

North Dakota Fertilizer Recommendation Tables and Equations

Based on Soil Test Levels and Yield Goals

D.W. Franzen
Extension Soil Specialist

Contents	
Table 1.	Soil Test Calibration Levels Used in North Dakota 5
Nutrient Recommendations	
Table 2.	Alfalfa 5
Table 3.	Barley, feed 6
Table 4.	Barley, malting 6
Table 5.	Buckwheat 6
Table 6.	Canola 6
Table 7.	Clovers (alsike, red, birdsfoot trefoil, grass-legume) 7
Table 8.	Corn, grain and popcorn 7
Table 9.	Corn, silage 7
Table 10.	Corn, sweet 7
Table 11.	Crambe 8
Table 12.	Dry bean (pinto, navy, other) 8
Table 13.	Flax 8
Table 14.	Forage/hay grasses, established, irrigated, new seedings, native grass 8
Table 15.	Millet and canary seed 9
Table 16.	Mustard 9
Table 17.	Oat 9
Table 18.	Pea, field, lentil and chickpea (garbanzo bean) 9
Table 19.	Potato 10
Table 20.	Safflower 10
Table 21.	Sorghum, grain 10
Table 22.	Sorghum, forage, sudangrass 10
Table 23.	Soybean 11
Table 24.	Sugarbeet 11
Table 25.	Sunflower 11
Table 26.	Wheat, spring, durum, winter and rye 11

The following soil test recommendation tables are based mainly on field research data obtained in North Dakota, South Dakota, western Minnesota and the Canadian prairie provinces. In the case of some crops, data in the literature were also used to supplement data available from this area.

These tables were developed in cooperation with South Dakota State University and the University of Minnesota under the Tri-State Recommendation Program.

Note that phosphorus and potassium soil test results in these tables are in parts per million (ppm). Some laboratories express results for P and K in terms of pounds per acre instead of ppm. Parts per million (ppm) times two is equal to pounds per acre for a zero- to 6-inch deep sample.

There are changes in this bulletin from previous publications. Please dispose of older editions. Changes in comparison to previous tables were made based on new data.

Recommendations for a limited number of yield goals are found in each table. Use the formulas directly below each table to determine recommendations for a yield goal not found in the table. Recommendations in the P and K tables are the values obtained from the average soil test within response category (very low, low, medium, high, very high) for the yield goal.



Recommendation Tables

Fertilizer needs should be determined after carefully evaluating the current fertility level of the soil and the nutrient needs of the crop to be grown, and setting realistic yield goals. Actual performance of the fertilizer will depend on source, placement, soil and weather conditions and management.

Nitrogen

Nitrogen (N) recommendations for most crops except some legumes and sugarbeets are based on the amount of nitrateN ($\text{NO}_3\text{-N}$) in the top two feet of soil and the yield goal. Yields are very sensitive to the total amount of N available to the crop. Nitrogen fertilizer recommendations are not adjusted based on method of placement, but are adjusted for previous crop and depth of sampling. Soil sampling may begin immediately following small grain harvest with no recommendation adjustments. To determine the amount of fertilizer N recommended, subtract the amount of $\text{NO}_3\text{-N}$ in the soil as determined by soil test from the total amount of available N needed for a particular yield goal and crop.

EXAMPLE:

Your soil test shows that there are 55 pounds of NO_3N present in the soil to two feet. Your yield goal is 40 bu./acre of spring wheat. The amount of nitrogen required for a 40-bushel yield goal is 100 pounds of N per acre. The difference between 100 pounds (from the N fertilizer recommendation table for wheat) and 55 pounds (the soil test) is 45 pounds of N. Therefore, the N recommendation is 45 lb. N/acre.

Adjusting N Recommendations

In a preplant NO_3N soil testing program, certain adjustments need to be made for previous crop:

Previous Crop N Credits

Some crop residues have a lower carbon/nitrogen ratio (C/N ratio) than others. Also, the mass of residue of some crops is smaller than others (dry bean compared to wheat or corn, for example). There is also evidence that certain crops (soybeans) may stimulate increased rates of nitrogen mineralization from soil organic matter. Nitrogen availability is

greater after crops with lower C/N ratio (sugarbeet, alfalfa) and crops having a lower mass of residue (soybean, dry bean) with less ability to tie up N during decomposition. The following credits will be subtracted from crop N recommendations.

