



General Guide

for Crop Nutrient

Recommendations in Iowa



IOWA STATE UNIVERSITY
University Extension

Ames, Iowa

Pm-1688 | October 1996

Prepared by R. D. Voss, A. P. Mallarino, and R. Killorn,
agronomists, Department of Agronomy, Iowa State University

General Guide for Crop Nutrient Recommendations in Iowa

Table of Contents

Introduction	3
Soil Test Procedures	3
Soil Test Categories	3
Recommendations	4
Micronutrients	5
Limestone	5
List of Tables and Figures	19

General Guide for Crop Nutrient Recommendations in Iowa

Introduction

Phosphorus (P), potassium (K), zinc (Zn) and lime recommendations based on soil testing are provided in this publication for the major agronomic crops grown in Iowa. Interpretation of soil test values and nutrient recommendations are based on soil samples taken to a 6 to 7-inch depth. Research results from long-term and short-term field experiments have been used to determine the interpretation of soil test values and the nutrient recommendations.

Nutrients applied to meet the recommended amounts may be from inorganic sources, from manure, or both. Nutrient contents of manures are most accurately determined by laboratory analyses, but if not analyzed, use average tabled values.

Soil Test Procedures

The soil tests for which interpretations are given in this publication are the Bray P₁ and the Olsen tests for P, the ammonium acetate test for K, the DTPA test for Zn, and the SMP buffer method for lime requirements. The Olsen test is the preferred test for P for soils with soil pH greater than 7.4. These tests, and that for soil pH, are among the tests prescribed for the North Central Region by the NCR-13 Regional Committee on

Soil Testing and Plant Analysis. These and other tests are described in the North Central Regional Publication No. 221 (Revised), Recommended Chemical Soil Test Procedures for the North Central Region.

Soil Test Categories

Soil test numerical values are reported as parts per million (ppm). Soil test values for phosphorus and potassium have been put into categories designated very low (VL), low (L), optimum (Opt), high (H), and very high (VH). These categories represent a decreasing probability of an economic yield response ranging from very high to very low.

The optimum category is the most profitable category to maintain over time.

The very high category indicates that the nutrient concentration exceeds crop needs, and further additions of that nutrient very seldom produce a profitable yield response.

Soil test categories for the numerical soil test values of P and K are given in Table 1. The interpretation of P and K soil test values into categories depends on the nutrient demand of the crop to be grown, the subsoil concentrations of P and K, and the soil test value. The

interpretation of P soil test values for wheat and alfalfa is different than for the other agronomic crops indicating that these two crops require a higher soil P level in the tillage zone for profitable production. The interpreta-

tion of P soil test values for all crops other than wheat and alfalfa and K soil test values for all agronomic crops differs according to subsoil P and K levels of the soil.

Table 1. Interpretation of soil test values for phosphorus (P) determined by Bray P₁ extractant or Olsen extractant and potassium (K) determined by ammonium acetate extractant for surface soil samples (6 to 7-inch deep cores).

Relative level *	Bray P ₁ : Phosphorus (P)			Potassium (K)	
	Wheat, alfalfa	All crops except wheat, alfalfa		All crops	
		Subsoil P		Subsoil K	
	Low	High	Low	High	
ppm					
Very low (VL)	0-15	0-8	0-5	0-60	0-40
Low (L)	16-20	9-15	6-10	61-90	41-80
Optimum (Opt)	21-25	16-20	11-15	91-130	81-120
High (H)	26-30	21-30	16-20	131-170	121-160
Very High (VH)	31+	31+	21+	171+	161+
	Olsen: Phosphorus (P)				
Very low (VL)	0-10	0-5	0-3		
Low (L)	11-14	6-10	4-7		
Optimum (Opt)	15-17	11-14	8-11		
High (H)	18-20	15-20	12-15		
Very High (VH)	21+	21+	16+		

* The optimum soil test category is the most profitable to maintain.

The very high soil test category indicates that the nutrient concentration exceeds crop needs, and further additions of that nutrient very seldom produce a profitable yield response.

Subsoil P and K levels are determined at the depth which provides the greatest range of soil test values for each nutrient. Subsoil P is determined by the Bray P₁ soil test for samples taken from the 30- to 42-inch depth. Subsoil K is determined by the ammonium acetate soil test for samples taken from the 12- to 24-inch depth. Subsoil P is designated low for subsoil test values of 8 ppm or less and high for values of 9 ppm or more. Subsoil K is designated low for subsoil test values of 50 ppm or less and high for values of 51 ppm or more. The effect of a high subsoil level of P or K is to require a lower concentration of that nutrient in the surface soil for optimum crop production.

Subsoil P and K levels for soil series with more than 5,000 acres and a corn suitability rating (CSR) greater than 30 are given in Table 18 for each of the major soil areas in Iowa that contain the principal soil associations shown in Figure 1. Subsoil levels do vary by soil series but not by soil mapping units within a soil series.

Recommendations

The recommended amounts of P₂O₅ and K₂O for very low (VL) and low (L) soil test categories are based on long-term research. These recommended amounts are not based on a yield goal. Annual application of the recommended amounts for these soil test categories

should increase soil test values over time.

The recommended amounts of P₂O₅ and K₂O for the optimum (Opt) soil test category will be based on nutrient removal for the reported yield of the harvested crop. The intent of this recommendation is to maintain soil test levels in the optimum category that are more profitable to maintain than a high or very high category. The nutrient contents per unit of yield of Iowa's primary agronomic crops, which will be used, are given in Table 2.

The recommended amounts of P₂O₅ and K₂O for all soil test P and K categories are given in the following tables:

- Table 3 Corn grain
- Table 4 Corn silage
- Table 6 Soybean
- Table 7 Alfalfa and alfalfa-grass hay
- Table 8 Oat with forage seeding
- Table 9 Oat with no forage seeding
- Table 10 Wheat
- Table 11 Sunflower
- Table 12 Legume-grass pasture
- Table 13 Tall cool-season grasses for pastures
- Table 14 Warm season grasses for pasture and hay
- Table 15 Bluegrass pasture
- Table 16 Sorghum-sudan pasture

These recommended amounts are based on yield responses to broadcast applications in current conventional tillage

Table 2. The nutrient content of harvested crops used to calculate nutrient removal and recommended amounts of P₂O₅ and K₂O for optimum soil test category.

