Fertilizer

Recommendations Guide

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Original Authors: 2005 – Jim Gerwing | Extension Soil Specialist

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Contents

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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:

a) **Soil Nitrate-N Test:** Soil nitrate-N is estimated by analyzing soil samples from 0 to 24 inches. If a 2-foot soil sample is not available, then the long-term average soil test nitrate-N value 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 24- to 48-inch soil sample is also taken and exceeds 30 lbs/ac, then only include 80% of the amount above 30 lbs/ac as part of the soil test N credit. For example, if there are 50

Table 1. Soil Test Calibration Levels Used in South Dakota and the probability that fertilizer applications will increase crop yield.

Nutrient	Soil Test	Very Low (VL)	Low (L)	Medium (M)	High (H)	Very High (VH)
Probability of yield response		**80%**	**60-80%**	**40-60%**	**20-40%**	**<20%**
				ppm extractable (0-6 inch samples)		
Phosphorus	Bray P-1	0-5	6-10	11-15	16-20	21+
Phosphorus	Olsen	0-3	4-7	8-11	12-15	16+
Potassium	NH_4Ac	0-40	41-80	81-120	121-160	161+
Zinc [1]	DTPA	0-0.25	0.26-0.50	0.51-0.75	0.76-1.00	1.01+
Iron [2]	DTPA	—	0-2.5	2.6-4.5	4.5+	—
Manganese [3]	DTPA	—	0-0.50	0.51-1.00	1.00+	—
Copper [3]	DTPA	—	0-0.10	0.11-0.20	0.20+	—
Boron [3]	Hot H_2O	—	0-0.25	0.26-0.50	0.50+	—
Magnesium [3]	NH_4Ac	0-10	11-20	21-30	31-40	41+
Calcium [3]	NH_4Ac	0-100	101-200	201-300	301-400	401+
				lbs/ac 2 ft		
Sulfur	500 ppm P	0-9	10-19	20-29	30-39	40+
Chloride [4]	0.01M $Ca(NO_3)$	0-15	16-30	31-45	46-60	61+

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

lbs of nitrate-N in the 24- to 48-inch depth, credit 16 lbs (16 lb N credit = (50 lbs N - 30 lbs N) × 80%).

b) **Legume credits:** Legume credits used in South Dakota are listed in Table 2.

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.

During the first 5 to 10 years of using no-till or strip-till, the nitrogen fertilizer recommendation can be increased by 30 lbs/ac. When switching to these less intensive tillage systems, breakdown of organic nitrogen is often slower, requiring higher nitrogen fertilizer rate recommendations. However, after 5 to 10 years, these less intensive systems no longer need the extra 30 lbs/ac of N.

Table 2. Legume N Credits

Previous Crop	Nitrogen Credit (lbs/ac)
Soybeans, edible beans, peas, lentils and other annual legumes	40

Previous Crop	plants/sq ft	Nitrogen Credit (lb/ac)
Alfalfa and legume green manure crops (sweet clover, red clover, etc) [1] [2]	> 5	150
	3-5	100
	1-2	50
	<1	0

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

Table 3. Nutrient Recommendation Equations Used by SDSU Extension, September 2005

