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NORTHEAST AGRICULTURE RESEARCH FOUNDATION

2012 Responsiveness of Oat to Fertilizer N and Fungicides

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ABSTRACT

Demonstrations were set up at Indian Head and Melfort SK to show the relatively weaker response to fertilizer N by oat compared with wheat, and the lack of response by oat to fungicides. The demonstrations were set up in a split plot design with Oat- no fungicides; Oat with Headline; Oat with Stratego and Wheat with Headline as the four main plot treatments, and eight rates of fertilizer N from 5 to 140 kg/ha as sub-plot treatments. As expected, fungicides had no effect on oat, and overall disease levels in oat were very low. Disease levels in wheat were much higher, but without a no fungicide check we can only speculate about the need for fungicides in this crop. Oat yield responded to fertilizer N at rates up to 100 kg/ha at Indian Head with little change in yield at rates above 100 kg/ha. At Melfort, oat yield increased with N rate right up to the highest rate of 140 kg/ha. At both locations, wheat yield increased with increasing N rate up to 80 kg/ha with no further increase at higher rates, showing a decline with rates above 80 kg/ha at Melfort. With both oat and wheat, the N rate where substantial lodging started corresponded closely to the rate where yield no longer responded to increased N. Volume weight of oat was unaffected by N rate at Melfort, but at Indian Head it declined at rates of N above 100 kg/ha. Reduced volume weight could result in oat being rejected from the premium milling grade.

Project objectives:

The objective of this project was to validate recent research results showing that oat requires substantially less N than other cereal crops in the region because oat scavenges soil N more effectively than other cereals like wheat. A second objctive was to validate other recent research results showing that oat does not require fungicide treatment because disease incidence and severity are too low to require treatment.

Project Rationale:

Oat yields in the Black soil zones of SK typically exceed 100 bu/ac and yields of 200 bu/ac are possible. Crop removal of nitrogen from soil is slightly more than 0.6 lb/bu meaning that a 150 bu/ac crop would remove more than 90 lb/ac of N. Very high yielding crops typically produce crop canopies where microenvironments are conducive to extensive disease development. For these reasons, growers who target high oat yields typically apply in excess of 80 lb/ac of fertilizer N and use foliar fungicides for leaf disease control.

Recent research on oat management calls these practices into question. These results indicated that oat yield was often optimized at N rates of 25 lb/ac and rarely responded to rates exceeding 55 lb/ac. The reason why oat was able to optimize yield at low N rates was linked to a more aggressive oat root system than other crops allowing oat to utilize N that other crops cannot use. If this is true, oat could fill an important role in rotations as a scavenger crop that uses N that would otherwise be lost where it could cause environmental damage. Additionally, if N rates are not adjusted accordingly, the environmental problems could be aggravated. Excessively high N rates can also reduce milling quality of oat.

The same studies indicated that oat did not require fungicide treatment because the crop rarely contracted diseases like crown rust. Use of fungicides where they are not required presents 2 risks. First there are increased costs without an offsetting increase in income. Second, the risk that diseases will develop resistance to fungicides increases with fungicide use.

Methodology:

The demonstration was set up as a split plot for oat combined with a 1 way factorial for N rate in wheat sprayed with Headline Fungicide. Main plot treatments applied to oat were 1) No Fungicide, 2) Headline, 3) Stratego, and 4) Headline applied to wheat. Sub plot treatments were N rates of 5, 20, 40, 60, 80, 100, 120, 140 kg/ha, to create a total of 32 treatments at each site.

Melfort:

The site at Melfort was located on a Thick Black clay loam soil on canola stubble that had received very little fertilizer over the past four years. Available soil N, P, K and S at the site prior to seeding was 36, 54, 540 and 74 kg/ha respectively. Roundup Weathermax (0.7 L/ac) tank mixed with Pardner (0.47 L/ac) was applied prior to seeding. Plots were seeded May 17, 2012 with an Edwards No-Till hoe drill with 8" row spacing. Triactor oat was seeded at 117 kg/ha and Unity VB wheat at 114 kg/ha to provide 300 viable seeds per square meter for each crop. During seeding fertilizer N, P, K and S were applied at rates of 5-8-4-4 kg/ha with seed and 46-0-0 was side banded at varying rates to prove a total of 5, 20, 40, 60, 80, 100, 120 or 140 kg/ha of N as per the treatment protocol.

