Fertilization of Cotton on Blackland Prairie Soils of Alabama

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Abstract

Clayey, smectitic soils of the Blackland Prairie of Central Alabama and Mississippi were once the heart of the North American cotton belt in the 19th Century. Although cotton is not as widely grown as it once was, farmers who do grow cotton on these soils are seeing more problems with K deficiencies in spite of the fact that these soils often test “high” or “very high” in K. In 2005, a comprehensive soil fertility experiment with cotton was established on a Vaiden clay (*very-fine, smectitic, thermic Aquic Dystruderts*) on the Black Belt Research and Extension Center in West-central Alabama. The objectives of this experiment were to determine optimum N rates and to provide soil test calibration for P and K for this soil. Treatments included 6 N rates, 5 P rates, and 6 K rates on a soil that initially tested low in P using the Mississippi-Lancaster procedure (16 mg P kg^{-1}), very high in K (180 mg K kg^{-1}) and high in Mg (60 mg Mg kg^{-1}). Six years of non-irrigated cotton yields show no response to added P but a significant response to K fertilization. These results suggest major changes are needed in our current soil test calibration for P and K for cotton. Current N recommendations appear to be satisfactory for non-irrigated cotton.

Situation

Farmer’s field on a Sumter-Watsonia clay in Marengo County, AL; photo taken August, 2002.

Premature leaf-drop problems caused some cotton producers on clayey, sometimes alkaline, Blackland Prairie soils (Black Belt) in Alabama to suspect inadequate K fertilization in spite of “high” and “very high” soil test K results. These soils often test “low” in P but rarely seem to respond dramatically to P fertilization. Leaching of N is not a concern on these soils but denitrification in wet weather could lead to higher N applications. Soil fertility research on these soils has been very limited.

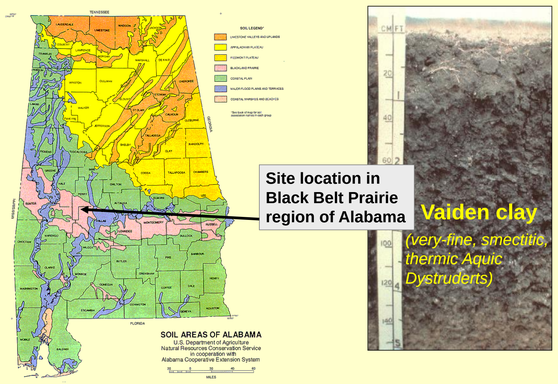
Objectives

- Determine the need for additional P & K fertilization for cotton on Blackland Prairie soils.
- Determne optimum N rate for cotton on Blackland Prairie soils.
- Establish a demonstration site for on-going soil fertility projects in the Black Belt of Alabama.

Methods

•Site established in 2004 on a Vaiden clay (*very-fine, smectitic, thermic Aquic Dystruderts*) by growing and harvesting sorghum–sudangrass to remove as much K as possible.

•17 treatments included annual N rates from 0 to 168 kg ha^{-1}, P rates from 0 to 112 kg P_2O_5 ha^{-1}, K rates from 0 to 112 kg K_2O ha^{-1} and a no-lime treatment.



•Treatments replicated 4 times in a randomized block design. Plots are 1.5 m wide and 10.5 m long.

•Cotton planted on ridges using minimum tillage in early May and harvested in mid to late October.

•All P and K and ½ the total N applied at planting. The remainder of N was applied as a sidedress at early squaring in June.

•All fertilizer applied by hand as ammonium nitrate (34-0-0), concentrated superphosphate (0-45-0), and muriate of potash (0-0-60). Gypsum was applied as a source of S on all treatments except the highest N rate.

•Yields were estimated by hand harvesting 6 m from the middle two rows in each plot. Yields are reported as kg lint ha^{-1} based on ginned samples. Lint quality was determined on selected treatments (not reported).

Fertilizer Treatments Applied Annually

Treatment	N*	P_2O_5	K_2O
	----------kg ha^{-1}----------		
	N Rates		
1. No N	0	112	112
2.	34	112	112
3.	68	112	112
4. Control	100	112	112
5.	134	112	112
6. No S	168	112	112
	P Rates		
7. No P	100	0	112
8.	100	22	112
9.	100	44	112
10.	100	68	112
	K Rates		
11. No K	100	112	0
12.	100	112	22
13.	100	112	44
14.	100	112	68
15.	100	112	90
16. No lime	100	112	112
17. Nothing	0	0	0

* N applied half at planting and half as a sidedress

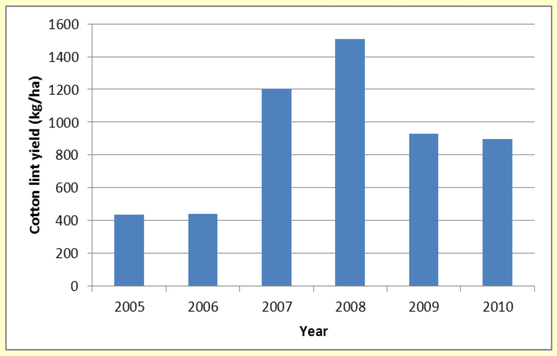
Results

Initial Soil test results from site in 2005.

