Grain Corn

Crop Highlights
• Target pH: 6.0 • Split nitrogen (N) applications to increase N use efficiency in corn. Apply a small amount of N (20 to 25%) at planting and the bulk of the N requirement (75 to 80%) when the plants are 12 to 15 inches tall. • Use the pre-sidedress soil nitrate test (PSNT) for manured ground to calculate crop N needs in season • For irrigated corn where fertigation is possible, split N applications to increase N use efficiency. Apply a small amount (15 to 20%) at planting and split the remainder into equal increments to be applied with irrigation water from the 5 to 6 leaf stage through silking. Use the Leaf Chlorophyll Meter to monitor crop N needs in season and make small adjustments as needed. • Use the corn stalk nitrate test (CSNT) at the end of the season to monitor the success of the N management program. • Monitor crop for manganese (Mn) deficiency, especially when soil test Mn is less than 3.4 lb/ac.

Yield Goal

Corn yields are influenced by many factors, including the variety selected, planting date, weather, soil type and water-holding capacity, nutrient and water availability, weed, insect and disease pressure, and crop management practices. **Typical yield goals for corn grown for grain on Delaware soils are shown in Table 1.** Ranges reflect the variation in soil type, water availability, and tillage management.

Delaware growers should use field history to determine the yield goal for each field and use that information to adjust management decisions and fertility programs accordingly. Delaware nutrient management law requires the use of optimal rolling average for determining the yield goal for a specific field when field history is available. To calculate the optimal rolling average yield, see University of Delaware Extension Fact Sheet ***Estimating Yield Goal for Crops***.

Table 1. Corn grain yield as a function of irrigation use and management level

Dryland Corn Production	Grain Yield
	---------- bu/ac ----------
Traditional Management	125 – 220
Irrigated Corn Production	
Level of Management	
High Management	240 – 270
Intensive Management	270 – 300

Soil pH and Liming

Target pH: 6.0 for most soils

Soils that are high in organic matter (e.g., "black" soils; soil organic matter >6.0%) have a lower target pH (5.6) because organic matter moderates some of the negative effects of excessive soil acidity (e.g., aluminum toxicity).

The lime recommendation for a specific field is calculated from the soil pH and Adam-Evans buffer pH measurements using the steps outlined in University of Delaware Extension Fact Sheet ***Calculating the Lime Requirement Using the Adams-Evans Soil Buffer***. Avoid over-liming to prevent deficiency of micronutrients such as manganese (Mn).

The recommended liming source is dependent upon Mehlich-3 (M3) soil test calcium (Ca) and magnesium (Mg) reported in University of Delaware fertility index value (FIV) and can be determined using Table 2.

Table 2. Recommended type of lime as a function of Mehlich-3 soil test calcium and magnesium concentrations.

Soil Test Levels	Recommended Lime Type
M3-Mg is less than 50 FIV	Dolomitic
M3-Mg between 50 and 100 FIV AND M3-Mg is less than M3-Ca	Dolomitic
M3-Mg greater than 100 FIV	Calcitic
M3-Mg is greater than 50 FIV AND M3-Mg is greater than M3-Ca	Calcitic

Nitrogen

The University of Delaware nitrogen (N) recommendations for grain corn production are based on an N rate of 1 lb/ac per bushel of expected yield – e.g, for an expected yield of 175 bu/ac, the total N recommendation would be 175 lb/ac.

Split N applications can increase N use efficiency, thus requiring less total N to achieve the same grain yield. For most efficient N use, total N should be split into two or more applications during the growing season. Apply no more than 25% of total N at or just prior to planting. The remainder of the total N should be sidedressed when corn plants are 12 to 15 inches tall and the period of maximum N uptake is beginning. For irrigated fields where fertigation is possible, the remainder of the N can be split into equal increments and applied with irrigation water beginning at the 5 or 6 leaf stage and continuing through silking.

For fields with a history of manure use, use the pre-sidedress soil nitrate test (PSNT) to determine the elemental sidedress N rate for the field. Information about sampling for and interpreting a PSNT is available in University of Delaware Cooperative Extension Fact Sheet ***Nitrogen Management for Corn in Delaware: The Pre-sidedress Nitrate Test.***

For in-season monitoring of crop N status, growers may wish to use the leaf chlorophyll meter. Use of a chlorophyll requires establishment of an N-rich strip for calibration of the meter.

Phosphorus

Phosphorus recommendations for corn are dependent upon the nutrient requirement of the crop as a function yield goal and crop management practices including tillage and nutrient application methods (e.g., banding,

broadcast application or a combination of the two methods). Three management scenarios with the recommended application rates are presented.

Table 3. Recommended phosphorus rate for grain corn as a function of expected yield when all phosphorus will be applied as a band application.