Frontline herbicide (0.5 L/ac) was applied June 7 at the 2 leaf stage of the crop. Plant density counts were done June 8 on two 1-M row lengths. Headline (0.160 L/ac) and Stratego (0.202 L/ac) were applied as required on July 6. Harvesting was done September 7 (wheat) and September 13 (oat) by straight combining a 1.3 x 10 M area down the centre of each plot.

Indian Head:

The site at Indian Head was located on canola stubble on a Thin Black heavy clay soil. Residual soil N at the site was 10 kg/ha and P_2O_5 was 16 kg/ha. Before seeding a tank mix of Credit 1 L/ac) plus Aim 0.03 L/ac was applied for pre-seeding weed control. A ConservaPak air drill with 12" was used to seed the plots (13' by 35') on May 14 to Triactor oat (171 kg/ha) and Unity VB wheat (121 kg/ha) to provide 300 viable seeds per square meter. During seeding, N and P were side banded at 5 and 23 kg/ha to all plots, and additional N was applied based on treatment requirements.

Prestige herbicide (Component A at 0.13 L/ac and Component B at 0.6 L/ac was applied for in-crop weed control on June 18. Plant density counts were made June 7 on two 1M row lengths per plot. Headline and Stratego were applied as required on July10. The oat crop was harvested August 31, and wheat September 5. Harvesting was done by straight combining the full 13' x 35' plots.

Data Collection:

1. Soil sampling was done for N, P, K and S determination in spring prior to seeding.
2. Plant density was determined by counting plant from two 1-M row lengths per plot at approximately 21 days after seeding

3. Tiller density was determined by counting the number of panicles at maturity on 2- one metre rows per plot.
4. Plant height was measured at 2 locations per plot at maturity.
5. Days to maturity when seeds were difficult to dent with the thumbnail was recorded.
6. Lodging, ratings were made on a 1-10 scale where 1= upright and10=flat.
7. **Crown Rust** ratings using modified Cobb Scale on no fungicide plots only (control plots) at the time of fungicide application on10 flag leaves and 10 flag-1 leaves per plot. Repeated on all plots at the milk stage.
8. **Stem Rust** ratings using modified Cobb Scale on control plots at time of fungicide application and repeat at milk stage on all plots, but only if stem rust is observed.
9. **Leaf diseases** other than rust (Pyrenophora leaf blotch and stagonospora leaf disease) were rated using the Horsfall - Barrett scale (using the same 10 flag leaves and 10 flag-1 leaves per plot, used for crown rust). Repeated on all plots at the milk stage.
10. Grain yield
11. Retain 1 kg sample to send to Indian Head for further testing as listed below
12. Test weight
13.1000 Kernel weight
15. % plump kernels
17. % wild oats in sample
18. Groat yield
19. Grain total N or protein
20. Beta Glucan

Results

At both Indian Head and Melfort, the 2012 growing season was cooler than normal during May (Table 1), near normal in June and August and warmer than normal in July. Overall the mean growing season temperature was within a half degree of normal. At Indian Head, July could be characterized as being much wetter than normal while other months were somewhat wetter or drier than normal, but not abnormally wet or dry (Table 2). Overall the growing season was almost 15% wetter than normal. At Melfort, June was very wet with other months also having above normal precipitation. Overall the growing season at Melfort was more than 35% wetter than normal.

Table 1. Mean monthly and long-term (1971-2000) normal temperatures for the 2012 growing season at Indian Head and Melfort Saskatchewan.

Location	Year	May	June	July	August	Avg. / Total
		-------------	-------------	Mean Temperature (°C)	-------------	-------------
Indian Head	2012	9.9	16.5	19.2	17.1	15.7
	Long-term[z]	**11.4**	**16.1**	**18.4**	**17.5**	**15.9**
Melfort	2012	9.6	15.2	18.9	17.1	15.2
	Long-term	**10.8**	**15.7**	**17.4**	**16.4**	**15.1**

[z]Long-term normals (1971-2000)

Table 2. Total monthly and long-term (1971-2000) normal precipitation for the 2012 growing season at Indian Head and Melfort, Saskatchewan.

