

## 2016 Corn Nitrogen Rate Study – John Heard, CROPS Manitoba Agriculture

### Background:

Manitoba Agriculture nitrogen rate guidelines for corn<sup>1</sup> were developed before 1990 and are out-of-date for current yield levels. Recently NDSU has released N rate guidelines for corn<sup>2</sup> and a number of in-crop scouting measures can be used to assess sufficiency and need for more N. The following study was initiated to evaluate a number of N decision guides for suitability in fertilizing corn in Manitoba.

### Methods:

Three locations were located near Melita, Carberry and Arborg and were managed by Crop Diversification staff. Additional sites were at St Adolphe (Kelburn farm) and a farm field north of Morden and were managed by Crops Branch, University of Manitoba and Richardson staff.

Nitrogen rates were 0-200 lb N/ac applied as post plant surface broadcast SuperU (46-0-0). To simulate the Y-drop application of side-dress stage N, liquid UAN (28-0-0) was applied at the 6 leaf stage of corn on each side of the corn plant (treatments 7 and 8)

Site description and field activities are listed in Table 1.

*Table 1. Site cropping history, soil characteristics and 2016 growing conditions.*

Site	Kelburn	Carberry	Arborg	Morden	Melita
Cooperator	M. Rogalsky	C Linde	Roger Burak	Eric Unrau/M Rogalsky	S Chalmers
Soil type	Scanterbury clay	Ramada clay loam	Peguis clay	Neuenberg sand loam	Ryerson loam
Prev crop	soybean	Canola	wheat	potatoes, rye cover crop	wheat
Soil analysis					
Nitrate-N lb/ac in 0-24"	71	55	106	35	57
24-48"	nd	24	nd	30	nd
PSNT nitrate-N lb/ac in 0-12"	170	74	254	63	95
OM%	7.7%	4.9%	8.6%	2.9%	4.0%
P ppm Olsen	28	8	47	33	7
K ppm	507	225	480	179	341
pH	7.1	6.0	8.0	7.8	8.0
May-Sept weather					
Crop Heat Units	3050	2775	2779	3110	2903
% of normal	112%	109%	106%	107%	108%
Precipitation (in)	16.1	12.2	11.7	18.1	14.2
% of normal	122%	101%	93%	139%	106%

Table 2. Field Practices.

Site	Kelburn	Carberry	Arborg	Morden	Melita
Planting Date	May 13/16	17-May	20-May	04-May	13-May
Hybrid	DEKALB 26-28	DKC26-28	DKC23-17	Pioneer 7958AM	DKC26-28
Population ('000/ac)	32	32	32	31	32
Sidebanded fertilizer					
MAP lb P2O5/ac	40	54	90	40	40
Potash lb K2O/ac	0	0	0	10	0
Pest management					
Herbicide1	<i>post plant</i>	14-Jun	10-Jun	09-May	21-May
product	Glyphosate	Roundup	Roundup	Glyphosate	Roundup
	Heat & Merge			Heat & Merge	Heat & Merge PrimeExtra II
Herbicide 2	June 14/16		15-Jul	10-Jun	17-Jun
product	Glyphosate		Roundup	Glyphosate	Maverick
Herbicide 3	July 08/16			20-Jun	
product	Basagran			Glyphosate	
Harvest	11-Oct	09-Nov	04-Nov	04-Oct	21-Oct

Table 3. Treatment applications and crop observations.

