South Dakota State University Extension

Guide on Using the South Dakota Fertilizer Rate Guidelines Calculator for Corn, Soybean, and Wheat

Extensive research has been conducted to develop fertilizer recommendations for crops grown in South Dakota. To calculate nitrogen (N) fertilizer rates the equation uses the factors yield potential, lbs N/bu of crop multiplier, preplant soil test N to a depth of 0 to 24 in., previous crop, manure application, and tillage type. To calculate phosphorus (P) and potassium (K) rates the equation uses the factors of soil test P (Olsen-P or Bray-1 P extraction tests) or soil test K (ammonium acetate extraction test) at a depth of 0 to 6 in. and yield potential. To calculate sulfur (S) fertilizer rates, the equation uses the factors of soil test S to a depth of 0 to 24 in. soil texture category and tillage type. This workbook has been developed to aid in the ease of calculating fertilizer rates (N, P, K, and S) for corn, soybean, and wheat. Future updates of this workbook will work to include other crops grown in South Dakota.

Instructions

Available Worksheets

When you first open the excel workbook you will notice 7 worksheets along the bottom. The first four worksheets can be used to calculate the N, P, and K fertilizer rate recommendations for corn grain, corn silage, soybean, and wheat/rye. The fourth worksheet (All Crops Sulfur) can be used to calculate S rate guidelines for all crops. The fifth worksheet (LegumeCredit_ppmTolbperacCalc) tab can be used to convert and soil test values from ppm to lbs/ac if this is not calculated for you on your soil test report received from the soil testing lab. This fourth worksheet also contains a table containing the legume N credits for the different legume crops that can be referenced when choosing the amount of legume credit to used when calculating N fertilizer rate recommendations in the first four tabs. The fifth worksheet (Equations) is a table of the equations used to calculate fertilizer rates in this workbook.

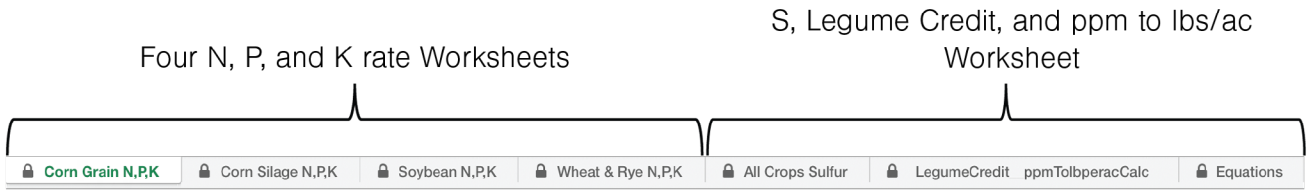

Figure 1. Photograph of the 7 worksheets within the Fertilizer Rate Guidelines Calculator workbook.

General Guidelines

There are instructions on how to use the worksheet to calculate fertilizer rate guidelines on each sheet. Generally, cells that are highlighted yellow are those where values can be written in or where drop-down lists appear. Grey cells are informational or areas where equations are located and cannot be altered due to the worksheets being protected.

N, P, and K Fertilizer Rate Worksheets

N, P, K Worksheet Notes

The below steps should be followed for calculating N, P, and K rate guidelines for corn grain, corn silage, soybean, and wheat & rye worksheets with the following exceptions:

- Only in the corn grain worksheet can a lbs N/bu crop multiplier be chosen from a drop-down list. Choices were given for corn grain as research has shown that the best multiplier is between 0.9 and 1.0. For all other crops, there is only one multiplier used, so there is not a drop-down menu to choose a lbs N/bu crop multiplier in other worksheet.

- Soybean worksheet: Since soybean obtain N from the atmosphere via symbiotic relationships with microbes, there are no soil test N, legume credit, or no-till debit columns to insert information and the N rate recommendation will always be 0.

N, P, K Worksheet Instructions

- Step 1: In the corn grain worksheet choose the lbs N/bu corn grain multiplier you would like to use from the drop-down list (i.e., “1.0”, “0.9”, or “0.8”). You will need to click on the yellow cell for the drop-down list to appear. Before 2023, the lbs N/bu corn grain multiplier was “1.2 lbs N/bu grain”. However, recent research (2018-2022) has shown that reducing this multiplier to 1.0 lbs N/bu grain improves the mean N rate recommendation accuracy by 34 lbs N/ac. You may choose the “1.0” multiplier from the drop-down menu above. You may also change this multiplier to lower values like 0.9 and 0.8 to compare recommended N rates with even lower coefficient values.

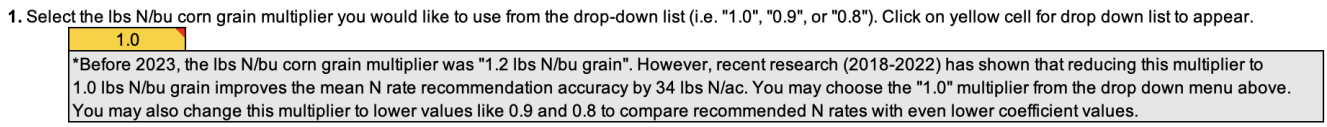

Figure 2. Photo of excel sheet where the N/bu corn grain multiplier is shown. In the yellow drop-down list, you can choose from a multiplier of 1.0, 0.9, or 0.8.

