Dry nitrogen fertilizer quality: Impact on spreading variability

Year 1 report
Peter Scharf, University of Missouri, Plant Sciences Division
Collaborator: Newell Kitchen, USDA Ag Research Service, Columbia, MO

Accomplishments in 2016

Fertilizer catch pans were prepared for use, but by the time they were ready and protocols were developed and tested, it was mid-March. We then began to try to find wheat and grass fields where we could catch dry N during normal field operations. Most N applications to these crops had already been completed and we did not manage to get into any fields where N application was still being done. As a result, all testing in 2106 was done in corn fields.

Two tests were done with pre-plant applications of dry N to corn. In both fields this was the total N program. It was a challenge without rows to place the pans in the appropriate position (centered on applicator path, not in the wheel path) before the application began. Our goal was that the applicator would run just as if we weren't there–we did not want to create any delays. To avoid 'edge effects' we did not want to catch in the first pass of the applicator, nor too near the beginning or end of a pass. Catch locations were in from the edges of the field in both directions, and it took a lot of careful work to position them correctly and with confidence.

Four tests were done with in-season applications of dry N to corn. In all cases, the main N application had been made before planting, and the in-season N was applied at a relatively low rate. Pan placement was much easier in these fields since the applicator was constrained to follow existing rows. This is part of the reason that we got more fields done with in-season N. We had also learned by this time that we needed to be quick and assertive in order to get a test in place.

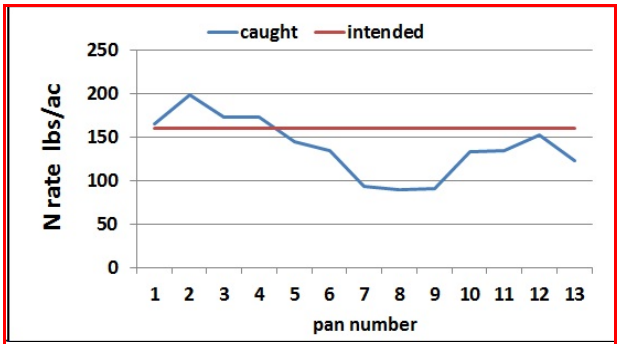
Background information for the six tests is shown in the table below.

Field	Date	Intended N rate	Power Unit	Box	Fertilizer	Spread width, plate height
1	March 18	160	Deere tractor	SMC pull-type	Urea	50', 27"
2	April 12	130	Deere self-propelled	New Leader	Ammonium nitrate + sulfur	85', 66"
3	June 11	40	Deere self-propelled	New Leader	Urea + amm sulfate	80', 62"
4	June 11	40	Deere self-propelled	New Leader	Urea + amm sulfate	80', 62"
5	June 10	40	Rogator	New Leader	Urea	70', 58"
6	June 10	50	Rogator	New Leader	Urea	70', 58"

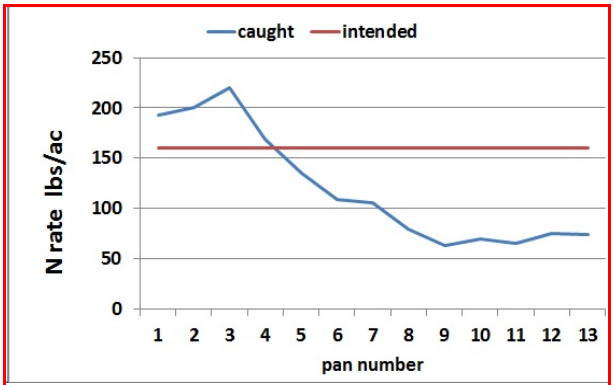
Spread test results

Field 1

Urea fertilizer was caught in two passes in this field, the applicator's 6th and 9th passes from the edge of the field where he started. In both passes, a pattern with a high rate on the left side of the applicator and low rate on the right side were seen. In pass 6, pans were not in place when the applicator applied pass 5, thus the overlap in the outside pans on that side was not measured.



