Conservation tillage, poultry litter, cropping system and cotton production

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Abstract

Disposal of poultry waste created by the burgeoning poultry industry in the SE USA is becoming a major environmental concern. Its use in agriculture has been limited to pasturelands and rice deltas. In order to develop a meaningful use for poultry litter in crop production, we designed a long-term study (1996-2002) evaluating its effects on soil quality and cotton (*Gossypium hirsutum*, L.) production in conjunction with different tillage treatments (conventional till, mulch till, and no-till) and cropping systems on a Decatur silt loam in north Alabama. The experiment was conducted in 1997 and 1998 and 2000 and 2001. Nitrogen was applied to cotton through poultry litter or ammonium nitrate. Cotton was rotated with corn (*Zea mays* L.) in 1999 and 2002 without any nitrogen application. Cotton was either fallowed in winter or sequenced with rye (*Secale cereale* L.) to generate additional crop residues for the conservation tillage treatments. Winter rye increased cotton lint yields by 222 to 365 kg/ha under no-tillage over the study period. Cotton lint yields under no-tillage with poultry litter as the nitrogen source were 200 to 436 kg/ha greater than those under conventional tillage with ammonium nitrate as the nitrogen source. Poultry litter application in conjunction with no-tillage and winter rye cover crop is a sound management practice for cotton production in the southeastern USA.

Media summary

Poultry litter application in conjunction with no-tillage and winter cover crop in crop production is a better way of its disposal in the southeastern USA.

Keywords

Corn, rye, conventional tillage, mulch-till, no-till, sequential crop

Introduction

The southeastern USA produced in excess of 3 billion broilers in the year 2001 (USDA-National Agricultural Statistics Services 2002) generating in excess of 2.5 billion kg of litter. Application of poultry litter as a source of N and P has been shown to increase yields of crops such as corn and pastures (Ma et al. 1999). Furthermore, our studies have shown that poultry litter improves soil chemical properties compared to inorganic sources of N (Nyakatawa et al. 2001).

Adoption of no-tillage in cotton production in the Southern U.S. states has increased from 627,000 acres in 1998 to 1,938,000 acres in 2002 (CTIC 2002). The inclusion of winter cover crops in a no-tillage cotton production system can provide crop residues to protect the soil (Bauer and Busscher 1996).

Crop rotations involving crops of different genus or species improve soil fertility, reduce erosion, reduce the build-up of pests, and increase net profits. Corn, which is an important crop for the south eastern USA, can be grown as a summer crop in rotation with cotton to break the life cycles of major cotton insect pests and diseases. Corn also supplies additional residues to increase soil organic matter in conservation tillage cotton production systems. The objectives of this study were to evaluate the long-term effects of poultry litter application on cotton grown in conjunction with conservation tillage and corn rotation and a winter rye cover crop.

Methods

A field study was conducted at the Alabama Agricultural Experiment Station, Belle Mina, Alabama (34° 41' N 86° 52' W) on a Decatur silt loam soil from 1996 to 2002. Treatments consisted of three tillage systems: conventional tillage (CT), mulch-till (MT), and no-tillage (NT); two cropping systems: cotton-winter fallow (cotton in summer and fallow in winter) and cotton-winter rye sequential cropping that is cotton in summer and rye in winter; and two N sources: ammonium nitrate at N = 100 kg/ha and poultry litter at N = 100, and 200 kg/ha. The recommended rate for cotton in the Tennessee Valley region is N = 100 kg/ha. The experimental design was an incomplete factorial arranged in a Randomized Complete Block Design with 4 replications. Plot size was 8-m wide and 9-m long, which resulted in 8 rows of cotton, 1 m apart.

Amounts of poultry litter to supply N = 100 kg/ha (100PL) and 200 kg/ha (200PL) were calculated for application each year based on the N content of the poultry litter (about 3 %). A 60 % adjustment factor was used to compensate for the reduced N availability from poultry litter during the first year. Poultry litter was incorporated in the conventional tillage and mulch tillage systems, whereas in the no-tillage system it was not incorporated.

