FACT SHEET

L-743

FIELD CROP FERTILIZATION ON TEXAS BLACKLAND AND GRAND PRAIRIE SOILS

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The Texas Blackland and Grand Prairie regions, indicated in figure 1, include 20 million acres of soils widely varied in characteristics. Most soils are upland, but more than 2 million acres of alluvial soils are included. Three-fourths of the Grand Prairie and about half the Blackland are rangeland.

Characteristics of Soils

Most soils are high in clay, and productivity generally is regulated by available moisture. When soils are dry, initial water intake is high. However, the presence of montmorillionitic-type clay results in swelling and closure of pores and cracks and a reduced infiltration rate during swelling.

The mineral and rock deposits from which these soils are formed are generally high in carbonates; therefore, soils have a high base status. Soils high in swelling clays require careful attention be given to a sound residue management program. This is essential for the maintenance of desirable soil structure and physical characteristics.

Soil Fertility Status

Soil characteristics, past fertilization and cropping practices have resulted in a wide range of fertility levels in these soils. Additions of nitrogen and phosphorus give responses on much of the cropland. For example, soil test summary data show 70 percent of samples tested to be low or very low in phosphorus. However, with the majority of the soils high in potassium, expected responses are less frequent than with nitrogen and phosphorus.

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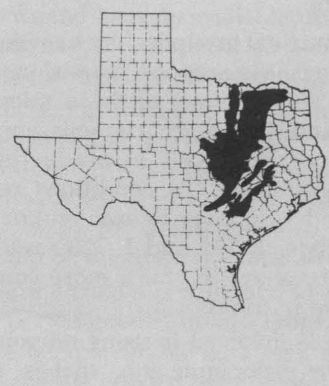

Figure 1. Location of Blackland and Grand Prairie regions.

N, P_2O_5 and K_2O for Major Crops

The wide range in fertility levels throughout the Blackland and Grand Prairie soils requires that fertilization practices be adapted to specific conditions. Soil tests, properly calibrated to express available nutrients, and correlated with crop response, are the best guide to profitable fertilization. The two important criteria for selecting the profitable rate of a nutrient are: (1) the level of available nutrients and (2) expected yield goal. A number of soil properties, along with the amount of extractable nutrient, must be evaluated to group soils for expressing the level of available nutrient. The second criterion is the expected yield, which expresses potential productivity and includes anticipated moisture and management conditions.

Rates of N, P_2O_5 and K_2O at varying soil test levels and expected yields for major crops are shown in Tables 1-3. Soil test levels used in these tables are based on Texas A&M University procedures and cali-

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brations. 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 1 a soil with a low (L) level of nitrogen, low (L) level of phosphorus and very high (VH) level of potassium would show 70-40-0 for 4,500 pounds per acre of grain sorghum.

Calcium, Magnesium and Sulfur

Blackland and Grand Prairie soils normally are very high in calcium because of the composition of the parent material. The magnesium levels appear adequate for current production levels. Sulfur, the third secondary nutrient, has been studied less than major nutrients. However, sulfur released from organic matter and that supplied by normal sources of plant nutrients are adequate to prevent widespread deficiencies. Sulfur responses have not been reported for the Blackland and Grand Prairie regions.

Micronutrients

The micronutrient group includes seven elements: iron, zinc, manganese, copper, boron, molybdenum and chlorine. The amounts of these micronutrients in Blackland and Grand Prairie soils appear to be adequate for current levels of production of field crops. However, there are conditions resulting in deficiencies and responses to zinc and/or iron. See Extension leaflets, L-721 and L-723, available from county agricultural agents, for a more complete discussion of these nutrients.

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

Conversion Factor

Fertilizers are labeled as percent P_2O_5 and K_2O 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 P_2O_5	to P	multiply by .44
From P	to P_2O_5	multiply by 2.2
From K_2O	to K	multiply by .83
From K	to K_2O	multiply by 1.2

Importance of Cropping System

A winter grain crop on clay soils of the Blackland region improves production of the following summer crop. This is attributed to better utilization of moisture and plant nutrients. Seven-year average grain sorghum yields at the Texas A&M University Research Center at McGregor were about the same with no fertilizer following oats as for 30-30-0 annually with continuous sorghum. Increased moisture following oats allows more time for nitrogen and phosphorus mineralization, hence higher yields. In years when moisture was adequate during the latter maturity stages, yield differences were smaller.

