AGRI-FACTS
Practical Information for Alberta's Agriculture Industry

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Fall-applied Nitrogen: Risks and Benefits

Farmers frequently ask about the relative effectiveness of fall versus spring nitrogen fertilizer applications. In a nutshell, fall fertilization can range from very effective to disastrous depending on three factors:

- soil moisture
- form of nitrogen used
- how it is applied

To understand the effect of these factors, we must understand the fate of fertilizer nitrogen (N) in soil.

Fertilizing

Fertilizer N is applied to soil in the form of urea ($CO(NH_2)_2$), anhydrous ammonia (NH_3), ammonium (NH_4^+), or nitrate (NO_3^-), depending on the product used. Urea and anhydrous ammonia quickly convert to ammonium. It is the ammonium and nitrate forms that are taken up by plants. If the soil is warm, moist and well aerated, ammonium is rapidly oxidized to nitrate through the nitrification process. This is a biological process performed by highly specialized soil bacteria.

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Banding slows the nitrification process by creating an environment near the band that inhibits the activity of the bacteria converting ammonium to nitrate. Therefore, if urea or anhydrous ammonia is banded in late fall, most of the N is retained in the ammonium form until the soil warms up in the spring.

If the fertilizer is broadcast or banded in early fall, likely most of the ammonium will be converted to nitrate before freeze-up. Large losses can then occur when soils are water saturated during and just after snow melt in early spring. The losses are caused by an anaerobic process called denitrification, which converts nitrate to nitrogen and oxygen gases.

Research has also shown that denitrification will occur in virtually all of Alberta's agricultural soils. This fact is not surprising since denitrification is not a particularly specialized function. Many different types of soil bacteria use denitrification as an alternative form of respiration when oxygen is in short supply.

What this means in terms of fertilizer management is that no soil type or region of the province is 100 per cent safe when it comes to losses of fall-applied N. The risk of winter N loss is highest in regions with moister climates, such as west central Alberta. There is less risk in regions that tend to be drier, such as south eastern Alberta, but even in these regions, N losses can be high during a wet spring.

In general, however, N losses through denitrification in the drier regions are normally small, and fall banded N is equal to spring banded N (see Table 1). In cases where spring banding causes a significant loss of seedbed moisture, fall banding can be superior to spring banding.

Denitrifying bacteria are less than 2 millonths of a meter in size. They could care less about the regional climate or moisture level during a given spring. They only respond to what is happening in their tiny corner of the field.

What does this mean? It means micro-climate is also important. Even during dry springs, there are localized wet areas such as depressions where

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Table 1. Fall-Applied N as a Per cent of Spring Broadcast and Incorporated				
	Soil Climate Categories			
Application Method	Dry	Medium	Wet	Irrigated
Spring Broadcast and Incorp	100	100	100	100
Spring Banded	120	110	105	110
Fall Broadcast and Incorp	90	75	65	95
Fall Banded	120	110	85	110

Dry = Well drained soils that are seldom saturated during spring thaw.
Medium = Well to moderately drained soils that are occasionally saturated during spring thaw for short periods.
Wet = Poorly to moderately drained soils that are saturated for extended periods during spring thaw.
Irrigated = Well drained soils in southern Alberta that are seldom saturated during spring thaw.

denitrification can occur. Think about this in terms of your own fields. Are they uniformly flat and well drained? Not likely. There are always spots that are wetter than the rest where runoff accumulates after a rain or spring snow melt. Winter N losses can vary greatly over a short distance. Fall-applied N can be very effective on upland and totally ineffective in a depression just a short distance away.

It is important to remember, fall application always puts your fertilizer N at risk. The level of risk is generally assessed at the regional level, but whether or not losses occur is a function of very local conditions.

General rules about application methods and timing:

- Generally, spring banded is the most effective method of application, and fall broadcast the least effective.
- Fall banded N will be as effective as spring banded if there is no extended period of saturation in the spring.
- Fall banded N may be more effective than spring banded when lack of seedbed moisture is a concern.

Management recommendations

With this information in mind, here are a few tips to consider before you fertilize in the fall:

- If your soils tend to be saturated with water for extended periods in the spring, then fall application is probably not a good option. However, if saturated soil conditions are normally not a problem for you, then you should get results from fall banding.
- Soil test to determine the optimum rates of fertilizer required. We encourage producers to sample 0 to 6, 6 to 12, and 12 to 24 inches to determine the cumulative N to 2 feet.
- Apply a conservative rate, say 75 per cent of soil test recommendation, or 75 per cent of what you would expect to apply, if you haven't got your results back at time of application. This conservative fall rate is a hedge against such things as high soil test N levels, low spring moisture or low crop prices. If conditions look favorable come spring, additional N can be drilled with the seed. Take note, however, that the amount of additional N that can be drilled with small seeded crops like canola is only 10 pounds with a disk drill and 20 to 35 lbs. with an air seeder.
- Select a fertilizer formulation that is right for your conditions. Generally under low risk conditions, such as in southern Alberta, anhydrous ammonia (82-0-0), urea (46-0-0), ammonium nitrate (34-0-0), or liquid nitrogen (28-0-0) perform equally well when fall banded. However, soils in southern Alberta tend to be alkaline, and losses through ammonia volatilization can occur if the bands are too shallow or the soil is dry and cloddy.
- Avoid the use of the nitrate-containing products 34-0-0 and 28-0-0 on soils that tend to be saturated in the spring. Nitrates are subject to both denitrification and leaching losses under wet spring conditions.
- Apply N in late fall after the soil temperature has dropped below 7°C and the nitrification process has slowed down.
- Band, don't broadcast. Banding restricts the contact between soil and fertilizer, and as a result, losses over winter are lower.

As you can see, there are a number of agronomic factors to consider before you go ahead and fall apply N. You may want to consult with a soil fertility specialist while you're setting up your fall fertilizer program.

Other management factors

- Fall fertilization can improve your time management. By applying fall fertilizer, a field operation can be eliminated in the spring, which can allow earlier planting.

- Fertilizer prices and payment schedules tend to be more favorable in the fall, making it economical to fall apply.
- Availability of product and application equipment is often better in the fall than during the peak demand periods in spring.
- Soils tend to be drier in the fall, so N application equipment is less likely to cause soil compaction.

The above information covers the major points to keep in mind when making your decision to fertilize this fall. It is always a good idea to get several opinions and consider all the factors before you make your final decision.

The Alberta Ag-Info Center at 1-866-882-7677, fertilizer dealers, fertilizer industry agronomists and Alberta Agriculture Extension Agronomists are excellent sources of information, so don't hesitate to give them a call.

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