

## **INFLUENCE OF WINTER COVER CROP, NITROGEN, LIME, AND TILLAGE ON COTTON NET REVENUES**

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### **Abstract**

Data collected from a seven-year study on cotton were used to evaluate the impact of nitrogen fertilization rate, lime rate, tillage method, and winter cover crop on net revenues. Net revenues for no cover, wheat and crimson clover covers were maximized when using no tillage combined with 60 lb/acre of nitrogen and lime at one-half the University of Tennessee Extension recommended rate. The 30 lb/acre nitrogen fertilization rate provided the maximum net revenue for vetch cover when combined with no tillage and the half-rate of lime. No tillage produced significantly higher lint yields resulting in a reduction in the total cost per acre when compared to conventional tillage cotton across the four nitrogen fertilization rates and two lime treatments. Overall, one-half the University of Tennessee Extension recommended rate of lime resulted in net revenues that were not significantly different from the net revenues for the full rate of lime.

### **Introduction**

Agronomic research has shown that conservation tillage practices such as no tillage and winter cover crops can improve soil quality by reducing erosion, increasing organic matter, and improving water-holding capacity (Meisinger et al., 1991). Despite the benefits of a no tillage system, surface application of nitrogen fertilizer can cause the top few inches of the soil to become more acidic due to nitrification. As a result, low pH levels in the soil may affect the productivity of nitrogen fertilizers in no tillage systems, thus requiring additional liming and increasing production costs.

Using a legume winter cover crop has proven beneficial in providing nitrogen to the next crop while reducing the need for commercial nitrogen fertilizer (Larson et al., 2001a; Bauer and Roof, 2004; Hoyt and Hargrove, 1986; Reeves, 1994). Profitability is important in a cotton farmer's decision to adopt winter cover crops (Larson et al., 2001b). In a study by Frye et al. (1985), corn preceded by hairy vetch resulted in larger net revenues than corn grown without a prior cover crop. Larson et al. (2001b) found profit maximizing revenues for cotton following vetch to be smaller than no cover because vetch cover establishment costs exceeded the nitrogen cost savings.

Tillage practices, cover crops, and applied nitrogen are all components of a cotton farmer's liming decision and directly affect profitability. Whether or not a farmer leases land also affects the profitability of their liming decision. A farmer may not want to incur the cost of liming acreage that may not be available for lease the following year, thereby losing the benefits of soil improvement. The objective of this study was to evaluate the effects of alternative nitrogen fertilization and lime rates on net revenues for no tillage and conventional tillage cotton using different winter cover options.

### **Methods and Materials**

#### **Yield Data**

Cotton yield data for 1981 through 2001 were obtained from a long-term winter cover crop experiment at the West Tennessee Experiment Station, Jackson, TN. Plots received the same nitrogen fertilization rate, cover crop, and tillage treatment each year. Cotton was planted on conventional tillage and no tillage plots after winter wheat, hairy vetch, crimson clover, and no winter cover crop alternatives. Rates of ammonia nitrate fertilizer applied to the plots were 0, 30, 60, and 90 lb N/acre. After letting pH deteriorate by delaying the regular application of lime for several years, plots were split into blocks that were randomly assigned two lime rates in 1995 - 100% of the recommended University of Tennessee Agricultural Extension lime rate and one-half the recommended lime rate. In this study, data from 1995 through 2001 were used to evaluate the impact of winter cover crop nitrogen fertilization rate, tillage method, and lime

rate on net revenues.

### **Net Revenues**

The following partial budgeting equation was used to calculate net revenues for each winter cover crop, nitrogen fertilizer rate, tillage method, and lime rate alternate:

$$(1) \quad NR = LP \times LY - NP \times NF - LIME - TM - CE,$$

where NR is revenue (\$/acre), LP is lint price (\$/lb), LY is lint yield (lb/acre), NP is the price of nitrogen fertilizer (\$/lb) NF is the nitrogen fertilization rate (lb/acre), LIME is the annual amortized cost of the lime applied to each plot in the experiment (\$/acre), TM is other variable costs, fixed equipment expenses, and overhead costs for conventional tillage or no tillage cotton production (\$/acre), and CE is the variable costs, fixed equipment expenses, and overhead costs for establishing the winter cover crop.

Average prices from 1984 through 1999 were used to calculate profit-maximizing values. Prices and costs were expressed in 1999 dollars so changes in net revenues would reflect changes in profit maximizing yields rather than inflationary price changes. A lint price of \$0.73/lb, a nitrogen fertilizer price of \$0.34/lb, and a lime price of \$22.44/ton were used to calculate net revenues. Materials costs for the lime applications for each plot were amortized over six years using the capital recovery method and a real interest rate of 7%. The real rate of interest was calculated using nominal interest rates paid by farmers for capital from Farm Credit Services for 1985 through 2000 (U. S. Department of Agriculture, Economic Research Service, 2001) and adjusted for inflationary changes. Winter cover establishment costs were zero for no cover, \$25.00 for wheat, \$34.00 for vetch, and \$25.00 for clover. Other costs of production that did not vary in this analysis were taken from the University of Tennessee Extension enterprise budgets for conventional and no tillage cotton (Gerloff, 2000). Statistical analyses of net revenues were performed using the mixed model procedure in SAS (SAS Institute, 1997).

