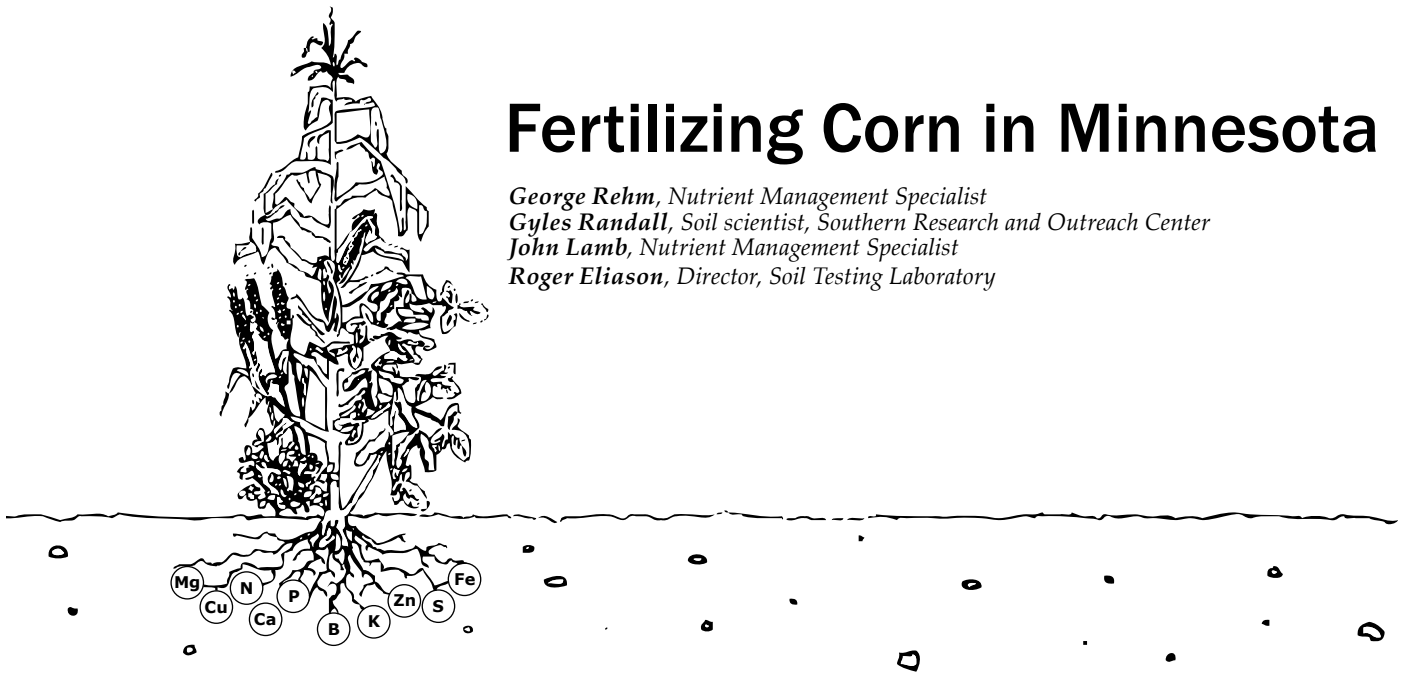


Fertilizing Corn in Minnesota

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In Minnesota, corn is grown on more acres than any other crop. Nationally, Minnesota ranks among the top five in corn production. Average corn yields have improved steadily over the past several decades. While general fertilizer use contributed substantially to yield increases in the past, total fertilizer management which optimizes nutrient efficiency will be needed to increase future production and profitability.

Nitrogen Suggestions

Minnesota corn growers receive substantial return for money invested in nitrogen (N) fertilizers. For many situations, the most profitable yield cannot be achieved unless N fertilizers are used.

There are many management decisions involved in the use of N fertilizers. The most important, however, is the selection of a N rate that will produce maximum profit while limiting the potential for environmental degradation. The choice of an appropriate rate of fertilizer N is not easy because of the transient nature of N in soils.

The productivity potential of the soil, the previous crop, the ratio of the price of N to the value of the crop, and risk assessment provide the basis for N rate guidelines. In western Minnesota, these guidelines should be adjusted for any residual nitrate-nitrogen measured.