Crop	Unit of Yield	Pounds per unit of yield	
		P ₂ O ₅	K ₂ O
Corn	bu	0.375	0.30
Corn silage	bu grain equivalent	0.55	1.25
Corn silage	ton, 65% H ₂ O	3.50	6.50
Soybean	bu	0.80	1.50
Oat and straw	bu	0.40	1.00
Oat straw	ton	5.0	33.0
Wheat	bu	0.60	0.30
Wheat straw	ton	4.0	25.0
Sunflower	100 lb	0.80	0.70
Alfalfa	ton	12.50	40.0
Red clover	ton	10.0	33.0
Vetch	ton	12.0	47.0
Smooth bromegrass	ton	9.0	47.0
Orchardgrass	ton	14.0	68.0
Tall fescue	ton	12.0	66.0
Timothy	ton	9.0	32.0
Perennial ryegrass	ton	12.0	34.0
Sorghum-sudan	ton	12.0	38.0
Switch grass	ton	12.0	66.0

systems. Research is currently underway to determine if these recommendations should be modified for different methods of placement in no-till, ridge-till and conventional tillage systems. Until the current research indicates otherwise, the recommended amounts are for all

tillage systems and methods of placement.

Placement of fertilizer with corn seed is not generally recommended, but if it is done, limit the amount of N + K₂O to 10 pounds or less per acre. If soils are sandy or dry, reduce the amount of N +

K₂O by one-half. It is recommended that no fertilizer be placed in contact with soybean seed.

Micronutrients

Iowa State University recommends only zinc for corn based on soil testing. The zinc soil test has been calibrated on Iowa soils. Zinc recommendations for corn are given in Table 5. Soil test procedures for the other micronutrients have not been calibrated because of either lack of or inconsistency of occurrence of deficiencies with the exception of iron deficiency on soybean. Iron deficiency on soybean occurs on high pH (calcareous) soils in central and north central Iowa and can be predicted by soil occurrence as shown in soil survey reports. Development of soybean varieties tolerant to low iron availability in calcareous soils has been an acceptable solution to the problem.

Limestone

Limestone recommendations are given in pounds of pure fine calcium carbonate (CaCO₃) as given in Table 17. This recommendation is equal to pounds of effective calcium carbonate equivalent (ECCE) that is determined for all

agricultural limestone sources in Iowa. Soil pH is to be used to determine whether or not to lime the soil. The SMP Buffer (also termed the Ohio Buffer) solution has been calibrated to determine the amount of lime to be applied to increase soil pH to a certain pH.

Recommendations are given to increase soil pH to 6.5 or to 6.9. Soil pH 6.0 is considered to be sufficient for grass pastures and grass haylands. Soil pH 6.9 is recommended for alfalfa. Soil pH 6.5 is considered to be sufficient for corn and soybean. Because of high pH subsoils in the Clarion-Nicollet-Webster, Galva-Pringhar-Sac, Moody, Ida-Monona, Marshall, and Luton-Onawa-Salix soil associations, soil pH 6.0 is considered sufficient for corn and soybean grown in these soil associations, but when liming is required, lime is recommended to raise soil pH to 6.5.

The amount of limestone recommended is adjusted for the depth of tillage which determines the volume of soil to be neutralized. The depth for no-till is considered to be 2- to 3-inch depth unless specified otherwise.

Table 3. Phosphorus and potassium recommendations for corn grain production.

Phosphorus (P) Soil Test (ppm) *					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Bray P₁:					
Low Subsoil P	0-8	9-15	16-20	21-30	31+
High Subsoil P	0-5	6-10	11-15	16-20	21+
Olsen P:					
Low Subsoil P	0-5	6-10	11-14	15-20	21+
High Subsoil P	0-3	4-7	8-11	12-15	16+
P₂O₅ to apply (lb/acre)					
	100	75	50	0	0

Potassium (K) Soil Test (ppm) *					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Ammonium Acetate Extractable K:					
Low Subsoil K	0-60	61-90	91-130	131-170	171+
High Subsoil K	0-40	41-80	81-120	121-160	161+
K₂O to apply (lb/acre)					
Fine Textured	120	90	40	0	0
Sandy Textured	100	70	40	0	0

* The recommended amounts of P₂O₅ and K₂O for the optimum soil test category are based on nutrient removal for the reported yield. The amounts shown in the table for the optimum soil test category are for 140 bu corn grain per acre, which will be used if no yields are given on information sheet.

Recommendation for soils with a corn suitability rating (CSR) of 30 or less will be based on expected crop yield and nutrient removal for soil test categories of optimum or lower.

Although P₂O₅ and K₂O are not recommended at high soil test category, a small amount equivalent to that contained in 100 pounds of a common complete NPK grade, applied as a starter fertilizer banded to the side and below the seed row, may be advantageous under conditions of limited soil drainage, cool soil conditions, or crop residues on the soil surface. None is recommended for the very high soil test category.

Table 4. Phosphorus and potassium recommendations for corn silage or sorghum silage production.

Phosphorus (P) Soil Test (ppm)*					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Bray P_i:					
Low Subsoil P	0-8	9-15	16-20	21-30	31+
High Subsoil P	0-5	6-10	11-15	16-20	21+
Olsen P:					
Low Subsoil P	0-5	6-10	11-14	15-20	21+
High Subsoil P	0-3	4-7	8-11	12-15	16+
P₂O₅ to apply (lb/acre)					
	105	90	75	0	0

Potassium (K) Soil Test (ppm) *					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Ammonium Acetate Extractable K:					
Low Subsoil K	0-60	61-90	91-130	131-170	171+
High Subsoil K	0-40	41-80	81-120	121-160	161+
K₂O to apply (lb/acre)					
Fine Textured	220	200	175	0	0
Sandy Textured	200	180	175	0	0

* The recommended amounts of P₂O₅ and K₂O for the optimum soil test category are based on nutrient removal for the reported yield. The amounts shown in the table for the optimum soil test category are for 140 bu corn grain equivalent per acre, which will be used if no yields are given on information sheet, or approximately 20 tons corn silage per acre.

Recommendation for soils with a corn suitability rating (CSR) of 30 or less will be based on expected crop yield and nutrient removal for soil test categories of optimum or lower.

Although P₂O₅ and K₂O are not recommended for the high soil test category, a small amount equivalent to that contained in 100 pounds of a common complete NPK grade, applied as a starter fertilizer banded to the side and below the seed row, may be advantageous under conditions of limited soil drainage, cool soil conditions, or crop residues on the soil surface. None is recommended for the very high soil test category.