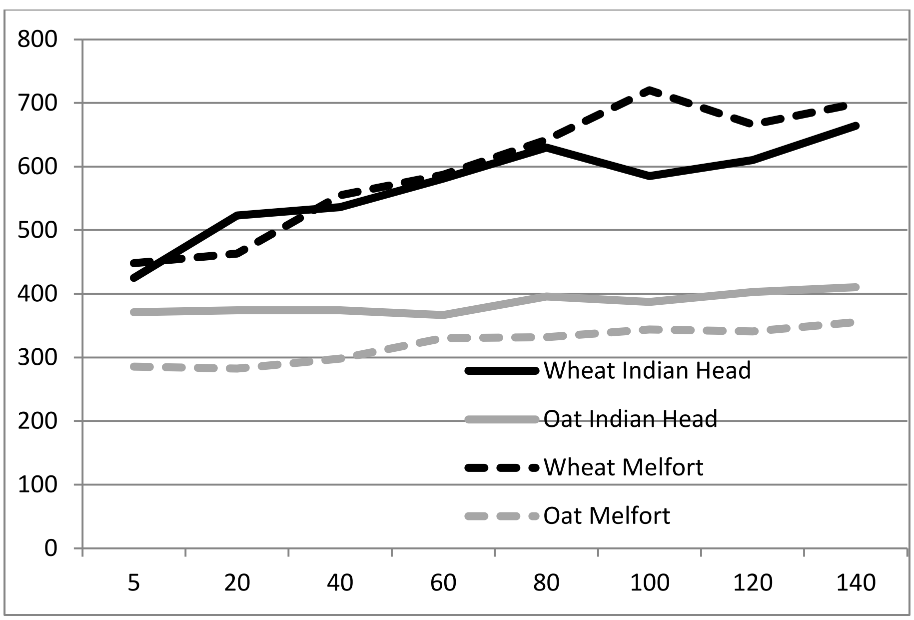
Location	Year	May	June	July	August	Avg. / Total
		----------	----------	Precipitation (mm)	----------	----------
Indian Head	2012	79.4	51.0	124.6	30.4	285.4
	Long-term[z]	**52.5**	**78.9**	**67.1**	**52.7**	**251.2**
Melfort	2012	55.2	112.3	97.8	68.1	333.4
	Long-term	**45.6**	**65.8**	**75.7**	**56.8**	**243.9**

[z]Long-term normals (1971-2000)

Plant populations at approximately 21 days after seeding were higher at Indian Head (oat 270, wheat 211 plants/M^2) than at Melfort (oat 208, wheat 183 plants/M^2). As well oat densities were higher than for wheat at both locations, by 22% at Indian Head and 12% at Melfort.

Despite lower plant densities for wheat than for oat, tiller numbers per unit area were higher for wheat than oat at both locations (Figure 1). Wheat tiller numbers also increased rather sharply as N rate increased, while oat tiller numbers increased less sharply as N rate increased from 5 to 60 or 80 kg/ha, but changed relatively little as N rate increased further.

Figure 1. Tiller Densities (tillers/M^2) for Oat and Wheat at Indian Head and Melfort SK in 2012 with Increasing Fertilizer N Rates (oat data is the mean of 3 no fungicides, Headline and Stratego).



N Rate (kg/ha)

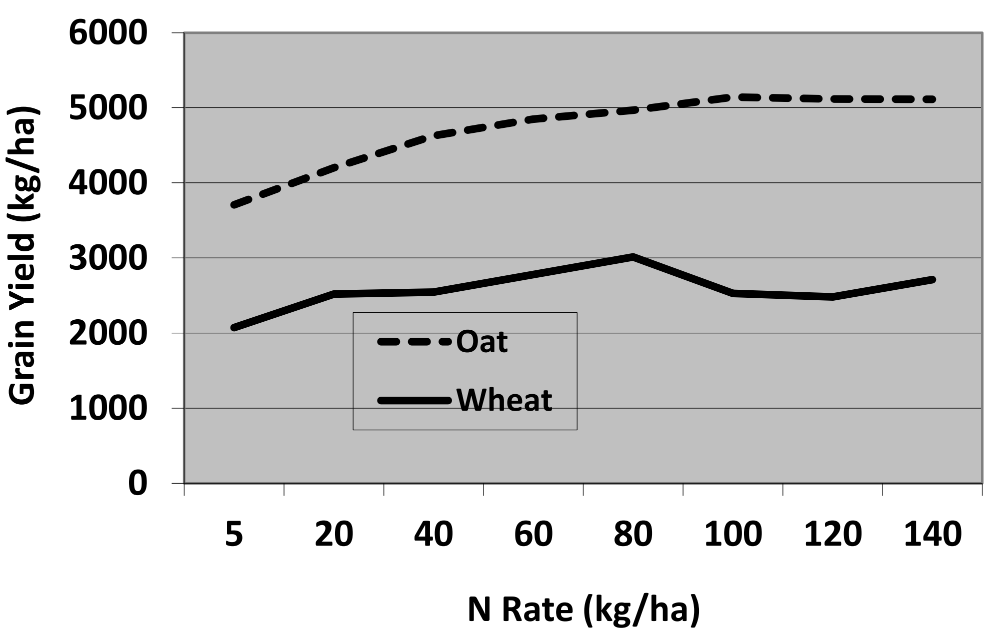
At Indian Head very little lodging was noted at N rates of 60 kg/ha or less, while slight lodging (ratngs up to 2) was noted at 80 and 100 kg/ha with both wheat and oat. At N rates of 120 and 140, oat lodging was much more severe with average ratings of 3,1 at 120, and 6.7 at 140 kg/ha of N. For wheat, lodging ratings were at 6.0 and 5.0 at N rates of 120 and 140 kg/ha respectively.

