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G74-174 Fertilizer Suggestions For Corn (Revised July 1995)

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NebGuide

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Fertilizer Suggestions For Corn

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

Fertilizer Needs[1]

Nitrogen is the nutrient most often required for growing corn. Nearly all corn in Nebraska will need some nitrogen fertilizer unless there is substantial nitrogen in the soil from fertilizer carryover, legumes, manure, or other nitrogen sources. Phosphorus is the second nutrient most likely to be needed, and needs are best determined with a reliable soil test. Potassium, sulfur, zinc, and iron fertilizer may be needed for growing corn on certain soils. Crop needs for calcium, magnesium, boron, chlorine, copper, manganese, and molybdenum are adequately supplied by Nebraska soils.

Nitrogen Management

Nitrogen Requirement

The amount of nitrogen needed for corn is based on expected yield, the amount of residual soil nitrate-nitrogen (NO_3-N) and soil organic matter. *Table I* 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 (0-2 to 0-4 ft. depth), OM = percent organic matter, and other N credits = nitrogen from legumes, manure and other organic waste products, and irrigation water.

The expected yield should be a reasonable estimate of what a grower can produce on a given field. Normally it should not exceed the five-year average by more than 5 percent. Where major management improvements are anticipated that will have a high probability of increasing yield, a higher yield goal may be appropriate.

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 above.

Nitrogen Adjustment for Soil Nitrate-Nitrogen

The amount of nitrogen fertilizer based on an expected yield needs to be adjusted for the soil nitrate-nitrogen (NO_3-N) in the rooting zone of the crop. Soil nitrate-nitrogen is plant available nitrogen left in the soil after the previous crop is harvested. For every ppm nitrate-nitrogen in the soil (average concentration in a 0-2 to 0-4 foot deep sample), the suggested rate of nitrogen is reduced eight pounds per acre *(Table I)*.

The method of calculating the average nitrate-nitrogen concentration in the root zone where the sample is divided into several depths is illustrated by the following example.

Soil Layer, inches	*Thickness, inches*	*Nitrate-Nitrogen, ppm*	*Calculations*
0 - 8	8	30	8 x 30 = 240
8 - 24	16	20	16 x 20 = 320
24 - 48	24	5	24 x 5 = 120
			680

680 ÷ 48 inch depth = 14.2 ppm

This procedure gives a depth-weighted concentration (the average concentration in the sampled depth of soil) which is needed to use the algorithm. Soil nitrate-nitrogen can best be determined by sampling soils to a minimum depth of two feet. Sampling to a greater depth (to four feet) is desirable wherever practical. See NebGuide G91-1000, *Guidelines for Soil Sampling*, for more information on soil sampling. When soil tests for nitrate-nitrogen are not available, a value of 3 ppm is used to make a nitrogen recommendation.

**Fertilizer Suggestions for Corn* was adapted from NebGuide G74-174 originally written by E.J. Penas, Extension Soils Specialist (Emeritus), G.W. Hergert, and R.B. Ferguson.

[1]All current UNL Department of Agronomy fertilizer recommendations are part of an IBM or compatible personal computer program. It can be ordered from the University of Nebraska Department of Agronomy, 139 Keim Hall, P.O. Box 830915, Lincoln, NE 68583-0915 for $50. Updates cost $10 and are done annually.

Table I. Nitrogen fertilizer suggestions 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%									
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
27										0	0
		Soil Organic Matter, 2%									
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%									
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

Note: Without a soil test for nitrate-nitrogen, assume 3 ppm; for organic matter, assume 1% for sands and panhandle, 2% for rest of Nebraska.

On soils that have an effective root zone less than 2 feet (gravel layer, water table, shale or hardpan) only limited credit for residual nitrate can be given. Prorate the Nitrate-N credit on the basis of a full rooting depth (4-5 feet).

Nitrogen Adjustment for Soil Organic Matter

Nitrogen is released as ammonium- and nitrate-nitrogen from organic matter in the soil by mineralization. Since this is a microbial process, conditions that favor high yields also favor microbial activity; thus, the estimated credit for nitrogen from organic matter is related to expected yield. For each 100 bushels of corn produced per acre, the suggested rate of nitrogen to be applied is reduced 14 pounds per acre for each percent soil organic matter (up to 3 percent maximum) as shown in *Table I*. 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 2 percent is assumed for other soils.