Code, Crop, Yield Unit	Nitrogen Recommendation	P_2O_5 Recommendation Olsen test	K_2O Recommendation
01, Alfalfa, ton	none	= (18.57 − (1.16 × STP)) × YG	= (55.71 − (0.38 × STK)) × YG
02, Alfalfa-Grass, ton	none	= (18.57 − (1.16 × STP)) × YG	= (55.71 − (0.38 × STK)) × YG
03, Alfalfa (new seeding), ton	none	= (18.57 − (1.16 × STP)) × YG	= (55.71 − (0.38 × STK)) × YG
04, Grass, ton	= 25 × YG	= 45.0 − (3.45 × STP)	= 80.0 − (0.53 × STK)
08, Sudan grass, ton	= 25 × YG − STN − LC	= (11.0 − (0.7 × STP)) × YG	= (43.0 − (0.3 × STK)) × YG
09, Grass (new seeding), ton	= 25 × YG	= 45.0 − (3.45 × STP)	= 80.0 − (0.53 × STK)
10, Corn (grain), bu	= 1.0 × YG − STN − LC	= (0.700 − (0.044 × STP)) × YG	= (1.1660 − (0.0073 × STK)) × YG [(1)]
11, Corn (silage), ton	= 8.9 × YG − STN − LC	= (5.62 − (0.35 × STP)) × YG	= (9.50 − (0.06 × STK)) × YG [(1)]
12, Sorghum, bu	= 1.1 × YG − STN − LC	= (0.666 − (0.041 × STP)) × YG	= (0.875 − (0.0058 × STK)) × YG
14, Soybean, bu	none	= (1.55 − (0.14 x STP)) × YG	= (2.2 − (0.0183 × STK)) × YG
15, Edible Beans, lbs	= 0.05 × YG − STN − LC	= (0.0231 − (0.0014 × STP)) × YG	= (0.0346 − (0.00021 × STK)) × YG
16, Barley (feed), bu	= 1.7 × YG − STN − LC	= (0.785 − (0.05 × STP)) × YG	= (1.286 − (0.0085 × STK)) × YG
17, Barley (malting), bu	= 1.5 × YG − STN − LC	= (0.785 − (0.05 × STP)) × YG	= (1.286 − (0.0085 × STK)) × YG
18, Wheat (winter), bu	= 2.5 × YG − STN − LC	= (1.071 − (0.067 × STP)) × YG	= (2.71 − (0.017 × STK)) × YG
19, Wheat (spring), bu	= 2.5 × YG − STN − LC	= (1.071 − (0.067 × STP)) × YG	= (2.71 − (0.017 × STK)) × YG
20, Rye, bu	= 2.5 × YG − STN − LC	= (1.071 − (0.067 × STP)) × YG	= (2.71 − (0.017 × STK)) × YG
21, Oats, bu	= 1.3 × YG − STN − LC	= (0.644 − (0.041 × STP)) × YG	= (1.277 − (0.0086 × STK)) × YG
22, Flax, bu	= 3.0 × YG − STN − LC	= (1.17 − (0.073 × STP)) × YG	= (2.2 − (0.014 × STK)) × YG
23, Rape Seed, Canola, cwt	= 6.5 × YG − STN − LC	= (3.6 − (0.22 × STP)) × YG	= (5.4 − (0.034 × STK)) × YG
24, Mustard, cwt	= 6.5 × YG − STN − LC	= (3.6 − (0.22 × STP)) × YG	= (5.4 − (0.034 × STK)) × YG
25, Millet, lbs	= 0.035 × YG − STN − LC	= (0.0171 − (0.00114 × STP)) × YG	= (0.03 − (0.00018 × STK)) × YG
26, Potatoes, cwt	= 0.4 × YG − STN − LC	= (0.5 − (0.034 × STP)) × YG	= (0.85 − (0.0057 × STK)) × YG
27, Sunflowers, lbs	= 0.05 × YG − STN − LC	= (0.0225 − (90.0014 × STP)) × YG	= (0.041 − (0.00027 × STK)) × YG
28, Garden	= 3.5 − (0.03 × STN)	= 3.6 − (0.23 × STP)	= 5.4 − (0.03 × STK)
29, Fallow	none	none	none
30, Buckwheat, bu	= 2.2 × YG − STN − LC	= (1.32 − (10.083 × STP)) × YG	= (1.86 − (0.0116 × STK)) × YG
31, Lawn	= 4.0 − (0.4 × STN)	= 2.5 − (0.16 × STP)	= 5.0 − (0.286 × STK)
32, Lawn (new seeding)	= 2.0 − (0.25 × STN)	= 5.0 − (0.32 × STP)	= 5.0 − (0.286 × STK)
33, Safflower, lbs	= 0.05 × YG − STN − LC	= (0.027 − (0.0017 × STP)) × YG	= (0.048 − (0.0003 × STK)) × YG
36, Field Pea, Lentil, Chickpea, lbs	none	= (0.0171 − (0.0011 × STP)) × YG	= (0.03 − (0.00018 × STK)) × YG

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 NO_3-N soil test, and soybeans as a previous crop:

145 bu/ac × 1.0 lbs N/bu = 145 lbs N/ac requirement.