At Melfort there was a weak trend for lodging to increase as N rate increased with oat, but ratings never exceeded 1.5 for any N rate. By contrast, wheat began lodging at 80 N (2.8 rating), and became severe at all higher rates, ranging from 5.5 to 6.8 as N rate increased from 100 to 140 kg/ha.

Neither stem nor crown rust was noted on oat at Melfort at the flag leaf fully emerged or at the milk stage. Incidence of other leaf diseases was very low on flag leaves at the milk stage, averaging less than 1.5 on the 1-10 rating scale for all oat treatments, and rating did not tend to be lower for fungicide treated compared with untreated at Melfort. Disease incidence was much higher on wheat at the milk stage of development, with ratings of 4.0 to 4.9 on the flag leaf, 4.0 to 5.5 on the flag minus 1 leaf (Horsfall-Barrett), and 4.9 to 6.5 on whole plants (McFadden)

As expected, fungicides (Headline or Stratego) did not affect yield at either location. At Melfort there was a weak (but statistically ns) tendency for yield to decline where fungicides were applied compared with no fungicide. This observation reflects that very little evidence of disease was noted on the no fungicide plots. Fertilzer N rate did significantly affect yield of both oat and wheat at both sites. Because N response by oat was our primary interest, the oat data was examined based on the means across the three funcide treatments which provided a more reliable response curve.

Figure 2. Yield Response (kg/ha) to Fertilizer N by Oat and Wheat at Indian Head, SK in 2012.



Yield of oat was much higher than wheat at both locations (Figures 2 and 3), while yield at Melfort was slightly that at Indian Head with both crops. At Indian Head, oat yield increased with increasing N rate up to about 100N, with very little change as N rate increased to 120 and 140 kg/ha. At Melfort, oat yield continued to incease over all N rates, with no indication that yield had reached a maximum even at 140 kg/ha. With wheat, yield increased with N rates up to 80 kg/a and declined with furtur N rate increases at both locations.

It is interesting to note that the N rate at which yield approached the maximium, was also the N rate above which serious lodging began.

Volume weight of oat changed relatively little at Melfort as N rate increased over the full range of rates used (Figure 4). By contrast at Indian Head, volume weight declined sharply at N rates exceeding 100 kg/ha.

Other grain quality analyses (1000 seed weight, % plump, groat yield, protein content and beta glucan content) have not been fully completed to date. Preliminary 1000 seed weights from Indian Head do indicate that seed weight began to decrease at the highest N application rate. Declining seed weight would also reduce probability that oat would be selected for milling.

Marginal returns were examined for a number of oat price scenarios (Table 3). When Oat prices were very high, the highest rates of N (120 or 140 kg/ha) were favored at Melfort, but at Indian Head lower rates in the 60-80 kg/ha range were favored. As oat prices declined, lower rates were favored at Melfort, but not at Indian Head. At Indian Head yield increased by 20 kg/ha for each additional kg of N added at N rates between 5 and 60 kg/ha. At Melfort, yield increased by only 13.5 kg/ha for each kg of added N in the same rate range. This would suggest that more of the fertilizer N was available to the crop at Indian Head than at Melfort. Because the Melfort site had a history of low fertilizer application it is probable that more N was being tied up by other soil organisms and not available to the crop because they had been deprived of N. By contrast at Indian Head with a history of adequate fertilizer applied, more of the fertilizer N was available to the crop. This points out an important facet of fertilizer N management in that deficits from previous years may need to be offset in order to optimize yield in future.

