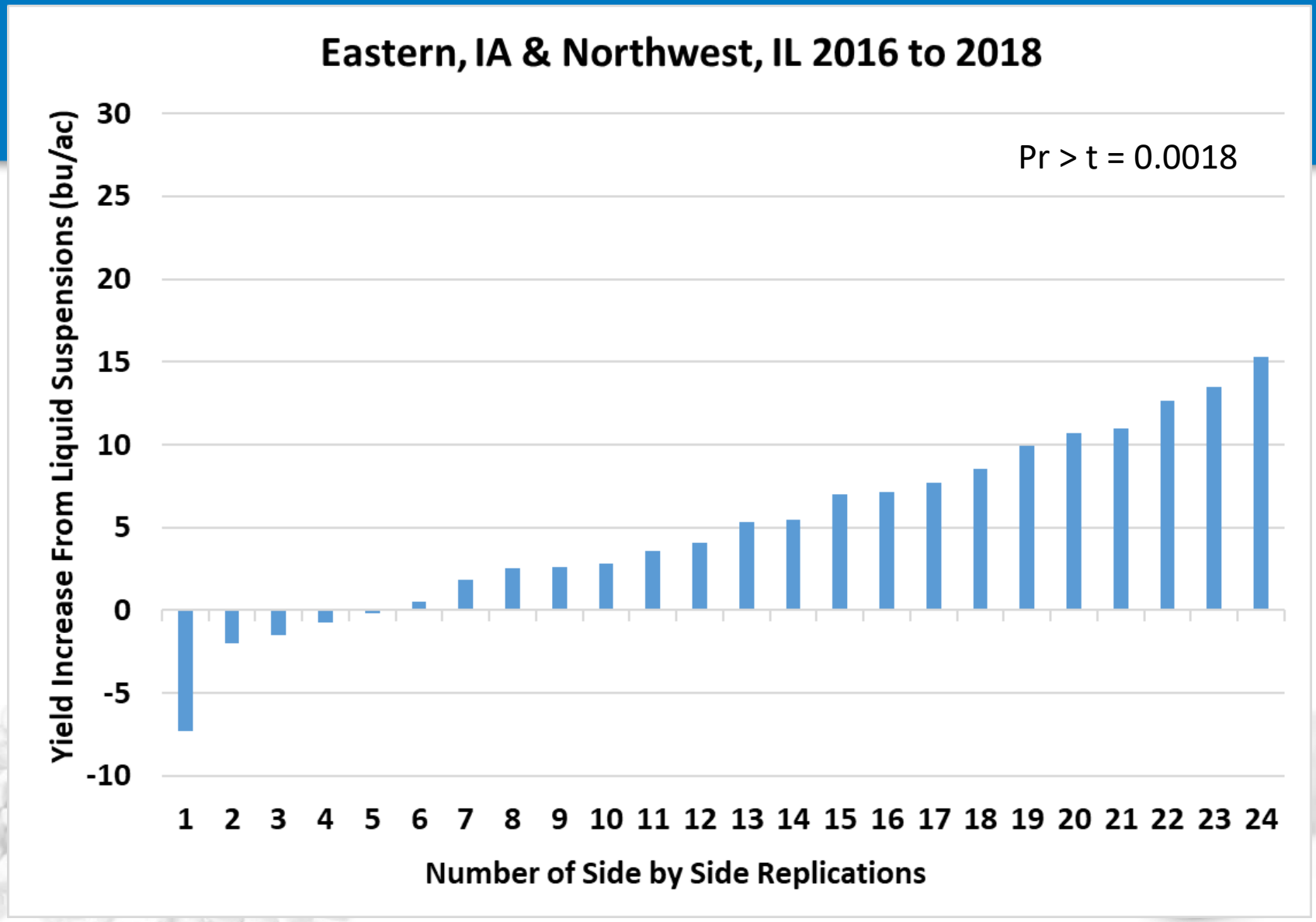
Liqui-Grow On-Farm Trials







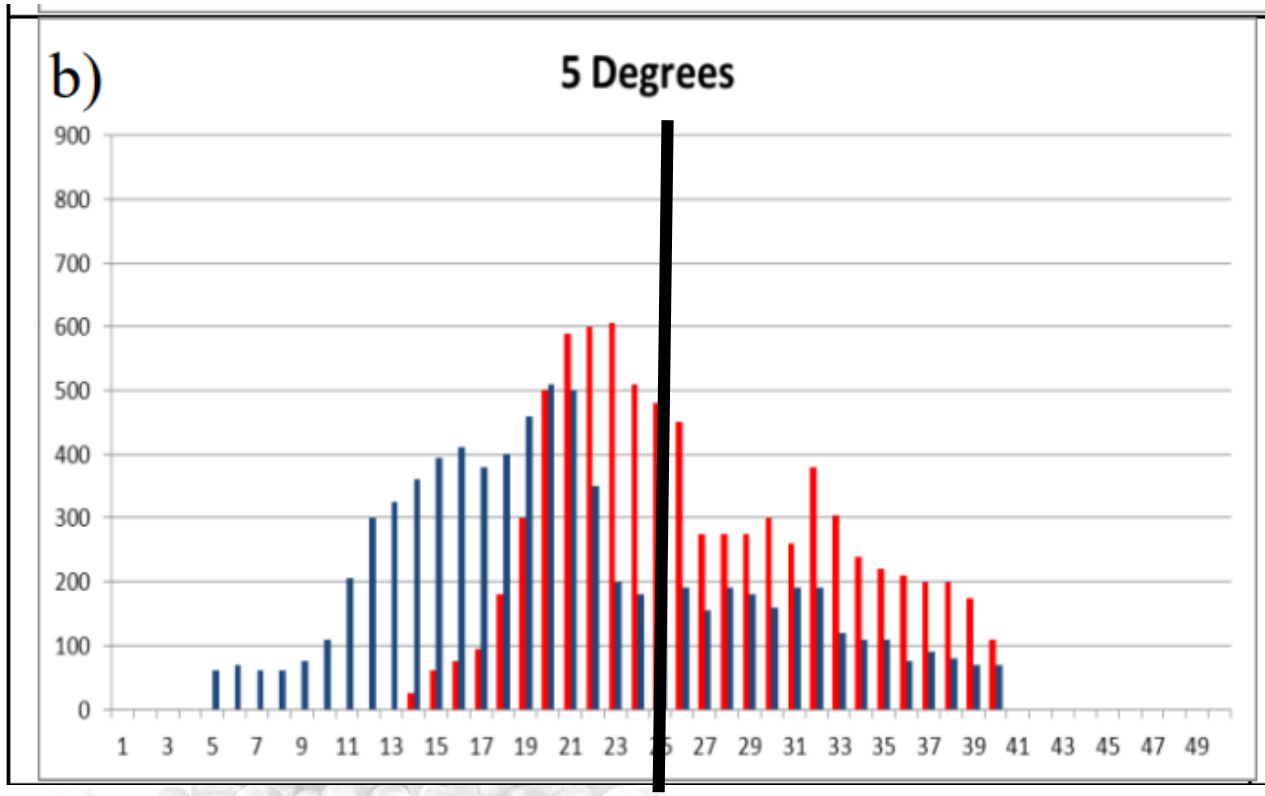
Avg STP = 25.5

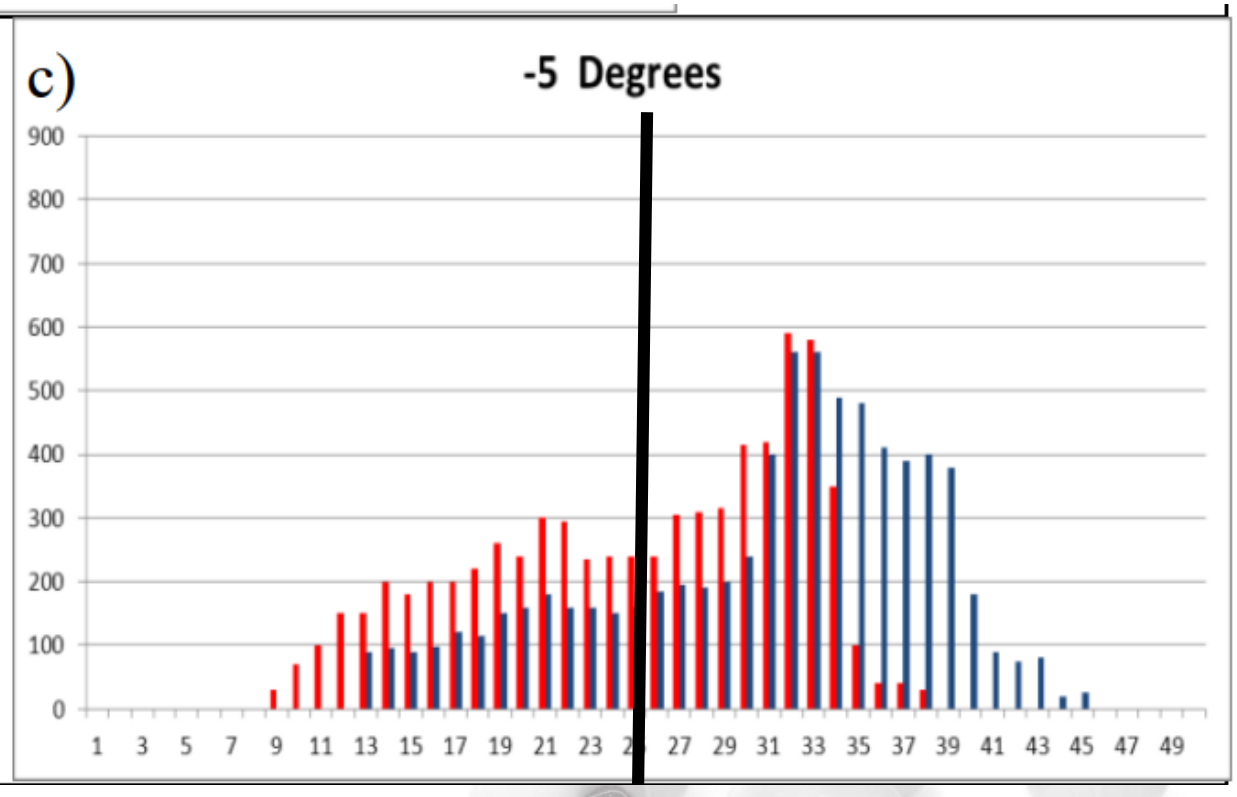
Avg STK = 141.8

Fertilizer Source	N-P-K-S-Zn-B Rate lb/ac	Moisture %	Yield bu/ac	Fertilizer Cost $/ac	Return $/ac
Liquid Dribble Band	0-50-75-15-0.5-0.2	16.2	242.1	47.6	**+17.2 $/ac** Liquid
