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Corn

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Farmers in Nebraska grow more corn than any other row crop. In 1997, Nebraska farmers produced 1.152 billion bushels of corn, which ranked Nebraska third in the nation in corn production. The average Nebraska corn yield in 1997 was 132 bushels per acre; Nebraska producers harvested an average of 151 bushels per acre from irrigated fields and 98 bushels per acre from non-irrigated fields. Nebraska producers harvested approximately 8.7 million acres of corn in 1997: 5.6 million irrigated acres and 3.1 million dryland acres. The five Nebraska counties having the largest corn harvest in 1997 were Phelps, York, Hamilton, Dawson and Kearney.

In 1996 Nebraska corn producers applied a per-acre average of 142 pounds of nitrogen (N), 34 pounds of phosphate (P_2O_5), and 22 pounds of potassium (K_2O) fertilizers. This compares to average 1984 rates of 156 pounds of nitrogen, 41 pounds of phosphate, and 25 pounds of potassium oxide per acre. This trend suggests that Nebraska farmers have become increasingly efficient in how they use fertilizers, with the average yield in 1984 at 117 bushels per acre compared to 143 bushels per acre in 1996.

Nitrogen and phosphorus (P) are the primary nutrients corn needs for optimum yield in Nebraska. Soil potassium (K) levels low enough to expect yield increases from potassium fertilization are relatively rare in the state. Other nutrients which may be limiting in soil and require fertilization for corn are sulfur (S), zinc (Zn), and occasionally iron (Fe).

Nitrogen

The producer should determine the amount of nitrogen fertilizer necessary for corn after accurately accounting for sources of nitrogen already available to the crop, such as mineralization from soil organic matter, residual soil nitrate, organic resources, previous legume crops, and irrigation water. The University of Nebraska (UNL) nitrogen recommendation equation for corn incorporates credit for organic matter and residual soil nitrate. One should credit other sources of nitrogen to derive the recommended fertilizer nitrogen rate.

The following equations are for the UNL recommended nitrogen rates for corn grain and silage respectively, where OM stands for organic matter content (%), NO_3-N is the average nitrate-nitrogen concentration (ppm) in the root zone at 0 - 2 to 0 - 4 feet, and EY stands for expected yield, either in bushels per acre (grain) or tons per acre (silage).

$$\text{Corn Grain N Rate (lb/acre)} = 35+(1.2\text{xEY})-(8\text{xNO}_3\text{-N ppm}) \\ -(0.14\text{xEYxOM}) - \text{other credits}$$

EQUATIONS 10-1 AND 10-2

University of Nebraska nitrogen rate equations for corn grain and silage respectively.

$$\text{Corn Silage N Rate (lb/acre)} = 35+(7.5\text{x}EY)-(8\text{x}NO_3\text{-N ppm}) -(0.85\text{x}EY\text{x}OM) - \text{other credits}$$

The producer should base the expected yield on the previous five years' yields, minus any atypical yields (significantly influenced by hail, wind damage, etc.), plus 5%. Table 10-1 provides nitrogen recommendations at three organic matter levels, with various soil residual nitrate and expected yield levels, once credits from other sources have been allowed.

The producer should base residual soil nitrate values on soil samples collected to a depth of at least two feet, and preferably three to four feet—the deeper the sample, the more accurate the estimate of soil residual nitrate-nitrogen credit. One should collect soil samples for residual nitrate-nitrogen according to procedures in Chapter 9 and in the NebGuide G91-1000, *Guidelines for Soil Sampling*.

