Fertilizing Corn and Sorghum in South Dakota: Dryland and Irrigation

Cooperative Extension South Dakota State University

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Recommended Citation
South Dakota State University, Cooperative Extension, "Fertilizing Corn and Sorghum in South Dakota: Dryland and Irrigation" (1972). SDSU Extension Fact Sheets. 1118.
https://openprairie.sdstate.edu/extension_fact/1118

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Fertilizing Corn and Sorghum in South Dakota

Dryland and Irrigated

Cooperative Extension Service
U. S. Department of Agriculture
South Dakota State University
Brookings
South Dakota farmers use more than 300,000 tons of fertilizer annually—about seven times more than 12 years ago. About half of the fertilizer applied in South Dakota is for corn and sorghum production, yet it is estimated that we could profitably use at least two times this amount on these two crops.

**PLANT NUTRIENTS FOR CORN, SORGHUM**

At least 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 or sorghum produced. If soil reserves cannot supply adequate amounts of these essential nutrients as required by our potential yields, then additional amounts of these nutrients must be provided as fertilizer. Nitrogen, phosphate, potash, and occasionally zinc, are the fertilizer nutrients most commonly found to be deficient, and therefore recommended for production of these crops in South Dakota.

**Nitrogen**

South Dakota soils have large quantities of nitrogen stored as organic matter (2,000-5,000 pounds of total N per acre in the plow layer). Release of this soil nitrogen however, is slow, usually only 1% to 2% of that total per year. This is seldom enough to meet the nutrient needs of annual crops such as corn and sorghum, thus additional nitrogen should be applied.

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 tips of these older leaves will first become yellow and this color change will follow up the midrib in a typical V-shaped pattern. The leaf will die prematurely depending on severity of 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 South Dakota soils ranges between 1,000 and 2,000 pounds per acre in the plow layer, the area of highest concentration in most soils. Most phosphorus in the soil, however, is in a form not readily available for plant uptake. Only a small quantity of phosphorus, usually less than a half pound per acre, is present in the soil solution at any one time. This phosphorus in the soil solution must be replenished from less available forms several hundred times during the growing season to furnish adequate phosphorus for plant growth.

Phosphorus in fertilizer reacts rapidly with soil, drastically restricting its movement in soil. The loss of phosphorus by leaching is negligible. Erosion and harvested crops are the principal means of depleting the soil's phosphorus supply.

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

**Potassium**

Most South Dakota soils are relatively high in total potassium (40,000-60,000 pounds K₂O per acre in the plow layer). However, available potassium, as measured by soil tests at South Dakota State University, represents only about 0.5% to 2.0% of the total amount in an average soil. Increasing numbers of potassium soil tests are falling in this medium to low range and receiving potash fertilizer recommendations. This suggests more farmers, particularly those in eastern South Dakota, should check the potassium levels with soil tests.

Note: Potassium deficiency symptoms of corn and sorghum 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 strips. The lower leaves are affected first. Stalk lodging may also be greater where potassium deficiencies exist.

**Sulfur**

Sulfur shortages in adjacent states have also been identified on some very sandy soils. In contrast, the use of sulfur does not increase crop yields on all soils even though surface soil sulfur tests show only low reserves exist. Information to date indicates the finer textured silt and clay soils in this area usually have adequate levels of sulfur.

Where sulfur use is reasonably certain of profitably increasing yields, commercial fertilizers such as ammonium sulfate (21-0-0), normal superphosphate (0-20-0), potassium sulfate (0-0-48), and thio-sulfate compounds can be used as sulfur sources. There may be others. Elemental sulfur has been used, however, it must be converted to the available sulfate form be-
fore it can be used by plants. This conversion is a slow process and therefore that material is a less desirable sulfur source.

Note: Sulfur deficiency can also be confused with nitrogen deficiency. Sulfur shortages affect young leaves, whereas nitrogen shortages show up on older leaves first and then more upward to young plant parts. Sulfur deficiency symptoms of corn and sorghum 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. Therefore, farmers should use caution before making large investments in such fertilizer programs.

KINDS OF FERTILIZER
Research indicates that fertilizer nutrients in either gaseous, liquid or dry forms are about equally effective pound for pound of properly applied plant food element. Thus plant food cost, convenience, and application equipment needed, become the determining factors as to which fertilizer to use.

TIME, METHOD OF APPLICATION
Fertilizer nutrients vary in chemical activity and movement in soil. For example, nitrogen is considered more mobil than phosphorus or potassium. Because of that difference and others, method and time of fertilizer application can greatly affect results. There are a number of choices available. In general, phosphorus and potassium should be applied at or before planting time for best results. This assures incorporation into the soil, which is very important if crops are to get maximum benefit from these fertilizers.

Nitrogen, however, can be surface applied or injected before as well as after planting. Again, some type of incorporation is recommended.