Table 5. Zinc recommendations for corn and sorghum production.

Zinc (Zn) Soil Test (ppm)			
Soil Test Category:	Low	Marginal	Adequate
DTPA Extractable Zn:			
	0-0.4	0.5-0.8	0.9+
	Zn to apply broadcast (lb/acre)		
	10	5	0
	Zn to apply in band (lb/acre) *		
	2	1	0

* Recommendation for amount to apply in band is based on other states' information.

Table 6. Phosphorus and potassium recommendations for soybean production.

Phosphorus (P) Soil Test (ppm)*					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Bray P_i:					
Low Subsoil P	0-8	9-15	16-20	21-30	31+
High Subsoil P	0-5	6-10	11-15	16-20	21+
Olsen P:					
Low Subsoil P	0-5	6-10	11-14	15-20	21+
High Subsoil P	0-3	4-7	8-11	12-15	16+
P₂O₅ to apply (lb/acre)					
	80	60	40	0	0

Potassium (K) Soil Test (ppm) *					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Ammonium Acetate Extractable K:					
Low Subsoil K	0-60	61-90	91-130	131-170	171+
High Subsoil K	0-40	41-80	81-120	121-160	161+
K₂O to apply (lb/acre)					
Fine Textured	90	75	65	0	0
Sandy Textured	80	65	65	0	0

* The recommended amounts of P₂O₅ and K₂O for the optimum soil test category are based on nutrient removal for the reported yield. The amounts shown in the table for the optimum soil test category are for 45 bu soybean per acre, which will be used if no yields are given on information sheet.

Recommendation for soils with a corn suitability rating (CSR) of 30 or less will be based on crop yield and nutrient removal for soil test categories of optimum or lower.

Table 7. Phosphorus and potassium recommendations for alfalfa and alfalfa-grass hay production.

Phosphorus (P) Soil Test (ppm) *					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Bray P_i:					
All Subsoil P Levels	0-15	16-20	21-25	26-30	31+
Olsen P:					
All Subsoil P Levels	0-10	11-14	15-17	18-20	21+
P₂O₅ to apply (lb/acre)					
	110	80	60	0	0

Potassium (K) Soil Test (ppm) *					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Ammonium Acetate Extractable K:					
Low Subsoil K	0-60	61-90	91-130	131-170	171+
High Subsoil K	0-40	41-80	81-120	121-160	161+
K₂O to apply (lb/acre)					
All Soil Textures	300	240	200	0	0

* 30 lb. P₂O₅ is recommended at seeding time regardless of soil test category. The recommended amounts of P₂O₅ and K₂O for the optimum soil test category are based on nutrient removal for the reported yield. The amounts shown in the table for the optimum soil test category are for 5 ton per acre harvested yield, which will be used if no yields are given on information sheet.

Recommendations for soils with a corn suitability rating (CSR) of 30 or less will be based on nutrient removal of the expected crop yield for soil test categories of optimum or lower.

Table 8. Phosphorus and potassium recommendations for oat grain and straw production with a forage seeding.

Phosphorus (P) Soil Test (ppm)*					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Bray P_i:					
Low Subsoil P	0-8	9-15	16-20	21-30	31+
High Subsoil P	0-5	6-10	11-15	16-20	21+
Olsen P:					
Low Subsoil P	0-5	6-10	11-14	15-20	21+
High Subsoil P	0-3	4-7	8-11	12-15	16+
P₂O₅ to apply (lb/acre)					
	90	70	35	0	0

Potassium (K) Soil Test (ppm)*					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Ammonium Acetate Extractable K:					
Low Subsoil K	0-60	61-90	91-130	131-170	171+
High Subsoil K	0-40	41-80	81-120	121-160	161+
K₂O to apply (lb/acre)					
Fine Textured	150	120	90	0	0
Sandy Textured	130	100	80	0	0

* If alfalfa is being established for forage production in following years, 30 lb. P₂O₅ is recommended at seeding time regardless of soil test category.

The recommended amounts of P₂O₅ and K₂O for the optimum soil test category are based on nutrient removal for the reported yield. The amounts shown in the table for the optimum soil test category are for 80 bu oat grain per acre and straw with a forage seeding, which will be used if no yields are given on information sheet.

Recommendation for soils with a corn suitability rating (CSR) of 30 or less will be based on nutrient removal of the expected crop yield for soil test categories of optimum or lower.

Table 9. Phosphorus and potassium recommendations for oat grain and straw production with no forage seeding.

Phosphorus (P) Soil Test (ppm)*					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Bray P_i:					
Low Subsoil P	0-8	9-15	16-20	21-30	31+
High Subsoil P	0-5	6-10	11-15	16-20	21+
Olsen P:					
Low Subsoil P	0-5	6-10	11-14	15-20	21+
High Subsoil P	0-3	4-7	8-11	12-15	16+
P₂O₅ to apply (lb/acre)					
	50	40	30	0	0

Potassium (K) Soil Test (ppm) *					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Ammonium Acetate Extractable K:					
Low Subsoil K	0-60	61-90	91-130	131-170	171+
High Subsoil K	0-40	41-80	81-120	121-160	161+
K₂O to apply (lb/acre)					
All Soil Textures	90	85	80	0	0

*The recommended amounts of P₂O₅ and K₂O for the optimum soil test category are based on nutrient removal for the reported yield. The amounts shown in the table for the optimum soil test category are for 80 bu oat grain per acre and straw, which will be used if no yields are given on information sheet.

Table 10. Phosphorus and potassium recommendations for wheat production.

Phosphorus (P) Soil Test (ppm) *					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Bray P_i:					
All Subsoil P Levels	0-15	16-20	21-25	26-30	31+
Olsen P:					
All Subsoil P Levels	0-10	11-14	15-17	18-20	21+
P₂O₅ to apply (lb/acre)					
	60	50	30	0	0

Potassium (K) Soil Test (ppm) *					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Ammonium Acetate Extractable K:					
Low Subsoil K	0-60	61-90	91-130	131-170	171+
High Subsoil K	0-40	41-80	81-120	121-160	161+
K₂O to apply (lb/acre)					
All Soil Textures	60	40	15	0	0

*The recommended amounts of P₂O₅ and K₂O for the optimum soil test category are based on nutrient removal for the reported yield. The amounts shown in the table for the optimum soil test category are for 50 bu wheat per acre, which will be used if no yields are given on information sheet.

Table 11. Phosphorus and potassium recommendations for sunflower.