Yield	M3-P (FIV)										
	0	10	20	30	40	50	60	70	80	90	100
	lb P_2O_5/ac										
125	80	70	60	50	40	25	25	20	20	15	15
150	90	75	70	60	50	30	30	25	25	20	20
175	95	80	80	70	60	45	45	30	30	25	25
200	100	85	85	80	70	50	50	45	45	30	30
225	105	90	90	85	80	55	55	50	50	35	35
250	110	95	95	90	85	60	60	55	55	40	40
275	115	100	100	95	90	65	65	60	60	45	45
300	120	110	105	100	95	70	70	65	65	50	50

Table 4. Recommended phosphorus rate for grain corn as a function of expected yield when all phosphorus will be applied as a broadcast application.

Yield	M3-P (FIV)										
	0	10	20	30	40	50	60	70	80	90	100
	lb P_2O_5/ac										
125	160	140	110	90	70	60	50	50	40	40	40
150	175	155	125	105	85	70	60	60	50	50	50
175	190	170	140	120	100	75	65	65	55	55	55
200	205	185	155	135	115	85	75	75	65	65	60
225	220	200	170	150	130	90	80	80	70	70	65
250	235	215	185	165	145	100	90	90	80	80	70
275	250	230	200	180	160	105	95	95	85	85	75
300	265	245	215	195	175	115	105	105	95	95	80

Table 5. Recommended phosphorus rate for grain corn as a function of expected yield when applied as a broadcast + starter application.

Yield	M3-P (FIV)										
	0	10	20	30	40	50	60	70	80	90	100
	lb P_2O_5/ac										
	Starter Band										
All yields	40	40	35	35	30	30	25	25	20	20	20
	Broadcast Rate										
125	80	60	40	20	10	0	0	0	0	0	0
150	95	75	55	35	25	10	10	10	10	10	10
175	110	90	70	50	40	15	15	15	15	15	15
200	125	105	85	65	55	25	25	25	25	25	25
225	140	120	100	80	70	30	30	30	30	30	30
250	155	135	115	95	85	40	40	40	40	40	40
275	170	150	130	110	100	45	45	45	45	45	45
300	185	165	145	125	115	55	55	55	55	55	55

1. Select Table 3 when phosphate will be banded only. **This is the recommended practice for no-till systems and is suitable for all tillage schemes.**
2. Select Table 4 when phosphate will be applied as a broadcast application at or prior to planting. **Broadcast applications are NOT recommended for no-till fields.**
3. Select Table 5 when starter P will be applied, and the remainder of the P will be applied as a broadcast application.

4. If M3 soil test P is “Excessive” (e.g., P-FIV’s >100), the application of P in fertilizers or manures is NOT RECOMMENDED.

Potassium

Table 6. Recommended potassium rate for grain corn as a function of expected yield.

Yield	M3-K (FIV)										
	0	10	20	30	40	50	60	70	80	90	100
	---------- lb K_2O/ac ----------										
125	110	95	80	60	40	40	40	40	40	40	40
150	140	120	100	80	60	45	45	45	45	45	45
175	170	145	120	95	70	55	55	55	55	55	55
200	190	165	140	110	80	60	60	60	60	60	60
225	210	190	160	140	115	70	70	70	70	70	70
250	230	205	180	155	130	75	75	75	75	75	75
275	250	220	200	170	145	85	85	85	85	85	85
300	270	240	220	185	160	95	95	95	95	95	95

1. Potassium (K) can be broadcast in the fall or spring or banded at planting.
2. For banded applications, reduce the rates in Table 6 by one-half.
3. To avoid salt injury to seedlings, do not band more than 75 lb K_2O/ac at planting. When N and K_2O are banded together, the sum of the N rate and the K_2O rate should not exceed 75 lb/ac.

Magnesium

Table 7. Recommended application rates of soluble magnesium as a function of soil test magnesium.

Soluble Mg	M3-Mg (FIV)								
	0	5	10	15	20	25	30	35	40
lb soluble Mg/ac	80	70	60	50	40	30	20	10	0

1. Magnesium (Mg) is recommended when M3 soil test Mg is less than 40 FIV.
2. If M3 soil test Mg is less than 40 FIV and lime is recommended, use dolomitic limestone.
3. If M3 soil test Mg is less than 40 FIV and lime is not needed, apply soluble Mg according to the rates in Table 7.

Sulfur

Sulfur (S) deficiency is frequently observed in corn grown on Delaware's sandy, highly leached, low-organic-matter soils. Deficiency is most likely to occur under irrigated production practices where intensive management is employed to obtain maximum yields. Deficiency is less common on high organic matter soils or those with a history of manure application, as both materials provide moderate amounts of plant-available S.

Prediction of S deficiency is difficult. Currently available soil tests are not good predictors of S deficiency situations because only surface soil samples are analyzed. Many Delaware soils have a supply of plant available S in subsoil horizons that will not be detected in soil samples taken from shallower depths. Subsoil sampling to a depth of 24 inches is highly recommended as a means of identifying soils with subsoil reserves of S.

Suspected S deficiency can be confirmed through tissue analysis of ear leaf samples collected at early silking. Tissue samples collected earlier in the season are not as good of an indicator of yield-limiting S deficiency because roots, may not have penetrated subsoil reserves at that time. In-season correction of S deficiency

may be difficult. If the ear leaf S concentration is less than the critical value of 0.12% or the N:S ratio is greater than 15:1, S deficiency is occurring.

