

SOIL NITROGEN MINERALIZATION FOLLOWING RYE AND CRIMSON CLOVER COVER CROPS IN NO-TILL COTTON

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INTRODUCTION

Crimson clover (*Trifolium incarnatum* L.) and winter rye (*Secale cereale* L.) are popular winter cover crops suitable for use with cotton in the southeast (Hoyt and Hargrove, 1986; Touchton et al., 1984). Nitrogen (N) management in cotton is critical because both under and over fertilization decrease yields (Mullins and Bunnester, 1990). Surface residues in no-till systems may reduce N availability to plants through immobilization (Rice and Smith, 1984) and slower rates of residue decomposition and N mineralization (Douglas et al., 1980; Schomberg et al., 1994). Efficient N use depends on understanding complex interactions among soil and site properties, crop characteristics, climate, and biological processes influencing N dynamics. Estimation of heat units, following residue incorporation, has been used successfully to predict N mineralization from cover crop residues (Honeycutt and Potaro, 1990). Reasonably accurate estimates of net N mineralization rates are needed to determine management influences on nutrient supply, particularly under conservation tillage conditions. Undisturbed soil cores incubated *in situ* have been used to measure N mineralization dynamics under a variety of conditions (Hook and Burke, 1995; Kolberg et al., 1997). The *in situ* technique has potential for evaluating management effects on N availability and microbial community dynamics and provide site specific information needed for improved nutrient management. The objective of this study was to evaluate cover crop effects on N mineralization in two no-tillage cotton-cover crop systems using *in situ* soil cores and the possibility of using heat units to predict N mineralization.

MATERIALS AND METHODS

Cover crop effects on N mineralization were determined during 1997 and 1998 in two no-till cotton-cover crop systems at the J. Phil Campbell, Sr., Natural Resources Conservation Center in Watkinsville, GA (33° 59' N, 83° 27' W). The study was conducted in two 3.3-acre (1.3-ha) watersheds. Cotton followed rye in one watershed and crimson clover in the other. The soil is a slightly eroded Cecil sandy loam (fine, kaolinitic, thermic Typic Kanhapludults). Cover crops were drilled into cotton residues in late October and killed with glyphosate 2 to 3 wk prior to planting cotton in May each year. Cotton was planted in May directly into cover crop residues with a four row no-till planter. Nitrogen as NH_4NO_3 was applied to cotton using a drop spreader at 30 lb/A (34 kg/ha) following crimson clover at 60 lb/A (67 kg/ha) following rye. Fall applications to rye were 50 lb/A (56 kg N/ha) at NH_4NO_3 .

Nitrogen mineralization was measured from cotton planting to harvest by incubating undisturbed soil cores *in situ* for 2- to 5-wk intervals at nine locations in each watershed (DiStefano and Gholz, 1986; Kolberg et al., 1997). A 4.3-by 2-inch (110- by 50-mm, depth by diameter) aluminum cylinder was driven into the ground and removed with the intact soil. Soil from the core bottom was removed and a nylon bag containing approximately 0.5 oz (15 g) of a 50:50 mixture of anion and cation exchange resins was placed in the cavity. Cores were returned to the same hole. After each incubation

period, cores were removed from the ground, soil and resin bag were removed from the cylinder and returned to the laboratory.

There were no replications of the cover crop systems for evaluating statistical differences between cover crop-cotton systems for N mineralization. Mean standard error values were determined for each watershed using location values within a cotton-cover crop system.

RESULTS

Yield, Biomass, and Soil N

Cotton yields (seed + lint) following clover and rye were 787 and 1076 lb/A (882 and 1205 kg/ha) respectively, in 1997 and 1393 and 2100 lb/A (1561 and 2352 kg/ha), respectively, in 1998. In 1997 and 1998, clover biomass was 2.7 and 2.4 ton/A (6.2 and 5.4 Mg/ha), respectively, and rye biomass was 5.0 and 2.3 ton/A (11.3 and 5.2 Mg/ha). Slow accumulation of growing degree days (GDD) limited yields in 1997 compared with 1998 even though rain was less in 1998. Averaged for 1997 and 1998, carbon (C) and N contents of clover residue were 42.4 and 2.3% and of rye residue were 43.5 and 1.4%, respectively. Soil C and N contents were 1.01 and 0.07% in the cotton-crimson clover soil and 1.04 and 0.07% in the cotton-rye soil, respectively.

Nitrogen Mineralization

Significant N mineralization occurred during the cotton growing season in both cropping systems for both years. Soil N mineralized from May through August was nearly three times greater in the cotton-crimson clover than in the cotton-rye system [2-year average 58 vs 21 lb/A (65 versus 23 kg N/ha), respectively]. Nitrogen mineralization was occasionally influenced by periods of drought, especially in 1997. More N was mineralized during the first 35 d in 1998 than in 1997 [approximately 18 lb/A (20 kg N/ha)]. This effect was believed to be related to a combination of factors. In 1998, cover

crops were killed at an earlier stage of growth and significant rainfall occurred immediately following planting and establishment of soil cores thus enhancing N mineralization. Differences in N mineralization between the clover and rye soils reflect differences in chemical characteristics of the cover crops and N inputs in the two systems. Although significant quantities of N were mineralized in the cotton-crimson clover soil, N availability to the cotton crop is unknown. The large difference in yield following the two cover crops was probably related more to water availability than to N availability.

Climatic Influences on N Mineralization

Soil degree days (heat units base 0 C) and rainfall for each period were evaluated for correlations with N mineralization. Soil degree days were significantly correlated with N mineralized in the crimson clover ($r = 0.56$, $P = 0.07$) and rye ($r = 0.52$, $P = 0.09$) systems. Cumulative rain for a period was not correlated with N mineralization. Nitrogen mineralization has been shown to be more closely associated with accumulation of heat units than with soil moisture (Honeycutt and Potaro, 1990). Absence of measurable water effects on N mineralization is attributed to soil water buffering capacity and the ability of microorganisms to function at low water potentials (Sierra, 1997; Doel et al., 1990). Soil water contents were low during the summer of 1998 but were apparently not below levels that significantly reduce microbial activity. Further work is being conducted to evaluate the use of heat units in predicting N mineralization.

SUMMARY AND CONCLUSIONS

Nitrogen mineralization in no-till cotton systems measured *in situ* using undisturbed soil cores was numerically greater with a crimson clover than a rye cover crop. Early season N mineralization released nearly two times more N

following crimson clover compared with following rye. Heat units showed a significant positive correlation to N mineralization. A reliable method of predicting N mineralization from readily available weather data and residue characteristics appears promising and could help improve timing and estimates of N amounts needed in no-till cotton.

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