# Integrating Conservation-Tillage and Crop Rotation for Management of Soybean Cyst Nematode

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## Abstract

A long-term rotation by tillage experiment was established to determine the effects of no-till planting. on the soybean cyst nematode *(Heterodera glycines* Ichinohe) and associated effects on the yield of soybean [*Glycine max* (L.) Merr.]. No-till resulted in significantly ( $P = 0.01$) lower numbers of cysts, eggs, and juveniles in 1986 and 1988. There was a trend toward lower soybean yield, at the outset of the experiment, in no-till. The trend to lower yields in no-till was reversed after five years with higher yields in no-till. Yield differences as a result of tillage were not, however, statistically significant. Rotation was effective in managing *H. glycines.*

## Introduction

A major constraint on soybean production in North Carolina is the soybean cyst nematode. Soybean yield losses in response to this pest range from minimal to crop failure in individual fields. Tactics for managing soybean cyst nematode are the use of resistant cultivars, crop rotation, cultural practices, and nematicides. The use of nematicides has given little economic gain even though the increase in yield is often statistically significant (3). Resistant cultivars are effective against only 20% of the SCN populations in North Carolina. Most growers must rely on crop rotation and other cultural practices to manage SCN and produce a profitable soybean crop. Conservation tillage needs to be integrated with tactics for managing soybean cyst nematode if it is to be a viable production practice.

The effects of conservation tillage on nematode population dynamics and disease development is not clear-cut. No-till production can suppress nematode numbers, but it generally requires several years to have a measurable effect. The short-term effects on nematode populations and yield of double cropping soybeans with wheat have been relatively small.

Distinct nematode population patterns are developing in fields farmed without tillage over the long term. The soils usually contain more free-living nematodes and fewer plant-parasitic nematodes than in conventionally tilled fields (Tables 2-4). Unfortunately, yields are sometimes lower with no-till treatments than with conventional tillage.

The current research was undertaken to evaluate the long-term effects of no-till soybean production on soybean yield and *H. glycines.* The objectives of this research were to: (i) evaluate soybean yield under no-till versus conventional tillage in fields infested with *H. glycines,* (ii) determine the effects of tillage on *H. glycines* population dynamics, and (iii) study the effects of rotation on *H. glycines* and soybean yield.

## Materials and Methods

A tillage study was initiated at the Tidewater Research Center near Plymouth, NC, in 1985. Plots were established in a Portsmouth fine sandy loam with 4.2% organic matter. Experimental plots were 40 ft. long with eight rows, 36-inch row spacing and 10 ft. alleys. The soil in conventional-tillage plots was disked and then tilled with a tilrovator. All plots were planted with a no-till planter.

Soybean cultivar Coker 156 was used until 1987, and the cultivar DPL-105 was used in subsequent years. Soybeans were planted in selected plots mid-May of each year except for the corn-wheat-soybean rotation which was planted in mid- to late-June.

Soybean and corn yields were collected from the two center rows of each plot. Soil samples for nematode enumeration and identification were collected from the center two rows. Nematode samples consisted of 10-15 cores, one-inch in diameter taken to a depth of six to nine inches and composited. Nematodes were extracted from one pint of soil by elutriation and centrifugation (1).

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The experiment was a randomized complete block with four replications. Experimental design was for a 4 X 2 factorial with four rotations and two tillage regimes, conventional and no-till. Rotations were continuous soybean, corn-soybean, corn-corn-soybean, and corn-wheat/soybean double-cropped. Rotations were established such that all four rotations appear every year after 1986. Data were subjected to analysis of variance (ANOVA) and orthogonal contrasts were used where appropriate.

## Results

Soybean yields were unaffected by tillage in 1985 (Table 1). One-year rotations were analyzed in 1986. There was a trend toward lower soybean yield in the no-till aspect although the difference was not significant. The corn-soybean or corn-wheat/soybean double cropped rotations gave significantly ($P = 0.001$) greater soybean yield than did continuous soybean (Table 1). Complete rotations were in place after 1987. A one- or a two-year rotation gave significantly greater ($P = 0.001$) soybean yield compared to monoculture during the 1987 growing season (Table 2). Late-planted soybean following wheat yielded the same as monoculture. There were no significant effects of rotation or tillage on 1988 soybean yield. Rotations of one or two years (excluding late-planted soybean after wheat) resulted in greater soybean yields ($P = 0.01$) compared to continuous soybean in 1989 (Table 2). No-till yields were somewhat greater than conventional tillage in 1989, but not significantly (Table 2). Numbers of *H. glycines* eggs were lower ($P = 0.05$) under no-till than conventional till after two years of no-till in the fall of 1986 (Table 3). Rotations with corn were effective in lowering population densities of *H. glycines* in every year. *H. glycines* cysts, eggs, and juveniles were significantly less ($P = 0.001$) in no-till plantings than in conventional till at the end of the 1986 growing season (Table 4). Rotations of one or two years resulted in lower numbers of *H. glycines* in the experiment in every year.