Standard N Guidelines

The consideration of soil productivity, price/value ratio, and previous crop are used to arrive at the fertilizer N guidelines for corn. This represents a significant change in the process of determining the rate of N to use. This process is a product of a seven-state effort, (Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin) to use a similar philosophy/approach for determining N rate guidelines for corn. The data used in the project was from research conducted since 1989 and involved over 700 locations in the corn belt.

Because of technology improvements in corn production practices such as weed and pest control, expected yield is not as important a factor in determining N rate as it has been in the past. Soil productivity has become a better indicator of N needs. A majority of Minnesota soils are highly productive and have generally produced maximum economic corn yield with similar N rates over the last 15 years. Some soils have a reduced potential attributed to erosion, reduced water holding capacity caused by lower organic matter content, sandy soil texture, poor drainage, and any restriction to root growth.

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With the current volatility in energy costs, fertilizer N cost has risen dramatically in the past three years. This increase does affect the economic optimum N rate. To account for this change, the ratio of the price of N per pound to the value of a bushel of corn has been added to the N rate decision. An example calculation of the price/value ratio is if N fertilizer costs \$0.30 per lb N or \$492 per ton of anhydrous ammonia, and corn is valued at \$2.00 per bushel, the ratio would be $0.30/2.00 = 0.15$.

Once the soil productivity and price/value ratio have been determined, a producer's attitude towards risk must be factored into the process. A producer who is risk adverse and cannot tolerate risk associated with less-than-maximum yields in some years even though economic return to N may not always be the greatest may want to use the N rates near the high end of the acceptable range shown in **Table 1**. On the other hand, if water quality concerns are an issue and/or localized N response data support lower N rates, producers may choose N rates near the low end of the acceptable range in **Table 1** if they are willing to accept the possibility of less-than-maximum yield in some years without sacrificing profit. This acceptable range gives each producer flexibility in arriving at an acceptable and profitable N rate. The maximum return to N value (MRTN) shown in **Table 1** is the N rate that maximizes profit to the producer based on the large number of experiments supporting these guidelines.

The N rate guidelines in **Table 1** are used if corn is grown in rotation with soybean or following corn under

high productivity conditions and guidelines in **Table 2** are used under medium productivity conditions. Corn grown on sandy soils deserves special consideration. If irrigated, the guidelines listed in **Table 1** are appropriate. For non-irrigated corn grown on sandy soils (loamy fine sands, sandy loams, loams) with more than 3% organic matter, use the guidelines given in **Table 2**. For non-irrigated corn grown on soils with a loamy fine sand texture and less than 3% organic matter, use the guidelines provided in **Table 3**.

To arrive at a guideline following other crops, an adjustment (credit) is made to the corn following corn guidelines. The adjustments can be found in **Table 4**. In **Table 4**, several crops are divided into Group 1 and Group 2. The crops for each group are listed in **Table 5**.

The N rates listed in **Tables 1, 2, and 3** define the total amount of fertilizer N that should be applied. Any N applied in a starter fertilizer, weed and feed program, DAP (diammonium phosphate) or MAP (monoammonium phosphate) should be included in the calculation of the total amount of N applied during the growing season. It's generally accepted that legume crops provide N to the next crop in the rotation. Some forage legumes provide some N in the second year after the legume was grown. These second year N credits are listed in **Table 6**. If corn is grown in the second year following alfalfa and red clover, these N credits should be subtracted from the N rates that would be used when corn follows the crops listed in Group 2, **Table 5**.

Table 1. Guidelines for use of nitrogen fertilizer for corn grown on soils considered to be highly productive.

N Price/Crop Value Ratio	corn/corn		corn/soybeans	
	MRTN	acceptable range	MRTN	acceptable range
	----- lb N /acre -----			
0.05	155	130 to 180	120	100 to 140
0.10	140	120 to 165	110	90 to 125
0.15	130	110 to 150	100	80 to 115
0.20	120	100 to 140	85	70 to 100

MRTN = maximum return to nitrogen

Table 2. Guidelines for use of nitrogen fertilizer for corn grown on soils considered to have medium productivity potential.

