University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

Historical Materials from University of Nebraska-Lincoln Extension

Extension

1974

G74-174 Fertilizer Suggestions For Corn (Revised November 2003)

Charles A. Shapiro
University of Nebraska-Lincoln, cshapiro1@unl.edu

Richard B. Ferguson
University of Nebraska - Lincoln, rferguson1@unl.edu

Achim R. Dobermann
University of Nebraska - Lincoln

Charles S. Wortmann
University of Nebraska - Lincoln, cwortmann2@unl.edu

Follow this and additional works at: https://digitalcommons.unl.edu/extensionhist

Part of the Agriculture Commons, and the Curriculum and Instruction Commons

Shapiro, Charles A.; Ferguson, Richard B.; Dobermann, Achim R.; and Wortmann, Charles S., "G74-174 Fertilizer Suggestions For Corn (Revised November 2003)" (1974). *Historical Materials from University of Nebraska-Lincoln Extension*. 1670.
https://digitalcommons.unl.edu/extensionhist/1670

This Article is brought to you for free and open access by the Extension at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Historical Materials from University of Nebraska-Lincoln Extension by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

Nebraska University of Lincoln

NebGuide

IANR

Published by Cooperative Extension, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln

G74-174-A
(Revised November 2003)

Fertilizer Suggestions For Corn

Charles A. Shapiro, Richard B. Ferguson, Gary W. Hergert, Achim R. Dobermann and Charles S. Wortmann, Extension Soils Specialists

Fertilizer nutrient requirements for corn are based on expected yield and nutrient levels in the soil.

Nutrient Needs

Crop production in Nebraska typically requires applying nitrogen to supplement that available in the soil. Phosphorus is the second most likely nutrient to be deficient in the soil for good corn yields. For corn after corn, annually test for residual nitrate in the soil profile in spring (0-4 ft) to fine-tune your nitrogen recommendation. This is not needed for corn grown after soybean. To determine phosphorus, potassium and micronutrient needs and the level of soil organic matter, collect soil samples from a depth of 0 to 8 inches every three to five years in the fall. Generally the soil can supply adequate amounts of potassium, sulfur, zinc, and iron, but on some soils the corn crop will benefit from applying one or more of these nutrients. Calcium, magnesium, boron, chlorine, copper, manganese, and molybdenum are seldom, if ever, deficient for corn production in Nebraska.

Nitrogen Requirement

Estimates of nitrogen needed for corn are based on expected yield, the amount of residual soil nitrate-nitrogen (NO_3-N) and soil organic matter. *Table II* illustrates the University of Nebraska nitrogen recommendation using the following algorithm (equation):

$$\text{Nitrogen Need (lb/ac)} = 35 + (1.2 \times EY) - (8 \times NO_3\text{-N ppm}) - (0.14 \times EY \times OM) - \text{other N credits}$$

where EY = expected yield (bu/ac),
NO_3-N ppm = average nitrate-nitrogen concentration in the root zone (2-4 ft depth) in parts per million,
and OM = percent organic matter.
Other N credits include nitrogen from legumes, manure and other organic materials, and from irrigation water.

The expected yield should be about 105 percent of the five-year yield average. A higher yield goal may be appropriate if management improvements are expected to result in increased yield.

The algorithm for nitrogen recommendations for corn silage is:

$$\text{Nitrogen Need (lb/ac)} = 35 + (7.5 \times EY_S) - (8 \times NO_3\text{-N ppm}) - (0.85 \times EY_S \times OM) - \text{other N credits}$$

where EY_S = expected silage yield in tons per acre and NO_3-N, OM and N credits are the same as those listed previously.