Phosphorus (P) Soil Test (ppm) *					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Bray P_i:					
Low Subsoil P	0-8	9-15	16-20	21-30	31+
High Subsoil P	0-5	6-10	11-15	16-20	21+
Olsen P:					
Low Subsoil P	0-5	6-10	11-14	15-20	21+
High Subsoil P	0-3	4-7	8-11	12-15	16+
P₂O₅ to apply (lb/acre)					
	70	50	15	0	0

Potassium (K) Soil Test (ppm)*					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Ammonium Acetate Extractable K:					
Low Subsoil K	0-60	61-90	91-130	131-170	171+
High Subsoil K	0-40	41-80	81-120	121-160	161+
K₂O to apply (lb/acre)					
All Soil Textures	80	50	15	0	0

* The recommended amounts of P₂O₅ and K₂O for the optimum soil test category are based on nutrient removal for the reported yield. The amounts shown in the table for the optimum soil test category are for 2,000 lb per acre seed yield, which will be used if no yields are given on information sheet.

Table 12. Phosphorus and potassium recommendations for legume-grass pasture.

Phosphorus (P) Soil Test (ppm)					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Bray P_i:					
Low Subsoil P	0-8	9-15	16-20	21-30	31+
High Subsoil P	0-5	6-10	11-15	16-20	21+
Olsen P:					
Low Subsoil P	0-5	6-10	11-14	15-20	21+
High Subsoil P	0-3	4-7	8-11	12-15	16+
P₂O₅ to apply (lb/acre)					
	70	50	40	0	0

Potassium (K) Soil Test (ppm)					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Low Subsoil K	0-60	61-90	91-130	131-170	171+
High Subsoil K	0-40	41-80	81-120	121-160	161+
K₂O to apply (lb/acre)					
All Soil Textures	90	70	50	0	0

Table 13. Phosphorus and potassium recommendations for tall cool-season grasses for pasture; bromegrass, orchardgrass, tall fescue, and reed canarygrass.

Phosphorus (P) Soil Test (ppm)					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Bray P_i:					
Low Subsoil P	0-8	9-15	16-20	21-30	31+
High Subsoil P	0-5	6-10	11-15	16-20	21+
Olsen P:					
Low Subsoil P	0-5	6-10	11-14	15-20	21+
High Subsoil P	0-3	4-7	8-11	12-15	16+
P₂O₅ to apply (lb/acre)					
	60	40	0	0	0

Potassium (K) Soil Test (ppm)					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Ammonium Acetate Extractable K:					
Low Subsoil K	0-60	61-90	91-130	131-170	171+
High Subsoil K	0-40	41-80	81-120	121-160	161+
K₂O to apply (lb/acre)					
All Soil Textures	80	60	0	0	0

Table 14. Phosphorus and potassium recommendations for warm season grasses for pasture and hay.

Phosphorus (P) Soil Test (ppm)					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Bray P_i:					
Low Subsoil P	0-8	9-15	16-20	21-30	31+
High Subsoil P	0-5	6-10	11-15	16-20	21+
Olsen P:					
Low Subsoil P	0-5	6-10	11-14	15-20	21+
High Subsoil P	0-3	4-7	8-11	12-15	16+
P₂O₅ to apply (lb/acre)					
	60	45	30	0	0

Potassium (K) Soil Test (ppm)					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Ammonium Acetate Extractable K:					
Low Subsoil K	0-60	61-90	91-130	131-170	171+
High Subsoil K	0-40	41-80	81-120	121-160	161+
K₂O to apply (lb/acre)					
All Soil Textures	80	60	30	0	0

Table 15. Phosphorus and potassium recommendations for blue-grass pasture.

Phosphorus (P) Soil Test (ppm)					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Bray P_i:					
All Subsoil P Levels	0-8	9-15	16-20	21-30	31+
Olsen P:					
All Subsoil P Levels	0-5	6-10	11-14	15-20	21+
P₂O₅ to apply (lb/acre)					
	40	30	0	0	0

Potassium (K) Soil Test (ppm)					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Ammonium Acetate Extractable K:					
All Subsoil K	0-60	61-90	91-130	131-170	171+
K₂O to apply (lb/acre)					
All Soil Textures	40	30	0	0	0

Table 16. Phosphorus and potassium recommendations for sorghum-sudan pasture.

Phosphorus (P) Soil Test (ppm)					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Bray P₁:					
Low Subsoil P	0-8	9-15	16-20	21-30	31+
High Subsoil P	0-5	6-10	11-15	16-20	21+
Olsen P:					
Low Subsoil P	0-5	6-10	11-14	15-20	21+
High Subsoil P	0-3	4-7	8-11	12-15	16+
P₂O₅ to apply (lb/acre)					
	60	40	0	0	0

Potassium (K) Soil Test (ppm)					
Soil Test Category:	Very Low	Low	Optimum	High	Very High
Ammonium Acetate Extractable K:					
Low Subsoil K	0-60	61-90	91-130	131-170	171+
High Subsoil K	0-40	41-80	81-120	121-160	161+
K₂O to apply (lb/acre)					
All Soil Textures	80	60	0	0	0

Table 17. Lime recommendations, based on SMP Buffer Test, are given in pounds of pure fine calcium carbonate (CaCO₃) to increase soil pH from its present level to pH 6.5 or 6.9 for the depth of soil to be neutralized.

Buffer pH	Depth of soil to be neutralized *							
	2 inch		3 inch		6 inch		8 inch	
	pH 6.5	pH 6.9	pH 6.5	pH 6.9	pH 6.5	pH 6.9	pH 6.5	pH 6.9
CaCO₃ to apply (lb/acre)								
7.0	0	400	0	600	0	1,100	0	1,500
6.9	0	600	0	1,000	0	1,900	0	2,500
6.8	200	900	300	1,400	600	2,700	800	3,600
6.7	400	1,200	700	1,800	1,300	3,500	1,700	4,700
6.6	700	1,500	1,100	2,200	2,100	4,400	2,800	5,900
6.5	900	1,700	1,400	2,600	2,800	5,200	3,700	6,900
6.4	1,200	2,000	1,800	3,000	3,500	6,000	4,700	8,000
6.3	1,400	2,300	2,100	3,400	4,200	6,800	5,600	9,100
6.2	1,700	2,600	2,500	3,900	5,000	7,700	6,700	10,300
6.1	1,900	2,800	2,900	4,300	5,700	8,500	7,600	11,400
6.0	2,200	3,100	3,200	4,700	6,400	9,300	8,600	12,400
5.9	2,400	3,400	3,600	5,100	7,100	10,100	9,500	13,500
5.8	2,600	3,700	4,000	5,500	7,900	11,000	10,600	14,700
5.7	2,900	3,900	4,300	5,900	8,600	11,800	11,500	15,900

* Soil pH 6.9 is recommended for alfalfa.

