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# MANAGEMENT OF PLANT-PARASITIC NEMATODES IN COTTON PRODUCTION SYSTEMS WITH POULTRY LITTER AND WINTER RYE

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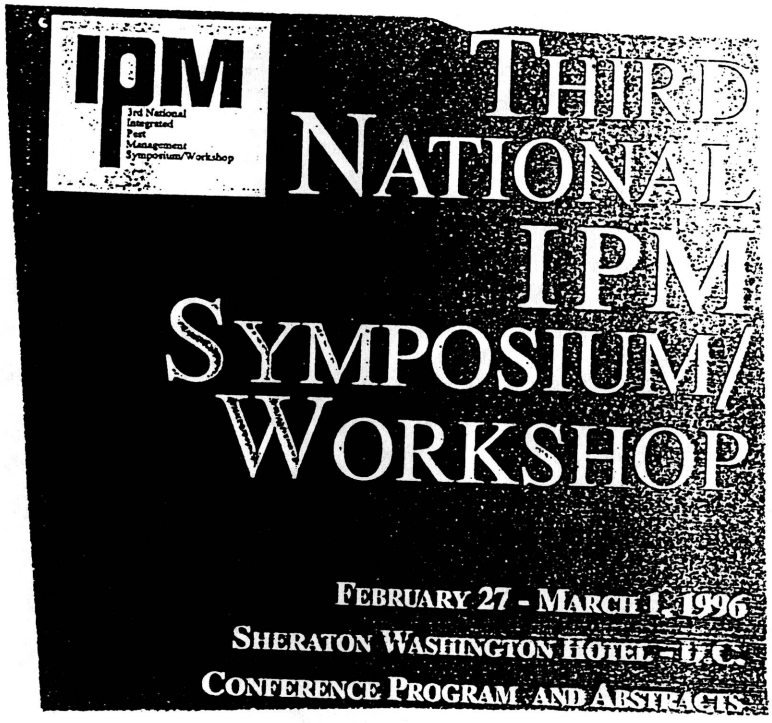
Cultural practices often are neglected as an option for nematode management in cotton. Use of animal wastes and other organic amendments or green manure crops such as a winter rye crop have promise for controlling many plant-parasitic nematodes. Field experiments were initiated in North Carolina to evaluate the influence of rates and dates of poultry litter application and (or) a winter rye cover crop on Columbia lance nematode, *Hoplolaimus columbus*, and cotton yield. Fertility levels for all plots were adjusted to those recommended by a soil test. A rye cover crop fertilized with various rates of chicken litter tended to suppress numbers of Columbia lance nematode, but also had a negative impact on cotton yield. There was a negative correlation ($P$=0.05) between seed cotton yield and the amount of rye incorporated into the soil. However, high rates of chicken litter increased ($P$=0.10) cotton yield and resulted in low numbers of this nematode in September. Early application (December) of litter tended to improve nematode control and enhance yield more than late application (April). Numbers of root-knot nematodes, *Meloidogyne incognita*, were lowest in plots receiving chicken litter, regardless of the date of application. The increased cotton yield in response to chicken litter application can be attributed to nematode control, since it is unlikely that fall-litter applications affected soil fertility during the growing season. Poultry litter also enhanced numbers of microbivorous (non-parasitic) nematodes, indicating increased microbial activity when this material was added to the soil. Overall, results from field as well as greenhouse tests show that these soil amendments were more effective in suppressing population densities of the plant parasites *M. Incognita* and *Paratrichodorus minor* than *H. columbus* and *Rotylenchulus reniformis*.



