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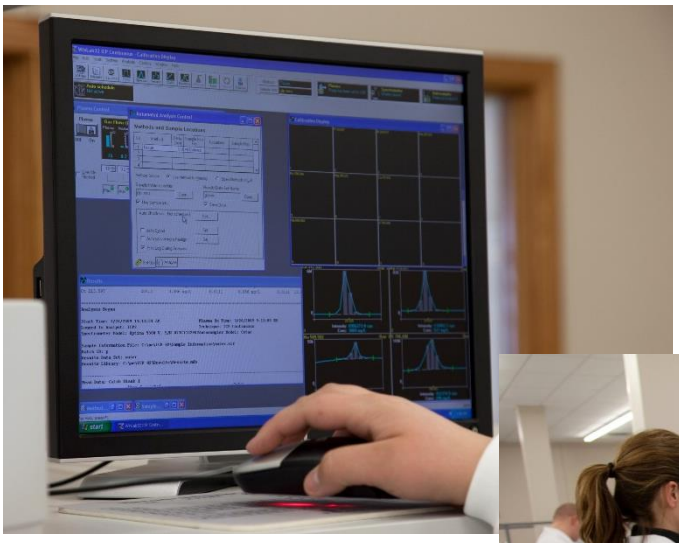
Agricultural Handbook & Fertilizer Guidelines

2021



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Guides

AGVISE Fertilizer Guidelines (NPK)

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AGVISE Fertilizer Guidelines

Soil Nitrogen Credits and Estimates

Previous Crop Nitrogen Credit

Previous crop nitrogen credit subtracted from nitrogen guideline.

	AGVISE		University
Previous crop	short-season crop	long-season crop	all crops
	lb/acre N		
Alfalfa	25	50	50
Chickpea	10	20	20
Clover	20	40	40
Corn, sweet	10	20	20
Bean, dry	15	30	40
Bean, faba	15	30	40
Lentil	10	20	20
Pea	15	30	20
Soybean	15	30	40

Soil Nitrogen Estimate

For soil samples where nitrate-nitrogen is not analyzed, soil nitrogen is estimated to improve the nitrogen guideline accuracy. For the university guideline, soil nitrogen is estimated where soil sample depth is less than 18 inches and nitrate-nitrate is analyzed. If the nitrate-nitrogen test value exceeds the estimated soil nitrogen, then the nitrate-nitrogen test value is used.

Soil organic matter	Estimated nitrogen
%	lb/acre N
not analyzed	20 + previous crop credit
≤3.0	20 + previous crop credit
>3.0	40 + previous crop credit

For AGVISE guidelines, soil nitrogen is estimated where the soil sample depth is less than 12 inches and nitrate-nitrate is analyzed.

Soil test nitrate-N	Estimated nitrogen
lb/acre, 0-6 inch depth	lb/acre N
<10	20 + previous crop credit
10-30	(Nitrate-N × 2) + previous crop credit
>30	(Nitrate-N + 30) + previous crop credit

For AGVISE guidelines, soil nitrogen is estimated where the soil sample depth is equal to 12 inches and nitrate-nitrogen is analyzed.

Estimated nitrogen = (Nitrate-N, 0-12 inch) × 1.5

Crop-specific Nitrogen Adjustments

Bean, dry

Adjustment when nitrate-N (0-6 inch) is less than 35 lb/acre N. Dry bean is a shallow-rooted crop that fixes only a small portion of its own nitrogen. In addition to seed inoculation, a small amount of nitrogen in the 0-6 inch soil profile is suggested. If the soil nitrate-N (0-24 inch) is high yet the soil nitrate-N (0-6 inch) is low, the nitrogen guideline will increase the total soil nitrate-N (0-6 inch) plus fertilizer N to 35 lb/acre N.

Example: If soil nitrate-N (0-24 inch) is 150 lb/acre N yet soil nitrate-N (0-6) is only 10 lb/acre N, then the nitrogen guideline is 25 lb/acre N. [35 lb/acre N – 10 lb/acre N = 25 lb/acre N]

Corn and small grains

Adjustment when nitrate-N (0-6 inch) is less than 50 lb/acre N. Cereal crops planted into cold soils require sufficient nitrogen in the early growing season. If the soil nitrate-N (0-24 inch) is high yet the soil nitrate-N (0-6 inch) is low, the nitrogen guideline will increase the total soil nitrate-N (0-6 inch) plus fertilizer N to 50 lb/acre N.

Example: If nitrate-N (0-24 inch) is 200 lb/acre N yet nitrate-N (0-6) is only 20 lb/acre N, then the nitrogen guideline is 30 lb/acre N. [50 lb/acre N – 20 lb/acre N = 30 lb/acre N]

Sugar beet: SMBSC crop choice

Discontinued February 2021 per SMBSC request.

Adjustment for Southern Minnesota Beet Sugar Cooperative (SMBSC) sugar beet crop choice.

