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SDSU Extension fertilizer recommendations are based on field research in South Dakota and neighboring states. However, information from outside this region is used where only limited local data was available. The tables were developed as part of continuing cooperation between these states to standardize recommendations across the three-state area.

The recommendations in the tables are generated by equations and, therefore, change consistently across yield goals and soil test levels. Due to space limitations, only the recommendations for selected yield goals and the mean soil test level of each soil test range (very low, low, medium, high, and very high) have been printed in this guide.

Where specific yield goals and/or soil test values are not listed in the table, recommendations can be determined by interpolating between the nearest two yield goals and soil test levels. In addition, recommendations for nitrogen, phosphorus, and potassium also can be calculated using the equations listed in each crop nutrient recommendation section and summarized in Table 3.

Statements that clarify or modify the recommendations are listed in each crop nutrient recommendation section.

**Soil Test Categories**

Soil test levels for all nutrients in the tables except nitrate nitrogen have been put into categories labeled very low (VL), low (L), medium (M), high (H), and very high (VH). These categories represent a decreasing probability of a yield response to broadcast fertilizer ranging from more than an 80% chance of a response at the very low soil test level to less than a 20% chance when soil tests are in the very high range. The probability of a yield response to fertilizer in the medium soil test range is estimated at between 40 and 60%. Soil test categories are listed in Table 1.

Soil test categories for the nitrate-nitrogen test are not given because calibration of the nitrate-nitrogen test depends on yield goal and crop to be grown. Categories listed for iron, manganese, copper, boron, calcium, and magnesium are not based entirely from calibration studies in this area because response to these nutrients is extremely limited in South Dakota. Manganese, copper, boron, calcium, and magnesium deficiencies have not been confirmed in South Dakota.

**Nitrogen**

The “soil N plus supplemental N required” column in the tables is not the amount of fertilizer N to apply. Nitrogen credits must be subtracted from this requirement. The remainder is the N fertilizer recommendation. Nitrogen credits include:

- **Deep Nitrate Soil Test**: If a 2-foot nitrate soil test is not available, then long-term average soil tests of 40 lbs/ac for re-cropped fields and 75 lbs/ac for fallow fields should be used when making an N recommendation. If a 2- to 4-foot deep nitrate test is available and it is more than 30 lbs/ac, then reduce the nitrogen recommendation by 4 lbs/ac for each 5-lb increment above 30 lbs. For example, if there are 50 lbs of NO₃-N in the 2-4-foot depth, credit 16 lbs (80% of 20 lbs).

- **Legume credits**: Legume credits used in South Dakota are listed in Table 2.
Table 1. Soil Test Calibration Levels Used in South Dakota and the probability that fertilizer applications will increase crop yield.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Soil Test</th>
<th>Very Low (VL)</th>
<th>Low (L)</th>
<th>Medium (M)</th>
<th>High (H)</th>
<th>Very High (VH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of yield response</td>
<td>80%</td>
<td>60-80%</td>
<td>40-60%</td>
<td>20-40%</td>
<td>&lt;20%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ppm extractable (0-6 inch samples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus Bray P-1</td>
</tr>
<tr>
<td>Phosphorus Olsen</td>
</tr>
<tr>
<td>Potassium NH₄Ac</td>
</tr>
<tr>
<td>Zinc (¹) DTPA</td>
</tr>
<tr>
<td>Iron (²) DTPA</td>
</tr>
<tr>
<td>Manganese (³) DTPA</td>
</tr>
<tr>
<td>Copper (³) DTPA</td>
</tr>
<tr>
<td>Boron (³) Hot H₂O</td>
</tr>
<tr>
<td>Magnesium (³) NH₄Ac</td>
</tr>
<tr>
<td>Calcium (³) NH₄Ac</td>
</tr>
<tr>
<td>Sulfur 500 ppm P</td>
</tr>
<tr>
<td>Chloride (⁴) 0.01M Ca(NO₃)</td>
</tr>
</tbody>
</table>

¹Calibration only for corn, sorghum, flax, potatoes, and edible beans
²pH is a better indicator to predict iron deficiency
³Deficiencies have not been confirmed in South Dakota
⁴Calibration only for wheat, barley, and rye

The SDSU Extension soil fertility recommendation can be increased by 30 lbs when no-till or strip-till is used. These tillage systems result in slower breakdown of organic nitrogen, requiring higher nitrogen fertilizer recommendations.

c) Manure: The fertilizer value of manure varies with age, type of animal, storage, and application procedures. The only accurate method of determining manure nutrient credits is with a manure analysis. Manure analysis should include both inorganic (ammonia) nitrogen and organic nitrogen. Credit 35% of the organic nitrogen in manure. Credit 98% of the inorganic nitrogen if liquid manure is injected below the soil surface. If manure is broadcast on the surface and incorporated within 24 hours, credit 90% of the inorganic N. If it is not incorporated until 5 days after application or later, credit only 20% of the inorganic N since most inorganic N may have volatilized as manure dries.

Estimates for the nutrient content of manures can be found in Midwest Plan Service -18, Manure Characteristics (MWPS-18, section 1, 2nd edition, 2004). It is available from a MWPS South Dakota representative at 605-688-5667.

Table 2. Legume N Credits

<table>
<thead>
<tr>
<th>Previous Crop</th>
<th>Nitrogen Credit (lbs/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans, edible beans, peas, lentils and other annual legumes</td>
<td>40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Previous Crop</th>
<th>Nitrogen Credit (lb/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa and legume green manure crops (sweet clover, red clover, etc) (¹)(²)</td>
<td>&gt; 5</td>
</tr>
<tr>
<td></td>
<td>3-5</td>
</tr>
<tr>
<td></td>
<td>1-2</td>
</tr>
<tr>
<td></td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

¹When no-tilling into alfalfa and legume green manure crops, use half credit.
²For 2nd year following alfalfa and legume green manure crops, use half credit.
Table 3. Nutrient Recommendation Equations Used by SDSU Extension, September 2005

<table>
<thead>
<tr>
<th>Code, Crop, Yield Unit</th>
<th>Nitrogen Recommendation</th>
<th>P₂O₅ Recommendation Olsen test</th>
<th>K₂O Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>01, Alfalfa, ton</td>
<td>none</td>
<td>$(18.57 - (1.16 \times STP)) \times YG$</td>
<td>$(55.71 - (0.38 \times STK)) \times YG$</td>
</tr>
<tr>
<td>02, Alfalfa-Grass, ton</td>
<td>none</td>
<td>$(18.57 - (1.16 \times STP)) \times YG$</td>
<td>$(55.71 - (0.38 \times STK)) \times YG$</td>
</tr>
<tr>
<td>03, Alfalfa (new seeding), ton</td>
<td>none</td>
<td>$(18.57 - (1.16 \times STP)) \times YG$</td>
<td>$(55.71 - (0.38 \times STK)) \times YG$</td>
</tr>
<tr>
<td>04, Grass, ton</td>
<td>25 x YG</td>
<td>45.0 $- (3.45 \times STP)$</td>
<td>80.0 $- (0.53 \times STK)$</td>
</tr>
<tr>
<td>08, Sudan grass, ton</td>
<td>25 x YG $- STN - LC$</td>
<td>(110.0 $- (0.7 \times STP)) \times YG$</td>
<td>(43.0 $- (0.3 \times STK)) \times YG$</td>
</tr>
<tr>
<td>09, Grass (new seeding), ton</td>
<td>25 x YG</td>
<td>45.0 $- (3.45 \times STP)$</td>
<td>80.0 $- (0.53 \times STK)$</td>
</tr>
<tr>
<td>10, Corn (grain), bu</td>
<td>1.2 x YG $- STN - LC$</td>
<td>(0.700 $- (0.044 \times STP)) \times YG$</td>
<td>(1.1660 $- (0.0073 \times STK)) \times YG$ (^{(1)})</td>
</tr>
<tr>
<td>11, Corn (silage), ton</td>
<td>10.4 x YG $- STN - LC$</td>
<td>(5.62 $- (0.35 \times STP)) \times YG$</td>
<td>(9.50 $- (0.06 \times STK)) \times YG$ (^{(1)})</td>
</tr>
<tr>
<td>12, Sorghum, bu</td>
<td>1.1 x YG $- STN - LC$</td>
<td>(0.666 $- (0.041 \times STP)) \times YG$</td>
<td>(0.875 $- (0.0058 \times STK)) \times YG$</td>
</tr>
<tr>
<td>14, Soybean, bu</td>
<td>none</td>
<td>1.55 $(1.55 - (0.14 \times STP)) \times YG$</td>
<td>2.2 $(2.2 - (0.0183 \times STK)) \times YG$</td>
</tr>
<tr>
<td>15, Edible Beans, lbs</td>
<td>0.05 x YG $- STN - LC$</td>
<td>(0.0231 $- (0.0014 \times STP)) \times YG$</td>
<td>(0.0346 $- (0.00021 \times STK)) \times YG$</td>
</tr>
<tr>
<td>16, Barley (feed), bu</td>
<td>1.7 x YG $- STN - LC$</td>
<td>(0.785 $- (0.05 \times STP)) \times YG$</td>
<td>(1.286 $- (0.0085 \times STK)) \times YG$</td>
</tr>
<tr>
<td>17, Barley (malting), bu</td>
<td>1.5 x YG $- STN - LC$</td>
<td>(0.785 $- (0.05 \times STP)) \times YG$</td>
<td>(1.286 $- (0.0085 \times STK)) \times YG$</td>
</tr>
<tr>
<td>18, Wheat (winter), bu</td>
<td>2.5 x YG $- STN - LC$</td>
<td>(1.071 $- (0.067 \times STP)) \times YG$</td>
<td>(2.71 $- (0.017 \times STK)) \times YG$</td>
</tr>
<tr>
<td>19, Wheat (spring), bu</td>
<td>2.5 x YG $- STN - LC$</td>
<td>(1.071 $- (0.067 \times STP)) \times YG$</td>
<td>(2.71 $- (0.017 \times STK)) \times YG$</td>
</tr>
<tr>
<td>20, Rye, bu</td>
<td>2.5 x YG $- STN - LC$</td>
<td>(1.071 $- (0.067 \times STP)) \times YG$</td>
<td>(2.71 $- (0.017 \times STK)) \times YG$</td>
</tr>
<tr>
<td>21, Oats, bu</td>
<td>1.3 x YG $- STN - LC$</td>
<td>(0.644 $- (0.041 \times STP)) \times YG$</td>
<td>(1.277 $- (0.0086 \times STK)) \times YG$</td>
</tr>
<tr>
<td>22, Flax, bu</td>
<td>3.0 x YG $- STN - LC$</td>
<td>(1.17 $- (0.073 \times STP)) \times YG$</td>
<td>(2.2 $- (0.014 \times STK)) \times YG$</td>
</tr>
<tr>
<td>23, Rape Seed, Canola, cwt</td>
<td>6.5 x YG $- STN - LC$</td>
<td>(3.6 $- (0.22 \times STP)) \times YG$</td>
<td>(5.4 $- (0.034 \times STK)) \times YG$</td>
</tr>
<tr>
<td>24, Mustard, cwt</td>
<td>6.5 x YG $- STN - LC$</td>
<td>(3.6 $- (0.22 \times STP)) \times YG$</td>
<td>(5.4 $- (0.034 \times STK)) \times YG$</td>
</tr>
<tr>
<td>25, Millet, lbs</td>
<td>0.035 x YG $- STN - LC$</td>
<td>(0.0171 $- (0.0014 \times STP)) \times YG$</td>
<td>(0.03 $- (0.00018 \times STK)) \times YG$</td>
</tr>
<tr>
<td>26, Potatoes, cwt</td>
<td>0.4 x YG $- STN - LC$</td>
<td>(0.5 $- (0.034 \times STP)) \times YG$</td>
<td>(0.85 $- (0.0057 \times STK)) \times YG$</td>
</tr>
<tr>
<td>27, Sunflowers, lbs</td>
<td>0.05 x YG $- STN - LC$</td>
<td>(0.0225 $- (90.0014 \times STP)) \times YG$</td>
<td>(0.041 $- (0.00027 \times STK)) \times YG$</td>
</tr>
<tr>
<td>28, Garden</td>
<td>3.5 $(3.5 - (0.03 \times STN))$</td>
<td>3.6 $(3.6 - (0.23 \times STP))$</td>
<td>5.4 $(5.4 - (0.03 \times STK))$</td>
</tr>
<tr>
<td>29, Fallow</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>30, Buckwheat, bu</td>
<td>2.2 x YG $- STN - LC$</td>
<td>(1.32 $- (10.083 \times STP)) \times YG$</td>
<td>(1.86 $- (0.0116 \times STK)) \times YG$</td>
</tr>
<tr>
<td>31, Lawn</td>
<td>4.0 $(4.0 - (0.4 \times STN))$</td>
<td>2.5 $(2.5 - (0.16 \times STP))$</td>
<td>5.0 $(5.0 - (0.286 \times STK))$</td>
</tr>
<tr>
<td>32, Lawn (new seeding)</td>
<td>2.0 $(2.0 - (0.25 \times STN))$</td>
<td>5.0 $(5.0 - (0.32 \times STP))$</td>
<td>5.0 $(5.0 - (0.286 \times STK))$</td>
</tr>
<tr>
<td>33, Safflower, lbs</td>
<td>0.05 x YG $- STN - LC$</td>
<td>(0.027 $- (0.0017 \times STP)) \times YG$</td>
<td>(0.048 $- (0.0003 \times STK)) \times YG$</td>
</tr>
<tr>
<td>36, Field Pea, Lentil, Chickpea, lbs</td>
<td>none</td>
<td>$(0.0171 - (0.0011 \times STP)) \times YG$</td>
<td>$(0.03 - (0.00018 \times STK)) \times YG$</td>
</tr>
</tbody>
</table>