Credits

Previous Crop	Credit
Soybean	40 lb. N/acre
Edible bean	40 lb. N/acre
Pea and lentil	40 lb. N/acre
Chickpea	40 lb. N/acre
Sweet clover that was harvested	40 lb. N/acre
Alfalfa that was harvested and unharvested sweet clover:	
>5 plants/sq. ft.	150 lb. N/acre
3-4 plants/sq. ft.	100 lb. N/acre
12 plants/sq. ft.	50 lb. N/acre
<1 plant /sq. ft.	0 lb. N/acre
Sugarbeet	
Yellow leaves	0 lb. N/acre
Yellow/green leaves	30 lb. N/acre
Dark green leaves	80 lb. N/acre

Second year N credits

Half of credit given for the first year for sweet clover and alfalfa, none for grain legumes and sugarbeet.

Depth Adjustments

The original data for calibration of the $\text{NO}_3\text{-N}$ test was based on soil samples taken to a depth of five feet. Sampling beyond two feet improved nitrogen recommendations somewhat, but in the late 1960s it was decided that the extra effort to sample to a depth of three or four feet was not practical or necessary for most crops. Drought and application of excess N, however, may result in a buildup of available N below two feet. When fields are tested for N each year and only the recommended amount of N is applied, an accumulation of nitrogen below two feet is unlikely. Sugarbeet is the most likely crop to be sampled to the four-foot depth, but adjustments are not necessary in N calculations. Recommendations for sugarbeets for two-foot and four-foot sampling are given in Table 24. If deeper sampling is conducted to refine recommendations or screen for problems in malting barley, sunflower or safflower, the following adjustments would apply.

1. If the amount of $\text{NO}_3\text{-N}$ in the two- to four-foot depth is less than 30 lb. $\text{NO}_3\text{-N/A}$, do not adjust the recommendation.
2. If the amount of $\text{NO}_3\text{-N}$ in the two- to four-foot depth is more than 30 lb. $\text{NO}_3\text{-N/A}$, reduce the N recommendation by 80 percent of the amount greater than 30 lb./A. For example, if there are 50 lb. $\text{NO}_3\text{-N/A}$ in the two- to four-foot depth, reduce the N recommendation by 16 lb/ N/A (80 percent of 50 lb. N/A less 30 lb. N/A, or 20 pounds).

Phosphorus and Potassium

The phosphorus (P) and potassium (K) recommended in these tables is the amount to be applied as a broadcast application. Since banded fertilizer is generally used more efficiently in the year of application, the amount of P_2O_5 and K_2O in the tables can be reduced by one-third when banding. Data from field trials in drier or cooler years indicates that small grain and other crops will respond to seed-placed or side-banded P fertilizer even on soils testing medium to high in phosphorus.

Some crops are very sensitive to fertilizer salt injury. No fertilizer is recommended with the seed for these crops in 15-inch rows or wider. Fertilizer sensitive crops include all legumes, such as soybean, pea, dry bean and others. Consult individual soil fertility bulletins for each crop for more information, or the North Dakota Fertilizer Handbook (EB-65). For information regarding fertilizer rates to use with small grains, consult NDSU Extension Service Publications EB-62, EB-65 or SF-712.

Under no-till and especially ridge-till systems, crops have responded to banded K even when soil test levels for K are high. Be aware that broadcast recommendations of P or K for low- and very-low testing soils include buildup P and K rates. When rates are reduced, soil test levels are not increased over time. A long-term P and K strategy should include buildup to at least medium soil test levels at some future date. Near-maximum yield potential is only achieved when these soil test levels are reached. Application of less-than-maintenance rates will result in a decline in P and K levels over time and an accompanying decline in the productivity of most crops.