145 lbs N/ac requirement − 35 lbs/ac soil nitrate N − 40 lbs/ac legume credit = 70 lbs N/ac recommended.

Example 2
50 bushel wheat yield goal in no-till, 40 lbs/ac 2-foot NO_3-N soil test:

50 bu/ac × 2.5 lbs N/bu = 125 lbs N/ac requirement.

125 lbs N/ac requirement − 40 lbs/ac soil nitrate N + 30 lbs N/ac for no-till = 115 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 Guidelines[1] for Seed Placed Fertilizer to Minimize Seed Injury

Crop and Row Spacing	Guidelines
Corn in 30-inch rows	• up to 10 lbs/ac N + K_2O • no urea or UAN
Soybean and Sunflower in 30-inch rows	• no fertilizer with the seed
Soybean in 7.5-inch rows	• up to 10 lbs/ac N + K_2O • no urea or UAN
Wheat, Oats, Barley, Rye in 7-inch rows	• up to 25 lbs/ac N + K_2O

[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

Equations for corn N, P, and K recommendations.

Nitrogen

NFR = 1.0 × YG − STN − LC

Phosphorus

Olsen P

PFR = (0.700 − (0.044 × STP)) × YG

Bray-1 P

PFR = (0.700 − (0.035 × STP)) × YG

Potassium

KFR = (1.1660 − (0.0073 × STK)) × 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 P_2O_5/ac)
STP = Soil test phosphorus (ppm)
KFR = K fertilizer rate (lbs K_2O/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 for less than 5 to 10 years, 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 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 P_2O_5 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
bu/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
80	80	51	37	23	8	0	82	60	60	60	0
100	100	63	46	28	11	0	102	72	60	60	0
120	120	76	55	34	13	0	122	87	60	60	0
140	140	89	64	39	15	0	143	101	61	60	0
160	160	101	73	45	17	0	163	116	69	60	0
180	180	114	82	51	19	0	184	130	78	60	0
200	200	127	92	56	21	0	204	145	86	60	0
220	220	139	101	62	23	0	224	159	95	60	0
240	240	152	110	68	25	0	245	174	104	60	0

Corn Silage – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for corn silage N, P, and K recommendations.

Nitrogen

NFR = 8.9 × YG − STN − LC

Phosphorus

Olsen P

PFR = (5.62 − (0.35 × STP)) × YG

Bray-1 P

PFR = (5.62 − (0.28 × STP)) × YG

Potassium

KFR = (9.50 − (0.06 × STK)) × YG

*(60-lb minimum when K is recommended)

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)

Corn Silage Statements

1. Nitrogen fertilizers
   a. If using very reduced tillage systems including strip-till and no-till systems for less than 5 to 10 years, 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 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 P_2O_5 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
ton/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
6	53	31	22	14	5	0	60	60	60	60	0
10	89	51	37	23	9	0	83	60	60	60	0
14	125	71	52	32	13	0	116	82	60	60	0
18	160	92	67	41	16	0	149	106	62	60	0
22	196	112	81	50	20	0	183	130	76	60	0
26	231	132	96	60	23	0	216	153	90	60	0

Sorghum – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for sorghum N, P, and K recommendations.

Nitrogen

NFR = 1.1 × YG − STN − LC

Phosphorus

Olsen P

PFR = (0.666 − (0.041 × STP)) × YG

Bray-1 P

PFR = (0.666 − (0.033 × STP)) × YG

Potassium

KFR = (0.875 − (0.0058 × STK)) × 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)

Sorghum Statements

1. Nitrogen fertilizers
   a. If using very reduced tillage systems including strip-till and no-till systems for less than 5 to 10 years, 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 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 P_2O_5 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
bu/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
60	66	36	26	17	7	0	46	31	18	4	0
80	88	48	35	22	9	0	61	42	23	5	0
100	110	60	44	28	11	0	76	52	29	6	0
120	132	73	53	33	14	0	91	63	35	7	0
140	154	85	62	39	16	0	106	73	41	8	0
160	176	97	70	44	18	0	121	84	47	10	0

Sunflowers – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for sunflowers N, P, and K recommendations.