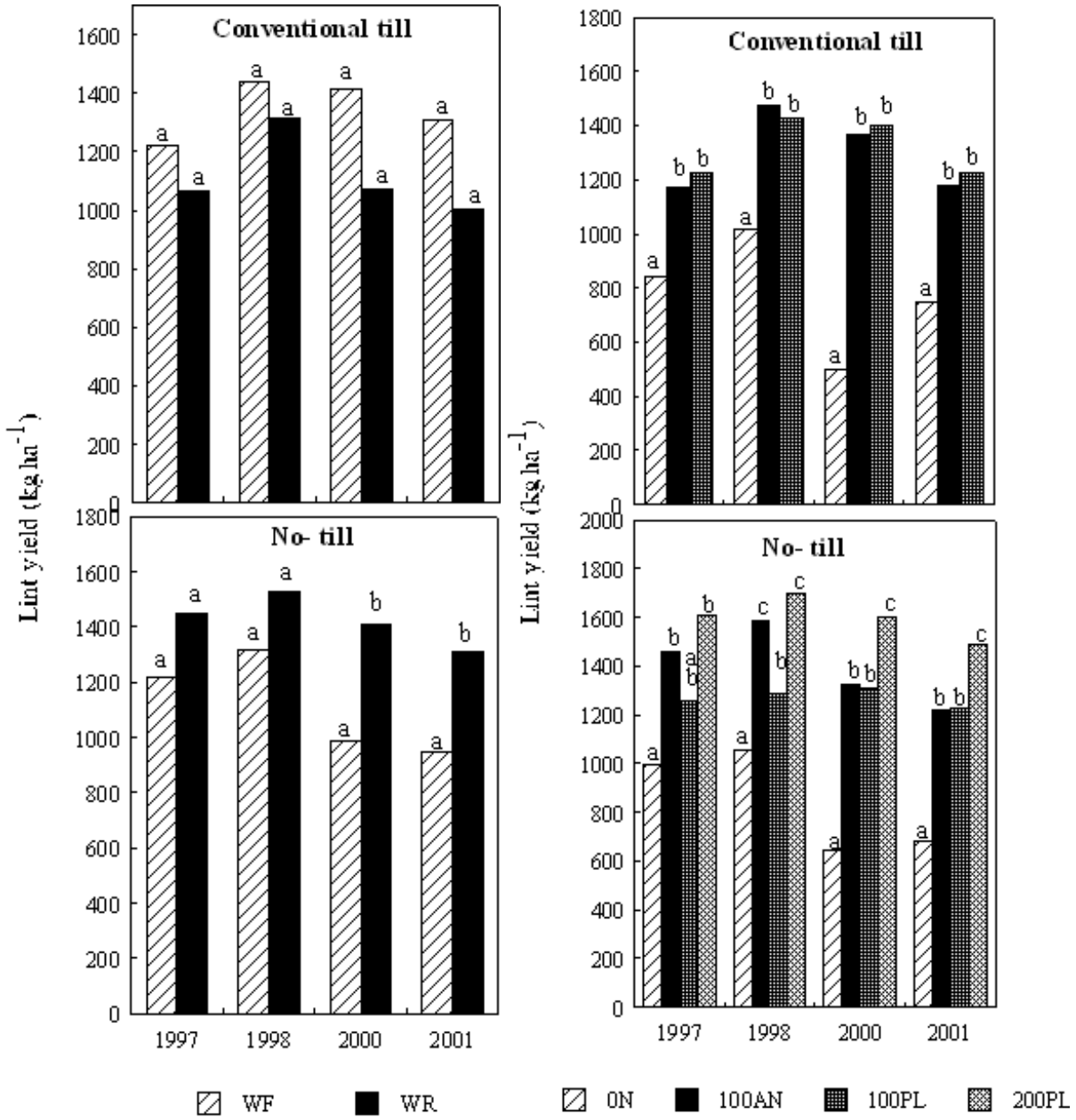
Conventional tillage included moldboard plowing in November and disking in April. A field cultivator was used to prepare a smooth seedbed after disking. Mulch tillage included tillage with a field cultivator before planting to destroy and partially incorporate crop residues to a depth of 5 to 7 cm. No-tillage included planting into un-tilled soil using a no-tillage planter.

The winter rye cover crop, variety ‘Oklon’ was planted each fall with a no-till grain drill at 60 kg/ha and killed with glyphosate herbicide about 7 d after flowering in the following spring, that is, spring of 1997, 1998, 2000, and 2001. The cover crop did not receive any fertilizer. Lint yield data for the treatments were determined by multiplying the seed cotton yield by a ginning percent of about 40 %. The data were statistically analyzed using General Linear Model procedures of the Statistical Analysis System (SAS 2001).

Results

In conventional tillage, rye cover cropping did not improve cotton lint yields (Fig. 1). Although not significant, cotton lint yields under conventional tillage with winter-rye cover cropping were in fact lower by 160, 119, 338, and 307 kg/ha than those in conventional tillage with winter fallow cropping in 1997, 1998, 2000, and 2001, respectively. This may be attributed to the fact that tillage increases the immediate N immobilization of the rye cover crop. On the other hand, in no-tillage with winter-rye cropping, cotton lint yields were 222, 214, 427, and 365 kg/ha greater than those in no-tillage with winter fallow cropping in 1997, 1998, 2000, and 2001, respectively (Fig. 1). Compared to conventional tillage with winter fallow cropping, lint yields in no-tillage with winter-rye cropping were 299 to 518 kg/ha greater over the study period.

From these consistent results over four years, it is obvious that the key to increasing cotton lint yields is keeping crop residues on the soil surface. This improves the plant environment by holding additional moisture (Nyakatawa and Reddy 2000), improving soil organic matter, and reducing soil erosion (Nyakatawa et al. 2001). Without winter rye cover cropping, no-tillage cotton performed similar to or slightly below conventional tillage in terms of lint yield (Fig. 1); similar results were reported by Pettigrew and Jones (2001).



(Means of WF and WR or AN and PL within a tillage system for each year followed by the same letter are not significantly different at the 5% level).

Fig. 1. Cotton lint yields as influenced by conventional and no-tillage systems with (WR) and without winter rye cover- cropping (WF) and with ammonium nitrate (AN) and poultry litter (PL) N treatments, Belle Mina AL, 1997 to 2001

Conventional tillage combined with N application in the form of ammonium nitrate or poultry litter significantly increased cotton lint yield except under the 100PL treatment in 1997 (Fig. 1). In mulch tillage plots where poultry litter was incorporated into the soil, there were no significant differences in cotton lint yields between 100AN and 100PL treatments in all years (data not shown). With 100 or 200 kg/ha of N as poultry litter, lint yields under no-tillage were 200 to 436 kg/ha greater than those under conventional tillage with 100 kg/ha of N as ammonium nitrate. Similarly to what was observed with rye cover cropping,

without application of N in the form of ammonium nitrate or poultry litter, yield gains from no-tillage alone are not consistent from year to year (Fig. 1). Poultry litter application to supply 200 kg/ha of N enhanced the impact of no-tillage and rye cover cropping.

Conclusions

Results from our study show that cotton lint yields were significantly improved by no-tillage with rye cover cropping and poultry litter application at a rate equivalent to 200 kg/ha of N. This production package not only improves cotton lint yields but also helps reduce soil erosion and to dispose-off poultry waste safely.

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