A special need for phosphate occurs after fallow and non-mycorrhizal crops such as sugarbeet and canola. These conditions deplete the numbers of beneficial fungi (mycorrhiza) that help bring P to the roots and may result in a condition known as "fallow syndrome." Corn is especially sensitive to "fallow syndrome" and should be fertilized using 40 lb./acre P_2O_5 as a 2 X 2 banded application following fallow or a non-mycorrhizal crop.

Sulfur

A deficiency of sulfur (S) is most likely to occur on sandy soils throughout the state and on well-drained medium-textured soils west of the Missouri River. It appears most often on higher landscape positions with a thin surface organic matter layer ('A' horizon) and coarse soil texture (loam to sand and gravel). Since sulfate-S ($\text{SO}_4\text{-S}$) is quite soluble, the top two feet of soil should be tested as is done for N and chloride.

If the amount of $\text{SO}_4\text{-S}$ is less than 16 lb./A in the top two feet, certain crops may respond to S fertilizer. Canola is especially responsive S. In canola, 20-30 lb. S/A is recommended regardless of soil test level. Sulfur is recommended for canola on high-testing soils because of the variability of soil S levels and the tremendous effect that S deficiency can have on this crop. Sulfur is not recommended on high-testing soils for other crops.

Chloride

The chloride (Cl) soil test is calibrated only for small grains, although responses have also been seen in corn. In general, responses to Cl in small grains have been in the range of 1-6 bu./A. on responsive sites. The most consistent effects of Cl on small grains are advancement of maturity and increased kernel plumpness. The greatest probability of wheat and barley response to Cl fertilizer is with soil test levels below 40 lb. Cl/A. The most commercially available and cheapest source of Cl fertilizer is 0-0-60 (potassium chloride, muriate of potash) which contains approximately 50 percent Cl.

Other Nutrients

Although very few soils in North Dakota are deficient in micronutrients, the DTPA test is used to test for zinc (Zn), iron (Fe), manganese (Mn) and copper (Cu). Calibration data are available only for Zn on Zn sensitive crops such as corn, potato, flax and edible bean. Other crops grown in North Dakota are unlikely to respond to Zn.

Zinc

When corn, potato, flax or edible beans are to be grown on a field testing low to very low in Zn, the recommendation is to apply a) 10 lb./acre of Zn as zinc sulfate in a broadcast application incorporated throughout the topsoil, or b) one-third of that rate as a band. Zinc is especially required in these crops if high levels of broadcast P or a starter P fertilizer is applied when soil Zn levels are low. Water solubility is important in efficient dispersion and uptake. This application should correct a Zn deficiency for four to five years.

Zinc humates or lignosulfonates are not significantly more available than zinc sulfate. Zinc EDTA at suggested manufacturer rates may also be used, but are relatively expensive per pound of plant food and offer no residual soil buildup. Banded chelates at 1-2 qt./A. are often used at planting. Foliar applications of zinc chelate and other soluble Zn fertilizers at low rates are also effective in correcting deficiencies for a single season.

No Zn is recommended on fields testing medium or above nor on fields testing very low, low or medium if the crop to be grown is not a Zn sensitive crop.

Iron

In general, the supply of soluble Fe to plants from soil is related to the soil carbonate level, which is important when soil pH is over 7. If carbonates are present, soil wetness, cold soils, excessive tillage and high soluble salt levels influence the presence and severity of chlorosis. Most of our crops are not sensitive to low available iron, and are adapted to regional conditions. However, iron chlorosis has been seen in flax, field pea and dry bean, and is a particularly serious problem in soybean.

Seed treatment with FeEDDHA provides an early-season greenup, but yield responses have been small. Foliar applications have been inconsistent in increasing yield and multiple application may be necessary. If treatments are made, they should be conducted early in the crop year. Late treatment of the crop will be much less effective. The best solution on fields where iron chlorosis occurs is to plant varieties which are more resistant to this problem. NDSU rates about 200 soybean varieties each year for chlorosis resistance. The most recent data can be found at : www.soilsci.ndsu.nodak.edu/yellowsoybeans .

Manganese

There are few documented responses to manganese in North Dakota. Therefore, a recommendation is not generally made for any soil test level.