Nitrogen

NFR = 0.05 × YG − STN − LC

Phosphorus

Olsen P

PFR = (0.0225 − (0.0014 × STP)) × YG

Bray-1 P

PFR = (0.0225 − (0.0011 × STP)) × YG

Potassium

KFR = (0.041 − (0.00027 × STK)) × 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 P_2O_5/ac)
STP = Soil test phosphorus (ppm)
KFR = K fertilizer rate (lbs K_2O/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 for less than 5 to 10 years, 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 + K_2O 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 P_2O_5 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
lbs/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
1000	50	20	15	9	4	0	36	25	14	3	0
1400	70	29	21	13	5	0	50	35	19	4	0
1800	90	37	27	17	6	0	64	44	25	6	0
2200	110	45	33	20	8	0	78	54	31	7	0
2600	130	53	38	24	9	0	93	64	36	8	0
3000	150	61	44	28	11	0	107	74	42	9	0
3400	170	69	50	31	12	0	121	84	47	10	0

Soybean – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for soybean N, P, and K recommendations.

Nitrogen

NFR = 0

Phosphorus

Olsen P

PFR = (1.55 − (0.14 × STP)) × YG

Bray-1 P

PFR = (1.55 − (0.10 × STP)) × YG

Potassium

KFR = (2.2 − (0.0183 × STK)) × YG

Acronym Definitions

NFR = N fertilizer rate (lbs N/ac)
PFR = P fertilizer rate (lbs P_2O_5/ac)
STP = Soil test phosphorus (ppm)
YG = Yield goal (bu/ac)
KFR = K fertilizer rate (lbs K_2O/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 + K_2O 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
bu/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
30	0	40	23	7	0	0	55	33	11	0	0
40	0	54	31	9	0	0	73	44	14	0	0
50	0	67	39	11	0	0	92	55	18	0	0
60	0	80	47	13	0	0	110	66	22	0	0
70	0	94	55	15	0	0	128	76	25	0	0
80	0	107	62	18	0	0	147	87	29	0	0
100	0	134	78	22	0	0	183	109	36	0	0

Edible Beans – Nitrogen Phosphorus and Potassium Recommendations

Equations for edible beans N, P, and K recommendations.

Nitrogen

NFR = 0.05 × YG − STN − LC

Phosphorus

Olsen P

PFR = (0.0231 − (0.0014 × STP)) × YG

Bray-1 P

PFR = (0.0231 − (0.0011 × STP)) × YG

Potassium

KFR = (0.0346 − (0.00021 × STK)) × 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 P_2O_5/ac)
STP = Soil test phosphorus (ppm)
KFR = K fertilizer rate (lbs K_2O/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 for less than 5 to 10 years, 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. 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 + K_2O 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
lbs/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
1000	50	21	15	10	4	0	30	22	13	5	0
1400	70	29	22	14	6	0	43	31	19	7	0
1800	90	38	28	18	8	0	55	39	24	9	0
2200	110	46	34	22	9	0	67	48	30	11	0
2600	130	55	40	25	11	0	79	57	35	13	0
3000	150	63	46	29	13	0	91	66	40	15	0

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

NFR = 0 when inoculated with proper *Bradyrhizobium* culture

Phosphorus

Olsen P

PFR = (0.0171 − (0.0011 × STP)) × YG

Bray-1 P

PFR = (0.0171 − (0.00085 × STP)) × YG

Potassium

KFR = (0.03 − (0.00018 × STK)) × YG

Acronym Definitions

NFR = N fertilizer rate (lbs N/ac)
PFR = P fertilizer rate (lbs P_2O_5/ac)
STP = Soil test phosphorus (ppm)
YG = Yield goal (lbs/ac)
KFR = K fertilizer rate (lbs K_2O/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 + K_2O 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
lbs/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
1400	0[1]	22	15	9	3	0	37	27	17	7	0
1800	0	28	20	12	4	0	48	34	21	8	0
2200	0	34	24	15	5	0	58	42	26	10	0
2600	0	40	29	17	6	0	69	50	31	12	0
3000	0	46	33	20	7	0	79	57	36	14	0

[1]Inoculation is necessary with proper *Bradyrhizobium* culture.

Wheat and Rye – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for wheat and rye N, P, and K recommendations.

