Cer1-2011 - Nitrogen Requirements for Intensively Managed SRW Wheat

CROP ADVANCES

Field Crop Reports

Volume 8 — February 2, 2012

Field Crops Team, Agriculture Development Branch
Ministry of Agriculture, Food and Rural Affairs
In partnership with
Ontario Soil and Crop Improvement Association
And other Agricultural Organizations and Businesses

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Nitrogen Requirements for Intensively Managed SRW Wheat

Purpose:

Current fertilizer N recommendations for soft wheat in Ontario were developed using research data collected mostly before 1990 (more than 20 years ago). Modern wheat varieties are substantially higher yielding compared to the varieties available prior to 1990. Also, use of fungicides and plant growth regulators are increasing because of a growing interest by Ontario's wheat producers to achieve higher yields and increased economic returns.

The purpose of this 3-year project was to evaluate fertilizer N requirements of intensively managed high yielding modern soft red winter (SRW) wheat varieties in Ontario. Trials included multiple rates of spring applied N fertilizer to determine maximum economic N rates. The impact of applying 30 lb-N/ac in the fall was also evaluated to determine if fall N application can increase wheat yields and economic returns.

Methods:

To date, wheat yield response to fertilizer N rates have been evaluated on 12 on-farm sites (3 in 2010 and 9 in 2011) with plots that were large enough to use cooperating farmers' commercial combines. Plots were typically 20-30ft wide by field length. All yields were recorded using weigh wagons. Except for nitrogen, wheat was produced using the cooperating farmers production practices which are summarized in Table 1. Wheat was always planted following either soybeans or edible beans. The 2010 Thamesville site had a history of recently applied biosolids, otherwise the sites had no manure applied in the previous 2 years. All wheat varieties were soft red winter. Fungicides were applied at T3 (fusarium timing, GS 61) and sometimes at T1 (weed control timing, GS 30-32). Growth regulators were not applied on these trials.

Spring N rates were 0 (0), 67 (60), 101 (90), 134 (120) and 168 (150) kg-N/ha (lb-N/ac) applied in April or early May as either broadcast Urea or UAN (28%). Site specifics on N fertilizer type and spring application date are presented in Table 1. Not all 5 spring N rates were applied at each site.

Fall N treatments were included at 5 of the 2011 sites. The Fall N treatments consisted of fall broadcast Urea applied at 34 kg-N/ha (30 lb-N/ac) in early November. An additional 101 (90) or 134 (120) kg-N/ha (lb-N/ac) of spring applied N was applied to the fall N plots.

The actual fall and/or spring N rates applied at each site are shown in Table 2 where the absence of yields indicates that the fertilizer N treatment was not included at that site.

Results:

Table 1. Production practices associated with the various on-farm trials evaluating soft red winter wheat response to fall and/or spring N application.

Site	Tillage	Starter (Amount)	Plant Date	Variety	Spring N Source	Fungicide	
						(T1)	(T3)
2010							
Palmerston	No-till			R045	Urea	Yes	Yes
Thamesville	No-till	MAP (50 lb/ac); Potash (25 lb/ac)	Oct 16	25R47	UAN	Yes	Yes
Watford	No-till	MAP (50 lb/ac); Potash (25 lb/ac)	Oct 02	25R47	UAN	Yes	Yes
2011							
Belmont	Minimum	6-24-6 (5 gal/ac)	Sep 27	25R47	Urea	Yes	Yes
Fergus	Minimum		Oct 01	25R47	Urea	No	No
Fingal	No-till				UAN	No	Yes
Fullerton	No-till	7-33-33 (93 lb/ac)	Sep 15	Emmit	Urea	No	No
Lucan	No-till	7-39-15 (125 lbs/ac)	Sep 22	25R47	Urea	Yes	Yes
Napanee	No-till	6-24-6 (7 gal/ac)	Sep 27	25R56	UAN	Yes	Yes
St. Catherines	No-till	MAP (30 lb/ac)	Oct 18	Emmit	Urea	Yes	Yes
St. Thomas	No-till	6-24-6 (6 gal/ac)	Oct 19	25R56	Urea	No	Yes
Woodstock	No-till	6-24-6 (5 gal/ac)	Sep 25	25R47	UAN	No	Yes

Table 2. Soft red winter wheat yield response to fall and/or spring applied N for each of the sites in 2010 and 2011.