Abbreviations: YG = yield goal; STN = soil test nitrogen (0-2 ft), lbs/ac; STP = soil test Olsen phosphorus (ppm); STK = soil test potassium (ppm); LC = legume credit (lbs/ac)

\(^{(1)}\) 60-lb minimum $K_2O$ recommendation when potassium is recommended for corn.
The equations used to calculate nitrogen recommendations are included in Table 3.

The following are two nitrogen recommendation examples:

Example 1
145 bu/ac corn yield goal, 35 lbs/ac 2-foot NO₃-N soil test, and soybeans as a previous crop:

\[ 145 \text{ bu/ac} \times 1.2 \text{ lbs N/bu} = 174 \text{ lbs N/ac requirement.} \]
\[ 174 \text{ lbs N/ac requirement} - 35 \text{ lbs/ac soil nitrate N} - 40 \text{ lbs/ac legume credit} = 99 \text{ lbs N/ac recommended.} \]

Example 2
50 bushel wheat yield goal in no-till, 40 lbs/ac 2-foot NO₃-N soil test:

\[ 50 \text{ bu/ac} \times 2.5 \text{ lbs N/bu} = 125 \text{ lbs N/ac requirement.} \]
\[ 125 \text{ lbs N/ac requirement} - 40 \text{ lbs/ac soil nitrate N} + 30 \text{ lbs N/ac for no-till} = 115 \text{ lbs N/ac recommended.} \]

Phosphorus and Potassium
Phosphorus and potassium soil test results in this guide are stated in parts per million (ppm) and not pounds per acre.

Interpretation for both the Olsen and Bray phosphorus soil test procedures are listed in this guide. The equations used to calculate phosphorus and potassium recommendations are listed in Table 3 and in each crop nutrient management section.

Phosphorus and potassium recommendations in the tables are the amounts to be applied as a broadcast application. Banding P and K near the seed as a starter frequently results in more efficient use of these fertilizers. Therefore, when starter phosphorus and potassium are used, rates can sometimes be reduced by one-third or more and still reach maximum yield. However, when rates are reduced, application may be below maintenance levels, resulting in a soil test level decline with time, especially with phosphorus.

Seed Placed Fertilizer
Fertilizer placed in contact with the seed (starter fertilizer) can often be very efficiently used by the plant. However, fertilizer placed in contact with the seed can also cause seed injury or death. To minimize potential injury, fertilizer rates placed with the seed, especially nitrogen and potassium, need to be kept low.

It is difficult to predict the exact rate which will cause seed injury since it is dependent on soil and environmental conditions. Injury from any given fertilizer is much more likely when soil is dry or sandy compared to wet or heavy textured. Row width also makes a large difference in acceptable rate per acre since narrower rows mean there are more feet of row per acre than wider rows. In general, seed injury is caused by too much “salt” per acre. However, nitrogen fertilizers such as urea that form ammonia in soil can cause severe injury, as can thiosulfate. Table 4 lists suggested fertilizer rates to limit seed placed fertilizer injury from common fertilizers. For crops not listed in the table, see statements after the crop N, P, and K recommendation equations.

Table 4. Suggested Guidelines¹ for Seed Placed Fertilizer to Minimize Seed Injury

<table>
<thead>
<tr>
<th>Crop and Row Spacing</th>
<th>Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn in 30-inch rows</td>
<td>• up to 10 lbs/ac N + K₂O</td>
</tr>
<tr>
<td></td>
<td>• no urea or UAN</td>
</tr>
<tr>
<td>Soybean and Sunflower in 30-inch rows</td>
<td>• no fertilizer with the seed</td>
</tr>
<tr>
<td>Soybean in 7.5-inch rows</td>
<td>• up to 10 lbs/ac N + K₂O</td>
</tr>
<tr>
<td></td>
<td>• no urea or UAN</td>
</tr>
<tr>
<td>Wheat, Oats, Barley, Rye in 7-inch rows</td>
<td>• up to 25 lbs/ac N + K₂O</td>
</tr>
</tbody>
</table>

¹ Reduce rate 50% for dry or sandy soil. Change rate proportionately for other row widths. Do not put thiosulfate with the seed.
Corn – Nitrogen, Phosphorus, and Potassium Recommendations


**Nitrogen**

NFR = 1.2 x YG – STN - LC

**Phosphorus**

- Olsen P
  
PFR = (0.700 – (0.044 x STP)) x YG
- Bray-1 P
  
PFR = (0.700 – (0.035 x STP)) x YG

**Potassium**

KFR = (1.1660 – (0.0073 x STK)) x YG

*(60-lb minimum when K is recommended)*

Acronym Definitions

- NFR = N fertilizer rate (lbs N/ac)
- YG = Yield goal (bu/ac)
- STN = Soil test nitrate-N-2 ft. (lbs/ac)
- LC = Legume credit (lbs/ac)
- PFR = P fertilizer rate (lbs P2O5/ac)
- STP = Soil test phosphorus (ppm)
- KFR = K fertilizer rate (lbs K2O/ac)
- STK = Soil test potassium (ppm)

Corn Statements

1. Nitrogen fertilizers
   a. If using very reduced tillage systems including strip-till and no-till systems, then 30 lbs/ac of additional nitrogen should be considered in the above N recommendation.

2. Phosphorus fertilizers
   a. The P2O5 recommendation can be reduced by one third if applying as a starter.
      i. If reduced by one third, soil test levels may be lowered over time.

3. Starter fertilizers
   a. Nitrogen plus K2O applications in contact with the seed should be limited to 10 lbs/ac for 30-inch rows.
   b. Nitrogen as urea, UAN, and ammonium thiosulfate (12-0-26) should NOT be in contact with the seed.
   c. Reduce these amounts by half for dry or coarse-textured soils.

4. If the previous “crop” was fallow or potatoes: The growth of corn after fallow or potatoes is sometimes not satisfactory. To correct this, apply 20-30 lbs/ac of P2O5 as a starter.

Table 5. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for corn calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs-N/ac-2’</td>
<td>lbs P2O5/ac</td>
<td>lbs K2O/ac</td>
</tr>
<tr>
<td></td>
<td>bu/ac</td>
<td>VL</td>
<td>L</td>
</tr>
<tr>
<td>80</td>
<td>96</td>
<td>51</td>
<td>37</td>
</tr>
<tr>
<td>100</td>
<td>120</td>
<td>63</td>
<td>46</td>
</tr>
<tr>
<td>120</td>
<td>144</td>
<td>76</td>
<td>55</td>
</tr>
<tr>
<td>140</td>
<td>168</td>
<td>89</td>
<td>64</td>
</tr>
<tr>
<td>160</td>
<td>192</td>
<td>101</td>
<td>73</td>
</tr>
<tr>
<td>180</td>
<td>216</td>
<td>114</td>
<td>82</td>
</tr>
<tr>
<td>200</td>
<td>240</td>
<td>127</td>
<td>92</td>
</tr>
<tr>
<td>220</td>
<td>264</td>
<td>139</td>
<td>101</td>
</tr>
<tr>
<td>240</td>
<td>288</td>
<td>152</td>
<td>110</td>
</tr>
</tbody>
</table>
Corn Silage – Nitrogen, Phosphorus, and Potassium Recommendations


Nitrogen

\[ \text{NFR} = 10.4 \times \text{YG} - \text{STN} - \text{LC} \]

Acronym Definitions

- **NFR** = N fertilizer rate (lbs N/ac)
- **YG** = Yield goal (bu/ac)
- **STN** = Soil test nitrate-N-2 ft. (lbs/ac)
- **LC** = Legume credit (lbs/ac)

Phosphorus

- **Olsen P**
  \[ \text{PFR} = (5.62 - (0.35 \times \text{STP})) \times \text{YG} \]
- **Bray-1 P**
  \[ \text{PFR} = (5.62 - (0.28 \times \text{STP})) \times \text{YG} \]

Potassium

\[ \text{KFR} = (9.50 - (0.06 \times \text{STK})) \times \text{YG} \]

*(60-lb minimum when K is recommended)*

**Acronym Definitions**

- **NFR** = N fertilizer rate (lbs N/ac)
- **YG** = Yield goal (bu/ac)
- **STN** = Soil test nitrate-N-2 ft. (lbs/ac)
- **LC** = Legume credit (lbs/ac)
- **PFR** = P fertilizer rate (lbs P₂O₅/ac)
- **STP** = Soil test phosphorus (ppm)
- **KFR** = K fertilizer rate (lbs K₂O/ac)
- **STK** = Soil test potassium (ppm)

Corn Silage Statements

1. Nitrogen fertilizers
   a. If using very reduced tillage systems including strip-till and no-till systems, then 30 lbs/ac of additional nitrogen should be considered in the above N recommendation.

2. Phosphorus fertilizers
   a. The P₂O₅ recommendation can be reduced by one third if applying as a starter.
      i. If reduced by one third, soil test levels may be lowered over time.