N Price/Crop Value Ratio	corn/corn	corn/soybeans
	----- lb N /acre -----	
0.05	130	100
0.10	120	90
0.15	110	80
0.20	100	70

Use of the Soil Nitrate Test Encouraged

Western Minnesota

The use of the soil nitrate test is a key management tool for corn producers in western Minnesota. The use of this test is appropriate for the shaded counties shown in **Figure 1**. The nitrate-N soil test is particularly useful for conditions where elevated residual nitrate-N is suspected. **Figure 2** is a decision tree that indicates situations where the nitrate-N soil test would be especially useful.

For this test, soil should be collected from a depth of 6-24 inches in addition to the 0-6 inch sample. The corn grower in western Minnesota also has the option of collecting soil from 0-24 inches and analyzing the sample for nitrate-nitrogen (NO₃⁻-N). This 0-24 inch sample should not be analyzed for pH, phosphorus, and potassium because the results cannot be used to predict lime needs and rates of phosphate and/or potash fertilizer needed.

When using the soil nitrate test, the amount of fertilizer N required is determined from the following equation:

$$NG = (\text{Table 1 for corn/corn}) - (0.60 * STN_{(0-24 \text{ in.})})$$

NG = Amount of fertilizer N needed, lb/acre

Table 1 value = the amount of fertilizer needed adjusted for soil potential, value ratio, and risk

STN₍₀₋₂₄₎ = Amount of nitrate-N measured by using the soil nitrate test, lb/acre

Table 5. Crops in Group 1 and Group 2.

Group 1 crops	Group 2 crops
alsike clover	barley
birdsfoot trefoil	buckwheat
grass/legume hay	canola
grass/legume pasture	corn
fallow	grass hay
red clover	grass pasture
	oats
	potatoes
	rye
	sorghum-sudan
	sugar beet
	sunflower
	sweet corn
	vegetables
	wheat

Table 3. Suggested nitrogen guidelines for corn grown on non-irrigated loamy fine sands with less than 3% organic matter.

Cost/value Ratio	Corn/corn	Corn/soybean
	----- lb N per acre -----	
0.05	100	70
0.10	90	60
0.15	80	50
0.20	70	40

Table 4. Nitrogen credits for different previous crops for the first year of corn.

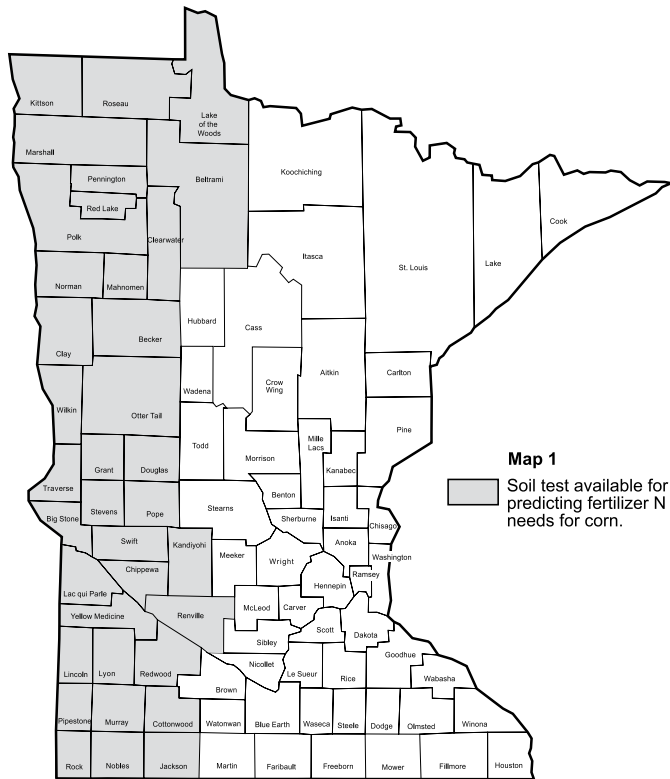
Previous crop	1st year nitrogen credit
	lb N per acre
Small grains*	40
Harvested alfalfa	
4 or more plants/ft ²	150
2-3 plants/ft ²	100
1 or less plants/ft ²	40
Group 1 crops	75
Group 2 crops	0
Edible beans	20
Field peas	20

*Use this credit if any small grain stubble in southeastern Minnesota counties was tilled after harvest; if there was no tillage, use guidelines for crops in Group 2. Use guidelines for crops in Group 2 if corn follows small grain in the remainder of the state.