Optimal nitrogen rates are relatively insensitive to normal fluctuations in fertilizer and corn prices; however, in years with a large change in the relative price of nitrogen to corn, the recommended nitrogen rate obtained from the UNL nitrogen algorithm or *Table II* may be changed slightly. Nitrogen recommendations in the standard UNL algorithm are suitable for situations when the value of one bushel of corn can purchase 9 to 16 pounds of actual nitrogen. If the value of a bushel of corn buys fewer than 9 pounds of nitrogen, reduce the nitrogen rate by 15 percent of the recommended nitrogen rate. If the value of one bushel buys more than 16 pounds of nitrogen, increase the nitrogen rate by 10 percent of the recommended nitrogen rate.

Nitrogen Adjustment for Soil Nitrate-Nitrogen

A corn crop will use soil nitrate-nitrogen remaining in the rooting zone from the previous year so the calculated nitrogen recommendation should be adjusted accordingly. The average nitrate-nitrogen concentration in the root zone (or the depth-weighted concentration) is determined from nitrate-nitrogen concentration in samples collected at several depths as illustrated in *Table I*. Soil nitrate-nitrogen can be estimated by sampling soils to a minimum depth of two feet, but can be better estimated from samples collected to a 3- or 4-foot depth. See NebGuide 91-1000, *Guidelines for Soil Sampling* (http://www.ianr.unl.edu/pubs/soil/g1000.htm), and Extension Circular EC 00-154, *Soil Sampling for Precision Agriculture*. For every ppm of average nitrate-nitrogen concentration to a 4-foot depth, the recommended nitrogen need is reduced by eight pounds per acre. When soil test results for nitrate-nitrogen are not available, a value of 3 ppm is used to calculate the nitrogen recommendation. To avoid over-crediting soil nitrate when shallower soil samples are taken, 3 ppm can be used for the unsampled depths.

Table I. Typical soil nitrate-nitrogen amounts at various depths.

Soil Layer, inches	*Thickness, inches*	*Nitrate-Nitrogen, ppm*	*Calculations for soil layer*	
0-8	8	15	8 x 15 =	120
8-24	16	10	16 x 10 =	160
24-48	24	3	24 x 3 =	72
Total				352
average ppm	352/48			7.3

Table II. Nitrogen fertilizer recommendations based on expected yield with adjustments for soil nitrate-nitrogen (NO_3-N) and soil organic matter.

Soil Test ppm NO_3-N	*Relative Level*	*Expected Yield, bu/ac* 60	80	100	120	140	160	180	200	220	240
		---N, pounds per acre, to apply---									
						Soil Organic Matter, 3%					
1	Very Low	75	90	105	121	135	150	170	180	200	215
3	Low	60	75	90	105	120	135	150	165	185	200
6		35	50	65	80	95	110	125	145	160	175
9	Medium	0	25	40	55	70	90	105	120	135	150
12			0	15	35	50	65	80	95	110	125
15	High			0	0	25	40	55	70	85	100
18						0	15	30	45	65	80
21							0	0	25	40	55
24	Very High								0	15	30
						Soil Organic Matter, 2%					
1	Very Low	80	100	120	140	155	175	190	210	230	250
3	Low	65	85	105	120	140	160	175	195	215	230
6		40	60	80	95	115	135	155	170	190	210
9	Medium	20	35	55	75	90	110	130	145	165	185
12		0	15	30	50	70	85	105	125	140	160
15	High		0	0	25	45	60	80	100	115	135
18					0	20	40	55	75	95	110
21						0	15	35	50	70	90
24	Very High						0	0	25	45	65
27									0	20	40
						Soil Organic Matter, 1%					
1	Very Low	90	110	120	155	175	200	220	240	260	280
3	Low	75	95	115	140	160	180	200	225	245	265
6		50	70	95	115	135	155	180	200	220	240
9	Medium	25	50	70	90	110	135	155	175	195	215
12		0	25	45	65	85	110	130	150	170	195
15	High		0	20	40	65	85	105	125	150	170
18				0	20	40	60	80	105	125	145
21					0	15	35	60	80	100	120
24	Very High					0	15	35	55	75	95
27							0	0	30	50	75

Algorithm—derived from field research at or below yield levels of 200 bushels per acre.
Note: Without a soil test for nitrate-nitrogen, assume 3 ppm; for organic matter, assume 1 percent for sands and Panhandle soils, and 2 percent for the rest of Nebraska.

