Conservation Tillage Interseeding of Soybeans into Standing Wheat

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Introduction

Doublecropping soybeans after winter wheat has been a successful practice in South Carolina for many years. Currently, approximately 50 to 60% of the state's soybean acreage is doublecropped. Though popular, doublecropping has become economically risky due to high production costs, low commodity prices, and drought-induced low soybean yields. The risks associated with conventional methods plus the advent of better herbicides and equipment have stimulated interest in intercropping as an economically-viable double cropping method. The idea of intercropping wheat and soybeans in the southern U. S. involves planting soybeans between rows of standing wheat in early to mid-May during the heading stage. The advantages of intercropping over conventional doublecropping are: a) better potential for full-season or mono-crop soybean yield; b) better utilization of soil moisture; c) reduced soil erosion and compaction; d) early competition with weeds; and e) potential for lower costs, especially for fuel and equipment.

Interseeding requires the planting of wheat in 13 in rows in the fall with soybeans planted between wheat rows the following May. To accomplish this with minimum damage to wheat, Clemson University's Agricultural Engineering Department developed an inexpensive interseeder drill. For wheat, the drill has 11 Danish or s-tine furrow openers on 13 in centers with small spring-mounted fingers, for covering the seed with soil, behind the seed drop tubes (Khalilian et al., 1987). Eight double-disk openers and small press wheels are utilized for interseeding the soybean crop. Figure 1 shows the intercropping planting pattern for wheat and soybeans.

The concept of interseeding soybeans into standing wheat utilizes the benefits of deep tillage before wheat planting, since there is no tillage prior to soybean planting. The objectives of this study were to determine the residual effects of various conservation tillage systems and controlled traffic on soybean yield, crop responses and the formation of soil hardpan.

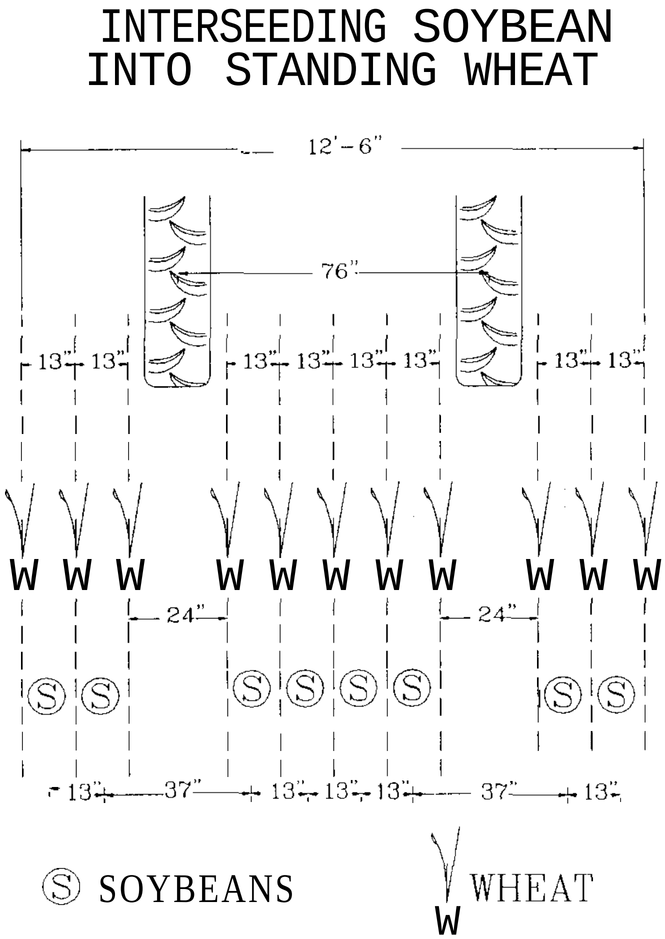

Figure 1. The intercropping planting pattern for wheal and soybean.

Procedures

Conservation tillage tests were conducted three years (1987-89) at the Edisto Research & Education Center at Blackville, S.C., to determine the proper tillage system for interseeding soybeans into standing wheat. Six treatments (Tablc 1) involving various tillage and planting comparisons were utilized on a Dothan sandy loam (irrigated location) and Varina loamy sand (non-irrigated location), both typical of productive soils in the southeastern Coastal Plains. A randomized complete block experimental design with six

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replications selected for evaluating the tillage/planting treatments.

Primary tillage equipment included a four-shank Paraplow with 22 in spacing, operating 12-13 in deep; an eleven-shank chiselplow , with 12 in spacing, operating at 11 in depth; and a four-shank 38-in spaced subsoiler operating at 12-13 in depth.

