Influence of Tillage Systems on Wheat Yields and the Need for In-row Subsoiling for Doublecropped Soybeans

R. R. Sharpe, J. T. Touchton and D. W. Reeves[1]

Introduction

Many of the sandy Coastal Plain soils are highly compactible, and contain root restricting tillage pans 8 to 12 inches below the soil surface. These relatively thin (1 to 2 inches thick) pans are created primarily by tillage implements and machinery traffic. If they are not fractured at planting, crop yields can be severely reduced, especially in dry years.

In areas where root restricting tillage pans are common, in-row subsoilers are used at planting. The subsoilers, which are generally attached to the planting unit, fracture the tillage pan directly under the row, and permit root growth into the subsoil area. In untilled soils, they also fracture and loosen a 6- to 12-inch strip of surface soil. Data reported by Whiteley and Dexter (1982) suggest the possibility that positive yield responses to in-row subsoilers are due as much from fracturing the surface soil as from fracturing the tillage pan.

Although these subsoilers are needed in soils with tillage pans, they create such problems as slow planting speeds, high horsepower requirements, and high initial investments. In addition, soils and or conditions in which in-row subsoilers are needed have not been well defined. These problems are some of the primary reasons for slow adoption of conservation tillage in sandy Coastal Plain soils.

For successful wheat and soybean doublecropping systems, soybeans have to be planted immediately after wheat harvest. Each one-day delay in planting soybeans after wheat harvest can reduce soybean yield an average of 0.3 bu/acre (Thurlow, 1986). To avoid delays caused by tillage, no-tillage production is frequently used. Data from a previous study (Touchton and Johnson, 1982) indicate that yield of no-tillage wheat can be reduced 8 bu/acre unless deep tillage (chisel or moldboard plowing) is used prior to planting soybeans or in-row subsoiling is used at soybean planting. Other studies have indicated that some form of deep tillage is needed prior to planting wheat (Hargrove and Hardcastle, 1984; Karlan and Gooden, 1987).

The interval between harvesting and planting is not as critical for soybean harvest and wheat planting as it is for wheat harvest and soybean planting. Thus, for soils where some tillage is needed, it would be more opportune to till prior to planting wheat instead of after wheat harvest. Since there is no fallow period between wheat harvest and planting of doublecropped soybeans, wheat root growth promoted by tillage may prevent soil recompaction and form macropores that would eliminate the need for in-row subsoiling for soybeans. The objectives of field studies reported here were to determine tillage effects on wheat yield, and if tillage prior to planting wheat would eliminate the need for in-row subsoiling at soybean planting.

Materials and Methods

Field studies were conducted for 3 years on seven soils within three geographic regions of Alabama. The first five soils listed in Table 1 are in the Coastal Plains, the Sumpter soil is in the Black Belt, and the Decatur soil is in the Tennessee Valley. Except for the Lucedale soil, the Coastal Plain soils contained defined tillage pans 5 to 9 inches below the soil surface. On these soils, yield responses to in-row sub-

[1]Graduate Research Assistant and Professor at Alabama Agricultural Experiment Station, Agronomy and Soils Department, Auburn University, AL; and Research Agronomist, USDA-ARS. Soil-Plant Interaction Research Unit, Auburn University, AL

Table 1. Wheat grain yields (3-year average) as affected by tillage prior to planting wheat.

Tillage	Dothan	Malbis	Benndale	Lucedale	Bama	Sumter	Decatur
				bu/acre			
None	32	36	19	43	26	31	32
Disk	40	42	21	51	37	40	42
Chisel	45	43	35	52	45	40	45
Turn	52	48	36	50	45	39	48
LSD (0.10)	4	3	3	3	4	3	2

soiling at soybean planting are not uncommon. The Sumter and Decatur soils generally do not contain root-restricting tillage pans, and yield responses to in-row subsoiling on these soils are not common.

