Pre-seeding Nitrate Nitrogen Test can save some dollars!

Dr. Tarlok Singh Sahota CCA

Do all your fields have similar nitrate nitrogen (NO_3^- N)? Do you think all your fields will need similar amounts of N application for a particular crop? If you think yes, you are mistaken. After all why do we apply fertilizers? To supplement soil nutrients to a level that is conducive to an economic optimum yield without impacting the environment. It is therefore essential to know what the nutrient content of a field is before deciding upon the rates of nutrients application. Most farmers go for basic soil test package that gives them an estimate of phosphorus (P) and potassium (K) content in the soil. There is a need to test nitrate N as well because by and large it is the form in which crop plants take N from the soil. N content in different fields could vary with the previous crops (legumes/non-legumes), fertilizers/manures applied to previous crops, crop yields and residual N after crops' harvest. At Thunder Bay Agricultural Research station (TBARS), Thunder Bay, we have observed that a field with previous crop (oats) applied with recommended rate of N (no manure application) had 8.2 ppm nitrate N (32.8 kg N/ha; ppm x 4 = kg/ha), in 0-30 cm soil, the next spring, whereas, a field with silage corn as a previous crop, applied with liquid manure and recommended amount of N had 26 ppm residual nitrate N (104 kg N/ha) in 0-30 cm soil. Cereals (mean over barley, wheat and oats) response to recommended rate of N (70 kg/ha) in the first field (8.2 ppm nitrate N) was 1,117 kg/ha (= 16 kg grains/kg N), whereas, there was no response to applied N in the second field (26 ppm nitrate N). Both the fields were in the adjoining (similar) plot ranges. Don't you think that in the latter case, at current prices of urea N ($1.30/kg), we could have saved $91/ha (= 70 kg x $1.30/kg)? This, compared to the direct cost of nitrate N test ($1.5/ha; assuming 25 acres unit for soil sampling), is a significant amount. If someone grows 100 acres of cereals, there is a potential of saving over $3,600. Traditionally, pre-seeding nitrate N test wasn't recommended, because nitrate N is generally believed not to stay in the soil, because of denitrification/or leaching losses. However, in well drained soils, especially in tiled drained fields, with no excessive moisture, where will the nitrate N go? Nowhere; it will be taken up by crop plants or stay in the soil. In a summer/spring fallow (tile drained) plot range at TBARS, Thunder Bay, pre-seeding nitrate N was unbelievably high (70 ppm = 280 kg/ha)! No wonder in this field application of N fertilizers tended to reduce the wheat grain yield.

In spring wheat, in a plot range with pre-seeding nitrate N test of 12 ppm (48 kg N/ha), response to 40 kg N/ha was 506 kg grains/ha (= 12.65 kg grains/kg N), and to 80 kg N/ha was 418.2 kg grains/ha, which equals 5.2 kg grains/kg N. This is a breakeven point for N application to spring wheat at $1.30/kg N and $260/tonne grains. Under the fluctuating/uncertain grain prices, it would be safer to apply 40 kg N/ha to spring wheat than applying 80 kg N/ha.

Apart from nutrient content in soil, it is also important to know how much nutrients are removed by crop plants so that the nutrients are replenished adequately to maintain soil fertility. See the following table for N removal by cereals per tonne of grains (kg/ha) at TBARS, Thunder Bay.

Spring cereals	Grain	Grain + Straw
Barley	17.8	23.3
Wheat	24.0	33.7
Oats	20.2	35.3

While planning for N application rates, it will be reasonable to assume at least 5 tonnes grain yield/ha for barley. N removal by barley at this yield will be 116.5 kg/ha, whereas only 70 kg N/ha is recommended for barley (in northwestern Ontario). Where from the rest of the N comes? It could come from soil (left over from previous crops, plant residues, dead earth worms/microorganisms, wild life excreta, fertilizers/manures, N held by clay and organic matter, and N in lower soil layers – 30-60 cm and 60-90 cm for which no nitrate test is done,) and air (fixation by legumes/leguminous weeds such as clover, trefoil or even volunteer alfalfa, free living soil bacteria such as azotobacter, and dissolved N in rain?). How much N could be there in deeper soil layers (30-60 cm and 60-90 cm)? In our research plots (4-5 experiments over two years), nitrate N content in 30-60 cm soil varied from 26% to 43 % (average ~35%; it may be safe to assume 30%) of nitrate N in the top 0-30 cm soil. Nitrate N in 60-90 cm was either 50% of/or same as that in 30-60 cm soil. As the crops grow, they can draw nutrients from deeper soil layers. Based on these assumptions, let's see how much nitrate N could be in the soil in a spring barley field with a pre-seeding nitrate N test of 8.2 ppm:

Soil – 0-30 cm: 32.8 kg/ha (8.2 ppm x4)
Soil – 30-60 cm: 9.8 kg/ha (30% of N in 0-30 cm)
Soil – 60-90 cm: 4.9 kg/ha (50% of N in 30-60 cm)
Fertilizer N: 70.0 kg/ha
Total (Soil + Fertilizer): 117.5 kg/ha. This more or less equals N removal by barley (116.5 kg/ha; see paragraph 4). It may therefore be logical to assume that fields having more than 8 ppm pre-seeding nitrate N would require less than 70 kg fertilizer N/ha. Our experience also shows that if the pre-seeding nitrate N is 25 ppm or more, spring cereals wouldn't respond to N application. In fact going by these calculations, N application to spring barley may not be required even if pre-seeding nitrate N test is 20 ppm. Why waste N and dollars on N then? It is quite probable that silage corn applied with manure and fertilizers and crops such as alfalfa and soybean could have residual nitrate N equal to 25 ppm or more (~2-3 times more than the residual N after cereals, especially those which didn't get a manure application).

Limited time for field operations and seeding in spring is a constraint in taking pre-seeding soil samples. Though ideally, soil samples should be taken before seeding, other options could be explored to overcome time constrains. These could be seeding without application of N or using MAP (11-52-0 at recommended rates of P application) at seeding and taking soil samples after seeding. Cereals take 3-4 weeks after seeding to initiate crown roots (which are close to soil surface and can absorb top dressed N) and tillering during which time nitrate soil test results could be available to decide if N needs to be applied to spring cereals or not and if needed, how much? The principle/practice can be extended to other crops (and areas based on location specific research) as well, and certified crop advisors or researchers/specialists in your area could be of help.

The bottom line is that pre-seeding nitrate N tests could not only save a lot of dollars, but also minimize potential impact of agricultural practices on environment!

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