Nitrogen

NFR = 2.5 × YG − STN − LC

Phosphorus

Olsen P

PFR = (1.071 − (0.067 × STP)) × YG

Bray-1 P

PFR = (1.071 − (0.054 × STP)) × YG

Potassium

KFR = (2.71 − (0.017 × STK)) × 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)

Wheat and Rye Statements

1. Nitrogen fertilizers
   a. If using very reduced tillage systems including strip-till and no-till systems for less than 5 to 10 years, 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 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. Examples of nitrogen, phosphorus, and potassium fertilizer recommendations for wheat and rye 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
bu/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
30	75	29	21	13	5	0	71	50	30	10	0
40	100	39	28	17	7	0	95	67	40	13	0
50	125	49	35	22	9	0	119	84	50	16	0
60	150	58	42	26	10	0	142	101	60	19	0
70	175	68	49	30	12	0	166	118	70	23	0
80	200	78	56	35	13	0	190	135	80	26	0
90	225	87	63	39	15	0	213	151	90	29	0
100	250	97	70	43	17	0	237	168	100	32	0
110	275	107	77	48	18	0	261	185	110	35	0

Oats – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for oats N, P, and K recommendations.

Nitrogen

NFR = 1.3 × YG − STN − LC

Phosphorus

Olsen P

PFR = (0.644 − (0.041 × STP)) × YG

Bray-1 P

PFR = (0.644 − 0.032 × STP) × YG

Potassium

KFR = (2.71 − (1.277 − (0.0086 × STK)) × 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)

Oats Statements

1. Nitrogen fertilizers
   a. If using very reduced tillage systems including strip-till and no-till systems for less than 5 to 10 years, 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 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. 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
bu/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
60	78	35	25	15	5	0	66	45	25	4	0
70	91	41	29	18	6	0	77	53	29	5	0
80	104	47	33	20	7	0	88	61	33	5	0
90	117	52	38	23	8	0	99	68	37	6	0
100	130	58	42	25	9	0	111	76	41	7	0
110	143	64	46	28	10	0	122	83	45	8	0
130	169	76	54	33	12	0	144	98	54	9	0
150	195	87	63	38	14	0	166	114	62	10	0

Feed Barley – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for feed barley N, P, and K recommendations.

Nitrogen

NFR = 1.7 × YG − STN − LC

Phosphorus

Olsen P

PFR = (0.785 − (0.05 × STP)) × YG

Bray-1 P

PFR = (0.785 − (0.039 × STP)) × YG

Potassium

KFR = (1.286 − (0.0085 × STK)) × 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 for less than 5 to 10 years, 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 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
bu/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
40	68	28	20	12	4	0	45	31	17	4	0
50	85	36	26	16	6	0	56	39	22	5	0
60	102	43	31	19	7	0	67	46	26	6	0
70	119	50	36	22	8	0	78	54	30	6	0
80	136	57	41	25	9	0	89	62	35	7	0
90	153	64	46	28	10	0	100	69	39	8	0
100	170	71	51	31	11	0	112	77	43	9	0
110	187	78	56	34	12	0	123	85	47	10	0
120	204	85	61	37	13	0	134	93	52	11	0

Malting Barley – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for malting barley N, P, and K recommendations.

Nitrogen

NFR = 1.5 × YG − STN − LC

Phosphorus

Olsen P

PFR = (0.785 − (0.05 × STP)) × YG

Bray-1 P

PFR = (0.785 − (0.039 × STP)) × YG

Potassium

KFR = (1.286 − (0.0085 × STK)) × 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)

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 for less than 5 to 10 years, 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 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
bu/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
50	75	36	26	16	6	0	56	39	22	5	0
60	90	43	31	19	7	0	67	46	26	6	0
70	105	50	36	22	8	0	78	54	30	6	0
80	120	57	41	25	9	0	89	62	35	7	0
90	135	64	46	28	10	0	100	69	39	8	0
100	150	71	51	31	11	0	112	77	43	9	0
110	165	78	56	34	12	0	123	85	47	10	0
120	180	85	61	37	13	0	134	93	52	11	0

Buckwheat – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for buckwheat N, P, and K recommendations.