- Sugar beet yield is set. The yield goal cannot be changed.
- Nitrogen guideline is based on soil sample depth. A minimum of soil nitrate-N (0-24 inch) analysis is required to generate nitrogen guideline.
    - If soil nitrate-N (0-48 inch), total soil nitrate-N plus fertilizer N equals 110 lb/acre N.
    - If soil nitrate-N (0-42 inch), total soil nitrate-N plus fertilizer N equals 100 lb/acre N.
    - If soil nitrate-N (0-36 inch), total soil nitrate-N plus fertilizer N equals 90 lb/acre N.
    - If soil nitrate-N (0-24 inch), total soil nitrate-N plus fertilizer N equals 90 lb/acre N.
- Minimum nitrogen guideline is 65 lb/acre N (0-24 inch), total soil nitrate-N plus fertilizer N. Required for early crop canopy development, regardless of deep soil nitrate-N.
- Previous crop nitrogen credit from university guideline.
- Phosphorus and potassium guidelines from university guideline.

Sugar beet: 130/100 N crop choice

Adjustment for 130/100 N sugar beet crop choice for sugar beet regions in Minnesota and North Dakota.

- Nitrogen guideline is based on soil sample depth. A minimum of soil nitrate-N (0-24 inch) analysis is required to generate nitrogen guideline.
    - If soil nitrate-N (0-48 inch), total soil nitrate-N plus fertilizer N equals 130 lb/acre N.
    - If soil nitrate-N (0-36 inch), total soil nitrate-N plus fertilizer N equals 115 lb/acre N.
    - If soil nitrate-N (0-24 inch), total soil nitrate-N plus fertilizer N equals 100 lb/acre N.

Example: If soil nitrate-N (0-24 inch) is 55 lb/acre N and soil nitrate-N (24-48 inch) is 30 lb/acre, then the nitrogen guideline is 45 lb/acre N. [130 lb/acre – (55 lb/acre N + 30 lb/acre N) = 45 lb/acre N]

Example: If soil nitrate-N (0-24 inch) is 55 lb/acre N and no deep soil nitrate-N, then the nitrogen guideline is 45 lb/acre N. [100 lb/acre – (55 lb/acre N) = 45 lb/acre N]

Boron Guidelines

Broadcast application only. Do not place boron with seed.

		High Sensitivity	Medium Sensitivity	Low Sensitivity
		Alfalfa Broccoli Cauliflower	Birdsfoot trefoil Cabbage Canola Carrot Clover Corn, sweet Potato Sainfoin Sugar beet Strawberry Sunflower Tomato Vegetable garden	Other crops
Soil test category	**Soil test B**			
	ppm, 0-6 inch	lb/acre B		
		broadcast	broadcast	broadcast
Very low	≤ 0.40	3	2	1
Low	0.41 – 0.80	2	1	0
Medium	0.81 – 1.20	1	0	0
High	> 1.20	0	0	0

Chloride Guidelines

A chloride guideline for small grains (barley, oat, rye, triticale, wheat) is generated. A chloride guideline for corn is generated as a trial. If soil chloride (0-24 inch) is less than 40 lb/acre Cl, the chloride guideline will increase the total soil chloride (0-24 inch) plus fertilizer chloride to 40 lb/acre Cl.

Copper Guidelines

		High Sensitivity		Medium Sensitivity		Low Sensitivity	
		Barley, grain Carrot Onion Vegetable garden Wheat		Alfalfa Barley, hay Birdsfoot trefoil Broccoli Cabbage Canary grass Cauliflower Clover Flax Grass, seed Potato Oat Sainfoin Sorghum Strawberry Sunflower Tomato		Other crops	
Soil test category	**Soil test Cu**						
	ppm, 0-6 inch	lb/acre Cu					
		broadcast	band	broadcast	band	broadcast	band
Very low	≤ 0.30	5	2	3	1	2	1
Low	0.31 – 0.50	3	1	2	1	0	0
Medium	0.51 – 0.80	2	1	1	0	0	0
High	> 0.80	0	0	0	0	0	0

Iron Guidelines

For iron deficiency chlorosis (IDC) of soybean and flax, soil carbonate and soluble salt (salinity) are more helpful factors in predicting IDC and crop response to iron fertilizer. Refer to section on soybean IDC.

Soil test category	Soil test Fe	All crops	
	ppm, 0-6 inch	lb/acre Fe	
		broadcast	band
Very low	≤ 1.5	5	2
Low	1.6 – 3.0	3	1
Medium	3.1 – 4.5	2	1
High	> 4.5	0	0