Table 6. Nitrogen credits for some forage legumes if corn is planted two years after the legume.

Legume crop	2nd year nitrogen credit
	lb N per acre
Harvested alfalfa	
4 or more plants/ft ²	75
2-3 plants/ft ²	50
1 or less plants/ft ²	0
Red clover	35

Figure 1. The fall soil nitrate test should be used for nitrogen guidelines in the counties that are shaded.



South-central, southeastern, east-central Minnesota

Research has led to the inclusion of a soil N test to adjust fertilizer N guidelines in south-central, southeastern, and east-central Minnesota (non-shaded areas of **Figure 1**). This test, in which soil nitrate-N is measured in the spring before planting from a two-foot sampling depth, is an option that can be used to estimate residual N. In implementing this test, the user should first evaluate whether conditions exist for residual N to accumulate. Factors such as previous crop, soil texture, manure history, and preceding rainfall can have a significant effect on accumulation of residual N.

A crop rotation that has corn following corn generally provides the greatest potential for significant residual N accumulation. In contrast, when soybean is the previous crop, much less residual N has been measured. This test should not be used following alfalfa.

The soil N test works best on medium and fine-textured soils derived from loess or glacial till. The use of the soil N test on coarse-textured soils derived from glacial outwash is generally not worthwhile because these soils consistently have low amounts of residual nitrate-nitrogen.

The amount of residual nitrate-nitrogen in the soil is also dependent on the rainfall received the previous year. In a year following a widespread drought, 1989 for example, a majority of fields will have significant residual nitrate. However, following relatively wet years, such as

the early 1990s, little residual nitrate can be expected. This soil N testing option, which estimates residual nitrate-nitrogen, will not be appropriate for all conditions. **Figure 2** can be used to help decide which fields may need to be sampled. This flowchart uses such factors as previous crop, manure history, and a knowledge of previous rainfall.

Nitrogen fertilizer guidelines for corn can be made with or without the new soil N test. The University of Minnesota's N guidelines (**Table 1**) are still the starting point. A five-step process is suggested when the soil nitrate-nitrogen test is considered.

1. Determine N rate guideline using **Table 1** using soil productivity, price/value ratio, and previous crop for the specific field. The prescribed rate assumes that best management practices will be followed for the specific conditions.
2. Determine whether conditions are such that residual nitrate-nitrogen may be appreciable. **Figure 2**, which includes factors such as previous crop, manure history, and previous fall rainfall can provide insight as to the applicability of testing for nitrate-nitrogen. If conditions are such that the probability of residual nitrate is small and soil testing for nitrate is not recommended, use the N guideline derived in Step 1.
3. If conditions suggest that a soil nitrate test is warranted, collect a preplant, 0-2 ft. soil sample taking enough soil cores from a field so that the sample is representative of the entire field. The sample should be sent to a laboratory and analyzed for nitrate-nitrogen.
4. Determine residual N credit based on the measured soil nitrate-nitrogen concentrations. Use **Table 7** to determine this credit.
5. Calculate the final N rate by subtracting the residual N credit (Step 4) from the previously determined N guideline (Step 1). The resulting fertilizer N rate can then be applied either preplant and/or as a sidedress application.

This soil nitrate-nitrogen test should not be used when commercial fertilizer was applied in the previous fall. The variability in the degree of N conversion to nitrate-N before spring makes this test meaningless in these situations.