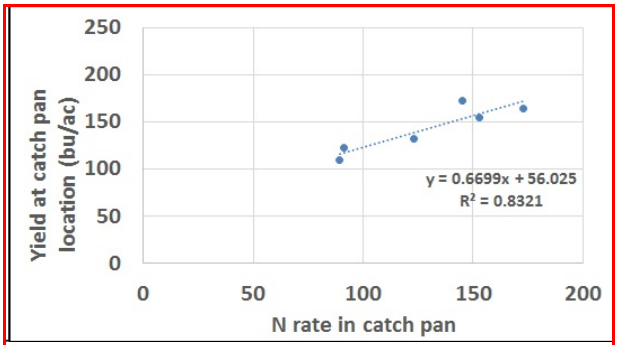
Intended N rate vs N rate caught in pass 9



Intended N rate vs N rate caught in pass 6. Pans were not in place during pass 5, so overlap from pass 5 was not caught (right side of graph).

In both pass 6 and pass 9, N rate was higher than intended on the left and lower than intended in the middle. In pass 9, N rate on the right was near the intended rate, but was much lower than intended in pass 6. This is likely partly because the pans were not in place at the time pass 5 was applied, so that the overlap from pass 5 was not caught.

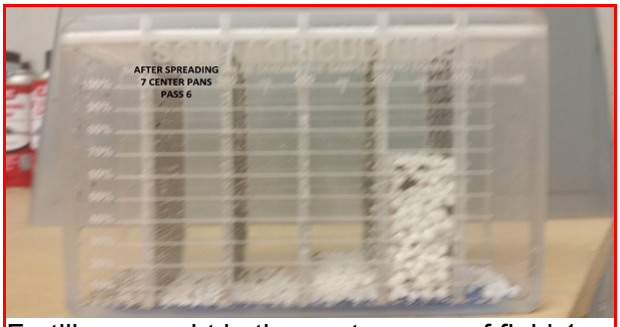
We had recorded the GPS location of each pan. Due to the relatively large differences between the intended and actual N rates, we went to several catch pan locations in September and hand-harvested the grain at those locations. In both pass 6 and pass 9, yield was higher at the locations where we caught more fertilizer in the catch pan, and lower at the locations where we caught less fertilizer in the catch pan. Applying the relationship between N rate and yield in the graph at the right to the catch all the way across the pattern, predicted yield is 149 bushels with the observed pattern and 163 bushels if the intended N rate had been applied everywhere. **The uneven pattern and lower-than-intended N rate resulted in a yield penalty that we estimate at 14 bushels/acre.** A similar outcome was found in pass 6.



Hand-harvested yield at 6 locations with varying N rates caught in pass 9.

Fertilizer samples from the spreader box and from the pans were put into SGN (size guide number) sieves to assess particle size. Initial quality appeared good. About 20% breakage of the urea granules was seen due to spreading (impact with spinner vanes).

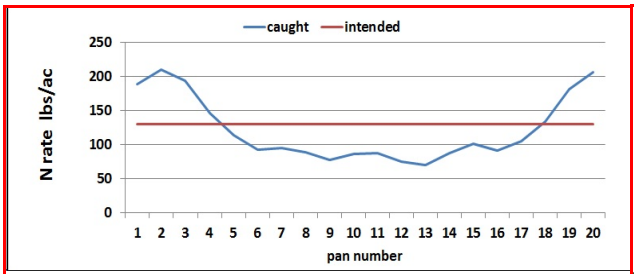
Fertilizer sampled from the spreader box in Field 1



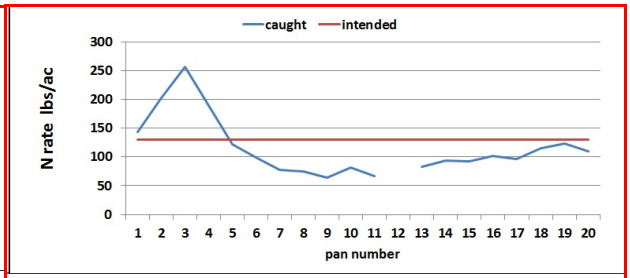
Fertilizer caught in the center pans of field 1; intact large granules decreased from 90% before spreading to 70% after spreading.