Lime Guidelines

		Target pH 6.5		Target pH 6.0		Target pH n/a
		Alfalfa Clover		Other crops		Blueberry Grass Potato
pH (1:1)	Buffer pH (Sikora)					
0-6 inch	0-6 inch	ton/acre				
		ENP	ag lime	ENP	ag lime	
6.5	--	0	0	0	0	0
6.4	--	1.00	2.0	0	0	0
6.3	--	1.00	2.0	0	0	0
6.2	--	1.50	3.0	0	0	0
6.1	--	1.50	3.0	0	0	0
6.0	--	1.50	3.0	0	0	0
< 6.0	6.8	1.50	3.0	1.00	2.0	0
< 6.0	6.7	1.75	3.5	1.00	2.0	0
< 6.0	6.6	2.00	4.0	1.00	2.0	0
< 6.0	6.5	2.25	4.5	1.25	2.5	0
< 6.0	6.4	2.50	5.0	1.50	3.0	0
< 6.0	6.3	2.75	5.5	1.75	3.5	0
< 6.0	6.2	3.00	6.0	2.00	4.0	0
< 6.0	6.1	3.25	6.5	2.25	4.5	0
< 6.0	6.0	3.50	7.0	2.50	5.0	0
< 6.0	5.9	3.75	7.5	2.75	5.5	0
< 6.0	5.8	4.00	8.0	3.00	6.0	0
< 6.0	5.7	4.25	8.5	3.25	6.5	0
< 6.0	≤ 5.6	4.50	9.0	3.50	7.0	0

Adjustments

- Effective neutralizing power (ENP) per ton lime is the State of Minnesota lime quality unit. Typical ag lime (crushed limestone) contains average 1000 lb ENP/ton ag lime.
- Reduce rate to 1/2 lime requirement for western Iowa, western Minnesota, North Dakota, South Dakota, Montana, and Manitoba.

Comments

- Soil pH determines if lime is needed.
- Buffer pH determines the lime requirement to increase soil pH to target pH.
- Soils with very low pH (<5.5) and high organic matter (peat) may have buffer pH suggesting no lime is necessary. A minimum of 1.0 ton/acre ENP may be required.
- Calcitic (calcium) and dolomitic (calcium and magnesium) limestone materials are equally effective, based on ENP rating. Dolomitic limestone may be preferred if soil test magnesium is low.

Magnesium Guidelines

		High Sensitivity		Medium Sensitivity	
		Potato Onion Vegetable garden		Other crops	
Soil test category	**Soil test Mg**				
	ppm, 0-6 inch	lb/acre Mg			
		broadcast	band	broadcast	band
Very low	≤ 50	100	50	50	25
Low	51 - 100	50	25	0	0
Medium	> 100	0	0	0	0

Manganese Guidelines

		High Sensitivity	Medium Sensitivity
		Carrot Strawberry Tomato Vegetable garden	Other crops
Soil test category	**Soil test Mn**		
	ppm, 0-6 inch	lb/acre Mn	
		broadcast	broadcast
Very low	≤ 0.5	3	3
Low	0.5 – 1.0	2	2
Medium	1.1 – 2.0	2	0
High	> 2.0	0	0

Sulfur Guidelines

		High Sensitivity		Medium Sensitivity	
		Alfalfa Canola Mustard Strawberry		Other crops	
Soil test category	**Soil test sulfate-S**				
	lb/acre, 0-6 inch	lb/acre sulfate-S			
		broadcast	band	broadcast	band
Very low	≤ 6	30	20	20	10
Low	7 - 14	25	17	15	7
Medium	15 - 30	20	15	10	5
High	> 30	10	10	0	0

Adjustments

- If subsoil sulfate-S (6-24 inch) is greater than 60 lb/acre sulfate-S, the sulfur guideline is reduced 10 lb/acre S for the following: barley, corn, oat, rye, triticale, sugar beet, wheat.
- If soil organic matter is less than 3%, then increase rate 5 lb/acre broadcast S guideline and 2 lb/acre band S guideline.
- Minimum sulfur application: 10 lb/acre S broadcast and 5 lb/acre S band.

Zinc Guidelines

		High Sensitivity		Medium Sensitivity		Low Sensitivity	
		Yield Goal		Yield Goal		Yield Goal	
Soil test category	**Soil test Zn**	Low	High	Low	High	Low	High
	ppm, 0-6 inch	lb/acre Zn broadcast					
Very low	≤ 0.30	8	10	3	5	2	3
Low	0.31 - 0.60	4	6	1	3	0	1
Medium	0.61 - 1.00	1	3	0	1	0	0
High	1.01 - 2.00	0	1	0	0	0	0
Very high	> 2.00	0	0	0	0	0	0

