OSU Soil Test Interpretations

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The following tables are soil test interpretations of major crops for the most commonly deficient plant nutrients in Oklahoma. These relationships are valid for interpreting soil test values from the OSU Soil, Water, and Forage Analytical Laboratory and are not intended for use with soil test results from other laboratories due to differences in testing procedures and field calibration. Nitrogen and sulfur requirements are based on yield goal. Other nutrient requirements are based on soil test values and their corresponding sufficiency levels. Requirements for phosphorus and potassium are annual amounts that must be applied each year to prevent deficiencies until another soil test is performed. Read the text following the tables before determining fertilizer rates.

Table 1. Primary Nutrient Soil Test Interpretations for Selected Small Grains and Row Crops.

Nitrogen Requirements

SMALL GRAINS				*GRAIN SORGHUM*		*CORN*		*COTTON*	
Yield Goal (bu/A)			***N***	*Yield Goal*	***N***	*Yield Goal*	***N***	*Yield Goal*	***N***
Wheat	*Barley*	*Oats*	***(lbs/A)***	*(lbs/A)*	***(lbs/A)***	*(bu/A)*	***(lbs/A)***	*(bales/A)*	***(lbs/A)***
15	20	25	**30**	2000	**30**	40	**40**	0.50	**30**
20	25	35	**40**	2500	**40**	50	**50**	0.75	**45**
30	35	55	**60**	3000	**50**	60	**60**	1.00	**60**
40	50	70	**80**	4000	**70**	85	**85**	1.25	**75**
50	60	90	**100**	4500	**85**	100	**110**	1.50	**90**
60	75	105	**125**	5000	**100**	120	**130**	1.75	**105**
70	90	125	**155**	7000	**160**	160	**190**	2.00	**120**
80	100	140	**185**	8000	**195**	180	**215**	2.25	**135**
100	125	175	**240**	9000	**230**	200	**240**	2.50	**150**

Phosphorus Requirements

P SOIL TEST INDEX	*SMALL GRAINS*		*GRAIN SORGHUM*		*CORN*		*COTTON*	
	Percent Sufficiency	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*
0	25	80	40	60	30	80	55	75
10	45	60	60	50	60	60	70	60
20	80	40	80	40	80	40	85	45
40	90	20	95	20	95	20	95	30
65+	100	0	100	0	100	0	100	0

Potassium Requirements

K SOIL TEST INDEX	*SMALL GRAINS*		*GRAIN SORGHUM*		*CORN*		*COTTON*	
	Percent Sufficiency	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*
0	50	60	40	100	40	120	40	110
75	70	50	65	75	60	80	60	80
125	80	40	80	50	75	60	75	60
200	95	20	95	30	90	40	90	40
250+	100	0	100	0	100	0	100	0

* The soil test index is two times the ppm (parts per million) value reported by many labs.

Table 2. Primary Nutrient Soil Test Interpretations for Selected Grasses and Silage.

Nitrogen Requirements

COOL SEASON GRASSES (FESCUE, ORCHARD, RYE)		WEEPING LOVEGRASS		BLUESTEM		BERMUDAGRASS		FORAGE SORGHUM OR CORN SILAGE		
Yield Goal (tons/A)	N (lbs/A)	**Yield Goal (tons/A)**	N (lbs/A)	**Yield Goal (tons/A)**	N (lbs/A)	**Yield Goal (tons/A)**	N (lbs/A)	**Yield Goal (tons/A) Silage**	**(tons/A) Hay**	N (lbs/A)
1	60	**1**	35	**1**	35	**1**	50	**5**	**2.5**	45
2	120	**2**	70	**2**	70	**2**	100	**10**	**5.0**	90
3	180	**3**	110	**3**	110	**3**	150	**15**	**7.5**	135
4	240	**4**	160	**4**	150	**4**	200	**20**	**10.0**	185
5	300	**5**	220	**5**	200	**5**	260	**25**	**12.5**	240
						6	320	**30**	**15.0**	300
						7	400			

Phosphorus Requirements

P SOIL TEST INDEX	COOL SEASON GRASSES (FESCUE, ORCHARD, RYE)		WEEPING LOVEGRASS		BLUESTEM		BERMUDAGRASS		FORAGE SORGHUM OR CORN SILAGE	
	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)	Percent Sufficiency	P_2O_5 (lbs/A)
0	30	80	50	60	50	60	50	75	30	100
10	50	60	70	40	70	40	65	60	60	75
20	70	40	85	30	85	30	80	40	80	45
40	95	30	95	20	95	20	95	20	95	25
65+	100	0	100	0	100	0	100	0	100	0