The effects of oats prior to cotton was even more pronounced in that fertilization of continuous cotton did not compensate for the effects of oats. Diseases and other conditions also contribute to these differences. Effective residue and soil management practices are essential for the maintenance of economical production levels on clay Blackland soils. The soil's physical condition affects infiltration, water holding capacity and available water. The structure and physical condition of clay soils is dependent on the products of crop residue decomposition. Therefore, to support continuous economical yield levels, farm managers must combine fertilization, crop rotation, soil and residue management with other proven production practices.

Time for Nitrogen Application

To insure high crop yields adequate amounts of nitrogen must be available throughout the growing season. This nutrient is absorbed and converted to protein and other compounds within a short time. This means that a constant nitrogen supply in the ammonium or nitrate form must be present to meet daily crop requirements. The peak requirement, as well as the total needed for the season, must be satisfied if top yields are produced. For these reasons the greatest efficiency from nitrogen fertilization is obtained when applied just before it is needed by the crop; however, this is not always the most convenient or economical.

When considering the best time to apply nitrogen, evaluate the following points:

- Ammonium (ammonia) nitrogen is held by clay particles against leaching.
- Ammonium is oxidized to nitrate slowly below 50 degrees F and rapidly in the 70 to 90 degree range.
- Nitrate nitrogen moves with water and can be lost through leaching, especially in coarse-textured soils.
- Some nitrogen can be lost from soil through bacterial denitrification, whereby nitrogen evolves as a gas under anaerobic or waterlogged conditions. Denitrification increases as temperatures rise, especially above 50 degrees F.

Factors Influencing Profitable N Rates

Results from a 6-year study of varying N rates for grain sorghum on a Houston black clay soil were combined with long term weather records to evaluate the relationship between available soil water in the soil profile (ASW), N cost, grain prices and the most profitable N rate.

Rainfall records between 1913 and 1973, along with calculated water losses during the growing season, were used to establish the probabilities of grain sorghum having different amounts of water stress during the growing season. The amount of available water in the surface 4 feet of soil at varying dates greatly affected the probability of water stress, and therefore, the crop's response to N fertilization. The greater the available soil water, the higher the probability of obtaining good fertilizer response.

To use this information, an estimate of the amount of available water is needed at the time nitrogen is being applied. Three methods of estimating available soil water (ASW) are suggested:

1. Measuring the depth to dry soil in a soil profile. If only the top foot is wet, ASW = 3.25 inches; top 2 feet wet, ASW = 5.75; top 3 feet wet, ASW = 7.8 inches.

2. Recording rainfall data since the last crop and deducting estimated evaporation losses of about .05 inch per day.

3. Using an average value provided by the county Extension office.

Information in tables 4 and 5 can be used to estimate the most profitable rate of N to apply under varying conditions. For example, a farmer is applying nitrogen on December 15 and estimates the ASW in the soil profile to be 6 inches. He also thinks the market value of grain will be about $4.00 per 100 pounds. Nitrogen is costing him 15 cents per pound. Table 4 (November 15 to January 15) shows the N rate to be 112 pounds per acre, provided there is adequate operating capital.

If the estimated ASW is less than 4 inches, the rate drops to 103 pounds. If the farmer has alternative uses for a limited supply of operating capital and wishes to have a $2 return for the last dollar invested in nitrogen, the rate would be 88 pounds and 73 pounds per acre, respectively, for the two conditions described.

If the soil profile becomes saturated any time between harvest and the last date for sidedressing, the values in Table 4 for over 7 inches would indicate the most profitable rate of nitrogen. If a low level of available soil moisture exists at the time nitrogen is applied, and late rains indicate a higher rate to be profitable, additional nitrogen can be applied up to about 45 days after planting, but preferably before May 1. See Table 5. For example, if we use the previous example from Table 4 where the ASW on December 15 was less than 4 inches, the rate was 73 pounds with limited capital. If winter rains raised the moisture to above 7 inches by March 15 and more capital became available, the rate would be 118 pounds and an additional 45 pounds of nitrogen could be applied before planting or as a sidedressing.

A reduction of from 5 to 10 pounds of N per acre from rates in Table 4 would apply to similar moisture conditions between January 15 and March 15 for moisture levels less than 4 inches, and between 4 and 7 inches. Rates for a soil moisture level above 7 inches would be the same any time after November 15.

