Fertilizing Corn: Dryland and Irrigated

Cooperative Extension South Dakota State University

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Fertilizing Corn
Dryland and Irrigated

COOPERATIVE EXTENSION SERVICE
SOUTH DAKOTA STATE UNIVERSITY
U.S. DEPARTMENT OF AGRICULTURE
About half of the fertilizer applied in South Dakota is used for corn production, yet it is estimated that twice this amount could profitably be used.

Plant Nutrients for Corn, Sorghum

Approximately 1.5 pounds of nitrogen (N), 0.5 pounds of phosphate (P₂O₅), and 1.2 pounds of potash (K₂O), along with varying amounts of other essential elements, are required for each bushel of corn produced. If soil reserves cannot supply adequate amounts of these essential nutrients for the desired yields, then additional amounts of nutrients must be provided as fertilizer. Nitrogen, phosphorus, potash, and occasionally, zinc are most commonly deficient.

NITROGEN

South Dakota soils have 2,000-5,000 pounds of total nitrogen per acre in the top layer. However, release of this soil nitrogen is usually only 1% to 2% of that total per year. This is seldom enough to meet the needs of annual crops such as corn and sorghum, and additional nitrogen should be applied.

Note: Nitrogen deficiency in young plants is characterized by stunted, spindly growth and light green foliage. In older plants, nitrogen will move out of the lower older leaves into newer growing parts. The midribs of these older leaves will become yellow and this color change will extend up the midrib in a typical V-shaped pattern. The leaf may die prematurely depending on the severity of the deficiency. Nitrogen deficiency should not be confused with lack of moisture, which affects the upper as well as the lower leaves.

PHOSPHORUS

Total phosphorus in the plow layer of South Dakota soils ranges between 1,000 and 2,000 pounds per acre. However, a small percentage of this phosphorus is readily available during a growing season. Failure to apply additional phosphorus to soil testing low in this nutrient usually results in very limited yields.

Phosphorus in fertilizer reacts rapidly with soil, drastically restricting its movement in soil. The loss of phosphorus by leaching, even under irrigation, is negligible compared to nitrogen.

Note: Phosphorus deficiency in young corn plants is characterized by slow, stunted growth and an unusually dark green color. Sometimes the lower leaves and stems will appear to be violet or purple in color.

POTASSIUM

Most South Dakota soils contain large amounts of potassium (40,000-60,000 pounds K₂O per acre in the plow layer). Research results and soil tests show few South Dakota soils need applications of potassium to produce maximum yields. Producers should not disregard potassium recommendation if needed, according to the soil test.

Note: Potassium deficiency symptoms of corn include a slower rate of growth. Prolonged deficiencies result in leaf edges and tips becoming dry and scorched, with the rest of the leaf showing yellowish stripes. The lower leaves are affected first. Stalk lodging may also be greater where potassium deficiencies exist.

ZINC

Zinc levels in soil range from 20 pounds to 600 pounds per acre, but like the other nutrients, much of it is unavailable to plants. Zinc does not leach from soils, and that which is returned in residue remains near the surface. Therefore, zinc deficiencies are usually associated with soil that is severely eroded, sandy, low in organic matter, or where subsoil is exposed as a result of leveling for irrigation or terracing. Corn exhibits zinc deficiencies more readily than most other crops grown in South Dakota. Soil tests are very effective in detecting deficiencies of this element.

Soil applications of fertilizers containing zinc sulfate, zinc oxide, zinc carbonate, and chelated zinc forms are all effective in correcting deficiencies. Recommended rates will vary from 5 to 10 pounds per acre of actual zinc in inorganic forms, depending on application method. Rates can be reduced by 50% if band applied. Recommended rates can also be reduced 35% where chelated forms are used.

Note: Zinc deficiency young corn plants develop pale yellow stripes on each side of the midrib of lower leaves. These yellow stripes start at or near the base of the leaf and continue about two thirds of the length of the leaf. Later, leaves may become reddish brown in color and may eventually die.