3. Starter fertilizers
   a. Nitrogen plus K₂O applications in contact with the seed should be limited to 10 lbs/ac for 30-inch rows.
   b. Nitrogen as urea, UAN, and ammonium thiosulfate (12-0-26) should NOT be in contact with the seed.
   c. Reduce these amounts by half for dry or coarse-textured soils.

4. If the previous “crop” was fallow or potatoes: The growth of corn after fallow or potatoes is sometimes not satisfactory. To correct this, apply 20-30 lbs/ac of P₂O₅ as a starter.

Table 6. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for corn silage calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>bu/ac</td>
<td>lbs-N/ac-2'</td>
<td>lbs P₂O₅/ac</td>
<td>lbs K₂O/ac</td>
</tr>
<tr>
<td>6</td>
<td>62</td>
<td>31</td>
<td>60</td>
</tr>
<tr>
<td>10</td>
<td>104</td>
<td>51</td>
<td>83</td>
</tr>
<tr>
<td>14</td>
<td>146</td>
<td>71</td>
<td>116</td>
</tr>
<tr>
<td>18</td>
<td>187</td>
<td>92</td>
<td>149</td>
</tr>
<tr>
<td>22</td>
<td>229</td>
<td>112</td>
<td>183</td>
</tr>
<tr>
<td>26</td>
<td>270</td>
<td>132</td>
<td>216</td>
</tr>
</tbody>
</table>
Sorghum – Nitrogen, Phosphorus, and Potassium Recommendations


Nitrogen

\[ NFR = 1.1 \times YG - STN - LC \]

Phosphorus

- **Olsen P**
  \[ PFR = (0.666 - (0.041 \times STP)) \times YG \]
- **Bray-1 P**
  \[ PFR = (0.666 - (0.033 \times STP)) \times YG \]

Potassium

\[ KFR = (0.875 - (0.0058 \times STK)) \times YG \]

Acronym Definitions

- **NFR** = N fertilizer rate (lbs N/ac)
- **YG** = Yield goal (bu/ac)
- **STN** = Soil test nitrate-N-2 ft. (lbs/ac)
- **LC** = Legume credit (lbs/ac)
- **PFR** = P fertilizer rate (lbs P₂O₅/ac)
- **STP** = Soil test phosphorus (ppm)
- **KFR** = K fertilizer rate (lbs K₂O/ac)
- **STK** = Soil test potassium (ppm)

Sorghum Statements

1. Nitrogen fertilizers
   - a. If using very reduced tillage systems including strip-till and no-till systems, then 30 lbs/ac of additional nitrogen should be considered in the above N recommendation.

2. Phosphorus fertilizers
   - a. The P₂O₅ recommendation can be reduced by one third if applying as a starter.
     - i. If reduced by one third, soil test levels may be lowered over time.

3. Starter fertilizers
   - a. Nitrogen plus K₂O applications in contact with the seed should be limited to 10 lbs/ac for 30-inch rows.
   - b. Nitrogen as urea, UAN, and ammonium thiosulfate (12-0-26) should NOT be in contact with the seed.
   - c. Reduce these amounts by half for dry or coarse-textured soils.

4. If the previous “crop” was fallow or potatoes: The growth of sorghum after fallow or potatoes is sometimes not satisfactory. To correct this, apply 20-30 lbs/ac of P₂O₅ as a starter.

Table 7: Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for sorghum calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>VL</td>
<td>L</td>
</tr>
<tr>
<td>bu/ac</td>
<td>lbs-N/ac-2'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>66</td>
<td>36</td>
<td>26</td>
</tr>
<tr>
<td>80</td>
<td>88</td>
<td>48</td>
<td>35</td>
</tr>
<tr>
<td>100</td>
<td>110</td>
<td>60</td>
<td>44</td>
</tr>
<tr>
<td>120</td>
<td>132</td>
<td>73</td>
<td>53</td>
</tr>
<tr>
<td>140</td>
<td>154</td>
<td>85</td>
<td>62</td>
</tr>
<tr>
<td>160</td>
<td>176</td>
<td>97</td>
<td>70</td>
</tr>
</tbody>
</table>
Sunflowers – Nitrogen, Phosphorus, and Potassium Recommendations

### Equations for sunflowers N, P, and K recommendations.

**Nitrogen**

\[
NFR = 0.05 \times YG – STN – LC
\]

**Acronym Definitions**

NFR = N fertilizer rate (lbs N/ac)

YG = Yield goal (lbs/ac)

STN = Soil test nitrate-N-2 ft. (lbs/ac)

LC = Legume credit (lbs/ac)

**Phosphorus**

- **Olsen P**
  \[
PFR = (0.0225 – (0.0014 \times STP)) \times YG
\]

- **Bray-1 P**
  \[
PFR = (0.0225 – (0.0011 \times STP)) \times YG
\]

**Acronym Definitions**

PFR = P fertilizer rate (lbs P₂O₅/ac)

STP = Soil test phosphorus (ppm)

**Potassium**

\[
KFR = (0.041 – (0.00027 \times STK)) \times YG
\]

**Acronym Definitions**

KFR = K fertilizer rate (lbs K₂O/ac)

STK = Soil test potassium (ppm)

### Sunflowers Statements

1. Nitrogen fertilizers
   a. If using very reduced tillage systems including strip-till and no-till systems, then 30 lbs/ac of additional nitrogen should be considered in the above N recommendation.

2. Starter fertilizers
   a. When planted in 30-inch rows, do not apply fertilizer in contact with the seed.
   b. When planted in 15-inch rows, limit seed placed N + K₂O to 5 lbs/ac but do not use urea or UAN.
   c. If the previous “crop” was fallow or potatoes: The growth of sunflowers after fallow or potatoes is sometimes not satisfactory. To correct this, apply 20-30 lbs/ac of P₂O₅ as a starter.

### Table 8: Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for sunflowers calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal (lbs/ac)</th>
<th>Soil N plus supplemental N required (lbs-N/ac-2')</th>
<th>Phosphorus Soil Test Category (lbs P₂O₅/ac)</th>
<th>Potassium Soil Test Category (lbs K₂O/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>50</td>
<td>VL 20 L 15 M 9 H 4 VH 0</td>
<td>VL 36 L 25 M 14 H 3 VH 0</td>
</tr>
<tr>
<td>1400</td>
<td>70</td>
<td>VL 29 L 21 M 13 H 5 VH 0</td>
<td>VL 50 L 35 M 19 H 4 VH 0</td>
</tr>
<tr>
<td>1800</td>
<td>90</td>
<td>VL 37 L 27 M 17 H 6 VH 0</td>
<td>VL 64 L 44 M 25 H 6 VH 0</td>
</tr>
<tr>
<td>2200</td>
<td>110</td>
<td>VL 45 L 33 M 20 H 8 VH 0</td>
<td>VL 78 L 54 M 31 H 7 VH 0</td>
</tr>
<tr>
<td>2600</td>
<td>130</td>
<td>VL 53 L 38 M 24 H 9 VH 0</td>
<td>VL 93 L 64 M 36 H 8 VH 0</td>
</tr>
<tr>
<td>3000</td>
<td>150</td>
<td>VL 61 L 44 M 28 H 11 VH 0</td>
<td>VL 107 L 74 M 42 H 9 VH 0</td>
</tr>
<tr>
<td>3400</td>
<td>170</td>
<td>VL 69 L 50 M 31 H 12 VH 0</td>
<td>VL 121 L 84 M 47 H 10 VH 0</td>
</tr>
</tbody>
</table>
Soybean – Nitrogen, Phosphorus, and Potassium Recommendations


<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>NFR = 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus</td>
<td>Olsen P</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Bray-1 P</td>
</tr>
<tr>
<td>Potassium</td>
<td>KFR = (2.2 – (0.0183 x STK)) x YG</td>
</tr>
</tbody>
</table>

Acronym Definitions
- NFR = N fertilizer rate (lbs N/ac)
- PFR = P fertilizer rate (lbs P₂O₅/ac)
- STP = Soil test phosphorus (ppm)
- YG = Yield goal (bu/ac)
- KFR = K fertilizer rate (lbs K₂O/ac)
- STK = Soil test potassium (ppm)

Soybean Statements
1. Nitrogen fertilizers
   a. Soybeans that have been well inoculated are not likely to respond to additional nitrogen fertilizer.
2. Starter fertilizers
   a. When planted in 30-inch rows, do not apply fertilizer in contact with the seed.
   b. When planted in 7.5-inch rows, limit seed placed N + K₂O to 10 lbs/ac but do not use urea or UAN.

Table 9. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for soybean calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs-N/ac-2'</td>
<td>VL</td>
<td>L</td>
</tr>
<tr>
<td>bu/ac</td>
<td>lbs-N/ac-2'</td>
<td>lbs P₂O₅/ac</td>
<td>lbs K₂O/ac</td>
</tr>
<tr>
<td>30</td>
<td>0</td>
<td>40</td>
<td>23</td>
</tr>
<tr>
<td>40</td>
<td>0</td>
<td>54</td>
<td>31</td>
</tr>
<tr>
<td>50</td>
<td>0</td>
<td>67</td>
<td>39</td>
</tr>
<tr>
<td>60</td>
<td>0</td>
<td>80</td>
<td>47</td>
</tr>
<tr>
<td>70</td>
<td>0</td>
<td>94</td>
<td>55</td>
</tr>
<tr>
<td>80</td>
<td>0</td>
<td>107</td>
<td>62</td>
</tr>
<tr>
<td>100</td>
<td>0</td>
<td>134</td>
<td>78</td>
</tr>
</tbody>
</table>
Edible Beans – Nitrogen Phosphorus and Potassium Recommendations


**Nitrogen**

\[ NFR = 0.05 \times YG - STN - LC \]

**Phosphorus**

\[ \begin{align*}
Olsen \ P & : \\
PFR &= (0.0231 - (0.0014 \times STP)) \times YG \\
Bray-1 \ P & : \\
PFR &= (0.0231 - (0.0011 \times STP)) \times YG
\end{align*} \]

**Potassium**

\[ KFR = (0.0346 - (0.00021 \times STK)) \times YG \]

**Acronym Definitions**

- **NFR** = N fertilizer rate (lbs N/ac)
- **YG** = Yield goal (lbs/ac)
- **STN** = Soil test nitrate-N-2 ft. (lbs/ac)
- **LC** = Legume credit (lbs/ac)
- **PFR** = P fertilizer rate (lbs P₂O₅/ac)
- **STP** = Soil test phosphorus (ppm)
- **KFR** = K fertilizer rate (lbs K₂O/ac)
- **STK** = Soil test potassium (ppm)

**Edible Beans Statements**

1. Nitrogen fertilizers
   a. Edible beans are legumes, which respond to nitrogen fertilizer.
   b. If using very reduced tillage systems including strip-till and no-till systems, then 30 lbs/ac of additional nitrogen should be considered in the above N recommendation.

2. Phosphorus fertilizers
   a. The P₂O₅ recommendation can be reduced by one third if applying as a starter.
      i. If reduced by one third, soil test levels may be lowered over time.

3. Starter fertilizers
   a. If nitrogen is applied as a starter it should NOT touch the seed.
   b. When planted in 30-inch rows do not apply fertilizer in contact with the seed.
   c. When planted in 7.5-inch rows limit seed placed N + K₂O to 10 lbs/ac, but do not use urea or UAN.