If root growth is restricted to less than 2 feet due to a high water table, a hardpan, or a layer of gravel, rock or shale, residual nitrate is estimated for the effective rooting depth only rather than for the 4-foot depth. When root zone is less than 2 feet, use zero ppm nitrate for the depth without soil to determine average nitrate.

Nitrogen Adjustment for Soil Organic Matter

Nitrogen is released as ammonium- and nitrate-nitrogen from organic matter in the soil by mineralization. Mineralization is a microbial process that is favored by conditions favorable to high corn yield; thus, the estimated credit for nitrogen from organic matter is related to expected yield. When a soil test for organic matter is not available, one percent organic matter is assumed for sandy soils and soils in the Panhandle, and two percent is assumed for other soils. The value is capped at three percent organic matter since few Nebraska soils above this level were represented in the data base used to develop the algorithm.

Nitrogen Adjustment for Legumes, Manure, Other Organic Materials, and Irrigation Water

Preceding legume crops result in improved nitrogen supply to the corn crop because legume crop residues decompose faster than cereal crop residues and they do not tie up as much soil nitrogen. When corn follows a legume in rotation, the nitrogen rates in *Table II* are reduced by the legume nitrogen credit *(Table III)*.

Soybeans are credited for 45 pounds of nitrogen per acre unless the yield was less than 30 bushels per acre. For yields less than this, credit one pound of nitrogen per bushel harvested.

Table III. Estimated nitrogen contributions from legumes.

Legume crop	*Nitrogen Fertilizer Reduction (lbs/acre)* *Medium and Fine Textured Soils*	*Sandy Soils*
Soybean	45	45
Alfalfa (70-100% stand, >4 plants/ft^2)	150	100
Alfalfa (30-69% stand, 1.5-4 plants/ft^2)	120	70
Alfalfa (0-29% stand, <1.5 plants/ft^2)	90	40
Sweet Clover and Red Clover	80% of credit allowed for alfalfa	

Soybeans are good scavengers of soil nitrate and levels often average 3 to 4 ppm nitrate-N after harvest. Unless higher soil nitrate levels are expected, deep sampling for nitrate-N is not necessary for corn after soybeans and a value of 3 ppm nitrate-N is used to calculate the nitrogen recommendation. Deep soil sampling for nitrate-N is recommended if organic amendments were applied within the previous two years or if the soybean crop yield was poor due to hail, weather or insect damage or if soybeans were fertilized with nitrogen.

When manure is applied in a rotation that includes corn, recommended rates of nitrogen should be reduced according to the source of manure, the amount applied, and the method of application. Follow guidelines in NebGuide G97-1335, *Determining Crop Available Nutrients from Manure* (http://www.ianr.unl.edu/pubs/wastemgt/g1335.htm). The preplant soil nitrate test does not estimate future manure nitrogen availability.

Irrigation water often contains a significant amount of nitrate-nitrogen that is readily available to corn. When the amount of nitrogen supplied in irrigation water exceeds 15 pounds nitrogen per acre it should be deducted from the nitrogen suggested in *Table II*. For each foot of effective

irrigation water applied, one ppm nitrate-nitrogen in water is equal to 2.72 pounds nitrogen per acre. Irrigation amounts vary from year to year and the nitrogen credit for irrigation should be based on 80 percent of the average amount applied over a three-year period. Based on long-term conditions, reasonable average applications for different areas of the State would be 6 inches in eastern Nebraska, 9 inches in central Nebraska, 12 inches in west central Nebraska and 15 inches in western Nebraska.

Time and Method of Nitrogen Application

Nitrogen fertilizer may be applied at different times including fall, spring preplant, planting time, sidedress or in irrigation water. Research has shown that fall applications are generally less efficient than growing season applications because of the increased risk of nitrogen loss from either leaching or denitrification. Multiple applications of nitrogen are usually more efficient than single large doses. This is especially true on sandy soils that are prone to leaching. Fertilizer nitrogen is most efficiently used if some is applied near the period of rapid nitrogen uptake which begins about the tenth leaf stage. Application of nitrogen after tasselling is rarely effective and should be avoided.

