

CROP FERTILIZATION ON EAST TEXAS SOILS

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This land resource area, Figure 1, includes 16 million acres of forest, pasture and cropland. Elevation ranges from 200 to 700 feet with an annual rainfall from 40 to 56 inches.

Soil Characteristics

Upland soils range from light brown to red. Topsoil is usually sandy with sandy loam to clay subsoils. A limited acreage is poorly drained. Because of their sandy texture, the water-holding capacity of these soils is low. However, rainfall is distributed reasonably well throughout the growing season. These soils are relatively easily managed and responsive to good management.

Soil Fertility Levels

Most of East Texas soils are acid and low in major plant nutrients. As shown in Table 1, 79 percent of samples tested were low in phosphorus; and 61 percent were low in potassium. In addition to low fertility, 42 percent were below pH 6.0. Returns for money invested in limestone and fertilizer depend on cropping and management systems. Much East Texas land is used for pasture. Thus higher fertilization generally means higher per acre production which requires better grazing management to utilize the additional forage.

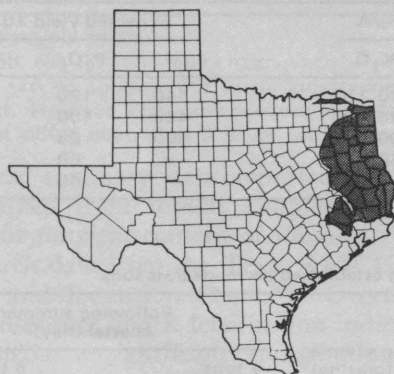


Figure 1. Location of East Texas region

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Table 1. Percentage distribution of East Texas soils in five ranges for phosphorus, potassium, magnesium and pH.

Soil test level	Percent of samples at each level				
	Phosphorus	Potassium	Magnesium	Soil pH range	Percent
VL	58	14	—	Below 5.0	3
L	21	47	18	5.1 - 5.5	12
M	14	22	53	5.6 - 6.0	27
H	5	14	29	6.1 - 6.5	30
VH	2	3	—	Above 6.5	28

Source of Nitrogen

Differences between sources of nitrogen have generally been small. However, with the high and varying cost per pound of N, efficiency becomes more important and small differences must be recognized. The time and method of application can affect the results from any given source of N.

Applying nitrogen just prior to the period of peak requirement has generally given the most efficient utilization by crops. Suggestions and limitations regarding methods for applying some sources of N are as follows:

1. Urea or mixtures containing urea should be put in the soil.
2. Solutions containing urea should not be sprayed on vegetation. Dribbling on the soil surface is preferred.
3. Where surface applications of lime have been made within 6 months prior to fertilization, the nitrogen material (especially urea and ammonium sulfate) should be put in the soil.
4. Urea is less acidifying than other ammonium sources.

N, P₂O₅ and K₂O for Major Crops

The wide range in soil fertility levels of East Texas soils calls for management practices and fertilization adapted to specific production requirements. Soil tests, properly calibrated to express available nutrients and correlated with crop response, are the best guide to profitable fertilization. Two important criteria needed for selecting the profitable rate of a nutrient are: (1) the level of available nutrient in the soil, and (2) the expected yield or production goal.

Many soil properties, as well as the amount of extractable nutrients, must be evaluated in grouping soils as a means of expressing the level of available nutrients. The expected yield expresses potential productivity to include anticipated moisture and management conditions.

Suggested rates of N, P₂O₅ and K₂O for varying soil test levels and expected crop yields are shown in Tables 2 through 12. These levels are based on Texas A&M University soil testing methods and calibrations. To use these tables, determine the soil test level in the left column and read across to the expected yield column for the rate of nutrient. For example, in Table 3 a soil very low (VL) in nitrogen, low (L) in phosphorus and very low (VL) in potassium would show a need for 400-80-200 for 8 tons of Coastal bermudagrass.

