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USING THE SOIL NITRATE TEST FOR CORN IN MINNESOTA

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Until recently, nitrogen (N) fertilizer recommendations for corn production have been based on estimates of the soil's nitrogen supplying capacity. This capacity is affected by several factors such as organic matter content, texture, and previous crop.

This approach to N recommendations gives a reasonable estimate of the fertilizer N amount needed under average conditions. It does not, however, take into consideration the variability of nitrate-nitrogen (NO_3^--N) present in soils prior to planting. The residual or carryover NO_3^--N found in soils can vary from almost nothing to amounts that meet a corn crop's N requirements.

Residual Nitrate-Nitrogen in Minnesota Soils

The majority of nitrogen used by row crops is absorbed in nitrate (NO_3^-) form. The NO_3^- can be supplied to the root system from several sources. These include: 1) animal manure breakdown, 2) previous legume crops releasing N, 3) soil organic matter breakdown, and 4) commercial N fertilizers.

Under some situations, the amount of NO_3^- supplied to the root system during one or more growing seasons can exceed the amount absorbed by a crop. This excess NO_3^- either can be lost from the soil system or used by crops in future years. The soil nitrate test is designed to measure this amount of residual or carryover NO_3^--N.

The Soil Nitrate Test Is a Management Tool

The residual NO_3^--N in the root zone is used by crops in the same way the NO_3^--N supplied from other sources is used. Therefore, the amount of fertilizer N that will be needed for corn production will depend on the amount of residual NO_3^--N present in the root zone before planting. For fields with very low amounts of residual NO_3^--N, N recommendations for optimum yields may need to be higher than those used in the past. In these situations, N rates used in the past were probably too low to produce top yields.

Suggested rates of fertilizer N can be reduced where fields have high levels of residual NO_3^--N. In this

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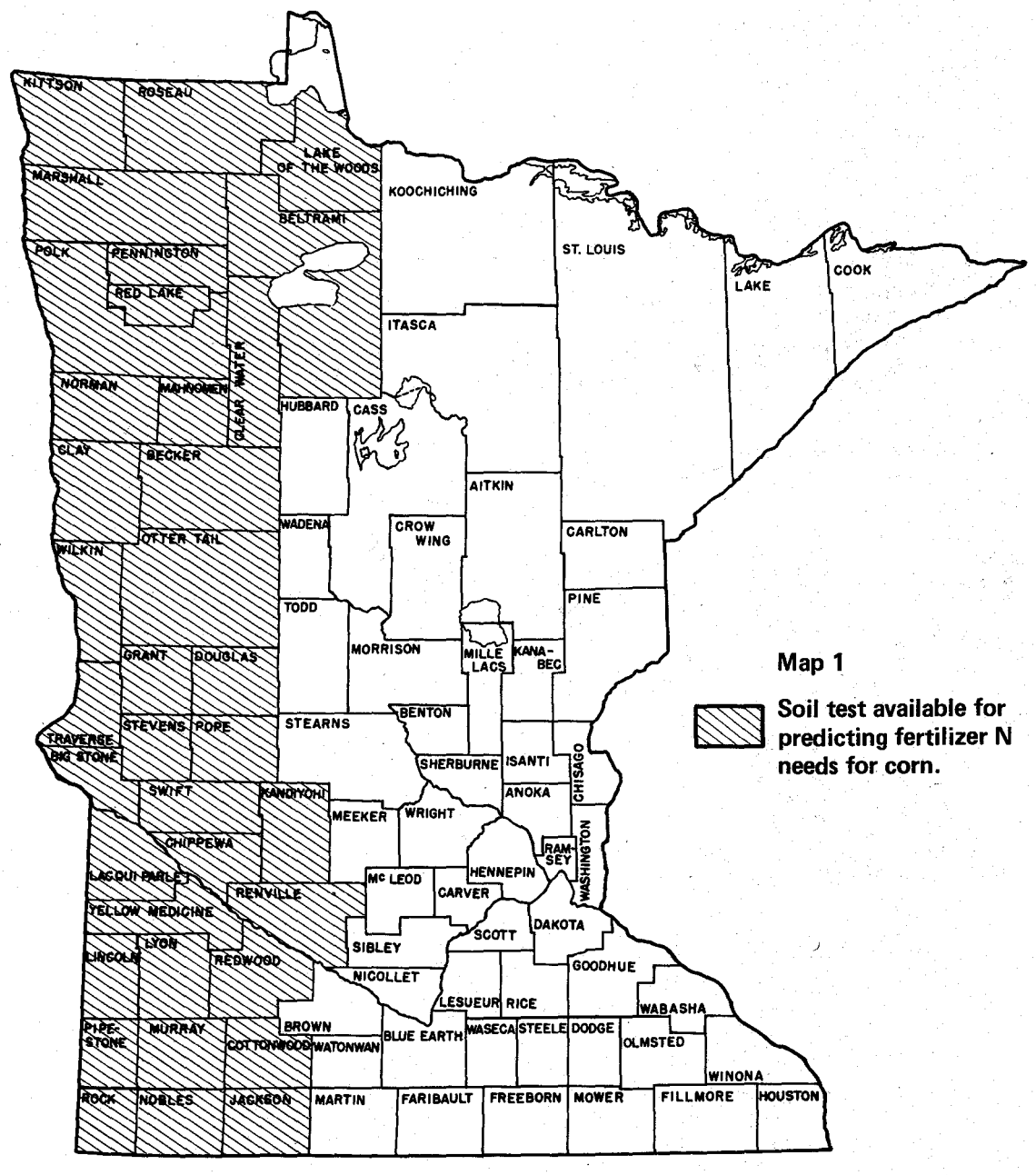

Map 1

Soil test available for predicting fertilizer N needs for corn.

situation, the soil test for NO_3^--N can substantially reduce the amount of fertilizer N required.