Wheat varieties 'Coker 983' (1987-88) and 'Coker 9766' (1989) were planted in late November each year immediately after tillage work at a seeding rate of 90 Ib/acre. The soybean variety 'Kirby' was interseeded at a rate of 60 Ib/acre between rows of standing wheat around mid-May. Only the plots in treatments one, three, and four (Table 1.) were interseeded with soybeans. Wheat from all plots was harvested around the first week in June, and soybeans planted in plots for treatments two, five, and six. Fertilizer, applied at rate based on soil analyses, was broadcast before any tillage in the fall. Postemergence herbicides were applied as needed.

Table 1. Tillage/Planting Trealmenl Combinations.

Treat. No.	Tillage Before Wheat			Wheat Planting Method		Tillage Before Soybean	Soybean Planting Method	
	Disk	Ch	Para	Clem	Drill	Para	Clem	KMC/Sub
1	x			x			1*	
2	x			x			2**	
3	x	x		x			1	
4	x		x	x			1	
5	x		x	x		X	2	
6***	x	x			x			2

* - Mid-May soybean interseeding date.
** - Soybean planted in june after wheal harvest.
*** - Conventional doublecropping method for wheat and soybeans in Coastal Plain soils.
Ch = chisel plow; Para = Paraplow; Clem = Clemson interseeder; Drill = conventional grain drill with 7 in rows; KMC/sub = KMC subsoiler-planter with 38 in rows.

To determine effects of deep tillage equipment, a tractor-mountcd recording penetrometer was used to quantify soil resistance to penetration. Soil compaction values were calculated from the measured force required to push a 0.5 in2base area cone into the soil. Penetrometer data were taken two months after wheat planting and one month after soybean planting. Two sets of penetromcter readings were taken from soybean plots, one from the soybean rows and the other from the tractor tire tracks.

Root weight and length were measured immediately after penetrometer data were taken. Core samples were taken at depths of 0-6, 6-12, and 12-18 in from the wheat plots. A steel tube, four inches in diameter with a hardened cutting edge, was used to take a minimum of nine cores from each plot. Thus a total of 54 cores were taken per treatment. Roots were separated from the soil by washing, samples were floated in shallow water in a clear glass tray, and root length measured with an area meter (Delta T Device) as described by Harris and Campbell (1987). *Also*, each sample was oven dried to determine root dry weight. Shoot growth was measured by clipping the wheat plant on the same date penetrometer data were taken.

Harvest data for both wheat and soybean were taken with a plot combine in 1987. Middle rows from each plot were harvested and weighed for yield determination. In 1988 and 1989, a conventional combine with 13 ft header was used to harvest the crops. An attachment was added to the combine for placing wheat straw in wheel tracks to aid in weed management.

Results and Discussion

Table 2 shows shoot growth, root growth at different soil depth nitrogen uptake by wheat, and cone index values averaged over the E-horizon (hardpan area) for tillage/planting equipment used in the test. The Paraplow significantly reduced soil compaction of the hardpan layer compared to chisel and disk plots. Cone index values in hardpan area for disk plots were not high enough to completely eliminate root penetration into the clay layer (cone index values above 290 psi generally stop root growth -- Taylor and Gardner 1963, and Carter and Tavernetti 1968). Also, there was a significant difference in soil compaction between chisel plots planted with Clemson interseeder and chisel plots planted with a conventional grain drill in 1987. This could be due to press wheels and double disk openers on the grain drill which tend to compact the soil. The grain drill used in 1988 did not have press wheels and used instead single disk openers. There were no differences in soil compaction between chisel plots planted with the grain drill and Clemson interseeder in 1988.

As shown in Table 2, two months after tillage a noticeable difference was observed in root length in the clay layer due to high resistance to penetration. There was a very good correlation between soil compaction in the hardpan and root length in the clay layer. Figure 2 shows the relationship between root distribution at different depths and shoot biomass for different tillage tools for 1987. A similar trend was observed in 1988. Shoot growth increased as root penetration of the clay layer increased. There was no significant difference in total root length of wheat plants in different tillage plots.

