In-row and Between-row Subsoiling for Sorghum Doublecropped with Winter Grains Grown in Various Tillage Systems

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Introduction

The need for in-row subsoilers in conservation tillage systems depends on many factors, such as the presence of a root-restricting plowpan, crop being grown, and previous tillage practices. In soils with severe root-restricting plowpans, the use of in-row subsoilers can greatly improve crop yields. However, there are disadvantages associated with in-row subsoiling, such as high horsepower requirements, slow planting speeds, high investment costs, and the creation of unfavorable seedbeds and more highly compacted soils.

These disadvantages can sometimes discourage the use of conservation tillage. Because of the disadvantages associated with the use of in-row subsoilers and the desperate need for conservation tillage, researchers throughout the Southeast have attempted to identify production practices that will eliminate the need for in-row subsoilers. Some of these practices have included variety selection (Granade and Akridge, 1984), previous crop tillage (Touchton and Johnson, 1982), slit tillage (Elkins and Thurlow, 1984), and starter fertilizer applications (Touchton *et* al., 1986). All of these practices have been successful with some crops on certain soils in some years, but none of them have resulted in a consistent cure for the need of in-row subsoiling.

When fibrous rooted plants are grown on highly compactible soils, some form of deep tillage will be needed either prior to or during the early part of the growing season. This tillage will help ensure that root growth can occur throughout the surface soil and that an acceptable amount of the rain received can infiltrate the soil.

Recently, Reeves and Touchton (1986) reported that between-row subsoiling may replace the need for in-row subsoiling for corn grown on a compactible soil. The potential advantages for between-row over in-row subsoiling include increased planting speeds, smaller tractors for pulling planting equipment (which would help reduce compaction problems when planting on a wet soil), and more favorable seedbeds. A disadvantage is that an extra tillage operation is required after crop emergence.

The objectives of this research were to determine: (1) if deep tillage prior to planting wheat influences the need for in-row subsoiling for subsequent grain sorghum; (2) if between-row subsoiling after sorghum emergence eliminates the need for in-row subsoiling at planting; and (3) if subsoiling operations for sorghum influence tillage needs for doublecropped winter grains.

Materials and Methods

These field studies were conducted on Coastal Plain soils for 3 years (1984-1986) at Headland (Dothan fsl), Brewton (Benndale ls) and Monroeville (Lucedale fsl), Alabama. Data from previous studies have indicated that the Dothan and Benndale soils are highly compactible and crops grown on these soils without deep preplant tillage generally respond favorably to in-row subsoiling at planting. The Dothan soil at Headland contains a root-restricting plowpan 8 to 10 inches below the soil surface. The Benndale soil at Brewton, which is very similar to the Dothan soil in physical characteristics, contains a root-restricting plowpan 5 to 6 inches below the soil surface. The Lucedale soil is generally not as compaction prone as the Dothan and Benndale soils. Crops grown without deep preplant tillage on this soil, which does not have a well-defined root-restricting plowpan, do not always respond to in-row subsoiling at planting.

The experimental plots were located on the same area as a previous tillage test with doublecropped wheat and soybeans, which is also reported in these proceedings (see pages 76-78). The tillage systems prior to planting the winter grains for this study consisted of (1) no-tillage, (2) disk, (3) chisel-disk, (4) turn-disk, (5) subsoil, and (6) subsoil plus fertilizer. The chisel-disk treatment consisted of a double-gang chisel plow. The shanks on the front and rear tool bars were offset to give an effective shank spacing of 7% inches. Depth of chiseling was 6 to 9 inches.

For the turn treatment, depth of turning was 8 to 10 inches. After chiseling and turning, the soil was leveled with a leveling disk. The subsoil treatment consisted of pulling a subsoiler commonly used for in-row subsoiling through the field. Distance between subsoil shanks was 36 inches and depth of subsoiling was 12 to 14 inches.

The subsoil plus fertilizer treatment was the same as the subsoil treatment except a solid fertilizer (150 lb/acre of

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13-13-13) was dropped into the subsoil tracks at Brewton and Monroeville and a solution fertilizer (150 lb/acre of 20-17-0) was placed at the bottom of the subsoil track at Headland. Leveling after subsoiling was not needed or used.

