Timing of Nitrogen Application on Winter Wheat: Fall Versus Spring, Recommended Practices and Current Research

D.P. Poisson, R.E. Karamanos, N.A. Flore and J.T. Harapiak, Western Cooperative Fertilizers Limited, P.O. Box 2500, Calgary, AB. T2P 2N1

Introduction

There are a number of options available to farmers for the timing of nitrogen fertilizer application for winter wheat. The choices include: banding prior to planting, apply at planting, broadcast late fall, broadcast on snow, broadcast early spring and broadcast late spring. The provincial recommendation in Manitoba is to apply nitrogen fertilizer on winter wheat in the early spring (Manitoba Agriculture and Food, 2003). This recommendation is based upon work completed by the University of Manitoba in the 1980's (Figure 1).

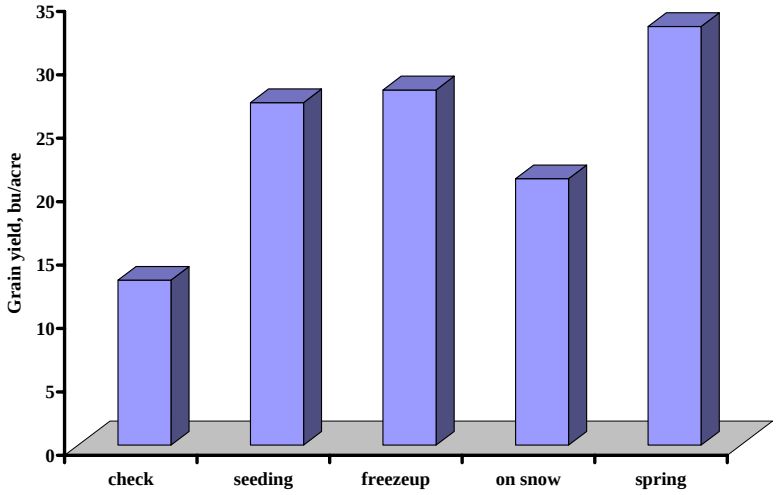

Figure 1. Effect of timing of fertilizer N application on the yield of winter wheat in Manitoba (courtesy John Heard).

Westco Agronomy has published research on timing of nitrogen application on winter wheat in the Dark Brown and Black soil zones of southern and south central Alberta. The results from these studies, in Figure 2, show that in Alberta the optimum time to apply nitrogen to winter wheat is at planting time (Karamanos et al. 2003).

There are a number of advantages for farmers to be able to apply all of the nitrogen requirements for their winter wheat crops before or at planting time. These advantages include:

1) Favorable nitrogen price. The price of nitrogen is often (nine out of the last ten years) less in the fall of the year than it is in the spring of the following year. There are also situations where the price of nitrogen is less in the early fall, when winter wheat is being planted, than in the late fall when a fall broadcast application would typically occur.
2) Less expensive nitrogen form. By being able to apply all nitrogen requirements for a winter wheat crop at planting time a farmer would be able to use urea or anhydrous ammonia. If urea is used as a source of nitrogen for early spring application it must be broadcast applied to the winter wheat and, hence, it is subject to volatilization losses. For this reason spring broadcast nitrogen applications are usually made with a more expensive nitrogen product such as ammonium nitrate or Agrotain coated urea to reduce the risk of volatilization losses.

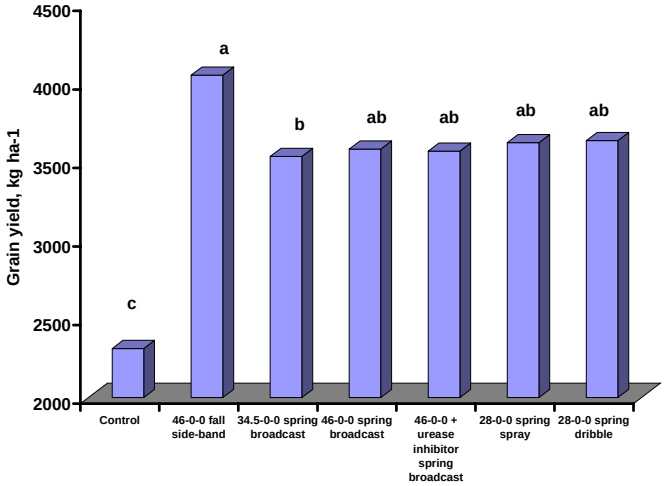

Figure 2. Yield Response of Winter Wheat to Nitrogen Placement and Time of Application in the Dark Brown and Black Soil Zones of South-Central and Southern Alberta.