Extract used	Soil pH_w	P	K	Mg	Ca
		----------mg/kg and rating----------			
Mehlich-1	6.0	4 Very Low	88 High	35 High	2330 (not rated)
Miss/Lancaster	6.0	16 Low	180 Very High	60 High	5,000+

Soil from this site is typical of many Blackland Prairie soils. Soil test P is “low” to “very low” and high rates of P would be recommended. On the other hand, K usually tests “high” or “very high” and no K is recommended for cotton.

Mean cotton lint yields from the fertilized control treatment (no. 4) during the 6-yr study.



2005. Excessive rains (3 tropical storms including Katrina); Total rainfall May-Sept. = 31.6”.

2006. Record drought; Total rainfall May-Sept. = 10.0”;

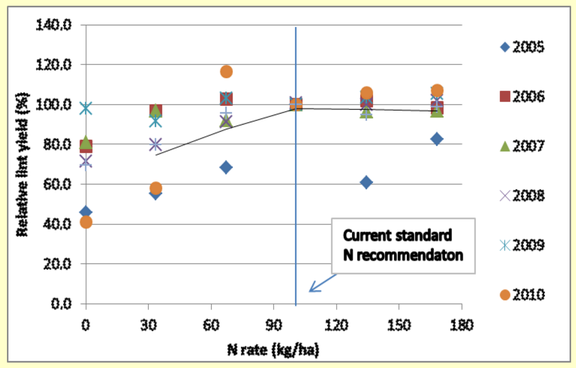
2007. Another record drought but June-July showers saved crop; Total rainfall May-Sept. = 12.0”.

2008. Dry spring, wet August and no rain in September and October. Total rainfall May-Sept. = 18.6”.

2009. Dry spring but extremely wet summer and fall; wet soil made harvesting very difficult. Total rainfall May-Sept. = 20.8”.

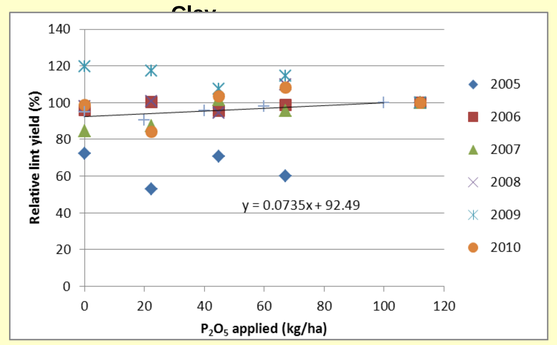
2010. Wet spring; very dry summer and fall; Total rainfall May-Sept. = 13.8”.

N Rates on a Vaiden Clay



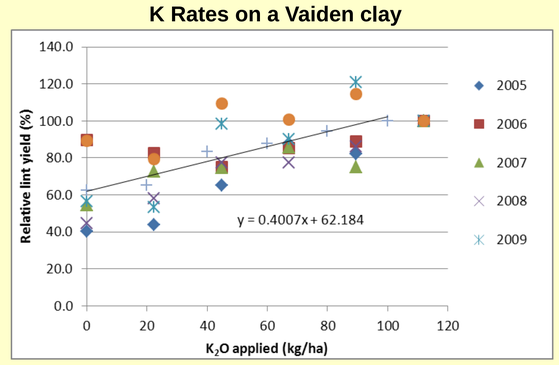
A standard N rate for these soils is 100 kg N ha^{-1} (90 lb. N ac^{-1}) which is considered the 100% relative yield. After 6 years of research, there is no evidence to support a change in this standard recommendation for this soil.

P Rates on a Vaiden Clay



Although soil test P is rated “low” and a response to added P was expected, this did not occur. These data suggest we need to change the current soil test critical level for cotton from its current value of 35 mg K kg^{-1} for the Mississippi/Lancaster extract to no higher than 16 mg K kg^{-1}. This would mean a dramatic reduction in the amount of P producers would need to apply to cotton.

K Rates on a Vaiden clay



Although soil test K was initially “high” and a yield response to added K was not expected, there was a significant cotton yield response ($P<0.05$) to added K in 5 out of 6 years. This indicates that we need to develop a new calibration curve for extractable K for cotton on these soils and raise the critical K level for cotton dramatically.

Conclusions

•Current recommended standard N rates for cotton on this soil appear adequate.

• Soil test P calibration under estimates available P i.e., we recommend more P than is necessary for optimum yields.

• Soil test K calibration for these soils appears to overestimate available K i.e., we recommend less K than is necessary for optimum yields.

• Although the cotton study was terminated in 2010, we now have a permanent site for on-going soil fertility research and demonstrations in the Black Belt region of Alabama, the only site with soil fertility variables on these soils where other crops can be evaluated.

Acknowledgements

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