Potassium Requirements

K SOIL TEST INDEX	COOL SEASON GRASSES (FESCUE, ORCHARD, RYE)		WEEPING LOVEGRASS		BLUESTEM		BERMUDAGRASS		FORAGE SORGHUM OR CORN SILAGE	
	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)	Percent Sufficiency	K_2O (lbs/A)
0	60	70	40	80	40	80	50	140	40	180
75	70	60	60	60	60	60	65	80	60	130
125	80	50	80	40	80	40	80	50	75	90
200	95	30	95	20	95	20	95	30	90	60
250+	100	0	100	0	100	0	100	0	100	0

Table 3. Primary Nutrient Soil Test Interpretations for Selected Forages.

Nitrogen Requirements

SMALL GRAINS FOR GRAZING		*LEGUMES IN PASTURE*	*NEW SEEDING OF INTRODUCED GRASSES*	*VIRGIN NATIVE HAY MEADOWS*	
Yield Goal (tons/A)	N (lbs/A)	Legumes will produce nitrogen for their growth. Very little nitrogen remains for the grasses after legume growth stops unless the legume growth is not harvested but allowed to decay.	40 lbs of nitrogen is needed to establish a grass. Refer to other table for nitrogen requirement for production.	**Yield Goal (tons/A)**	N (lbs/A)
0.5	30			**1.0**	0
1.0	60			**1.5**	50
1.5	90			**1.6**	100
2.0	120				
2.5	150				
3.0	180				

Phosphorus Requirements

P SOIL TEST INDEX	*SMALL GRAINS FOR GRAZING*		*LEGUMES IN PASTURE*		*NEW SEEDINGS OF INTRODUCED GRASSES*		*VIRGIN NATIVE HAY MEADOWS*	
	Percent Sufficiency	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*
0	25	80	50	75	30	80	50	40
10	45	60	65	60	50	60	80	20
20	80	40	80	40	70	40	95	0
40	90	20	95	20	95	20	100	0
65+	100	0	100	0	100	0	100	0

Potassium Requirements

K SOIL TEST INDEX	*SMALL GRAINS FOR GRAZING*		*LEGUMES IN PASTURE*		*NEW SEEDINGS OF INTRODUCED GRASSES*		*VIRGIN NATIVE HAY MEADOWS*	
	Percent Sufficiency	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*
0	50	60	50	80	50	80	40	40
75	70	50	65	60	65	60	70	30
125	80	40	80	40	80	40	85	20
200	95	20	95	20	95	20	95	0
250+	100	0	100	0	100	0	100	0

Table 4. Primary Nutrient Soil Test Interpretations for Selected Legumes.

Nitrogen Requirements

ALFALFA	*PEANUTS*	*SOYBEANS*	*MUNGBEANS, COWPEAS, & GUAR*
10-20 lbs/A for establishment. None needed for maintenance.	10-20 lbs/A with P & K.	10-20 lbs/A with P & K. Inoculate seed.	10-20 lbs/A with P & K. Inoculate seed.

Phosphorus Requirements

P SOIL TEST INDEX	*ALFALFA*		*PEANUTS*		*SOYBEANS*		*MUNGBEANS, COWPEAS, & GUAR*	
	Percent Sufficiency	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*	*Percent Sufficiency*	*P_2O_5 (lbs/A)*
0	20	200	40	80	40	70	40	70
10	50	150	60	60	60	50	60	50
20	70	100	80	40	80	30	80	30
40	90	60	95	20	95	20	95	20
65+	100	0	100	0	100	0	100	0

Potassium Requirements

K SOIL TEST INDEX	*ALFALFA*		*PEANUTS*		*SOYBEANS*		*MUNGBEANS, COWPEAS, & GUAR*	
	Percent Sufficiency	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*	*Percent Sufficiency*	*K_2O (lbs/A)*
0	20	280	40	80	40	100	50	80
75	50	210	60	60	60	70	60	60
125	70	140	75	40	75	60	80	45
200	90	80	90	30	90	40	90	30
275	95	40	100	0	100	0	100	0
350+	100	0	100	0	100	0	100	0