Dry Broadcast		16.2	237.1	44.7	Dribble Band

Joy, IL 2018 - 8 Reps Per Location		
	Yield at 15.5% Mst (bu/ac)	
Treatment	Corn after Soybean	Corn after Corn
Dry Broadcast	283.0	233.0
15' Surface Dribble Band	289.3	237.2
Subsurface Strip	282.4	247.4

Fertilizer Application Uniformity & Sloping Fields?





Red line indicates center line of the fertilizer applicator

Fertilizer Application Uniformity & Sloping Fields?

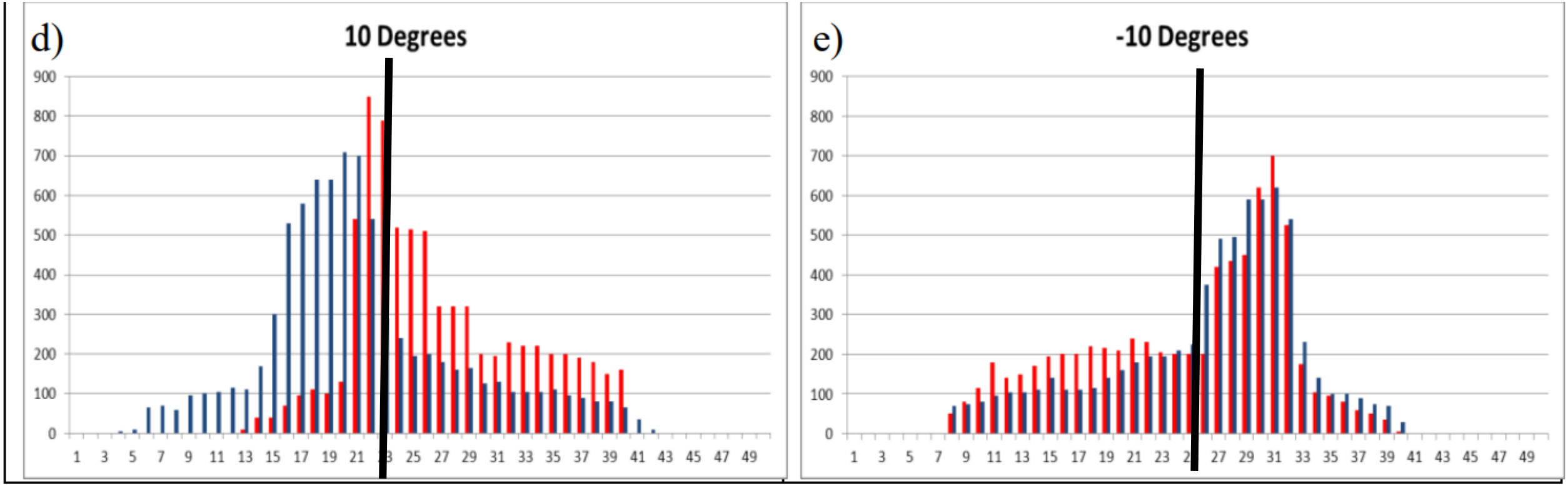


Figure 2 Adapted from Yilidrim (2008) a) indicate spreader performance (kg Spread per ha) on level surface. b and c), 5 and -5 degree of slope.d and e) 10 and -10 degrees of slope.

