Spread Patterns of Broadcast Fertilizer Applicators in Manitoba

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Background:

- Broadcast application of fertilizer is still a minor practice by Prairie farmers. Farmer surveys by STRATUS Ag Research[1] show 6-10% of nitrogen (N) and 5-6% of phosphorus (P) is applied to wheat and canola by broadcast methods. Manitoba corn growers apply 48% and 36% of N and P by broadcast. application respectively, compared to 67% and 33% by Ontario growers.
- When traditional band applications of fertilizer are thwarted by unfavorable soil conditions, broadcast is an important alternative and may provide in-crop fertilization options to correct deficiencies or for protein enhancement.
- But poor spread patterns cause crop injury (lodging) or lost yield
- Hence calibration for pattern uniformity is important. Uniformity is measured by the "Coefficient of Variation" (C.V.) = the standard deviation/average rate. Target C.V. values for N is generally <15% and <25% for non-N products (P and potassium K)[2].
- This survey of spreaders was done to evaluate standard application patterns.

Method:

Eleven to 15 calibration pans were dispersed across 1-1.5 x fertilizer spread width according to general guidelines[2]
Fertilizer was collected two times:

1. In a single pass to show distribution
2. With adjacent passes to show in-field distribution and for calculation of C.V.

- Collection pans were steel trays containing a gridded baffle to reduce any deflected granules and maintain them within trays (Figure 5, right)
- Measured wind speed
- Compared a number of applicators – 7 spin spreaders and 3 pneumatic spreaders (see below)
- Fertilizer was sifted to remove soil and weighed but not segregated by product
- Australia and New Zealand fertiliser associations conduct regular spin spreader calibration and analyse patterns using the Accu-Spread and Spreadmark Test methods, respectively[3,4]. Our data was analysed using these techniques to determine maximum acceptable driving width (bout width).

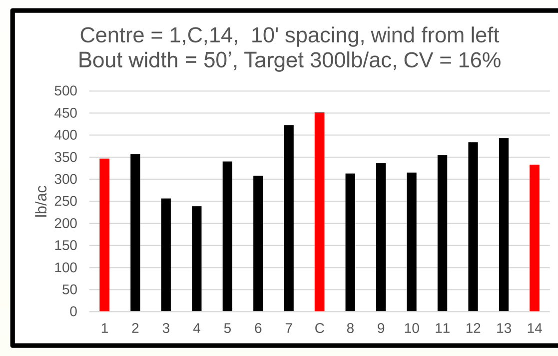
Figure 1. Broadcast fertilizer applicators evaluated.

Spread patterns:

Following are a number of acceptable patterns observed (Figure 2)

Pattern from single pass. In test tube rack.

Spread patterns with adjacent passes (spreader 4)



Spread pattern with single pass (pneumatic spreader 9). Wind from right.

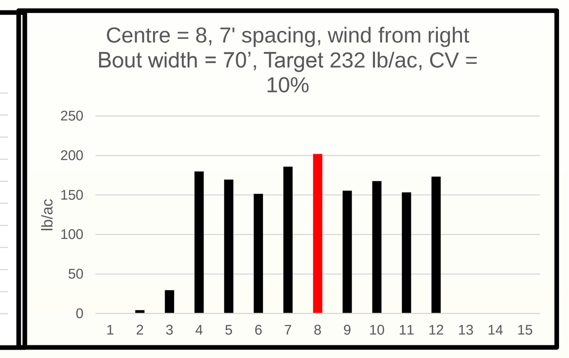


Figure 2. Examples of acceptable spread patterns. Red bar is the applicator pass. Measured rates and variability are reported in Table 1.

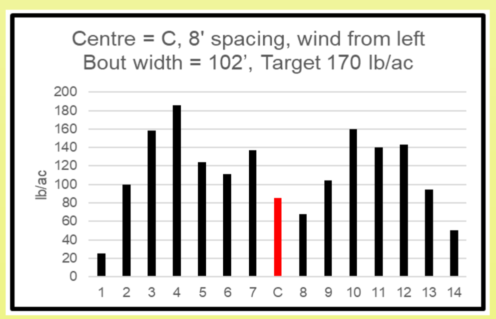
Table 1. Spreader application details and measured rate and variation (C.V.).
*dd= dual disc, sd = single disk spin spreaders, p = pneumatic boom spreader.