Notes for Nitrogen (N) Interpretations

The nitrogen fertilizer rate is calculated by subtracting the soil test nitrogen value from the nitrogen requirement for a selected crop and yield goal. For deep rooted non-legume crops such as wheat or bermudagrass, a sample representing the 7 to 24 inch subsoil layer should accompany the surface soil for a separate available nitrogen test. If the subsoil sample depth is other than 7 to 24 inches, the actual depth should be recorded on the sample bag and the test result adjusted for the difference. The subsoil only needs to be tested for nitrate-nitrogen. If sulfate and chloride are tested in the surface, subsoil sample should also be included. Yield goals should be sufficiently greater than long-term average yields to insure nitrogen will not be the factor limiting crop production during years with better than average growing conditions. As a rule of thumb, the average yield from the last five years plus 20 percent is an appropriate yield goal.

Forage production under grazing conditions can be roughly estimated by assuming 1000 pounds of small grain forage, or 1500 to 2000 pounds of other types of forage, will be required to produce 100 lbs of beef. The actual conversion rate varies depending on the quality and condition of the pasture and livestock. If small grain is used for grazing and grain production, additional N needs to be considered to replace N removed as beef. Two pounds of N are still needed to produce one bushel of grain, but 30 lbs. N are needed to produce 100 lbs. of beef or 1000 lbs. of forage grazed. Therefore, N requirement for dual purpose wheat is:

N (lbs./acre) = 2 x yield goal (bu./A) + 0.3 x beef (lbs./A) – soil test N (lbs./A)

Seasonal nitrogen requirements for actively growing sorghum sudans and bermudagrass pastures may be split to provide 50-60 lbs of actual nitrogen every 4-6 weeks. The same split application should be made for each cutting of sorghum sudan hay. For bermudagrass hay, the total seasonal nitrogen requirement can be applied in early spring except on very deep sandy soils under high rainfall or irrigation where split application is needed.

Small grains following alfalfa will generally not need nitrogen for one year. Credits should be given to available nutrients from animal manure and biosolids applications.

Table 5. N, P and K Soil Test Interpretations for Lawn and Garden.

Nitrogen Recommendation	
Soil Test N (lbs/A)	*N (lbs/1000sq. ft)*
0-15	1.0
15-30	0.7
30-45	0.3
>45	0.0

Phosphorus Recommendations	
P Soil Test Index	*P_2O_5 (lbs/1000 sq. ft)*
0-20	2.5
20-40	2.0
40-65	1.0
>65	0

Potassium Recommendations	
K Soil Test Index	*K_2O (lbs/1000 sq. ft)*
0-100	6
100-200	3
200-300	1
>300	0

Secondary Nutrient Interpretations

Calcium (Ca)

Calcium deficiency has not been observed on any crop except peanuts. Gypsum may be applied over the pegging zone during early bloom stage to correct the deficiency for peanut. Appropriate rates are listed in Table 6.

Magnesium (Mg)

Magnesium deficiencies are indicated by soil test index values less than 100 lbs/A. Deficiencies can be corrected by applying 30-40 lbs of magnesium fertilizer per acre or by using dolomitic limestone if lime is needed.

Table 6. Recommended Gypsum Rates to Alleviate Calcium Deficiency in Peanuts.

Calcium Soil Test Index (lb/A)	*Gypsum Needed (lb/A)*
0-150	750
150-300	500
300-450	400
450-600	300
600-750	200
750+	0

Sulfur (S)

Sulfur is a mobile nutrient in the soil and therefore plant requirements are based on yield goals similar to that of nitrogen. Sulfur requirements for non-legumes are calculated by dividing the nitrogen requirement by 20. The available S measured by the S soil test for both the surface and subsoil is subtracted from the S requirement to determine the fertilizer rate. The rate may also be reduced by an additional 6 lbs/acre due to sulfur supplied through rainfall and other incidental additions such as N, P, and K fertilizer impurities. The following is an example for bermudagrass:

Crop: bermudagrass

1) Yield goal: 6 tons/acre
2) N requirement (Table 2) = 320 lbs/acre
3) S requirement = N req/20 = 320/20 = 16 lbs/acre
4) Sulfur soil test values: surface = 2 lbs/acre
   subsoil = 7 lbs/acre
   total = 2 + 7 = 9 lbs/acre
5) Incidental sulfur additions: 6 lbs/acre
6) Sulfur fertilizer rate = 16 - 9 - 6 = 1 lbs S/acre

A similar calculation is used to determine the sulfur fertilizer rate for legumes, with the exception that the sulfur requirement is obtained from Table 7 rather than dividing the nitrogen requirement by 20.