With wheat, marginal returns were optimized at 60 kg/ha at both locations at wheat prices between $275 and $325/T (data not shown).

Figure 3. Yield Response (kg/ha) to Fertilizer N by Oat and Wheat at Melfort, SK in 2012.

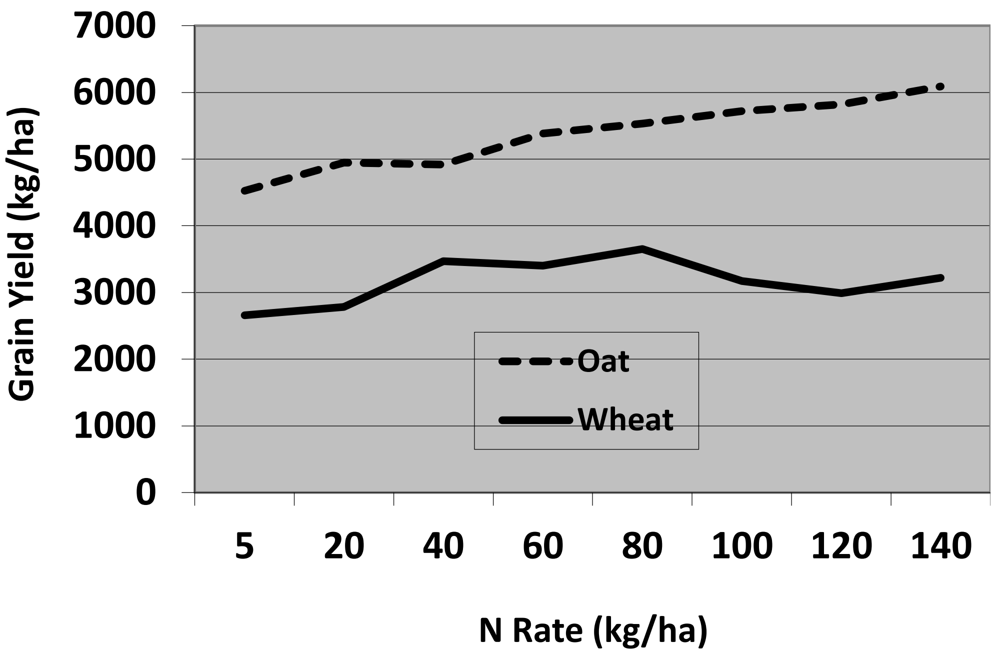


Figure 4. Influence of Fertilizer N Rate on Volume Weight of Oat at Indian Head and Melfort, SK in 2012.

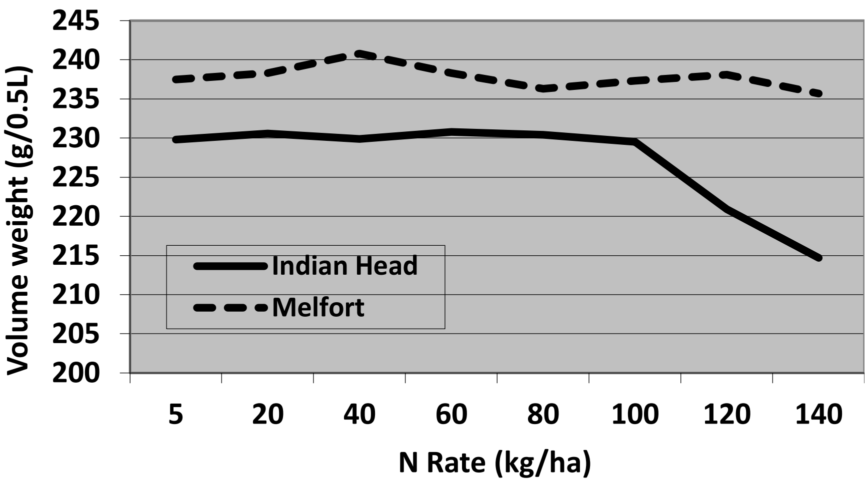


Table 3. Influence of N Rate and Oat Price on Marginal Returns ($/ha) Based on N Yield Response Curves for Melfort and Indian Head($/ha).