Table 2. Application rates of nutrients for establishing coastal bermudagrass

Soil test level	At sprigging			First summer		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
VL	40	100	70-90	40	0	40-60
L	30	80	60-80	30	0	30-50
M	30	60	50-70	30	0	0
H	—	0	0	—	0	0
VH	—	0	0	—	0	0

Table 4. Application rates of nutrients for summer perennial grass maintenance (common bermuda, bahia, etc.)—two production levels.¹

Soil test level	2 tons/A			4 tons/A		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
VL	80	40	30-50	180	60	90-110
L	60	30	30-40	160	40	50-90
M	40	0	0	120	20	0-50
H	—	0	0	—	0	0
VH	—	0	0	—	0	0

¹ If a legume such as crimson is planted, apply P₂O₅ and K₂O in the fall and delay nitrogen until that furnished by clover is used.

Table 3. Application rates of nutrients for three levels of coastal bermudagrass hay production.*

level	Expected yield 6 tons/A			Expected yield 8 tons/A			Expected yield 10 tons/A		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
VL	280	80	140-180	400	100	180-220	540	120	220-260
L	220	60	80-120	340	80	140-180	480	100	180-220
M	160	40	50-70	280	60	100-140	400	80	140-180
H	—	0	0	—	40	60-100	—	60	80-120
VH	—	0	0	—	0	0	—	40	0-80

*Would be similar for other perennial grasses.

Table 5. Application rates of nutrients for crimson clover, vetch or similar legumes in established bermudagrass sods.

Soil test level	Crimson clover fall planting ¹			Following summer common (grazing) ²	Following summer coastal (hay) ³		
	N	P ₂ O ₅	K ₂ O		4 tons		6 tons
				N	P ₂ O ₅	K ₂ O	
VL	25	100	100	120	120	180	80
L	20	80	80	100	100	140	60
M	0	60	60	80	80	120	0
H	—	0	0	—	—	—	0
VH	—	0	0	—	—	—	0

¹ Omit N and use about ½ the rate of P₂O₅ for vetch and peas. Reduce further for 16- to 20-inch drill spacing.

² One a.u./A.

³ Four tons production for grazing represents about 1 a.u./A.

Table 6. Application rates of nutrients for ryegrass, oats and similar winter grasses (no legume).¹

Soil test level	2 tons/A			4 tons/A		
	N ²	P ₂ O ₅	K ₂ O	N ²	P ₂ O ₅	K ₂ O
VL	100	40	40-60	220	80	90-110
L	80	30	30-40	160	60	70-90
M	60	20	0-30	120	40	50-70
H	—	0	0	—	30	0
VH	—	0	0	—	0	0

¹ Grazing period about 6 months.

² Divide N into 2 or 3 applications.

Table 7. Application rates of nutrients for seeding and maintenance of S₁ Louisiana white clover-grass pasture.

Soil test level	At or before planting			Grazing maintenance ¹		
	N	P ₂ O ₅	K ₂ O	N ³	P ₂ O ₅	K ₂ O
VL	30	120	180-220 ²	0	80	180-220
L	25	100	120-160 ²	0	60	130-170
M	20	80	90-110	0	40	80-120
H	—	60	40-80	—	0	50-70
VH	—	0	0	—	0	0

¹ Annual topdressing after first year.

² May apply half the next spring after seeding.

³ Nitrogen topdressing may be needed in midseason depending on management and grazing requirements.

Calcium, Magnesium and Sulfur

In East Texas a high proportion of the soils are low in calcium, especially if not limed. However, a good liming program will supply adequate calcium for crops.

Many of the deep, highly leached, acid, sandy soils are low in magnesium. The most economical method of applying magnesium is through the use of magnesium limestone. For soils low in magnesium, the limestone should contain at least 10 percent magnesium carbonate. The need for magnesium can be determined from a soil test.

Yield responses from applications of sulfur have been obtained on some East Texas soils. This has occurred with Coastal bermudagrass grown on deep

Table 8. Application rates of nutrients for corn—three production levels.