3) Reduced application cost. If the winter wheat crop nitrogen requirements can be fulfilled by applications at planting time, the expense of an additional pass over the field (pre-plant banding or post emergence broadcast) to apply the nitrogen required by the crop is eliminated.
4) Maximize yield potential. For spring broadcast applications of nitrogen on winter wheat to be effective in maximizing yield potential the applications must be made early. If these applications are delayed in the spring, because of poor weather conditions as an example, then the yield potential of the winter wheat crop will be reduced. The ability to apply the nitrogen fertilizer requirements of a winter wheat crop at planting time ensures that nitrogen is available in the early spring when yield potential is determined.

The risks and concerns with nitrogen application in the fall either at time of winter wheat planting are:

1) Application of nitrogen requirements at planting time will promote excess growth and will reduce the winter hardiness of the winter wheat crop.
2) Banding nitrogen prior to planting will reduce stubble and reduce snow trapping making the winter wheat crop more susceptible to winter kill.
3) Nitrogen applied in the early fall as either urea or anhydrous ammonia will convert into the nitrate form and be susceptible to: leaching, denitrification and/or immobilization losses. Loss of nitrogen via these mechanisms means lower yield and is also an environmental concern.
4) Research in Manitoba, Figure 1, shows that applying nitrogen at seeding time is a lower yield potential option than application of nitrogen in early spring.

Farmers in Manitoba who are interested in trying nitrogen application at time of seeding with winter wheat are encouraged to use test strips in their fields and evaluate both yield and winter hardiness (Manitoba Agriculture and Food, 2002).

Materials and Methods

Westco Agronomy began a research program in Manitoba in September 2002 to evaluate nitrogen source and time of application on winter wheat in Manitoba. One site was planted in early September 2002 near the town of Thornhill, Manitoba. This study compared a nitrogen rate of 107 lb N/acre applied as: urea pre-plant banded, urea side-banded at seeding, ammonium nitrate broadcast applied in the spring, urea broadcast applied in the spring and Agrotain coated urea broadcast applied in the spring. There were two

check treatments in this study a tilled check and a direct seeded check. The winter wheat variety used in this trial was CDC Falcon. Spring nitrogen applications were made in early May.

Results and Discussion

Yield results from this site showed a significant yield increase from the application of nitrogen fertilizer but no significant difference in yield between any of the time of nitrogen application treatments or nitrogen source used as seen in Figure 3. The site was in a field location that would not be subject to short or long term flooding.

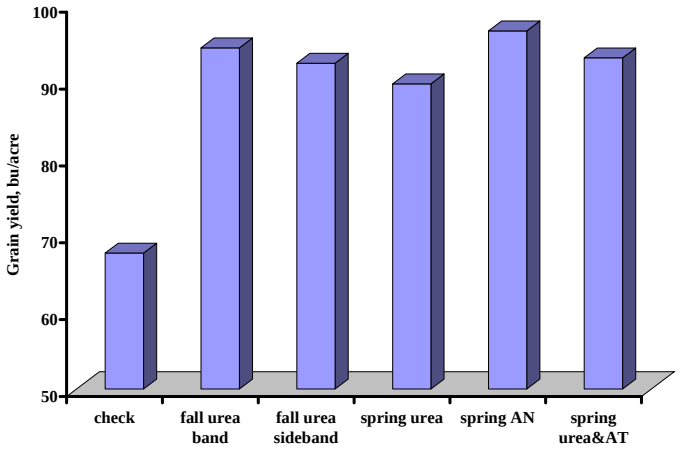

Figure 3. Effect of Nitrogen Source and Time of Application on Yield of CDC Falcon Winter Wheat – Westco Agronomy Thornhill Research Site 2002/2003.

The time of application and the source of nitrogen fertilizer used had no significant impact on the moisture content of the winter wheat and are shown in Figure 4. All nitrogen fertilizer application times and all nitrogen sources resulted in a significant increase of protein content of the winter wheat grain from the checks but differences between protein content as a result of nitrogen application times and nitrogen sources was minimal (Figure 5).