Table 7. Sulfur Requirements for Legumes.

ALFALFA		*PEANUTS*		*SOYBEANS*	
Yield Goal (tons/A)	*S (lbs/A)*	***Yield Goal (cwt/A)***	*S (lbs/A)*	***Yield Goal (bu/A)***	*S (lbs/A)*
2	6	**6**	2	**10**	3
4	11	**12**	3	**20**	6
6	17	**18**	5	**30**	9
8	22	**24**	7	**40**	12
10	28	**30**	9	**50**	15
		36	11	**60**	18

MUNGBEANS		*COWPEAS*	
Yield Goal (tons/A)	*S (lbs/A)*	***Yield Goal (cwt/A)***	*S (lbs/A)*
5	1.5	**5**	1.5
10	3.0	**10**	2.5
15	4.5	**15**	4.0
20	6.0	**20**	5.5

Micro-Nutrient Interpretations

Zinc (Zn)

The soil test interpretation for zinc is presented in Table 8. Zinc soil test index values less than 0.30 ppm are considered deficient for all crops except small grains, cool season grasses (fescue, orchardgrass, and ryegrass) and new seedings of introduced grasses. The recommended rates are enough to correct a deficiency for several years. Applications should not be repeated until a new soil test is taken. Some producers may wish to apply 2 pounds of zinc per year until the total recommended amount is applied. Zinc can be toxic to peanut, so caution should be used when application is made.

Table 8. Zinc Soil Test Interpretation.

Zinc Soil Test Index (ppm)	*Interpretation*	*Zinc Requirement (lbs/A)*
0.0-0.3	Deficient for all crops except small grains, cool season grasses (fescue, orchard, and rye), and new seedings of introduced grasses.	6-10
0.3-0.8	Deficient for corn and pecans only.	2-5
0.8-2.0	Deficient for pecans only.	Foliar only.
2.0+	Adequate for all crops.	0

Iron (Fe)

Iron soil test values less than 2.0 ppm are considered low and may cause iron chlorosis in crops which are moderately sensitive such as wheat, soybeans, and peanuts. Soil test values in the medium range, 2.0-4.5 ppm, may cause chlorosis in sensitive crops such as sorghum and sudan. Levels above 4.5 ppm are usually adequate for all crops. Crop sensitivity is increased when soil pH increases above 8.2 and soil test manganese levels are high (above 50 ppm). Foliar application of a 3% ferrous sulfate (or ammonium ferrous sulfate) solution is effective for correction. Severe chlorosis may require several applications and may not be economic to correct. Effective control can be obtained by applying 2 lbs of iron per acre in chelated form or 8 lbs of ferrous sulfate per acre with ammonium polyphosphate solution in a band near the seed. It is important to apply polyphosphate and ferrous sulfate solutions in the same band (Table 9).

Table 9. Iron Soil Test Interpretation.

Iron Soil Test Value (ppm)	*Interpretation*	*Iron Requirement lbs/A*
< 2.0	Deficient for moderate sensitive crops, e.g., Wheat, soybean, peanuts.	2 foliar 8 banding
2.0 - 4.5	Def. for sensitive crops, e.g., sorghum and sudan	2 foliar 8 banding
> 4.5	Adequate for all crop	0

Manganese (Mn)

Soil test index levels less than 1.0 ppm manganese are considered deficient and levels above 1.0 ppm are considered adequate. To date, no deficient levels have been reported in Oklahoma. Levels above 50 ppm may be harmful; however, this problem can easily be corrected by a good liming program.

Boron (B)

Boron deficiency in Oklahoma is uncommon but may occur in legumes, particularly alfalfa and peanuts. The soil test interpretation for boron is presented in Table 10.

Table 10. Recommended Fertilizer Rates to Alleviate Boron Deficiency in Peanuts and Alfalfa.