Soil test level	60 to 70 bu/A			70 to 80 bu/A			90 to 100 bu/A		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
VL	80	60	50-70	100	70	70-90	140	80	80-120
L	60	50	30-50	80	60	50-70	120	70	70-90
M	40	40	0-20	60	50	30-50	100	60	50-70
H	—	0	0	—	30	0	—	40	30-50
VH	—	0	0	—	0	0	—	0	0

Table 9. Application rates of nutrients for cotton—three production levels.

Soil test level	Expected yield 1 bale/A			Expected yield 1½ bale/A			Expected yield 2 bales/A		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
VL	60	60	70-90	80	80	80-120	100	100	100-140
L	40	50	50-70	60	70	70-90	80	80	80-120
M	0	40	30-50	40	60	50-70	60	70	60-100
H	—	30	20-30	—	40	30-50	—	60	50-70
VH	—	0	0	—	0	0	—	0	0

sandy soils under high nitrogen fertilization with adequate phosphorus and potassium. Since a satisfactory soil test for sulfur is not available, the use of *sulfur-containing fertilizers* should be based on trial plots, observations of deficiency symptoms and plant composition. Many mixed fertilizers are formulated from materials containing sulfur. This is one of the most economical methods of sulfur fertilization.

Sulfur deficiency causes plants to lack chlorophyll and appear light green. This can be confused with nitrogen deficiency. Sulfur fertilization should not be considered unless the supply of nitrogen is adequate.

Where sulfur is needed, the following rates should be considered:

Source	Annual rate lb./acre
Ammonium sulfate*	400
Calcium sulfate (gypsum)	300**
Elemental sulfur (very fine)	40***

*will also supply 84 lb. of N.

**Can apply 600 lb. every other year.

***Enough can be applied in a single application to last 2 to 3 years. However, high rates produce more acidity. One pound of sulfur neutralizes 3 lb. of calcium carbonate.

Soil test summary data reported in Table 1 were obtained from topsoil samples and do not indicate the nutrient content of subsoils. The fact that research data from the Texas A&M University Research and Extension Center at Overton show low responses to P and K fertilization indicates that subsoils make a significant contribution to the nutrient requirement of deep rooted crops such as Coastal bermudagrass. Fertility levels of subsoils must receive more consideration in soil sampling and fertilization.

Soil Testing

Soil tests provide the best method for evaluating fertility levels of soils. Obtaining the greatest benefit from soil tests involves the following:

1. *Good samples.* Composite samples to represent the plowlayer for cultivated fields and top 3 to 4 inches for perennial sods.

2. *Regular sampling plan.* Each field should be sampled at 2 to 4 year intervals, depending on the cropping system. Sampling ¼ to ½ of the farm each fall or winter is a good plan.

3. *Map and record.* A farm map with permanent field numbers serves as a permanent record to compare results from previous samples.

4. *Use results.* Be able to translate soil test results and suggested rates of plant nutrients and limestone into a profitable soil fertility program.

Table 10. Application rates of nutrients for grain sorghum—three production levels.

Soil test level	Expected yield 3,000 lb/A			Expected yield 4,000 lb/A			Expected yield 5,000 lb/A		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
VL	50	40	30-50	75	50	50-70	100	60	70-90
L	30	30	20-30	55	40	30-50	80	50	50-70
M	0	20	0-20	30	30	20-30	60	40	30-50
H	—	0	0	—	20	0-20	—	30	20-30
VH	—	0	0	—	0	0	—	0	0

Table 11. Application rates of nutrients for alfalfa.

Soil test level	New seeding			Annual maintenance		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
VL	30	200	180-220 ¹	0	100	180-220 ²
L	25	150	130-170 ¹	0	75	130-170 ²
M	0	100	80-120	0	50	80-120
H	—	50	40-60	—	25	40-60
VH	—	0	0	—	0	0

¹ Half may be applied next spring after seeding.

² Apply half after the second harvest.

Micronutrients

The micronutrient group includes seven elements—iron, zinc, manganese, copper, boron, molybdenum and chlorine. The greater availability of most micronutrients in acid soils and current low levels of production have caused micronutrient deficiencies to go unnoticed in East Texas. Problems may be encountered in small areas or under unusual soil conditions.