Best Management Practices for Nitrogen

Because of the diversity of soils, climate, and crops in Minnesota, there are no uniform statewide guidelines for selection of a source of fertilizer N, placement of the N fertilizer, and use of a nitrification inhibitor. In order to accurately address this diversity, Minnesota has been

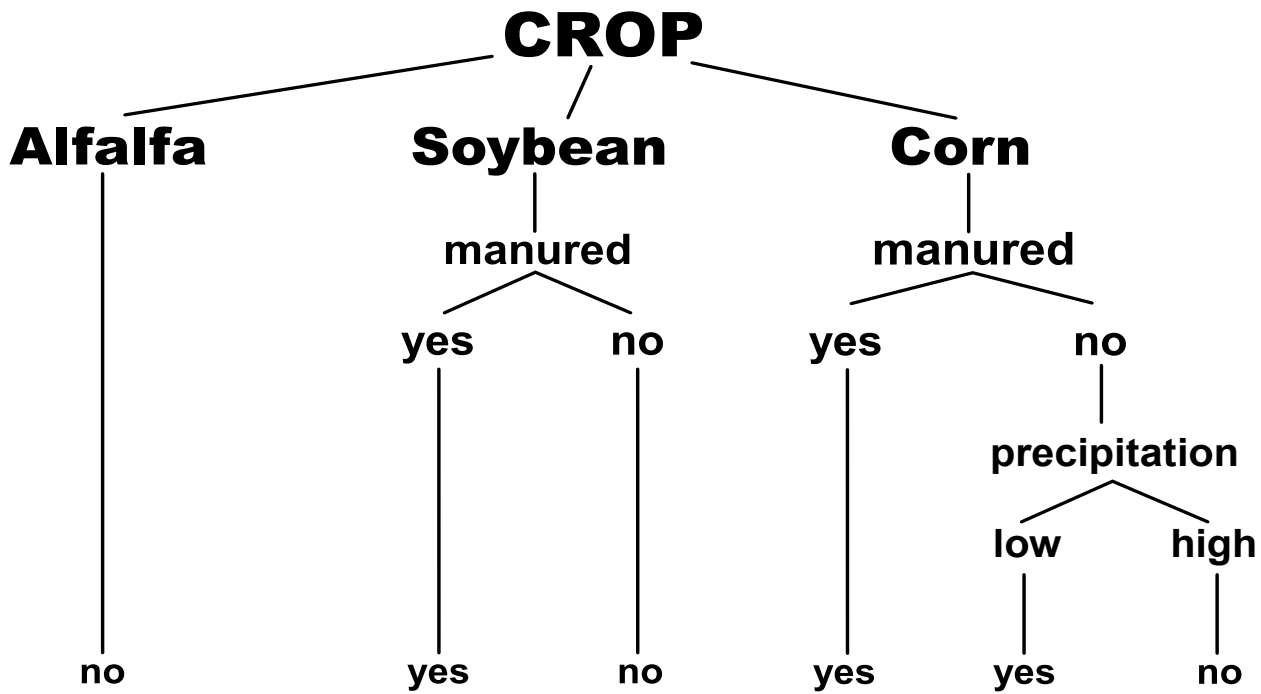


Figure 2. Flow chart decision-aid for determining the probability of having significant residual nitrate-nitrogen in the soil.

divided into five regions and best management practices (BMPs) for N use in each region have been identified and described. The listing of these management practices for all regions is not appropriate for this publication. This information is available at local County Extension Offices.

Currently, the use of these best management practices is voluntary. Corn growers should implement BMPs to optimize N use efficiency, profit, and protect against increased losses of nitrate-nitrogen to groundwater aquifers and surface waters. Time of application, selection of a N source, placement of fertilizer N, and decisions regarding the use of a nitrification inhibitor are topics that are discussed in detail in other Extension publications listed at the end of this folder.

Phosphate and Potash Suggestions

When needed, the use of phosphate and/or potash fertilizer can produce profitable increases in corn yields. The suggestions for phosphate fertilizer use are summarized in **Table 8**. The suggestions for potash fertilizer use are listed in **Table 9**.

Rate Changes with Placement

The phosphate suggestions provided in **Table 8** change with soil test level for phosphorus (P), expected yield, and placement. In general, the results of the Olsen test should be used if the soil pH is 7.4 or higher. There are some situations where the results of the Bray test are higher than the results of the Olsen test when soil pH values are higher than 7.4. For these cases, the amount of phosphate recommended should be based on the soil test value that is the higher of the two.

Measurement of P by the Mehlich III procedure is not recommended in Minnesota. However, some soil testing laboratories analyze P with this analytical test. For these situations, use the recommendations appropriate for the results of the Bray procedure. The definition of categories is the same for both the Bray and Mehlich III analytical procedures.