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

Legumes have a positive effect on the nitrogen available in the soil because nitrogen is released to corn when the legume is destroyed either by tillage or herbicide. Therefore, the nitrogen suggestions in *Table I* need to be reduced for a legume nitrogen credit. A good stand of alfalfa should provide a credit of 150 pounds of nitrogen per acre. For stands below 70 percent (less than four plants per square foot), less credit is given. For more details, see NebGuide 94-1178, *Fertilizer Nitrogen Best Management Practices*. Sweet clover and red clover will supply about 80 percent as much as alfalfa. Soybeans should be credited for 45 pounds of nitrogen per acre unless the yield of soybeans was less than 30 bu/ac.

When manure is applied before corn is planted, 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 G94-1178, *Fertilizer Nitrogen Best Management Practices*.

Irrigation water often contains a significant amount of nitrate-nitrogen which is a very available nitrogen source for corn. The amount supplied in the irrigation water should be deducted from the nitrogen suggested in *Table I*. For each foot of effective irrigation water applied, one ppm nitrate-nitrogen in water is equal to 2.72 pounds nitrogen per acre. When irrigation water contains 10 ppm nitrate-nitrogen or more, adjustments should be made in the amount of nitrogen fertilizer applied.

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. Corn will usually use more of the applied nitrogen when applied closer to the period of most rapid nitrogen uptake which begins at about the tenth leaf stage. Therefore, applying fertilizer nitrogen as a sidedressing 30 to 40 days after plant emergence or in irrigation water are highly recommended practices for improving nitrogen fertilizer efficiency. However, most of the nitrogen needs to be applied

prior to tasseling stage to maximize the effect of nitrogen fertilizer.

Fall application of nitrogen is not recommended on sandy soils. On very sandy soils it is desirable to apply most of the needed nitrogen as sidedress and with irrigation water after corn is one-foot tall and prior to tasseling. For additional information on nitrogen application, see NebGuide G94-1178, *Fertilizer Nitrogen Best Management Practices.*

Phosphorus Management

Phosphorus Requirement

About 20 to 30 percent of Nebraska soils in corn production will need phosphorus fertilizer to increase corn yields. Yield increases may be expected from phosphorus applications when soil test levels are below 16 parts per million (ppm) Bray P-1 P or 11 ppm SB-P (see *Table II*). When phosphorus soil tests are below 10 ppm Bray P-1, the probability of a yield increase to applied phosphorus fertilizer is greater than when phosphorus soil tests are between 10 and 15 ppm Bray P-1. For soil tests in the range of 16 to 30 ppm Bray P-1, only starter fertilizer phosphorus may be desirable for some producers. See note below *Table II* and NebGuide G77-361, *Using Starter Fertilizers for Corn, Grain Sorghum, and Soybeans* for more information on use of starter fertilizers.

Table II. Phosphorus fertilizer suggestions.

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

* Bray & Kurtz P-1 for acid and neutral soils.
** Sodium Bicarbonate-P for calcareous soils.
*** Applied in a band preplant or beside the row at planting.
Note: The application of 10 to 20 lbs/ac P_2O_5 with 5 to 10 lbs/ac N in a band at planting time may increase early growth on these soils. See NebGuide 77-361, *Using Starter Fertilizers for Corn, Grain Sorghum and Soybeans*, for more information.

Phosphorus Application Methods

Phosphorus fertilizers can be applied broadcast prior to planting or by placing the fertilizer in bands into the root zone. Broadcast applied phosphorus fertilizer needs to be incorporated into the soil to be effective. Under no-till systems where no tillage or cultivation is done, surface applied phosphorus can be effective provided adequate moisture is available, such as sprinkler irrigation, to keep the surface soil under the residue moist. Broadcast application of phosphorus on ridge plant systems also is effective. See NebGuide G90-996, *Ridge Plant Systems: Fertility* for more information.

Application of phosphorus fertilizer in bands is usually more efficient than broadcast, 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 becoming a common practice. To be most effective, bands should not be placed more than 15 to 20 inches apart and not deeper than six inches. Producers commonly 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,* for more information on phosphorus fertilizer use.

Potassium Suggestions

Most Nebraska soils are capable of supplying enough potassium for excellent corn yields. Soil tests will help determine whether potassium is needed for corn production. *Table III* gives the suggested rates for potassium based on soil test and method of application.

Table III. Potassium fertilizer suggestions.