The no-tillage, disk, chisel, and turn treatments used in this study are on the same plots as the previous 3-year test so they represent 4 to 6 years of the same tillage system for these plots. The subsoil treatments replaced leveling method treatments used on the previous test.

When the winter grains were harvested, the tillage plots were split. All of the grain sorghum was planted without preplant tillage but half of each tillage plot was planted with in-row subsoiling and the other half was planted without in-row subsoiling. The same planting implement was used for each split treatment, but subsoil shanks were removed for planting the non-subsoiled plots. Each year at Brewton and in the third year at Monroeville, the plots were split a second time and the row middles in half of each plot were subsoiled 4 weeks after planting. Depth of subsoiling for all operations was approximately 12 inches.

The winter grains, which were triticale (Beagle) at Headland and wheat (Coker 762) at the other locations, were drilled (6⅔-inch row widths) in November each year. The grain sorghum (Savanna 5) was planted in 24-inch row widths during the first week of June each year. All plots for each crop were harvested with a small farn-type combine modified for plot work

Except for the one treatment where fertilizer was applied prior to planting the winter grain, fertilizer and lime applications were in accordance with recommendations based on soil test data. Recommended pesticides were applied as needed to control weeds and insects.

Results and Discussion

Wheat and Triticale Yields

Small grain yields did not vary among subsoiling treatments for sorghum (in-row at planting or subsoiling in the row middles one month after planting). Therefore, data listed in Table 1 are averaged over subsoiling treatments for sorghum. Other studies have also shown that tillage prior to planting the summer crop may not affect wheat yields (Baker, 1987), but some studies have indicated that previous crop tillage can influence wheat yields on some soils (Touchton and Johnson, 1982).

Small grain yields were lowest with no tillage at each location and year (Table 1). When compared to the best yielding tillage treatment, no tillage resulted in a 75 percent yield reduction at Brewton, a 63 percent reduction at Monroeville, and a 49 percent reduction at Headland. Disk tillage resulted in considerable yield improvements over no tillage, however, yields from disk tillage were inferior to the best yielding deep tillage treatment each year at Brewton and Headland, and one year at Monroeville. When averaged across years within locations and compared to yields with the turn treatment, disk tillage resulted in 6, 3, and 8 bu/acre lower yields at Brewton, Monroeville, and Headland, respectively.

Chisel plowing resulted in lower yields than turning in one year at Brewton and in 2 years at Headland. In each of these years, however, subsoiling on 36-inch centers resulted in yields equal to turning, which indicates that depth of chiseling (6 to 9 inches) was too shallow. Depth of chiseling, however, is frequently a function of soil strength, which is directly influenced by soil moisture, a factor over which the operator has limited control. With only one exception, subsoiling resulted in yields equivalent to turning.

Since subsoiling is essentially a no-tillage system with channels cut 12 to 14 inches deep on 36-inch centers, it appears that the reported adverse effects of no-tillage on wheat yields (Hargrove and Hardcastle, 1984; Karlen and Gooden, 1987, Martin and Touchton, 1982) may be due to subsurface compaction and not entirely to surface soil compaction or residue effects. This hypothesis is supported by the occasional low yields with chisel plowing on the two sites with hardpans (Brewton and Headland). Chisel plowing on these sites would have eliminated surface soil compaction in the upper 6 inches of soil and would have incorporated heavy surface mulches, but would not have consistently eliminated plowpans. It should be noted that no-tillage wheat production does not reduce yields on some soils (Griffin and Taylor, 1986; Sanford, 1979; Undersander and Reiger, 1985).

Dropping fertilizers behind the subsoil shanks improved yields in only 1 of the 6 location years (Brewton in 1986).

Table 1. Wheat grain yields at Brewton and Monroeville and triticale yields at Headland as affected by tillage prior to planting.