The soil nitrate test is a management tool that can be used by growers to increase the accuracy of N fertilizer recommendations. When accuracy of these N recommendations is improved, efficient use of N fertilizer will follow.

Nitrate Test Is Appropriate for Western Minnesota

The soil nitrate test is now recommended only in western Minnesota (see map). Rainfall is often limiting in this area of the state. Therefore, loss of NO_3^--N due to leaching is expected to be small, and major changes in the amount of NO_3^--N are not likely to occur between the time of fall sampling and the next growing season.

Untimely, heavy rains can cause soil denitrification in this part of the state. When this occurs, no soil tests for NO_3^--N or other methods of predicting N needs are reliable.

The potential for substantial N losses from leaching and/or denitrification makes the soil nitrate test unreliable for predicting the amount of fertilizer N needed for a corn crop in the remainder of the state (central and eastern).

It is important to point out that the nitrate test is **not recommended** for any coarse-textured soils (sandy loams, loamy sands, sands) throughout Minnesota. Loss of NO_3^--N due to leaching may be high in these soils. Much of this leaching could easily occur between sampling and planting.

In addition, the soil nitrate test is not recommended for very poorly drained soils. Losses of NO_3^--N due to denitrification may be high for this situation.

Sampling Procedure

The soil sample collection from depths below the plow layer or tillage zone is necessary before the amount of residual or carryover NO_3^--N can be measured. Normally, soil samples are collected from a depth of 0-6 or 0-8 in. Soil from this depth is routinely analyzed for pH, organic matter, phosphorus (P), potassium (K), sulfur (S) and micronutrients.

Research has shown that soil taken from below the tillage zone is needed before the amount of residual NO_3^--N in the root zone can be measured accurately. Therefore, in addition to a sample from the 0-6 in. depth, soil samples must also be collected from a 6-24 in. depth. The total amount of residual NO_3^--N in the 0-24 in. zone is calculated from an analysis of soil collected from these two depths.

If the grower is interested only in a nitrate test, a 0-24 in. sample is all that is needed. To further increase the accuracy of the residual NO_3^--N measurement, soil should also be collected from a 24-48 in. depth.

It is important to keep soil collected from various depths in separate containers. **Do not** take a sample from a 0-48 in. depth and submit it as a single sample.

The sample collected from a field, including the soil collected to either 24 or 48 in., should be a composite of 15 cores taken from a uniform area of not more than 20 acres. In some cases, where soil type and crop fertilizer history are known to be uniform, an area as large as 30 to 40 acres may be represented by one soil sample. The 15 cores should be mixed thoroughly in plastic buckets and 2/3 of a pint of soil removed for analysis.

Sampling for residual NO_3^--N usually should be completed prior to planting the corn crop. The amount of residual NO_3^--N found in soils can be affected by weather, amount of fertilizer N previously applied, previous yields, etc. Therefore, fields should be sampled each year for continuous corn production. For corn-soybean rotations, samples should be collected after the soybean harvest but before the corn crop is planted. Samples can be collected either in the fall (after September 15) or in early spring.

It is possible to sample soils after planting but prior to sidedress N application. This sampling would result in an accurate N recommendation but would be of little value in determining fertilizer needs for other nutrients for that year.

The samples must be air-dried as quickly as possible after collection. To dry, spread the samples on a clean sheet of paper or plastic. Samples should dry within 24-48 hours. The samples (each clearly marked with the appropriate depth) can then be sent to the soil testing laboratory.

Soil from 24-48 in. Is Important

Soil collected from 24-48 in. can be used to improve the accuracy of N fertilizer recommendations where substantial amounts of NO_3^--N have accumulated at this depth. Build-up takes place when N uptake by the crop is less than the amount of NO_3^--N available in the root zone.

Accumulation of NO_3^--N can occur when: 1) rates of fertilizer N used in the past have been higher than needed, 2) high rates of manure have been applied, and 3) corn yields have been substantially reduced by drought, hail, or other yield-limiting factors.

Accumulation of NO_3^--N below 24 in. is not likely after growers begin to sample for residual NO_3^--N and adjust the rates of N fertilizer used for the amount of residual NO_3^--N found before planting.

Information from the Grower

The following information is essential for an accurate N fertilizer recommendation and must be supplied on the information sheets submitted with the soil samples:

1) Depths from which the soil was collected
2) Realistic yield goal
3) The previous crop

The sampling depth and previous crop information is not complicated. However, there always seems to be some confusion about a realistic yield goal. It is reasonable to expect all growers to strive for the highest yield possible. However, everyone is not capable of reaching the same high yields. Sometimes, yield goals are too high. This results in using excessively high rates of fertilizer N with a subsequent accumulation of NO_3^--N in the root zone.

In estimating a yield goal, both soil type and weather conditions must be considered. With good management practices, yield goals should be realistic as well as optimistic.

Limitations to the Soil Nitrate Test

The soil nitrate test is not considered to be completely foolproof. If heavy rains occur after the samples are collected, especially if these rains occur in warm weather, substantial losses of NO_3^--N due to leaching or denitrification can occur. If this happens, the nitrate test would no longer be correct and the suggested rate of fertilizer N should be adjusted upward. Another option would be to collect another set of soil samples and send to the laboratories for NO_3^--N analysis.

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