Red line indicates center line of the fertilizer applicator

Why Band Crop Nutrients?

- Banding creates dense patches of nutrients that cause roots to proliferate (increase in #) into the zone of high nutrient concentration
- Well know plant mechanism to use resources efficiently "i.e. invest root resources wisely"
- Greater nutrient uptake per root area

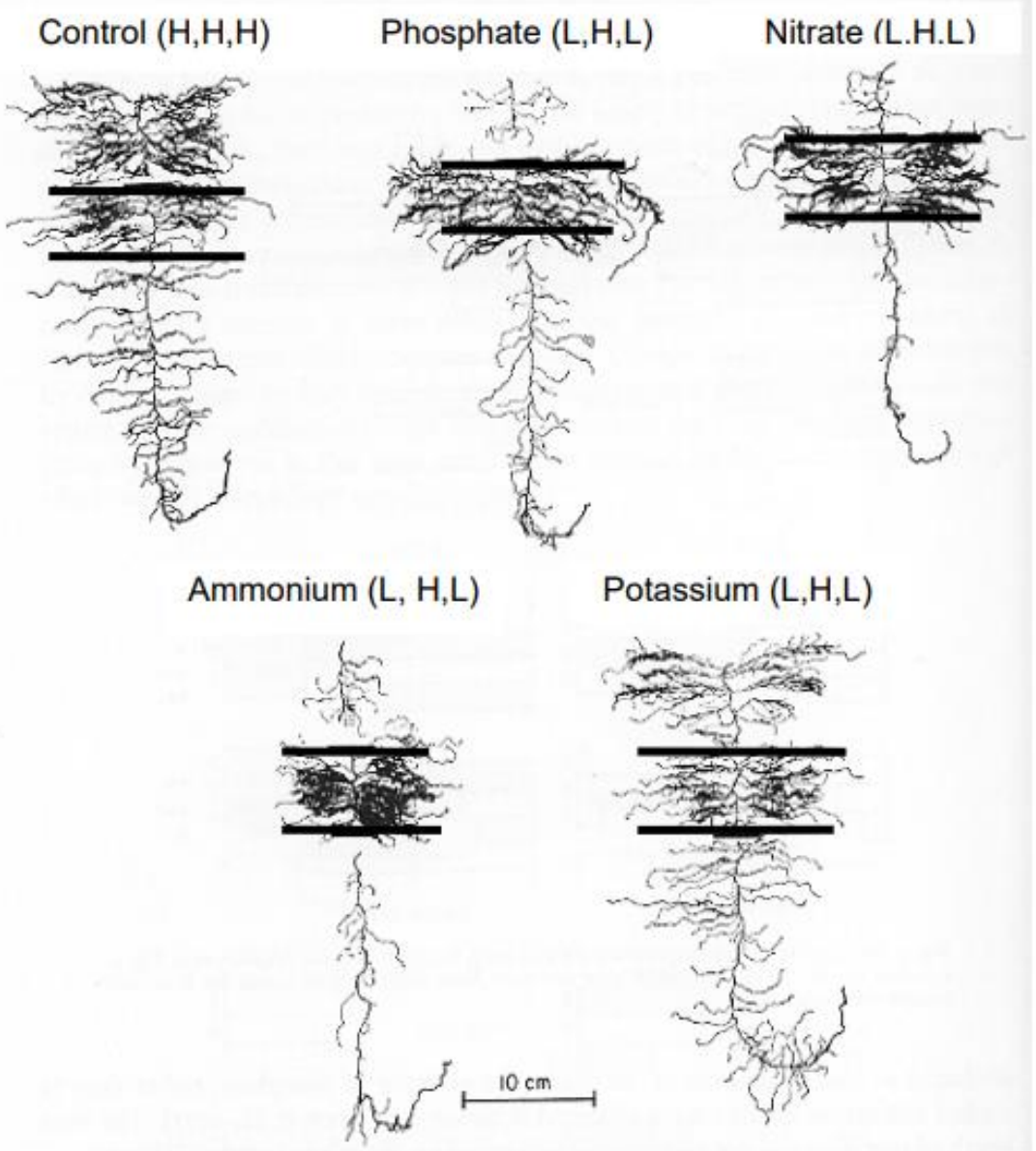


Figure 2. Barley plant root growth responses to zones of nutrient enrichment for N, P, and K. Zones are designed as L or H from the surface downward. (Drew, H. C., 1975).