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FACT SHEET
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Sidedress Nitrogen Fertilizer for Corn in Atlantic Canada

Written by Keith Reid

INTRODUCTION

Nitrogen (N) is often the limiting nutrient in many crop production systems in Atlantic Canada. Nitrogen fertilizer is a significant expense for producing grain or silage corn, but the efficiency of N use is low. Increasing the nutrient use efficiency (NUE) of nitrogen fertilizers would improve the profitability of crop production as well as reduce the environmental impacts from the "lost" nitrogen. Split application of N, where a small amount of the total requirement is applied at planting and the balance as a sidedress application, is one tool which could be used to improve NUE. This factsheet will discuss the potential benefits and challenges of split N application as well as the steps for successful implementation.

POTENTIAL BENEFITS OF SIDEDRESS N

Spreading the workload

There is always too much to do at planting time, so delaying the bulk of N application until sidedress can help to get the planting done faster by eliminating one pass over the field before planting. This will have less impact if a broadcast application is required for other nutrients (e.g. potash).

Reduced risk of N loss

Plant-available nitrogen in the form of nitrate (NO_3-N) is very mobile and prone to losses. Because of the cool, wet climate of the Atlantic provinces, N losses are a big concern as runoff, leaching, and denitrification increase under wet conditions.

- **Runoff** - Heavy rains following planting can increase the risk of nitrogen loss in runoff water or through erosion. Soils are often bare after planting and, therefore, increase the risk of runoff and erosion.
- **Leaching** - Heavy rains following planting on coarse-textured soils can carry spring applied N below the rooting zone, so it is not available to the crop. We cannot predict with certainty if these heavy rains will occur.
- **Denitrification** - Under saturated conditions, nitrate N in the soil can be converted to nitrous oxide or nitrogen gas and lost to the atmosphere. The nitrous oxide portion is a potent greenhouse gas. Delaying N application has two impacts on nitrous oxide production: reducing the time when soil nitrate may be exposed to saturated conditions before crop uptake and by applying N when the soil is normally warmer and drier, so the risk of denitrification is reduced.

Reduced N fertilizer rates

With improved NUE, there may be opportunities for using less N fertilizer, but this is going to be site-specific. In some cases, adjusting fertilizer rates higher to feed a crop with high yield potential will be justified, so the total N applied will be greater, but the N per unit of yield will be less.

More certainty about N rates

Delaying the application of the bulk of the total N for the crop will provide more confidence that the crop can utilize the fertilizer. At the simplest level, if parts of a field have been destroyed by frost or flooding, then no fertilizer needs to be applied; the overall NUE has improved from this simple act by not needlessly spreading fertilizer in areas without crops. With a more detailed assessment, the crop requirements for additional N become clearer as the impact of spring weather becomes known rather than predicted.

- Better utilization of residual N from legumes or manure
  Organic N from previous legume crops or manure applications is a potentially rich source of N for crops, but the mineralization of this N varies with temperature and soil moisture. Delaying N applications until later in the season allows a better assessment of the release of this organic N.

CHALLENGES WITH SIDEDRESS N

Specialized equipment

Application equipment for sidedress N must be able to travel through the emerged crop without excessive trampling and place the fertilizer where it will be available to the crop and protected from loss. The equipment used for pre-plant applications may not be able to meet these requirements. Wheel spacing may need to be adjusted to fit the row spacing of the crop, equipment may need to be fitted with narrower tires, and ground clearance of the equipment may need to be increased to avoid breaking the crop. Broadcast spreaders can work for topdress applications, but the ground clearance means applications must be made before the crop gets too tall. Sidedress into taller corn will require either a toolbar for injection or drop streamers (Y-drop™, for example) that place the fertilizer below the crop canopy.

Cost of N source

The most commonly used N fertilizer in Atlantic Canada is urea, but it is not as efficient for sidedress applications because of the risk of ammonia loss to the air, particularly under the warm conditions that prevail at sidedress time. There are a number of options for reducing the risk of ammonia volatilization:

- Use inter-row cultivation to incorporate the broadcast urea.
- Use a polymer-coated urea (e.g. ESN™) or urea treated with a urease inhibitor (e.g., Agrotain™, SuperU™).
- Switch to granular fertilizer alternatives with less volatilization risk (ammonium sulphate, ammonium nitrate), but they are significantly more expensive per unit of N than urea. A blend of urea and ammonium sulphate may be a more cost-effective option.

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- Use urea-ammonium nitrate solution (UAN, 28-0-0). Most sidedress equipment is set up to handle liquids, but it is more expensive than urea (generally intermediate between urea and ammonium nitrate). Depending on the facilities at your local fertilizer dealer, you may need to arrange on-farm storage tanks so you don't need to depend on delivery in the spring.

Weather risk

Wet weather at sidedress time can lead to impassable fields, keeping application equipment parked in the yard. This can leave the crop short of N at the time of maximum demand and also risk having the crop grow too large to allow equipment to travel through without stalk breakage. Less common is the other extreme, where dry soils leave the sidedress fertilizer "stranded" near the surface where there is insufficient moisture for roots to be active.