SULFUR

Plant analysis has detected what appears to be deficient sulfur levels in corn plants from a limited number of fields in South Dakota. Those fields were located on rather sandy soils. The use of sulfur has not consistently increased crop yields on these soils even though surface soil sulfur tests show only low reserves exist. Information to date indicates the finer textured silt and clay soils in these areas usually have adequate levels of sulfur.

Where sulfur use is reasonably certain of profitably increasing yields, commercial fertilizers such as ammonium sulfate (24% S), potassium sulfate (18% S), thio-sulfate compounds (12% S) and gypsum (18% S) can be used as sulfur sources. There may be others. Elemental sulfur has been used, but it must be converted to the available sulfate form before it can be used by plants. Since this conversion is a slow process, elemental sulfur is a less desirable sulfur source.

Note: Sulfur deficiency can be confused with nitrogen deficiency. Sulfur shortages affect the entire plant, while nitrogen shortages show up on the lower older leaves first.

Sulfur deficiency symptoms of corn appear on the young leaves as a light green to yellowish-green color. Close examination shows the tissue between the veins to be lighter green in color than the veins, and these stripes continue to the tip of the leaf.

OTHER ELEMENTS

Research to date shows little or no yield increase on most soils from application of the other essential elements not listed here. Farmers should use caution before making large investments in such fertilizer programs.

Kinds of Fertilizer

Research indicates that fertilizer nutrients in gaseous, liquid, dry or organic forms are about equally effective pound for pound of properly applied available plant food. The cost, convenience, and application equipment needed become the determining factors in deciding which fertilizer to use.

Time, Method of Application

Fertilizer nutrients vary in chemical activity and movement in soil. Method and time of fertilizer application can affect results. In general, phosphorus and potassium should be applied at or before planting time.

Nitrogen can be applied or injected before and/or after planting. Some type of incorporation is recommended.
Research shows that properly incorporated fall and spring fertilizer applications are about equally effective on most fields. One possible exception, which requires special consideration, is fall nitrogen application on sandy or very fine-textured soils, particularly where irrigated. Leaching losses of fall-applied nitrogen can become significant if excessive amounts of water move into or through the root zone. In those cases, nitrogen should be broadcast in the spring or sidedressed before final cultivation.

Effective recovery and use of soil nitrogen by irrigated crops appears to be closely related to water management. Nebraska research shows N recovery from fertilizer can reach 80-85% if irrigators avoid applying water in excess of what is removed by evapotranspiration. Fifty to 60% is considered normal recovery the first year. Splitting N applications between preplant, sidedress, and injection in the system can give improved results. The use of commercial nitrogen inhibitors may also improve results from fall-applied nitrogen, particularly under irrigation or sandy soil conditions.

Surface applications of fertilizer or manure on frozen, sloping soil is not a recommended practice. It can be costly in terms of nutrient loss by runoff, as well as a contributory factor to pollution problems. Applications on any soil should be made when the materials can be worked into thawed soil. Nitrogen loss as a gas can also result from surface applications. Incorporating the material right after application will minimize such losses.

STARTER

Starter fertilizer placed near the seed at planting time can stimulate early plant growth. Its use in South Dakota has given erratic results. Average yield increases over a several year period have been about 3 to 4 extra bushels per year, however, actual yield decreases have occurred some years. Starter fertilizers containing N-P-K in 1:4:0 or 1:4:2 ratios, or others similar to these, are well-suited for South Dakota.

Starter fertilizers may be applied in any one of three ways, depending on equipment availability: (1) side dress, (2) with seed (pop-up), and (3) preplant. Keep in mind, however, that excessive fertilizer salts placed with the seed (as in pop-up) can delay or reduce seedling emergence, particularly if dry or sandy soil conditions exist. It is important to use very low fertilizer rates when placing it with the seed. Total N + K actual plant food applied (as in pop-up) should not exceed 6 pounds per acre in 40-inch rows, or proportionately greater amounts where narrower row widths are used.