Copper

In a recent study in North Dakota, yield increases due to soil applied copper were documented, however, the responses were on low organic matter, loamy sand soils with low (less than 0.3 ppm) copper soil test levels. A number of companion trials on similar soils resulted in no yield increase. At best, copper should only be applied to low organic matter, sandy soils with low copper levels, but expect a success rate of less than 15 percent. Copper is expensive, and its use should be based on weighing the productivity of responsive soils with low frequency of return when copper was applied.

Fertilization Recommendation Tables for Crops Commonly Grown in North Dakota

The following tables can be used for the yield goals shown.

For other yield goals, use the equations at the bottom of each table.

The abbreviations used in the tables are as follows:

- YG = yield goal
- STN = soil test nitrogen
- STP = soil test phosphorus
- STK = soil test potassium
- PCC = previous crop credit

Table 1. Soil test calibration levels used in North Dakota.

Nutrient	Name of Test	Categories				
		Very Low	Low	Medium	High	Very High
		ppm extractable				
Phosphorus (P), ppm	Olsen	0-3	4-7	8-11	12-15	16+
Potassium (K), ppm	Ammonium acetate	0-40	41-80	81-129	121-160	161+
Zinc (Zn)*, ppm	DTPA	0-0.25	0.26-0.50	0.51-0.75	0.76-1.00	1.01+
Iron (Fe), ppm	DTPA	no categories				
Copper (Cu)**	DTPA	0-0.10	0.10-0.20	0.20-0.30	0.30+	
Manganese (Mn)***, ppm	DTPA	no categories				
Boron, ppm	Hot water	no categories				
		lbs/acre extractable				
Nitrogen (N)	H ₂ O Extractable	Calibration of nitrogen is dependent on yield goal and crop				
Sulfur (S), lb/a-2'	H ₂ O Extractable	0-9	10-19	20-29	30-39	40+
Chloride (Cl), lb/a-2****	H ₂ O Extractable	0-10	10-20	20-30	30-40	40+

* This calibration is only for sensitive crops such as corn, potato, flax and edible beans.

** This calibration is only for wheat and barley in sandy loam or coarser soils with organic matter less than 2.5 percent. Response to copper is not common. Responses have only been found in 15 percent of medium- or lower-testing locations.

*** Deficiencies of these nutrients have not been confirmed in North Dakota.

**** This calibration is only for small grain.

The amount of nutrient extracted by a particular soil extractant has little meaning or usefulness until it has been calibrated under field conditions. In North Dakota, we use five soil test calibration categories to give meaning to the soil test results. The categories from very low to very high are defined as follows, unless explained differently above:

- **Very Low (VL)** In this category the probability of getting a response to applied nutrient is greater than 80 percent.
- **Low (L)** Crops growing on fields in this category will respond to applied nutrient 60 to 80 percent of the time.
- **Medium (M)** The probability of getting a response to applied nutrient is 40 to 60 percent.
- **High (H)** In this category, crops will respond to applied nutrient about 20 to 40 percent of the time.
- **Very High (VH)** The probability of getting a response to applied nutrient is less than 20 percent.

Growing conditions (weather) have a large influence on whether or not crops will respond to applied nutrients in any particular year. Since growing conditions are unpredictable, the exact response to applied nutrients cannot be predicted and is given as a range above. In spite of this, soil testing remains by far the best guide to determine the amount of fertilizer needed.

Table 2. Alfalfa

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm					Alfalfa
			VL	L	M	H	VH	VL	L	M	H	VH	
ton/a	lb/acre-2'		0-5	6-10	11-15	16-20	21+	0-40	41-80	81-120	121-160	161+	
			0-3	4-7	8-11	12-15	16+						
			lb P ₂ O ₅ /acre					lb K ₂ O/acre					
2	0		34	24	15	6	0	96	66	35	5	0	
4	0		67	49	30	12	0	192	132	71	10	0	
5	0		84	61	38	15	0	241	165	89	13	0	
6	0		101	73	45	17	0	289	197	106	15	0	