Site	Kelburn	Carberry	Arborg	Morden	Melita
Nitrogen Tmts					
Tmts 1-6	20-May	15-Jun	08-Jul	09-May	13-May
Tmts 7-8	27-Jun	08-Jul	14-Jul	27-Jun	29-Jun
Observations					
PSNT	27-Jun	08-Jul	14-Jul	27-Jun	11-Jul
SPAD	nd	08-Jul	14-Jul	28-Jun	29-Jun
GreenSeeker1	27-Jun	08-Jul	14-Jul	28-Jun	29-Jun
GreenSeeker2	nd	18-Jul	nd	nd	20-Jul
N Deficiency Leaf rating	03-Aug	09-Aug	04-Aug	28-Jul	nd
Stalk N	11-Oct	nd	nd	nd	03-Oct

- nd = not determined at this site
- PSNT (pre sidedress nitrate-N test) soil sample is taken between the rows to a depth of 12" only on those plots with a base rate of 40 N (values reported in Table 1)
- SPAD chlorophyll readings are taken mid-leaf of the earliest leaf with a developed collar. SPAD values are referenced as an index of those measured at full N rates.
- GreenSeeker readings of NDVI are taken with the pocket GreenSeeker.

- N deficiency ratings are the number of lower corn leaves with visible N deficiency (yellowing of the midrib). The value is the number of deficiency leaves observed in 10 plants.
- Stalk N is the end of season stalk nitrate test as an index of N sufficiency/excess.

**Results:**

Results are reported by location.

*Table 4. St. Adolphe corn response.*

Treatments lb N/ac	NDVI	N Def rating	Moisture %	Yield Bu/ac	Test wt Lb/bu	Stalk N pm NO3
1=0N	0.69	9 a	26.8	202	52	494
2=40N	0.70	7 ab	26.6	201	52	856
3=80N	0.70	4 bc	26.7	211	51	2931
4=120N	0.68	3 c	27.0	202	51	3081
5=160N	0.69	3 c	26.8	203	52	4894
6=200N	0.71	1 c	26.6	206	51	5469
7=40N+40N	0.70	5 bc	25.8	204	50	2013
8= 40N+80N	0.70	5 bc	26.1	204	51	619
Mean	0.7	5	26.5	204.1	51.1	
Pr>F	0.9917	<.0001	0.0763	0.9321	0.6441	
CV	6	60	2	5	2	

Values in columns followed by different letters are significantly different at the 5% probability level (according to Tukey-Kramer).

*Table 5. Carberry corn N response.*

Treatments lb N/ac	SPAD	SPAD Index	NDVI	N Def rating	Yield Bu/ac	Green snap
1=0N	49.3	87%	0.38	5 a	120	1.0
2=40N	56.3	100%	0.44	1 b	115	1.5
3=80N	53.8	95%	0.41	1 b	111	1.5
4=120N	52.5	93%	0.48	0 b	123	1.8
5=160N	52.8	94%	0.44	0 b	119	2.3
6=200N	53.0	94%	0.39	0 b	123	2.3
7=40N+40N	49.0	87%	0.35	0 b	123	2.3
8= 40N+80N	56.3	100%	0.42	1 b	122	2.0
Mean	52.8		0.41		119	1.8
Pr>F	0.6484		0.1535	<.0001	0.7197	0.4312
CV	14		22	89	3	115

Values in columns followed by different letters are significantly different at the 5% probability level (according to Tukey-Kramer).

1. Volunteer wheat was not controlled until mid June and competed for N and early season corn growth.

- Severe wind caused green snap of plants. Values in table are the number of 10 plants that snapped.
- Deer damaged several of the plots adding variability to yield results.

Table 6. Arborg corn N response.

Treatments lb N/ac	SPAD	SPAD Index	NDVI	N Def rating	Moisture %	Yield Bu/ac	Weed growth lb/ac	N in weeds lb/ac
1=0N	47.0 b	87	0.78	10 a	26.5	154 c	858	23
2=40N	50.0 ab	93	0.79	8 a	26.1	169 bc	444	13
3=80N	50.5 ab	94	0.78	5 b	25.5	186 ab	605	25
4=120N	54.3 a	100	0.80	3 bc	25.1	194 a	327	17
5=160N	54.1 a	100	0.81	2 bc	25.2	191 a	480	14
6=200N	53.2 a	98	0.79	1 c	25.7	193 a	599	19
7=40N+40N	50.0 ab	93	0.80	4 b	26.2	187 ab	616	19
8= 40N+80N	49.7 ab	93	0.80	3 b	25.7	194 a	911	37
Mean	51			4	25.8	183.4		
Pr>F	0.0014		0.4293	<.0001	0.1661	<.0001		
CV	7		3	70	3	9		

Values in columns followed by different letters are significantly different at the 5% probability level (according to Tukey-Kramer).