Treatments consisted of six tillage systems prior to planting wheat and two at soybean planting. Tillage treatments prior to planting wheat were (1) no-tillage, (2) disk only, (3) chisel-disk, (4) turn-disk, (5) chisel-level, and (6) turn-level. The leveling implements for treatments 5 and 6 consisted of a drag bar at three locations and a roterra at three locations. The disk-only treatment consisted of one pass with an offset disk. Depth of disking was 3 to 5 inches. Shank spacing on the chisel plows was 15 inches for each of the dual tool bars. The shanks on the front and back tool bars were offset so that actual distance between chisel points was 7½ inches. Actual depth of chiseling ranged between 6 and 9 inches. Turning depth with the moldboard plow for treatments 4 and 6 was 8 to 10 inches.

Soybeans were planted into wheat stubble with (except on the Sumter and Decatur soils) and without in-row subsoiling. Depth of subsoiling was 10 to 12 inches. Each year, wheat was planted in November and soybeans were planted in late May or early June. Wheat was drilled in 6⅔-inch row widths, and soybeans were planted in 36-inch row widths the first year and 24- to 30-inch row widths in subsequent years when the in-row subsoiler was used. When the subsoiler was not used, row widths were 18 to 24 inches depending on location. Seeding rates were 60 and 90 lb/acre for soybean and wheat, respectively.

Results and Discussion

Soil leveling methods (disking, dragging, roterring) after deep tillage had no effects on wheat or subsequent no-tillage soybean yields. Therefore, data presented for the chisel and turn plow treatments are averaged over leveling methods.

Although differences between years occurred and interactions between years and tillage treatments existed, the effects of tillage were consistent enough that conclusions drawn from 3-year averages did not result in substantially different conclusions than using any one year of data. No treatment resulted in higher wheat (Table 1) or soybean yields (Table 2) than moldboard plowing, and for comparison purposes, the moldboard plow is used as the standard treatment.

Wheat grain yields

No-tillage resulted in lower yields than any other treatment (Table 1). When averaged across soils, no-tillage resulted in 23, 30, and 31 percent lower wheat grain yields than disking, chiseling, and turning, respectively.

On the Lucedale and Sumter soils, disking only resulted in yields equal to moldboard plowing. On the Benndale, Lucedale, Bama, Sumter, and Decatur soils, chiseling resulted in yields equal to moldboard plowing. The increase in yields as the amount of surface soil tilled increased indicates that yield-restricting surface soil compaction existed on all soils. Those showing the greatest yield response to the amount of surface soil tilled (disking vs. chiseling or turning) were the Dothan, Benndale, and Bama soils. Since incremental increases in yields decreased as the amount and depth of surface soil tilled increased (yields averaged 31, 40, 44, and 45 bu/acre for no till, disk, chisel, and turn, respectively), it appears that surface soil compaction is a yield restricting factor with no-tillage wheat.

On coarse, loamy soils with well-developed tillage pans, such as those that exist in the Dothan and Benndale soils, depth of tillage can have a large influence on plant growth and yields. The tillage pan depth on the Dothan and Benndale soils was 8 to 9 and 5 to 6 inches, respectively. The moldboard plow (10-inch depth) penetrated the tillage pan on both soils, but the chisel plow did not penetrate the deep pan in the Dothan soil. Failure to penetrate the tillage pan in the Dothan soil may be the reason chisel plowing resulted in lower yields than the moldboard plow on the Dothan, but not the closely related Benndale soil. This response indicates that the disruption of tillage pans is also important for wheat production.

Yield difference between no tillage and the absolute highest yielding deep tillage treatment was greater the second than first year except on the Lucedale and Sumter soils. The difference continued to increase the third year on the Dothan, Malbis, and Bama soils, which indicates that the adverse effect of continuous no-tillage on wheat-grain yield can increase with time on some soils.

Table 2. Yield of no-till soybeans (3-year average) as affected by in-row subsoiling at planting and tillage prior to planting wheat.

