Double-Cropping Wheat and Soybeans with Conservation Tillage

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Double-cropping soybeans after wheat is a popular practice in South Carolina, with an estimated two-thirds of the soybean crop planted in June after wheat harvest. Even though double-cropping has been a profitable system for many farmers, high costs and constraints on time and labor have caused more interest in adopting conservation tillage for both crops. Previously, research has shown that no-till wheat and soybeans are not feasible because of problems with stands and soil compaction. Now, better drills, varieties, and deep tillage tools designed for breaking hardpans in almost a broadcast fashion, while leaving the majority of surface residues in place, have enhanced the chances for success of conservation tillage.

SOIL CHARACTERISTICS

The sandy soils typical of the southeast Coastal Plains are inherently low in fertility and waterholding capacity. They are also subject to leaching and often exhibit significant runoff during the growing season when most rainfall comes as thunderstorms. The organic matter content of the topsoil (A horizon) for these soils is low (usually less than 1 percent), and with excessive tillage this figure may be closer to 0.5 percent. This situation results in poor soil tilth and reductions in rainfall infiltration potential. Some agronomists attribute the lowering of soil productivity and crop yield potential to these factors. Also, excessively tilled low organic Coastal Plain soils possess less buffering potential against the effects of drought stress, such as during the summer of 2002.

Another important characteristic of most Coastal Plain soils is a hardpan that restricts root growth and increases the potential for serious yield losses during drought. The hardpan, or E horizon, is usually 1 to 4 inches thick and about 7 to 15 inches deep and is lighter in texture than the topsoil or plow layer (A horizon). Subsoiling is the most common method farmers use to break the hardpan to encourage root growth into the clay or B horizon, where additional moisture and nutrients are available. Yield increases for wheat and soybeans can be 10 to 15 percent, or more, with good deep tillage practices for alleviating the effects of soil compaction. Chisel plow tines are spring loaded and thus are relatively ineffective ineffective in disrupting the E horizon.

CONSERVATION TILLAGE TOOLS AVAILABLE

Deep tillage tools that feature bent shanks or "wings" are available for use in conservation tillage systems. These plows (Tye or Bingham Bros. Paratill, Worksaver's Terra-Max, and DMI's Ecolo-Till), equipped with coulters for cutting through surface residues, actually lift the soil and then drop it as they are pulled through the field. This action shatters hardpans similar to dropping concrete. Such practice effectively loosens the soil above the shanks or wings. Thus, there is almost a broadcast type (about 70 percent of the soil is affected) of deep tillage vs. the furrow type of tillage effect with conventional shank subsoilers. The idea is that this type of hardpan shattering will last longer than the furrow-type done by conventional shanks. Experience has shown that reconsolidation of compacted zones occurs earlier with the conventional shank type of deep tillage. Also, crop roots can more effectively "search" the profile for water and nutrients after use of these winged plows.

ONE-PASS WHEAT PLANTING SYSTEM

Conventional wheat planting systems in the Coastal Plains typically involve a minimum of two or three diskings to bury previous crop residue, followed by subsoiling, smoothing, and then planting. For soybeans, the small grain residue is either burned or disked, and then there is a one-pass subsoil-planting operation for soybeans. Energy consumption and the investment in equipment, time and labor is high. Also, little consideration is given to the potential for runoff and/or erosion with these conventional tillage systems. A reduced tillage, one-pass wheat/soybean system has the potential to save energy, reduce production costs and erosion, provide food for quail and other wildlife, and expand the planting interval available to farmers.

Tests to evaluate a one-pass system were conducted between 1995 and 1997 by Drs. Ahmad Khalilian and Jay Chapin at the Edisto Research and Education Center at Blackville. The soil was a Varina loamy sand, and the objective of the study was to compare a conventional double-crop system with the one-pass and no-till systems for wheat and soybeans. All one-pass and no-till wheat treatments were planted in soybean stubble from the previous year. Measurements were taken for yield, ground cover, soil compaction with a penetrometer, soil organic matter and energy requirements. Recommended practices for variety selection, soil fertility, and pest management were followed.

The tillage tools for the study were as follows:

a) A four-shank modified Tye Paratill with a 24-inch spacing (modification is a roller-conditioner mounted behind the tillage shanks for preparing a more uniform level seedbed);

b) An eleven-shank chiselplow with points 2 inches wide and spaced 12 inches apart; and

c) A ten-shank Worksaver Terra-Max II with a 30-inch row spacing, double shanks per row (one on front toolbar turned in one direction and the other on the back toolbar turned in the other direction). A steel roller conditioner was mounted on the back of the Terra-Max to level the soil.

The no-till drill used in the study was the 14-foot wide Clemson No-till Interseeder Drill equipped with a Gandy Orbit Air Applicator and 11 Yetter Seeder Coulters set 13 inches apart for wheat and eight - set 13 inches apart - for soybeans (with two 22-inch rows for the tractor tires). The row spacing with this drill can be changed for different production schemes and cropping systems. A goose-neck type hitch system was used to attach the Clemson No-till drill to the tractor behind the deep tillage tools (Paratill and Terra-Max). This arrangement allowed for tillage and planting to be accomplished in one pass.

Each year the wheat variety 'Coker 9835' was planted in late November at a seeding rate of 120 pounds per acre. The soybean variety 'Hagood' was planted in early June of 1995 and 1996 after wheat harvest at a rate of 60 pounds per acre. In 1997, the Roundup Ready variety 'Hartz 7550RR' was used. The 30-inch rows were planted with a KMC no-till planter with the subsoiler shanks removed. The 12-inch soybean plots were planted with the Clemson No-till Drill. The results from the one-pass study are presented in Table 1.