The Pre-sidedress Nitrate Test (PSNT), developed in Vermont and Iowa, has not been fully calibrated for Nebraska conditions. The test relies on soil samples taken from the top one to two feet of the root zone when corn plants are six to twelve inches tall. The test provides an estimate of plant available nitrogen that has been mineralized during the spring. Although research on the application of the test to Nebraska soils is not complete, the test may be useful for producers desiring to fine-tune their nitrogen management, particularly in eastern Nebraska. For more information on PSNT sampling and interpretation, see the Iowa State University publication PM-1714, *Nitrogen Fertilizer Recommendations for Corn in Iowa.*

■ *Nitrogen Credits*

The farmer should estimate sources of nitrogen credit as carefully as possible in order to avoid over or under fertilization of the crop. The legume credits in Table 10-2 are conservative—typically the evident nitrogen credit to legumes will be greater than those shown. One cannot determine legume credits from a soil test because the credits reflect nitrogen that will be mineralized (or not immobilized) due to high nitrogen content legume residues in the following crop year. The producer can more accurately determine credits from irrigation water and organic resources by analyzing representative samples. The farmer should base irrigation water credits (Table 10-3) on a nitrate analysis of the irrigation water the preceding year. These irrigation water credits are also conservative, in that they do not reflect the normal total amount of irrigation water applied during the season, but only that irrigation water amount from which nitrogen is effectively used. Table 10-4 provides generalized, conservative nitrogen credits from a variety of organic resources. Whenever possible, the producer should have organic resources analyzed to more accurately determine the nitrogen credit. Additional information and guidance on nitrogen credits is available in the NebGuide G94-1178, *Fertilizer Nitrogen Best Management Practices*, and the UNL extension circular EC97-147-S, *Nitrogen Rate Slide Chart*.

TABLE 10-1

Nitrogen fertilizer recommendations for corn based on expected yield with adjustments for soil nitrate-nitrogen and soil organic matter.

Nitrogen Soil Test	**Relative Level**	**Expected Yield (Bu/Acre)**									
		60	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**
ppm		*pounds of N to apply per acre*									
		3% soil organic matter									
3	Low	60	75	90	105	120	135	150	165	185	200
6	Low	35	50	65	80	95	110	125	145	160	175
9	Medium	0	25	40	55	70	90	105	120	135	150
12	Medium		0	15	35	50	65	80	95	110	125
15	High			0	0	25	40	55	70	85	100
18	High					0	15	30	45	65	80
21	High						0	0	25	40	55
24	Very high								0	15	30
27	Very high									0	0
		2% soil organic matter									
3	Low	65	85	105	120	140	160	175	195	215	230
6	Low	40	60	80	95	115	135	155	170	190	210
9	Medium	20	35	55	75	90	110	130	145	165	185
12	Medium	0	15	30	50	70	85	105	125	140	160
15	High		0	0	25	45	60	80	100	115	135
18	High				0	20	40	55	75	95	110
21	High					0	15	35	50	70	90
24	Very high						0	0	25	45	65
27	Very high								0	20	40
		1% soil organic matter									
3	Low	75	95	115	140	160	180	200	225	245	265
6	Low	50	70	95	115	135	155	180	200	220	240
9	Medium	25	50	70	90	110	135	155	175	195	215
12	Medium	0	25	45	65	85	110	130	150	170	195
15	High		0	20	40	65	85	105	125	150	170
18	High			0	20	40	60	80	105	125	145
21	High				0	15	35	60	80	100	120
24	Very high					0	15	35	55	75	95
27	Very high						0	0	30	50	75
33	Very high									0	25
36	Very high										0

Without a soil test for nitrate-N, assume 3 ppm; without a soil test for organic matter, assume 2%

TABLE 10-2

Estimated apparent nitrogen contributions from legumes.

Legume Crop	Nitrogen Fertilizer Reduction	
	Medium/Fine Textured Soils	*Sandy Soils*
	pounds per acre	
Soybean	45	45
Alfalfa (70 to 100% stand. > 4 plants/ft^2)	150	100
Alfalfa (30 to 69% stand, 1.5 to 4 plants/ft^2)	120	70
Alfalfa (0 to 29% stand, <1.5 plants/ft^2)	90	40
Sweet and red clover	80% of credit allowed for alfalfa	

Credits for legumes are based on the Universiety of Wisconsin recommendations.