Soil pH 6.5 is considered to be sufficient for corn and soybean. Because of high pH subsoils in the Clarion-Nicollet-Webster, Galva-Primghar-Sac, Moody, Ida-Monona, Marshall, and Luton-Onawa-Salix soil associations, soil pH 6.0 is considered sufficient for corn and soybean grown in these soil associations, but when liming is required, lime to soil pH 6.5.

Soil pH 6.0 is sufficient for grass pastures and grass hayland.

Table 18. Subsoil phosphorus (P) and potassium (K) levels that are to be used to determine phosphorus and potassium nutrient recommendations for very low and low soil test levels for the major soil series in each of the twelve major soil areas in Iowa. Soil series of more than 5,000 acres and with a corn suitability rating of greater than 30 are listed.

Abbreviations used in the subsections of this table are as indicated:

- Sl: sandy loam
- Fsl: fine sandy loam
- L: loam
- Sil: silt loam
- Sicl: silty clay loam
- Sic: silty clay
- Cl: clay loam
- Mk-Sil: mucky silt loam
- Str Sub: stratified subsoil
- Sub: subsoil

- R: rock
- S&G: sand and gravel

- Calc: calcareous

- Surf: surface

- Complx, com, comp: complex

- W: west
- NW: northwest

A. Major soil area 1 that includes the Downs, Fayette, and Fayette-Dubuque-Stonyland soil associations.			
I. Loess derived soils			
Soil Name	Acres in Series	Sub P	Sub K
Arenzville	18,464	H	L
Bertrand	11,081	H	L
Caneek	8,388	H	L
Chaseburg	47,218	H	L
Chaseburg-Arenzvil Sil	52,334	H	L
Dorchester	25,133	H	L
Downs	590,213	H	L
Downs Benches	9,420	H	L
Fayette	1,299,360	H	L
Fayette Benches	6,010	H	L
Festina	5,944	H	L
Huntsville	16,659	L	L
New Vienna	19,125	H	L
Orion	13,535	H	L
Orwood	31,942	H	L
Ossian	9,630	H	L
Otter-Worthen Sil	22,905	H	L
Palsgrove	5,255	H	L
Rozetta	16,915	H	L
Rozetta-Eleroy Sil	23,880	H	L
Watkins	5,844	H	H
Worthen	10,542	H	L
2. Till derived soils			
Soil Name	Acres in Series	Sub P	Sub K
Jacwin	9,585	L	L
Lamont	26,410	H	L
Rockton 20-40" To R	6,330	L	L
Waucoma	5,938	L	L

B. Major soil area 2 that includes the Dinsdale-Tama and Tama-Muscatine soil associations.			
Soil Name	Acres in Series	Sub P	Sub K
Ackmore-Colo Complex	64,395	H	L
Amana-Lawson-Perks	7,238	L	L
Atterberry	56,514	H	L
Atterberry Benches	11,385	H	L
Atterberry Sandy Sub	13,945	H	L
Bremer	37,013	H	H
Colo	195,324	H	L
Colo Overwash	65,852	H	L
Colo-Ely Sicl	333,363	H	L
Colo-Zook Sicl	9,435	H	L
Dinsdale	399,708	L	L
Downs Sandy Sub	16,560	H	L
Downs and Tama Sil	40,208	H	H
Fayette Sandy Sub	5,000	H	L
Franklin	43,277	H	L
Fruitfield	7,760	L	L
Garwin	79,062	L	L
Garwin Sandy Sub	5,450	L	L
Harpster Sicl	6,991	L	L
Judson	30,545	H	H
Kennebec Sil	8,776	H	H

Table continued in next column

(Continued from previous column)			
Soil Name	Acres in Series	Sub P	Sub K
Killduff	110,635	H	L
Klinger-Maxfield Sicl	8,980	L	L
Koszta	14,848	H	L
Lawson	34,437	H	L
Liscomb	10,375	L	L
Maxfield	99,620	L	L
Mt. Carroll	5,610	H	L
Muscatine	230,263	H	L
Muscatine Benches	8,006	H	L
Nevin	45,966	H	H
Nodaway	106,925	H	L
Nodaway-Arenzville Sil	25,042	H	L
Port Byron	10,160	H	L
Raddle	7,575	H	L
Richwood	13,158	H	L
Rowley	12,539	H	L
Sawmill	50,455	H	L
Sawmill-Garwin Sicl	35,937	L	L
Shaffton	16,820	H	L
Tama	875,985	H	L
Tama Benches	19,674	H	L
Tama Sandy Sub	23,777	H	L
Timula	12,575	H	L
Walford	24,350	H	L
Walford Benches	5,122	H	L
Waubeek	33,582	H	L
Waukegan	23,863	H	L
Whittier	9,805	H	L
Wiota	26,173	H	H
Zook Sic	10,094	H	L
Zook-Colo-Ely Complex	22,640	H	L

C. Major soil area 3 that includes the Otley-Mahaska-Taintor and Clinton-Keswick-Lindley soil associations.			
Soil Name	Acres in Series	Sub P	Sub K
Amana	22,693	H	L
Ambraw	19,945	H	L
Ambraw Rarely Flooded	5,560	H	L
Clinton	369,279	H	L
Clinton Benches	20,234	H	L
Colo Rarely Flooded	6,305	H	L
Ely	41,103	H	H
Givin	38,352	H	L
Hedrick	41,215	H	L
Inton	9,835	H	H
Kalona	21,415	L	L
Keomah	15,827	H	L
Klum	5,333	L	L
Ladoga	274,799	H	L
Ladoga Benches	14,609	H	L
Mahaska Sicl	194,321	H	H
Nira	72,929	H	L
Otley	285,220	H	L
Otley Benches	5,568	H	L
Otley-Nira Sicl	5,670	H	L
Sparta Variant	5,981	L	L
Sperry	13,886	H	H
Taintor	147,117	L	L
Tama-Dickinson Complex	12,429	L	L
Titus	5,340	H	L