Potassium Soil Test, ppm K	*Relative Level*	*Amount to Apply Annually (K_2O), lbs/ac*		
		Broadcast		Row*
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

* Banded beside seed row but not with the seed.

Sulfur Suggestions

The ability of soils to supply sulfur to plants varies greatly in Nebraska. Sandy soils low in organic matter are the only soils likely to need added sulfur fertilizer.

The need for sulfur also depends on the sulfur content of irrigation water. The sulfur content of irrigation water is variable, but is generally low in the Sandhills and is usually adequate for crops irrigated with groundwater in the remainder of the state. Guidelines for broadcast or row applications of sulfur are given in *Table IV*.

Sulfur must be in the sulfate form to be used by plants; thus, elemental sulfur must be oxidized to the sulfate form to

Table IV. Sulfur fertilizer suggestions (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	
Less than 6	10 row* or 20 broadcast	5 row*
6 - less than 8	5 row* or 10 broadcast	0
8 and greater	0	0
	Irrigation water with 6 or greater ppm SO_4-S	
Less than 6	5 row* or 10 broadcast	0
6 - less than 8	5 row* or 10 broadcast	0
8 and greater	0	0

Sulfur Test - $Ca(H_2PO_4)_2$ Extraction

* Applied in a band next to row but not with seed.

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. Using some elemental sulfur when application is prior to planting reduces the risk of leaching loss 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 time, sulfate sulfur should be used. 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 seed germination damage. Ammonium thiosulfate is an excellent source to inject into irrigation water for sprinkler application and can provide sulfur in-season if deficiency develops.

Micronutrients

Zinc

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) at the rates shown in *Table V*. Periodic soil testing 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 on the use of zinc fertilizers, see NebGuide G82-596, *Use and Management of Micronutrient Fertilizers in Nebraska.*

Table V. Zinc fertilizer suggestions.

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

*Rates are for inorganic forms of zinc such as zinc sulfate.

Iron

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. Because of the nature of such soils, correction of iron deficiency is difficult. For these problem soils, several approaches are suggested.

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, then the application of iron materials may be necessary.

Current research shows the most effective treatment for correcting high pH chlorosis in corn is at-planting seed-row application of 50 to 150 pounds of ferrous sulfate heptahydrate ($FeSO_4 \cdot 7H_2O$) per acre. This is an economical treatment ($6-$25/a depending on source cost) but it does require dry fertilizer application equipment on the planter.

A second approach is to apply a stable iron chelate (FeEDDHA) with the seed as a liquid. This method may be preferable for producers who have liquid fertilizer application equipment. Research shows that at least 2.5 to 4 pounds of FeEDDHA per acre is required. The dry FeEDDHA is dissolved in water then applied. Chlorosis correction from FeEDDHA has not equalled that of $FeSO_4 \cdot 7H_2O$ in research at North Platte and the chelate is expensive ($30-$50/a). The FeEDDHA works well for correcting soybean chlorosis on high pH soils but not on corn due to Fe uptake chemistry differences between grasses and legumes.

Foliar sprays using ferrous sulfate or FeEDDHA can be used but are not always effective in producing significant yield responses. Failure to correct chlorosis with foliar treatment is often due to an application being made too late. Treatment needs to begin as soon as chlorosis first becomes visible and usually must be applied several times. Repeat 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 solution.

A 1 percent solution of iron sulfate can be produced by adding 8 pounds of ferrous sulfate ($FeSO_4$) or 15 pounds of ferrous sulfate heptahydrate ($FeSO_4 \cdot 7H_2O$) to 100 gallons of water. Using an iron sulfate concentration greater than 1.5 percent usually results in excessive leaf burning. Iron chelates can also be used. Follow directions on the product container. Adding a commercial wetting agent or a cup of mild detergent to each 100 gallons improves plant coverage. The addition of 25 pounds of feed grade urea or 5 gallons of 28-0-0 urea-ammonium nitrate fertilizer per 100 gallons of spray solution also enhances iron uptake.

Lime Suggestions

Corn is less sensitive to acid soils than legumes. Lime application is suggested when soil tests indicate soil pH is 6.2 or less where alfalfa, clovers, or other legumes are grown. 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 the lower depths of the soil are calcareous (see NebGuide G74-1096, *Understand Your Soil Test: pH—Excess Lime—Lime Needs.*)

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 over a five-year period to determine if the soil pH is declining. Subsoil samples from eight to 16 inches should be checked. If the subsoil becomes more acid (below pH 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 large investments are made in lime.

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