# Tillage and Crop Rotation Effects on Sustaining Soybean Yields on a Hapludult

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## ABSTRACT

Strip-tillage (in-row chiseling), no-tillage, and conventional tillage (moldboard plow) systems have been evaluated for 10 years together with cropping sequences of continuous corn *(Zea mays* L.), continuous soybean (Glycine max [L.] Merr.), and corn-wheat (Triticum aestivum sp.)-soybean. 'Essex' soybean yields for 1981 to 1984 were highly correlated with soybean cyst nematode (Heterodera *glycine* Ichinohe, SCN) population. Yields were up to 39% higher with strip and no-tillage than with conventional tillage, and yields were up to 28% higher when rotated with corn. In 1985, strip-tillage treatments were split to include a SCN resistant soybean cultivar ('Forrest') and in 1987 all tillage treatments were split to include the SCN-resistant cultivar. Soybean yields in all tillage systems were increased by use of a SCN resistant cultivar; however, when crop rotation was considered, yields of both soybean cultivars were increased up to 30 to 46%. In the double-crop rotation treatment, soybean yields were equal to continuous soybean, but soybean yields were reduced when wheat was a cover crop and not harvested for grain. In 1989, the corn-w-soybean rotation was not planted because for 20 days between May 19 and June 9 no rainfall was recorded but during the next 14 days 11 inches of rainfall was recorded. This prevented planting of double-crop soybean in 1989.


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## INTRODUCTION

In the first four years of a conservation tillage study conducted on a Hartsells fine sandy loam (fine-loamy, siliceous, thermic, Typic Hapludults), soil conservation tillage resulted in 16 to 39% higher soybean yields than conventional tillage in 3 of 4 years (Edwards et al., 1988). By the fourth year of the experiment (1983), soybean yields with conventional tillage were reduced to 690 kg $ha^{-1}$ compared to 1660 and 1930 kg $ha^{-1}$ with strip-tillage and no-tillage. Conservation tillage systems in combination with corn-soybean rotation for both full-season or double-cropped soybean gave the most consistent yield increase for the 10 years.

A significant tillage x rotation interaction for soybean yield occurred in 1981, 1982, and 1983 and was probably caused by a buildup of soybean cyst nematode population. These SCN populations increased faster in conventional tillage with continuous soybean than in strip- or no-tillage treatments. The SCN populations in 1984 were highest in all tillage systems with continuous soybean and were lowest with no-till when soybean was rotated with corn. In 1985 and 1986, all strip-tillage soybean plots were split so that Forrest, a SCN race 3 resistant cultivar, could be compared with Essex, a SCN susceptible cultivar. All strip-tillage treatments were split to compare soybean yields in 1985 and 1986 and all tillages were split in the other tillage system with respect to corn-soybean rotation. Thus, the objectives were to determine effects of time on yields and to follow the soybean cyst nematode population as influenced by crop rotation, tillage, and soybean cultivars.

Table 1. Influence of crop rotation on average soybean yields for 'Essex' and 'Forrest' with strip-tillage.

| Crop Rotation | Essex | | Forrest |
|---|---|---|---|
| | 10 yr avg. | 6 yr avg. | 6 yr avg. |
| Continuous | 1870 | 1808 | 2410 |
| Corn-Soybean | 2283 | 2169 | 2810 |
| C-W-S[a] | 2083 | 1760 | 2450 |

[a] Corn-Wheat for grain-Soybean.

Table 2. Influence of conservation tillage systems on average soybean yields for 'Essex' and 'Forrest.'

| Tillage | Essex | | Forrest |
|---|---|---|---|
| | 10 yr avg. | 6 yr avg. | 6 yr avg. |
| | kg ha$^{-1}$ | | |
| Conventional | 1880 | 1710 | |
| Strip-tillage | 2163 | 1986 | 2436 |
| No-tillage | 2191 | 2093 | |

Table 3. Soybean cyst nematode counts found in 1985 through 1987 at Crossville, Alabama, with different tillage and crop rotation systems.