**Table 10. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for edible beans calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.**

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs/ac</td>
<td>lbs-N/ac-2’</td>
<td>lbs P₂O₅/ac</td>
</tr>
<tr>
<td>lbs/ac</td>
<td>VL</td>
<td>L</td>
<td>M</td>
</tr>
<tr>
<td>1000</td>
<td>50</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>1400</td>
<td>70</td>
<td>29</td>
<td>22</td>
</tr>
<tr>
<td>1800</td>
<td>90</td>
<td>38</td>
<td>28</td>
</tr>
<tr>
<td>2200</td>
<td>110</td>
<td>46</td>
<td>34</td>
</tr>
<tr>
<td>2600</td>
<td>130</td>
<td>55</td>
<td>40</td>
</tr>
<tr>
<td>3000</td>
<td>150</td>
<td>63</td>
<td>46</td>
</tr>
</tbody>
</table>
Field Pea, Lentil, & Chickpea (Garbanzo Bean) – Nitrogen, Phosphorus, and Potassium Recommendations

**Equations for field pea, lentil, and chickpea (garbanzo bean) N, P, and K recommendations.**

**Nitrogen**

\[ \text{NFR} = 0 \quad \text{when inoculated with proper} \quad \text{Bradyrhizobium} \quad \text{culture} \]

**Phosphorus**

- **Olsen P**
  \[ \text{PFR} = (0.0171 - (0.0011 \times \text{STP})) \times \text{YG} \]

- **Bray-1 P**
  \[ \text{PFR} = (0.0171 - (0.00085 \times \text{STP})) \times \text{YG} \]

**Potassium**

\[ \text{KFR} = (0.03 - (0.00018 \times \text{STK})) \times \text{YG} \]

**Acronym Definitions**

- NFR = N fertilizer rate (lbs N/ac)
- PFR = P fertilizer rate (lbs P2O5/ac)
- STP = Soil test phosphorus (ppm)
- YG = Yield goal (lbs/ac)
- KFR = K fertilizer rate (lbs K2O/ac)
- STK = Soil test potassium (ppm)

Field Pea, Lentil, & Chickpea (Garbanzo Bean) Statements

1. Starter fertilizers
   a. When planted in 30-inch rows, do not apply fertilizer in contact with the seed.
   b. When planted in 7.5-inch rows, limit seed placed N + K2O to 10 lbs/ac but do not use urea or UAN.

Table 11. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for field pea, lentil, and chickpea (garbanzo bean) calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs/ac</td>
<td>VL</td>
<td>L</td>
</tr>
<tr>
<td>1400</td>
<td>0(1)</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td>1800</td>
<td>0</td>
<td>28</td>
<td>20</td>
</tr>
<tr>
<td>2200</td>
<td>0</td>
<td>34</td>
<td>24</td>
</tr>
<tr>
<td>2600</td>
<td>0</td>
<td>40</td>
<td>29</td>
</tr>
<tr>
<td>3000</td>
<td>0</td>
<td>46</td>
<td>33</td>
</tr>
</tbody>
</table>

(1) Inoculation is necessary with proper Bradyrhizobium culture.
### Wheat & Rye – Nitrogen, Phosphorus, and Potassium Recommendations


**Nitrogen**

\[
NFR = 2.5 \times YG - STN - LC
\]

**Phosphorus**

- **Olsen P**
  \[
PFR = (1.071 - (0.067 \times STP)) \times YG
\]
- **Bray-1 P**
  \[
PFR = (1.071 - (0.054 \times STP)) \times YG
\]

**Potassium**

\[
KFR = (2.71 - (0.017 \times STK)) \times YG
\]

#### Acronym Definitions

- **NFR** = N fertilizer rate (lbs N/ac)
- **YG** = Yield goal (bu/ac)
- **STN** = Soil test nitrate-N-2 ft. (lbs/ac)
- **LC** = Legume credit (lbs/ac)
- **PFR** = P fertilizer rate (lbs P$_2$O$_5$/ac)
- **STP** = Soil test phosphorus (ppm)
- **KFR** = K fertilizer rate (lbs K$_2$O/ac)
- **STK** = Soil test potassium (ppm)

#### Wheat & Rye Statements

1. **Nitrogen fertilizers**
   
a. If using very reduced tillage systems including strip-till and no-till systems, then 30 lbs/ac of additional nitrogen should be considered in the above N recommendation.

2. **Phosphorus fertilizers**
   
a. The P$_2$O$_5$ recommendation can be reduced by one third if applying as a starter.
   
i. If reduced by one third, soil test levels may be lowered over time.

3. **Starter fertilizers**
   
a. Nitrogen plus K$_2$O applications in contact with the seed should be limited to 25 lbs/ac when placed in contact with the seed in 6- or 7-inch row spacings.
   
i. Reduce these values proportionately for wider row widths
   
ii. Reduce these amounts by half for dry or coarse textured soils.
   
iii. DO NOT place thiosulfate in direct contact with the seed.

#### Table 12.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required (lbs-N/ac-2′')</th>
<th>Phosphorus Soil Test Category (lbs P$_2$O$_5$/ac)</th>
<th>Potassium Soil Test Category (lbs K$_2$O/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>bu/ac</td>
<td></td>
<td>V L</td>
<td>L</td>
</tr>
<tr>
<td>30</td>
<td>75</td>
<td>29</td>
<td>21</td>
</tr>
<tr>
<td>40</td>
<td>100</td>
<td>39</td>
<td>28</td>
</tr>
<tr>
<td>50</td>
<td>125</td>
<td>49</td>
<td>35</td>
</tr>
<tr>
<td>60</td>
<td>150</td>
<td>58</td>
<td>42</td>
</tr>
<tr>
<td>70</td>
<td>175</td>
<td>68</td>
<td>49</td>
</tr>
<tr>
<td>80</td>
<td>200</td>
<td>78</td>
<td>56</td>
</tr>
<tr>
<td>90</td>
<td>225</td>
<td>87</td>
<td>63</td>
</tr>
<tr>
<td>100</td>
<td>250</td>
<td>97</td>
<td>70</td>
</tr>
<tr>
<td>110</td>
<td>275</td>
<td>107</td>
<td>77</td>
</tr>
</tbody>
</table>
## Oats – Nitrogen, Phosphorus, and Potassium Recommendations

### Equations for oats N, P, and K recommendations.

#### Nitrogen

\[ \text{NFR} = 1.3 \times \text{YG} - \text{STN} - \text{LC} \]

#### Phosphorus

- **Olsen P**
  \[ \text{PFR} = (0.644 - (0.041 \times \text{STP})) \times \text{YG} \]

- **Bray-1 P**
  \[ \text{PFR} = (0.644 - 0.032 \times \text{STP}) \times \text{YG} \]

#### Potassium

\[ \text{KFR} = (2.71 - (1.277 - (0.0086 \times \text{STK})) \times \text{YG} \]

### Acronym Definitions

- **NFR** = N fertilizer rate (lbs N/ac)
- **YG** = Yield goal (bu/ac)
- **STN** = Soil test nitrate-N-2 ft. (lbs/ac)
- **LC** = Legume credit (lbs/ac)
- **PFR** = P fertilizer rate (lbs P2O5/ac)
- **STP** = Soil test phosphorus (ppm)
- **KFR** = K fertilizer rate (lbs K2O/ac)
- **STK** = Soil test potassium (ppm)

### Oats Statements

1. **Nitrogen fertilizers**
   - a. If using very reduced tillage systems including strip-till and no-till systems, then 30 lbs/ac of additional nitrogen should be considered in the above N recommendation.

2. **Phosphorus fertilizers**
   - a. The P2O5 recommendation can be reduced by one third if applying as a starter.
     - i. If reduced by one third, soil test levels may be lowered over time.

3. **Starter fertilizers**
   - a. Nitrogen plus K2O applications in contact with the seed should be limited to 25 lbs/ac when placed in contact with the seed in 6- or 7-inch row spacings.
     - i. Reduce these values proportionately for wider row widths
     - ii. Reduce these amounts by half for dry or coarse textured soils.
     - iii. DO NOT place thiosulfate in direct contact with the seed.

### Table 13

Table 13. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for oats calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal (bu/ac)</th>
<th>Soil N plus supplemental N required (lbs-N/ac-2')</th>
<th>Phosphorus Soil Test Category (lbs P2O5/ac)</th>
<th>Potassium Soil Test Category (lbs K2O/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>78</td>
<td>35 25 15 5 0</td>
<td>66 45 25 4 0</td>
</tr>
<tr>
<td>70</td>
<td>91</td>
<td>41 29 18 6 0</td>
<td>77 53 29 5 0</td>
</tr>
<tr>
<td>80</td>
<td>104</td>
<td>47 33 20 7 0</td>
<td>88 61 33 5 0</td>
</tr>
<tr>
<td>90</td>
<td>117</td>
<td>52 38 23 8 0</td>
<td>99 68 37 6 0</td>
</tr>
<tr>
<td>100</td>
<td>130</td>
<td>58 42 25 9 0</td>
<td>111 76 41 7 0</td>
</tr>
<tr>
<td>110</td>
<td>143</td>
<td>64 46 28 10 0</td>
<td>122 83 45 8 0</td>
</tr>
<tr>
<td>130</td>
<td>169</td>
<td>76 54 33 12 0</td>
<td>144 98 54 9 0</td>
</tr>
<tr>
<td>150</td>
<td>195</td>
<td>87 63 38 14 0</td>
<td>166 114 62 10 0</td>
</tr>
</tbody>
</table>
Feed Barley – Nitrogen, Phosphorus, and Potassium Recommendations


**Nitrogen**

\[ \text{NFR} = 1.7 \times \text{YG} - \text{STN} - \text{LC} \]

**Phosphorus**

- **Olsen P**
  \[ \text{PFR} = (0.785 - (0.05 \times \text{STP})) \times \text{YG} \]
- **Bray-1 P**
  \[ \text{PFR} = (0.785 - (0.039 \times \text{STP})) \times \text{YG} \]

**Potassium**

\[ \text{KFR} = (1.286 - (0.0085 \times \text{STK})) \times \text{YG} \]

Acronym Definitions

- NFR = N fertilizer rate (lbs N/ac)
- YG = Yield goal (bu/ac)
- STN = Soil test nitrate-N-2 ft. (lbs/ac)
- LC = Legume credit (lbs/ac)
- PFR = P fertilizer rate (lbs P$_{2O_5}$/ac)
- STP = Soil test phosphorus (ppm)
- KFR = K fertilizer rate (lbs K$_2O$/ac)
- STK = Soil test potassium (ppm)

Feed Barley Statements

1. Nitrogen fertilizers
   a. If using very reduced tillage systems including strip-till and no-till systems, then 30 lbs/ac of additional nitrogen should be considered in the above N recommendation.

2. Phosphorus fertilizers
   a. The P$_2$O$_5$ recommendation can be reduced by one third if applying as a starter.
      i. If reduced by one third, soil test levels may be lowered over time.

3. Starter fertilizers
   a. Nitrogen plus K$_2$O applications in contact with the seed should be limited to 25 lbs/ac when placed in contact with the seed in 6- or 7-inch row spacings.
      i. Reduce these values proportionately for wider row widths
      ii. Reduce these amounts by half for dry or coarse textured soils.
      iii. DO NOT place thiosulfate in direct contact with the seed.