A combination of band and broadcast applications is suggested if the soil test for P is very low (0-5 ppm for Bray; 0-3 ppm for Olsen). For fields with these very low values, plan on using the suggested band rate in a band at planting, subtract this amount from the suggested broadcast rate, then broadcast and incorporate the remainder before planting. Phosphate fertilizer can be applied as either a broadcast application or in a band fertilizer if the soil test value for P is in the low (6-10 ppm for Bray; 4-7 ppm for Olsen) or medium (11-15 ppm for Bray; 8-11 ppm for Olsen) ranges. For any banded application, use the rates suggested for band use.

Table 7. Residual N credit values based on the concentration of nitrate-N measured before planting in the spring from the top two feet of soil.

Soil nitrate-N	Residual N credit
ppm	lb N per acre
0.0 – 6.0	0
6.1 – 9.0	35
9.1 – 12.0	65
12.1 – 15.0	95
15.1 – 18.0	125
> 18.0	155

Broadcast applications of phosphate fertilizer have a low probability of increasing corn yields when the soil test for P is in the high range (16-20 ppm for Bray; 12-15 ppm for Olsen). The use of phosphate in a banded fertilizer is suggested for these situations. No phosphate fertilizer is suggested for either broadcast or banded application if the soil test is higher than 25 ppm (Bray), or 20 ppm (Olsen), and conventional tillage systems are used.

As with phosphate, the suggested rates of potash vary with the soil test for potassium (K), expected yield, and placement (**Table 9**). A combination of broadcast and band applications is suggested when the soil test for K is in the range of 0-40 ppm. For fields with these values, plan on using the suggested rate in the band at planting, subtract this amount from the suggested broadcast rate, then broadcast and incorporate the remainder needed before planting. The grower has the choice of either broadcast or band placement if the soil test for K is in the low (41-80 ppm) or medium (81-120 ppm) range. The application of potash in a band is emphasized if the soil test for K is in the high range (121-160 ppm).

There is a low probability of response to broadcast applications of potash if the soil test for K is higher than 160 ppm. No potash will be needed in either broadcast or a band application if the soil test for K is 175 ppm or higher, and conventional tillage systems are used.

Special Considerations

Because of the diversity in Minnesota's soils and climate, rental and lease arrangements for land, and goals of individual growers, the phosphate and potash suggestions listed in **Tables 8** and **9** cannot be rigid across the entire state. There are some special situations where rates might be changed. Some, but not all, of these situations are described in the following paragraphs.

East Central Minnesota Soils in this region of the state usually have high native levels of soil test P and strict interpretation of the guidelines suggests that no phosphate is needed in a fertilizer program. Yet, many have observed responses to phosphate when applied in a band at planting. Soils in this region are frequently cool and wet in the spring and these conditions can lead to a requirement for phosphate fertilizer early in the growing season. Therefore, a rate of 15-20 lb phosphate per acre is suggested for use in a banded fertilizer placed close to the seed at planting for corn production in these situations, regardless of soil test level for P.

Broadcasting Low Rates Some of the suggestions for phosphate and potash use listed in **Tables 8** and **9** are small and fertilizer spreaders cannot be adjusted to apply these low rates. In some situations, the suggested broadcast rate of phosphate can be blended with the suggested broadcast rate of potash and the mixture could then be applied with available equipment.

In other situations, broadcast applications of low rates of only phosphate or potash may be suggested. For these fields, it may be more practical to double the suggested broadcast rate and apply on alternate years.

Changes in Soil Test Values Many growers would prefer to maintain soil test values for P and K in the medium to high range. This is especially true if they own, rather than rent, the land. There is justified concern that soil test levels for either P or K will drop substantially if low rates of phosphate or potash fertilizers are applied year after year.

Research in Minnesota has shown that soil test levels for these two nutrients do not change rapidly with time. Yearly decreases have been small for situations where no phosphate or potash fertilizer has been applied.