Farmers are also cautioned against applying unusually high levels of phosphates as a starter fertilizer at corn seeding time, regardless of planting methods. Research to date shows yield reductions can occur when phosphate rates, applied as a starter, exceed 30 lbs actual P2O5 per acre. Splitting applications of recommended phosphorus rates that exceed 30 lbs per acre is perhaps the best way to avoid such yield loss.

Split boot methods of applying starter, once a common practice, are not widely used today. Reductions in stand can occur, however, if plant food quantities, including plant food earlier for pop-up, are exceeded.

SIDEDRESSING

Sidedressing is a method of applying additional nitrogen fertilizer between the rows after planting. It frequently is used in addition to a starter fertilizer containing other needed nutrients.

Gaseous, liquid, or dry forms of nitrogen fertilizer can be sidedressed on the crop from the time it is planted until the crop reaches heights of perhaps 15 to 18 inches. For maximum results from nitrogen fertilizer, a crop should be sidedressed before it is 12 inches high. This may be done while cultivating or as a separate application.

Special Problems

FERTILIZING LISTED OR NO-TILL CORN

The practice of broadcasting and plowing fertilizer under for surface planted crops is ineffective for lister and no-till planted crops, because plowing normally does not precede listing or till planting. Action of the lister places the fertilizer in the ridge between rows where it is relatively unavailable. This is particularly true for phosphorus, which moves little in the soil during any one growing season.

There are fertilizer attachments, which place the fertilizer near the seed, designed for use with a lister. They work well on coarse-textured soils, but work less effectively on the more clayey soils. However, the use of these attachments is encouraged, because the fertilizer is placed near the seed where it becomes readily available to the plants.

Many listers are equipped with fertilizer boxes but not placement equipment. With this planting system, the fertilizer is applied just ahead of the covering disks and is mixed with the seed and soil. There is some potential danger of germination damage if excessive nitrogen and potash fertilizer comes in contact with the seed. Despite that drawback, this may be a reasonably practical method of applying needed amounts of phosphorus and potassium for listed corn on higher clay content soils. Starter fertilizer rates recommended earlier for placement with the seed (pop-up), should be used as guides.

Nitrogen fertilizer can be sidedressed on lister-planted crops, either as a separate operation or with a fertilizer attachment on the cultivator.

CORRECTING CORN GROWTH ON FALLOWED SOILS

Farmers and researchers have observed for some time how corn frequently fails to make normal growth early in the season on soil that was fallow-tilled part time or all through the previous year. The reason for this early suppression of growth is not fully understood. Tests in South Dakota show that banding phosphorus at planting has successfully corrected most early growth suppression on fallow fields, but has not consistently increased yields.

Post-emergence fertilizer application of phosphate and potash have not been effective.

Recommendation: Apply approximately 30 pounds of phosphate (P2O5) per acre, as a starter fertilizer when growing corn on fallow land. Observe earlier cautions for starter applications of amounts of N + K in starter fertilizers.

PHOSPHORUS-INDUCED ZINC DEFICIENCY

Under certain conditions (low to medium soil test zinc levels and/or high soil phosphorus levels) the use of phosphorus as a starter fertilizer has induced zinc deficiency, particularly in corn.

Recommendation: Do not exceed 30 lbs of P2O5 per acre in a band or as pop-up at planting time when soil tests recommend phosphorus use. Correct zinc deficiency according to soil test recommendations.

RECOMMENDED FERTILIZER RATES

Several factors can affect the results obtained from fertilizer. The yield desired and existing soil fertility levels are the most important factors when planning fertilizer rates.

Nitrogen fertilizer recommendations will vary, depending on test levels found in the soils and yield desired, as shown in Table 1. The newer, deeper nitrate-nitrogen soil test is perhaps the
most accurate tool today on which to base nitrogen recommendations. It is routinely run on all samples from fields being planted to non-legumes. It requires sampling depths to at least two feet. Nitrogen recommendations will be based on the less accurate organic matter tests, also shown in Table 1, where deep nitrate samples are not available. The use of the nitrate test is more accurate because it can detect the wide variability in carry-over levels of available nitrogen that occur in fields from year to year.