Table 14. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for feed barley calculated for different yield goals and the soil test categories shown in Table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>bu/ac</td>
<td>lbs-N/ac-2’</td>
<td>lbs P$_{2O_5}$/ac</td>
</tr>
<tr>
<td>40</td>
<td>68</td>
<td>28</td>
<td>12</td>
</tr>
<tr>
<td>50</td>
<td>85</td>
<td>36</td>
<td>16</td>
</tr>
<tr>
<td>60</td>
<td>102</td>
<td>43</td>
<td>17</td>
</tr>
<tr>
<td>70</td>
<td>119</td>
<td>50</td>
<td>22</td>
</tr>
<tr>
<td>80</td>
<td>136</td>
<td>57</td>
<td>25</td>
</tr>
<tr>
<td>90</td>
<td>153</td>
<td>64</td>
<td>28</td>
</tr>
<tr>
<td>100</td>
<td>170</td>
<td>71</td>
<td>31</td>
</tr>
<tr>
<td>110</td>
<td>187</td>
<td>78</td>
<td>56</td>
</tr>
<tr>
<td>120</td>
<td>204</td>
<td>85</td>
<td>56</td>
</tr>
</tbody>
</table>
Malting Barley – Nitrogen, Phosphorus, and Potassium Recommendations


Nitrogen

\[ NFR = 1.5 \times YG - STN - LC \]

Phosphorus

\begin{align*}
\text{Olsen P} \\
\text{PFR} &= (0.785 - (0.05 \times STP)) \times YG \\
\text{Bray-1 P} \\
\text{PFR} &= (0.785 - (0.039 \times STP)) \times YG
\end{align*}

Potassium

\[ KFR = (1.286 - (0.0085 \times STK)) \times YG \]

Acronym Definitions

- **NFR** = N fertilizer rate (lbs N/ac)
- **YG** = Yield goal (bu/ac)
- **STN** = Soil test nitrate-N-2 ft. (lbs/ac)
- **LC** = Legume credit (lbs/ac)
- **PFR** = P fertilizer rate (lbs P₂O₅/ac)
- **STP** = Soil test phosphorus (ppm)
- **KFR** = K fertilizer rate (lbs K₂O/ac)
- **STK** = Soil test potassium (ppm)

Malting Barley Statements

1. Nitrogen fertilizers
   a. To increase the probability of obtaining malting barley grade, a two-foot deep sample for the nitrate nitrogen test should be taken.
   b. If using very reduced tillage systems including strip-till and no-till systems, then 30 lbs/ac of additional nitrogen should be considered in the above N recommendation.

2. Phosphorus fertilizers
   a. The P₂O₅ recommendation can be reduced by one third if applying as a starter.
      i. If reduced by one third, soil test levels may be lowered over time.

3. Starter fertilizers
   a. Nitrogen plus K₂O applications in contact with the seed should be limited to 25 lbs/ac when placed in contact with the seed in 6- or 7-inch row spacings.
      i. Reduce these values proportionately for wider row widths
      ii. Reduce these amounts by half for dry or coarse textured soils.
      iii. DO NOT place thiosulfate in direct contact with the seed.

Table 15. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for malting barley calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal (bu/ac)</th>
<th>Soil N plus supplemental N required (lbs N/ac-2')</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>VL</td>
<td>L</td>
</tr>
<tr>
<td>50</td>
<td>75</td>
<td>36</td>
<td>26</td>
</tr>
<tr>
<td>60</td>
<td>90</td>
<td>43</td>
<td>31</td>
</tr>
<tr>
<td>70</td>
<td>105</td>
<td>50</td>
<td>36</td>
</tr>
<tr>
<td>80</td>
<td>120</td>
<td>57</td>
<td>41</td>
</tr>
<tr>
<td>90</td>
<td>135</td>
<td>64</td>
<td>46</td>
</tr>
<tr>
<td>100</td>
<td>150</td>
<td>71</td>
<td>51</td>
</tr>
<tr>
<td>110</td>
<td>165</td>
<td>78</td>
<td>56</td>
</tr>
<tr>
<td>120</td>
<td>180</td>
<td>85</td>
<td>61</td>
</tr>
</tbody>
</table>
Buckwheat – Nitrogen, Phosphorus, and Potassium Recommendations


Nitrogen

\[ \text{NFR} = 2.2 \times YG - \text{STN} - \text{LC} \]

Phosphorus

\[ \begin{align*}
\text{Olsen P} \\
\text{PFR} &= (1.32 - (0.083 \times \text{STP})) \times YG \\
\text{Bray-1 P} \\
\text{PFR} &= (1.32 - (0.066 \times \text{STP})) \times YG
\end{align*} \]

Potassium

\[ \text{KFR} = (1.86 - (0.0116 \times \text{STK})) \times YG \]

Acronym Definitions

- NFR = N fertilizer rate (lbs N/ac)
- YG = Yield goal (bu/ac)
- STN = Soil test nitrate-N-2 ft. (lbs/ac)
- LC = Legume credit (lbs/ac)
- PFR = P fertilizer rate (lbs P2O5/ac)
- STP = Soil test phosphorus (ppm)
- KFR = K fertilizer rate (lbs K2O/ac)
- STK = Soil test potassium (ppm)

Buckwheat Statements

1. Nitrogen fertilizers
   a. If using very reduced tillage systems including strip-till and no-till systems, then 30 lbs/ac of additional nitrogen should be considered in the above N recommendation.

2. Phosphorus fertilizers
   a. The P2O5 recommendation can be reduced by one third if applying as a starter.
      i. If reduced by one third, soil test levels may be lowered over time.

3. Starter fertilizers
   a. Nitrogen plus K2O applications in contact with the seed should NOT exceed 10 lbs/ac when using six- or seven-inch rows.
   b. Nitrogen from urea, DAP (18-46-0), and ammonium thiosulfate (21-0-0-26) should NOT be placed with the seed.

Table 16. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for buckwheat calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required lbs-N/ac-2’</th>
<th>Phosphorus Soil Test Category lbs P2O5/ac</th>
<th>Potassium Soil Test Category lbs K2O/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>bu/ac</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>53</td>
<td>29</td>
<td>39</td>
</tr>
<tr>
<td>32</td>
<td>70</td>
<td>38</td>
<td>52</td>
</tr>
<tr>
<td>40</td>
<td>88</td>
<td>48</td>
<td>65</td>
</tr>
<tr>
<td>48</td>
<td>106</td>
<td>57</td>
<td>78</td>
</tr>
</tbody>
</table>
Safflower – Nitrogen, Phosphorus, and Potassium Recommendations


Nitrogen
\[
\text{NFR} = 0.05 \times \text{YG} - \text{STN} - \text{LC}
\]

Phosphorus

\[
\text{Olsen P} \\
\text{PFR} = (0.027 - (0.0017 \times \text{STP})) \times \text{YG}
\]

\[
\text{Bray-1 P} \\
\text{PFR} = (0.027 - (0.0014 \times \text{STP})) \times \text{YG}
\]

Potassium
\[
\text{KFR} = (0.048 - (0.0003 \times \text{STK})) \times \text{YG}
\]

Acronym Definitions

- NFR = N fertilizer rate (lbs N/ac)
- YG = Yield goal (lbs/ac)
- STN = Soil test nitrate-N-2 ft. (lbs/ac)
- LC = Legume credit (lbs/ac)
- PFR = P fertilizer rate (lbs P₂O₅/ac)
- STP = Soil test phosphorus (ppm)
- KFR = K fertilizer rate (lbs K₂O/ac)
- STK = Soil test potassium (ppm)

Safflower Statements

1. Nitrogen fertilizers
   a. If using very reduced tillage systems including strip-till and no-till systems, then 30 lbs/ac of additional nitrogen should be considered in the above N recommendation.

2. Phosphorus fertilizers
   a. The P₂O₅ recommendation can be reduced by one third if applying as a starter.
      i. If reduced by one third, soil test levels may be lowered over time.

3. Starter fertilizers
   a. Nitrogen plus K₂O applications in contact with the seed should NOT exceed 10 lbs/ac when using six- or seven-inch rows.
   b. Nitrogen from urea, DAP (18-46-0), and ammonium thiosulfate (21-0-0-26) should NOT be placed with the seed.

Table 17. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for safflower calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs/ac</td>
<td>lbs-N/ac-2’</td>
<td>lbs P₂O₅/ac</td>
</tr>
<tr>
<td>800</td>
<td>40</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>1200</td>
<td>60</td>
<td>29</td>
<td>21</td>
</tr>
<tr>
<td>1600</td>
<td>80</td>
<td>39</td>
<td>28</td>
</tr>
<tr>
<td>2000</td>
<td>100</td>
<td>49</td>
<td>35</td>
</tr>
<tr>
<td>2400</td>
<td>120</td>
<td>59</td>
<td>42</td>
</tr>
</tbody>
</table>
Mustard, Rapeseed, & Canola – Nitrogen, Phosphorus, and Potassium Recommendations


Nitrogen

\[ \text{NFR} = 6.5 \times \text{YG} - \text{STN} - \text{LC} \]

Phosphorus

\[ \text{Olsen P} \]
\[ \text{PFR} = (3.6 - (0.22 \times \text{STP})) \times \text{YG} \]
\[ \text{Bray-1 P} \]
\[ \text{PFR} = (3.6 - (0.17 \times \text{STP})) \times \text{YG} \]

Potassium

\[ \text{KFR} = (5.4 - (0.034 \times \text{STK})) \times \text{YG} \]

Acronym Definitions

NFR = N fertilizer rate (lbs N/ac)
YG = Yield goal (bu/ac)
STN = Soil test nitrate-N-2 ft. (lbs/ac)
LC = Legume credit (lbs/ac)
PFR = P fertilizer rate (lbs P_2O_5/ac)
STP = Soil test phosphorus (ppm)
KFR = K fertilizer rate (lbs K_2O/ac)
STK = Soil test potassium (ppm)

Mustard, Rapeseed, and Canola Statements

1. Nitrogen fertilizers
   a. If using very reduced tillage systems including strip-till and no-till systems, then 30 lbs/ac of additional nitrogen should be considered in the above N recommendation.

2. Phosphorus fertilizers
   a. The P_2O_5 recommendation can be reduced by one third if applying as a starter.
      i. If reduced by one third, soil test levels may be lowered over time.

3. Starter fertilizers
   a. Nitrogen plus K_2O applications in contact with the seed should NOT exceed 10 lbs/ac when using six- or seven-inch rows.
   b. Nitrogen from urea, DAP (18-46-0), and ammonium thiosulfate (21-0-0-26) should NOT be placed with the seed.