The principle involved in using micronutrients is the same as for other nutrients; to identify and confirm the need, then apply amounts sufficient to meet production requirements.

Table 12. Application rates for soybeans.¹

Soil test level	For the production of from 35 to 40 bu/A		
	N	P ₂ O ₅	K ₂ O
VL	0	60	70-100
L	0	40	50-70
M	0	20	30-50
H	—	0	0
VH	—	0	0

¹Inoculated soybeans can get nitrogen from the atmosphere. However, on new fields where soybeans have never been grown, up to 20 to 30 lb. of nitrogen per acre may be included in the fertilizer application to supply nitrogen until good inoculation is attained.

Conversion Factors

Fertilizers are labeled as percent P₂O₅ and K₂O and soil test values are reported in these terms. However, plant analyses results usually are reported as percentages of the element. For this reason, the following factors are presented for use in converting from one form to the other.

From P₂O₅ to P multiply P₂O₅ by .44

From P to P₂O₅ multiply P by 2.3

From K₂O to K multiply K₂O by .83

From K to K₂O multiply K by 1.2

Liming Acid Soils

The soil pH should be known before liming acid soils. In addition to pH, the cropping system and soil properties are considered in determining application rate.

The desirable pH to maintain in a soil is determined by the crops to be grown. Legumes are classified as high calcium or high pH crops and most non-legumes are low calcium or low pH crops.

Grain sorghum appears to be less tolerant to acidity than corn and grasses. An important means of raising the pH of an acid soil is to apply lime which converts aluminum and manganese to less soluble compounds. For desirable pH ranges for specific crops see L-164, Soil Reaction (pH) Ranges, available from the county Extension agents.

Rates and Types of Limestone

Once the soil pH is obtained from a reliable soil test and the desirable range determined for the crops being grown, three questions need answers. Does the soil need lime? What is the lime requirement? Should magnesium limestone be used? Lime requirement is defined as the amount of limestone needed to bring the pH into the desired range and/or maintain it for at least three years.

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Soils are limed to raise the pH and to keep them in this range for 3 to 5 years. Therefore, conditions that contribute to the development of acidity are considered in determining the lime requirement. Probably the most common contribution to the rapid development of acidity is the application of high rates of ammonium nitrogen. When ammonium is oxidized to nitrate by nitrifying bacteria, hydrogen is activated to produce acidity. Therefore, for each 100 pounds (N) of ammonium nitrogen to be applied, the lime requirement should increase about 300 pounds per acre. For example, the lime requirement for Coastal bermudagrass, to be fertilized with 300 pounds of N annually from ammonium nitrate (150 pounds of ammonium N), would be increased about 1,250 pounds of 1/2 ton during a 3-year period.

The major soil property influencing the lime requirement is the amount of clay expressed as soil texture. Clay contributes to the cation exchange capacity which determines the amounts of calcium and magnesium required to raise the pH. A general lime requirement guide is presented in Table 13.

Table 13. Rates of limestone.

Desired pH range ¹		Rates in tons/A		
High Ca crops	Low Ca crops	Sands	Sandy loams and loams	Clays and clay loams
6.0-6.4	5.8-6.2	1	1	1½
5.6-5.9	5.4-5.7	1	1½	2
5.0-5.5	5.0-5.3	2	3	4

¹High-calcium crops are legumes and legume-grass mixtures. The pH levels under low-calcium crops are for grasses and row crops.

Need for Magnesium Limestone

The best basis for deciding whether to use magnesium limestone is from soil test results for magnesium. Dolomitic or magnesium limestone is a mixture of calcium and magnesium carbonates. This liming material brings about a similar change in pH as calcitic limestone and supplies magnesium. It can be used on all soils but is most needed for those soils low in magnesium. Extractable magnesium and soil test ratings are shown in Table 14.

Table 14. Ratings for magnesium.

Lb./A Magnesium ¹	Soil test rating
0-75	Low ²
75-250	Medium
above 250	High

¹Refers to the soil testing methods and calibrations used by Texas A&M University.

²Limestone containing at least 10% magnesium carbonate should be used for soils low in this nutrient.