Nitrogen

NFR = 2.2 × YG − STN − LC

Phosphorus

Olsen P

PFR = (1.32 − (0.083 × STP)) × YG

Bray-1 P

PFR = (1.32 − (0.066 × STP)) × YG

Potassium

KFR = (1.86 − (0.0116 × STK)) × 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)

Buckwheat Statements

1. Nitrogen fertilizers
   a. If using very reduced tillage systems including strip-till and no-till systems for less than 5 to 10 years, 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 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
bu/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
24	53	29	21	13	5	0	39	28	17	6	0
32	70	38	28	17	6	0	52	37	22	7	0
40	88	48	35	21	8	0	65	46	28	9	0
48	106	57	41	26	10	0	78	56	33	11	0

Safflower – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for safflower N, P, and K recommendations.

Nitrogen

NFR = 0.05 × YG − STN − LC

Phosphorus

Olsen P

PFR = (0.027 − (0.0017 × STP)) × YG

Bray-1 P

PFR = (0.027 − (0.0014 × STP)) × YG

Potassium

KFR = (0.048 − (0.0003 × STK)) × 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 P_2O_5/ac)
STP = Soil test phosphorus (ppm)
KFR = K fertilizer rate (lbs K_2O/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 for less than 5 to 10 years, 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 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
lbs/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
800	40	20	14	9	3	0	34	24	14	5	0
1200	60	29	21	13	5	0	50	36	21	7	0
1600	80	39	28	17	6	0	67	48	29	9	0
2000	100	49	35	22	8	0	84	60	36	12	0
2400	120	59	42	26	10	0	101	72	43	14	0

Mustard, Rapeseed, & Canola – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for mustard, rapeseed, and canola N, P, and K recommendations.

Nitrogen

NFR = 6.5 × YG − STN − LC

Phosphorus

Olsen P

PFR = (3.6 − (0.22 × STP)) × YG

Bray-1 P

PFR = (3.6 − (0.17 × STP)) × YG

Potassium

KFR = (5.4 − (0.034 × STK)) × 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 for less than 5 to 10 years, 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
bu/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
10	65	33	24	15	6	0	47	33	20	6	0
15	97	49	36	23	9	0	71	50	30	9	0
20	130	65	48	30	13	0	94	67	40	12	0
25	162	82	60	38	16	0	118	84	50	16	0
30	195	98	72	45	19	0	142	101	59	19	0

Flax – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for flax N, P, and K recommendations.

Nitrogen

NFR = 3.0 × YG − STN − LC

Phosphorus

Olsen P

PFR = (1.17 − (0.073 × STP)) × YG

Bray-1 P

PFR = (1.17 − (0.058 × STP)) × YG

Potassium

KFR = (2.2 − (0.014 × STK)) × 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)

Flax Statements

1. Nitrogen fertilizers
   a. If using very reduced tillage systems including strip-till and no-till systems for less than 5 to 10 years, 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.
   b. The above phosphorus recommendation will seldom increase flax yields, but it will help maintain the phosphorus soil test level.
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 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
bu/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
20	60	21	15	10	4	0	38	27	16	5	0
30	90	32	23	14	6	0	58	41	24	7	0
40	120	42	31	19	7	0	77	54	32	9	0
50	150	53	38	24	9	0	96	68	40	12	0
60	180	64	46	29	11	0	115	81	48	14	0
70	210	74	54	33	13	0	134	95	56	16	0

Alfalfa – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for alfalfa N, P, and K recommendations.

Nitrogen

NFR = 0

Phosphorus

Olsen P

PFR = (18.57 − (1.16 × STP)) × YG

Bray-1 P

PFR = (18.57 − (0.93 × STP)) × YG

Potassium

KFR = (55.71 − (0.38 × STK)) × YG

Acronym Definitions

NFR = N fertilizer rate (lbs N/ac)
PFR = P fertilizer rate (lbs P_2O_5/ac)
STP = Soil test phosphorus (ppm)
YG = Yield goal (tons/ac)
KFR = K fertilizer rate (lbs K_2O/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 ⅓ 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
tons/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
2	0	34	24	15	6	0	96	65	35	5	0
3	0	50	37	23	9	0	144	98	53	7	0
4	0	67	49	30	12	0	192	131	70	9	0
5	0	84	61	38	15	0	241	164	88	12	0
6	0	101	73	45	17	0	289	196	105	14	0
7	0	118	85	53	20	0	337	229	123	16	0
8	0	135	98	60	23	0	385	262	140	19	0

Grass – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for grass N, P, and K recommendations.