Spreader *	Drive width (bout) ft	Nutrients supplied lb/ac	Target rate lb/ac	Measured rate lb/ac	C.V. %	Wind speed km/hr
1 dd	102'	30-50-0-15S	170	172	**38%**	7-10
2 dd	102'	90-0-12	220	251	**19%**	5-19
3 dd	78'	11-52-0	100	98	**18%**	18-26
4 dd	50'	80-50-30-10S	300	343	**16%**	6-9
5 dd	80'	120-0-0	265	258	**30%**	17-19
6 dd	80'	130-35-0-15	384	286	**22%**	light
7 sd	35'	32-52-60-21S	300	222	**55%**	light
8 p	70'	60-20-20-0 120-30-20-5	193 349	116 251	**23%** **15%**	13-17
9 p	70'	100-10-0-3S	232	171	**10%**	27-28
10 p	70'	60-40-0	188	113-139	**8-22%**	low

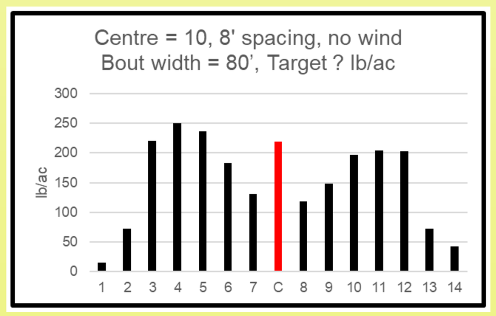
- Driving width (or bout) varied among spreaders. Wind was a major distorter of patterns, particularly of N due to low density of urea and fines.
- C.V.s were often acceptable, but some poor pattern problems were identified and warranted adjustment (Figure 3 below)
- Pneumatic boom spreaders provided very good C.V., but all appeared to "under-deliver" the specified rate of fertilizer. Small pan sampling is not generally considered appropriate for spreader "rate" calculations.[5]

Problematic Spread Patterns:

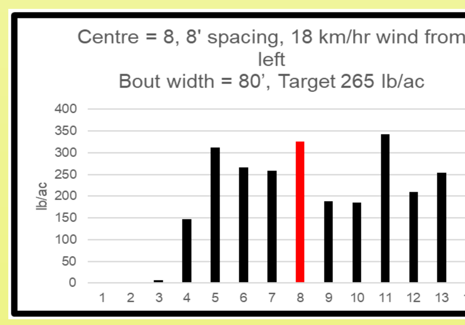
M-pattern



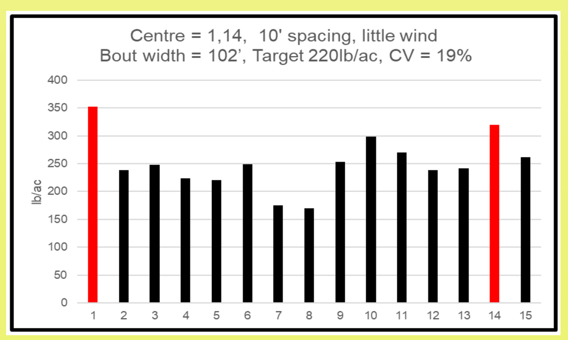
W-pattern



High and gusty wind



Bout width too wide



Improper back and forth operation of single disc spreader (by poster author)

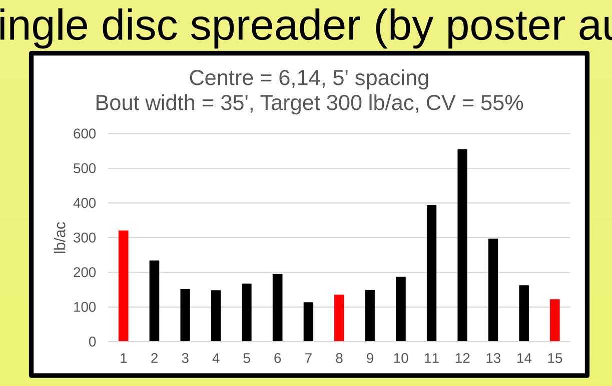


Figure 3. Examples of spread patterns needing adjustments.