Table 18. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for mustard, rapeseed, and canola calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal (bu/ac)</th>
<th>Soil N plus supplemental N required (lbs-N/ac-2')</th>
<th>Phosphorus Soil Test Category (lbs P_2O_5/ac)</th>
<th>Potassium Soil Test Category (lbs K_2O/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>65</td>
<td>33 24 15 6 0</td>
<td>47 33 20 6 0</td>
</tr>
<tr>
<td>15</td>
<td>97</td>
<td>49 36 23 9 0</td>
<td>71 50 30 9 0</td>
</tr>
<tr>
<td>20</td>
<td>130</td>
<td>65 48 30 13 0</td>
<td>94 67 40 12 0</td>
</tr>
<tr>
<td>25</td>
<td>162</td>
<td>82 60 38 16 0</td>
<td>118 84 50 16 0</td>
</tr>
<tr>
<td>30</td>
<td>195</td>
<td>98 72 45 19 0</td>
<td>142 101 59 19 0</td>
</tr>
</tbody>
</table>
Flax – Nitrogen, Phosphorus, and Potassium Recommendations


**Nitrogen**

\[ NFR = 3.0 \times YG - STN - LC \]

**Phosphorus**

\[
\begin{align*}
Olsen \text{ P} & : \\
PFR &= (1.17 - (0.073 \times STP)) \times YG \\
Bray-1 \text{ P} & : \\
PFR &= (1.17 - (0.058 \times STP)) \times YG
\end{align*}
\]

**Potassium**

\[ KFR = (2.2 - (0.014 \times STK)) \times YG \]

**Acronym Definitions**

- NFR = N fertilizer rate (lbs N/ac)
- YG = Yield goal (bu/ac)
- STN = Soil test nitrate-N-2 ft (lbs/ac)
- LC = Legume credit (lbs/ac)
- PFR = P fertilizer rate (lbs P<sub>2</sub>O<sub>5</sub>/ac)
- STP = Soil test phosphorus (ppm)
- KFR = K fertilizer rate (lbs K<sub>2</sub>O/ac)
- STK = Soil test potassium (ppm)

**Flax Statements**

1. **Nitrogen fertilizers**
   - If using very reduced tillage systems including strip-till and no-till systems, then 30 lbs/ac of additional nitrogen should be considered in the above N recommendation.

2. **Phosphorus fertilizers**
   - The P<sub>2</sub>O<sub>5</sub> recommendation can be reduced by one third if applying as a starter.
     1. If reduced by one third, soil test levels may be lowered over time.
   - The above phosphorus recommendation will seldom increase flax yields, but it will help maintain the phosphorus soil test level.

3. **Starter fertilizers**
   - Nitrogen plus K<sub>2</sub>O applications in contact with the seed should NOT exceed 10 lbs/ac when using six- or seven-inch rows.
   - Nitrogen from urea, DAP (18-46-0), and ammonium thiosulfate (21-0-0-26) should NOT be placed with the seed.

**Table 19.** Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for flax calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs N/ac-2’</td>
<td>lbs P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;/ac</td>
<td>lbs K&lt;sub&gt;2&lt;/sub&gt;O/ac</td>
</tr>
<tr>
<td></td>
<td>bu/ac</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>60</td>
<td>21 15 10 4 0</td>
<td>38 27 16 5 0</td>
</tr>
<tr>
<td>30</td>
<td>90</td>
<td>32 23 14 6 0</td>
<td>58 41 24 7 0</td>
</tr>
<tr>
<td>40</td>
<td>120</td>
<td>42 31 19 7 0</td>
<td>77 54 32 9 0</td>
</tr>
<tr>
<td>50</td>
<td>150</td>
<td>53 38 24 9 0</td>
<td>96 68 40 12 0</td>
</tr>
<tr>
<td>60</td>
<td>180</td>
<td>64 46 29 11 0</td>
<td>115 81 48 14 0</td>
</tr>
<tr>
<td>70</td>
<td>210</td>
<td>74 54 33 13 0</td>
<td>134 95 56 16 0</td>
</tr>
</tbody>
</table>
Alfalfa – Nitrogen, Phosphorus, and Potassium Recommendations


<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>Acronym Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFR = 0</td>
<td>NFR = N fertilizer rate (lbs N/ac)</td>
</tr>
</tbody>
</table>

**Phosphorus**

| Olsen P | PFR = (18.57 – (1.16 x STP)) x YG |
| Bray-1 P | PFR = (18.57 – (0.93 x STP)) x YG |

| Potassium | KFR = (55.71 – (0.38 x STK)) x YG |

Acronym Definitions:

NFR = N fertilizer rate (lbs N/ac)
PFR = P fertilizer rate (lbs P<sub>2</sub>O<sub>5</sub>/ac)
STP = Soil test phosphorus (ppm)
YG = Yield goal (tons/ac)
KFR = K fertilizer rate (lbs K<sub>2</sub>O/ac)
STK = Soil test potassium (ppm)

Alfalfa Statements

1. When alfalfa yield goals are high (greater than 5 tons/ac), soil nutrient withdrawal will likely be large. Therefore, you should soil test each year.
2. New alfalfa seedings:
   a. If using a companion crop when establishing alfalfa, only apply the fertilizer for the new alfalfa seeding. Additional nitrogen fertilizer may cause too much competition from the companion crop for the new alfalfa seedlings.
3. Established alfalfa stands
   a. The above fertilizer recommendations are to be applied annually as long as the stand is maintained and the soil tests recommend fertilizer.
   b. Alfalfa grass mixture
      i. If your alfalfa-grass mixture contains at least 1/3 alfalfa, no additional nitrogen should be needed.
4. The 0-2 ft. nitrate-nitrogen test is of little value in adjusting fertilizer recommendations for alfalfa.

Table 20. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for alfalfa calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soil N plus supplemental N required</td>
<td>V L</td>
<td>L</td>
</tr>
<tr>
<td>tons/ac</td>
<td>lbs-N/ac-2'</td>
<td>lbs P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;/ac</td>
<td>lbs K&lt;sub&gt;2&lt;/sub&gt;O/ac</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>34</td>
<td>24</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>50</td>
<td>37</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>67</td>
<td>49</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>84</td>
<td>61</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>101</td>
<td>73</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>118</td>
<td>85</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>135</td>
<td>98</td>
</tr>
</tbody>
</table>
Grass – Nitrogen, Phosphorus, and Potassium Recommendations


**Nitrogen**

\[ NFR = 25 \times YG \]

**Phosphorus**

- **Olsen P**
  \[ PFR = 45.0 - (3.45 \times STP) \]

- **Bray-1 P**
  \[ PFR = 45.0 - (2.5 \times STP) \]

**Potassium**

\[ KFR = 80.0 - (0.53 \times STK) \]

Acronym Definitions

- NFR = N fertilizer rate (lbs N/ac)
- YG = Yield goal (tons/ac)
- PFR = P fertilizer rate (lbs P\(_2\)O\(_5\)/ac)
- STP = Soil test phosphorus (ppm)
- KFR = K fertilizer rate (lbs K\(_2\)O/ac)
- STK = Soil test potassium (ppm)

Grass Statements

1. When your alfalfa grass mixture contains at least 1/3 alfalfa, no additional nitrogen should be needed.
2. The 0-2 ft. nitrate-nitrogen test is of little value in adjusting fertilizer recommendations for grass.
3. Newly seeded grass
   a. These recommendations are for the seeding year and each year thereafter. However, do not apply more than 20 lbs/ac of nitrogen during the seeding year.
4. Established grass
   a. The above recommendation may be applied to cool season grasses in the late fall or early spring and to warm season grasses in mid-May.

Table 21. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for grass calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>tons/ac</td>
<td>lbs-N/ac-2'</td>
<td>lbs P(_2)O(_5)/ac</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>75</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>100</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>125</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>150</td>
<td>40</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>175</td>
<td>40</td>
</tr>
</tbody>
</table>
Sudan Grass & Forage Sorghum – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for sudan grass and forage sorghum N, P, and K recommendations.

Nitrogen

\[ NFR = 25 \times \text{YG} - \text{STN} - \text{LC} \]

Phosphorus

Olsen P

\[ \text{PFR} = (11.0 - (0.7 \times \text{STP})) \times \text{YG} \]

Bray-1 P

\[ \text{PFR} = (11.0 - (0.533 \times \text{STP})) \times \text{YG} \]

Potassium

\[ \text{KFR} = (43.0 - (0.3 \times \text{STK})) \times \text{YG} \]

Acronym Definitions

- NFR = N fertilizer rate (lbs N/ac)
- YG = Yield goal (tons/ac)
- STN = Soil test nitrate-N-2 ft. (lbs/ac)
- LC = Legume credit (lbs/ac)
- PFR = P fertilizer rate (lbs P_2O_5/ac)
- STP = Soil test phosphorus (ppm)
- KFR = K fertilizer rate (lbs K_2O/ac)
- STK = Soil test potassium (ppm)

Sudan Grass & Forage Sorghum Statements

1. Nitrogen fertilizers
   a. The recommended nitrogen should be divided in half if more than 100 lbs N/ac is recommended
   i. One half should be applied at/or prior to seeding time and the other half after the first cutting.

Table 22. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for sudan grass and forage sorghum calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>tons/ac</td>
<td>lbs-N/ac-2'</td>
<td>lbs-P_2O_5/ac</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>75</td>
<td>30</td>
<td>21</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>40</td>
<td>29</td>
</tr>
<tr>
<td>5</td>
<td>125</td>
<td>50</td>
<td>36</td>
</tr>
<tr>
<td>6</td>
<td>150</td>
<td>60</td>
<td>43</td>
</tr>
<tr>
<td>7</td>
<td>175</td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td>8</td>
<td>200</td>
<td>80</td>
<td>57</td>
</tr>
</tbody>
</table>
Millet – Nitrogen, Phosphorus, and Potassium Recommendations


**Nitrogen**

\[ NFR = 0.035 \times YG - STN - LC \]

**Phosphorus**

- **Olsen P**
  \[ PFR = (0.0171 - (0.00114 \times STP)) \times YG \]
- **Bray-1 P**
  \[ PFR = (0.0171 - (0.00085 \times STP)) \times YG \]

**Potassium**

\[ KFR = (0.03 - (0.00018 \times STK)) \times YG \]

**Acronym Definitions**

- **NFR** = N fertilizer rate (lbs N/ac)
- **YG** = Yield goal (lbs/ac)
- **STN** = Soil test nitrate-N-2 ft. (lbs/ac)
- **LC** = Legume credit (lbs/ac)
- **PFR** = P fertilizer rate (lbs P₂O₅/ac)
- **STP** = Soil test phosphorus (ppm)
- **KFR** = K fertilizer rate (lbs K₂O/ac)
- **STK** = Soil test potassium (ppm)

**Millet Statements**

1. Starter fertilizers
   a. Nitrogen plus K₂O applications in contact with the seed should NOT exceed 20 lbs/ac when using six- or seven-inch rows.
   i. Reduce these values proportionately for wider row widths

Table 23. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for millet calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs/ac</td>
<td>lbs-N/ac-2'</td>
<td>lbs P₂O₅/ac</td>
</tr>
<tr>
<td>1000</td>
<td>35</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>1400</td>
<td>49</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td>1800</td>
<td>63</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td>2200</td>
<td>77</td>
<td>34</td>
<td>14</td>
</tr>
<tr>
<td>2600</td>
<td>91</td>
<td>40</td>
<td>16</td>
</tr>
<tr>
<td>3000</td>
<td>105</td>
<td>46</td>
<td>19</td>
</tr>
</tbody>
</table>
Potatoes – Nitrogen, Phosphorus, and Potassium Recommendations


**Nitrogen**
\[ NFR = 0.4 \times YG - STN - LC \]

**Phosphorus**
- **Olsen P**
  \[ PFR = (0.5 - (0.034 \times STP)) \times YG \]
- **Bray-1 P**
  \[ PFR = (0.5 - (0.026 \times STP)) \times YG \]

**Potassium**
\[ KFR = (0.85 - (0.0057 \times STK)) \times YG \]

**Acronym Definitions**
- **NFR** = N fertilizer rate (lbs N/ac)
- **YG** = Yield goal (cwt/ac)
- **STN** = Soil test nitrate-N-2 ft. (lbs/ac)
- **LC** = Legume credit (lbs/ac)
- **PFR** = P fertilizer rate (lbs P$_2$O$_5$/ac)
- **STP** = Soil test phosphorus (ppm)
- **KFR** = K fertilizer rate (lbs K$_2$O/ac)
- **STK** = Soil test potassium (ppm)

**Potatoes Statements**

1. Phosphorus and Potassium
   a. The best placement of fertilizer for potatoes on very low testing soils is 2 inches below and 2 inches on each side of the seed piece.
   b. Avoid placement of fertilizer in contact with the seed piece.