TABLE 10-3

Nitrogen contributions from irrigation water.

Area of State	Net Irrigation	Irrigation Water Nitrate-N (ppm)						
		10	**15**	**20**	**25**	**30**	**35**	**40**
	inches	*pounds per acre*						
East	6	14	20	27	34	41	48	54
Central	9	20	30	41	51	61	71	82
West	12	27	41	54	68	81	95	108
Panhandle	15	34	51	68	85	102	118	135

TABLE 10-4

Estimated nitrogen contributions from manures and other waste materials for the first crop after application.

Dry Materials	Pounds of N/Ton	Liquid Materials	Pounds of N/1000 Gallons
Beef feedlot manure	4 to 5	Swine, liquid pit	10 to 15
Dairy manure	3	Swine, lagoon	2 to 5
Sheep manure	5	Beef, liquid pit	10 to 12
Poultry manure	12 to 7	Beef, lagoon	1 to 2
Composted beef feedlot manure	10 to 14	Dairy, liquid pit	7 to 8
		Dairy, lagoon	1 to 2
Sewage sludge	2 to 3	Cheese whey	1 to 2
Horse manure	3		

Phosphorus

Research at the University of Nebraska and other Midwestern universities has shown that significant yield increases due to phosphorus fertilization of corn are unlikely above a Bray-1 P soil test of 15 ppm. Table 10-5 reflects these findings. However, recent research investigating the spatial variability of nutrients in fields has shown that soil phosphorus levels are highly variable. Often phosphorus levels and distribution patterns in fields are influenced substantially by livestock manures. High concentrations of phosphorus are found near current or abandoned livestock confinement areas. These high levels can persist for many years after livestock are gone. In many cases, producers currently farming the land are unaware of past livestock confinement areas. If random soil sampling to determine average fertility levels includes samples collected where manures have been stockpiled or heavily applied, the phosphorus test from a composite soil sample will be higher than the rest of the field, and may result in the producer under-fertilizing a significant portion of the field. If the farmer is aware of past livestock confinement areas, or if he suspects their presence, he should exclude those areas from composite sampling and sample them separately.

The producer should base phosphorus fertilizer needs for corn on phosphorus soil test levels and the method of fertilizer phosphorus application as shown in Table 10-5. The efficiency with which corn uses phosphorus is generally low—the crop often takes up only 10% to 20% of the applied phosphorus fertilizer. The producer can improve plant-phosphorus use efficiency—by reducing soil-fertilizer contact, and by concentrating phosphorus near plant roots—by banding phosphorus fertilizer, either in preplant bands or at planting (starter). The increased efficiency of banded phosphorus fertilizer is reflected in lower recommended rates for band application as shown in Table 10-5.

TABLE 10-5

Phosphorus fertilizer recommendations for corn.

Phosphorus Soil Test		**Relative Level**	**P_2O_5 to Apply**	
*Bray-1 P**	*Olsen P**		*Broadcast*	*Band***
ppm			*pounds per acre*	
0 to 5	0 to 3	Very low (vl)	80	40
6 to 15	4 to 10	Low (l)	40	20
16 to 24	11 to 16	Medium (m)	0	†
25 to 30	17 to 20	High (h)	0	†
>30	>20	Very high (vh)	0	0

*Phosphorus tests: Bray-1 P for acid and neutral soils; Olsen P for calcerous soils (pH 7.3 or greater).

** Applied in a band preplant or beside the row at planting.

†Applying 10 to 20 pounds per acre P_2O_5 with 5 to 10 pounds per acre N in a band at planting may increase early growth on these soils. See NebGuide G77-361, Using Starter Fertilizers for Corn, Grain Sorghum and Soybeans.

Potassium

Most soils in Nebraska contain adequate amounts of potassium for maximum corn yields. For those soils low in potassium, the producer should apply potassium fertilizer according to the guidelines in Table 10-6.