- The broadcast N application was not applied until early July. A second flush of weeds was not controlled and biomass and N uptake was measured and reported in Table 6.

Table 7. Morden corn N response.

Treatments lb N/ac	SPAD	SPAD Index	NDVI	N Def rating	Moisture %	Yield Bu/ac	Test wt Lb/bu	Stalk N pm NO3
1=0N	41.9 c	88	0.64	9 a	23	178	49	46
2=40N	46.7 ab	98	0.65	7 ab	24	194	52	502
3=80N	45.1 bc	94	0.69	6 bc	24	196	52	4102
4=120N	47.3 ab	98	0.70	4 cd	23	199	51	2234
5=160N	48.5 a	100	0.66	3 de	24	199	51	4234
6=200N	47.6 ab	100	0.69	1 e	23	197	50	3885
7=40N+80N	45.9 ab	96	0.67	5 bcd	24	186	51	2173
8= 40N+120N	46.7 ab	98	0.70	4 cd	23	184	51	3931
Mean	46		0.7	5	23	191	51	2638
Pr>F	<.0001		0.1500	<.0001	0.2183	0.1856	0.7873	
CV	6		5	54	4	7	5	

Values in columns followed by different letters are significantly different at the 5% probability level (according to Tukey-Kramer).

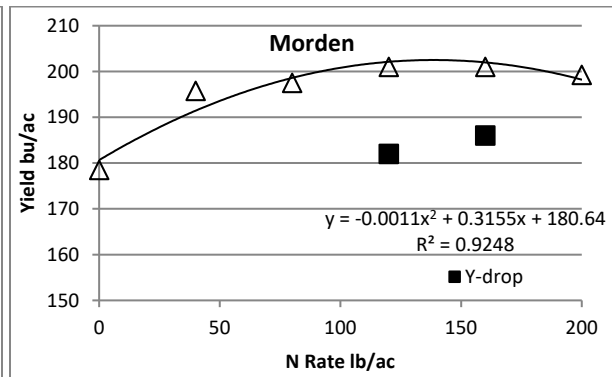
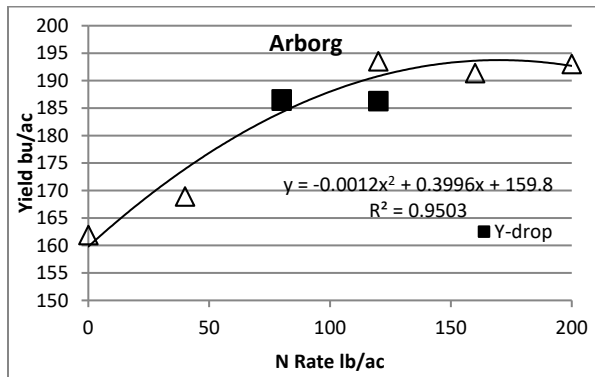
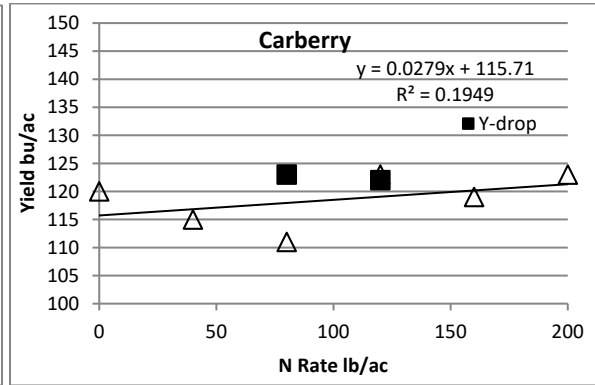
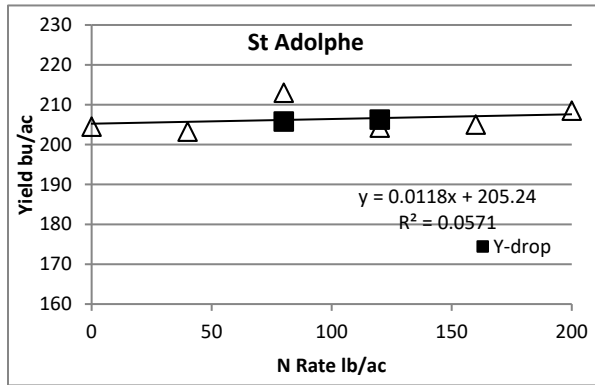
Table 8. Melita corn N response.