Fall application of nitrogen is not recommended on sandy soils. On very sandy soils it is desirable to apply most of the nitrogen as sidedress or with irrigation water after corn is one foot tall. Up to a third of the planned nitrogen can be applied at or before planting to prevent early season nitrogen deficiency on sandy soils and soils low in organic matter.

Phosphorus Fertilization

About 20 percent to 30 percent of Nebraska soils need phosphorus to increase corn yields. Yield increases are expected from phosphorus applications when soil test levels are below 16 ppm by the Bray -1 and Mehlich-3 phosphorus soil tests, or 11 ppm by the Olsen phosphorus soil test (also known as the sodium bicarbonate phosphorus test; see *Table IV*). When phosphorus soil tests are below 10 ppm Bray-1 P or Mehlich-3 P, the probability of a yield increase to applied phosphorus fertilizer is greater than when phosphorus soil tests are between 10 and 15 ppm. For soil tests in the range of 16 to 30 ppm Bray-1 P or Mehlich-3, only starter fertilizer phosphorus is recommended. UNL recommendations for phosphorus are based on the sufficiency concept. The critical soil test levels used are valid for normal yield ranges of corn in Nebraska (120 to 200 bushels/acre). For yields above 200 bushels/acre, increased phosphorus application may be required on soils with <25 ppm Bray-P or <15 ppm Olsen P. See NebGuide G77-361, *Using Starter Fertilizers for Corn, Grain Sorghum, and Soybeans* revised December 1990, (http://www.ianr.unl.edu/pubs/fieldcrops/g361.htm), for more information on use of starter fertilizers.

Table IV. Phosphorus fertilizer recommendations.

Phosphorus Soil Test, ppm P		*Relative Level*	*Amount to Apply Annually (P_2O_5), lbs/ac*	
Bray-1 P or Mehlich-3[1]	Olsen P[2]		Broadcast[3]	Band[4]
0 - 5	0 - 3	Very Low (VL)	80	40
6 - 15	4 - 10	Low (L)	40	20
16 - 24	11 - 16	Medium (M)	0	0
25 - 30	17 - 20	High (H)	0	0
>30	>20	Very High (VH)	0	0

[1]Bray P-1 for acid and neutral soils, Mehlich-3 for all soils.
[2]Olsen P for calcareous soils.
[3]The following equation provides an alternative to using table values:
P_2O_5 (lb/acre) = 25 - Bray P (ppm) × 4; if Bray P (ppm) <25.
[4]Applied in a band preplant or beside the row at planting.

Phosphorus Application Methods

Phosphorus fertilizers can be applied broadcast prior to planting or by placing the fertilizer in bands in the root zone. Incorporating phosphorus into the soil results in more effective use and less potential for loss through runoff. Tillage associated with reforming ridges in ridge plant systems incorporates fertilizer adequately for efficient use. If phosphorus fertilizer is not incorporated, the soil surface must be moist for the phosphorus to be available to the crop. Broadcast application of phosphorus on ridge plant systems also is effective.

Application of phosphorus fertilizer in bands is usually more efficient than broadcast application, especially when soil phosphorus levels are very low. The fertilizer can be applied in preplant bands or banded beside the row when corn is planted. Preplant banding with anhydrous ammonia (dual-placement) is also an effective application method. To be most effective, bands should not be placed more than 15 to 20 inches apart and not deeper than six to eight inches. Producers often use two knives per row in ridge-plant systems; thus, knife spacing is determined by row width. This same knife spacing is effective for systems other than ridge plant. Placement of 10-34-0 fertilizer (with anhydrous ammonia or alone) four to six inches deep into the soil is effective on most soils. See NebGuide *G82-601, Using Phosphorus Fertilizers Effectively* revised October 1993, (http://www.ianr.unl.edu/pubs/soil/g601.htm) for more information on phosphorus fertilizer use.