Research shows properly incorporated fall and spring fertilizer applications to be about equally effective on most fields. One possible exception, which requires special consideration, is fall nitrogen application on sandy soils. Phosphorus and potash fertilizers can be applied prior to as well as during the fall and spring tillage operations. Nitrogen can also be applied in the same manner on most medium to fine textured soils. However, leaching losses of fall applied nitrogen can measurably increase as the amount and depth of sand in the surface soil and rainfall increase. In those cases, nitrogen should be applied in the spring or as a sidedress method.

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 unfrozen soil. Nitrogen loss as a gas can also result from surface applications. Here again, incorporating the material right after application will minimize such losses.

Starter
Young seedling growth frequently lacks vigor early in the spring under cool wet soil conditions. Starter fertilizer placed near the seed at planting time can stimulate early plant growth. An early vigorous start, when accompanied by adequate moisture or rainfall during the growing season, can mean additional yield and/or earlier maturity.

Starter fertilizer use in South Dakota has given erratic results with yield decreases having actually occurred some years. The average gain over a longer period, however, has averaged about 3 to 4 bushels per acre per year. 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. Additional nitrogen is usually needed and can be applied as preplant or sidedress.

Starter fertilizers may be applied in any one of three ways, depending on equipment availability: (1) band, (2) with seed (pop-up) and (3) split boot.

The current most commonly used method for applying starter is band placement. This method places the fertilizer 1 to 2 inches to the side of, and slightly below, the seed. Fertilizer placement with the seed, commonly called "pop-up," is also a recommended method. Limited South Dakota research shows this method of applying starter fertilizer to be equal to or slightly better than that of band placement. Keep in mind, however, excessive fertilizer salts placed with the seed as in pop-up can delay or reduce seedling emergence, particularly if dry soil conditions exist. It is important, therefore, to use very low fertilizer rates when placing it with the seed. In most instances, it will be necessary to use broadcast applications in addition to starter when pop-up placement is used in applying recommended rates. Total N+K actual plant food applied as pop-up should not exceed 8 to 10 pounds per acre in 40-inch rows, and equivalent amounts in narrower rows. Fertilizers with plant food ratios of 1:4:0, 1:3:0, 1:4:2, and so on are recommended for use as pop-up. Split boot methods of applying starter, while commonly used at one time, are not widely used today. Reductions in stand can occur if plant food quantities outlined 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 combination with 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 it is no longer possible to get into the field. For maximum response 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 Corn and Sorghum
Lister-planted corn and sorghum present some special fertilizer placement problems. The practice of broadcasting and plowing fertilizer under for surface planted crops, is ineffective for lister-planted crops because plowing normally does not precede listing. The action of the lister moldboards places the fertilizer in the ridge between the rows where it is relatively unavailable. This is particularly true for phosphorus, which moves little in the soil during one growing season.

There are fertilizer attachments designed for use on a lister which place the fertilizer near the seed. They work well on coarse-textured soils but apparently work less effectively on the more clayey soils. The use of these attachments is encouraged, however, because the fertilizer is placed at or near the seed where it becomes readily available to the seedling plants.
Many listers are equipped with fertilizer boxes but without placement equipment. With this system, the fertilizer is applied just ahead of the covering disks and is mixed with the seed and soil. There is some danger of germination damage if excessive nitrogen and potash fertilizer comes in contact with the seed when it is applied in this manner. Despite these objections, this may be a reasonably practical method of applying small amounts of phosphorus and potassium for listed corn and sorghum on higher clay content soils.

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 have observed for some time how corn and sorghum frequently fail to make normal growth early in the season on soil fallow-tilled part or all of the previous year. The reason for this early suppression of growth is not fully understood.

Tests in South Dakota, however, show that banding phosphate at planting time has successfully eliminated the early growth suppression on fallow fields.

Post-emergence fertilizer application of phosphate and potash have seemed ineffective.

Recommendation: Apply 30 - 40 pounds of phosphate (P₂O₅) per acre or more depending on P soil test, as a starter fertilizer when growing corn and sorghum on fallow land.

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. Phosphorus use as a starter should be based on soil test recommendations.

Recommendation: Band phosphorus at seeding time, when justified by a soil test, at rates not to exceed 50 pounds P₂O₅ per acre except on very low P testing soils.

FERTILIZER APPLICATION RATES

Profitable fertilizer use is dependent on climate, soils, levels of management practices used, and yield desired. These factors vary widely in South Dakota. For that reason, fertilizer recommendations, shown in the accompanying tables, are based on yield potentials and soil tests.

Soil Test Recommendations

Soil testing is perhaps the best tool we have to measure available plant food levels in the soil. Based on that information, fertilizer rates can be selected which will correct deficiencies and provide the plant food needs of desired crop yields. This takes the guess work out of selecting fertilizer rates. SDSU soil tests can measure organic matter, nitrates, available phosphorus, potash, zinc, calcium, magnesium, salts, and acidity. Soil sampling procedures are very important and vary between tests. Consult your county agent for assistance and instructions for sampling.