1. Apply 30-40 lb/ac of S as ammonium sulfate to correct the deficiency.

To prevent S deficiency in subsequent years, apply one of the following treatments:

1. Broadcast 30-40 lb/ac of S as ammonium sulfate (24% S) or gypsum (19% S) at planting.
2. Band 20-30 lb/ac of S as ammonium sulfate at planting.

Long-term applications of ammonium sulfate or other acid-forming fertilizers may lower pH of the soil surface and require correction with lime. Monitor surface pH with a 0- to 2-inch soil sample, especially in no-till systems. Also remember that sulfate-S is available for crop uptake immediately after application. If a reduced form of S is applied (e.g., thiosulfate or elemental S), allow adequate time for oxidation of the applied S to the sulfate form to occur.

Manganese

Manganese (Mn) needs are predicted by an availability index that includes M3 soil test Mn and soil pH. Interpretation is crop specific.

$$MnAI = 101.7 – (15.2 \times \text{soil pH}) + (2.11 \times \text{M3-Mn})$$

Where:

MnAI = Mn availability index
Soil pH = Soil pH measured in water (1:1 V:V)
M3-Mn = Mehlich 3 soil test Mn in lb/ac

Table 7. Interpretation of manganese availability index.

Mn Availability Index	Interpretation
Less than 25	Mn deficiency is likely at this soil pH and soil test Mn concentration
25 to 35	Mn deficiency is possible at this soil pH and soil test Mn concentration. Monitor the crop for symptoms, especially if liming has been recommended.
Greater than 35	Mn deficiency is unlikely.

1. If Mn deficiency is predicted or was observed in the previous growing season, broadcast 20 to 30 lb/ac elemental Mn.
2. In some cases, broadcast applications of acid forming fertilizers may correct Mn deficiency without the application of Mn; however, acid-forming fertilizers may be less effective than Mn fertilizers.
3. If Mn deficiency symptoms appear during the growing season or after an application of lime, a foliar application of Mn sulfate or Mn oxide at a rate of 1.0 to 2.0 lb/ac elemental Mn or chelated Mn (Mn-EDTA) at a rate of 0.5 to 1.0 lb/ac elemental Mn can alleviate the symptoms and restore yield potential. **Apply only when adequate growth is present to aid absorption of foliar Mn.**

NOTE: When using foliar application to correct Mn deficiency, growers may combine the treatment with a post emergence herbicide application to reduce the number of trips across the field. Sulfate containing forms of Mn (e.g., manganese sulfate [Techmangam] and manganese-lignin-sulfate) may be antagonistic to weed control with Roundup™. To overcome this antagonism, growers should add ammonium sulfate at a rate of 17 lb per 100 gallons of solution. Chelated-Mn (Mn-EDTA) has shown a slight degree of antagonism but little to no reduction in weed control was noted in the field studies.

Zinc

Zinc (Zn) deficiency is predicted by an availability index that includes not only M3 soil test Zn, but also soil pH and M3 soil test P. It is most common on soils with a pH of 6.5 or higher and high soil test P concentrations but may also be induced by environmental conditions such as cold, wet soils that may limit root growth. Zinc deficiency symptoms often appear early in the season and disappear as root growth increases or environmental conditions improve. See Table 9 to determine if Zn deficiency is predicted for this field.

Table 9. Interpretation of Zn availability index.

Soil Test Criteria	Interpretation
M3-Zn is less than 1.9 lb/ac	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is higher than 7.0	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is 6.6 or higher **AND** M3-P is 100 FIV or higher	Zn deficiency is predicted
M3-Zn is 3.2 lb/ac or higher	Zn deficiency is not likely

If zinc deficiency is predicted by the availability index or was observed the previous year, one of the following treatments can be applied:

1. Broadcast Zn sulfate or Zn oxide at a rate of 10 to 12 lb/ac elemental Zn or Zn chelate (Zn-EDTA) at a rate of 2 to 3 lb/ac elemental Zn. Broadcast applications should correct Zn deficiency for several years.
2. If a banded application is preferred, apply 6 to 8 lb/ac elemental Zn as Zn sulfate or Zn oxide or 1 to 2 lb/ac elemental Zn as Zn chelate (Zn-EDTA) in the fertilizer band. Banded applications are only effective in the growing season in which they are applied.
3. Foliar application of Zn sulfate or Zn oxide at a rate of 1 lb/ac elemental Zn or Zn chelate (Zn-EDTA) at a rate of 0.5 lb/ac elemental Zn in 20 to 50 gallons of water. **Apply only when adequate growth is present to aid in the adsorption of foliar Zn.** Foliar Zn application should be repeated if symptoms re-appear.

Boron

Boron (B) deficiency is occasionally observed in intensively managed, irrigated corn production. However, B applications are not a general recommendation for corn. If B deficiency symptoms appear, contact your county agent for assistance with diagnosis and corrective recommendations.