Table 8. Phosphate suggestions for corn production in Minnesota.*

		Soil test P (ppm)									
		v. low		low		medium		high		v. high	
Expected	Bray:	0-5		6-10		11-15		16-20		21+	
Yield	Olsen:	0-3		4-7		8-11		12-15		16+	
		Bdcst	Band	Bdcst	Band	Bdcst	Band	Bdcst	Band	Bdcst	Band
bu/acre		----- P ₂ O ₅ per acre to apply (lb per acre) -----									
< 100		60	30	40	20	25	20	10	10-15	0	10-15
100 – 124		75	40	50	25	30	20	10	10-15	0	10-15
125 – 149		85	45	60	30	35	25	10	10-15	0	10-15
150 – 174		100	50	70	35	40	30	15	10-15	0	10-15
175 – 199		110	55	75	40	45	30	15	10-15	0	10-15
200 +		120	60	85	45	50	35	15	10-15	0	10-15

* Use one of the following equations if a P₂O₅ recommendation for a specific soil test value and a specific expected yield is desired.

$$P_{2O_5Rec} = [0.700 - .035 (\text{Bray P ppm})] (\text{expected yield})$$

$$P_{2O_5Rec} = [0.700 - (.044 (\text{Olsen P ppm}))] (\text{expected yield})$$

No phosphate fertilizer is recommended if the soil test for P is higher than 25 ppm (Bray) or 20 ppm (Olsen).

Table 9. Potash suggestions for corn production in Minnesota.*

	Soil test K (ppm)									
	v. low		low		medium		high		v. high	
Expected	0-40		41-80		81-120		121-160		160+	
Yield	Bdcst	Band	Bdcst	Band	Bdcst	Band	Bdcst	Band	Bdcst	Band
bu/acre	----- K ₂ O per acre to apply (lb per acre) -----									
< 100	100	50	75	40	45	30	15	10-15	0	10-15
100 – 124	120	60	90	45	50	30	20	10-15	0	10-15
125 - 149	145	75	105	55	60	40	20	10-15	0	10-15
150 - 174	165	85	120	60	70	40	25	10-15	0	10-15
175 - 199	185	90	135	70	80	50	25	10-15	0	10-15
200 +	205	105	160	80	90	55	30	10-15	0	10-15

* Use one of the following equations if a K₂O recommendation for a specific soil test value and a specific expected yield is desired.
 $K_2O_{Rec} = [1.166 - .0073 (\text{Soil Test K, ppm})] (\text{expected yield})$
 No potash fertilizer is recommended if the soil test for K is 175 ppm or higher.

A small decrease in soil test levels for P and K can be expected when phosphate and potash are used repeatedly in a banded fertilizer. Likewise, some reduction can be expected when low rates of phosphate and potash are used year after year. When soil test values drop, broadcast applications of higher rates of phosphate and/or potash fertilizers are justified if profitability and cash flow is favorable and the grower wants to maintain soil test values in the medium or high range.

Unless long-term leases or rental arrangements are used, the use of a banded placement for phosphate and/or potash may be the most profitable management system for rented land. It is difficult to economically justify the use of high rates of phosphate and/or potash to build soil test levels on rented acres.

Adjusting for Manure Use

The plant nutrients used in a fertilizer program for corn should be reduced if manure is used. The nutrient value of manure, however, varies with type of livestock, handling system, and method of application. Old rules of thumb are no longer appropriate when calculating the nutrient value of manure. Manure nutrient credits should be subtracted from the fertilizer guideline. There are several extension publications that describe in detail the use of manure. These publications are listed at the end of this folder.

Using a Banded Fertilizer

The use of a banded fertilizer at planting is an excellent management tool for corn production in Minnesota especially when soil conditions are cold and wet at planting. Yield increases are not always guaranteed with the use of a starter when soil test values are in the very high range. More recent research shows frequent responses to banded fertilizer when soil test values for P and/or K are in the high range and yield potential is high. The use of this management practice, however, can be considered to be a good insurance policy.

The rate of fertilizer that can be applied in a band below and to the side of the seed at planting varies with the nutrient used, the distance between seed and fertilizer, and soil texture. See Use of Banded Fertilizer for Corn Production (FO-74250) for more information.

CAUTION! Do not apply urea, ammonium thiosulfate (12-0-0-26) or fertilizer containing boron in contact with the seed.

Sulfur Use

The addition of sulfur (S) to a fertilizer program should be a major consideration when corn is grown on sandy soils.