Nitrogen

Nitrogen fertilizer recommendations, until recently, have been based on “organic matter soil test” levels and on yield potential desired as shown in Table 1. It is a basic recommendation for a continuous cropping system that does not include adjustments for legumes or the use of manure.

Here is an example of how a recommendation is made. Let’s assume that you are farming in an area with a per-acre production potential of 60 bushels of corn. Your rotation contains no legumes or manure and the soil test for organic matter is 2.2%. The 2.2% organic matter is in the 2.1-3% range, Table 1. The nitrogen fertilizer recommendation for a 2.2% soil test for 60 bushels therefore would be 60 pounds of nitrogen.

Both legumes and manure will increase soil nitrogen levels. It is necessary therefore to adjust the above basic nitrogen recommendation downward if legumes have been used in the rotation or manure has been added recently to the soil. Guidelines for adjusting the nitrogen recommendations are discussed in Agronomy Pamphlet 31 as revised March, 1969, entitled “Explanations of Soil Test Recommendations” which is returned with each soil test recommendation.

The newer “nitrate soil test” is a very valuable tool in adjusting the nitrogen recommendations which normally are based only on the organic matter test. This nitrate test is now run upon request. It measures residual soil nitrate levels, not determined in the regular organic matter test. Any need-adjustments in nitrogen rates, based on these test results, are made at the Lab. This inexpensive test will detect excessive soil nitrogen buildups which suggest to the operator somewhat lower fertilizer rates can be used without reducing yield. It can also alert operators to the need for additional nitrogen to prevent yield loss due to inadequate soil nitrogen reserves.

Phosphorus

The recommended rates for phosphorus application depending on yield level are given 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).

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).

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 as pounds of elemental plant food.

Fertilizer for Irrigated Corn and Sorghum

Recommended fertilizer rates for irrigated corn and sorghum 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 Rate Recommendations

<table>
<thead>
<tr>
<th>Nitrogen Potential Bu./A.</th>
<th>N. Soil Test % Organic Matter</th>
<th>Recommendation Lbs. N./A.</th>
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</thead>
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<tr>
<td>190</td>
<td>Less than 2.0</td>
<td>235</td>
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<tr>
<td>2.1-3.0</td>
<td>220</td>
<td></td>
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<tr>
<td>3.1-4.0</td>
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<tr>
<td>4.1-up</td>
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(Table 1—continued next page)
### Table 1—continued

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<tr>
<th>Value</th>
<th>Description</th>
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<td>Less than 2.0</td>
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<tr>
<td>2.1-3.0</td>
<td>150</td>
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<tr>
<td>3.1-4.0</td>
<td>135</td>
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<tr>
<td>4.1-up</td>
<td>105</td>
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</table>

### Table 2. Recommended Rates of Phosphorus

<table>
<thead>
<tr>
<th>Yield Potential</th>
<th>Fertilizer Placement</th>
<th>Very Low 0-5</th>
<th>Low 6-15</th>
<th>Medium 16-25</th>
<th>Medium-High 26-40</th>
<th>High 41+</th>
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<tr>
<td>145+</td>
<td>Broadcast only</td>
<td>120</td>
<td>80</td>
<td>60</td>
<td>45</td>
<td>0</td>
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<tr>
<td>95-140</td>
<td>Broadcast only</td>
<td>90</td>
<td>50</td>
<td>30</td>
<td>25</td>
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<td>55-90</td>
<td>Broadcast only</td>
<td>60</td>
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<tr>
<td>Less than 50</td>
<td>Broadcast only</td>
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<tr>
<td></td>
<td>Starter*</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>0</td>
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*The 15 lbs. of K₂O recommended as a starter can be applied in addition to the broadcast K₂O recommended.

### Table 3. Recommended Rates of Potassium

<table>
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<th>Yield Potential</th>
<th>Fertilizer Placement</th>
<th>Very Low 0-80</th>
<th>Low 81-150</th>
<th>Medium 151-250</th>
<th>High 251-400</th>
<th>Very High 400+</th>
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<tr>
<td>145+</td>
<td>Broadcast</td>
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<td>200</td>
<td>120</td>
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<td>0</td>
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<td>Starter*</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
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<tr>
<td>95-140</td>
<td>Broadcast</td>
<td>150</td>
<td>90</td>
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</table>

*The 15 lbs. of K₂O recommended as a starter can be applied in addition to the broadcast K₂O recommended.

### Table 4. Zinc Rate Recommendations

<table>
<thead>
<tr>
<th>Zinc Soil Test</th>
<th>Lbs. Zn/A.</th>
<th>*Recommendation</th>
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<tr>
<td>Low</td>
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<tr>
<td>Medium</td>
<td>2-10</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

*Apply once each 5 to 6 years unless it is established that zinc deficiency continues to limit yield.