Potassium Fertilization

Most Nebraska soils are capable of supplying enough potassium for excellent corn yields. Soil sample tests for the 0 to 8 inch depth are useful in determining potassium fertilizer needs for corn *(Table V)*. UNL recommendations for potassium are based on the sufficiency concept. The critical soil test levels used are valid for normal yield ranges of corn in Nebraska (120 to 200 bushels/acre). Future research may result in changes in potassium recommendations when very high yields are achieved.

Sulfur Fertilization

Table V. Potassium fertilizer suggestions.

Potassium Soil Test, ppm K	*Relative Level*	*Amount to Apply Annually (K_2O), lbs/ac*		
		Broadcast[1]		Row[2]
0 to 40	Very Low (VL)	120	plus	20
41 to 74	Low (L)	80	plus	10
75 to 124	Medium (M)	40	or	10
125 to 150	High (H)	0		0
Greater than 150	Very High (VH)	0		0

Potassium test - exchangeable K
[1]The following equation provides an alternative to using table values:
K_2O (lb/acre) = 150 – soil test (ppm) K; if soil test K <150.
[2]Banded beside seed row but not with the seed.

Nebraska soils generally supply adequate sulfur for excellent corn production. Only sandy soils that are low in organic matter are likely to need added sulfur. The ability of soils to supply sulfur to plants varies greatly in Nebraska. The need for sulfur also depends on the sulfur content of irrigation water. The sulfur content of irrigation water is generally low in the Sandhills but is usually adequate to meet the needs of crops irrigated with groundwater elsewhere in the state.

Table VI. Sulfur fertilizer recommendations (sandy soils only).

Sulfur Soil Test ppm SO_4-S	*Amount to Apply Annually (S), lbs/ac*		
	Soil Organic Matter 1% or less		*Soil Organic Matter Greater than 1%*
Irrigation water with less than 6 ppm SO_4-S			
	Broadcast	Row[1]	Row[1]
Less than 6	20	10	5
6 - less than 8	10	5	0
8 and greater	0	0	0
Irrigation water with 6 or greater ppm SO_4-S			
Less than 6	10	5	0
6 - less than 8	10	5	0
8 and greater	0	0	0

Sulfur test - $Ca(H_2PO_4)_2$ extraction
[1]Applied in a band next to row but not with seed

Guidelines for broadcast or row applications of sulfur are given in *Table VI.*

Sulfur must be in the sulfate form to be used by plants; thus, elemental sulfur must be oxidized to the sulfate form to be utilized. Where sulfur is applied preplant on very sandy soils, one-half of the applied sulfur should be finely ground elemental sulfur and the rest sulfate sulfur. Elemental sulfur can be granulated or flaked with a binding agent, but prilled sulfur is not effective. Applying some elemental sulfur at planting reduces leaching losses in sands during wet springs and allows adequate time for oxidation to sulfate. Band application is the most effective method of applying sulfur. When sulfur is applied in a band at planting, use sulfate sulfur. The oxidation process is not rapid enough for elemental sulfur to be effective. Ammonium thiosulfate (12-0-0-26S) also is effective, but must not be placed with the seed because of the potential for seed germination damage. Ammonium thiosulfate is an excellent source when injected into irrigation water for sprinkler application and can provide sulfur in-season if a deficiency develops.

Zinc Fertilization

Zinc deficiency in corn occurs most often where subsoil is exposed on soils leveled for irrigation. Western Nebraska calcareous soils low in organic matter or sandy soils are more likely to show a need for zinc than eastern Nebraska soils. Soil zinc can be easily raised to adequate levels by broadcasting zinc fertilizer, usually zinc sulfate, (*Table VII)*. Periodic soil testing to an 8-inch depth is suggested to assess zinc levels in soils. Zinc applied in a band beside the row also is effective, provided about 10 pounds of nitrogen is placed in the same band. For more information using zinc fertilizers, see NebGuide *G82-596, Use and Management of Micronutrient Fertilizers in Nebraska* (http://www.ianr.unl.edu/pubs/soil/g596.htm).

