Is Dribble Banding Liquid Suspensions Still Relevant?

Jacob Vossen kemper, PhD – Agronomy Lead
FFF Technology Workshop – Council Bluffs, IA Dec 11-12th 2019
Manage Research & Development

Sales Support (grower meetings/key account visit’s)
FFF Tech Workshop

Lead Agronomic Trainings

Agronomic Service Calls
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

1 gallon of water can hold about 1 lb of KCL in solution

Dribble Bands at 15 inches apart
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
Brand new New Leader L4500G4 spinner bed, just calibrated for a 60 ft swath width
54 lbs of fert material/ac = 24.8 lbs P from DAP
108 lbs of fert material/ac = 49.6 lbs P from DAP
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.
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.
Fertilizer Application Uniformity & Variable Rate Technology

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

PERFORMANCE
FOR LIQUI
GROW

SCIENECE DRIVEN DECISIONS

OFFICE NOZZLES

ication

or

www.liqui-grow.com
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
Dry Spinner = 33% variation from target rate across the swath width

Fluid Fert = 3.4% variation from target rate across the boom
Table 4.4. Summary information for the "as-applied" surface for field A.

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

Total number of points: 952
Application rate (kg/ha)

- Minimum: 0.0
- Maximum: 557.3

9 lb/ac
Figure 3. Comparison between actual and prescription (a) and actual vs. as-applied map rates (b) for the three fields.
Fertilizer Application Uniformity & Variable Rate Technology

(a) Bin 1 (N32) 1997
- Line y=x
- Regression line
  y = 9.1 + 0.965x
  R² = 0.960
  n = 202

(b) Bin 2 (11-37-0) 1997
- Line y=x
- Regression line
  y = 1.2 + 0.981x
  R² = 0.986
  n = 120

Yang, 2001 – USDA-ARS
Does Banding Nutrients Increase Crop Yield vs Broadcasting?

- The answer is yes, sometimes.
- More often in low testing P and/or K soils.
- More often in soils that have a high capacity to fix applied P or K.
- More often in no or reduced tillage (Kovar - ARS).
- More often when nutrients are co-applied.

Find plenty of studies that both support and do not 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 Banding Nutrients Increase Crop Yield vs Brodcasting?

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

Rhizosphere pH affects P uptake by corn

**Total P uptake, mg P (g DM)^{-1}**

- Wendigo SL
- Oneida L
- Buford Sil.

**Rhizosphere pH**

- MCP + CaCl\(_2\)
- MCP + Ca(NO\(_3\))\(_2\)
- MCP + (NH\(_4\))\(_2\)SO\(_4\)
### 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.

<table>
<thead>
<tr>
<th>Fertilizer NPKSZn (lb/ac)</th>
<th>Yield (bu/ac)</th>
<th>Yield Increase (bu/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-45-65</td>
<td>210.1</td>
<td>-</td>
</tr>
<tr>
<td>24-45-65-0.5Zn</td>
<td>212.9</td>
<td>2.8</td>
</tr>
<tr>
<td>24-45-65-10s</td>
<td>212.7</td>
<td>2.6</td>
</tr>
<tr>
<td>24-45-65-10s-0.5Zn</td>
<td>218.1</td>
<td>8.0</td>
</tr>
</tbody>
</table>

LSD at 0.10 = 5.1
Speciation of Phosphorus in a Fertilized, Reduced-Till Soil System: In-Field Treatment Incubation Study

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.

<table>
<thead>
<tr>
<th>Sample depth (cm)</th>
<th>pH</th>
<th>CEC (cmolc kg⁻¹)</th>
<th>Extractable</th>
<th>Total N (mg kg⁻¹)</th>
<th>Total P (mg kg⁻¹)</th>
<th>OM (%)</th>
<th>Textural class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>M₃P</td>
<td>Ca₅</td>
<td>Fe₅</td>
<td>Mn₅</td>
<td>Al³⁺</td>
</tr>
<tr>
<td>0-7</td>
<td>5.9</td>
<td>16.1</td>
<td>45.4</td>
<td>2426.0</td>
<td>7.9</td>
<td>58.3</td>
<td>0.0</td>
</tr>
<tr>
<td>7-15</td>
<td>5.7</td>
<td>20.3</td>
<td>19.6</td>
<td>2540.0</td>
<td>8.2</td>
<td>57.8</td>
<td>0.4</td>
</tr>
<tr>
<td>15-30</td>
<td>6.1</td>
<td>18.8</td>
<td>5.9</td>
<td>3174.0</td>
<td>27.8</td>
<td>25.0</td>
<td>0.1</td>
</tr>
</tbody>
</table>

† CEC, cation exchange capacity; M₃P, Mehlich III-extractable phosphorus; Ca₅, ammonium acetate-extractable calcium; Fe₅, diethylene triamine pentaacetic acid-extractable iron; Mn₅, diethylene triamine pentaacetic acid-extractable manganese; Al³⁺, potassium chloride-extractable aluminum; OM, organic matter content; Sil, silty loam; SiCl, silty clay loam.

December 2012

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

Khatiwada et al., 2012
Plant Available Phosphorus – 6 Months After Application

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

Khatiwada et al., 2012
Water Gradient Carries Dissolved Minerals that Fix Phos Fertilizer

Dry Phos-Granule

\[ P_2O_5 + Ca^{2+} = Ca(H_2PO_4)_2 \]

Khatiwada et al., 2012
Why Band Crop Nutrients?
Liqui-Grow On-Farm Trials

Potassium Distribution

Phosphorus Distribution

Lbs K₂O/ac

Lbs P₂O₅/ac

Swath Width (ft)

Dry  Liquid

Dry  Liquid
Eastern, IA & Northwest, IL 2016 to 2018

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

Pr > t = 0.0018

Avg STP = 25.5
Avg STK = 141.8
### Joy, IL 2018 - 8 Reps Per Location

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Corn after Soybean</th>
<th>Corn after Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Broadcast</td>
<td>283.0</td>
<td>233.0</td>
</tr>
<tr>
<td>15' Surface Dribble Band</td>
<td>289.3</td>
<td>237.2</td>
</tr>
<tr>
<td>Subsurface Strip</td>
<td>282.4</td>
<td>247.4</td>
</tr>
</tbody>
</table>
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