Site	No Fall N					Fall N	
	0 lb-N/ac	60 lb-N/ac	90 lb-N/ac	120 lb-N/ac	150 lb-N/ac	90 lb-N/ac	120 lb-N/ac
2010	----------bu/ac ----------						
Palmerston	48 c+	71 b	74 b	82 a	87 a		
Thamesville	92 ab	95 a		94 a	89 b		
Watford	60 c	90 b		110 a	109 a		
2011	----------bu/ac ----------						
Belmont	45 d	67 bc	68 bc	74 ab	77 a	64 c	69 bc
Fergus	50 b	69 a	71 a	79 a	78 a		
Fingal			108	117	125		
Fullerton	71 c	93 b	96 ab	94 b	99 a	97 ab	95 ab
Lucan	74 d	105 c	111 bc	118 ab	121 a	114 ab	117 ab
Napanee		70 c	88 b	103 a	108 a		
St. Catherines	25 d	39 c	52 b	65 a	64 a	51 b	61 ab
St. Thomas	48 b	64 b	79 a	84 a	86 a	83 a	90 a
Woodstock	80	98	110	103	121		

+ Within row (site) yields followed by the same letter are not different at the 10% level of probability. Yields without following letters means the site was not replicated.

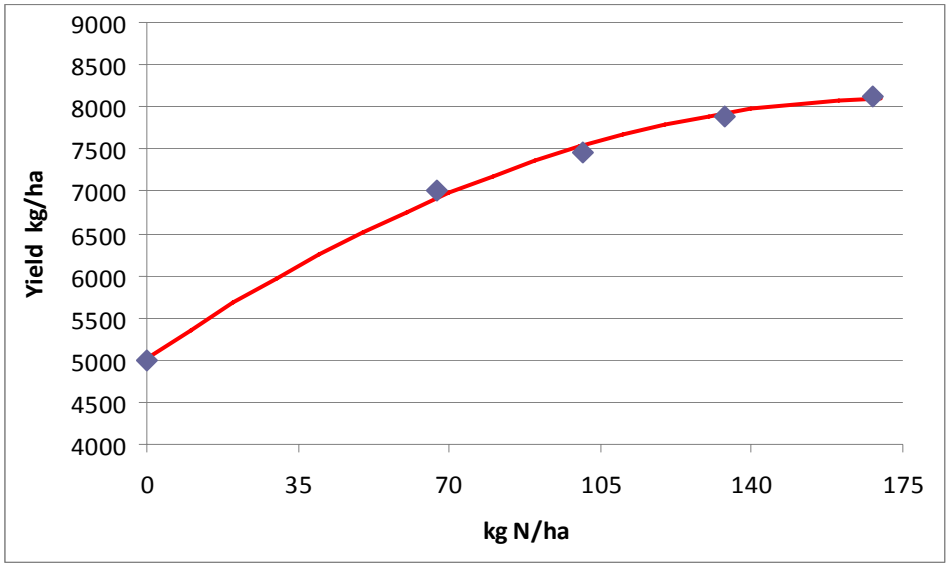
Optimal Spring N Rates

Eleven trials (3 in 2010 & 8 in 2011) had at least 4 spring N rates allowing development of yield response equations to spring applied N. Most sites had all 5 rates with the exception of the Thamesville and Watford sites in 2010 where the 101 kg-N/ha (90 lb-N/ac) rate was not included and the 2011 Napanee site which did not include the 0 rate. Fall N treatments were not included in development of yield response equations because only 2 spring N rates were applied to plots that received Fall N. The coefficients of variation (c.v.) associated with fitting N regression curves for the various sites were generally low, ranging from 1.4 to 7.7% which is desirable (Table 3).

One of the 11 sites did not respond to applied N (2010 Thamesville) (Table 3). The average yield at this site was 6220 kg/ha (93 bu/ac). This site had a history of applied biosolids, which appear to have provided sufficient N for the wheat crop such that additional N showed no response.

Only 2 of the 10 responsive sites produced non-N limited yields with spring N rates that were less than 168 kg-N/ha (150 lb-N/ha) (Table 3). Figure 1 shows a typical wheat yield response to spring N rates observed in 2011 where on many of the sites yields continued to increase up to the highest spring N rate applied.

Figure 1. Soft red winter wheat yield response to spring applied N at Lucan (2011).