Crop-specific Zinc Sensitivity and Yield Goal Break

High Sensitivity		Medium Sensitivity		Low Sensitivity	
Bean, dry	2000 lb/ac	Alfalfa, seed		Alfalfa, hay	3 ton/ac
Bean, faba	2000 lb/ac	Buckwheat	40 bu/ac	Barley, grain	80 bu/ac
Bean, navy	2000 lb/ac	Canary grass, seed	1900 lb/ac	Barley, hay	4 ton/ac
Bean, pinto	2000 lb/ac	Canola	2200 lb/ac	Birdsfoot trefoil	3 ton/ac
Broccoli		Canola	44 bu/ac	Clover	3 ton/ac
Cabbage		Carrot	400 cwt/ac	Cotton	1200 lb/ac
Cauliflower		Chickpea	2000 lb/ac	Grass, hay/pasture	4 ton/ac
Corn, grain	160 bu/ac	Crambe	2000 lb/ac	Grass, lawn	
Corn, pop	75 bu/ac	Lentil	2000 lb/ac	Grass, seed	
Corn, silage	20 ton/ac	Millet, seed	1800 lb/ac	Grass, seed (brome)	500 lb/ac
Corn, sweet	8 ton/ac	Mustard	2200 lb/ac	Grass, timothy	
Flax	40 bu/ac	Pea, fresh green	2000 lb/ac	Hemp, seed	800 lb/ac
Grape		Safflower	1500 lb/ac	Oat, grain	120 bu/ac
Onion	400 cwt/ac	Soybean	40 bu/ac	Oat, silage	
Potato, dryland	275 cwt/ac	Sugar beet	20 ton/ac	Pea, dry field	40 bu/ac
Potato, irrigated	400 cwt/ac	Tomato	250 cwt/ac	Peanut	5000 lb/ac
Sorghum, grain	60 bu/ac			Rye	70 bu/ac
Sorghum, hay	8 tons/ac			Sainfoin	3 ton/ac
Sorghum, silage	15 ton/ac			Small grain, hay	4 ton/ac
Strawberry				Small grain, silage	10 ton/ac
Vegetable garden				Sunflower	2000 lb/ac
				Triticale	70 bu/ac
				Wheat, durum	70 bu/ac
				Wheat, spring	70 bu/ac
				Wheat, winter	70 bu/ac

Adjustments

- If yield goal is less than or equal to yield goal break, reduce rate 2 lb/acre Zn broadcast (low yield goal Zn guideline). Crops without yield goal break use low yield goal Zn guideline.
- For band application, reduce rate to 1/3 broadcast Zn guideline.
- Minimum application: 1 lb/acre Zn broadcast, 1 lb/acre Zn band.

Fruit and Vegetable Guidelines

	N	Phosphorus (Olsen, ppm)						Potassium (ppm)						Sulfur (lb/acre)				Zinc (ppm)				Boron (ppm)		Copper (ppm)		
		0-7	8-15	16-25	26-33	34-41	40-49	≤40	41-80	81-120	121-160	161-200	>200	≤6	7-14	15-30	>30	≤0.3	0.3-0.6	0.6-1.0	1.0-2.0	≤0.4	0.4-0.9	≤0.3	0.3-0.5	0.5-0.8
Apple (established)	50	100	75	50	25	0	0	200	150	100	50	0	0	30	25	15	0	10	8	5	2	2	1	3	2	1
Bean, garden	80	100	50	20	0	0	0	100	75	50	25	0	0	30	25	15	0	10	8	5	2	1	0	1	0	0
Beet, red garden	120	200	150	100	75	50	25	200	150	100	75	50	0	30	25	15	0	10	8	5	2	4	2	2	1	0
Cantaloupe, muskmelon	120	200	150	100	75	50	25	200	150	100	75	50	0	30	25	15	0	6	4	2	0	2	1	2	1	0
Cucumber	120	150	100	75	50	25	0	200	125	50	25	25	0	30	25	15	0	10	8	5	2	1	0	2	1	0
Flower	110	130	90	50	40	25	0	180	150	120	90	50	0	30	25	15	0	10	8	5	2	1	0	2	1	0
Garlic	140	200	150	100	75	50	25	200	150	100	75	50	0	30	25	15	10	6	4	2	0	2	1	2	1	0
Grape (new)	80	150	125	100	75	50	25	250	200	150	100	50	0	30	25	15	0	10	8	5	2	2	1	1	0	0
Herb	140	120	100	70	40	20	0	120	100	70	40	20	0	30	25	15	0	6	4	2	0	2	1	2	1	0
Horseradish	160	200	150	100	75	50	25	200	150	100	75	50	0	30	25	15	0	10	8	5	2	2	1	2	1	0
Horseradish (SOM>20)	100	200	150	100	75	50	25	200	150	100	75	50	0	30	25	15	0	10	8	5	2	2	1	2	1	0
Kale (Florida)	140	150	100	75	50	25	0	200	150	100	75	50	0	35	30	25	15	6	4	2	0	2	1	2	1	0
Leek	150	200	150	100	75	50	25	200	150	100	75	50	0	30	25	15	0	10	8	5	2	1	0	2	1	1
Lettuce	140	150	100	75	50	25	0	200	150	100	75	50	0	30	25	15	0	10	8	5	2	1	0	3	2	1
Onion, green	100	200	150	100	75	50	25	200	150	100	75	50	0	30	25	15	0	10	8	5	2	1	0	3	2	1
Parsnip	140	200	150	100	75	50	25	200	150	100	75	50	0	30	25	15	0	6	4	2	0	2	1	2	1	0
Pepper, bell	160	150	100	75	50	25	0	200	150	100	75	50	0	30	25	15	0	10	8	5	2	1	0	2	1	0
Potato, sweet	80	120	100	80	40	0	0	120	100	80	40	0	0	30	25	15	0	6	4	2	0	1	0	2	1	0
Pumpkin	90	150	100	75	50	25	0	200	150	100	75	50	0	30	25	15	0	10	8	5	2	1	0	1	0	0
Radish	70	100	75	50	25	0	0	100	75	50	25	0	0	30	25	15	0	10	8	5	2	2	1	2	1	0
Radish, cover crop	40	40	30	10	0	0	0	50	35	25	0	0	0	15	10	0	0	4	2	0	0	1	0	1	0	0
Raspberry (established)	80	75	50	25	0	0	0	100	75	50	25	0	0	30	25	15	0	10	8	5	2	2	1	2	1	0
Raspberry (new)	80	100	75	50	25	0	0	200	150	100	75	50	0	30	25	15	0	10	8	5	2	2	1	2	1	0
Saskatoon, juneberry (established)	60	100	75	50	25	0	0	150	100	75	50	0	0	30	25	15	0	4	2	0	0	1	0	1	0	0
Saskatoon, juneberry (new)	100	150	125	100	75	50	25	200	150	100	50	0	0	30	25	15	0	4	2	0	0	1	0	1	0	0
Spinach	120	250	200	150	100	50	0	250	200	150	100	50	0	30	25	15	0	10	8	5	2	2	1	3	2	0
Squash	90	150	100	75	50	25	0	200	150	100	75	50	0	30	25	15	0	10	8	5	2	1	0	1	0	0
Strawberry	100	150	125	100	75	50	25	200	150	100	50	25	0	35	30	25	15	10	8	5	2	2	1	3	2	0
Tomato	150	250	200	150	100	50	25	250	200	150	100	50	0	30	25	15	0	10	8	5	2	4	2	3	2	0
Tree	120	100	75	40	0	0	0	200	125	50	25	25	0	30	25	15	0	6	4	2	0	1	0	1	0	0
Turnip	80	100	75	50	25	0	0	100	75	50	25	0	0	30	25	15	0	6	4	2	0	1	0	2	1	0
Turnip, cover crop	45	40	30	10	0	0	0	50	35	25	0	0	0	15	10	0	0	4	2	0	0	1	0	1	0	1
Watermelon	120	200	150	100	75	50	25	200	150	100	75	50	0	30	25	15	0	10	8	5	2	1	0	1	0	0
Zucchini	90	150	100	75	50	25	0	200	150	100	75	50	0	30	25	15	0	10	8	5	2	1	0	1	0	1