D. Major soil area 4 that includes the Adair-Seymour, Grundy-Haig, Adair-Grundy-Haig, and Lindley-Keswick-Weller soil associations.			
Soil Name	Acres in Series	Sub P	Sub K
Appanoose	6,040	H	L
Arispe	107,577	L	L
Beckwith	7,755	H	L
Belinda	28,037	H	L
Caleb	19,890	L	L
Cantril	9,118	L	L
Chequest	17,540	H	L
Clearfield-Arispe Sicl	9,252	L	L
Coppock	27,690	H	L
Edina	105,834	L	L
Gara	442,227	H	L
Grundy	125,068	H	L
Grundy (Warren Co.)	7,200	H	L
Haig Sicl	7,722	H	L
Haig Sil	87,441	H	L
Humeston	7,357	H	L
Humeston West	24,534	H	L
Kennebec-Amana Sil	12,235	H	L
Kniffin	48,519	H	L
Lineville	17,487	L	L
Nodaway-Cantril Complx	71,343	L	L
Olmitz	38,304	L	H
Olmitz-Vesser-Colo Com	179,992	L	L
Pershing Sicl	48,475	H	L
Pershing Sicl Benches	12,234	H	L
Pershing Sil	138,315	H	L
Pershing Sil Benches	11,725	H	L
Seymour	125,992	H	L
Tuskeego	15,755	H	L
Vesser	43,853	H	L
Weller Sil	110,996	H	L

E. Major soil area 5 that includes the Shelby-Sharpsburg-Macksburg soil association.

Soil Name	Acres in Series	Sub P	Sub K
Ackmore	93,785	H	L
Bremer West	11,051	H	H
Clearfield	51,144	H	L
Clinton West	25,565	H	L
Colo West	151,916	H	L
Colo Overwash West	56,968	H	L
Colo-Judson-Nodaway	32,590	—	—
Ladoga Benches West	10,124	H	L
Ladoga West	165,304	H	L
Macksburg	95,834	H	H
Nevin West	23,185	H	H
Nira West	100,824	H	L
Nira-Sharpsburg Sicl	25,248	H	L
Sharpsburg	647,365	H	H
Sharpsburg Benches	17,769	H	H
Shelby	442,634	L	L
Wabash Sic	25,764	H	H
Wabash Sicl	27,104	H	H
Winterset	23,574	H	H
Zook Sicl	56,746	H	L
Zook Sil Overwash	8,599	H	L

F. Major soil area 6 that includes the Marshall soil association.

Soil Name	Acres in Series	Sub P	Sub K
Burchard	7,215	L	L
Calco	61,082	H	L
Colo-Ely Sicl West	614,740	H	L
Ely West	10,862	H	H
Exira	234,720	L	H
Judson West	135,285	H	H
Kennebec Overwash W	22,301	H	H
Kennebec West	127,427	H	H
Knox	5,257	H	H
Marshall	928,782	H	H
Marshall Benches	44,816	H	H
Minden Benches	6,673	H	H
Monona	51,680	L	L
Nodaway West	170,134	H	L
Zook Sicl West	95,424	H	L
Zook Sil Overwash West	18,813	H	L

G. Major soil area 7 that includes the Monona-IdaHamburg soil association.

Soil Name	Acres in Series	Sub P	Sub K
Castana Sil	5,575	L	L
Ida	536,150	L	L
Monona	681,910	H	L
Monona Benches	6,154	H	L
Napier	208,649	L	H

H. Major soil area 8 that includes the Luton-OnawaSalix soil association.

Soil Name	Acres in Series	Sub P	Sub K
Albaton Sic	40,535	L	H
Blake Sicl	17,080	L	H
Blencoe	9,410	L	H
Carr	5,920	L	H
Cooper Sicl	7,165	L	H
Forney	5,810	L	H
Grable Sil	7,945	L	H
Haynie	34,250	L	H
Keg	18,790	L	H
Kennebec-McPaul Sil	8,015	H	H
Lakeport	10,040	L	H
Luton Sic	54,365	L	H
Luton Sic Thin Surf	17,575	L	H
McPaul	70,800	H	H
McPaul-Kennebec Sil	29,410	H	H
Modale Sil	8,505	L	H
Moville	6,710	H	H
Napier-Castana Sil	13,545	L	L
Napier-Kenn-Nod Sil	55,790	L	L
Onawa Sic	21,590	L	H
Percival	6,215	L	H
Salix	19,065	L	H
Woodbury	9,135	L	H

I. Major soil area 9 that includes the Galva-Primghar-Sac soil association.			
Soil Name	Acres in Series	Sub P	Sub K
Ackmore	7,535	H	L
Afton	45,552	L	L
Allendorf	5,520	L	L
Bolan	8,117	L	L
Colo NW	80,827	H	L
Colo-Ely Sicl NW	28,610	H	L
Davis L	5,970	H	L
Ely NW	7,235	H	H
Everly	59,439	L	L
Galva	1,066,817	L	L
Galva Benches	67,332	L	L
Galva Str Sub	15,715	L	L
Judson NW	7,255	H	H
Kennebec Sicl	27,810	H	H
Letri	16,741	L	L
Letri Calc	5,445	L	L
Marcus	159,279	L	L
Millington	5,418	L	L
Ocheyedan	16,123	L	H
Primghar	366,779	L	L
Radford	63,095	H	L
Ransom	12,555	L	L
Sac Clay Loam Sub	40,583	L	L
Sac Loam Sub	129,015	L	L
Spicer	7,195	L	L
Spillco	11,195	H	L
Spillville NW	7,960	L	L
Terril NW	9,280	L	L
Wadena 24-32" To S&G NW	5,910	L	L
Wilmington Cl	24,494	L	L
Wilmington Sicl	23,815	L	L

J. Major soil area 10 that includes the Moody soil association.			
Soil Name	Acres in Series	Sub P	Sub K
Crofton	6,095	L	L
Egan	17,620	L	L
Moody	153,555	L	L
Moody Loamy Sub	5,015	L	L
Trent	13,100	L	L

K. Major soil area 11 that includes the Clarion-Nicollet-Webster soil association.			
Soil Name	Acres in Series	Sub P	Sub K
Biscay 32-40" To S&G	55,099	L	L
Blue Earth	16,208	L	L
Bode	56,321	L	L
Brownton	57,027	L	L
Canisteo	1,034,003	L	L
Clarion	1,682,880	L	L
Clarion Long Slopes	27,830	L	L
Clarion-Storden Loams	82,451	L	L
Coland	163,838	H	L
Coland-Spillville Comp	20,927	L	L
Coland-Terril Complex	48,964	L	L
Collinwood	19,024	L	L
Crippin	40,208	L	L
Cylinder 24-32" To S&G	15,894	L	L
Cylinder 32-40" To S&G	43,471	L	L
Table continued in next column			