Field 2

Fertilizer (ammonium nitrate and elemental sulfur blend) was caught in 2 passes in this field, passes 3 and 8 from the applicator's starting point. The application pattern was 85 feet, which was quite a bit wider than field 1. However, a very similar catch pattern was seen in the two fields–high on the left, low in the middle, and mixed on the right. The operator, on seeing the higher catch in the outside pans of pass 3, got out the manual to see how to correct the pattern.

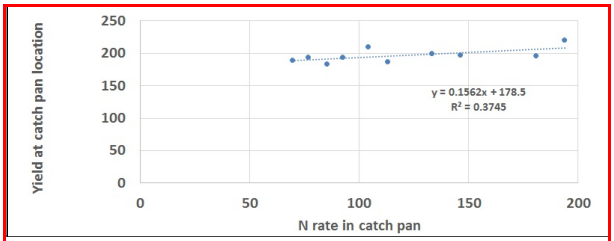


Intended N rate vs N rate caught in pass 3

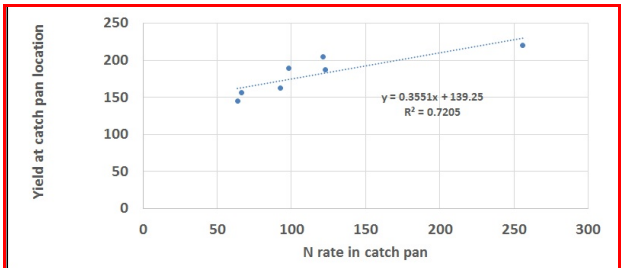


Intended N rate vs N caught in pass 8. Pan 12 was spilled.

Lower-than-intended N rates in pass 3 affected yield, but not dramatically. Projected yield at the intended N rate was 199, and at observed N rates was 197. Uneven application only cost 2 bushels in this part of the field. In pass 8, the yield effect of varying N rates was larger. Projected yield at the intended N rate was 185, and at the observed N rates across the entire pass was 178 (a 7-bushel yield penalty).



Hand-harvested yield at 10 locations with varying N rates caught in pass 3.

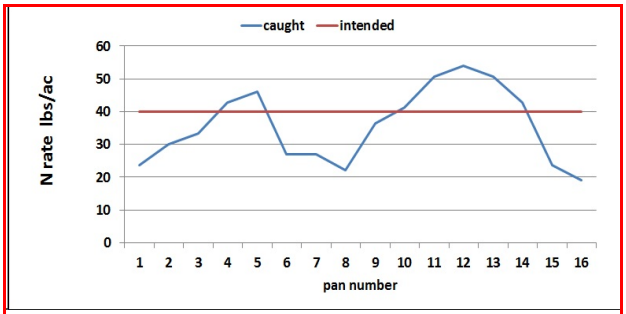


Hand-harvested yield at 7 locations with varying N rates caught in pass 8.

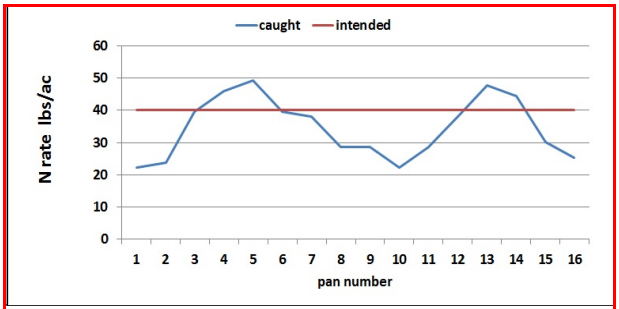
Field 3

The material spread on field 3 was a blend of urea and ammonium sulfate, spread at an intended rate of 40 lb N/acre. The main N application had been made before planting. It was spread on June 11 to low-chest-high corn (44") (stage V11).

Pans were set up to catch fertilizer on passes 2 and 3. The same M-shaped pattern was observed in both.