Nitrogen

NFR = 25 × YG

Phosphorus

Olsen P

PFR = 45.0 − (3.45 × STP)

Bray-1 P

PFR = 45.0 − (2.5 × STP)

Potassium

KFR = 80.0 − (0.53 × STK)

Acronym Definitions

NFR = N fertilizer rate (lbs N/ac)
YG = Yield goal (tons/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)

Grass Statements

1. When your alfalfa grass mixture contains at least ⅓ 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
tons/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
1	25	40	26	12	0	0	69	48	27	6	0
2	50	40	26	12	0	0	69	48	27	6	0
3	75	40	26	12	0	0	69	48	27	6	0
4	100	40	26	12	0	0	69	48	27	6	0
5	125	40	26	12	0	0	69	48	27	6	0
6	150	40	26	12	0	0	69	48	27	6	0
7	175	40	26	12	0	0	69	48	27	6	0

Sudan Grass and Forage Sorghum – Nitrogen, Phosphorus, and Potassium Recommendations

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

Nitrogen

NFR = 25 × YG − STN − LC

Phosphorus

Olsen P

PFR = (11.0 − (0.7 × STP)) × YG

Bray-1 P

PFR = (11.0 − (0.533 × STP)) × YG

Potassium

KFR = (43.0 − (0.3 × STK)) × 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 and 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
tons/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
3	75	30	21	13	5	0	111	75	39	3	0
4	100	40	29	17	6	0	148	99	51	3	0
5	125	50	36	22	8	0	185	124	64	4	0
6	150	60	43	26	9	0	222	149	44	5	0
7	175	70	50	30	11	0	259	174	90	6	0
8	200	80	57	35	12	0	296	199	103	7	0

Millet – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for millet N, P, and K 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 P_2O_5/ac)
STP = Soil test phosphorus (ppm)
KFR = K fertilizer rate (lbs K_2O/ac)
STK = Soil test potassium (ppm)

Millet Statements

1. Starter fertilizers
   a. Nitrogen plus K_2O 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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
lbs/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
1000	35	15	11	6	2	0	26	19	12	5	0
1400	49	22	15	9	2	0	37	27	17	7	0
1800	63	28	19	11	3	0	48	35	21	8	0
2200	77	34	24	14	4	0	58	42	26	10	0
2600	91	40	28	16	4	0	69	50	31	12	0
3000	105	46	32	19	5	0	79	57	36	14	0

Potatoes – Nitrogen, Phosphorus, and Potassium Recommendations

Equations for potatoes N, P, and K recommendations.

Nitrogen

NFR = 0.4 × YG − STN − LC

Phosphorus

Olsen P

PFR = (0.5 − (0.034 × STP)) × YG

Bray-1 P

PFR = (0.5 − (0.026 × STP)) × YG

Potassium

KFR = (0.85 − (0.0057 × STK)) × 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 P2O5/ac)
STP = Soil test phosphorus (ppm)
KFR = K fertilizer rate (lbs K2O/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.

Yield Goal	Soil N plus supplemental N required	Phosphorus Soil Test Category					Potassium Soil Test Category				
		VL	L	M	H	VH	VL	L	M	H	VH
cwt/ac	lbs-N/ac-2'	lbs P_2O_5/ac					lbs K_2O/ac				
200	80	90	63	35	8	0	147	101	55	10	0
250	100	112	78	44	10	0	184	126	69	12	0
300	120	135	94	53	12	0	221	152	83	15	0
350	140	157	110	62	14	0	258	177	97	17	0
400	160	180	125	71	16	0	294	202	111	20	0
450	180	202	141	80	18	0	331	227	125	22	0

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.