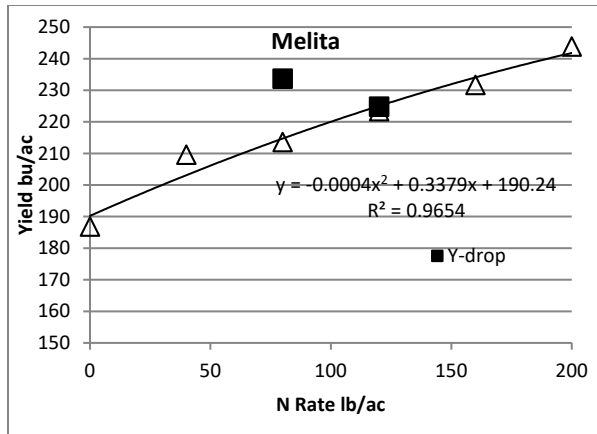
Treatments lb N/ac	SPAD SPAD	SPAD Index	NDVI	Moisture %	Yield Bu/ac	Test wt Lb/bu
1=0N	41.4 bc	89	0.46	27.2 a	187 b	52
2=40N	42.4 abc	91	0.50	24.6 ab	210 ab	54
3=80N	42.6 abc	93	0.51	24.7 ab	214 ab	53
4=120N	45.6 a	100	0.52	23.7 b	223 ab	54
5=160N	42.8 abc	93	0.49	24.4 b	232 ab	53
6=200N	44.2 ab	96	0.53	24.5 ab	244 a	54
7=40N+40N	40.1 c	87	0.51	23.4 b	230 ab	54
8= 40N+80N	41.8 bc	91	0.56	23.8 b	228 ab	54
Mean	42.6		0.51	24.5	221	53
Pr>F	0.0039		0.6096	0.0064	0.015	0.2933
CV	6		13	6	11	2

Values in columns followed by different letters are significantly different at the 5% probability level (according to Tukey-Kramer).

**Discussion:**

Corn did not respond to applied N at St Adolphe or Carberry, but responded significantly at Arborg and Melita and tended to increase at Morden (Figures 1-5).





Figures 1-5. Nitrogen response of corn at St Adolphe, Carberry, Arborg, Morden and Melita.

The post plant applications to simulate the Y-drop applicator did not produce different yield than post plant surface applications of SuperU. The exception was at Morden where the UAN application inadvertently splashed onto bottom leaves causing leaf burn and slightly lower yields (but ns). The application technique was modified to prevent such splash at other locations.

Few of the N decision methods or guides (Table 9) matched well with the actual N rate producing the most economic yield (Table 10). And even though visual N deficiency symptoms matched well with N rate at St Adolphe, Carberry, Arborg and Morden, they were not a particularly good guide for nitrogen sufficiency. Even where there was no yield response to N at St Adolphe, 9 of 10 plants had leaves with N deficiency symptoms (Table 4).

Table 9. Decision criteria for N rate recommendations for corn.