(Continued from previous column)			
Soil Name	Acres in Series	Sub P	Sub K
Dickman	15,958	L	L
Estherville L	15,657	L	L
Fieldon	11,369	L	L
Fostoria	8,731	L	H
Guckeen	11,452	L	L
Hanlon	12,246	L	L
Hanska	5,325	L	L
Harcot	23,090	L	L
Harps	277,222	L	L
Havelock	13,735	L	L
Hayden	44,864	H	L
Kilkenny	18,660	H	L
Knoke Mk-Sil	10,685	L	L
Knoke Sicl	13,445	L	L
Kossuth	76,968	L	L
Le Sueur	17,701	H	L
Lester	124,099	H	L
Lester Long Slopes	5,050	H	L
Linder 24-32" To S&G	8,683	L	L
Luther	8,684	H	L
Marna	23,015	L	L
Mayer 24-32" To S&G	7,472	L	L
Mayer 32-40" To S&G	5,620	L	L
Moingona	6,221	H	L
Nicollet	1,145,924	L	L
Okoboji Mk-Sil	71,876	L	L
Table continued in next column			

(Continued from previous column)			
Soil Name	Acres in Series	Sub P	Sub K
Okoboji Sicl	263,628	L	L
Okoboji-Harps Complex	40,650	L	L
Ottosen	72,172	L	L
Ridgeport	21,542	H	H
Rolfe	9,370	L	H
Spicer	5,882	L	L
Spillville	30,085	L	L
Storden	146,599	L	L
Talcot 32-40" To S&G	45,660	L	L
Terril West	33,982	L	L
Truman Str Sub	7,020	H	L
Vinje	6,836	L	L
Wacousta	21,677	L	L
Wadena 24-32" To S&G	86,039	L	L
Wadena 32-40" To S&G	36,185	L	L
Waldorf	24,575	L	L
Webster	974,295	L	L
Webster-Nicollet Comp	77,907	L	L
Zenor	16,995	H	L

L. Major soil area 12 that includes the Kenyon-Floyd-Clyde and Cresco-Lourdes-Clyde soil associations.			
Soil Name	Acres in Series	Sub P	Sub K
Ansgar	12,080	L	L
Aredale	39,374	L	L
Ashdale	6,255	H	L
Table continued in next column			

(Continued from previous column)			
Soil Name	Acres in Series	Sub P	Sub K
Atkinson	6,978	L	L
Bassett	148,506	H	L
Bolan	44,492	L	L
Burkhardt-Saude Complx	7,276	L	L
Clyde	382,738	L	L
Clyde-Floyd Complex	318,086	L	L
Coggon	7,078	H	L
Coland-Spillville Comp	29,291	L	L
Cresco	39,378	L	L
Cresken	8,350	L	L
Dickinson Loamy Sub	16,775	L	L
Dickinson Fsl	116,855	L	L
Dickinson-Ostrander	5,039	L	L
Dinsdale	26,395	L	L
Donnan	24,976	L	L
Flagler	50,104	L	L
Floyd	257,058	L	L
Hayfield 24-32" To S&G	23,484	H	L
Hayfield 32-40" To S&G	9,739	H	L
Hoopeston Fsl & Sl	10,649	L	L
Jameston	6,484	L	L
Kenyon	599,884	L	L
Klinger	146,264	L	H
Lawler 24-32" To S&G	40,252	L	L
Lawler 32-40" To S&G	60,231	L	L
Lourdes	19,330	L	L
Marshan 24-32" To S&G	27,524	L	L
Table continued in next column			

(Continued from previous column)			
Soil Name	Acres in Series	Sub P	Sub K
Marshan 32-40" To S&G	94,080	L	L
Olin	63,200	L	L
Oran	83,395	L	L
Ostrander	94,498	L	L
Palms	49,903	L	L
Protivin	34,767	L	L
Racine	45,536	L	L
Readlyn	200,296	L	L
Riceville	13,283	L	L
Rockton 20-30" To R	42,235	L	L
Rockton 30-40" To R	22,146	L	L
Rossfield	8,075	H	L
Sattre	8,986	L	L
Saude	138,450	L	L
Schley	61,513	L	L
Seaton	12,376	H	L
Shandep	5,161	L	L
Sparta	138,673	L	L
Sparta Loamy Sub	5,540	L	L
Spillville	71,025	L	L
Terril	24,220	L	L
Tripoli	102,534	L	L
Turlin	7,712	L	L
Udolpho 24-32" To S&G	5,105	H	L
Udolpho 32-40" To S&G	8,925	H	L
Wapsie	55,618	H	L
Waukee	69,092	H	L
Whalan 20-30" To R	5,448	H	L
Winneshiek 20-30" To R	27,512	H	L