Garden/ Lawn	Nitrogen Recommendations					Phosphorus Recommendations					Potassium Recommendations				
	Soil Test Nitrogen, lbs/6 inches					Soil Test Phosphorus[1], ppm					Soil Test Potassium, ppm				
	0	25	50	75	100	2	6	10	14	16+	20	60	100	140	161+
	lbs N/1000 sq. ft					lbs P_2O_5/1000 sq. ft					lbs K_2O/1000 sq. ft				
Garden	3.5	3.0	2.0	1.5	0.5	3.0	2.0	1.5	0.5	0.0	5.0	3.5	2.5	1.0	0.0
Established Lawn	4.0	3.0	2.0	1.0	0.0	2.0	1.5	1.0	0.5	0.0	4.5	3.5	2.0	1.0	0.0
New Lawn	2.0	1.5	1.0	0.0	0.0	4.0	3.0	2.0	1.0	0.0	4.5	3.5	2.0	1.0	0.0

[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. (pounds of element ÷ percent of that element in the fertilizer) x 100 = lbs. of fertilizer needed per 1,000 sq. ft. Repeat this calculation for each nutrient that is recommended.
   b. Application of P_2O_5 or K_2O 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 N is 1.5 lbs/1000 sq. ft. or greater, the 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 N is less than 1.5 lbs/1000 sq.ft., delay 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 N is recommended, the 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.
   c. If less than 3 pounds of nitrogen is recommended, apply half of the total application in early May and the second half in mid-September.
   d. For additional information refer to the fertilizing section of the publication FS 715 Lawn Care.
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

Zinc Soil Test (ppm)	Interpretation	Zinc Recommendations (lb/acre[1])
0-0.25	Very low	10
0.26-0.50	Low	10
0.51-0.75	Medium	5
0.76-1.00	High	0
1.01 +	Very high	0

[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

Soil Texture	Tillage Type	Sulfur Soil Test Categories (lbs/ac 2')				
		Very low (0-9)	Low (10-19)	Medium (20-29)	High (30-39)	Very high (40-49)
		Sulfur Recommendations (lbs Sulfur/ac)				
Coarse	Tilled[1]	25	25	15	15	0
	Strip-till or no-till	25	25	25	15	0
Medium/Fine	Tilled	25	15	0	0	0
	Strip-till or no-till	25	25	15	15	0

[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.

Chloride Soil Test (lbs/ac 2 ft)	Relative Level
0-15	Very low
16-30	Low
31-45	Medium
46-60	High
> 60	Very High

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

Magnesium Soil Test (ppm)	Interpretation	Magnesium Recommendations (lbs/ac)
0-10	Very low	50
11-20	Low	50
21-30	Medium	25
31-40	High	0
> 40	Very high	0

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

Calcium Soil Test (ppm)	Interpretation	Calcium Recommendation
0-100	Very low	lime
101-200	Low	lime
201-300	Medium	0
301-400	High	0
> 400	Very low	0

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

Iron Soil Test (ppm)	Interpretation	Iron Recommendations (lbs/ac)
0-2.5	Low	0.15
2.6-4.5	Medium	0.15
> 4.5	High	0

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

Boron Soil Test (ppm)	Interpretation	Boron Recommendations (lbs/ac)
0-0.25	Low	2
0.26-0.50	Medium	2
> 0.50	High	0

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

Copper Soil Test (ppm)	Interpretation	Copper Recommendations (lbs/ac)
0-0.10	Low	2
0.11-0.20	Medium	2
> 0.20	High	0

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

Manganese Soil Test (ppm)	Interpretation	Manganese Recommendations (lbs/ac)
0.50	Low	20
0.51-1.0	Medium	20
> 1.0	High	0

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

Buffer index[1]	Lime required[2] for 6" soil depth (tons/ac)
6.8-6.5	0
6.4-6.1	2.0
6.0-5.9	2.5
5.8-5.7	3.0
5.6 or less	3.5

[1] This is not soil pH but is the SMP buffer.
[2] Rates based on a calcium carbonate equivalent of 90% and a total effectiveness of 70%. One ton of pure $CaCO_3$ 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 $CaCO_3$ 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 $CaCO_3$ 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 $CaCO_3$ 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 $CaCO_3$ 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

Low	Medium	High	Very High
< 3	3-5	5.1-10.0	> 10

Sodium Level in Soil

Exchangeable Sodium Percentage (ESP)

Low	Medium	High
< 9	9-13	> 13

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.

South Dakota State University Extension

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