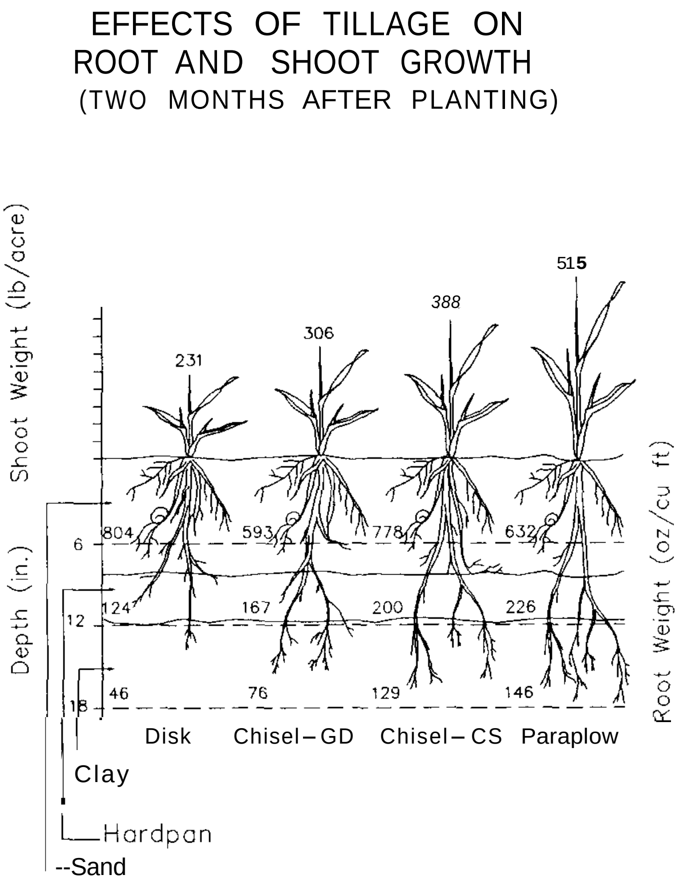


Figure 2. Correlation of root distribullon at different depths and shoot biomas (1987).

Deep tillage increased nitrogen uptake by the wheat plant. The plants in the Paraplow and chiselplow plots had the higher levels of nitrogen uptake compared to those in disk plots (Table 2). This would result in a higher protein forage for winter grazing.

A comparison of individual root dry weight measurements with root length data, measured by the Delta T Device area meter, showed a good relationship between root weight and length (Figure 3). The correlation coefficient was 0.978 (significant at the 95 percent level). Root length measurement requires excessive time expenditure and is not without error. Root weight is relatively easy to obtain and can be used to estimate root length from prediction equation developed for the 'Coker 983' wheat variety.

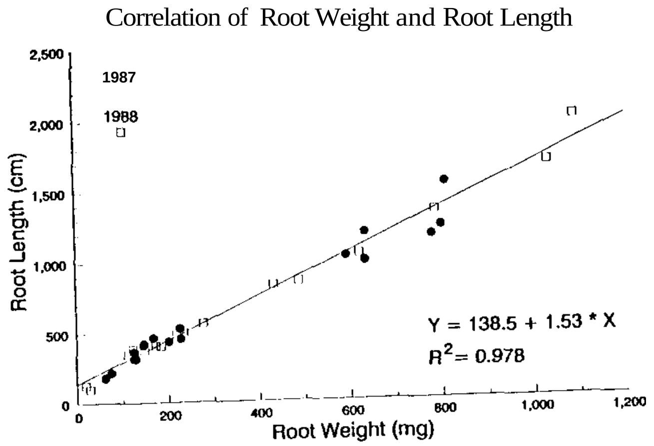


Figure 3. Correlation of root weight and root length for wheal (Coker 983).

The Paraplow plots produced significantly higher wheat yield per acre than any other tillage treatments at both locations (Figures 4 and 5). There was no significant difference in yield between chiselplow plots planted with Clemson interseeder (13-in rows) and those planted with conventional grain drill (7-in rows). Seeding rate per acre for both planters was the same (90 lb/acre). Interseeding soybeans between rows of standing wheat did not reduce wheat yields (Disk 'CS-IN' vs. Disk 'CS-AH' and Paraplow 'CS-IN' vs. Paraplow 'CS-AH', Figures 4 and 5). Disk plots produced significantly less yields compared to Paraplow and chiselplow plots in both locations.