Bray-1 P recommendation = (18.57-0.93 STP)YG

Olsen P recommendation = 18.57-1.16 STP)YG

Potassium recommendation = (55.71-0.38 STK)YG

Table 3. Barley, feed**Barley, feed**

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
bu/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
40	70		28	20	12	4	0	45	31	17	3	0
60	100		43	31	19	7	0	67	47	26	5	0
80	135		57	41	25	9	0	89	62	35	7	0
100	170		71	51	31	11	0	112	78	44	8	0

Nitrogen recommendation = 1.7 YG-STN-PCC
 Bray-I P recommendation = (0.785-0.039 STP)YG
 Olsen P recommendation = (0.785-0.050 STP)YG
 Potassium recommendation = (1.2860-0.0085 STK)YG

Table 4. Barley, malting grade**Barley, malting grade**

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
bu/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
40	60		28	20	12	4	0	45	31	17	3	0
60	90		43	31	19	7	0	67	47	26	5	0
80	120		57	41	25	9	0	89	62	35	7	0
100	150		71	51	31	11	0	112	78	44	8	0

Nitrogen recommendation = 1.5 YG-STN-PCC
 Bray-I P recommendation = (0.785-0.039 STP)YG
 Olsen P recommendation = (0.785-0.050 STP)YG
 Potassium recommendation = (1.2860-0.0085 STK)YG

Early planting is critical for greatest success.
 Planting later than May 15 will require lower N rates.
 Applying potassium chloride (0-0-60) at 15-20 lb. K₂O/acre can increase kernel plumpness on well-drained soils if a chloride test is not available.

Table 5. Buckwheat**Buckwheat**

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
bu/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
25	55		30	22	13	5	0	41	29	18	6	0
30	65*		36	26	16	6	0	49	35	21	7	0
35	75*		42	30	19	7	0	57	41	25	8	0
40	90*		48	35	21	8	0	65	47	28	9	0

Nitrogen recommendation = 2.2 YG-STN-PCC
 Bray-I P recommendation = (1.320-0.066 STP)YG
 Olsen P recommendation = (1.320-0.083 STP)YG
 Potassium recommendation = (1.8600-0.0116 STK)YG

* N fertilizer rates greater than 50 lb./acre can cause lodging in wet years.

Table 6. Canola**Canola**

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
lb/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
1000	65		33	24	15	6	0	47	34	20	6	0
1500	100		49	36	23	9	0	71	50	30	10	0
2000	130		65	48	30	13	0	94	67	40	13	0
2500	165		82	60	38	16	0	118	84	50	16	0

Nitrogen recommendation = 0.065 YG-STN-PCC
 Bray-I P recommendation = (0.036-0.0017 STP)YG
 Olsen P recommendation = (0.036-0.0022 STP)YG
 Potassium recommendation = (0.054-0.00034 STK)YG

Note: Canola has a high requirement for sulfur
 Application of 20-30 lb./acre S is recommended regardless of soil test for this crop.
 Apply S as sulfate or thiosulfate form.

Table 7. Clover (Alsike, Red, Birdsfoot Trefoil, grass-legume)

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
ton/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
2	0		36	25	13	2	0	87	60	34	7	0
3	0		54	37	20	3	0	130	90	50	11	0
4	0		72	49	27	4	0	173	120	67	14	0
5	0		90	62	34	6	0	217	150	84	18	0

**Clover
(Alsike, Red,
Birdsfoot
Trefoil,
grass-
legume)**

Bray-1 P recommendation = (20-STP)YG
 Olsen P recommendation = (20-1.4 STP)YG
 Potassium recommendation = (50.000-0.332 STK)YG

Table 8. Corn, grain and popcorn

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
bu/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
50	60		32	23	14	5	0	51	36	22	7	0
100	120		63	46	28	11	0	102	73	44	14	0
150	180		95	69	42	16	0	153	109	65	22	0
200	240		127	92	56	21	0	204	146	87	29	0

**Corn,
grain and
popcorn**

Nitrogen recommendation = 1.2 YG-STN-PCC
 Bray-1 P recommendation = (0.700-0.035 STP)YG
 Olsen P recommendation = (0.700-0.044 STP)YG
 Potassium recommendation = (1.1660-0.0073 STK)YG

