Nitrogen Sources in Potato Fertilizers

Introduction
Appropriate fertility management is a requirement in effective and prosperous potato production systems. A successful fertilizer program helps provide top yields of high quality potatoes while maximizing returns on fertilizer investment. As fertility programs become more specialized, one factor which cannot be overlooked is the source of nitrogen in the fertilizers applied to the crop.

In general, the nitrogen source used in potato fertilizer is not critical in the overall effectiveness of the fertilizer. There are, however, some differences in the way various nitrogen sources behave in the soil and knowledge of these differences can be useful.

Most commercial fertilizers supply nitrogen to the soil in one of two forms: ammonium-nitrogen and nitrate-nitrogen. Plants use only the nitrate form directly. However, nitrogen supplied in the ammonium form is converted to the nitrate form by soil micro-organisms during the growing season through a process called nitrification.

If only the nitrate form of nitrogen is taken up by plants, one might logically expect that fertilizers containing only nitrates would be preferable. This is not normally the case, however, because nitrates are also highly subject to leaching losses. If only nitrate-nitrogen was applied in the spring and heavy rains occurred before the nitrogen is taken up by the plant, substantial nitrogen losses could occur resulting in crop deficiencies.

An ideal nitrogen program is one that employs both ammonium and nitrate sources which, in turn, provides a steady and adequate supply of nitrate-nitrogen to the growing crop over the season. Knowledge of the forms of nitrogen commonly used in fertilizer materials is useful, therefore, in planning a fertilizer program for potatoes.

Common Nitrogen Sources:

Diammonium Phosphate (18% N): Diammonium phosphate (DAP) is commonly used in almost all fertilizers sold on Prince Edward Island. Although it is the major source of phosphorus used in blended fertilizers, it also supplies a significant amount of nitrogen to the final product. In a 1:2:2 ratio fertilizer, (i.e.10-20-20), DAP supplies approximately 80% of the nitrogen in the fertilizer; whereas in a 1:1:1 ratio fertilizer (i.e. 15-15-15), approximately 40% of the nitrogen in the blend is supplied by DAP.

It should also be noted that the nitrogen contained in DAP is all in the ammonium form.

Ammonium Nitrate (34% N): This has been one of the most commonly used nitrogen sources on Prince Edward Island for many years. One half of the nitrogen contained in ammonium nitrate is in the nitrate form while the other half is in the ammonium form. Ammonium nitrate is, therefore, an excellent nitrogen source in circumstances where nitrogen is required immediately for plant uptake, such as topdressing, because 50% of its nitrogen is readily available to the plant. This can be a disadvantage, however, in cases where fertilizer is applied early in the spring, before the crop's need for nitrogen is significant. If heavy rains occur during this period, it can result in a significant portion of the nitrate in the fertilizer being lost due to leaching though the soil profile, past the root zone.
Ammonium nitrate picks up moisture very rapidly from the air and can get "sticky" very quickly under humid conditions and should be stored in a cool, dry area. Although there is a common belief that when ammonium nitrate is used as a topdressing, it vaporizes and is lost in the air if not covered immediately upon application to the soil, the amount of N lost due to ammonia volatilization in ammonium nitrate is much less than other fertilizers with higher ammonium contents (i.e. urea). Although the fertilizer granules pick up moisture from the air and appear to "melt" into the soil, the amount of N lost is often small and is dependent on ideal conditions for ammonia volatilization (i.e. high soil pH or increased length of air exposure). In fertilizers with high ammonium content like urea, or within high alkaline soils, large amounts of N lost can be lost through ammonia volatilization. Since the nitrogen source in ammonium nitrate is 50% ammonium, there is potential for some ammonium volatilization; however the amount lost is often small. It is for this reason ammonium nitrate is considered a useful fertilizer for side-dressing or top-dressing, or for use within no-till systems.

**Ammonium Sulfate (21% N):** Ammonium sulfate contains nitrogen only in the ammonium form. It will, therefore, require some time after application, particularly when soils are cold in early spring, before it is converted into nitrate. However, this also means that early season nitrate losses are minimized with use of this product.

Because ammonium sulfate has a relatively low nitrogen content, its relative shipping cost per unit of nitrogen is high. Therefore, its cost per unit of nitrogen is often quite high as well, and it is used only occasionally in our region. The low nitrogen content, in addition, makes it unsuitable for use in high analysis blended products such as 17-17-17 or 12-24-24. Ammonium sulfate also provides the added benefit of supplying approximately 24% sulphur, which is a component of many essential amino acids and involved with protein synthesis.