Optimum winter wheat yield is a function of proper nitrogen fertilization. The responsiveness of winter wheat yield to nitrogen application in Alberta was demonstrated by Westco research (Karamanos et al. 2003) as seen in Figure 6.

In Manitoba nitrogen rates are determined using the Most Economic Rate of Nitrogen (MERN) calculation (Manitoba Agriculture and Food, 2000). MERN is calculated by the following formula (180 pounds of nitrogen per acre – (1.44 x nitrogen in pounds per acre in the 0 – 24” depth).

How did the fertility used at the Westco Agronomy winter wheat trial compare with the MERN calculation? The background fertility at the Westco Agronomy winter wheat trial location at Thornhill is listed in Table 1.

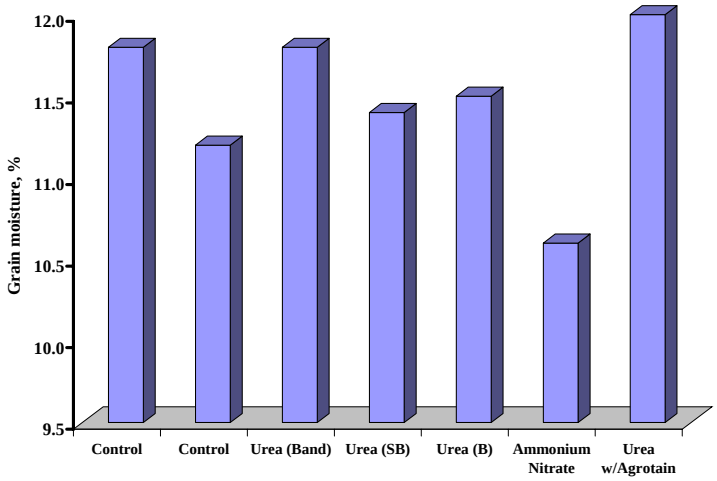

Figure 4. Effect of Nitrogen Source and Time of Application on Moisture Content of CDC Falcon Winter Wheat seed – Westco Agronomy Thornhill Research Site 2002/2003.

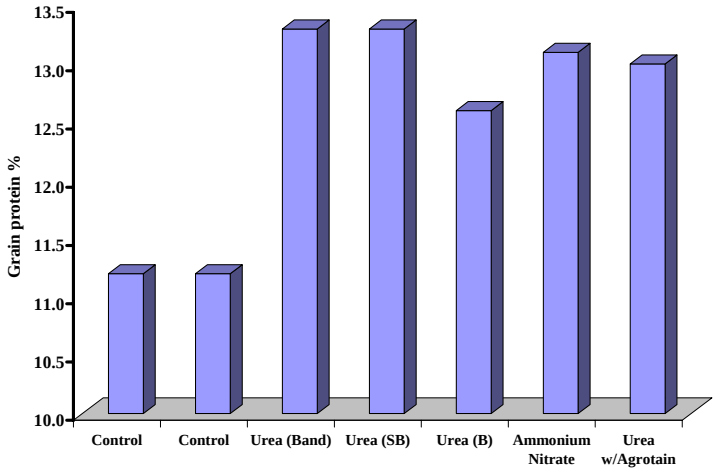

Figure 5. Effect of Nitrogen Source and Time of Application on Protein Content of CDC Falcon Winter Wheat seed – Westco Agronomy Thornhill Research Site 2002/2003.

Using the MERN calculation the required rate of nitrogen for the Thornhill site would have been 100 pounds of actual nitrogen per acre. 107 pounds of nitrogen per acre was applied. Based upon MERN a reasonable level of nitrogen fertilizer was used. Looking at strictly yield data one could be skeptical about the lack of difference between the fall and the spring nitrogen treatments because it is possible that nitrogen fertilizer in excess of that required by the winter wheat crop was applied masking potential losses which may have occurred in the fall treatments. If nitrogen losses from the fall treatments did occur one would expect protein contents for the spring applied nitrogen treatments to be higher than the protein contents in the fall applied nitrogen treatments. Both the yield and protein data for the fall and spring nitrogen treatments were not significantly different. It can be concluded that little or no loss of nitrogen occurred due to time of nitrogen application.