### **Results**

The 60 lb/acre nitrogen fertilization rate for no cover crop provided the largest net revenues averaged across the two lime treatments and the two tillage methods producing \$168/acre more net revenues than when no nitrogen fertilizer was applied to the cotton crop. The half-rate of lime provided \$17/acre larger net revenues and a significantly higher lint yield than full recommended rate of lime averaged across the four nitrogen fertilization rates and the two tillage methods for no cover crop. No tillage provided \$40/acre larger net revenue than conventional tillage averaged across the four nitrogen fertilization rates and the two lime treatments.

Results for a wheat cover indicate the 60 lb/acre nitrogen fertilization rate resulted in the largest net revenue of \$284/acre but was not significantly different from the 90 lb/acre net revenue. The half-rate of lime resulted in a net revenue of \$224/acre combined with a wheat cover. This net revenue was \$8/acre more than the net revenue for the full-rate of lime recommended by Extension. Net revenue of \$256/acre for no tillage was significantly higher than conventional tillage at \$184/acre. No tillage cotton using 60 lb/acre of nitrogen and either the half or full rate of lime produced the largest net revenues for a wheat cover crop of \$338/acre each.

Thirty lb/acre of nitrogen produced the largest net revenue of \$300/acre for a vetch cover. One-half of Extension's recommended rate of lime produced larger net revenue (\$267/acre) than the full recommended rate. Net revenue for no tillage was 33% higher at \$300/acre compared to conventional tillage. A combination of a vetch cover crop, no tillage, 30 lb/acre of nitrogen, and the half-rate of lime produced the largest net revenue of \$364/acre.

Net revenue for a crimson clover cover was maximized at \$262/acre when nitrogen was applied at 30 lb/acre but was not significantly different from the 90 lb/acre nitrogen fertilization rate. Half of Extension's recommended rate of lime produced significantly larger net revenue of \$248/acre when compared to the full rate of lime. The no tillage method achieved the largest net revenue and was significantly different from conventional tillage. A combination of no tillage, the half-rate of lime, and 60

lb/acre of nitrogen produced the largest net revenue of \$334/acre. Lime costs were higher for the vetch and clover winter covers when compared with the no cover and winter wheat cover. Notwithstanding the higher lime cost, vetch produced the largest net revenue among the four winter covers.

### **Conclusions**

Net revenues for no cover, wheat, and crimson clover covers were maximized when using no tillage combined with 60 lb/acre of nitrogen and lime at one-half Extension's recommended rate. The 30 lb/acre nitrogen fertilization rate provided the maximum net revenue for vetch cover when combined with no tillage and the half-rate of lime. Overall, one-half the University of Tennessee Extension recommended rate of lime provided net revenues that were not statistically different from the net revenues obtained with the full rate of lime. Also, using vetch or crimson clover as a winter cover will result in higher net revenues when compared to a wheat cover.

### **References**

- Bauer, P.J., and M.E. Roof. 2004. "Nitrogen, Alicarb, and Cover Crop Effects on Cotton Yield and Fiber Properties." *Agronomy Journal* 96:369-376.
- Frye, W.W., W.G. Smith, R.G. Williams. 1985. "Economics of Winter Cover Crops as a Source of Nitrogen for No-till Corn." *Journal of Soil and Water Conservation* 40:246-248.
- Gerloff, D. 2000. Cotton budgets for 2000. The University of Tennessee Agricultural Extension Service, AE&RD No 42, Knoxville, TN.
- Hoyt, G.D., and W.L. Hargrove. 1986. "Legume Cover Crops for Improving Crop and Soil Management in the Southern United States." *Horticultural Science* 21:397-402.
- Larson, J.A., E.C. Janeicke, R.K. Roberts, and D.D. Tyler. 2001a. "Risk Effects of Alternative Winter Cover Crop, Tillage, and Nitrogen Fertilization Systems in Cotton Production." *Journal of Agricultural and Applied Economics* 33,3(December 2001):445-457.
- Larson, J.A., R.K. Roberts, E.C. Janeicke, and D.D. Tyler. 2001b. "Profit-Maximizing Nitrogen Fertilization Rates for Alternative Tillage and Winter Cover Systems." *Journal of Cotton Science* 5:156-168.
- Meisinger, J.J., W.L. Hargrove, R.L. Mikkelsen, J.R. Williams, and V.W. Benson. 1991. Effects of Cover Crops on Groundwater Quality. p. 57-68. In W.L. Hargrove (ed.) *Cover Crops for Clean Water*. Soil and Water conservation Society of America, Ankeny, IA.
- Reeves, D.W. 1994. "Cover Crops and Rotations." p.125-172. In J.L. Hatfield and B.A. Stewart (ed.) *Advances in Soil Science: Crops Residue Management*. Lewis Publ., Boca Roton, FL.
- SAS Institute. 1988. SAS/STAT User's guide. 6.03 edition, SAS Institute, Cary, NC.
- U.S. Department of Agriculture, Economic Research Service. 2001. Agricultural Income and Finance, ERS-AIS-77. Washington DC: U.S. Department of Agriculture, Economic Research Service.