- Step 2: Select the soil phosphorus test from the drop-down list reported in your soil test report (i.e., Olsen P or Bray-1 P). You will need to click on the yellow cell for the drop-down list to appear. It is important to remember that P fertilizer rate recommendations can only be given for one type of soil test P value at a time (i.e., either Olsen P or Bray-1 P). Therefore, if you have results for soil test P for Olsen and Bray-1 then you will need to switch between these two options to get the P recommendation based on each value. Another note is that if you have chosen Olsen P in the drop-down list but place your soil test P value in the column for Bray-1 P or vice versa, no P rate recommendation will appear. Therefore, please check to make sure the appropriate soil test P test in the drop-down menu is chosen and matches the column where soil test P data is input in the worksheet.

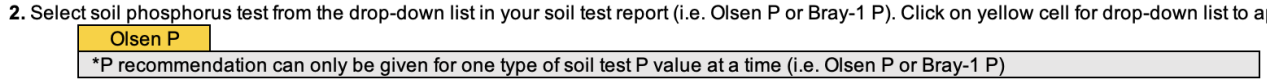

Figure 3. Photo of excel sheet where the P soil test method can be chosen. Olsen P or Bray-1 P can be chosen.

- Step 3: Input the appropriate plant and soil information into the ‘Data Input’ table: Yield goal, sol test nitrogen (0-24 in.), legume credit, no-till N adjustment, soil test phosphorus (either in the Olsen P or Bray-1 P columns depending on the tests used at the soil testing lab), and soil test potassium. See below for more details regarding each column.
  - Yield goal: Insert realistic yield potentials in this column.
  - Soil Test N: Insert soil test nitrogen values here for the top 24 inches in lbs N/ac.
    - If you need to convert N values from ppm to lbs/ac you can use the calculator on the “LegumeCredit__ppmTolbperacCalc” worksheet.
    - If soil test nitrogen values are not known then use 40 lbs/ac as the default value.
  - Legume Credit: See table in “LegumeCredit__ppmTolbperacCal” tab (e.g. previous crop of soybean = 40 lbs N/ac credit).
  - No-till N adjustment: If using very reduced tillage systems including strip-till and no-till systems then 30 lbs/ac of additional N should be considered (e.g., Leave blank or put 30 in this cell).
  - Olsen P, 0-6 in. (STP): If the soil test phosphorus test used is Olsen P, insert values in this column. Otherwise leave blank.
  - Bray-1 P, 0-6 in. (STP): If the soil test phosphorus test used is Bray-1 P, insert values in this column. Otherwise leave blank.
  - Potassium, 0-6 in. (STK): Insert soil test potassium levels in this column.

3. Input plant and soil information into below table: Yield goal, sol test nitrogen (0-24 in.), legume credit, no-till N adjustment, soil test phosphorus, and soil test potassium.

Yield goal: Insert realistic yield potentials in this column.
Soil Test N: Insert soil test nitrogen values here for the top 24 inches in lbs N/ac.
If you need to convert N values from ppm to lbs/ac, you can use the calculator on the "LegumeCredit__ppmTolbperacCalc" tab.
If soil test nitrogen values are not known, use 40 lbs/ac as the default value.
Legume Credit: See table in "LegumeCredit__ppmTolbperacCal" tab (e.g. previous crop of soybean = 40 lbs N/ac credit).
No-till N adjustment: If using very reduced tillage systems including strip-till and no-till systems then 30 lbs/ac of additional N should be considered (e.g. Leave blank or put 30 in this cell).
Olsen P, 0-6 in. (STP): If the soil test phosphorus test used is Olsen P, insert values in this column. Otherwise leave blank.
Bray-1 P, 0-6 in. (STP): If the soil test phosphorus test used is Bray-1 P, insert values in this column. Otherwise leave blank.
Potassium, 0-6 in. (STK): Insert soil test potassium levels in this column.

	Data Input								Recommendation		
Sample	Field ID	Yield Goal (YG)	Soil Test Nitrogen, 0-24 in. (STN)	Legume Credit (LC)	No-till N adjustment	Olsen P, 0-6 in. (STP)	Bray-1 P, 0-6 in. (STP)	Potassium, 0-6 in. (STK)	Nitrogen	Phosphorus	Potassium
#		bu/ac	lb N/ac	lb N/ac		ppm	ppm	ppm	lb N/ac	lb P_2O_5/acre	lb K_2O/acre
1	Brookings 1	200	42	40	0		12	140	118		60
2											
3											

Figure 4. Photo of excel sheet where the yield goal, soil test N, legume credits, no-till N adjustment, and soil test P and K can be input along with where the subsequent N, P, and K rate recommendations will appear.