Over time, repeated use of ammonium sulfate within crop production can lead to lower (or more acidic) soil pHs. This is caused by the conversion from ammonium to nitrate within the soil through nitrification. This is normally seen as a disadvantage within agricultural crop production systems as a lower soil pH can lead to reduced nutrient availability to the crop, and therefore greater amounts of limestone may be required to counteract its use as compared to most other nitrogen sources. However, potato producers wishing to reduce the pH of the soil in the rooting zone to help suppress Common Scab may find the use of ammonium sulfate advantageous for this reason.

**Urea (46% N):** Urea is another excellent source of nitrogen which has many relative advantages in manufacture and transportation. In all probability, it is and will continue to be the most economical source of nitrogen available in the region for the foreseeable future.

Urea has a somewhat unique chemistry because it contains neither nitrate-nitrogen nor ammonium-nitrogen. Once placed in the soil, however, soil micro-organisms quickly convert it into ammonium-nitrogen and it is therefore normally considered equivalent to an ammonium source.

One aspect of the unique chemistry of urea places some restrictions on its use as a banded source of nitrogen for potatoes. During the biological conversion of urea-nitrogen to ammonium-nitrogen, free ammonia gas can be evolved in significant quantities near the fertilizer band for short periods of time. Because this also occurs near the seed-piece, this free ammonia gas can cause damage to emerging potato sprouts or root systems. This problem is more predominant under warm dry soil conditions such as with late season plantings. It is recommended, therefore, that no more than 120 kg/ha (110 lb/acre) of nitrogen be banded with potato seed if the potato fertilizer contains over 20% of its nitrogen in the urea form. If over 120 kg/ha of nitrogen is needed for the crop, any nitrogen in excess of 120 kg/ha should be broadcast, either before or after planting.
The major advantages of urea as a nitrogen source for potato production lie in its relatively low cost and its ability to resist losses in early season if excessive rainfall occurs in the first few weeks after planting. A major disadvantage associated with urea would be the application of urea as a side-dress or broadcast fertilizer, if not incorporated. Due to its rapid conversion to ammonia, large amounts of N can be lost to the atmosphere through the process of ammonia volatilization. In order to avoid these losses, all broadcasting or side-dressing of urea should be immediately incorporated with the soil upon application.

**Calcium Ammonium Nitrate (27% N):** This source of nitrogen is similar to that of ammonium nitrate as it is approximately 80-90% ammonium nitrate, and 10-20% dolomitic limestone. The uses for calcium ammonium nitrate are similar to those of ammonium nitrate, but the addition of limestone allows for safer handling and storage in comparison as well as some soil neutralizing capabilities. It also supplies approximately 5% calcium, which is an essential plant nutrient that is beneficial in maintaining cell wall stability and structure.

**Recommendations:**

High yields of quality potatoes can be achieved in most years, regardless of the source of nitrogen used in fertilizer blends. Rates and timing of application are usually more critical in determining final yield than the source used. The following points, however, should serve as a guide to the differences in fertilizer use as related to the source:

- Because the response to different fertilizer nitrogen sources is often minimal, the relative cost of a nitrogen source must be a prime consideration. The most economical source of nitrogen is usually the best type to use if managed properly, unless special circumstances indicate otherwise.
- The potato crop does not have a high requirement for nitrogen in the first three to four weeks after planting. Therefore, to prevent excessive loss of nitrogen due to heavy rains which may occur during that period, a fertilizer with most or all of the nitrogen in the ammonium (or urea) form is preferred at planting.
- If fertilizer banded at planting contains over 20 percent of its nitrogen in the urea form, not more than 120 kg/ha of nitrogen should be banded with the planter. Any nitrogen in excess of this amount should be broadcast prior to planting or top-dressed on the growing crop.
- **Fertilizer placement is critical.** Injury to emerging sprouts or roots can occur if the fertilizer is closer than the recommended spacing of 10 cm below AND to the side of the seed piece. This spacing is especially important if the banded fertilizer contains urea.
- If the fertilizer is applied as a topdressing or side-dressing to overcome a suspected nitrogen deficiency, it should have at least a portion of its nitrogen in the nitrate form. This should ensure rapid availability to the crop.

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