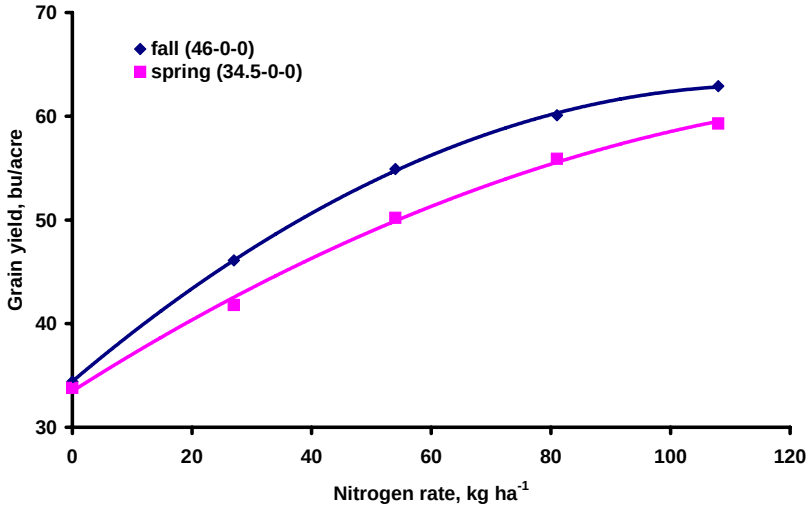

Figure 6. Effect of Nitrogen Rate and Time of Application on Yield of Winter Wheat in the Dark Brown and Black Soil Zones of South Central and Southern Alberta – Westco Agronomy 1998-2000.

Table 1. Soil Nutrient Levels at Westco Agronomy Research Site, Thornhill, Manitoba Fall 2002.

Depth (inches)	pH	OM (%)	EC	N	P	K	S
				ppm			
0 – 6	8.0	3.7	0.2	11.7	2.4	197.8	18.8
6 – 12				7.2		125.3	49.5
12 - 24				9.2			74.3

The phosphorus fertility at the Westco Agronomy Thornhill site was very low with soil test levels of 2.4 ppm in the 0-6 inch depth. A small phosphorus study was conducted at this location adjacent to the nitrogen timing and response study. Nitrogen was side-banded at seeding time at the rate of 107 lbs nitrogen per acre. Three rates of phosphorus were compared: a check, 26.8 lbs P_20_5 per acre and 53.5 lbs P_20_5 per acre. The results of the phosphorus study are summarized in Figure 7. The treatments in this experiment were visually distinct in addition to the yields being significantly different.

There were no visual differences at the Westco Agronomy Thornhill research site in either the nitrogen timing and source experiment or the phosphorus rate experiment indicating greater or lesser over wintering mortality for any of the treatments. No plant stand counts were made. Moisture contents of the treatments in the nitrogen timing trial, shown in Figure 4, did not indicate any maturity differences between the treatments.

Application of nitrogen before or at the time winter wheat planting will increase fall growth. Westco Agronomy initiated a second year of the effect of nitrogen timing and nitrogen source on winter wheat experiments in Manitoba in September 2003. Differences in growth, shown in Figure 8, were visible between nitrogen treatments and the check. Winter wheat growth at the Westco Agronomy Thornhill site in fall 2003 was improved by the application of nitrogen at time of seeding. The enhanced growth was not considered excessive.

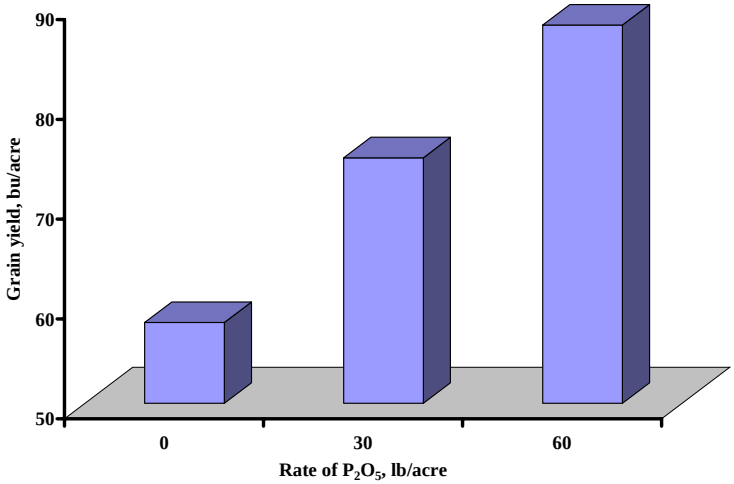

Figure 7. Effect of Phosphorus on Yield of AC Falcon Winter Wheat – Westco Agronomy Thornhill Research Site 2002/2003

