EFFECT OF VARIABLE RATE LIME ON COTTON YIELDS

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Abstract

A study was initiated in 1996 to determine the economic feasibility of variable rate application of lime for cotton in Missouri. On a field at East Prairie, Missouri in 1996, cotton yields were significantly greater when lime was variable rate applied as compared to uniform lime application. Economic returns were increased $11 per acre. On a field at Portageville, Missouri, three year average cotton lint yields were not significantly different between conventional and variable rate lime application systems.

Introduction

Maintaining a proper soil pH is important for preventing aluminum and manganese toxicity in cotton and maximizing the availability of nutrients such as phosphorus. Symptoms of manganese or aluminum toxicity resulting from low soil pH are crinkled leaves and stunted growth. These symptoms can be easily mistaken for thrips damage in cotton. During the farm crisis of the early 1980's, many Missouri farmers reduced production costs by applying less lime. Growers are still using less lime than they did in the 1970's. In 1998, approximately 71% of the soil samples sent into the Delta Center Soil Lab from cotton producing counties had pH values less than 6.0.

An economic analysis at Purdue University found that annual returns increased $7.91 per acre when variable rate lime application was used with an ecomomic decision rule on corn and soybeans. (Bongiovanni and Lownberg-DeBoor, 1998). Retrofitting a lime spreaders to apply variable rate is relatively inexpensive compared to modifying fertilizer spreaders for varying rate of multiple nutrients. In Missouri, variable rate lime application is often the first site specific management service offered by agricultural chemical dealers. In 1996, we began evaluating the economics of variable rate lime because we believed it had a greater potential for profitability than variable rate potassium or phosphorus.

Materials and Methods

Three fields were sampled by conventional 20-acre composite sampling and 2.5-acre grid point sampling using differential global positioning system (GPS). Lime was applied in replicated strips by conventional uniform and variable rate systems in fields located at East Prairie and Portageville, Missouri. The East Prairie cotton field was 125 acres. The Portageville field was 60 acres. Treatments were replicated three times across each field. At the Portageville field, samples were also sampled by compositing samples from 2.5-acre cells. Lime was applied in strips by varying rates to each 2.5-acre cell. A low tech site-specific lime management was also evaluated by using the lime map created from grid sampling. When the map showed an area needed greater than 1 ton per acre more than the average rate for the field, an uniform lime application was made in strips followed by a second application at the same rate in those areas. Soil samples were also collected 15 months after lime was applied at Portageville. Because the test was conducted on a grower's field at East Prairie, we did not include untreated check strips. Since the grower rotated the field into soybeans in 1997, we were only able to collect cotton yields for 1996.

Gross returns were calculated for each lime application method based on $0.70/lb lint. Costs of soil sampling, testing and lime application were prorated over three years. Costs of soil sampling were based on a survey of local consultants and fertilizer dealers. Average cost of soil sampling and analysis on 2.5-acre grid was $8.50 per acre and variably applying lime was $1.50 acre. Soil sampling and analysis for 20-acre composite samples was $3.75 per acre.

Results and Discussion

Average soil pH_{salt} at the East Prairie field was 4.4. Although less than three tons per acre was applied in most of the field, strips with variable rate applications had areas that varied from one to five tons per acre. A comparison of soil pH maps for the fields at East Prairie and a second location at Portageville showed that the soil pH variability was not as great at Portageville as compared to the field at East Prairie. Average soil pH_{salt} at the Portageville field was 5.0.

In the East Prairie field, soil pH_s from grid samples varied from 3.9 to 5.2. Lime recommendations varied from 1.2 to 4.8 tons per acre. The Portageville field was less acid with average lime recommendations of 2.3 tons per acre. Phosphorus and potassium levels varied across each field. However, Bray-1 phosphorus and ammonium acetate potassium test results were consistently medium or high (> 100 lb P/acre, and >250 lb K/acre). Therefore, no P or K fertilizer was applied. Results from soil samples collected 15 months after lime application at Portageville showed that strips that had variable rate lime applied had more consistent soil pH across the field as compared to strips with uniform lime applications.

In the East Prairie field, we found that cotton yields were statistically greater in strips with variable rate lime than strips with uniform application (Table 1). At the Portageville field, cotton yields from strips that variable rate

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lime was applied were greater than yields from cotton in strips that lime was applied uniformly. But, none of the lime application treatments resulted in significantly greater yields than the untreated check (Table 2). This indicates that some work may be needed on our current lime recommendations for cotton. Although the Missouri soil test recommendation is for a target pH_{salt} of 6.0, none of the field tests conducted in the 1960's nor more recent work in the 1990's has shown cotton yield increase from lime when soil pH were 5.0 or greater. Soybeans, which are often rotated with cotton, produced optimum yields at pH_{salt} 6.0 to 6.5 (Fisher, 1968).

A method is needed to predict whether a field is likely to respond to variable rate liming. One of the current problems with variable rate technology is that a farmer has to commit to paying the costs of intense soil sampling with little information to know whether it is needed. A composite sample from the field to determine whether the soil pH is in the range to expect a response to lime is good starting point. Eighty-five percent of the cost of variable rate lime application is associated with soil sampling and test analysis. Applying lime with a variable rate applicator in our area is only about $1.50 per acre greater than with a uniform application. A yield map was developed of the Portageville field in 1997 by using global positioning and load cells mounted under a cotton picker basket. As cotton yield monitors become more common, farmers will be able to identify low yielding field locations and do preliminary soil sampling for pH. When pocket pH meters are calibrated correctly, we have found them to be reliable for doing in-field soil pH measurements.

Table 1. One year average yields and gross returns per acre from liming a 125-acre irrigated cotton field in East Prairie, Missouri.

Method of lime application	Tons of lime/acre	Lint/acre 1996	Prorated Costs	Gross return
Uniform	2.8	481	$19.92	$316.78
Variable from 2.5- acre grid	2.1	493	$17.33	$327.77

Cotton yields were significantly different between treatments (Pr>F 0.06).

Table 2. Three year average yields and gross returns per acre from liming a 60-acre irrigated cotton field in Portageville, Missouri.

Method of lime application	Tons of lime/acre	Lint/acre 1996	Prorated Costs	Gross return
Uniform	2.3	653	$16.58	$440.52
Variable from 2.5-acre grid	2.3	679	$18.66	$456.64
Variable from 2.5-acre cells	2.2	685	$18.00	$461.50
2X rate in low pH areas	2.8	630	$21.50	$419.50
Untreated	0	682	$0	$477.40

Cotton yields were not significantly different between treatments.

References

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