Table VII. Zinc fertilizer recommendations

Zinc Soil Test Level		*Amount to Apply (Zn), lbs/ac[1]*			
DTPA Extraction	*Relative Level*	*Calcareous Soils[2]*		*Noncalcareous Soils*	
ppm Zn		Broadcast	Band	Broadcast	Band
0 to 0.4	Low (L)	10	2	5	2
0.41 to 0.8	Medium (M)	5	1	3	1
> 0.8	High (H)	0	0	0	0

[1]Rates are for inorganic forms of zinc such as zinc sulfate.
[2]Calcareous soils defined as soils with moderate to excess lime.

Iron Fertilization

Symptoms of iron chlorosis, observed as yellow striping on corn leaves, may occur on highly calcareous or saline-sodic soils with pH levels above 7.8.

Correction requires several strategies. First, select corn hybrids that have tolerance to chlorosis. Genetic tolerance to chlorosis may be adequate. If not, iron fertilizers may need to be applied. Current research shows the most effective treatment for correcting high pH chlorosis in corn is an at-planting in seed-row application of 50 to 100 pounds of ferrous sulfate heptahydrate ($FeSO_4 \cdot 7H_2O$) per acre. This treatment costs $10-$30 per acre depending on product cost and requires dry fertilizer application equipment on the planter.

A second approach is to apply a stable iron chelate (FeEDDHA) with the seed as a liquid. At least 2.5 to 4 pounds of FeEDDHA per acre is required. Chlorosis correction from FeEDDHA has not equalled that of $FeSO_4 \cdot 7H_2O$ in research at North Platte and the chelate is more expensive ($30-$50/a). The FeEDDHA works well for correcting soybean chlorosis on high pH soils but not on corn due to differences in iron uptake chemistry between grasses and legumes.

Foliar sprays using ferrous sulfate or FeEDDHA are not always effective in producing significant yield responses. Treatment needs to begin as soon as chlorosis first becomes visible and repeated every 7 to 10 days until newly emerged leaves remain green. Spray must be directed over the row to be effective. A standard application is 20 gallons per acre of a 1 percent iron sulfate solution.

Lime Suggestions

Corn is less sensitive than legumes to acid soils. Where corn is grown continuously or with other grain crops, lime application is advised when the soil pH is 5.5 or less, except in the central and western parts of the state where the surface soil may be acid and lower depths of the soil are calcareous. If subsoil samples from 8 to 16 inches show pH below 5.5, liming should be considered.

Where corn is irrigated with groundwater, sufficient lime in the water may maintain a satisfactory soil pH level. Before applying lime on irrigated fields, soil pH change should be monitored for three to five years to determine if the soil pH is declining. If subsoil samples from 8 to 16 inches show pH below 5.5, liming should be considered. Since liming is an expensive practice and can only be economical on a long-term basis, it is prudent to lime some areas and observe the results before making a large investment in lime.

Other Related NebGuides and Extension Circulars

Understanding Potassium for Crop Production in Nebraska, G87-587 (http://www.ianr.unl.edu/pubs/soil/g587.htm).
Understand Your Soil Test: Sulfur, G89-901 (http://www.ianr.unl.edu/pubs/soil/g901.htm).
Nutrient Management for Agronomic Crops in Nebraska, EC01-155
Lime Use for Soil Acidity Management, G03-1504 (http://www.ianr.unl.edu/pubs/soil/g1504.htm)

File under: FIELD CROPS
C-2, Corn
Revised November 2003,2,000

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture.
Elbert C. Dickey, Dean and Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.

University of Nebraska Cooperative Extension educational programs abide with the non-discrimination policies of the University of Nebraska-Lincoln and the United States Department of Agriculture.