Five out of the responsive sites had maximum economic N rates, at a nitrogen:wheat price ratio of 5, that were less than 168 kg-N/ha (150 lb-N/ac). Of the 10 responsive sites, 9 required more than 101 kg-N/ha (90 lb-N/ha) to produce maximum economic yields.

Table 3. Summary of soft red winter wheat yield response equations to spring applied N for each of the sites with at least 4 spring N rates in 2010 and 2011.

Site	C.V.[+]	Non-N Limited[++]		Economic[+++]	
		N	Yield	N	Yield
	%	(lb-N/ac)	(bu/ac)	(lb-N/ac)	(bu/ac)
2010					
Palmerston	5.0	>150	>86	>150	>86
Thamesville	2.7	0	93	0	93
Watford	1.4	146	110	128	109
2011					
Belmont	5.1	>150	>77	130	75
Fergus	7.7	>150	>78	120	77
Fullerton	3.9	96	96	81	96
Lucan	3.7	>150	>121	13	120
Napanee	3.3	>150	>108)	>150	>108
St. Catherines	5.7	>150	>67	>150	>67
St. Thomas	4.6	>150	>88	>150	>88
Woodstock		>150	>117	>150	>117

+ Coefficient of variation. No C.V. means the site was not replicated.

++ The N rate which maximizes yield response to fertilizer N. Any N rates and yields starting with a ">" symbol indicates that the highest N rate applied may not have maximized yields.

+++ The N rate which produces the maximum economic yield at a nitrogen:wheat price ratio of 5. Any N rates and yields starting with a ">" symbol indicates that the estimated N rate required to produce the maximum economic yields may exceed the highest N rate applied at that site.

The yield loss associated with applying 101 kg-N/ha (90 lb-N/ac) instead of 168 kg-N/ha (150 lb-N/ac) averaged over the 11 sites is 590 kg/ha (9 bu/ac). Assuming wheat price of $220/tonne ($6.00/bu) and N cost of $1.10/kg-N ($0.50/lb-N), the net loss of applying 101 kg-N/ha (90 lb-N/ac) instead of 168 kg-N/ha (150 lb-N/ac) is $55/ha ($22/ac).

At a nitrogen:wheat price ratio of 7, 4 of the 10 responsive sites still required more than 168 kg-N/ha (150 lb-N/ac) to produce maximum economic yields. Applying 101 kg-N/ha (90 lb-N/ac) instead of 168 kg-N/ha (150 lb-N/ac) had a loss averaging $25/ha ($10/ac) assuming Wheat at $220/tonne ($6.00/bu) and N price of $1.54/kg-N/ha ($0.70/lb-N) (nitrogen:wheat price ratio of 7).

At most sites spring N rate affected crude protein content (Table 4). At half of the sites applying 134 kg-N/ha (120 lb-N/ac) increased crude protein by 0.6% to 1.5% over where no N was applied. At 3 sites, applying 168 kg-N/ha (150 lb-N/ac) increased crude protein by 0.5% to 0.7% over where 134 kg-N/ha (120 lb-N/ac) was applied.

Bushel weights, thousand kernel weights and harvest moisture were generally not affected by spring N rates (data not shown).

Fall N

At 5 sites 34 kg-N/ha (30 lb-N/ac) was applied in the fall in early November along with an additional 101 kg-N/ha (90 lb-N/ac) or 134 kg-N/ha (120 lb-N/ac) in the spring. Within these 5 sites, fall N application rarely affected harvest moisture content, bushel weight, 1000 kernel weight, crude protein level or yield.

Across site average response to fall N application and the 101 (90 lb-N/ac) and 134 kg-N/ha (120 lb-N/ac) spring N rates are presented in Table 5. The interactions between fall and spring N rates were not significant (ns) indicating that any effects that spring N rates had on wheat harvest moisture, bushel weights, 1000 kernel weights, crude protein levels or yield were not affected by fall N application. In fact, fall N application did not have an effect on any of these measurements. Averaged over fall N rates and sites, applying 134 kg-N/ha (120 lb-N/ac) instead of 101 kg-N/ha (90 lb-N/ac) increased crude protein by 0.3%, decreased 1000 kernel weight by 0.5 g and increased yield by 340 kg/ha (5.4 bu/ac).