Wheat yields from the one-pass planting (ave. for treatment no. 1 and no. 2) were 12 percent higher than those from the conventional wheat planting system (treatment no. 3). Soybean yields, averaged over the two-row spacings for the one-pass treatments, were also 12 percent higher than the soybean yields following the conventional wheat system. The narrow-row 12-inch soybeans averaged 5 bushels per acre more than the soybeans planted in the 30-inch rows for all treatments in the three years of the study. Earlier shading of the row middles in the narrow-row soybeans could have advantages in weed management due to increased crop competition. Also, the narrow rows enable the crop to better utilize sunlight as well as soil moisture and nutrients.

Table 1. One-pass wheat/soybean test* results for yield (bu/acre), 1995-1997

Trt. No.	Fall deep tillage/ planting	Wheat yield (ave. '95-'97)	Soybean yield 30-inch row (ave. *'95-'97)*	Soybean yield 12-inch row (ave. *'95-97)*
1	Terra-Max + CU Drill**	60	47	54
2	Paratill + CU Drill**	59	47	53
3	Disk(2), Chisel + Grain Drill	53	42	46
4	No-tillage + CU Drill	31	35	39

*Research by Jay Chapin, Professor of Entomology,Soils, and Plant Sciences; and Ahmad Khalilian, Professor of Agricultural and Biological Engineering, Clemson University
** One-pass planting

Percent ground cover for the treatments in Table 1 averaged 35 percent for the two one-pass systems, 79 percent for the no-till treatment and only 13 percent for the conventional tillage system. The minimum amount for meeting conservation tillage requirements is 30 percent ground cover. The one-pass systems tested are unique in that they provide the deep tillage critical for optimum production for wheat and soybean yields in the Coastal Plains, yet they also conserve surface residues. Over the long term, the surface residues help improve organic matter in the top 1 to 2 inches of the soil, reduce runoff and erosion, help reduce weed seed germination, and improve rainfall infiltration rates.

OTHER REDUCED-TILLAGE RESEARCH IN SC

At the Pee Dee Research and Education Center at Florence, other reduced-tillage doublecropping research has been conducted by Clemson researchers, Drs. Jim Frederick and Gloria McCutcheon, and Drs. Warren Busscher and Phil Bauer of USDA-ARS. The objectives of their work were to:

a) determine the impact of deep tillage, narrow row spacings, and conservation tillage on the yield and profitability of various wheat/soybean double-cropping systems;

b) quantify changes in pest populations and need for pesticide applications for the various treatments;

c) measure changes in soil compaction resulting from the use of no surface tillage and deep tillage practices; and

d) examine the relationship between soybean yield response to treatments and soil characteristics such as soil organic matter concentration and depth to clay.

All pest management practices for the study were conducted according to Clemson University Extension Service recommendations. A John Deere 750 no-till drill was used to plant the wheat and the narrow-row soybeans (both in 7.5-inch rows), and a John Deere 7200 4-row planter was used to plant the wide-row soybeans that did not have any deep tillage, i.e., subsoiling. For those wide-row plots receiving subsoiling, a 4-row KMC subsoiler/planter was used. For all plots receiving broadcast deep tillage, a 6-shank Paratill plow (24-inch shank spacing) was utilized.

The yield results from 1995-1997 from Florence are presented in Table 2.

Table 2. Wheat and soybean yields (bu/acre) for reduced tillage tests ('95-97 ave.) at the Pee Dee REC, Florence, SC

Fall deep tillage*	Surface tillage	Spring deep tillage*	Wheat yield Soy *row width* (in) 30	7.5	Soybean yield *Soy row width* (in) 30	7.5
yes	disced	yes	48	47	37	63
yes	disced	no	45	45	36	53
yes	no-till	yes	51	51	43	85
yes	no-till	no	46	53	39	67
no	disced	yes	37	45	39	59
no	disced	no	35	35	36	49
no	no-til	yes	40	44	41	70
no	no-till	no	34	34	36	52

Research conducted by Jim Frederick and Gloria McCutcheon, Clemson University, and Phil Bauer and Warren Busscher, USDA-ARS at Florence, SC Paratill

In looking at the wheat yields only, fall deep tillage definitely provides a yield advantage. It is interesting to note that the no-till wheat yields with deep tillage (either in the fall only or fall and spring) do not show a yield decrease vs. conventional surface tillage. In fact, no-till/deep-till wheat yields show an upward trend for yield.

For soybeans at Florence the results are more dramatic. For example, drilled row spacings, fall deep tillage, and no-till all look to be the best treatments. However, there is an 18-bushel average increase in drilled no-till soybean yields when the soil is Paratilled both in the fall and spring.

CONCLUSIONS

The bottom line in these discussions of reduced-tillage systems for profitable wheat/soybean double-cropping systems for South Carolina is as follows:

1. Winged plows that break soil hardpans in a more broadcast fashion and leave most of the surface residues undisturbed are here to stay, and will become more prevalent as more farmers adopt conservation tillage;

2. Deep tillage tools like the subsoiler will continue to be used, as will wide 30- to 40-inch rows for soybeans; however, farmers who wish to adopt drilled conservation tillage technologies for double-cropping, as those discussed in this section, will quickly recognize the benefits in better yields, need for less labor and equipment, and enhanced environmental compatibility;

3. Better drills, Roundup Ready varieties, and controlled traffic systems will help enhance the chances for success.