| Tillage system | soybean cyst nematode count (# cm$^{-3}$ soil) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1984 | 1985 | | 1986 | | 1987 | |
| | Essex | Essex | Forrest | Essex | Forrest | Essex | Forrest |
| | Corn - soybean rotation | | | | | | |
| CONV[1] | 712 | 260 | | 161 | | 134 | 19 |
| STRIP[2] | 632 | 612 | 36 | 538 | 48 | 362 | 12 |
| NO-TILL[3] | 216 | 149 | | 399 | | 171 | 13 |
| | Continuous soybean rotation | | | | | | |
| CONV | 586 | 303 | | 126 | | 91 | 21 |
| STRIP | 779 | 627 | 133 | 238 | 23 | 510 | 52 |
| NO-TILL | 797 | 426 | | 310 | | 264 | 128 |

[1] Conventional tillage (moldboard plow)
[2] In-row subsoiling
[3] No-tillage

## MATERIALS AND METHODS

Strip-tillage treatment consisted of planting soybean over 20 to 22-cm deep chisel slots. No-tillage treatments were planted with a doubledisk opener planter directly into the untilled soil surface. Conventional tillage consisted of turning the wheat cover in spring, disking in herbicides, and planting. Cropping sequences were continuous soybean; continuous corn; corn-soybean; and corn-wheat for grain-soybean. Wheat was planted in the fall on all plots as a winter cover, including those plots not used for grain crop. The wheat was killed on the winter cover plots 10 days before planting corn or soybean. The experiment was located on a Hartsells fine sandy loam soil on the Sand Mountain Substation at Crossville, AL, which is in the Appalachian Plateau area of AL. The experiment was a split-plot design in a randomized complete block with four replications. Whole plots were tillage (32.9 by 15.25 m) and subplots were rotation treatments (5.49 by 15.25 m). Row spacing was 0.92 m for corn and 0.69 m for soybean. Essex soybean has been used since the experiment was started in 1980. In 1985, the soybean treatments were split to include a SCN resistant cultivar Forrest.

Soil samples were collected in March, July, and August for nematode analysis. The March soil was collected before the soybean was planted. The July and August samples were sampled 58 and 59 days after planting full-season and double-cropped soybean. Eighteen cores were taken 12 to 14 cm deep under the rows of each plot for each sampling time. The full-season soybean was planted in late May and double-cropped soybean was planted in late June after wheat was harvested for grain. All plots were uniformly fertilized according to Auburn University soil test recommendations.

## RESULTS AND DISCUSSION

When crop rotation is considered, Essex soybean yield was increased each year (1981-90) by having corn in the rotation (Fig. 1). This relationship was observed in years (1982, 1984, 1987, 1988, and 1989) when reduced rainfall caused water stress during critical growth periods. The only year that conventional tillage soybean yield was greater than no-till or strip-tillage was in 1981 (Fig 1). In all other years (1982-90), no-tillage and strip-tillageyields were higher than conventional tillage.

The six-year (1985-90) yields of Essex soybean have continued to decrease with strip-tillage when compared to the ten year average yields (Table 1). However, soybean yields with strip tillage were increased 33% with continuous soybean, 29% with full-season soybean, and 39% with double-crop soybean when the SCN resistant cultivar Forrest was included in the soybean rotation. The highest yields for the six years were obtained when a SCN resistant soybean cultivar was rotated with corn and full-season soybean was grown (Fig. 2).

Essex soybean yields as affected by tillage systems also decreased during the six years (1985-1987) when compared to the ten-year average yields (Table 2). However, yields with no-tillage are being maintained even though the SCN population appears to be building up when compared to conventional or strip-tillage (Table 3). Strip-tillage soybean yields were increased by 23% by using Forrest as compared to yields with Essex.

The number of SCN counts 60 days after planting with conventional tillage appear to be declining in numbers over the last four years, however, yields of Essex soybean continue to be lower indicating that some factor other than cyst nematode population was limiting yields. There also appears to be an increase in the number of SCN with Forrest in the no-tillage systems where continuous soybean was planted as compared to when soybean were rotated with corn (Table 3).