- Operator manuals or extension guides[6] provide guidance on pattern correction, through adjustment of flow dividers, spinner disk blade tips, spinner speed, etc.

Accu-Spread Analysis:

Analysis of spin spreader patterns was analysed using the Accu-Spread and Spreadmark Test methods (Figure 4 and Table 2.) This procedure uses the single pass pattern to determine the maximum bout width that still meets C.V. targets in simulated back and forth pattern (⇅⇅), and race track pattern (⇈ ⇊).

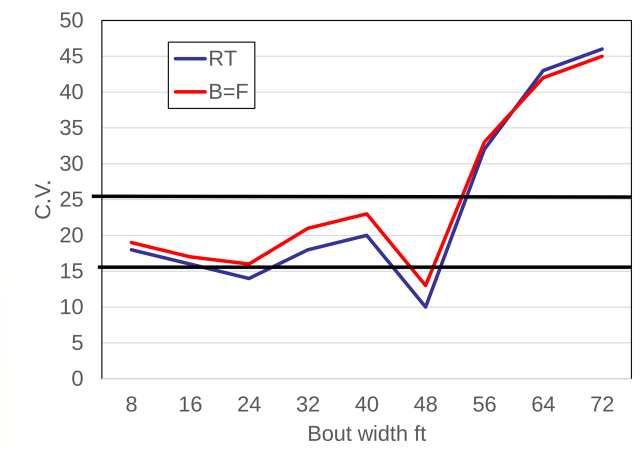


Figure 4. Spreadmark test for spreader 6.

Table 2. Bout width to meet C.V. targets.

Spreader	Farmer bout width ft	Max bout width to achieve desired variability (C.V.)			
Pattern		Back and Forth Pattern		Race Track Pattern	
Variability (C.V.)		<15%	<25%	<15%	<25%
1 dd	102'	-	56'	48'	48'
2 dd	102'	40'	48'	40'	72'+
3 dd	78'	24'	32'	48'	64'
4 dd	50'	56'	72'	56'	72'
5 dd	80'	-	48'	-	40'
6 dd	80'	48'	56'	48'	56'

This analysis offered little value since Table 1 data indicated several spreaders were already meeting these C.V. targets at greater bout widths (spreaders 1,3,4,6). It is suspected that wind distortion during the single pass pattern determination may limit this approach.

Pan evaluations:

Official ASABE calibration pans[6] were not available for this project. Four types of pans were used when calibrating a pass of spreader 10 (Fig 5 and Table 3). All pans had baffles to limit fertilizer bounce and escape.

Figure 5. Collection pans.

Table 3. Comparison of various pans.

Pans	Pan Dimensions L x W x H (in) and area (ft^2)	n	C.V.	Measured rate lb./ac
Amazon (orange)	19.25" x 19.25" x 3.75" = 2.57 ft^2	5	8%	113
Aluminum trays	19" x 11.5" x 3.5" = 1.52 ft^2	5	17%	119
Plastic pans	13" x 11.5" x 4.5" = 1.04 ft^2	11	11%	139
Steel trays	21" x 11.5" x 2.75" = 1.68 ft^2	11	22%	130

- Slow motion camera footage during application confirmed fertilizer bounce out of most pans.
- The pan with the largest area had the lowest C.V. and the pan with highest sides collected the amount most similar to target rate (188 lb/ac).

Summary:

- Agronomists and farmers should conduct regular pattern evaluation of spreaders to identify and correct problems.
- Improve results with larger pans with high sides and interior baffles. Pans were placed every 5-10' but suggestions are every 2.5 ft^5.
- Spreader operation in windy conditions contributes to poorer patterns

References:

[1] STRATUS Ag Surveys. Contact Fertilizer Canada info@fertilizercanada.ca
[2] https://extension.uga.edu/publications/detail.html?number=C798&title=Calibration%20of%20Bulk%20Dry%20Fertilizer%20Applicators
[3] Urea spread patterns shows a high level of variation - Grain ...www.giwa.org.au › _literature_161856 › Kraak,_Jeff
[4] https://www.researchgate.net/publication/303804663_MEASURING_THE_SPREAD_PATTERNS_OF_SPREADERS_UNDER_NORMAL_FIELD_CONDITIONS_COMPARED_TO_TEST_CONDITIONS
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