Once all the above instructions are followed, the fertilizer rate recommendations for N, P, and K should appear in the 'Recommendation' columns. Tables below the Data Input table contain the equations used to calculate fertilizer rate recommendations along with soil test calibration levels for P and K used in South Dakota to determine the probability that fertilizer application will increase crop yield.

All Crops Sulfur Worksheet

- Input the appropriate plant and soil information into the 'Data Input' table: Soil texture, tillage practice, and soil test S (0-24 in.).
  - Soil Texture: Select the appropriate soil texture for each field from the drop-down menu ("Coarse" or "Medium/Fine"). Click on the yellow cell for the drop-down list to appear.
  - Tillage Practice: Select the appropriate tillage practice from the drop-down menu ("Conventional" or "Strip till or No-till"). Click on the yellow cell for the drop-down list to appear.
  - Soil Test S: Insert soil test sulfur values here for the top 24 inches in lbs S/ac.
    - If you need to convert S values from ppm to lbs/ac you can use the calculator on the 'LegumeCredit__ppmTolbperacCalc' worksheet.
    - A soil sample taken to a 24 in. depth is needed to evaluate the sulfur status of your soil.

1. Input soil and tillage practice information into the below table: Soil texture, tillage practice, and soil test S (0-24 in.).

Soil Texture: Select the appropriate soil texture from drop down menu ("Coarse" or "Medium/Fine"). Click on the yellow cell for the drop-down list to appear.
Tillage Practice: Select the appropriate tillage practice from the drop-down menu ("Conventional" or "Strip till or No-till").
Click on the yellow cell for the drop-down list to appear.
Soil Test S: Insert soil test sulfur values here for the top 24 inches in lbs S/ac.
If you need to convert S values from ppm to lbs/ac, you can use the calculator on the "LegumeCredit__ppmTolbperacCalc" worksheet.
A soil sample taken to a 24 in. depth is needed to evaluate the sulfur status of your soil.

	Data Input				Recommendation
Sample	Field ID	Soil Texture	Tillage Practice	Soil Test Sulfur, 0-24 in.	Sulfur
#				lb S/ac	lb S/ac
1	Aurora	Coarse	Conventional	15	25
2	Yankton	Coarse	Stip till or No-till	15	25
3	SW133	Medium/Fine	Conventional	45	0

Figure 5. Photo of excel sheet where the soil texture, tillage practice, and soil test S values can be input along with where the subsequent S rate recommendations will appear.

Legume N Credit and ppm to lbs/ac Calculator Worksheet

ppm to lbs/ac Calculator

If your soil test N or S values are in ppm, you can use this converter to change ppm values to lbs/ac.

- Input the appropriate plant and soil information into the 'Soil Test ppm to lbs/ac Calculator: Beginning depth of soil sample, ending depth of soil sample, and soil test value.
  - Beginning depth: This is the beginning depth of your soil sample. For example, enter 0 if the beginning is the soil surface or 6 if is a sample from the 6 to 24 inch depth.
  - Ending depth: This is the ending depth of your soil sample. For example, for a 0 to 6 in. sample, enter 6. For a 6 to 24 in. sample, enter 24.
  - Soil Test Value: Insert soil test values here for each depth evaluated.

Once all the above instructions are followed, the lbs/ac value of the nutrient will appear in the soil test value column. If multiple depths are input such as 0 to 6 and 6 to 24, the total of the two depths in lbs/ac is found at the end of the table.

Table 1. Example of table located in the 'LegmeCredit__ppmTolbperacCalc' worksheet used to convert soil test values from ppm to lbs/ac so they can be used in the N and S rate recommendation worksheets.

Soil Test ppm to lbs/ac Calculator			
Soil Sample Depth			
Beginning Depth	**Ending Depth**	**Soil Test Value**	**Soil Test Value**
inches	**inches**	**ppm**	**lbs /ac**
0	6	9	18
6	24	4	24
			0
			0
			0
		Total Soil Test Value, lbs/ac	**42**

*If soil test nitrogen values are not known then use 40 lbs/ac as the default value. There is no default soil test sulfur value for South Dakota.
**Calculation: Multiply ppm by 2 for every 6 inches of soil sample depth. e.g. for a 12 inch soil sample, multiply ppm by 4 (9 ppm N x 4 = 36 lbs N/ac).

Legume N Credit Table

The Legume N Credits table is found below the Soil Test ppm to lbs/ac Calculator table. The table contains the N credits based on previous crop that should be used when calculating N fertilizer rate recommendations. If the previous crop is not contained in this table, the credit should be 0.

Table 2. Example of table located in the 'LegmeCredit__ppmTolbperacCalc' worksheet showing the legume N credit information needed to determine the legume credit it the N, P, and K rate worksheets.

Previous Crop	Plants/sq. ft.	Nitrogen credit (lbs/ac)
Soybean, edible beans, peas, lentils, and other annual legumes	-	40
Alfalfa and legume green manure crops (sweet clover, red clover, etc.)*	>5	150
	3-5	100
	1-2	50
	<1	0

*When no-tilling into alfalfa and legume green manure crops, use half credit.
**For 2nd year following alfalfa and legume green manure crops, use half credit.