Fertilizer guideline rates in lb/acre on elemental basis and P_2O_5 and K_2O conventions.

Nitrogen guideline based on 24-inch soil depth. See nitrogen adjustments if nitrogen was not analyzed or only 0-6 inch depth analyzed.

University Fertilizer Guidelines

Sulfur Guidelines (1-depth)

		High Sensitivity	Low Sensitivity
Soil test category	**Soil test sulfate-S**	Alfalfa Canola	Other crops
	lb/acre, 0-6 inch	lb/acre sulfate-S	
		broadcast	broadcast
Very low	≤ 6	25	25
Low	7 - 14	25	25
Medium	15 - 30	25	0
High	> 30	0	0

Sulfur Guidelines (2-depth)

		High Sensitivity	Low Sensitivity
Soil test category	**Soil test sulfate-S**	Alfalfa Canola Mustard Strawberry	Other crops
	lb/acre, 0-24 inch	lb/acre sulfate-S	
		broadcast	broadcast
Very low	≤ 19	25	25
Low	20 - 29	25	20
Medium	30 - 39	25	15
High	≥ 40	25	0

Zinc Guidelines

		High Sensitivity		Low Sensitivity
Soil test category	**Soil test Zn**	Bean, dry Bean, faba Corn Flax Potato Sorghum		Other crops
	ppm, 0-6 inch	lb/acre Zn		
		broadcast	seed-placed	broadcast
Low	≤ 0.50	10	2	0
Medium	0.50 - 0.76	5	1	0
High	> 0.76	0	0	0