# MANAGEMENT OF PLANT-PARASITIC NEMATODES IN COTTON PRODUCTION SYSTEMS WITH POULTRY LITTER AND WINTER RYE,

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Cultural practices often are neglected as an option for nematode management in cotton. Use of animal wastes and other organic amendments or green manure crops such as a winter rye crop have promise for controlling many plant-parasitic nematodes. Field experiments were initiated in North Carolina to evaluate the influence of rates and dates of poultry litter application and (or) a winter rye cover crop on Columbia lance nematode, *Hoplolaimus columbus*, and cotton yield. Fertility levels for all plots were adjusted to those recommended by a soil test. A rye cover crop fertilized with various rates of chicken litter tended to suppress numbers of Columbia lance nematode, but also had a negative impact on cotton yield. There was a negative correlation ($P$=0.05) between seed cotton yield and the amount of rye incorporated into the soil. However, high rates of chicken litter increased ($P$=0.10) cotton yield and resulted in low numbers of this nematode in September. Early application (December) of litter tended to improve nematode control and enhance yield more than late application (April). Numbers of root-knot nematodes, *Meloidogyne incognita,* were lowest in plots receiving chicken litter, regardless of the date of application. The increased cotton yield in response to chicken litter application can be attributed to nematode control, since it is unlikely that fall-litter applications affected soil fertility during the growing season. Poultry litter also enhanced numbers of microbivorous (non-parasitic) nematodes, indicating increased microbial activity when this material was added to the soil. Overall, results from field as well as greenhouse tests show that these soil amendments were more effective in suppressing population densities of the plant parasites *M. Incognita* and *Paratrichodorus minor* than *H. columbus* and *Rotylenchulus reniformis*.

## INTRODUCTION

Plant-parasitic nematodes, including the Columbia lance nematode (*Hoplolaimus columbus*), frequently limit cotton yields by as much as 15% and may even result in crop failure. Although Columbia lance nematode (Cln) is limited in its distribution to the Carolinas and Georgia, it may spread to other cotton production areas with sandy soils. The poor plant growth caused by these pathogens results in an array of other negative impacts, including a crop unable to utilize available soil moisture and nutrients. Restricted plant growth also may lead to increased leaching and/or run-off of pesticides and soil-applied nutrients such as nitrogen and potassium.

Management of plant-parasitic nematodes relies on only a few tactics, including resistant varieties, nematicides, rotations, and other cultural practices that effectively control these pests. Many nematicides currently are under review because of high toxicity, and potential to contaminate water supplies. Rotation usually is not a viable option for the Columbia lance nematode since most crops are hosts for this parasite and cotton varieties resistant to this nematode have not been developed.

Cultural practices often are neglected as an option for nematode management in cotton. Use of animal wastes, other organic amendments or green manure crops have promise for controlling many nematodes. Limited studies indicate that combinations of various plant or animal wastes have promise for nematode control. Many cotton farmers plant winter (Abruzzi)rye as a cover crop to reduce soil erosion. The rye is incorporated in the spring prior to cotton planting. Preliminary findings indicate that rye may be detrimental to various species of plant-parasitic nematodes.

A series of field experiments were conducted in farmers' fields in Hoke, Robeson and Scotland Counties, NC to evaluate the effects of poultry litter and/or a winter rye cover crop on nematodes parasitic on cotton with emphasis on the Columbia lance nematode, *Hoplolaimus columbus*.

## OBJECTIVES

1. Determine the effectiveness of a winter rye cover crop in suppressing nematodes pathogenic to cotton and enhancing cotton yield.
2. Evaluate the effects of applications of poultry litter on nematode populations (plant-parasitic as well as free-living nematodes) and cotton yield.
3. Measure the impact of timing and rate of poultry litter application on cotton yield and the population dynamics of Columbia lance and associated nematodes.

## MATERIALS AND METHODS

Three experiments were conducted in the 1994-1995 season. Each experiment had six replications and was established at each of two locations. The first experiment, conducted in Scotland and Robeson Counties, NC, consisted of applications of 0, 1.5, 3.0 and 4.5 tons/acre of poultry litter added to selected experimental plots in November of 1994 and incorporated with or without a rye cover crop. A second experiment entailed applications of chicken or turkey litter at rates of 0, 3.0, 6.0 and 9.0 tons/acre in December, 1994, March, 1995, or April 1995. In the third and final experiment turkey or chicken litter was applied in April 1995 at rates of 0, 3.0, 6.0 or 9.0 tons/acre to selected plots at sites in Scotland and Hoke Counties, NC. Each site was disced to incorporate the litter within 1 week of application. Plots not receiving poultry litter were fertilized with traditional chemical-based fertilizer after planting, according to recommendations of a soil chemical analyses. A side-dress application of nitrogen was made to all treatments in July because of excessive rainfall in June.