**Table 1. Influence of tillage and rotation on soybeon yield (Bu/acre) at Ihe beginning of lhis study at the Tidewater Research Station.**

| Year crop sequence1 | Tillage: Conventional | Tillage: No-till |
|---|---|---|
| **1985** | | |
| S-S | 33.0 | 32.0 |
| ANOVA: tillage ($P = 0.7185$) | | |
| **1986** | | |
| S-S | 35.9 | 36.4 |
| C-S | 50.7 | 45.5 |
| C-W-S | 48.4 | 44.2 |
| ANOVA: rotation ($P = 0.0001$), tillage ($P = 0.2300$), tillage X rotation ($P = 0.5984$) | | |

[1] S-S indicates continuous soybean, C-S is a one-year corn-soybean rotation, and C-W-S denotes corn-wheat-soybean.

**Table 2. Effects of tillage and rotation on soybean yield (Bu/acre) at the Tidewater Research Station In a field Infested wilh soybean cysl nemalode.**

| Year crop sequence[1] | Years[2] between soybean crops | Tillage: Conventional | Tillage: No-till |
|---|---|---|---|
| **1987** | | | |
| S-S-S | 0 | 30.7 | 33.8 |
| S-C-S | 1 | 39.4 | 42.2 |
| S-C-W-S | 1+ | 29.2 | 24.6 |
| C-C-S | 2 | 38.2 | 40.8 |
| ANOVA: rotation ($P = 0.001$), tillage ($P = 0.4903$) ; orthogonal contrasts one- and two-year rotations vs. no rotation ($P = 0.001$). | | | |
| **1988** | | | |
| S-S-S | 0 | 28.0 | 22.6 |
| S-C-S | 1 | 28.1 | 27.8 |
| S-C-W-S | 1+ | 27.0 | 27.8 |
| C-C-S | 2 | 29.0 | 31.5 |
| ANOVA: rotation ($P = 0.1823$), tillage ($P = 0.6929$); all contrasts NS. | | | |
| **1989** | | | |
| S-S-S | 0 | 28.4 | 33.2 |
| S-C-S | 1 | 35.9 | 38.5 |
| S-C-W-S | 1+ | 23.8 | 26.4 |
| C-C-S | 2 | 39.3 | 35.6 |
| ANOVA: rotation ($P = 0.0001$), tillage ($P = 0.3150$); orthogonal contrasts one- and two-year rotations vs. no rotation ($P = 0.01$). | | | |

[1] S-S-S denotes continuous soybean, S-C-S indicates a one-year soybeancorn rotation, S-C-W-S denotes soybean followed by corn then double-cropped wheat-soybean, C-C-S indicates two-yean of corn followed by soybean.

[2] The one 1+ years rotation applies to soybean double-cropped with wheat. This is a short-season soybean crop and thus has somewhat lower yields than full-season crops.

## Discussion

No-till resulted in lower numbers of *H. glycines* life stages in 1986 and 1988 when compared to conventional tillage. The effects of no-till on *H. glycines* were generally not significant in other years probably because of environmental factors. High rates of irrigation in 1987 and high rainfall in 1989 resulted in lower numbers of *H. glycines* possibly confounding the effects of tillage treatments in these years. soybean yields tended to be lower in no-till treatments at the outset of the experiment, but were higher than

Table 3. Population change of the soybean cyst nematode eggs from Spring 1985 to Fall 1986. at (he Tidewater Research Station.

| Rotation | Conventional till $P_i$ | Conventional till $P_f$ | No-till $P_i$ | No-till $P_f$ |
|---|---|---|---|---|
| Continuous soybean | **1800** | **13000** | **8275** | **8300** |
| Corn-soybean | **2075** | **10300** | **1700** | **2200** |
| Soybeancorn | **1725** | **0** | **2325** | **0** |
| Corn-corn | **1950** | **0** | **1575** | **0** |

ANOVA: tillage ($P$ = 0.0788), rotation ($P$ = 0.003), tillage X rotation ($P$ = 0.1803) for final population densities ($P_f$).

Table 4. Numbers of *Heterodera glycines* cycsts, eggs, and juveniles/pint of soil at the end of the 1988 growlng season from the Tidewater Research Station

| Crop sequence | Conventional Cyst | Conventional Eggs | Conventional Juveniles | No-till Cyst | No-till Eggs | No-till Juveniles |
|---|---|---|---|---|---|---|
| Continuous soybean | **150** | **14475** | **305** | **52** | **3675** | **80** |
| Soybean after corn | **122** | **11388** | **163** | **57** | **4513** | **105** |
| Soybean aftercorn &wheat | **126** | **12200** | **275** | **15** | **1625** | **8** |
| 1-year corn after soybean | **1** | **13** | **1** | **4** | **388** | **0** |
| 1-year corn after wheat & soybean | **0** | **0** | **3** | **2** | **75** | **8** |
| 2-years corn after soybean | **0** | **0** | **0** | **2** | **75** | **0** |

ANOVA: cyst-tillage ($P$ = **0.005),** rotation ($P$ = **0.0001),** tillage X rotation **($P$ = 0.0801);** eggs-tillage ($P$ = **0.004).** rotation ($P$ = **0.0002),** tillage X rotation ($P$ = **0.0773);** juveniles-tillage ($P$ = **0.0024).** rotation ($P$ = **0.0265).**

conventional till in later years. These trends were not statistically significant but may be a result of long-term benefits to be derived from no-till plantings. The experiment was designed to continue for another five years. Rotation effects were highly significant in every year except 1988.

Crop rotation must be integrated with tillage practices to obtain optimal soybean yield. No-till planting may be an effective tool in managing soybean cyst nematode provided it is combined with other tactics to manage soybean cyst nematode.

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