	Loeation and Year								
	Brewton			Monroeville			Headland		
Tillage	1984	1985	1986	1984	1985	1986	1984	1985	1986
	bu/acre								
No-till	8	6	15	25	6	9	22	19	12
Disk	40	25	31	47	21	28	25	22	35
Chisel	40	27	38	51	28	28	25	23	41
Turn	50	30	34	49	28	29	33	31	42
Subsoil	46	24	36	46	26	28	33	29	40
Subsoil + fertilizer	46	28	45	50	30	26	32	29	39
LSD (0.10)	5	4	5	5	6	6	6	6	6

Evidently, starter fertilizers are not as effective with winter grains as with summer crops.

Gmin Sorghum Yields

Grain sorghum yields (Table 2) varied among years and were relatively low. The yields obtained, however, were actually higher than average yields of doublecropped sorghum in south Alabama.

Tillage prior to planting the winter grain crops had no effect on grain sorghum yields, and unlike soybean in previous studies, deep tillage prior to planting the winter crops did not eliminate the need for in-row subsoiling at sorghum planting.

In-row subsoiling at planting without subsoiling the row middles, which is the common practice, resulted in higher yields than no in-row subsoiling each year at Brewton and Headland and in one of the 3 years at Monroeville. When averaged over years, in-row subsoiling compared to no in-row subsoiling resulted in yield increases of 10, 6, and 24 bu/acre at Brewton, Monroeville, and Headland, respectively.

At Brewton, between-row subsoiling in addition to in-row subsoiling reduced yields one year, improved yields one year, and had no effect the other year; 3-year averages were equal (58 hu/acre). Between-row subsoiling without in-row subsoiling, compared to in-row subsoiling alone, resulted in laver yields the first year, equivalent yields the second year, and higher yields the third year. Averaged over the 3 years, between-row subsoiling compared favorably to traditional in-row subsoiling (55 vs 58 bu/acre) at this site. When comparing between-row subsoiling alone with no subsoiling, the between-row subsoiling improved yields 2 out of 3 years and resulted in 7 bu/acre higher yields for the 3-year average.

At Monroeville, between-row subsoiling was used only in the third year. Yield response in this year was due entirely to between-row subsoiling, and the average yields were 62 and 48 bu/acre with and without between-row subsoiling, respectively. In-row subsoiling alone resulted in yields of 47 bu/acre.

It is not known why yield responses to between-row subsoiling occurred. The responses could have been due to the elimination of between-row surface soil compaction, which could have resulted in improved root growth between rows, to increased water infiltration, or a combination of the two. In each year, subsoiling the middles of the relatively narrow rows (24-inch row widths) resulted in severe plant damage. Except for the 1984 growing season at Brewton, the sorghum plants were able to compensate for this early-season plant damage.

Table 2. Grain sorghum yields as affected by in-row subsoiling at planting and between-row subsoiling 4 weeks after planting.

	Subsoiling		Year			
	In-row	Between-row	1984	1985	1986	Mean
			bu/acre			
Brewton						
	Yes	Yes	43	60	70	58
		No	50	53	70	58
	No	Yes	34	51	81	55
		No	35	46	62	48
	LSD (0.10)[1]		5	6	6	
Monroeville						
	Yes	Yes	—[2]	—	60	—
		No	79	53	41	60
	No	Yes	—	—	64	—
		No	65	50	48	54
	LSD (0.10)		*	ns	5	
Headland						
	Yes	—	90	42	62	65
	No	—	71	15	37	41
	LSD (0.10)		*	*	*	

[1]Statistics are for values in a column within years and locations. Where only two values occurred within a location year, * indicates that the two values are different at the 5% level of probability, and ns indicates no difference.

[2] — Indicates that treatments were not used.

Summary

No tillage and disk tillage for wheat production can result in severe yield reduction for both wheat and triticale. Genera-ly, chisel plowing, turn plowing, or subsoiling on 36-inch centers resulted in equivalent yields. Chisel plowing resulted in lower yields than turning where depth of chiseling was not adequate. Tillage prior to planting small grains had no effect on subsequent grain sorghum yields, and deep tillage prior to planting winter grains did not eliminate the need for in-row subsoiling for grain sorghum. It appears that between-row subsoiling after stand establishment may be an alternative to the requirement for in-row subsoiling at sorghum planting.

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