All plots were sampled for nematodes prior to litter application, after planting, midseason (September) and at cotton harvest in October or November, 1995. Soil and root samples for nematode assays were processed by elutriation and centrifugation and Seinhorst mist. Plant-parasitic nematodes were identified and enumerated for all sites. In addition, all nematodes were identified to trophic group (plant-parasites, predators, omnivores, bacterivores, and fungivores) from two locations. Statistical analyses consisted of analysis of variance (ANOVA) with orthogonal contrasts, regression, and correlation.

## RESULTS AND DISCUSSION

The rye accumulated excessive biomass for a cover crop where poultry litter was applied (Fig. 1). This cover crop resulted in lower ($P$=0.10) numbers of lance nematode at the April and midseason (September) sampling dates (Fig. 2), indicating suppression of this parasite by the rye. However, cotton yield was negatively affected by the rye cover crop (Fig. 3), and stand reduction was moderate to severe at one location in particular because the rye was incorporated too close to cotton planting.

Application of chicken litter in November resulted in lower numbers of Cln (Fig. 4) and a related increase in seed cotton yield (Fig. 5). Chicken litter incorporated into soil in April, at rates ranging from 0-9 tons/acre in a field infested with Columbia lance nematode near Laurinburg, NC, effected a significant ($P$=0.10) increase in the yield of seed cotton (Fig. 6-A) and lower population densities of Cln (Fig. 6-B). Similarly, applications of these high rates of chicken litter resulted in a linear decrease ($P$=0.10)in midseason numbers of lance nematode at another site in Scotland County, NC (Fig. 7). Lower population densities of nematodes at midseason is a good indicator that some level of nematode control was achieved. Fall applications of chicken litter tended to result in better nematode control and higher cotton yield than spring applications (Fig. 8, 9). Higher rates of poultry litter were required to attain increased cotton yield with spring versus fall application of this

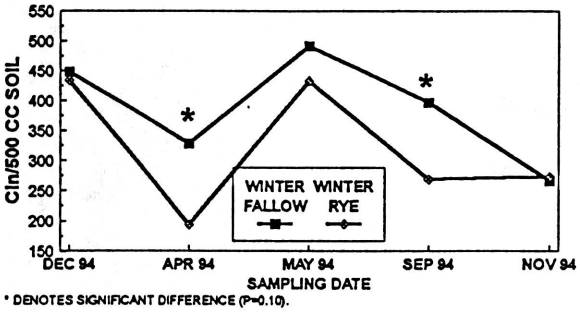
material.

The efficacy of relatively low rates of litter applied in the fall in increasing cotton yield indicate that the yield enhancement is likely a result of nematode control rather than a fertility effect. Addition of poultry litter in the spring resulted in significant ($P$=0.05) linear decrease in numbers of lance nematode related to the amount of litter added, and an increase in the midseason numbers of bactivorous nematodes at a Scotland County site (Fig. 10). Fungivorous nematode population densities at cotton harvest were positively related (P=0.05) the amount of litter added to plots (Fig. 11). Numbers of Cln and bactivorous nematodes at cotton harvest were not affected by the rate of litter applied in the spring. Similar results were obtained at a site in Hoke County, NC, although plant-parasitic nematodes were below the damage threshold at this location. Higher levels of these free-living nematodes associated with the addition of litter suggest enhanced species diversity in the soil microbial community. The increase in population levels of non-parasitic "microbivorous" nematodes may be important in nutrient cycling and general "soil health".

## CONCLUSIONS

1. Addition of poultry litter enhanced cotton yield and suppressed population densities of Columbia lance nematode in field experiments.
2. Rye had a negative impact on CIn, but cotton yield was suppressed by incorporating excessive amounts of this material into soil.
3. Relatively high rates of poultry litter must be applied to soil to achieve a measurable effect on this nematode.
4. The efficacy of low rates of litter addition in the fall, as opposed to addition of high rates in the spring, suggests that a shift in the microbial community may be responsible for changes in the population densities of plant-parasitic nematodes.
5. Enhanced numbers of fungivorous and bactivorous nematodes associated with addition of poultry litter to soil indicate an increase in soil microbial activity.

FIG. 2. POPULATION DYNAMICS OF COLUMBIA LANCE NEMATODE (Cln), AS INFLUENCED BY A WINTER RYE COVER CROP IN SCOTLAND COUNTY, NC DURING THE 94-95 SEASON.