Boron Soil Test Index (ppm)	*Boron Requirement --------(lbs/A)--------*	
	Peanuts	*Alfalfa*
0.0-0.25	1.0	2.0
0.25-0.50	0.5	1.0
0.50+	0.0	0.0

Chloride (Cl)

Some research has shown that small grains responded to Cl fertilization, especially in sandy soils. Collect both surface and sub-surface (6-24") soil samples if Cl nutrition is in questions. Current Cl recommendation is:

Cl (lbs/A) needed = 60 – soil Cl

Lime Requirements

The following should be considered when determining lime requirements:

1. A buffer index (BI) reading will be determined on all soils having a pH less than 6.3.
2. Refer to Table 11 for the lime requirement for each buffer index.
3. If the soil pH is less than 6.1, a minimum of 1.0 tons ECCE lime should be applied to alfalfa regardless of the buffer index. Apply higher rates of lime if indicated by the buffer index, using split applications for established alfalfa.
4. A minimum of 0.5 tons ECCE lime should be applied whenever the soil pH is 0.5 units less than the low end of the pH range shown for the crop in the table of pH preferences of common field crops (Table 12).

Table 11. Lime Required to Raise Soil pH to 5.5 for Continuous Wheat and to pH 6.8 for Other Crops in the 6 Inch Acre Furrow Slice.

Soil Buffer Index	*All Crop but Continuous Wheat ECCE* Lime (tons/A)*	*Continuous Wheat ECCE* Lime (tons/A)*	*Lawn and Garden ECCE* Lime (lbs/1000sq. ft.)*
6.2	4.2	1.0	193
6.3	3.7	0.9	170
6.4	3.1	0.8	142
6.5	2.5	0.6	115
6.6	1.9	0.5	87
6.7	1.4	0.5	64
6.8	1.2	0.5	55
6.9	1.0	0.5	46
7.0	0.7	0.5	32
7.1	0.5	0.5	23
7.2+	0.0	0.0	0

* Effective Calcium Carbonate Equivalent - Pure calcium carbonate ground fine enough to be 100% effective. The rate of ag-lime to apply can be determined from the ECCE requirement using the following formula: Tons of ag-lime / A = Tons ECCE lime required / %ECCE x 100.

Table 12. Soil pH Preference of Selected Field Crops.*

Legumes	*pH Range*
Cowpeas, crimson clover, mungbeans, vetch	5.5-7.0
Peanuts, soybeans	5.8-7.0
Alsike, red, and white (ladino) clovers, arrowleaf clover	6.0-7.0
Alfalfa, sweet clover	6.3-7.5

Non-legumes	*pH Range*
Bluestem, fescue, native hay, weeping lovegrass	4.5-7.0
Buckwheat	5.0-6.5
Corn, guar, oats, orchardgrass, ryegrass, sorghum, sudan, wheat	5.5-7.0
Bermudagrass	5.7-7.0
Barley	6.3-7.0
Cotton	5.7-7.0

* Most legumes will tolerate a pH 0.5 units less and 1.0 units higher than indicated above, but production may be significantly reduced. Non-legumes tend to tolerate a pH 0.5 to 1.0 units less (but not less than 4.0) and 1.0 to 2.0 units higher than indicated.

5. It usually is not economical to apply less than 1 ton of ag-lime per acre due to cost of application.
6. When the recommended rate exceeds 5 tons/A, the application should be split to improve spreading and mixing with the soil. No more than 4 tons/A of ag-lime should be applied to established alfalfa or pasture at any one time.
7. When the recommended rate has been applied, it will take several weeks for the soil pH to change, but it should not be necessary to reapply lime for several years.
8. When liming for continuous wheat, it is only necessary to raise the pH to above 5.5 because higher pH may favor some root rot diseases. The minimum amount of lime to apply is 0.5 ton ECCE lime or 1/4 the amount recommended to raise soil pH to 6.8, whichever is greater (see Table 11).

Important Conversion Factors

$K_2O = K \times 1.2$
$P_2O_5 = P \times 2.29$
lbs./A = ppm x 2 (6 inch depth)

Other Related Extension Publications

L-241 Test Service and Price List 1997: Soil, Water, & Forage Analytical Laboratory
PSS-2207 How to Get a Good Soil Sample
PSS-2229 Soil pH and Buffer Index
PSS-2237 Sulfur Requirements of Oklahoma Crops
PSS-2240 Managing Acid Soils for Wheat Production
PT–96-25 Use Animal Manure as a Plant Nutrient Source
Oklahoma Soil Fertility Handbook, 6th edition, 2006
Oklahoma Homeowners Handbook for Soil and Nutrient Management

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