Summary:

The spring of 2011 had unusually high rainfall amounts which delayed N application and also may have resulted in N loss due to denitrification and/or leaching. As a consequence, fertilizer N requirements observed in 2011 may be higher than normal and yields may be less than normal at some sites.

For 9 of 11 sites, fertilizer N requirements exceeded 101 kg-N/ha (90 lb-N/ac) to produce maximum economic yields when nitrogen:wheat price ratios were in the 5 to 7 range. Estimated losses associated with applying 101 kg-N/ha (90 lb-N/ac) with an assumed wheat price of $220/tonne ($6.00/bu) averaged about $55/ha ($22/ac) at a nitrogen:wheat price ratio of 5 and $25/ha ($10/ac) for a price ratio of 7.

Based on a single year of results, applying fall broadcast urea in early November did not consistently affect wheat harvest moisture content, bushel weights, 1000 kernel weights, crude protein levels or yield.

Table 4. Soft red winter wheat crude protein response to fall and/or spring applied N for each of the sites in 2010 and 2011.

Site	No Fall N					Fall N	
	0 kg-N/ha 0 lb-N/ac	67 kg-N/ha 60 lb-N/ac	101 kg-N/ha 90 lb-N/ac	134 kg-N/ha 120 lb-N/ac	168 kg-N/ha 150 lb-N/ac	101 kg-N/ha 90 lb-N/ac	134 kg-N/ha 120 lb-N/ac
2010	---------- %CP ----------						
Palmerston	9.4 d[+]	9.8 cd	10.1 c	10.5 b	11.0 a		
Thamesville	11.4 a	11.5 a		11.5 a	10.2 b		
Watford	8.9 a	9.2 a		9.9 a	9.9 a		
2011							
Belmont	9.0 c	9.1 c	9.3 c	9.7 b	10.1 a	9.3 c	9.8 b
Fergus	8.9 c	9.3 bc	9.5 ab	9.8 a	10.0 a		
Fullerton	9.0 f	9.5 e	10.1 d	10.5 b	11.2 a	10.5 bc	10.2 cd
Lucan	9.0 d	9.9 abc	9.6 bcd	10.2 ab	10.5 a	9.3 cd	10.4 ab
Napanee		8.0 c	7.7 d	8.2 b	8.4 a		
St. Catherines	9.2 a	8.5 c	9.1 ab	9.3 a	9.3 a	8.7 bc	9.1 ab
St. Thomas	8.1 ab	7.6 c	7.9 bc	8.1 ab	8.4 a	8.2 ab	8.2 ab

+ Within row (site) crude protein values followed by the same letter are not different at the 10% level of probability.

Table 5. Soft red winter wheat response to fall (0 or 34 kg-N/ha; 0 or 30 lb-N/ac) and spring (101 or 134 kg-N/ha; 90 or 120 lb-N/ac) N rates averaged over five 2011 sites.

Treatments	Crude Protein	Harvest Moisture	Test Weight	1000 Kernel Weight	Grain Yield	
	%	%	lb/bu	g	kg/ha	bu/ac
Fall N						
Yes	9.4	15.2	59.0	36.9	5650	90.2
No	9.4	15.1	59.0	36.6	5650	90.1
Significance[+]	nsns	nsns	nsns	nsns	nsns	
Spring N Rate						
101 kg-N/ha	9.2	15.2	59.0	37.0	5480	87.4
134 kg-N/ha	9.5	15.1	59.0	36.5	5820	92.9
Significance[+]	<1%	nsns	nsns	5%	<1%	
Interaction Significance[++]	nsns	nsns	nsns	nsns	nsns	

\+ Indicates if averages are different at the 1% (<1%), 5% or not significant at the 10% level (ns).

++ Interaction Significance indicates if response to spring N rate was affected by fall N rate. The symbol ns indicates that fall N rate did not have a significant effect on response to spring N rate.

Next Steps:

Field sites have been identified and fall N applied for year 2 of this project. The project is currently funded until 2013.

Acknowledgements:

This project has been supported financially by the Farm Innovation Program, the Grain Farmers of Ontario, and the Middlesex Soil and Crop Improvement Association. Many thanks to all our cooperators, this project would not have been possible without your efforts. Thanks to Shane McClure, Jimmy Greenfield, Kaye McLagan and Marian Desjardine for the real work on this project, and to Ken Janovicek for the statistical analysis and report writing.

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