AGRI-FACTS
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Fall-applied Nitrogen: Risks and Benefits

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

- soil moisture and temperature
- form of nitrogen used
- how fertilizer is applied

To understand the effect of these factors, producers need to understand the fate of fertilizer nitrogen (N) in soil.

Fertilizer nitrogen

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 in soil quickly convert to ammonium. In warm, moist, well aerated soils, ammonium is rapidly oxidized to nitrate by highly specialized soil bacteria through a process known as nitrification.

Banding ammonia or urea creates an environment near the band that inhibits the activity of bacteria that convert ammonium to nitrate, delaying nitrification. If urea or anhydrous ammonia is banded in late fall after the soils have cooled and micro-organism activity has slowed, most of the fertilizer 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 when soils are warm, most of the ammonium will be converted to nitrate before freeze-up.

Fall fertilization can have a range of effectiveness.

Substantial N losses can occur when soils go into winter with a large pool of available nitrate and then become water-saturated during and just after snow melt in early spring. Soil N is lost when micro-organisms in anaerobic conditions (saturated soil) convert nitrate N to nitrous oxides and/or nitrogen gas in a process called denitrification.

Research has shown that denitrification can occur in virtually all of Alberta's agricultural soils. This fact is not surprising since denitrification is not a particularly specialized function, and many different types of soil bacteria use the process as an alternative to aerobic respiration when oxygen is in short supply.

For fertilizer management, this situation means 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 over-winter N loss is typically highest in regions with moister climates, such as west central Alberta, and lowest in regions that tend to be drier, such as south eastern Alberta.

However, even in low risk regions, N losses can still be high with wet spring conditions. In general, N losses through denitrification in drier regions are normally small, and fall-banded N is usually equally effective to spring-banded N (see Table 1). In cases where spring banding causes a significant loss of seedbed moisture, fall banding can actually produce a higher yield than spring banding.

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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 incorporation	100	100	100	100
Spring banded	120	110	105	110
Fall broadcast and incorporation	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.

Denitrifying bacteria are very small, less than 2 microns (2 millionths of a metre) in size. Consequently, soil moisture on a micro-climate or micro-site basis highly influences denitrification, and over-winter N losses can vary greatly over short distances.

Fall-applied N can be very effective on well drained upper slopes and totally ineffective in poorly drained depressions just a short distance away. Even during dry springs, there are localized wet areas within fields where denitrification can occur since few fields are uniformly flat and well drained. It is important to remember that 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.

Principles of N fertilizer application methods and timing:

- Generally, spring banding 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 springtime seedbed moisture is limited.

Management recommendations

With this information in mind, here are a few tips to consider before fall banding N:

- If soils are poorly drained and 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, fall banding can be an effective N application method.
- Soil test to determine the optimum rates of fertilizer required. Consider taking samples at 0 to 6, 6 to 12, and 12 to 24 inch depth increments to determine the total nitrate N to 2 feet.
- Select a fertilizer product that is right for the conditions. Generally under low risk conditions, such as in southern Alberta, anhydrous ammonia (82-0-0), urea (46-0-0) or liquid urea-ammonium nitrate (UAN) (28-0-0) perform equally well when properly 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.
- Apply a conservative rate, perhaps about 75 per cent of the crop requirement in the fall. This conservative fall rate is a hedge against potential over-winter losses, low spring moisture or low crop prices. If conditions look favourable in the spring, additional N can be applied at seeding.
- Avoid the use of the nitrate-containing products (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, do not broadcast. Banding restricts the contact between soil and fertilizer, concentrating the fertilizer and delaying nitrification. Consequently, over-winter N losses are lower with banding than with broadcasting.

Other management factors

Fall fertilization shifts some of the growing season workload from the spring to the fall. The efficiency of seeding operations can improve dramatically if the majority of N fertilizer is fall applied, and fertilizer handling is minimized at seeding.

- Fertilizer prices tend to be lower in the fall than in the spring, often leading to an economic advantage with fall fertilization over spring fertilization.

- Soils also tend to be drier in the fall than in the spring, leading to fewer soil compaction problems in the subsequent crop.

The above information covers the major points to keep in mind when considering fall fertilization. It is always a good idea to get several opinions and consider all the factors before you making final decision. The Alberta Ag-Info Centre (call toll free 310-FARM), fertilizer dealers, industry agronomists and Alberta Agriculture Extension Agronomists can all be excellent sources of information.

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More information

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