Soil Test Interpretation

Relative Soil Test Index Values

Soil Test Parameter	Unit	Depth (inch)	Soil Test Interpretation Category: Very Low	Low	Medium	High	Very High
Primary macronutrients							
Nitrate-N (residual NO_3-N)	lb/acre	0-6	≤10	11-20	21-30	31-40	>40
Nitrate-N (residual NO_3-N)	lb/acre	0-24	≤15	16-30	31-45	46-60	>60
Phosphorus (Bray-1 P)	ppm	0-6	≤5	6-10	11-15	16-20	>20
Phosphorus (Olsen P)	ppm	0-6	≤3	4-7	8-11	12-15	>15
Potassium (K)	ppm	0-6	≤50	51-100	101-150	151-200	>200
Secondary macronutrients							
Calcium (Ca)	ppm	0-6	≤500	501-1000	1001-1500	1501-2000	>2000
Magnesium (Mg)	ppm	0-6	≤83	84-166	167-250	251-400	>400
Sulfate-S (SO_4-S)	lb/acre	0-6	≤6	7-14	15-30	31-40	>40
Sulfate-S (SO_4-S)	lb/acre	0-24	≤25	26-56	61-120	>120	
Micronutrients							
Boron (B)	ppm	0-6	≤0.40	0.41-0.80	0.81-1.20	1.21-1.60	>1.60
Chloride (Cl)	lb/acre	0-24	≤15	16-30	31-40	41-60	>60
Copper (Cu)	ppm	0-6	≤0.20	0.21-0.40	0.41-0.60	0.61-0.80	>0.80
Iron (Fe)	ppm	0-6	≤2.5	2.6-5.0	5.1-7.5	7.6-10.0	>10.0
Manganese (Mn)	ppm	0-6	≤0.5	0.51-1.0	1.1-2.0	2.1-10.0	>10.0
Zinc (Zn)	ppm	0-6	≤0.30	0.31-0.60	0.61-1.00	1.01-2.00	>2.0
Soil properties							
pH (1:1)	---	0-6	<5.5	5.6-6.5	6.6-7.5	7.6-8.5	>8.5
Salinity (EC 1:1)	dS/m	0-6	<0.25	0.26-0.50	0.51-0.75	0.76-2.0	>2.0
Sodium (Na)	ppm	0-6	≤40	41-80	81-120	121-160	>160
Carbonate (CCE)	%	0-6	<1.0	1.1-2.5	2.6-5.0	5.1-10.0	>10.0
Organic matter	%	0-6	<1.5	1.6-3.0	3.1-4.5	4.6-6.0	>6.0

Estimating Soil Texture

Cation exchange capacity (CEC) can help estimate soil texture. For soils with pH > 7.3 or salinity > 0.5 dS/m, soil texture is not accurately estimated from CEC. For soils with pH < 7.3, an estimated soil texture from CEC will be generated.

Cation exchange capacity (CEC)	Soil organic matter	Estimated soil texture	Particle size family
$cmol_c/kg$	%		
< 10	< 20	Sand	Coarse
10 – 20	< 20	Coarse loam	Medium
21 – 30	< 20	Fine loam	Medium
> 30	< 20	Clay or clay loam	Fine
	> 20	Peat or muck	Organic

Seed-placed Fertilizer

General

- Do not use seed-placed blends containing urea, diammonium phosphate (DAP, 18-46-0), ammonium thiosulfate (ATS, 12-0-0-26S), or boron. Crop-specific allowances noted below.
- For sandy or dry soils, seedling injury may occur (reduced germination or emergence). Reduce seed-placed fertilizer rate by one-half.
- These guidelines are compiled from university and extension research in the upper Midwest, northern Great Plains, and Canadian Prairies.

Bean, dry

- Do not place any fertilizer with seed.

Buckwheat, canola, flax, mustard, safflower, sunflower

- Limit seed-placed N + K_2O (lb/acre) to less than 10 lb/acre.
- Response to starter fertilizer has not been consistent.

Corn

- Seed-placed 5 gal/acre ammonium polyphosphate (APP, 10-34-0) has shown good plant development and yield responses.
- For 30-inch rows, limit seed-placed N + K_2O (lb/acre) to less than 10 lb/acre.

Small grains

- Keep anhydrous ammonia at least 2 to 3 inches away from seed.
- For 6-8 inch rows, limit seed-placed urea to less than 15 lb/acre N, or 10 lb/acre N if soil is dry or sandy.
- For 6-8 inch rows, limit seed-placed N + K_2O (lb/acre) to less than 30 lb/acre.

Soybean

- For 30-inch rows, do not place any fertilizer with seed.
- For 6- to 8-inch rows, limit seed-placed N + K_2O (lb/acre) to less than 10 lb/acre.

Sugar beet

- Seed-placed 3 or 4 gal/acre ammonium polyphosphate (APP, 10-34-0) has shown good plant development and yield responses.
- Limit seed-placed ammonium polyphosphate (APP, 10-34-0) to less than 6 gal/acre.

Plant Analysis Sufficiency Ranges for Major Crops

		Barley, oat, rye, triticale, wheat		
		tiller	boot	heading
		whole plant	flag leaf	flag leaf
Primary macronutrients				
Nitrogen (N)	%	3.8-5.5	3.8-5.0	3.6-4.5
Phosphorus (P)	%	0.30-0.50	0.30-0.50	0.30-0.50
Potassium (K)	%	2.5-3.5	2.0-3.5	2.0-3.0
Secondary macronutrients				
Sulfur (S)	%	0.20-0.50	0.20-0.50	0.20-0.50
Calcium (Ca)	%	0.20-0.50	0.20-0.50	0.30-0.50
Magnesium (Mg)	%	0.13-0.40	0.15-0.40	0.15-0.40
Sodium (Na)	%	< 0.10	< 0.10	< 0.10
Micronutrients				
Boron (B)	ppm	3-40	3-40	3-24
Chloride (Cl)	%	0.30-0.60	0.21-0.50	0.21-0.50
Copper (Cu)	ppm	5-25	5-25	5-24
Iron (Fe)	ppm	50-250	50-250	50-250
Manganese (Mn)	ppm	25-100	25-100	25-100
Zinc (Zn)	ppm	20-70	20-70	20-70