Source	
MERN	Determined using \$5/bu corn and \$0.50 /lb N and by fitting a quadratic function to yield response (where applicable).
Manitoba Agriculture	Using N recommendations from Soil Fertility Guide for 130 bu/ac corn and soil test N. <sup>1</sup>
NDSU	Using N calculator based on soil texture, historic yields less than 160 bu/ac, soil test N and OM, \$5/bu corn and \$0.50 /lb N. <sup>2</sup>
AgVise	Using yield goal of 150 bu/ac for Morden and 125 bu/ac for other locations and soil test N.
SPAD	Sufficiency is the N rate when SPAD index is >95%.
NDVI	Using NUE web-based N rate calculator for Minnesota corn. <sup>3</sup>
PSNT	Measured on plots with base rate of 40N and using AgVise criteria for supplementation and yield goal of 150 bu/ac for Morden and 125 bu/ac for others. See Table 1 for PSNT amounts.
Stalk nitrate	Low (<250 ppm) = N was deficient, Marginal (250-700 ppm) = possible that N shortage limited yield, Optimal (700-2,000 ppm) = yield not limited by N shortage, Excessive (>2,000 ppm) = N rates was high or some other factor reduced yield.

Table 10. Observed N response and predicted N needs.

Site	St Adolphe	Carberry	Arborg	Morden	Melita
	Lb N/ac				
<b>MERN</b>	<b>0</b>	<b>0</b>	<b>125</b>	<b>98</b>	<b>200+</b>
Mb Ag	95	130	0	170	120
NDSU	0	95	0	112	93
AgVise	79	95	44	144	93
SPAD	-	40	120	40	120
NDVI	0	120	0	0	0
PSNT	10	75	10	128	55
Stalk N	80	-	-	80	-

The lack of agreement between N guidelines and actual response may be caused by:

- Higher yields that we have previously experienced.
- Higher mineralization of N from organic matter.

Soil mineralization of OM obviously contributed greatly to the high check yields. A very crude calculation of N mineralization is shown in Table 11. The estimate is based on using a 1.12 lb whole plant N uptake/bu<sup>4</sup> less soil nitrate, less starter fertilizer N. The estimated mineralization values of 56 – 160 lb N/ac are much greater than normally anticipated. Unfortunately measurements were not taken to allow consideration of nitrate-N from deeper depths or residual N at harvest.

Table 11. Crude estimate of nitrogen mineralization.

Site	St Adolphe	Carberry	Arborg	Morden	Melita
	Lb N/ac				
Check Yield bu/ac	202	120	154	178	187
Est .N uptake <sup>4</sup>	226	134	172	199	209
Soil nitrate 0-2'	71	55	106	35	57
Starter fertilizer N	4	6	10	4	4
Mineralized N est.	151	73	56	160	148
Measured OM%	7.7%	4.9%	8.6%	2.9%	4.0%

Such high corn yields and large N mineralization rates challenge N recommendations developed with current preplant planning techniques. A next step would be to use combined models of soil N dynamics and crop growth adjusted with real-time weather information.

**References:**

- <sup>1</sup> Manitoba Soil Fertility Guide. 1996. Manitoba Agriculture  
<http://www.gov.mb.ca/agriculture/crops/soil-fertility/soil-fertility-guide/>
- <sup>2</sup> Franzen. 2014. Soil Fertility Recommendations for Corn. NDSU F722  
<https://www.ndsu.edu/pubweb/soils/corn/>
- <sup>3</sup> <http://www.nue.okstate.edu/SBNRC/mesonet.php>
- <sup>4</sup> Bender et al. 2013. Better Crops. Vol.97 No. 1 p7-10.

**Acknowledgements:**

- Manitoba Corn Growers Association
- AgVise Laboratories
- KOCH Fertilizers
- DeKalb(Monsanto Canada)
- Magda Rogalsky, Soil Science dept, University of Manitoba
- Manitoba Agriculture Crop Diversification Centres at Carberry, Melita and Arborg and research staff (Craig Linde, Scott Chalmers and Roger Burak)
- Kelburn Farm and Brian Hellegards, Richardson's Int.
- Southern Potato Farms and Eric Unrau