Workload at sidedress time

Reducing the workload at planting time does not eliminate the time required for N application; it delays it, and it may take longer to cover each field with the sidedress equipment, so consider what other activities need to be done at sidedress time. Depending on the type of operation, there may be conflicts with post-emergent herbicide or fungicide spraying, forage harvest, or planting of late crops.

SYSTEMS WITH THE BEST OPPORTUNITY FOR SIDEDRESS N

The benefits from splitting N applications will be greatest for the crops with the highest N demands and with the longest growing season. Crops with a relatively modest N requirement have a much smaller envelope for changing N rates and have a much lower mass of N at risk for loss to the environment. Crops with a short growing season also have a shorter window when N losses could occur, and so less opportunity to benefit from splitting applications.

For Atlantic Canada, the crops most likely to benefit from side-dressing part of the N requirements are corn and main crop potatoes. Both have high N requirements, and both have a lag time of several weeks between planting and the time of rapid N uptake. This leaves N applied at planting time vulnerable to losses through leaching or denitrification anytime excess rainfall occurs after planting.

The potential benefit will also depend on the soil type in the field. Coarse textured soils have the greatest risk of N losses by leaching, while fine textured soils can lose nitrogen through denitrification during wet periods. Medium textured soils (loams and silt loams) have a lower risk of N losses through either pathway and may show limited benefit to split N applications.

A final consideration is how well side-dressing fits into the farming operation. A dairy farm, for example, may have the greatest opportunity to capitalize on residual N from previous legume crops or manure applications, but the time for side-dressing corn may overlap with forage harvest. Unless there is additional equipment and labour available to do both jobs, the economic penalty of reduced feed quality in the hay crop is much higher than the potential savings in nitrogen fertilizer.

GUIDELINES FOR ADJUSTING SIDEDRESS N RATES

While it is commonly assumed that splitting N applications will result in lower N fertilizer rates, this is not always the case. Several tools are available to adjust N rates, which will help to get more tons of yield per kilogram of N applied if they are used judiciously.

General N recommendations

There are no general recommendations for reducing N rates with sidedress applications in Atlantic Canada. There do not appear to have been any direct comparisons between pre-plant and split application of N on corn in Atlantic Canada, but trials that have been done on potatoes did not show any difference in optimum N rates between split and single applications (Zebarth et al., 2004). In Ontario, an assessment of multiple years of N fertilizer trials showed no difference in optimum rates between pre-plant and sidedress applications on sandy soils but a reduction in sidedress N of about 20% on fine-textured soils (Ontario Ministry of Agriculture Food and Rural Affairs, 2017). Since most agricultural soils in Atlantic Canada are on the coarse-textured end of the scale, there may not be a large difference in optimum rates. If any farmer has been adding "insurance" applications of N over recommended rates to pre-plant fertilizer, eliminating these for side-dress would be wise.

Soil N tests

Soil mineral N (NO_3-N + NH_4-N) varies through the growing season as organic N mineralizes and N is lost through leaching or denitrification, so soil tests taken at pre-sidedress should reflect the N available to the crop better than a test taken at planting time. Unfortunately, this variability means the soil N may change over a few days, so it is a challenge to interpret what the values mean. New Brunswick has published preliminary interpretations of Pre-Sidedress N Tests (PSNT) shown in Table 1, but Nova Scotia does not currently have any PSNT recommendations for corn.

Biologic Nitrogen Activity is a test that can be conducted at the PEI soil analytical lab. This method measures the model for nitrogen mineralization in your soil. These numbers can be used to help reduce nitrogen application rates; however, it is a newer technology and recommendations are still under review.

Table 1. Sidedress fertilizer nitrogen recommendations based on the PSNT.

PSNT test value (ppm)	Sidedress N rate (kg N/ha)
25 or higher	0
20 - 24	30
15 - 19	60
10 - 14	90
less than 10	120

(Zebarth et al., 2006)

Plant tissue testing

Collecting samples during the growing season and measuring the N concentration can provide a detailed picture of the N status of the crop but may not be particularly useful for determining sidedress N rates. Recommended sampling is the ear leaf at tasselling when the crop is too large to drive through with application equipment, so it is a "report card" on the current year's management rather than a guide to how much to apply.

Crop sensing

The greenness of a crop can be related to the nitrogen status since N is a key component in the chlorophyll, which gives plants their green colour. There have been many experiments using this relationship to predict the N requirements of the crop, with mixed success as far as practical application. An advantage of crop sensing is the ability to vary the rate of sidedress N across the field to "even out" the nutrition of the crop. The biggest issue for implementation is that the differences in greenness become most apparent when the crop has a full canopy which is later than most sidedress fertilizer applications (Ziadi et al., 2012). There are also situations where the colour differences are due to environmental stresses rather than N deficiency (Cambouris et al., 2014). Accuracy is improved if there are reference strips in the field that have been fully fertilized, but this creates logistical challenges. Crop sensing shows promise for future implementation as work is ongoing to identify better indicators of N status in the crop.