		Corn			Soybean
		< 12 in	12 in to tassel	tassel	all stages
		whole plant	1st leaf	ear leaf	1st trifoliate
Primary macronutrients					
Nitrogen (N)	%	3.5-5.0	3.0-4.0	2.9-4.0	4.0-5.5
Phosphorus (P)	%	0.35-0.80	0.30-0.50	0.25-0.50	0.26-0.50
Potassium (K)	%	3.0-5.0	2.0-3.0	1.8-2.8	1.7-2.5
Secondary macronutrients					
Sulfur (S)	%	0.18-0.50	0.16-0.50	0.16-0.50	0.20-0.60
Calcium (Ca)	%	0.30-1.60	0.30-0.80	0.25-0.60	0.36-2.00
Magnesium (Mg)	%	0.21-0.80	0.16-0.60	0.16-0.40	0.26-1.00
Sodium (Na)	%	< 0.10	< 0.10	< 0.10	< 0.10
Micronutrients					
Boron (B)	ppm	6-25	5-25	5-25	20-55
Copper (Cu)	ppm	6-20	5-15	5-15	7-29
Iron (Fe)	ppm	50-300	50-250	50-250	50-350
Manganese (Mn)	ppm	50-160	18-150	18-150	21-100
Zinc (Zn)	ppm	20-75	20-75	19-75	21-50

		Alfalfa	Canola		Dry bean	Sugar beet
		all stages	rosette	bud	all stages	all stages
		upper 6 in	whole plant	5th leaf	1st trifoliate	1st leaf
Primary macronutrients						
Nitrogen (N)	%	2.6-3.7	2.5-4.0	2.0-4.5	3.1-6.0	3.5-5.0
Phosphorus (P)	%	0.26-0.70	0.28-0.69	0.25-0.50	0.26-0.50	0.31-0.80
Potassium (K)	%	2.5-3.8	1.5-2.5	2.9-5.1	1.9-2.5	2.0-6.0
Secondary macronutrients						
Sulfur (S)	%	0.31-0.50	0.25-0.50	0.17-1.04	0.21-0.40	0.25-0.50
Calcium (Ca)	%	0.51-3.00	0.50-4.00	1.00-3.00	0.81-3.00	0.50-1.50
Magnesium (Mg)	%	0.31-1.00	0.20-1.50	0.20-0.75	0.26-0.70	0.30-2.50
Sodium (Na)	%	< 0.10	< 0.10	0.02-0.50	< 0.10	0.03-3.70
Micronutrients						
Boron (B)	ppm	31-80	30-80	15-54	21-60	25-79
Copper (Cu)	ppm	8-29	3-20	4-25	7-20	6-30
Iron (Fe)	ppm	30-250	21-200	30-200	31-450	56-140
Manganese (Mn)	ppm	21-200	16-100	25-250	31-300	25-360
Zinc (Zn)	ppm	21-70	16-70	22-49	21-50	21-80

Corn Stalk Nitrate Test

The corn stalk nitrate test is a late-season or end-of-season plant analysis on mature corn stalks. Iowa State University developed the corn stalk sampling protocol and interpretation to help evaluate nitrogen management in corn after maturity. If corn does not have sufficient nitrogen, the corn stalk nitrate level will be low.

Interpretation

- Low: less than 250 ppm. Nitrogen was likely deficiency and limited yield potential.
- Sufficient: 250 – 2000 ppm.
- High: greater than 2000 ppm. Nitrogen supply exceeded plant requirement.

When to sample

Corn stalks may be collected one to three weeks after physiological maturity (black layer, R6 growth stage) through just after harvest. After harvest, nitrate in corn stalk may leach from plant tissue.

- Earliest: One-quarter milk line (R5 growth stage) on majority of corn kernels. Nitrate concentration may be higher if collected early.
- Optimum: One to three weeks after physiological maturity (black layer, R6 growth stage) on 80% of corn kernels.
- Latest: Up to harvest. Nitrate concentration may be low if nitrate leached from plant tissue.

How to sample

- Plant part: measure 6 inches from the ground, cut the next 8 inches of corn stalk (the 6-14 inch stalk section measured from plant base)
- Amount: 12 to 15 corn stalks
- Remove outside leaf sheath.
- Place corn stalks in ventilated plant tissue bag. Do not use plastic or Zip bag.
- Do not collect diseased or damaged corn stalks.