Intended N rate vs N rate caught in pass 2



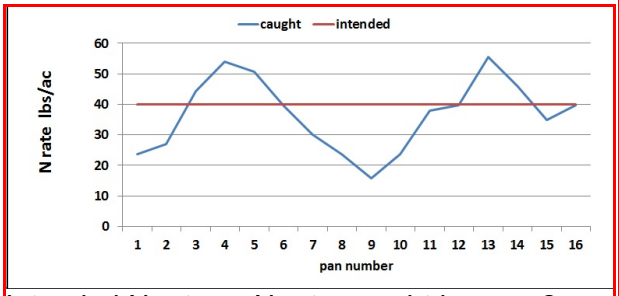
Intended N rate vs N rate caught in pass 3

Four hand-harvested yield checks found that yield was the same (194 bushels) at both the high and the low parts of this pattern in pass 2. Three hand-harvested yield checks found that yield was the same (183 bushels) at both the high and the low parts of the pattern in pass 3.

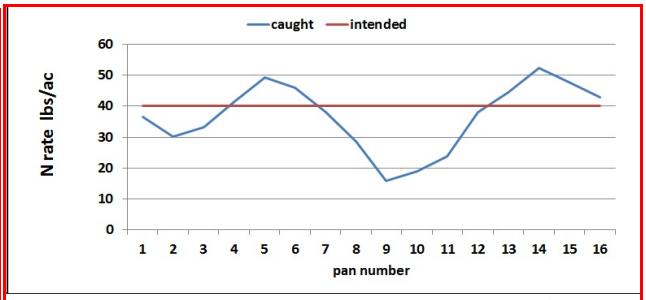
Field 4

The material spread on field 4 was the same blend of urea and ammonium sulfate used on field 3, spread with the same machine and at the same intended rate of 40 lb N/acre. The main N application had been made before planting. It was spread on June 11 to knee-high corn (21") (stage V7).

Pans were set up to catch fertilizer on passes 2 and 3. The same M-shaped pattern was observed in both as was seen in Field 3.



Intended N rate vs N rate caught in pass 2



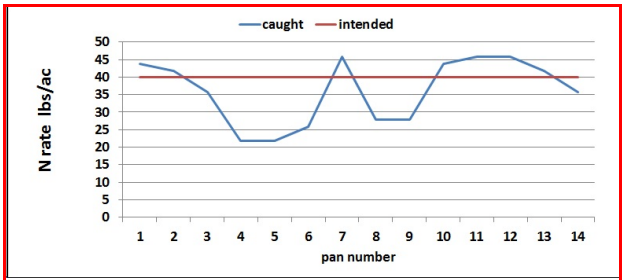
Intended N rate vs N rate caught in pass 3

In both passes, hand-harvested yield checks found that yield was the same at both the high and the low parts of this pattern–172 bushels in pass 2 and 160 bushels in pass 3.

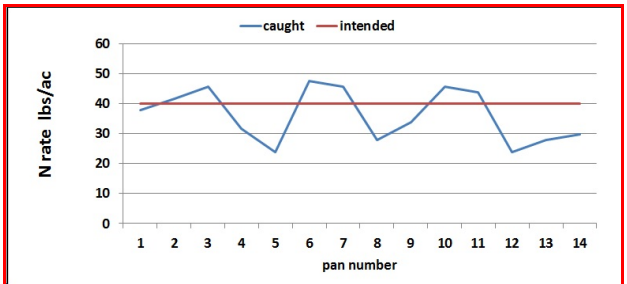
Field 5

The material spread on field 5 was urea, spread at an intended rate of 40 lb N/acre. The main N application had been made before planting. It was spread on June 10 to thigh-high corn (30") (stage V8).

Pans were set up to catch fertilizer on passes 3 and 4. A W-shaped/sawtooth pattern was observed in both.