Table 9. Corn, silage

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
ton/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
10	105		51	37	23	9	0	83	59	35	11	0
14	145		71	52	32	13	0	116	83	49	15	0
18	185		92	67	41	16	0	149	106	63	20	0
22	230		112	81	50	20	0	183	130	77	24	0

Corn, silage

Nitrogen recommendation = 10.4 YG-STN-PCC
 Bray-1 P recommendation = (5.62-0.28 STP)YG
 Olsen P recommendation = (5.62-0.35 STP)YG
 Potassium recommendation = (9.50-0.06 STK)YG

Table 10. Sweet corn

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
ton/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
4	70		40	29	17	6	0	78	57	36	15	0
6	110		60	43	26	9	0	116	85	54	23	0
8	145		80	57	35	12	0	155	114	72	30	0
10	180		100	72	44	16	0	194	142	90	38	0

Sweet corn

Nitrogen recommendation = 18 YG-STN-PCC
 Bray-1 P recommendation = (11.000-0.533 STP)YG
 Olsen P recommendation = (11.0-0.7 STP)YG
 Potassium recommendation = (22.00-0.13 STK)YG

Table 11. Crambe

Crambe

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
lb/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
1000	50		33	24	15	6	0	47	34	20	6	0
1500	75		49	36	23	9	0	71	50	30	10	0
2000	100		65	48	30	13	0	94	67	40	13	0
2500	125		82	60	38	16	0	118	84	50	16	0

Nitrogen recommendation = 0.05 YG-STN-PCC
 Bray-I P recommendation = (0.0360-0.0018 STP)YG
 Olsen P recommendation = (0.0360-0.0023 STP)YG
 Potassium recommendation = (0.05400-0.00036 STK)YG

Table 12. Dry bean (pinto, navy, other)

Dry bean (pinto, navy, other)

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
lb/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
1400	70		29	22	14	6	0	32	12	0	0	0
1600	80		34	25	16	7	0	37	14	0	0	0
1800	90		38	28	18	8	0	41	16	0	0	0
2000	100		42	31	20	8	0	46	18	0	0	0
2200	110		46	34	22	9	0	51	20	0	0	0
2400	120		50	37	24	10	0	55	22	0	0	0

Nitrogen recommendation = 0.05 YG-STN-PCC
 Bray-I P recommendation = (0.0231-0.0011 STP)YG
 Olsen P recommendation = (0.0231-0.0014 STP)YG
 Potassium recommendation = (0.0346-0.00043 STK)YG

Table 13. Flax

Flax

Yield goal	Soil N plus fertilizer N required	Soil Test Potassium, ppm				
		VL	L	M	H	VH
		0-40	41-80	81-120	121-160	161+
bu/a	lb/acre-2'	lb K ₂ O/acre				
20	60	38	27	16	5	0
30	90	58	41	24	7	0
40	120	77	54	32	10	0
50	150	96	68	40	12	0

Nitrogen recommendation = 3 YG-STN-PCC

Do not overestimate yield goal. Be conservative in N application to reduce risk of lodging. Phosphorus application is not necessary for flax. Phosphorus can be applied, but no yield increase should be expected regardless of soil test level. Potassium recommendation = (2.200-0.014 STK)YG

Table 14. Forage/hay grasses, established grass, irrigated, new seedings

Forage/hay grasses, established grass, irrigated, new seedings

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
ton/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
2	50*		40	26	12	0	0	69	48	27	6	0

Nitrogen recommendation = 25 YG-STN
 Bray-I P recommendation = 45.0-2.5 STP
 Olsen P recommendation = 45.00-3.45 STP
 Potassium recommendation = 80.00-0.53 STK

* Nitrogen application to native grass stands is discouraged due to selective pressures from less desirable plants with higher N. nutrition. Native grass stands can sometimes benefit from P application.