Collecting a good sample:

- Sample 1-3 weeks after black layer
- Collect 15 eight-inch stalk segments between six and 14 inches above the soil surface
- Randomly select stalks from about a one acre area that represents a larger area
- Separately sample different soil types and management areas
- Place stalks in paper bags, not plastic, for shipment to the lab
- Ship samples within one day or refrigerate until shipping

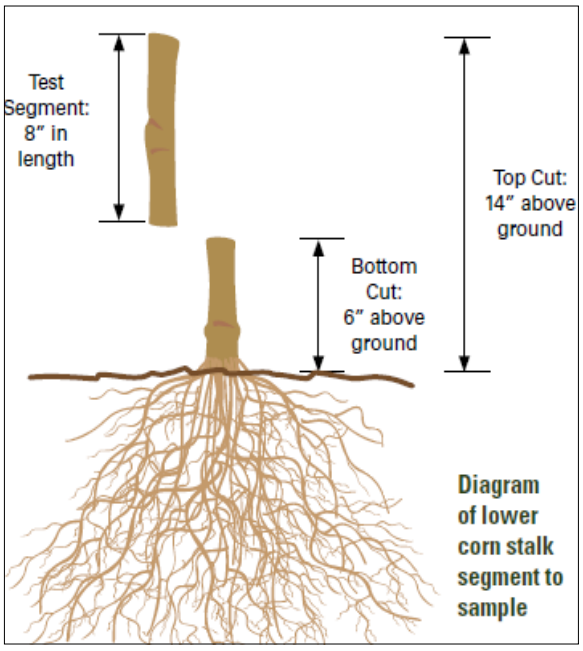

Diagram of lower corn stalk segment to sample

Soybean Cyst Nematode (SCN)

Soybean cyst nematode (SCN) populations can vary greatly across a field, especially when SCN density is low. In certain areas, the SCN population may be very high, while others are low. Examine soybean roots in late June and early July for SCN female cysts. Collect an SCN soil test, including infected soybean root tissue, to determine SCN severity. Soil sampling for SCN is the easiest way to confirm the presence or absence of SCN.

University SCN Guidelines

Soil test category	SCN Population	University Guideline
	eggs/100 g soil	
Very low	< 200	Susceptible soybean variety may be planted
Low	201 – 2,000	Resistant soybean variety should be planted
Medium	2,001 – 10,000	Resistant soybean variety may be planted, some yield loss expected
High	> 10,000	Soybean should not be planted

Crop Rotation after SCN Detected

- Year 1: Corn or other non-host crop
- Year 2: SCN-resistant soybean variety
- Year 3: Corn or other non-host crop
- Year 4: SCN-resistant soybean variety with different resistance trait than Year 2

Soil Sampling

- Soil depth: 0-6 or 0-8 inch
- Location: in the soybean row, collect root tissue
- Amount: 10 – 20 soil cores per sample
- Time of year
    - Just before or after soybean harvest (before any tillage)
    - Summer for troubleshooting problem areas
    - Paired “at-planting” and “at-harvest” to measure SCN population increase during growing season (e.g. SCN-resistance trait failure)

Soybean Iron Deficiency Chlorosis (IDC)

Soils with high carbonate content and salinity are more likely to develop iron deficiency chlorosis (IDC) in soybean. Soil testing for carbonate and salinity helps evaluate the risk potential for soybean IDC development. Always choose fields with the lowest carbonate and salinity for soybean. In management zones where carbonate and salinity are high, plant an IDC-tolerant soybean variety; this may increase the overall field average yield. Other crops sensitive to IDC are flax and dry bean if carbonate and salinity are high.

Soils with low carbonate and low salinity have low risk potential for soybean IDC development. Fields with high carbonate and high salinity have much higher risk potential for soybean IDC development and symptoms may be severe. All soils with pH > 7.3 should have carbonate (calcium carbonate equivalent, CCE) and salinity analyzed. Soils with high pH may widely different CCE content, ranging from near zero to over 20%. Soil carbonate content must be analyzed in the laboratory to assess soybean IDC risk potential.

Soybean IDC Guidelines

	Soybean IDC risk potential		
Salinity (1:1)	**Calcium carbonate equivalent (CCE)**		
dS/m	< 2.5 %	2.6 – 5.0 %	> 5.0 %
< 0.25	Low	Low	Moderate
0.26 – 0.50	Low	Moderate	High
0.51 – 1.00	Moderate	High	Very high
> 1.00	Very high	Very high	Extreme

- Low: Soybean IDC is not likely.
- Moderate: Soybean IDC may develop in certain management zones if cool, wet conditions are present. Choose an IDC-tolerant soybean variety.
- High: Soybean IDC is likely to develop in certain management zones if cool, wet conditions are present. Choose an IDC-tolerant soybean variety.
- Very high: Soybean IDC may be severe if cool, wet conditions are present. Choose an IDC-tolerant soybean variety, strongly advised.
- Extreme: Soybean IDC maybe be severe if cool, wet conditions are present. Soybean IDC severity may reduce yield significantly. Soybean is not recommended.