Table 10-6

Potassium fertilizer recommendations for corn.

Potassium Soil Test*	Relative Level	K_2O to Apply		
		Broadcast		*Band***
		pounds per acre		
0 to 40	Very low (vl)	120	+	20
41 to 74	Low (l)	80	+	10
75 to 124	Medium (m)	40	or	10
125 to 150	High (h)	0		0
>150	Very high (vh)	0		0

* Potassium test: exchangeable K.
** Banded beside the seed row, but not with the seed.

Sulfur

Nebraska corn crops generally only need sulfur on low organic matter, sandy soils. Guidelines for sulfur fertilizer needs for corn are given in Table 10-7. Most irrigation water, except in the very sandy area of north central Nebraska, contains enough sulfur to supply the sulfur requirement of corn. In these regions, therefore, applying fertilizer containing sulfur in a band at planting time on sandy soils is an effective method and the most efficient method to supply corn's early sulfur needs.

Table 10-7

Sulfur fertilizer recommendations for corn on sandy soils.

Sulfur Soil Test*	S to Apply Annually (> 1% Organic Matter)	
ppm	*pounds per acre*	
	<=6 ppm in irrigation water	
<6	10 row‡ or 20 broadcast	5 row
60 to 8	5 row or 10 broadcast	0
>8	0	0
	>6 ppm in irrigation water	
<8	5 row‡ or 10 broadcast	0
>8	0	0

* Sulfur test: $Ca(H_2PO_4)_2$ extraction.
‡ Banded beside the seed row, but not with the seed.

Zinc

The producer can best determine zinc fertilizer requirements with a soil test for zinc. Table 10-8 gives the recommended rates of zinc to apply according to the soil zinc level and excess lime content of the soil. Recommended broadcast rates are for raising soil zinc content to a level that is adequate for several years. Row treatment rates are for annual application.

TABLE 10-8

Zinc fertilizer recommendations for corn.

DTPA-Zn	**Relative Level**	**Zn to Apply**	
		Calcareous Soils	*Non-calcareous Soils*
ppm		*pounds per acre*	
0 to 0.4	Low	2 row or 10 broadcast	2 row or 5 broadcast
0.41 to 0.8	Medium	1 row or 5 broadcast	1 row or 3 broadcast
>0.8	High	0	0

Iron

Symptoms of iron chlorosis, consisting of yellow striping on corn leaves, may occur when soils are highly calcareous or saline-sodic with pH levels above 7.8. Because of the nature of such soils, correcting an iron deficiency is difficult.

In such a case, the producer should select corn hybrids that have tolerance to these soil conditions. Corn hybrids vary greatly in tolerance to chlorosis. This genetic tolerance to chlorosis may be adequate. If not, the producer may have to apply iron materials to the soil.

Current research has shown that the most effective treatment for correcting high pH chlorosis in corn is an at-planting seed-row application of 50 to 150 pounds of ferrous sulfate heptahydrate ($FeSO_4•7H_2O$) per acre. This is an economical treatment, but it does require dry fertilizer application equipment on the planter.

Another way to combat iron chlorosis is for the producer to apply a stable dry iron chelate (FeEDDHA), dissolved in water, with the seed. This method may be preferable if the producer has liquid fertilizer application equipment. Research has shown that at least 2.5 to 4 pounds of FeEDDHA per acre is necessary. Chlorosis correction from FeEDDHA has not equaled that of $FeSO_4•7H_2O$ in research at North Platte and the chelate is expensive ($30 to $50 per acre). The FeEDDHA works well for correcting soybean chlorosis on high pH soils, but not on corn because of iron uptake chemistry differences between grasses and legumes.