The use of a soil test for sulfur is not a reliable predictor of the need for sulfur in a fertilizer program. Soil texture is a reliable predictor. If the soil texture is a loamy sand or sandy loam, either apply 12 to 15 lb S per acre in a banded fertilizer or broadcast and incorporate 25 lb S per acre before planting. Keep in mind that ammonium thiosulfate should not be placed in contact with the seed. This material will not harm germination or emergence if there is 1 inch of soil between seed and fertilizer.

There are several materials that can be used to supply S. Any fertilizer that supplies S in the sulfate (SO₄²⁻-S) form is preferred. Because the greatest need for S occurs early in the growing season, application of any needed S in a starter fertilizer is preferred.

Magnesium Needs

Most Minnesota soils are well supplied with magnesium (Mg) and this nutrient is not usually needed in a fertilizer program. There are some exceptions. The very acid soils of east-central Minnesota might need Mg. There should be no need for the addition of Mg if dolomitic limestone has been applied for legume crops in the rotation. There is a soil test that can be used to predict the need for this nutrient. The suggestions for using Mg in a fertilizer program are summarized in **Table 10**.

Table 10. Suggestions for magnesium use for corn production.

Magnesium soil test ppm	Relative level	Mg to apply	
		Broadcast ----- lb per acre -----	Band
0 – 50	Low	50 - 100	10 - 20
51 – 100	Medium	0	Trial *
101 +	Adequate	0	0

* Apply 10 - 20 lb. Mg per acre in a band only if a Mg deficiency is suspected or if a deficiency has been confirmed by plant analysis.

Micronutrient Needs

Research trials conducted throughout Minnesota indicate that zinc (Zn) is the only micronutrient that may be needed in a fertilizer program for the corn crop. This nutrient, however, is not needed on all fields. The soil test for Zn is very reliable and will accurately predict the needs for this essential nutrient. The suggestions for Zn are summarized in **Table 11**.

Because corn is the only agronomic crop that will consistently respond to Zn fertilization, the use of Zn in a

banded fertilizer is highly recommended. However, carryover to succeeding years will be better with broadcast applications. There are several fertilizer products that can be used to supply Zn. Except for large particles of zinc oxide, all are equally effective. Cost should be a major consideration in product selection.

The use of iron (Fe), copper (Cu), manganese (Mn), and boron (B) is not suggested for corn fertilizer programs in Minnesota.

Table 11. Zinc suggestions for corn production in Minnesota.

Zinc soil test* - ppm -	Zinc to apply	
	Broadcast ----- lb per acre -----	Band
0.0 – 0.25	10	2
0.26 – 0.50	10	2
0.50 – 0.75	5	1
0.76 – 1.00	0	0
1.01 +	0	0

* Zinc extracted by the DTPA procedure.

Related Publications

Check your local University of Minnesota County Extension Office or www.soils.umn.edu/extension/extension_publications.php for these publications that may provide more details on management practices related to fertilizer use for corn production.

- FO-0636 *Fertilizer Urea*
 - FO-0720 *Zinc for Crop Production*
 - FO-0725 *Magnesium for Crop Production in Minnesota*
 - FO-0792 *Understanding Phosphorus in Minnesota Soils*
 - FO-0794 *Sulfur for Minnesota Soils*
 - FO-2392 *Managing Nitrogen for Corn Production on Irrigated Sandy Soils*
 - FO-3073 *Using Anhydrous Ammonia in Minnesota*
 - FO-3769 *Providing Proper N Credit for Legumes*
 - FO-3770 *Understanding Nitrogen in Soils*
 - FO-3774 *Nitrification Inhibitors and Use in Minnesota*
 - FO-5879 *Fertilizing Cropland with Swine Manure*
 - FO-5880 *Fertilizing Cropland with Dairy Manure*
 - FO-5881 *Fertilizing Cropland with Poultry Manure*
 - FO-5882 *Fertilizing Cropland with Beef Manure*
 - FO-7425 *Use of Banded Fertilizer for Corn Production*
 - FO-6074-B *Fertilizer Management for Corn Planted in Ridge-Till or No-Till Systems*
- Corn Nitrogen Rate Calculator: <http://extension.agron.iastate.edu/soilfertility/nrate.aspx>

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