IMPLEMENTING A SIDEDRESS N PROGRAM

Switching from all nitrogen being applied pre-plant to the addition of sidedress N-timing can mean a fundamental change to your fertilizer management system.

Planning for sidedress N on corn should begin in the winter or even the fall before planting since there may be a lead time required to have the proper materials and equipment on hand. The application equipment for different fertilizer materials goes together as well, so the planning has to take both into account at the same time. The thought process outlined here should help to guide you in the planning process:

What are you spreading with?

- Broadcast or streamer application
  - Granular fertilizer can be topdressed into a growing corn crop until the corn is about 25 cm tall as long as the equipment wheel spacing matches the corn rows, but the risk of ammonia loss from conventional urea is high. Ammonium nitrate or ammonium sulfate have a lower risk of volatilization, or switch to a protected urea source with either a polymer coating or a double inhibitor (e.g., Super-U® or Agrotain Plus®). Apply when the foliage is dry. There may be some pin-hole burning from fertilizer granules that land in the whorl of the corn plant, but this is cosmetic.
  - Some farmers have experimented with using streamer nozzles on their sprayers to apply liquid fertilizer (UAN, 28-0-0) to corn with inconsistent success. These nozzles are not designed to place the liquid below the crop canopy, and foliage in contact with the stream will be severely burned. The crop will generally grow out of this damage but will be set back. This method is applicable to cereal crops but not for corn.
- Injected or Surface Band
  - Injecting UAN solution below the soil surface is the gold standard for protecting the N from ammonia loss to the atmosphere and placing it where it is accessible to plant roots. It will require a toolbar with injector knives, tanks to carry the fertilizer (either towed or tractor mounted), and the pumps and hoses to meter the liquid from the tanks to the knives. Injecting N is slower than any broadcast system, and it is not suited to hilly or stony ground. The height of the toolbar will dictate how small the corn must be for sidedress (generally less than 60 cm or 2').
  - Surface banding below the crop canopy is an option as long as there is enough moisture to carry the N into the soil where plant roots can reach it. This allows using an existing sprayer by adding extended nozzles that place a stream of N solution at the base of each cornrow (Y-drop® or Ezee-drop®). The time required for N application is intermediate between injection and broadcast, and the crop canopy mitigates the risk of ammonia loss. This system can be used on larger corn than the injection toolbar as long as there is enough clearance under the sprayer. DO NOT use regular spray nozzles for sidedress applications, as the foliar burn will be extreme.

When should you spread?

In corn operations, mid-season nitrogen application should be spread at the V4-V6 stage of corn (Figure 1 and 2). This is when the corn plants begin a period of rapid growth and nitrogen uptake. Therefore, nitrogen losses are reduced because the plant will make use of available nitrate in the soil. In Nova Scotia, this timing may differ based on the climate of your location (e.g., farmers in the Annapolis Valley will likely hit the appropriate corn staging before farmers in Cape Breton) and

seasonal weather patterns (e.g., heavy rain or drought can impact application timing). This is typically late June to early July in Nova Scotia.

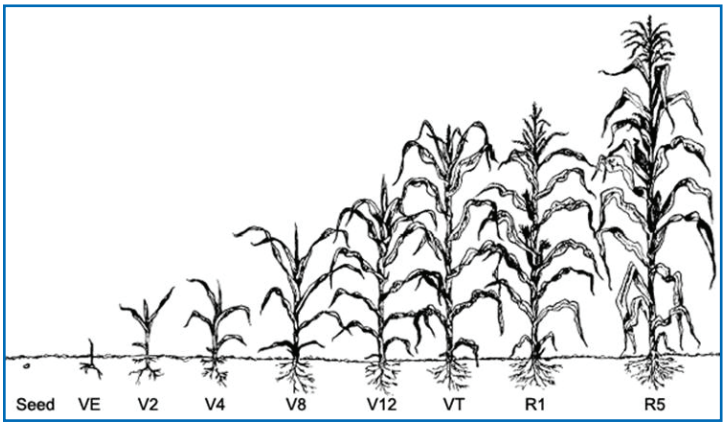

Figure 1. Corn growth Stages (Ohio State University Extension).

Figure 2: Picture of corn field at approximate stage for sidedress and topdress.

SUMMARY

Sidedress N is an option to improve nutrient use efficiency for many corn growers in Atlantic Canada, but it will not fit every operation. There does not always appear to be a large yield increase to sidedress application in the Maritime climate, but it can definitely reduce the risk of denitrification or N leaching and eliminate the "insurance" applications of N that some farmers add in anticipation of losses between planting and crop uptake, therefore making sidedress application more economically and environmentally friendly. The key to successful sidedress N programs is to plan ahead.

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