## CONCLUSION

The corn-soybean rotation and conservation tillage (no-tillage or strip-tillage) increased yields of Essex and Forrest soybean

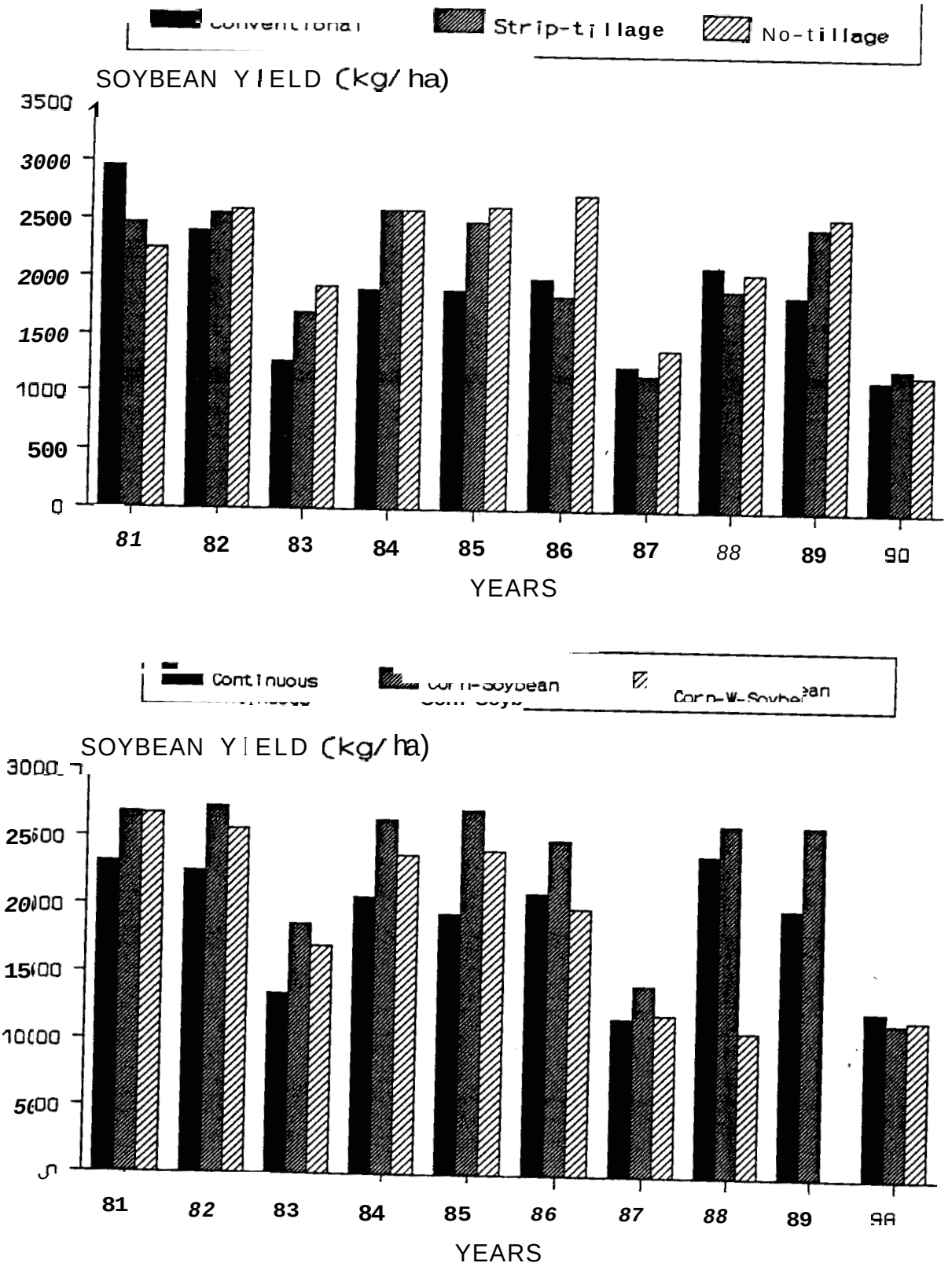


**Fig. 1.** Influence **of** tillage **and** crop rotation **on Essex** soybean yields.

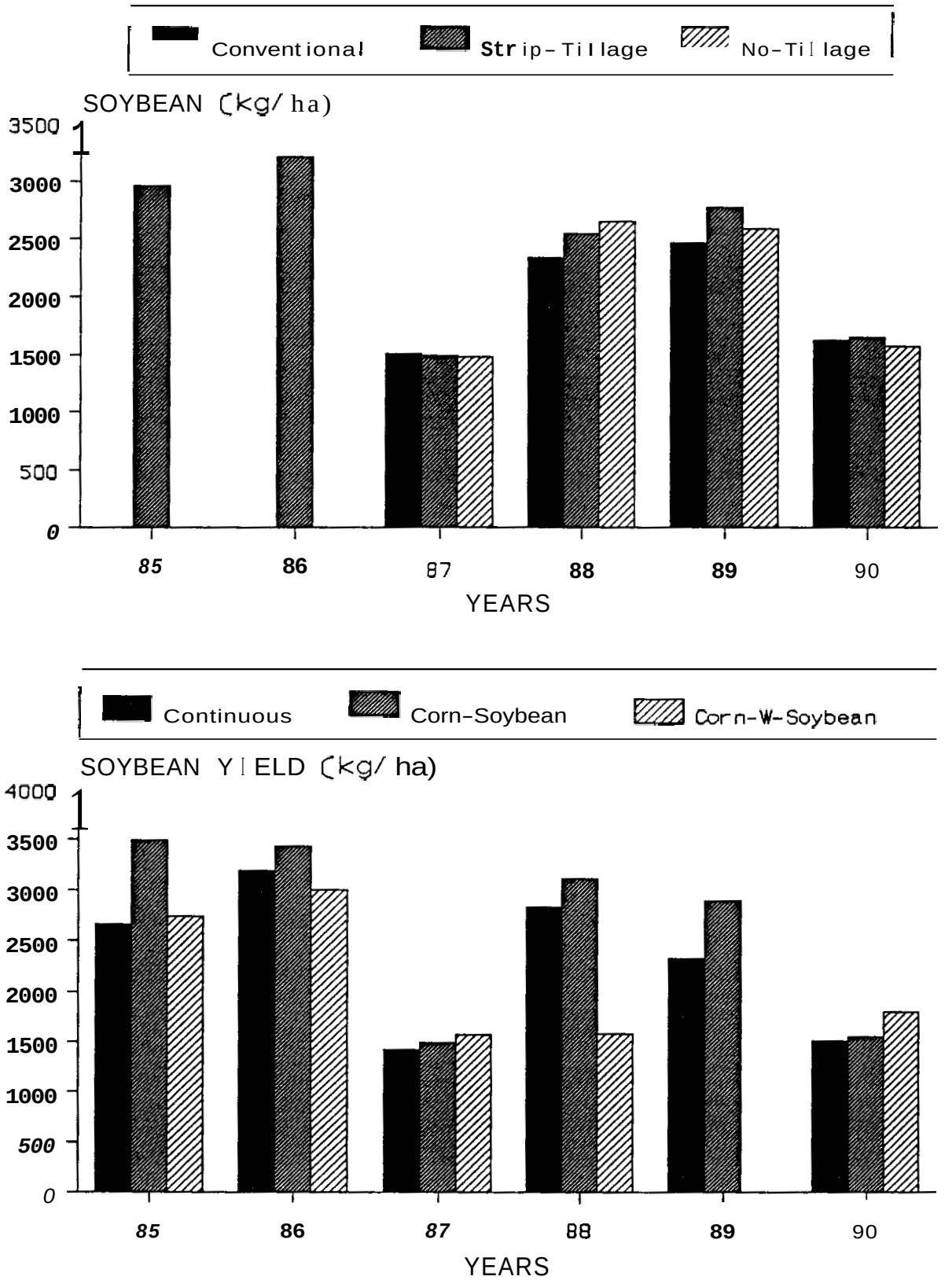


**Fig. 2.** Influence **of tillage and crop rotation on** Forrest **soybean yields.**

cultivars. With conventional tillage, there was a build-up of cyst nematodes to damaging levels in the first 60 days after planting during the first four years of the experiment. The cyst nematode population reached the same levels in the no-tillage and strip-tillage systems, but the build-up was at a slower rate than with the conventional tillage. By the sixth and seventh years, the conservation tillage had even higher cyst nematodes population when compared to conventional tillage, but soybean yields were not affected. However, the cyst nematode build-up declined with time when Essex was grown with conventional tillage, suggesting that factors other than nematode populations were affecting Essex soybean yields. In general the largest yield difference because of rotation was with the strip-tillage and largest soybean differences due to cultivar were observed in the soybean-wheat for grain-corn rotation.

## RELATED LITERATURE

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