* DENOTES SIGNIFICANT DIFFERENCE (P=0.10).

FIG. 3. INFLUENCE OF AMOUNT OF RYE BIOMASS (GRAMS FROM 1 SQUARE METER OF PLOT) INCORPORATED INTO SOIL ON SEED COTTON YIELD NEAR MAXTON, NC - 1995.

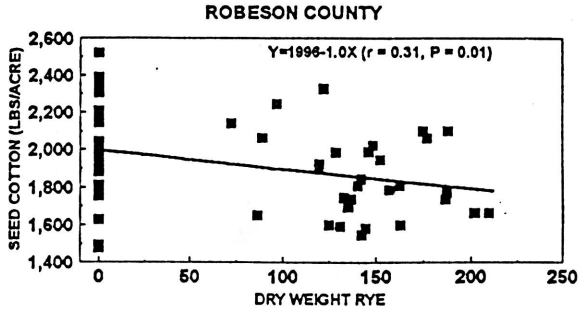



FIG. 4. EFFECTS OF FALL (NOVEMBER) ADDITION OF DIFFERENT LEVELS OF CHICKEN LITTER ON THE MIDSEASON (SEPTEMBER) POPULATION DENSITY (Pm) OF COLUMBIA LANCE NEMATODE (Cln) NEAR MAXTON, NC - 1995.

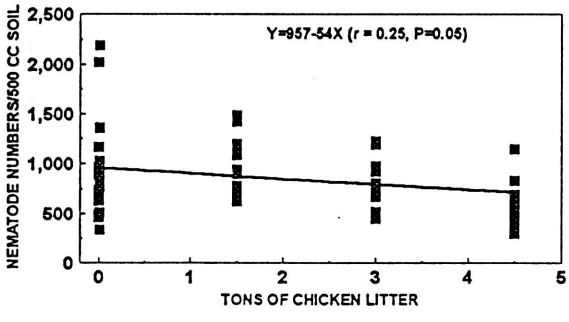
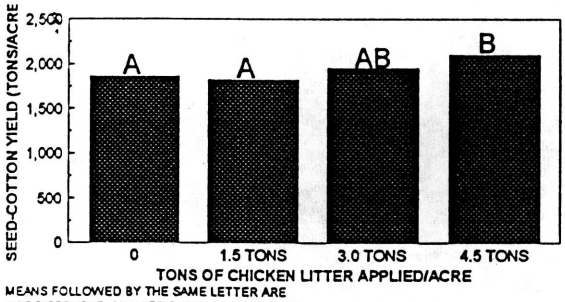
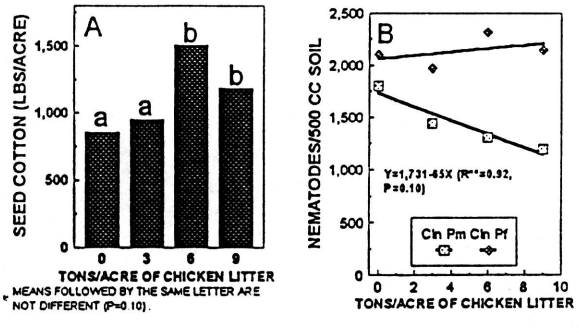



FIG. 5. SEED-COTTON YIELD IN THE PRESENCE OF COLUMBIA LANCE NEMATODE, AS RELATED TO FALL (NOVEMBER) APPLICATIONS OF DIFFERENT RATES OF CHICKEN LITTER NEAR MAXTON, NC -1995.



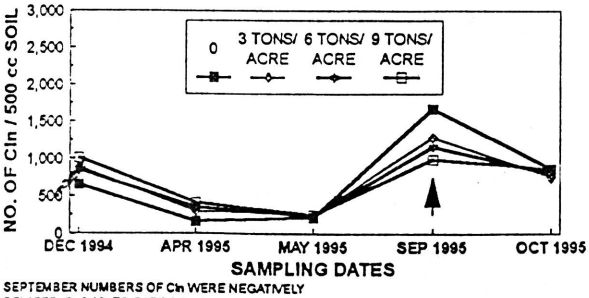

MEANS FOLLOWED BY THE SAME LETTER ARE NOT DIFFERENT - WALLER DUNCAN (K RATIO=50).