Table 15. Millet and canary seed

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
lb/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
1500	50		23	16	9	3	0	40	29	18	7	0
2000	70		31	22	13	3	0	53	38	24	10	0
2500	90		38	27	16	4	0	66	48	30	12	0
3000	105		46	32	19	5	0	79	58	36	14	0

Millet and canary seed

Nitrogen recommendation = 0.035 YG-STN-PCC
 Bray-I P recommendation = (0.0171-0.00085 STP)YG
 Olsen P recommendation = (0.0171-0.00114 STP)YG
 Potassium recommendation = (0.03-0.00018 STK)YG

Table 16. Mustard

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
lb/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
1000	65		33	24	15	6	0	47	34	20	6	0
1500	100		49	36	23	9	0	71	50	30	10	0
2000	130		65	48	30	13	0	94	67	40	13	0
2500	165		82	60	38	16	0	118	84	50	16	0

Mustard

Nitrogen recommendation = 0.065 YG-STN-PCC
 Bray-I P recommendation = (0.036-0.0017 STP)YG
 Olsen P recommendation = (0.036-0.0022 STP)YG
 Potassium recommendation = (0.054-0.00034 STK)YG

Table 17. Oat

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
bu/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
50	65		29	21	13	5	0	55	38	21	4	0
70	90		41	29	18	7	0	77	53	29	5	0
90	115		52	38	23	8	0	100	69	38	7	0
110	145		64	46	28	10	0	122	84	46	8	0

Oat

Nitrogen recommendation = 1.3 YG-STN-PCC
 Bray-I P recommendation = (0.644-0.032 STP)YG
 Olsen P recommendation = (0.644-0.041 STP)YG
 Potassium recommendation = (1.2777-0.0086 STK)YG

Table 18. Pea, field, Lentil and Chickpea (Garbanzo bean)

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
lb/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
1400	20		22	15	9	3	0	37	27	17	7	0
1800	20		28	20	12	4	0	48	35	22	9	0
2200	20		34	24	15	5	0	58	42	26	11	0
2600	20		40	29	17	6	0	69	50	31	13	0

Pea, field, Lentil and Chickpea (Garbanzo bean)

Bray-I P recommendation = (0.0171-0.00085 STP)YG
 Olsen P recommendation = (0.0171-0.0011 STP)YG
 Potassium recommendation = (0.03-0.00018 STK)YG
 Inoculation is necessary with proper Rhizobium culture.

Table 19. Potato

Potato

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
cwt/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
200	80		90	63	35	8	0	147	102	56	10	0
300	120		135	94	53	12	0	221	152	84	16	0
400	160		180	125	71	16	0	294	203	112	21	0
500	200		225	157	89	21	0	368	254	140	26	0

Nitrogen recommendation = 0.4 YG-STN-PCC
 Bray-I P recommendation = (0.5-0.024 STP)YG
 Olsen P recommendation = (0.5-0.034 STP)YG
 Potassium recommendation = (0.85-0.0057 STK)YG

Under irrigation, N application should be split to reduce nitrate leaching risk. Supplemental N should be directed through the use of petiole/sap testing.

Table 20. Safflower

Safflower

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
lb/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
800	40		20	14	9	3	0	34	24	14	5	0
1200	60		29	21	13	5	0	50	36	22	7	0
1600	80		39	28	17	6	0	67	48	29	10	0
2000	100		49	35	22	8	0	84	60	36	12	0

Nitrogen recommendation = 0.05 YG-STN-PCC
 Bray-I P recommendation = (0.027-0.0014 STP)YG
 Olsen P recommendation = (0.027-0.0017 STP)YG
 Potassium recommendation = (0.048-0.0003 STK)YG

N rates for safflower should be developed using conservative yield goals to maximize seed oil content. Safflower will extract N to a depth of over 4 feet.

