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Managing Nitrogen for Corn Production on Irrigated Sandy Soils

by
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Nitrogen (N) fertilizer is a major input for corn production throughout Minnesota. The amount of money used for the purchase of N fertilizers usually dominates the cost of the total fertilizer program. Therefore, considerable attention should be given to the management of fertilizer N. This is especially true for corn production on irrigated sandy soils.

There are many decisions involved in the management of fertilizer N. Growers must decide on rate to be applied, source or sources to use, time of application, and whether to use a nitrification inhibitor.

General Nature of Minnesota's Sandy Soils

Most of the sandy-textured soils of Minnesota have a low water-holding capacity and a medium to low organic matter content. Because of the low water-holding capacity, heavy rains can move (leach) nitrogen below the root zone if it is in the nitrate (NO_3^-–N) form. Likewise, excessive applications of irrigation water can produce accelerated downward movement of NO_3^-–N. So, management of fertilizer N must be closely tied to the management of irrigation water.

Since the organic matter content of these soils is relatively low, they cannot supply large amounts of N to the corn crop. The major portion of the N needed must, therefore, be supplied through a well managed fertilizer N program.

Matching N Rate to Yield

In Minnesota, rates of fertilizer N recommended for corn production on sandy soils vary with previous crop and yield goal. Suggested rates of fertilizer N are listed in the following table. Selection of a realistic yield goal is important. Everyone, of course, would like to grow the highest yields possible. Yet, it's difficult to substantially increase average yields over a short period of time. The choice of a yield goal substantially higher than any yield achieved in the past is generally not practical and usually results in the application of excessive amounts of fertilizer N. If excessive amounts of N are applied to sandy soils, the N is not used by the crop and is subject to loss by leaching. The leaching of N to the groundwater not only creates environmental concerns, but also results in the loss of money spent for fertilizer N.

Suggested rates of fertilizer N for corn production on irrigated sandy soils

YIELD GOAL		PREVIOUS CROP			
Grain	Silage	Corn, Potatoes, Sugar-beets	Soybeans, Small grain, Sun-flowers	Clover, Alfalfa (poor stand)	Alfalfa (good stand)
(bu/acre)	(ton/acre)	N to apply (lb/acre)			
more than 175	more than 24	220	180	160	120
156-175	22-24	200	160	140	100
136-155	19-21	180	150	120	80
116-135	16-18	150	120	90	50
96-115	13-15	120	100	60	30
76-95	10-12	90	70	40	0
75 or less	9 or less	60	50	30	0

The N rates listed in the table have been adjusted for the usual amounts of N supplied by a previous crop. If manure is applied, some adjustment should be made for the N added from this source. In general, one ton of manure will supply about five pounds of N. The amount of N supplied by manure can vary with type used, method of storage, etc. Manure should be analyzed to determine the exact amount of N it is supplying.

The irrigation operator should also consider the amount of N supplied by the irrigation water itself. The N content of irrigation water can vary over a wide range. An analysis of the irrigation water is needed before the amount of N supplied from this source can be determined. A water sample should be taken annually from the irrigation water supply during the irrigation pumping season. One part per million (ppm) of nitrate nitrogen in water is equal to 2.72 pounds of nitrogen applied per acre with each 12 inches of irrigation water applied. The table below lists the amount of N applied per acre related to amount of irrigation water applied and nitrate content.

Nitrogen applied per acre in relation to nitrate content and amount of irrigation water applied

Water applied	NO_3–N content of water (ppm)			
(inches)	5	10	20	40
	N from water, lbs/A			
6	7	14	27	54
12	14	27	54	109
18	20	41	81	163

Flexibility in Nitrogen Management Is Important

In contrast to phosphorous (P) and potassium (K), N in the nitrate form is mobile in soils—especially sandy soils. Because of this mobility, the irrigator must maintain flexibility in the management of fertilizer N for corn production on the sandy soils.

Research in Minnesota and other states has shown that split applications of fertilizer N are important for high corn yields on irrigated sandy soils. When split applications of fertilizer N were used in these studies, the corn crop utilized more of the applied N, and movement of NO_3^-–N to the groundwater was minimized.

When planning a N management program for corn, some important points to remember are:

- The N requirement of the corn crop is at a peak at the 12 to 16 leaf growth stage. For most efficient use of fertilizer N, apply at least one half of the total N to be used prior to this stage of growth. A sidedress application is a convenient way to supply needed N at this time. Plan to start the sidedress applications early. There can be extensive damage to corn if application equipment is used at the 12-leaf stage or later.
- The corn crop will utilize fertilizer N throughout the growing season. Research, however, has shown that the efficiency of N use decreases fairly rapidly after silking. Therefore, apply all fertilizer N used for the irrigated crop before the silks turn brown.
- Apply starter fertilizer at planting time to supply N. Liquid N can be mixed with an herbicide (weed and feed practice) and applied. There is a potential for loss of some N from the liquid source if broadcast on the soil surface when temperatures are high and the pH is 7.3 or higher. There is also potential for loss of N from the liquid N source if broadcast

where there are high amounts of residue on the soil surface. A light incorporation will greatly reduce the possibility of N losses in these situations.