Table 24. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for potatoes calculated for different yield goals and the soil test categories shown in table 1. Calculations used the mean soil test value for each category and phosphorus was based on the Olsen Phosphorus test.

<table>
<thead>
<tr>
<th>Yield Goal</th>
<th>Soil N plus supplemental N required</th>
<th>Phosphorus Soil Test Category</th>
<th>Potassium Soil Test Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cwt/ac</td>
<td>VL</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>lbs-N/ac-2'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>80</td>
<td>90</td>
<td>63</td>
</tr>
<tr>
<td>250</td>
<td>100</td>
<td>112</td>
<td>78</td>
</tr>
<tr>
<td>300</td>
<td>120</td>
<td>135</td>
<td>94</td>
</tr>
<tr>
<td>350</td>
<td>140</td>
<td>157</td>
<td>110</td>
</tr>
<tr>
<td>400</td>
<td>160</td>
<td>180</td>
<td>125</td>
</tr>
<tr>
<td>450</td>
<td>180</td>
<td>202</td>
<td>141</td>
</tr>
</tbody>
</table>
Garden & Lawn – Nitrogen, Phosphorus, and Potassium Recommendations
Table 25. Fertilizer recommendations for gardens and lawns based on soil test values for nitrogen, phosphorus, and potassium.

<table>
<thead>
<tr>
<th>Garden/Lawn</th>
<th>Nitrogen Recommendations</th>
<th>Phosphorus Recommendations</th>
<th>Potassium Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soil Test Nitrogen, lbs/6 inches</td>
<td>Soil Test Phosphorus, ppm</td>
<td>Soil Test Potassium, ppm</td>
</tr>
<tr>
<td>Garden</td>
<td>0  25  50  75  100</td>
<td>2  6  10  14  16+</td>
<td>20  60  100  140  161+</td>
</tr>
<tr>
<td>Established Lawn</td>
<td>3.5 3.0 2.0 1.5 0.5</td>
<td>3.0 2.0 1.5 0.5 0.0</td>
<td>5.0 3.5 2.5 1.0 0.0</td>
</tr>
<tr>
<td>New Lawn</td>
<td>2.0 1.5 1.0 0.0 0.0</td>
<td>2.0 1.5 1.0 0.5 0.0</td>
<td>4.5 3.5 2.0 1.0 0.0</td>
</tr>
<tr>
<td></td>
<td>lbs N/1000 sq. ft</td>
<td>lbs P₂O₅/1000 sq. ft</td>
<td>lbs K₂O/1000 sq. ft</td>
</tr>
</tbody>
</table>

1 Olsen (sodium bicarbonate) phosphorus soil test.

Garden & Lawn Statements

1. Calculating the amount of fertilizer needed for the recommended nutrients
   a. This formula is used to determine the quantity of a fertilizer material you need to apply:
      i. \((\text{pounds of element ÷ percent of that element in the fertilizer}) \times 100 = \text{lbs. of fertilizer needed per 1,000 sq. ft.}\) Repeat this calculation for each nutrient that is recommended.
   b. Application of \(\text{P}_2\text{O}_5\) or \(\text{K}_2\text{O}\) in amounts greater than recommended will not be harmful to growth.

2. Vegetable Gardens:
   a. Any P or K recommended should be broadcast on the surface and worked in during seedbed preparation.
   b. If recommended \(\text{N}\) is 1.5 lbs/1000 sq. ft. or greater, the \(\text{N}\) should be split applied with 1/3 being applied during seedbed preparation and the remainder when vine crops, potatoes, and tomatoes have set fruit.
   c. If recommended \(\text{N}\) is less than 1.5 lbs/1000 sq.ft., delay \(\text{N}\) application until vine crops have set fruit.

3. Flower gardens:
   a. Apply recommended fertilizer in spring.

4. Lawns
   a. Recommended fertilizers should be broadcast on the surface as evenly as possible per 1,000 square feet (NOT lbs/ac).
   b. If three or more pounds of \(\text{N}\) is recommended, the \(\text{N}\) application should be split into three applications. First application should be in early May, second application in early August, and third application in mid-September.

5. New lawns
   a. Recommended fertilizers should be broadcast on the surface and worked into the soil before seeding. The above nutrients are per 1,000 square feet.

6. Lawn and new lawn when pH is 7.6 or higher.
   a. Your soil pH is high. This could lead to iron chlorosis symptoms on your grass. This condition is characterized by bright yellow, irregular patches of grass scattered throughout the lawn. If you have these symptoms, obtain an iron fertilizer product from your garden center and apply according to label directions.

7. Trees or shrubs when pH is 7.6 or higher.
   a. Your soil pH is high. This could lead to iron chlorosis symptoms on your trees or shrubs. This condition is typically characterized by pale yellow leaves with green veins.

8. Soluble salts
   a. Soluble salt is less than 3.0 mmhos in garden, lawn, new lawn, trees, and shrubs and no fertilizer is recommended.
      i. If fertility is high, then no fertilizer is recommended.
      ii. If you are encountering poor growth, it is probably due to factors other than soil fertility such as available moisture, shade, compaction, drainage, insects, etc.
   b. Soluble salt is 3.0-6.0 mmhos in garden
i. Soluble salt content of this soil is higher than considered desirable. Only crops (radish, celery, and green beans) that are sensitive to excessive salts will be affected and then only when moisture is in short supply. Tomato, cabbage, lettuce, potatoes, cucumber, beets, kale, asparagus, and spinach are somewhat more tolerant to the excessive salts.

c. Soluble salt greater than 3.0 mmhos in new lawn

i. The soluble salt level of this sample is at such a high level that difficulty in turf growth or establishing a lawn may result.

ii. If you have had difficulty, try seeding Fairway crested wheatgrass. Watering with softened water may have caused this problem.

iii. Improving internal or surface drainage may help.

iv. Correction of this problem is often not practical.

d. Soluble salt is 6.1-10.0 mmhos in garden

i. Total soluble salts are at such a level that successful growth of radish, celery, and green beans can be expected only under the most favorable conditions. Tomatoes, cabbage, lettuce, potatoes, cucumbers, and beets will also be affected by the excessive salts.

e. Soluble salt is greater than 10.0 mmhos in garden

i. The soluble salt level of the sample tested is at such a level that the growth of only tolerant crops such as beets, kale, asparagus, and spinach are likely to be successful. Under very favorable weather conditions, some of the crops may produce a partial crop.

f. Soluble salt is greater than 10.0 mmhos in lawn.

i. The soluble salt level is at such a high level that poor growth may result.

ii. Correction of this problem is often not practical.
### Zinc Recommendations for Corn, Sorghum, Flax, Potatoes and Edible Beans

<table>
<thead>
<tr>
<th>Zinc Soil Test (ppm)</th>
<th>Interpretation</th>
<th>Zinc Recommendations (lb/acre(^1))</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - .25</td>
<td>Very low</td>
<td>10</td>
</tr>
<tr>
<td>.26 - .50</td>
<td>Low</td>
<td>10</td>
</tr>
<tr>
<td>.51 - .75</td>
<td>Medium</td>
<td>5</td>
</tr>
<tr>
<td>.76 - 1.00</td>
<td>High</td>
<td>0</td>
</tr>
<tr>
<td>1.01 +</td>
<td>Very high</td>
<td>0</td>
</tr>
</tbody>
</table>

\(^1\) Based on inorganic products as source of zinc such as zinc sulfate

**Zinc Statements**

1. **Corn, sorghum, edible beans, flax, and potatoes when zinc test is equal to or below 0.75 ppm.**

Zinc recommendations are made for the use of inorganic products such as zinc sulfate. One application of broadcast and incorporated zinc should be effective for 2-4 years. If banded, one-third to one-half the recommended amount should be applied each year for 3 years to distribute zinc throughout the soil. Chelates may be used at about one-third the rate of inorganic products.

2. **All crops except corn, sorghum, edible beans, flax and potatoes when zinc test is equal to or below 0.75 ppm.**

Experience has shown that only the crops of corn, sorghum, edible beans, flax, and potatoes respond to added zinc.

### Sulfur Recommendations

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>Tillage Type</th>
<th>Sulfur Soil Test Categories (lbs/ac 2’)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Very low (0-9)</td>
</tr>
<tr>
<td>Coarse</td>
<td>Tilled(^1)</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Strip-till or no-till</td>
<td>25</td>
</tr>
<tr>
<td>Medium/Fine</td>
<td>Tilled</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Strip-till or no-till</td>
<td>25</td>
</tr>
</tbody>
</table>

\(^1\) Conventional tillage

**Sulfur Statements**

1. **When sulfur is recommended.**

Apply above sulfur as broadcast or apply 10-15 lbs actual sulfur in the row or with the drill. Sulfate forms of sulfur (ammonium sulfate 24% S, gypsum 18% S, and potassium sulfate 17% S) are the best sources for immediate effectiveness. However, elemental sulfur (95-98% S) is usually available from dealers and least expensive. Elemental sulfur requires 1-3 months in warm soil before it is completely available.

2. **When no deep (0-2 ft) soil analysis is available and a sulfur recommendation would result using the topsoil analysis.**

A deep (6-24 inch) sample should be taken to evaluate the sulfur status of your soil.
**Chloride Recommendations**

Chloride recommendations are made by subtracting the 2-foot-deep chloride soil test level from 60, with a minimum recommendation of 15 lbs chloride/ac.

<table>
<thead>
<tr>
<th>Chloride Soil Test (lbs/ac 2 ft)</th>
<th>Relative Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 15</td>
<td>Very low</td>
</tr>
<tr>
<td>16 – 30</td>
<td>Low</td>
</tr>
<tr>
<td>31 – 45</td>
<td>Medium</td>
</tr>
<tr>
<td>46 – 60</td>
<td>High</td>
</tr>
<tr>
<td>&gt;60</td>
<td>Very High</td>
</tr>
</tbody>
</table>

**Chloride Statements**

1. **Wheat and barley when chloride is recommended.**

   The recommendation should be applied as a broadcast application. Seed placement of chloride has shown no advantage over a broadcast application. Higher rates of chloride with the seed can cause seedling injury. Chloride is most economically applied by using muriate of potash (0-0-60) that is 45% chloride. The amount of KCl fertilizer to apply is calculated as: lbs/ac fertilizer needed = recommended Cl X 2.2.

