Fertility of Zero-tilled Winter Wheat in Manitoba

Winter wheat is capable of achieving high yields in Manitoba providing an adequate level of nutrients is supplied. Factors favouring high yield potential include the development of shorter, strong strawed cultivars and the crop's growth and development in the spring, which avoids excessively high temperature, drought and much disease pressure.
The proper supply of nutrients is dependent upon rate, placement and timing.

Nitrogen

Rates

Nitrogen rates have been developed for Manitoba growing conditions based upon the soil N supply (Table 1). These rates have been found appropriate across a wide range of yields for varieties currently grown in Manitoba.

Table 1. Nitrogen recommendations for hard red winter wheat based on spring broadcast applications.

Spring soil nitrate		N recommendation
Lb N/ac in 0-24"	Rating	lb N/ac
20	VL	150
30	L	135
40	M	120
50	M	110
60	H	95
70	H	80
80	VH	65
90	VH	50
100	VH+	35

Timing

Traditional timing for N application has been spring broadcast application. Spring nitrogen should be applied as soon as soil conditions permit in April. Early nitrogen encourages tillering, which is especially important to improve productivity of thin stands. However, if wet conditions do delay field operations, N application is still profitable at the stem elongation stage.

Late fall surface applications of nitrogen have proven to be less efficient than spring application, yielding about 6% less with lower protein. In order to produce yields equal to spring application, higher nitrogen rates would need to be applied in the fall. Current research is evaluating the effectiveness of applying N at seeding and subsurface banding N in the late fall. Subsurface application of late fall N shows promise to minimize losses through run-off, volatilization and nitrification to nitrate forms (which are susceptible to spring leaching and denitrification losses).

Sources

Ammonium nitrate (34-0-0) has been the traditional spring broadcast N source because it is not subject to the same volatilization loss of N as urea (46-0-0) or UAN solution (urea-ammonium nitrate solution or 28-0-0). Volatilization is the gaseous loss of N as urea breaks down to free ammonia (NH_3) at the soil surface. Conditions that increase risk of volatilization loss are high temperatures, lack of rainfall, high surface crop residues, high soil pH and low soil organic matter.

Management practices may be used to minimize losses from urea-forms. Agrotain, a urease enzyme inhibitor, can be applied to urea or UAN to inhibit volatilization losses for 5-14 days depending on rates. Dribble or strip band application increases the efficiency of UAN.

The results of 15 field trials in Manitoba found that serious N loss due to volatilization was not as big a problem as initially expected (Figure 1). The N treatments were applied in April when conditions are normally not conducive for volatilization, since temperatures are usually cool and rainfall is frequent. In fact, in 1998 and 1999, conditions were dry and warm following application, and N granules actually remained intact for up to 10 days before rain occurred. Nevertheless, at one site urea yielded 14 bu/ac less than ammonium nitrate. Conditions at this site provided maximum potential for volatilization loss, with sufficient soil moisture to dissolve urea granules shortly after application, no rain for 2 weeks, a low soil cation exchange capacity (CEC) due to low soil organic matter and sandy texture, and soil pH was very high (8.4). This one trial illustrates that when the conditions present themselves the loss of surface applied urea can be significant.

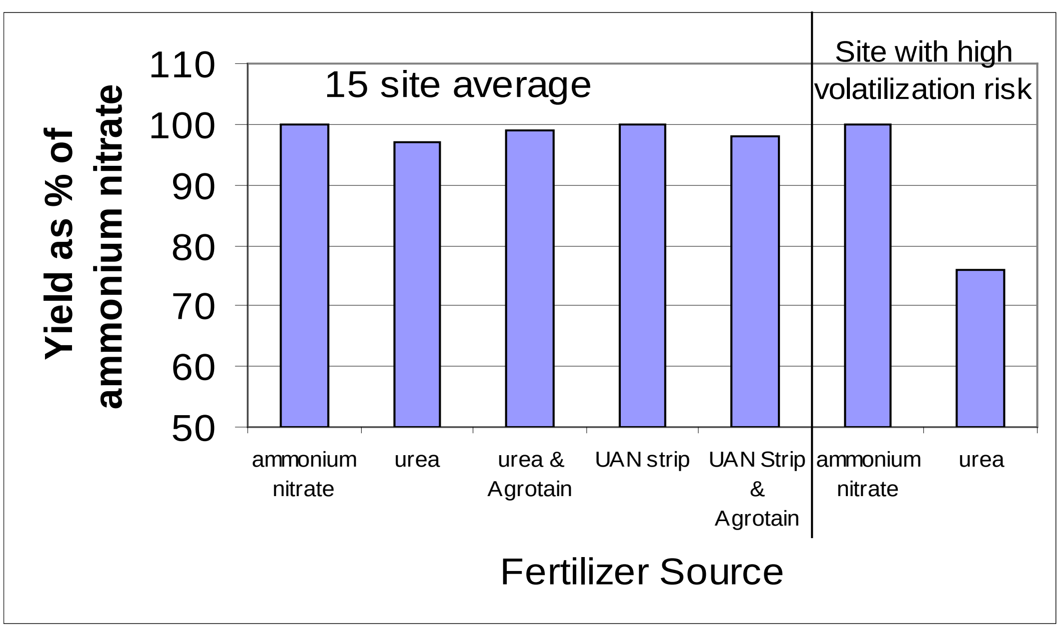

Figure 1. Comparison of different N fertilizer sources @ 80 lb N/ac compared to ammonium nitrate.