- While higher yields have usually been recorded where the largest portion of the needed N is applied as a sidedress treatment, some irrigators may wish to substitute a preplant application for the sidedress treatment. This practice increases the potential for loss of NO_3^-–N by leaching due to heavy late spring and early summer rains.
- If the N is applied to the sandy soils before planting, it's important that a nitrification inhibitor be used. The nitrification inhibitor should be added to any fertilizer N that is applied before the 8-leaf stage of corn development.
- The injection of fertilizer N into the irrigation water (chemigation) is an effective way to apply some of the N requirement for irrigated corn grown on sandy soils. There are no firm guidelines for the amount of N to be injected with the irrigation water, but a good guide would be to apply about 1/3 of the total N to be used in this way. For maximum efficiency, split the amount of N to be injected with the irrigation water into two or three applications. Chemigation has the potential to allow the injected chemical to backflow into the irrigation water supply if proper check valves are not in place or maintained. Minnesota fertilizer law requires chemigation systems to be registered with the Minnesota Department of Agriculture (MDA) and contain approved anti-pollution check valves. Specific information on check valves and registration is available from the MDA (612/297-2614).

Nitrogen Management Options

There are several ways that split applications of fertilizer N can be used for corn production on irrigated sandy soils. Two suggested options are outlined below. Nitrogen rates are not listed because these will vary with individual yield goals and cropping histories.

Option I

- Apply some N in a starter fertilizer.
- Apply about 1/3 of the total N to be used with the irrigation water.
- Apply the majority of the N needed as a sidedress treatment. Use a nitrification inhibitor if the N is applied before the 8-leaf stage.

Option II

- Apply some N in a starter fertilizer.
- Apply about 1/3 of the total N to be used with the irrigation water.
- Apply the majority of the N needed before planting. Use a nitrification inhibitor with all N applied before planting.

Option I is preferred because this management system provides for the application of most of the N close to the time of maximum N use by corn.

It is possible to mix liquid N fertilizer with most herbicides used in corn production. This mixture can be used in both of the options listed. For best results, the fertilizer-herbicide mixture is either applied at the time of planting or broadcast on the soil surface immediately after planting. The amount of N applied in this way should be subtracted from the amount of N needed in either the preplant or sidedress applications. The fertilizer-herbicide mixture is best suited where early sidedress applications are not practical.

Nitrogen Sources

The irrigator can select from several sources of fertilizer N. Sometimes, the selection of an N source depends on the method of application to be used. Liquid N (28-0-0) is the only N source that, from a practical standpoint, can be injected into the irrigation water. Do not inject anhydrous ammonia (82-0-0) into irrigation water. This practice can cause the formation of insoluble salts that will plug nozzles and create expensive repair bills.

Urea (45-0-0), 82-0-0, and 28-0-0 can be used for preplant applications. Either 82-0-0 or 28-0-0 is suitable for use as a sidedress treatment. Urea can be used for the sidedress treatment, but lack of suitable equipment for this type of application is a problem.

Nitrogen can be supplied in both liquid and dry starter fertilizers. Several trials have shown that liquid and dry materials are equal in performance.

For preplant and sidedress applications, the choice of the N source will depend on price, preference for handling, ease of handling, availability of equipment, etc. From an agronomic standpoint, all N sources are equal in performance if N losses do not occur.

There is potential for loss of N from 45-0-0 and 28-0-0 broadcast on the soil surface. Loss from these sources can be prevented if some light incorporation is used. There can be loss of N in the application of 82-0-0 if the soil is very dry or if application depth is too shallow. Loss of 82-0-0 can be easily detected by the odor.

Matching Nitrogen and Water Management

The management of the irrigation water is an important component of the total N management system needed for sandy soils. It is obvious that there is no practical way to prevent leaching of NO_3^- – N caused by uncontrolled heavy rains. However, the management practices that were described can be used to keep these losses at a minimum. Leaching of NO_3^- – N caused by use of excessive amounts of irrigation water is as serious as leaching losses caused by heavy rains.

Proven irrigation scheduling techniques have been developed for Minnesota that, if used, will result in the use of adequate but not excessive amounts of irrigation water. Effective irrigation is possible with regular monitoring of soil-water-plant conditions in the field, predicting future crop water needs and following the best recommended water management strategies. For example, to minimize the leaching potential of agrichemicals during the vegetative stage and after denting, allow the soil water deficit to reach 60-70 percent depletion before irrigating. This period normally produces more rainfall than evapotranspiration. More information on irrigation scheduling strategies and tools is discussed in AG-FO-3875, Irrigation Water Management Considerations for Sandy Soils in Minnesota, available at county extension offices.

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