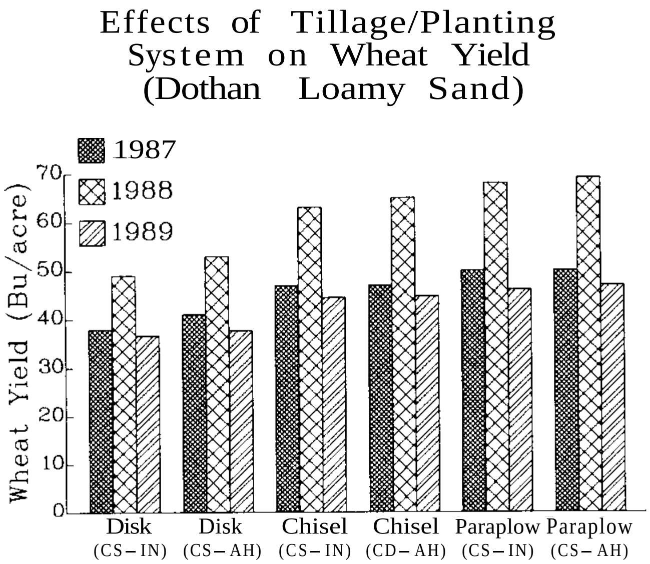
Table 2 Average shoot weight, root length at different soil depth, nitrogen uptake and cone index values two months after wheat planting.

Tillage	Planter	Shoot Weight	Root length (in/quart)			Nitrogen Uptake	Average* Cone index
		(lb/ac)	0-6"	6-12'	12-18"	(% DM)	(Psi)
1987:							
Paraplow	Clem.	515 a**	405 a	184 a	156 a	3.83 a	96 a
Chisel	Clem.	388 b	434a	163a	117 ab	3.55 a	129a
Chisel	Drill	343 c	382 a	175 a	81 b	3.66 a	178 b
Disk	Clem.	259 c	514a	127a	68 b	2.93 b	200 b
1988							
Paraplow	Clem.	558 a	434 b	198 a	152 a	3.80	98 a
Chisel	Clem.	504a	317 c	182 a	131 a	3.70	137a
Chisel	Drill	508 a	308 c	193a	144 a	3.70	127a
Disk	Clem.	383 b	681 a	138 a	43 b	3.20	198 b

* Cone index values are averaged over E horizon (hardpan area), depth = 8 to 11 in.
** Values followed by the same letter are not significantly different (based on Duncan's Multiple Range lest).

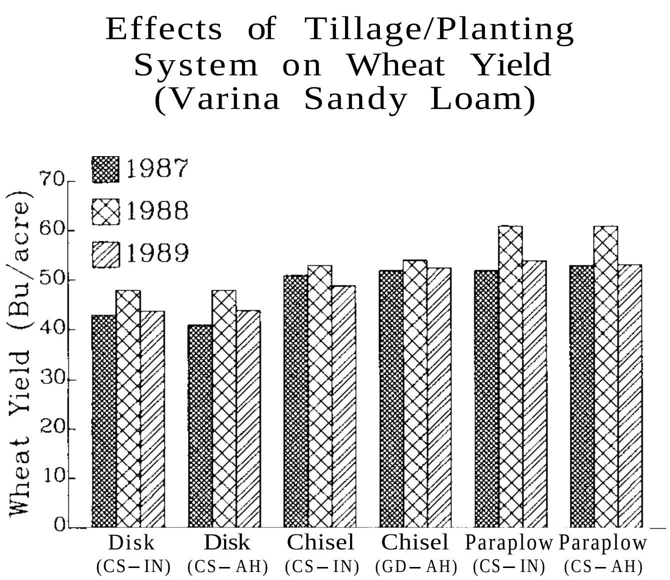
Traffic significantly increased soil compaction compared to penetrometer measurements within the soybean rows. The biggest difference in soil compaction was experienced in the hardpan area. Due to controlled traffic deep tillage benefits from Paraplowing before small grain planting carried over and benefitted soybeans. There was no significant difference in soil compaction between Paraplow plots tilled in fall with those of conventional doublecropped plots (chiselplowing in the fall followed with subsoiling prior to planting soybeans). Also, there was no significant difference in penetrometer measurements between plots Paraplowed only once in the fall with those which had an extra deep tillage operation with the Paraplow in next June. This indicates that, when interseeding is practiced behind deep tilling for wheat, there is no advantage to deep tillage for soybeans.

Interseeding soybeans into standing wheat produced higher soybean yield compared to those planted after wheat harvest for each tillage system ('IN vs. 'AH', Figures 6 and 7). Paraplowing before wheat significantly increased soybean yields compared to chiselplow and disk. Top interseeded soybean yields for both irrigated and non-irrigated locations were significantly better than conventional KMC row-subsoil planted yields of 'Kirby' soybeans after wheat harvest. Irrigation increased soybean yields about 15 bushels per acre in 1989 but increased only 2 bushels per acre in 1988 (irrigation decisions were not made with aid of tensiometers).