Both legumes and manure will increase levels of available nitrogen. Soil test procedures presently used cannot measure such nitrogen reserves accurately, so the nitrogen recommendations in Table 1 should be adjusted downward accordingly by farmers for these two fertility practices. Guidelines for adjusting the recommendations will accompany soil test recommendations returned to farmers.

PHOSPHORUS
The recommended rates for phosphorus application depending on soil tests and yield level are in Table 2. Phosphorus is not generally recommended for areas with a production potential of less than 40 bushels, unless soils test very low in this element. The recommendations are given in Table 2 as pounds of phosphate (P₂O₅) per acre.

POTASSIUM
The recommended rates of application for potassium, also based on yield potential, are given in Table 3. Rates are given as pounds of potash (K₂O) per acre.

ZINC
Research shows use of zinc fertilizer on corn and sorghum will usually increase net profit for those farmers whose fields have low zinc levels. The zinc soil test is the simplest and most economical method to detect low soil zinc levels. Zinc application rates, based on soil test levels, are shown in Table 4 and in Fact Sheet 674 as pounds of elemental plant food.

OTHER SECONDARY AND TRACE ELEMENTS
The other secondary and trace elements as yet unmentioned are equally important for corn and sorghum growth. Because of adequate soil reserves, applications of fertilizers containing these elements (i.e. sulfur, iron, boron, copper, manganese, etc.) have not significantly increased yields of these two crops. Upon occasion the use of sulfur has temporarily improved plant color and vigor but has failed to significantly increase corn yields produced in soil suspected of being low in this nutrient.

LIME
The use of lime is a very important fertility practice for soils located in states east of South Dakota. However, SDSU research to date shows the use of lime has not consistently increased corn yields, as well as that of other crops. This is the reason SDSU seldom, if ever, recommends the use of lime. Growers are cautioned against applying lime where it's not needed, because reductions in soil phosphorus availability and eventually crop yields can result.

FERTILIZER FOR IRRIGATED CORN
Recommended fertilizer rates for irrigated corn can be found in Tables 1, 2 and 3 depending on yield desired and existing soil test levels. Researchers and producers have found that incorporating part of the nitrogen prior to planting, and applying the rest as sidedressing or in the irrigation system, has given improved results. This practice would seem particularly beneficial on coarser-textured or sandy soil.

Table 1. Nitrogen Recommendations

<table>
<thead>
<tr>
<th>Yield</th>
<th>Total Nitrogen Required*</th>
<th>Organic Matter Soil Test - %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silage T/A</td>
<td>Grain BU/A</td>
<td>Lb/A</td>
</tr>
</tbody>
</table>

Lbs N/A Recommended

Table 2. Phosphorus Recommendations

<table>
<thead>
<tr>
<th>Yield</th>
<th>Phosphorus Soil Test—Lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silage T/A</td>
<td>Grain BU/A</td>
</tr>
</tbody>
</table>

Lbs P₂O₅/A Recommended

Table 3. Potassium Recommendations

<table>
<thead>
<tr>
<th>Yield</th>
<th>Potassium Soil Test—Lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silage T/A</td>
<td>Grain BU/A</td>
</tr>
</tbody>
</table>

Lbs K₂O/A Recommended

Table 4. Zinc Recommendations

<table>
<thead>
<tr>
<th>Soil Test</th>
<th>Lbs Zin/C/A* Recommended</th>
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</thead>
<tbody>
<tr>
<td>Irrigated</td>
<td>Dryland</td>
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<tr>
<td>Low</td>
<td>10</td>
</tr>
<tr>
<td>Marginal</td>
<td>5</td>
</tr>
<tr>
<td>Adequate</td>
<td>0</td>
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</tbody>
</table>

* Broadcast recommendation for inorganic type zinc fertilizer (i.e. zinc sulfate). Reduce by 50% if band-applied or by ½ if chelate types are used.
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