Protein management
Winter wheat is so yield responsive to N, that under low soil N conditions, the increase in yield may actually dilute the protein content (Figure 2). It is important to apply sufficient nitrogen to attain optimum yield or low protein levels may result. In general, if winter wheat grain protein is less than 11.5%, the crop was inadequately fertilized to reach optimum yield potential. When protein levels exceed 11.5%, then sufficient N was applied to surpass yield potential or another factor(s) was limiting yield expression. This thumbrule should be used by growers in assessing the appropriateness of their fertility program. Currently the protein premiums in winter wheat are minimal and growers are not rewarded for producing high protein crops through additional N fertilization.

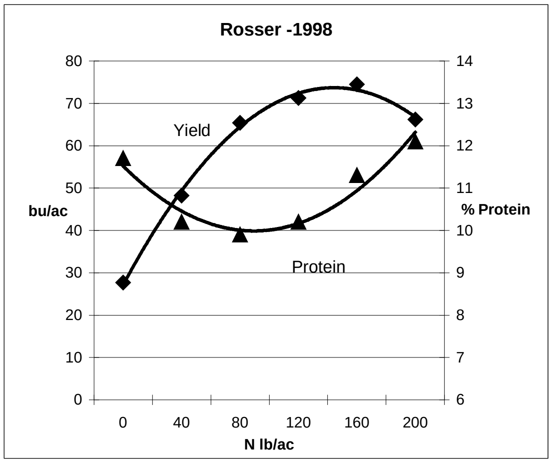

Figure 2. Winter wheat yield and protein response to applied nitrogen on low N soil.

Crop Scouting
In-crop assessment of N sufficiency may aid growers in identifying deficiencies in time to make effective additional N applications. Insufficient nitrogen may be present if N losses have occurred (leaching, volatilization of urea, etc) or low rates were initially applied. The following guidelines were developed in Manitoba field studies (Table 2).

Table 2. Critical levels for winter wheat.

Tool	Critical level
Seedling N content	<4.2% N
SPAD chlorophyll index	<90%

Figure 3. Use of SPAD meter to assess N sufficiency.

Measurements should be made at Zadok's stage 31 (at the start of stem elongation). Seedling N content is determined on 50 plants clipped at ground level. Chlorophyll measurements are taken with the SPAD meter on the first fully expanded leaf, one-half the distance between the leaf tip and the collar and halfway from the leaf margin to the mid-rib (Figure 3) The index is determined relative to a highly fertilized reference area which should be fertilized with extra nitrogen in the early spring.

Phosphorus

Phosphorus must be applied at seeding for successful winter wheat establishment and yield. Rates should be based on soil testing, and are usually 30-40 lb P_2O_5/ac. Applied P benefits winter wheat in several ways:

- promotes emergence and establishment in the fall
- promotes winter hardiness
- Promotes recovery from winter injury in the spring

Potassium and chloride

Potassium is required by winter wheat on low testing soils. Sandy soils are most likely to be deficient in potassium. When required, potash placement with or close to the seed is recommended.

Winter wheat is also particularly susceptible to Physiologic Leaf Spot (PLS) which visually resembles leaf disease but is due to low chloride levels in the plant (Figure 4). Certain varieties, such as Kestrel, are more sensitive than others to this condition. Potash (KCl) contains 60% K2O and 50% Cl, and can reduce the leaf spotting but yield responses are generally small (about 3%). Since chloride is mobile in the soil, spring broadcast applications of potash may help meet Cl needs of the crop.

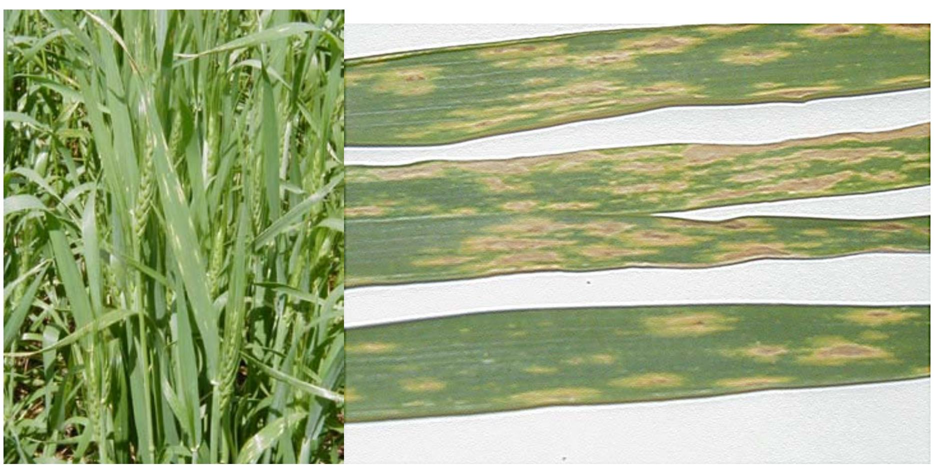

Figure 4. Physiologic leaf spotting on winter wheat leaves.

Copper

Winter wheat is among the most sensitive crops to copper deficiency. The greatest risk of copper deficiency is on soils testing low in copper (<0.4 ppm), sandy texture, low soil organic matter and high soil pH.

Suggested copper fertilization strategies are to:

- Build soil copper levels in crops preceding winter wheat
- Apply copper at seeding (seedplaced rates >1 lb Cu/ac may cause seed damage)
- Foliarly apply copper at tillering
- Foliarly apply copper at the boot stage

Where deficiencies are severe a combination of the above methods may be required to meet the crop needs.