FIG. 6. EFFECTS OF APRIL APPLICATIONS OF VARIOUS RATES OF CHICKEN LITTER ON COTTON YIELD (A) AND (B) NUMBERS OF COLUMBIA LANCE NEMATODE (Cln) AT MIDSEASON (Pm) AND AT COTTON HARVEST (Pf) IN SCOTLAND COUNTY -1995.



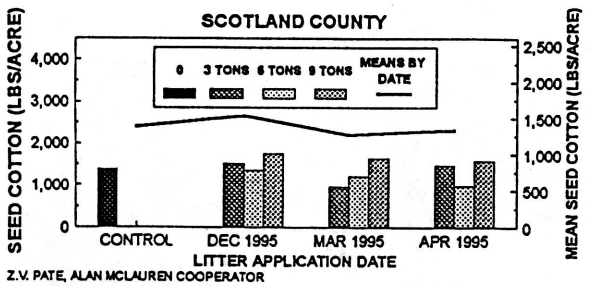

* MEANS FOLLOWED BY THE SAME LETTER ARE NOT DIFFERENT (P=0.10).

FIG. 7. POPULATION DENSITIES OF COLUMBIA LANCE NEMATODE (Cln) AT FIVE SAMPLING DATES, AS INFLUENCED BY APPLICATION OF VARIOUS RATES OF CHICKEN LITTER AT THREE DATES (DEC-APRIL 1995) AT A SITE IN SCOTLAND CO., NC.



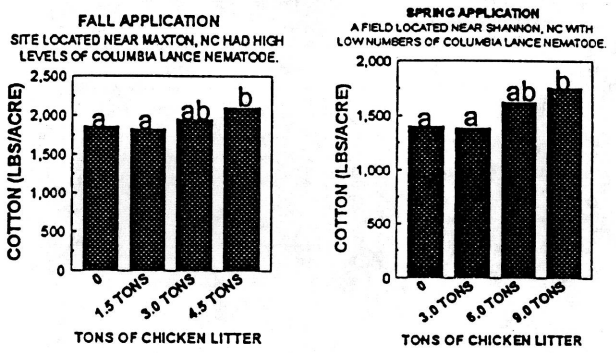

SEPTEMBER NUMBERS OF Cln WERE NEGATIVELY RELATED (P=0.10) TO RATE OF LITTER.

FIG. 8. INFLUENCE OF APPLICATION DATE AND RATE OF CHICKEN LITTER ON COTTON YIELD IN 1995.



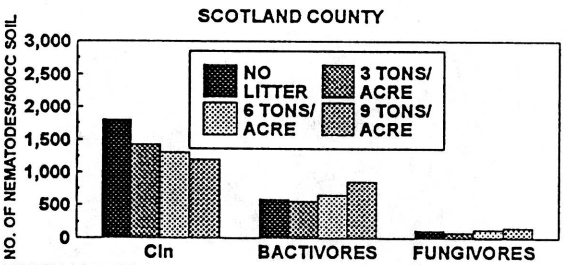

Z.V. PATE, ALAN MCLAUREN COOPERATOR
COTTON YIELD WAS GREATEST WITH DECEMBER APPLICATION OF LITTER.

FIG. 9. INFLUENCE OF FALL VS. SPRING APPLICATION OF DIFFERENT RATES OF CHICKEN LITTER ON SEED-COTTON YIELD - 1995 .




MEANS FOLLOWED BY THE SAME LETTER ARE NOT DIFFERENT - WALLER DUNCAN (K RATIO = 50).

FIG. 10. MIDSEASON NUMBERS OF COLUMBIA LANCE NEMATODE (Cln), BACTERIVORUS, AND FUNGIVORUS NEMATODES, AS INFLUENCED BY APPLICATIONS OF CHICKEN LITTER IN 1995.




NUMBERS OF Cln ARE NEGATIVELY RELATED TO THE AMOUNT OF LITTER, WHEREAS BACTIVORES AND FUNGIVORES WERE ENHANCED (P=0.10).

FIG. 11 EFFECTS OF DIFFERENT RATES OF CHICKEN LITTER ON POPULATION DENSITIES OF H. COLUMBUS, BACTERIOVOUS, AND FUNGIVOROUS NEMATODES IN 1995.