	Melfort				Indian Head			
	Predicted Yield Increase Kg/ha	Oat Price $/T			Predicted Yield Increase Kg/ha	Oat Price $/T		
N Rate (kg/ha)		***$220***	***$200***	***$180***		***$220***	***$200***	***$180***
20	264	32.28	27.00	21.72	455	74.30	65.20	56.10

40	511	52.22	42.00	31.78	821	120.40	104.00	87.85
60	741	68.42	53.60	38.78	1100	**147.4**	**125.40**	**103.40**
80	953	80.60	61.60	**42.54**	1291	**155.02**	**129.20**	**103.38**
100	1149	89.38	**66.40**	**43.42**	1395	143.5	115.60	87.70
120	1328	**94.36**	**67.80**	41.24	1411	112.62	84.40	56.18
140	1489	**95.38**	65.60	35.82	1339	62.38	35.60	8.80

We calculated rates of N removal and N balance (additions from fertilizer minus removal) for each N rate at each site. Removal rates at both sites increased with yield. However at rates where returns were optimised N balances were generally near zero or slightly positive for Melfort particularly with high oat prices. At Indian Head, balances were negative at optimum Nates for all price scenarios. This would suggest that where adequate N has been used historically, oat would be a good crop to use to glean unused N from preceding crops. However, on fields with a history of inadequate N use, it is probable that higher rates that would begin to replace what had been previouslly removed would be required.

Table 4. Influence of Fertilizer N Rate on N Removal and N Balance for Oat at Melfort and Indian Head in 2012 (Based on predicted yield from yield response to N and N content of oat at 19.25 kg/T).

	Melfort			**Indian Head**		
Fertilizer N Rate (kg/ha)	**Predicted Yield (kg/ha)**	**N Removal (kg/ha)**	**N Balance (kg/ha)**	**Predicted Yield (kg/ha)**	**N Removal (kg/ha)**	**N Balance (kg/ha)**
5	**4563**	**88**	**-83**	**3740**	**72**	**-67**
20	**4827**	**93**	**-73**	**4195**	**81**	**-60**
40	**5074**	**98**	**-58**	**4561**	**88**	**-48**
60	**5304**	**102**	**-42**	**4840**	**93**	**-33**
80	**5516**	**106**	**-26**	**5031**	**97**	**-16**
100	**5712**	**110**	**-10**	**5135**	**99**	**1**
120	**5891**	**113**	**7**	**5151**	**99**	**21**
140	**6052**	**117**	**23**	**5079**	**98**	**42**

Conclusions and Recommendations

Results to date support other research on oat concluding that this crop does not respond well to fungicides. However, this does conflict with perceptions of growers in the local area who feel they get good responses to fungicides. This discrepancy likely reflects that most growers plant the older less disease resistant variety Morgan. The variety Triactor as used has good crown rust and leaf disease resistance. The demonstration did provide a good opportunity to discuss crown rust management strategies at the Melfort Field Day. Nitrogen responses by oat generally agree with previous research indicating that yield is usually optimized at rates of 60 kg/ha or less, and that quality declines where nitrogen rates become overly excessive. However we found little evidence that oat was better able to ‘glean’ N from the soil than wheat, or that oat required less fertilizer N to optimize yield than wheat. This latter conclusion may reflect that the wheat cultivar used, Unity VB, did not have good lodging resistance and lodged badly at high N rates. The study also provided some insight into impact of fertilizer management over time, suggesting that deficits built up over time could restrict N responses. Conversely, could N surpluses limit need for N in future, and should we develop strategies to glean surplus N from the soil to avoid having it lost.

There is a need to repeat this experiment for another year to ensure that we can update recommendations on disease and fertilzer N management. There also is a need for a better understanding of the relative N requirements of oat. This information would allow us to better determine whether oat could play an important role in utilizing residual fertilizer not used by crops like canola and wheat where higher N rates are typically applied. To this end we have re-applied to conduct this demonstration at the same sites in 2013.

Plans are in place to present results at meetings scheduled for January 30, 31, February 1, March 12 and 21 in Wynyard, Yorkton, Tisdale, Melfort and Prince Albert.

<u>Supporting Information</u>

Acknowledgements

This project was funded by the Agricultural Demonstration of Practices and Technologies (ADOPT) program of the federal and provincial governments. Signage was present at both the Indian Head and Melfort field sites, along with general signage acknowledging AgriARM and ADOPT at the main farm sites.

Acknowledgement of ADOPT and AgriARM was provided in all presentations associated with this demonstration, and will be in future ones.

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