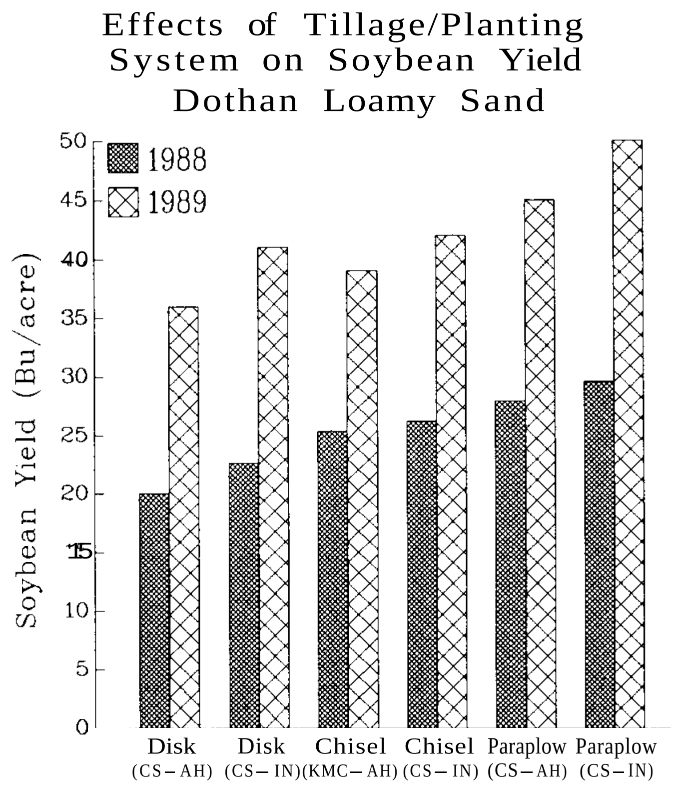
CS = Clemson Seeder; KMC = Subsoiler/planter
CI = Interseded into wheat; AH = After Harvest

Figure 4. Effects of tillage/planting system on wheat yield (Dothan loamy sand).



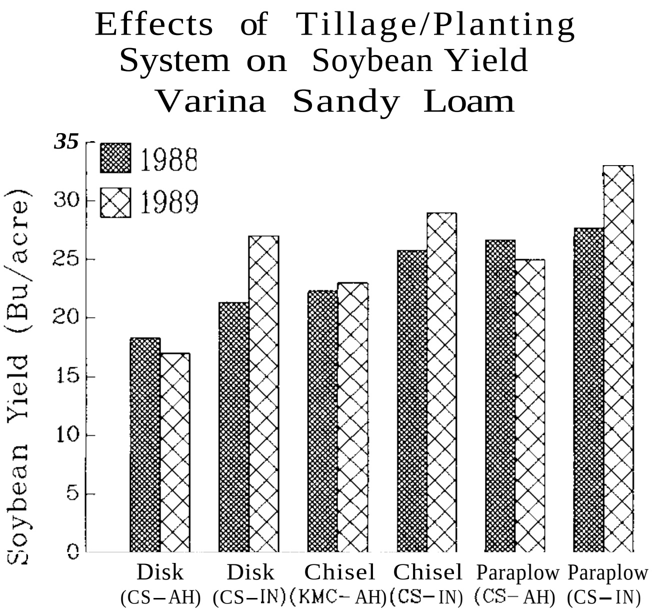
CS = Clemson Seeder; KMC = Subsoiler/planter
CI = Interseded into wheat; AH = After Harvest

Figure 5. Effect of tillage/planting system on wheal yield (Varina sandy loam).



CS = Clemson Seeder; KMC = Suhsoiledplanter
CI = Interseeded into wheat; AH = After Harvest

Figure 6. Effects of tillage/planting system on soybean yield (Dothan loamy sand).



CS = Clenison Seeder, KMC = Subsoiler/planter
CI = Interseeded into wheat; AH = After Harvest

Figure 7. Effects of tillage/planting system on soybean yield (Varina sandy loam).

Conclusions

a) Paraplowing significantly reduced soil compaction in the hardpan area compared to chiselplow and tandem disk.

b) Shoot biomass for wheat increased as root penetration of clay layer increased.

c) Wheat yields were not affected by row spacing at yield levels of 40 to 70 bushels per acre. Deep tillage significantly increased wheat yields. Interseeding soybeans into standing wheat did not reduce wheat yields.

d) Deep tillage benefits from Paraplowing before small grain planting carried over and benefitted soybeans due to controlled traffic patterns associated with the interseeding system.

e) Interseeded soybeans yielded significantly more than conventional double-cropped soybeans at both the irrigated and non-irrigated locations.

References

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