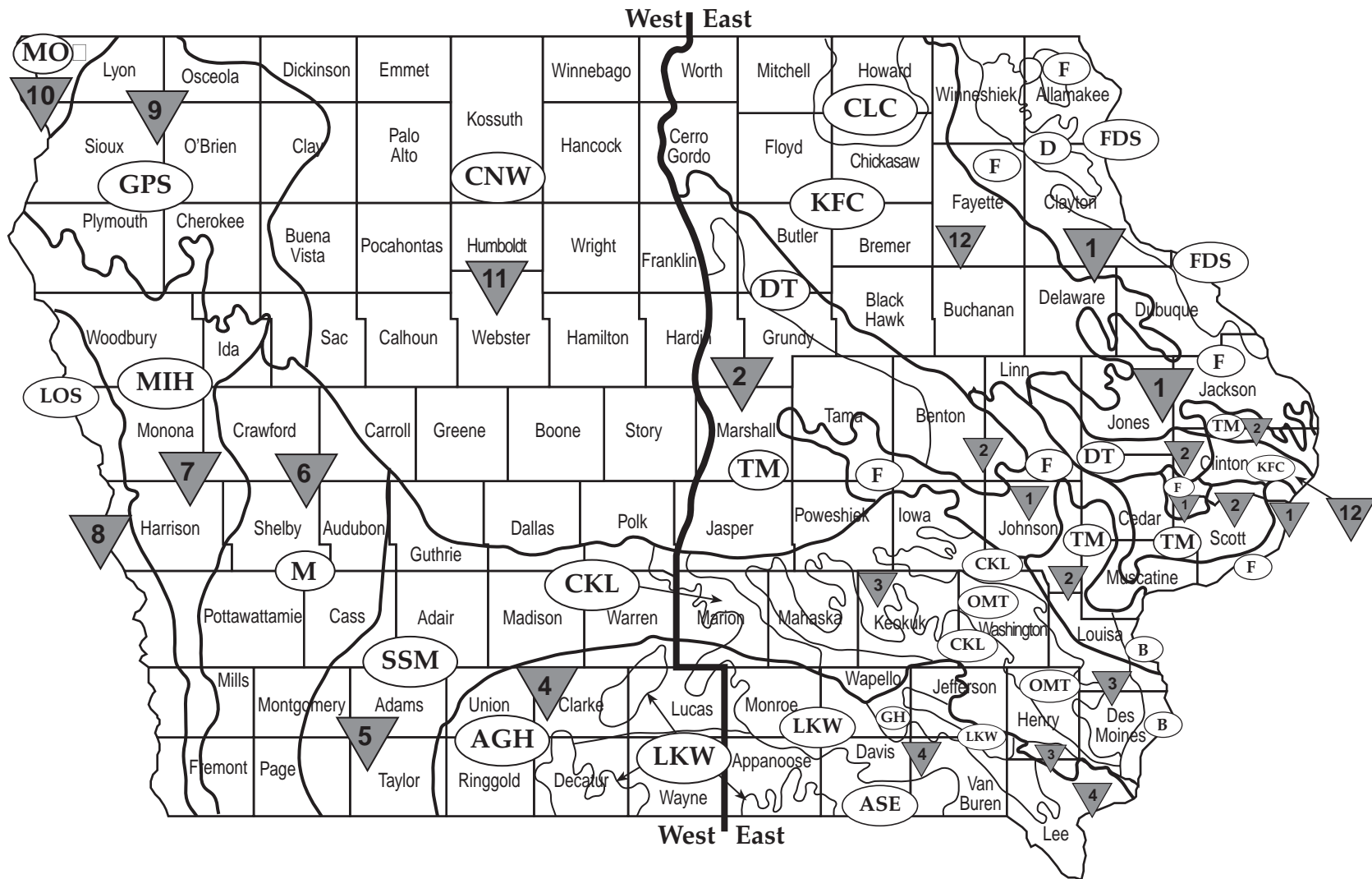


Figure 1. Map of Iowa delineating the 21 principal soil association areas (letters) and the 12 major soil areas (numbers). B designates the Mississippi bottomland.

- | | | | |
|-------------------------------|--------------------------------|-----------------------------|----------------------------------|
| AGH: Adair-Grundy-Haig | D: Downs | GH: Grundy-Haig | MIH: Monona-Ida-Hamburg |
| ASE: Adair-Seymour-Edina | DT: Dinsdale-Tama | KFC: Kenyon-Floyd-Clyde | Mo: Moody |
| CKL: Clinton-Keswick-Lindley | F: Fayette | LKW: Lindley-Keswick-Weller | OMT: Otley-Mahaska-Taintor |
| CLC: Cresco-Lourdes-Clyde | FDS: Fayette-Dubuque-Stonyland | LOS: Luton-Onawa-Salix | SSM: Shelby-Sharpsburg-Macksburg |
| CNW: Clarion-Nicollet-Webster | GPS: Galva-Primghar-Sac | M: Marshall | TM: Tama-Muscatine |

Tables and Figures

- Table 1. Interpretation of soil test values for phosphorus (P) determined by Bray P₁ extractant or Olsen extractant and potassium (K) determined by ammonium acetate extractant for surface soil samples (6 to 7-inch deep cores). Page 3
- Table 2. The nutrient content of harvested crops used to calculate nutrient removal and recommended amounts of P₂O₅ and K₂O for optimum soil test category. Page 4
- Table 3. Phosphorus and potassium recommendations for corn grain production. Page 5
- Table 4. Phosphorus and potassium recommendations for corn silage or sorghum silage production. Page 6
- Table 5. Zinc recommendations for corn and sorghum production. Page 6
- Table 6. Phosphorus and potassium recommendations for soybean production. Page 7
- Table 7. Phosphorus and potassium recommendations for alfalfa and alfalfa-grass hay production. Page 7
- Table 8. Phosphorus and potassium recommendations for oat grain and straw production with a forage seeding. Page 8
- Table 9. Phosphorus and potassium recommendations for oat grain and straw production with no forage seeding. Page 8
- Table 10. Phosphorus and potassium recommendations for wheat production. Page 9
- Table 11. Phosphorus and potassium recommendations for sunflower. Page 9
- Table 12. Phosphorus and potassium recommendations for legume-grass pasture. Page 10
- Table 13. Phosphorus and potassium recommendations for tall cool-season grasses for pasture; bromegrass, orchardgrass, tall fescue, and reed canarygrass. Page 10
- Table 14. Phosphorus and potassium recommendations for warm season grasses for pasture and hay. Page 11
- Table 15. Phosphorus and potassium recommendations for bluegrass pasture. Page 11
- Table 16. Phosphorus and potassium recommendations for sorghum-sudan pasture. Page 12
- Table 17. Lime recommendations, based on SMP Buffer Test, are given in pounds of pure fine calcium carbonate (CaCO₃) to increase soil pH from its present level to pH 6.5 or 6.9 for the depth of soil to be neutralized. Page 12
- Table 18. Subsoil phosphorus (P) and potassium (K) levels that are to be used to determine phosphorus and potassium nutrient recommendations for very low and low soil test levels for the major soil series in each of the twelve major soil areas in Iowa. Soil series of more than 5,000 acres and with a corn suitability rating of greater than 30 are listed. Pages 13–17
- Figure 1. Map of Iowa delineating the 21 principal soil association areas (letters) and the 12 major soil areas (numbers). B designates the Mississippi bottomland. Page 18

 File: Agronomy 8-2



... and justice for all

The Iowa Cooperative Extension Service's programs and policies are consistent with pertinent federal and state laws and regulations on nondiscrimination. Many materials can be made available in alternative formats for ADA clients.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Stanley R. Johnson, director, Cooperative Extension Service, Iowa State University of Science and Technology, Ames, Iowa.