The producer can use foliar sprays using ferrous sulfate or FeEDDHA, but they are not always effective in producing significant yield responses. Failure to correct chlorosis with foliar treatment is often due to late application. The farmer must treat as soon as chlorosis first becomes visible and he must usually treat several times. The producer should repeat such treatment every seven to ten days until newly emerged leaves remain green and he must spray directly over the row in order for the treatment to be effective. A standard application is 20 gallons per acre of a 1% solution.

To develop a 1% solution of iron sulfate, the producer should add 8 pounds of $FeSO_4$ or 15 pounds of $FeSO_4 \cdot 7H_2O$ to 100 gallons of water. Using an iron sulfate concentration greater than 1.5 % usually results in excessive leaf burning.

Rather than using iron sulfate, the producer may opt to use an iron chelate; he should carefully follow the directions on the product container. Adding a commercial wetting agent or a cup of mild detergent to each 100 gallons will improve plant coverage. The addition of 25 pounds of feed grade urea or 5 gallons of 28-0-0 UAN fertilizer per 100 gallons of spray solution also enhances iron uptake.

Nutrient Removal and Sufficiency Ranges

Table 10-8 illustrates nutrient uptake of the nutrients most often applied as fertilizers in Nebraska for a typical yield of corn. Because of the nutrient supply in organic matter and clay minerals, most Nebraska soils can adequately meet crop requirements of potassium and sulfur for many years without supplemental fertilization. The sufficiency ranges for nutrients shown in Table 10-8 reflect nutrient levels in plants capable of optimum yield. Levels of nutrients in plant tissue can be influenced by hybrid and climate. Nutrient levels below those shown are likely to result in a yield limiting deficiency, and may be reflected in the appearance of the crop. Nutrient levels significantly above those shown may reflect over-fertilization and luxury uptake, but yield limiting toxicities of these nutrients are unlikely.

TABLE 10-9

Corn nutrient requirements (150 bushels per acre grain yield, 9000 pounds per acre stover yield).

Nutrient	Removed in Grain	Remaining in Stover	Total Uptake
	pounds per acre		
N	135	100	235
P_2O_5	64	36	100
K_2O	42	144	186
S	14	11	25
Zn	0.15	0.3	0.45

Nutrient	Sufficiency Ranges	
	Whole Plant, 3 to 4 Leaf Stage	Ear Leaf at Silk
	percent	
N	3.5 to 5.0	2.7 to 3.5
P	0.4 to 0.8	0.2 to 0.4
K	3.5 to 5.0	1.7 to 2.5
S	0.2 to 0.3	0.1 to 0.2
Zn	20 to 50 ppm	20 to 70 ppm

Source:
1. Franzen, D. and J. Gerwing, 1997. Effectiveness of Using Low Rates of Plant Nutrients. North Central Regional Publication 341. University of Nebraska, Lincoln, NE.
2. Voss, R.D. 1993. Corn. In W.F. Bennett (ed.) Nutrient Deficiencies and Toxicities in Crop Plants. Am. Phytopathological Societ, St. Paul. MN.

Resources

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3. Hergert, G.W., R.B. Ferguson, and C.A. Shapiro. 1995. Fertilizer Suggestions for Corn. NebGuide G74-174A. University of Nebraska, Cooperative Extension, Lincoln, NE.

4. Penas, E.J., and G.W. Hergert. 1977. Using Starter Fertilizers for Corn, Grain Sorghum and Soybeans. NebGuide G77-361. University of Nebraska, Cooperative Extension, Lincoln, NE.

5. Peterson, T.A., T.M. Blackmer, D.D. Francis, and J.S. Schepers. 1993. Using a Chlorophyll Meter to Improve N Management. NebGuide G93-1171A. University of Nebraska, Cooperative Extension, Lincoln, NE.

6. Ritchie, S.W., J.J. Hanway, and G.O. Benson. How a Corn Plant Develops. Special Report No. 48, Iowa State University.

7. Shapiro, C.A. 1997. Nitrogen Rate Slide Chart. EC97-145S. University of Nebraska, Cooperative Extension, Lincoln, NE.