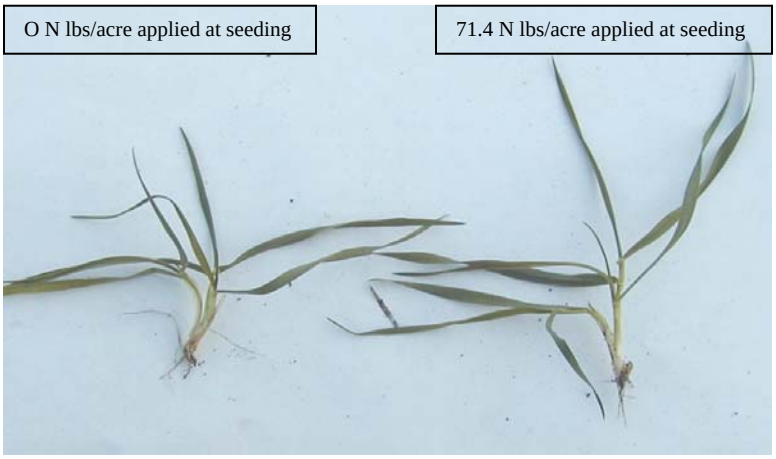

Figure 8. Comparison of fall growth of CDC Falcon Winter Wheat, plant from a O N check versus plant from a 71.4 lb N/acre applied at planting treatment – Westco Agronomy Thornhill Research Site – October 21, 2003 (Photo courtesy of John Heard).

High rates of nitrogen applied to winter wheat in the fall have been shown to reduce over winter survival of winter wheat (Grant et al. 1984). Other research has shown that high levels of N and P have little effect on the freezing tolerance of winter wheat plants in early winter but that high levels of P with N resulted in an accelerated loss of freezing tolerance in mid-winter (Gusta et al. 1984). Nitrogen fertilizer applied at seeding has not been an issue in Alberta studies. It was not an issue in the first site year of the Westco Agronomy winter wheat study at Thornhill, Manitoba. Fertility at seeding time may be more of a concern if poor management practices are used (Gusta et al. 1984.) Poor management practices would include late

seeding, choice of a less winter hardy variety, poor stubble and snow management and poor field selection.

Conclusion

The initial results from the Westco Agronomy research trial are very encouraging and are similar to results obtained in Alberta. Westco Agronomy will be continuing this research project. The Westco Agronomy research site at Thornhill was not subject to either short or long term flooding during the test period and results with application of nitrogen at planting time with winter wheat, under these conditions, are not known. No impact on winter hardiness in either the nitrogen or phosphorus experiments were observed at the Thornhill research site in spring 2003. Phosphate nutrition is very important for optimum winter wheat yields.

References

Grant, C.A., Stobbe, E.H. and Racz, G.E. 1984. The effect of N and P fertilization on winter survival of winter wheat under zero-tilled and conventionally tilled management. Can. J. Soil Sci. 64: 293-296.

Gusta, L.V. O'Conner, B.J., and Lafond, G.L. 1999. Phosphorus and nitrogen effects on the freezing tolerance of Norstar winter wheat. Can. J. Plant Sci. 79: 191-195.

Karamanos, R.E., Stonehouse, T.A., and Flore, N.A. 2003. Response of winter wheat to nitrogen and phosphate fertilizer placement and time of application. Can. J. Plant Sci. 83: 483-488.

Manitoba Agriculture and Food. 2000. Winter wheat nutrient needs. [Online] Available: http://www.gov.mb.ca/agriculture/news/topics/daa15d07.html [3 December 2003].

Manitoba Agriculture and Food. 2002. Fertility options and decisions abound for winter wheat. [Online] Available: http://www.gov.mb.ca/agriculture/news/topics/daa41d02.html [3 December 2003].

Manitoba Agriculture and Food. 2003. Winter wheat – production and management. [Online] Available: http://www.gov.mb.ca/agriculture/crops/cereals/bfg01s01.html [3 December 2003].