Wheat tillage	Soil and Subsoiling[1]											
	Dothan		Malhis		Benndale		Lucedale		Bama		Sumter	Decatur
	ss	NS	ss	NS	ss	NS	ss	NS	ss	NS		
	...bu/acre											
None	43	40	52	49	46	30	32	35	31	28	35	33
Disk	45	40	49	47	49	36	31	36	29	24	30	30
Chisel	46	44	49	49	48	43	38	35	31	21	33	31
Turn	43	44	50	52	49	45	31	36	30	28	31	28
LSD *(0.10)*	3		ns		5		ns		ns		ns	ns

[1]SS is in-row subsoiling and NS is no subsoiling. Subsoiling was not a treatment variable **on** the Sumter and Decatur soils

In-row subsoiling at soybean planting resulted in an early-season visual growth response for wheat planted without tillage and with disk tillage. The wheat for 4 to 6 inches on each side of the old subsoil track grew faster and had a darker green color than wheat in the old row middles. This early season growth difference resulted in higher grain yields in one year on the Dothan (6bu/acre) and Benndale (8 bu/acre) soils. Improved wheat yields from in-row subsoiling for soybeans, however, did not result in yields equal to those obtained with deep tillage (chisel or turn) prior to planting wheat at any location.

Soybean yield

Tillage prior to planting wheat did not have an effect on soybean yields except on the Dothan and Benndale soils (Table 2). Within years, the response to tillage occurred in 2 of the 3 years on the Dothan soil and each year on the Benndale soil. At the five locations where in-row subsoiling was a treatment, it improved yields only on the Dothan and Benndale soils. These were the same soils in which tillage prior to planting wheat influenced soybean yields. On all soils, however, in-row subsoiling resulted in more rapid early season growth and larger plants at maturity than when in-row subsoilers were not used (data not shown).

In-row subsoiling improved yields only when deep tillage was not used prior to planting wheat, which indicates that deep tillage prior to planting wheat can eliminate the need for expensive in-row subsoilers for no-tillage soybeans when soybeans are planted in relatively narrow rows (18 to 24 inches). If wider rows (30 to 36 inches) had been used, however, the increased plant growth from in-row subsoiling probably would have resulted in yield increases over smaller plants in non-subsoiled rows.

Summary and Conclusions

As expected, method of leveling the soil after deep tillage had no effect on yields. Therefore, when leveling is needed, a drag bar attached to the tillage implement would be more economical than a separate leveling operation.

When yields of both crops are considered, the highest yielding system would be no-tillage soybeans with deep tillage prior to planting wheat on soils with physical characteristics similar to either the Dothan, Malbis, Benndale, Bama, or Decatur soils. On soils with physical characteristics similar to the Lucedale or Sumter soils, diskng prior to planting wheat would be the most economical tillage system. However, it is not easy to separate the Lucedale from the Dothan, Malbis, or Bama soils on the basis of soil characteristics.

If the presence of a root-restricting tillage pan cannot be determined, the best option would be to chisel plow prior to planting wheat. On soils with root restricting tillage pans, deep tillage prior to planting wheat can eliminate the need for expensive in-row subsoilers in conservation-tillage soybean production. Although in-row subsoiling at soybean planting can have some residual effect on yield of the subsequent wheat crop, it will not compensate for deep tillage prior to planting wheat. Deep tillage can be accomplished and conservation practices can be maintained by using a chisel plow instead of a moldboard plow prior to planting wheat

Literature Cited

Hargrove, W. L., and W. S. Hardcastle. 1984. Conservation tillage practices for winter wheat production in the Appalachian Piedmont. J. Soil Water Conserv. 39:324-326.

Karlen, D. L., and D. T. Gooden. 1987 Tillage systemr for wheat production in the in the Southeastern Coastal Plains. Agron. *J.* 79:582-587.

Thurlow, D. L. 1986. Planting date effect on soybean growth and yield. Alabama Agric., Exp. Stn. Res. Rept. 4:17-19.

Touchton, J. T.. and J. W. Johnson. 1982. Soybean tillage and planting method effects on yield of double-cropped wheat and soybeans. Agron. J. 74:57-59.

Whiteley, G. M., and A. R. Dexter. 1982. Root development and growth of oilseed, wheat, and pea crops on tilled and non-tilled soils. Soil Tillage Res. 2:379-393.