- Where nitrogen is applied 2 to 4 months before the period needed by row crops, and conditions have been favorable for losses, additional nitrogen will be needed before planting or as a sidedressing.

Table 1. Application rates of nutrients for continuous grain sorghum and corn — three production levels.

Soil test level	Expected yield (50)[1] 3500 lb./A			Expected yield (65)[1] 4500 lb./A			Expected yield (80)[1] 5500 lb./A		
	N[2]	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
VL	60	40	30-40	90	50	40-50	120	60	50-60
L	40	30	20-30	70	40	30-40	100	50	40-50
M	20	0	0	50	30	20-30	80	40	30-40
H	0	0	0	0	0	0	0	0	0-20
VH	0	0	0	0	0	0	0	0	0

[1]Bushels shelled corn/acre.
[2]Following cotton or small grains reduce N by 20 to 30 lbs./acre.

Table 2. Application rates of nutrients for cotton — three production levels.[1]

Soil test level	Expected yield ¾ bale/A			Expected yield 1 bale/A			Expected yield 1¼ bale/A		
	N[2]	P_2O_5	K_2O	N[2]	P_2O_5	K_2O	N[2]	P_2O_5	K_2O
VL	40	40	40-50	50	50	50	60	60	60
L	30	30	30-40	40	40	40	50	50	50
M	20	0	0-30	30	30	30	40	40	40
H	0	0	0	0	0	0	0	0	0
VH	0	0	0	0	0	0	0	0	0

[1]These rates are applicable where root rot is not a problem.

Table 3. Application rates of nutrients for wheat — three production levels.

Soil test level	Expected yield 30 bu./A			Expected yield 40 bu./A			Expected yield 50 bu./A		
	N[1]	P_2O_5	K_2O	N[1]	P_2O_5	K_2O	N[1]	P_2O_5	K_2O
VL	60	40	30-40	80	50	40-50	120	60	50-60
L	40	30	20-30	60	40	30-40	90	50	40-50
M	20	20	20	40	30	20-30	60	40	30-40
H	0	0	0	0	0	0	0	0	0
VH	0	0	0	0	0	0	0	0	0

[1]Apply all of the P_2O_5 and part of the N at or before planting. Topdress the remainder of the nitrogen in late winter. If small grains follow a legume, reduce nitrogen by about half and in proportion to the amount of growth.

Table 4. The most profitable rate of N for continuous grain sorghum at varying soil moisture levels between November 15 and January 15.[1]

N cost $/lb.	Less than 4 inches[2]			4 to 7 inches[2]			Above 7 inches[2]		
	$4.00[3]	5.00	6.00	4.00	5.00	6.00	4.00	5.00	6.00
				Unlimited capital — maximum profit					
.10	111	115	118	120	123	125	124	127	129
.15	103	109	113	112	116	120	118	122	126
.20	93	101	107	104	110	115	112	118	120
.25	84	94	100	96	104	110	104	112	116
.30	74	86	94	88	98	104	98	106	112
				Limited capital — $2 return/$ invested					
.10	92	100	106	103	110	115	110	116	120
.15	73	85	93	88	98	104	96	105	111
.20	54	71	81	72	85	94	82	94	102
.25	36	55	69	56	73	84	68	83	92
.30	16	41	56	40	60	73	53	71	83

[1]Following cotton or small grains reduce N by 20 to 30 lbs./acre.
[2]Estimated inches of available soil water (ASW) in top 4 feet of soil.
[3]Estimated value of grain per 100 lbs.

Table 5. The most profitable rate of N for continuous grain sorghum at varying soil moisture levels between March 15 and May 1.[1]

N cost $/lb.	Less than 4 inches[2]			4 to 7 inches[2]		
	$4.00[3]	5.00	6.00	4.00	5.00	6.00
			Unlimited capital — maximum profit			
.10	97	102	105	114	117	120
.15	86	94	100	104	110	114
.20	72	84	92	96	104	108
.25	60	74	82	86	96	102
.30	46	64	74	78	90	96
			Limited capital — $2 return/$ invested			
.10	73	83	90	96	103	108
.15	49	64	74	77	89	96
.20	25	45	59	59	75	85
.25	0	26	43	41	61	73
.30	0	8	27	23	46	61

[1]Following cotton or small grains reduce N by 20 to 30 lbs./acre.
[2]Estimated inches of available soil water (ASW) in top 4 feet of soil.
[3]Estimated value of grain per 100 lbs.

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