Intended N rate vs N rate caught in pass 3

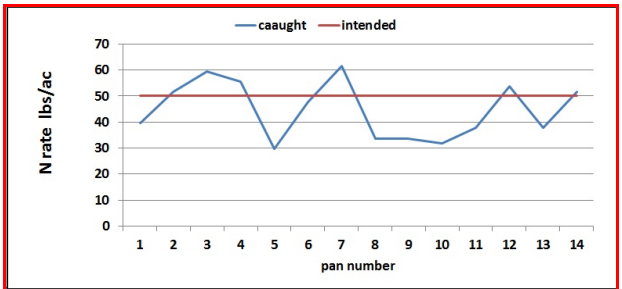


Intended N rate vs N rate caught in pass 4

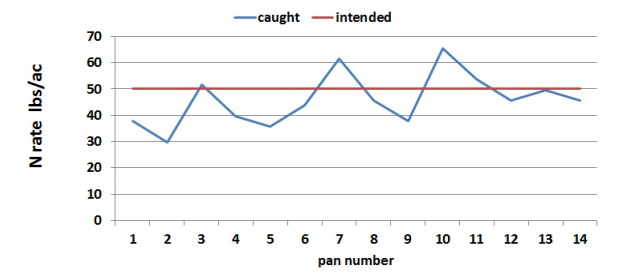
In both passes, hand-harvested yield checks found that yield was the same at both the high and the low parts of this pattern–214 bushels in pass 3 and 189 bushels in pass 4.

Field 6

The material spread on field 6 was urea, spread with the same machine as field 5 at an intended rate of 50 lb N/acre. The main N application had been made before planting. It was spread on June 10 to hip-high corn (35") (stage V9).



Intended N rate vs N rate caught in pass 2.



Intended N rate vs N rate caught in pass 3.

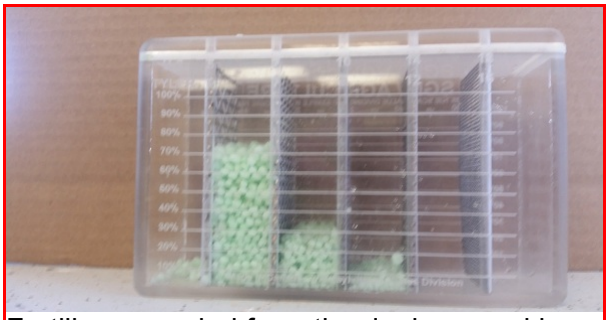
Pans were set up to catch fertilizer on passes 2 and 3. A sawtooth pattern was seen in both passes.

In both passes, hand-harvested yield checks found that yield was the same at both the high and the low parts of this pattern–195 bushels in pass 2 and 201 bushels in pass 3.

Fertilizer sampled from the dry box used in Field 2

Fertilizer sampled from the dry box used in Field 3

Fertilizer sampled from the dry box used in Field 4



Fertilizer sampled from the dry box used in Field 5

Fertilizer sampled from the dry box used in Field 6

Fertilizer Quality

The physical integrity of the fertilizer material did not appear to be a serious problem in any of the fields we tested. I've seen both urea and ammonium nitrate with higher levels of fine particles than we saw in any of the fertilizer that we sampled from the dry boxes in these six fields. Although premium urea products like SuperU and ESN may more reliably have uniform and intact granules, results in these fields probably would have been similar with those materials. Probably none of the fertilizer used was sourced from new North American production facilities. The only, to my knowledge, new ammonium nitrate plant has just reached full production in late January 2017, and a new urea plant did so in fall 2016. These facilities may increase the reliability of dry N quality in the North American market.

Summary

- Six trials catching dry N applications were carried out in 2016
- Uneven spread was observed in all six fields
- Uneven patterns were not high rates in the middle due to dusty fertilizer as we had expected
- Several different kinds of uneven spread patterns were seen: high on the left, high on the ends, and up-and-down
- Breakage of granules due to spreader vane impact was seen
- Uneven spread affected corn yield in both fields where dry N was applied preplant as the total N program
  - Average yield loss due to uneven spread was 14 bushels in one field and 4.5 bushels in the other
  - It seems likely that spreader adjustments would solve the pattern problems that we saw in these fields
- Uneven spread did not affect corn yield in the fields where it was applied in-season; this would be expected since rate was much lower and the difference between the lowest and highest rates was small

Budget year 2:

Research Specialist time	$19,500
Benefits @ 33%	6,500
Field supplies and mileage	2,000
Total year 2	**$28,000**