2. **Chloride test done for crops other than wheat or barley.**

   The chloride test has only been calibrated for wheat and barley. However, corn, soybean, and oats have not responded to chloride. Therefore no recommendation is given. If wheat or barley is grown, the chloride recommendation would be: 60 - chloride test (lbs/ac, 2 ft.) = recommended chloride (lbs/ac).

3. **Chloride test is done and soil sample depth is less than 18 inches.**

   A deep (24 inch) sample should be taken to evaluate the chloride status of your soil.

**Magnesium Recommendation**

<table>
<thead>
<tr>
<th>Magnesium Soil Test (ppm)</th>
<th>Interpretation</th>
<th>Magnesium Recommendations (lbs/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 10</td>
<td>Very low</td>
<td>50</td>
</tr>
<tr>
<td>11 – 20</td>
<td>Low</td>
<td>50</td>
</tr>
<tr>
<td>21 – 30</td>
<td>Medium</td>
<td>25</td>
</tr>
<tr>
<td>31 – 40</td>
<td>High</td>
<td>0</td>
</tr>
<tr>
<td>&gt;40</td>
<td>Very high</td>
<td>0</td>
</tr>
</tbody>
</table>

**Magnesium Statement**

1. **The magnesium recommendation is for a broadcast application.**

   Reduce to 10-20 lbs/ac actual magnesium if row applied. Sources such as magnesium sulfate (11% Mg) can be used. Magnesium deficiency has not been confirmed in South Dakota.

**Calcium Recommendation**

<table>
<thead>
<tr>
<th>Calcium Soil Test (ppm)</th>
<th>Interpretation</th>
<th>Calcium Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 100</td>
<td>Very low</td>
<td>lime</td>
</tr>
<tr>
<td>101 - 200</td>
<td>Low</td>
<td>lime</td>
</tr>
<tr>
<td>201 - 300</td>
<td>Medium</td>
<td>0</td>
</tr>
<tr>
<td>301 - 400</td>
<td>High</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 400</td>
<td>Very low</td>
<td>0</td>
</tr>
</tbody>
</table>

**Calcium Statement**

1. **The calcium recommendation should be based on a buffer pH lime test.**

   Calcium deficiency has only been observed on very acid, sandy soils (pH less than 5.0). Calcium deficiency has not been confirmed in South Dakota.
Iron Recommendation

<table>
<thead>
<tr>
<th>Iron Soil Test (ppm)</th>
<th>Interpretation</th>
<th>Iron Recommendations (lbs/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 2.5</td>
<td>Low</td>
<td>0.15</td>
</tr>
<tr>
<td>2.6 - 4.5</td>
<td>Medium</td>
<td>0.15</td>
</tr>
<tr>
<td>&gt; 4.5</td>
<td>High</td>
<td>0</td>
</tr>
</tbody>
</table>

Iron Statement

1. The iron test cannot be adequately calibrated in our area.

High pH (greater than 7.5) will likely be a better indication of potential iron deficiencies in susceptible crops. Research in other areas has shown that an iron soil test above 4.5 ppm is sufficient for crop needs. If the test is below this level, 0.15 lb/ac of iron should be applied as a foliar application when iron deficiency symptoms are first observed. Use a chelated form of iron, such as EDDHA. Soil application of iron is generally not effective in South Dakota and extremely expensive. Iron is recommended only for sensitive crops such as sorghum, beans, corn, flax, sudan, and potatoes. Deficiencies are often more severe when soils are wet and cold and may disappear as the soil dries down and warms up.

Boron Recommendation

<table>
<thead>
<tr>
<th>Boron Soil Test (ppm)</th>
<th>Interpretation</th>
<th>Boron Recommendations (lbs/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.25</td>
<td>Low</td>
<td>2</td>
</tr>
<tr>
<td>0.26 - 0.50</td>
<td>Medium</td>
<td>2</td>
</tr>
<tr>
<td>&gt; 0.50</td>
<td>High</td>
<td>0</td>
</tr>
</tbody>
</table>

Boron Statement

1. The boron soil test has not been adequately calibrated for our area.

Research in other areas has shown that a boron soil test above 0.50 ppm is adequate for crop needs. A boron application should always be broadcast applied and never applied in direct seed contact (row or drill fertilizers). Alfalfa and clovers are the most sensitive to boron deficiency. Because of possible toxic overfertilization with boron, never apply unless a boron soil test has first been taken. Boron deficiency has not been confirmed in South Dakota.

Copper Recommendation

<table>
<thead>
<tr>
<th>Copper Soil Test (ppm)</th>
<th>Interpretation</th>
<th>Copper Recommendations (lbs/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.10</td>
<td>Low</td>
<td>2</td>
</tr>
<tr>
<td>0.11 - 0.20</td>
<td>Medium</td>
<td>2</td>
</tr>
<tr>
<td>&gt; 0.20</td>
<td>High</td>
<td>0</td>
</tr>
</tbody>
</table>

Copper Statement

1. The copper soil test has not been adequately calibrated for our area.

Research in other areas has shown that a copper soil test above 0.20 ppm is adequate for crop needs. If the test is below this level, 2 lb/a copper should be applied. Copper deficiency has never been confirmed in South Dakota.

Manganese Recommendation

<table>
<thead>
<tr>
<th>Manganese Soil Test (ppm)</th>
<th>Interpretation</th>
<th>Manganese Recommendations (lbs/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50</td>
<td>Low</td>
<td>20</td>
</tr>
<tr>
<td>0.51 - 1.0</td>
<td>Medium</td>
<td>20</td>
</tr>
<tr>
<td>&gt; 1.0</td>
<td>High</td>
<td>0</td>
</tr>
</tbody>
</table>

Manganese Statement

1. The manganese soil test has not been adequately calibrated for our area.

Research in other areas has shown that a manganese soil test above 1.0 ppm is adequate for crop needs. If the test is below this level, apply 20 lbs/ac manganese. Manganese deficiency has never been confirmed in South Dakota.
### Lime Recommendation

<table>
<thead>
<tr>
<th>Buffer index&lt;sup&gt;(1)&lt;/sup&gt;</th>
<th>Lime required&lt;sup&gt;(2)&lt;/sup&gt; for 6” soil depth (tons/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.8 - 6.5</td>
<td>0</td>
</tr>
<tr>
<td>6.4 - 6.1</td>
<td>2.0</td>
</tr>
<tr>
<td>6.0 - 5.9</td>
<td>2.5</td>
</tr>
<tr>
<td>5.8 - 5.7</td>
<td>3.0</td>
</tr>
<tr>
<td>5.6 or less</td>
<td>3.5</td>
</tr>
</tbody>
</table>

<sup>(1)</sup>This is not soil pH but is the SMP buffer.

<sup>(2)</sup>Rates based on a calcium carbonate equivalent of 90% and a total effectiveness of 70%. One ton of pure CaCO<sub>3</sub> is equivalent to 1.60 tons of such a limestone.

### Lime Statements

1. **Buffer test should be run when water pH is below 5.6.**

2. **Buffer test (index) is run and is 6.5 or higher.**
   
   No lime is recommended based on this buffer index test.

3. **Buffer test (index) is 6.1-6.4.**
   
   Apply 2 tons/ac of lime per 6 inches of soil depth. This rate is based on a calcium carbonate equivalent of 90% and a total effectiveness of 70%. One ton of pure CaCO<sub>3</sub> is equivalent to 1.6 tons of such a limestone. Lime recommendations are based on the buffer test (index) and not directly on soil pH. The buffer index should be run when the soil pH is below 5.6. Lime recommendations are based on raising soil pH to 6.0.

4. **Buffer test (index) is 5.9-6.0.**
   
   Apply 2.5 tons/ac of lime per 6 inches of soil depth. This rate is based on a calcium carbonate equivalent of 90% and a total effectiveness of 70%. One ton of pure CaCO<sub>3</sub> is equivalent to 1.6 tons of such a limestone. Lime recommendations are based on the buffer test (index) and not directly on soil pH. The buffer index should be run when the soil pH is below 5.6. Lime recommendations are based on raising soil pH to 6.0.

5. **Buffer test (index) is 5.7-5.8.**
   
   Apply 3 tons/ac of lime per 6 inches of soil depth. This rate is based on a calcium carbonate equivalent of 90% and a total effectiveness of 70%. One ton of pure CaCO<sub>3</sub> is equivalent to 1.6 tons of such a limestone. Lime recommendations are based on the buffer test (index) and not directly on soil pH. The buffer index should be run when the soil pH is below 5.6. Lime recommendations are based on raising soil pH to 6.0.

6. **Buffer test (index) is 5.6 or less.**
   
   Apply 3.5 tons/ac of lime per 6 inches of soil depth. This rate is based on a calcium carbonate equivalent of 90% and a total effectiveness of 70%. One ton of pure CaCO<sub>3</sub> is equivalent to 1.6 tons of such a limestone. Lime recommendations are based on the buffer test (index) and not directly on soil pH. The buffer index should be run when the soil pH is below 5.6. Lime recommendations are based on raising soil pH to 6.0.
Salts and Sodium Recommendation

Salt Level in Soil

Electrical Conductivity (EC), millimhos (mmhos)/cm

<table>
<thead>
<tr>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3</td>
<td>3 - 5</td>
<td>5.1 - 10.0</td>
<td>&gt; 10</td>
</tr>
</tbody>
</table>

Sodium Level in Soil

Exchangeable Sodium Percentage (ESP)

<table>
<thead>
<tr>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 9</td>
<td>9 - 13</td>
<td>&gt; 13</td>
</tr>
</tbody>
</table>

Salts and Sodium Statements

1. **Soluble salts greater than 3.0 mmhos/cm.**

   Excessive salts are usually associated with poor drainage either past or present. Frequently, these areas are relatively small in relation to the rest of the field. Little can be done to increase their productivity unless the internal drainage can be improved. This is often impossible or uneconomical. Heavy applications of crop residues and phosphate fertilizer sometimes increases the productivity of these soils.

2. **Soluble salts in 3.1-5.0 mmhos/cm range.**

   The soluble salt content of this soil is higher than considered desirable. Only salt sensitive crops such as corn, soybeans, flax, potatoes, field beans, sunflower, and new alfalfa seedlings may be affected and then only when soil moisture is in short supply. Phosphorus should be maintained at a medium to high level.

3. **Soluble salts in 5.1-10.0 mmhos/cm range.**

   The total soluble salts are at such a level that normal growth of crops such as corn, soybean, flax, potatoes, field bean, sunflower, and new alfalfa seedlings can be expected only in relatively wet years. You should consider growing a small grain or grass on this land. Grass or legume establishment may be difficult.

4. **Soluble salts in 10.1-16.0 mmhos/cm range.**

   The total soluble salts are at such a level that the growth of only salt-tolerant crops such as rye, millet, barley, and grasses such as western wheatgrass, crested wheatgrass, and tall wheatgrass should be considered. Grass establishment may be difficult.

5. **Soluble salts greater than 16 mmhos/cm.**

   The total soluble salts are at such a level that the growth of only the extremely salt-tolerant crops should be attempted. Tall and western wheatgrasses are the most tolerant. Grass establishment may be difficult.

6. **When ESP is in the 9.0-13.0 range.**

   The soluble sodium content of this soil is high enough so that a dispersed soil condition may now or soon will exist.

7. **When ESP is greater than 13.0.**

   The sodium hazard of this soil is high. Correction of this problem is often not practical.