Table 21. Sorghum, forage, and Sudangrass

Sorghum, forage, and Sudangrass

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
ton/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
3	75		30	21	13	5	0	111	75	39	3	0
5	125		50	36	22	8	0	185	125	65	5	0
7	175		70	50	30	11	0	259	175	91	7	0
9	225		90	64	39	14	0	333	225	117	9	0

Nitrogen recommendation = 25 YG-STN-PCC
 Bray-I P recommendation = (11.000-0.533 STP)YG
 Olsen P recommendation = (11.0-0.7 STP)YG
 Potassium recommendation = (43.0-0.3 STK)YG

Table 22. Sorghum, grain

Sorghum, grain

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
bu/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
60	66		36	26	17	7	0	46	32	18	4	0
80	88		48	35	22	9	0	61	42	24	5	0
100	110		60	44	28	11	0	76	53	30	6	0
120	132		72	53	33	14	0	91	63	35	8	0

Nitrogen recommendation = 1.1 YG-STN-PCC
 Bray-I P recommendation = (0.666-0.033 STP)YG
 Olsen P recommendation = (0.666-0.041 STP)YG
 Potassium recommendation = (0.875-0.0058 STK)YG

Table 23. Soybean

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
bu/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
30	50*		40	23	10	0	0	55	33	11	0	0
40	50*		54	31	10	0	0	73	44	15	0	0
50	50*		67	39	11	0	0	92	55	19	0	0
60	50*		80	47	13	0	0	110	66	22	0	0

Bray-I P recommendation = (1.55-0.10 STP)YG
 Olsen P recommendation = (1.55-0.14 STP)YG
 Potassium recommendation = (2.2000-0.0183 STK)YG

Inoculation, or rotation within four years of a well-nodulated soybean crop is necessary.
 * Ignore N recommendation if soybeans have been successfully grown in the field with little chlorosis and good nodulation.

Soybean

Table 24. Sugarbeet

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
lb/acre-4'			lb P ₂ O ₅ /acre					lb K ₂ O/acre				
130			80	58	36	15	0	110	77	43	9	0

Bray-I P recommendation = (4.38-0.22 STP)YG
 Olsen P recommendation = (4.38-0.27 STP)YG
 Potassium recommendation = (6.350-0.042 STK)YG

A minimum of 65 lb. N should be in the 0-2 foot depth. Soil N plus fertilizer N required with a 0-2 foot core only is 100. lb/acre.

Sugarbeet

Table 25. Sunflower

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
lb/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
1000	50		20	15	9	4	0	36	25	14	3	0
1500	75		31	22	14	5	0	53	37	21	5	0
2000	100		41	30	18	7	0	71	50	28	6	0
2500	125		51	37	23	9	0	89	62	35	8	0

Nitrogen recommendation = 0.05 YG-STN-PCC
 Bray-I P recommendation = (0.0225-0.0011 STP)YG
 Olsen P recommendation = (0.0225-0.0014 STP)YG
 Potassium recommendation = (0.041-0.00027 STK)YG

Table 26. Wheat, spring, durum, winter and rye

Yield goal	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
			VL	L	M	H	VH	VL	L	M	H	VH
			0-5 0-3	6-10 4-7	11-15 8-11	16-20 12-15	21+ 16+	0-40	41-80	81-120	121-160	161+
bu/a	lb/acre-2'		lb P ₂ O ₅ /acre					lb K ₂ O/acre				
20	50		19	17	9	3	0	47	34	20	7	0
40	100		39	35	17	7	0	95	68	40	13	0
60	150		58	52	26	10	0	142	101	60	20	0
80	200		78	69	35	13	0	190	135	80	26	0

Nitrogen recommendation = 2.5 YG-STN-PCC
 Bray-I P recommendation = (1.071-0.054 STP)YG
 Olsen P recommendation = (1.071-0.067 STP)YG
 Potassium recommendation = (2.71-0.017 STK)YG

Wheat, spring, durum, winter and rye

For more information on this and other topics, see: www.ag.ndsu.nodak.edu



3 F-882

NDSU Extension Service, North Dakota State University of Agriculture and Applied Science, and U.S. Department of Agriculture cooperating. Duane Hauck, Interim Director, Fargo, North Dakota. Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. We offer our programs and facilities to all persons regardless of race, color, national origin, religion, sex, disability, age, Vietnam era veterans status, or sexual orientation; and are an equal opportunity employer.

This publication will be made available in alternative formats for people with disabilities upon request, 701/231-7881.

1.5M-9-03; 1M-1-04