RESEARCH IN NORTH CAROLINA WITH REDUCED TILLAGE SYSTEMS FOR PEANUT (1997-2001)

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ABSTRACT

Reduced tillage peanut (*Arachis hypogaea* L.) production has gained considerable interest in North Carolina over the past few years. Determining if peanut yield is maintained in reduced tillage compared with conventional tillage is important in determining the utility of this approach to peanut production. Thirty experiments were conduced from 1997 through 2001 in North Carolina to compare peanut yield in conventional tillage systems to yield when peanut was strip tilled into stubble from the previous crop or a small grain cover crop. When pooled over experiments, pod yield in conventional tillage was 164 lb acre^{-1} or 5.0% higher than pod yield in strip tillage. Differences in yield between systems were as high as 29.9%, with greater yield differences noted on finer-textured soils. Yield in conventional tillage exceeded that of strip tillage when major differences in yield were noted. In eleven of these experiments, pod yield of peanut in conventional tillage, strip tillage into stubble, and strip tillage into stale seedbeds (beds established the previous fall or winter) was compared. When peanut was strip tilled into stale seedbeds and crop stubble, pod yield was 6.0% and 11.4% lower than yield in conventional tillage, respectively. Results from these experiments suggest that while peanut yield can equal and occasionally exceed that of conventional tillage when strip tilled into crop stubble or stale seedbeds, yield generally remained higher in conventional tillage. These experiments were conducted in situations that would be considered a transition from conventional tillage to strip tillage. Results from long-term strip tillage production may be more positive due to improvements in soil tilth in strip tillage.

KEYWORDS

Conventional tillage, stale seedbed, wheat cover crop.

INTRODUCTION

Peanut in the United States is typically grown in conventionally tilled systems (Sholar *et al*., 1995). Peanut response to reduced tillage has been inconsistent. Research suggests that yields in reduced tillage can be lower than (Brandenburg *et al*., 1998; Cox and Sholar, 1995; Grichar, 1998; Sholar *et al*., 1993; Wright and Porter, 1995) or similar to (Baldwin and Hook, 1998; Hartzog *et al*., 1998; Williams *et al*., 1998) yields in conventional tillage systems. Higher yields in reduced tillage systems have been associated with lower incidence of tomato spotted wilt *tospovirus* (Baldwin and Hook, 1998).

Between 10 and 18% of growers planted peanut in reduced tillage systems in North Carolina from 1998 through 2000 (Jordan, 2002). Although reduced tillage systems offer several potential benefits, consistency of yield is a concern of growers and their advisors. Therefore, experiments were conducted in North Carolina to compare pod yield of peanut grown in conventional tillage and strip tillage systems in an attempt to define factors influencing peanut response to tillage.

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MATERIALS AND METHODS

Experiments were conducted in North Carolina from 1997 through 2001 at a variety of locations, on several soils, with various Virginia market type cultivars, and with several different seedbeds prepared for strip tillage (Table 1). In eleven of these experiments, beds were established in separate plots during the previous fall or winter prior to spring planting (referred to as stale seedbeds). With the exception of tillage systems, all other production and pest management practices were held constant over the entire test area. Plot size ranged from four rows to eight rows (36-inch spacing) by 30 to 75 feet long. With the exception of experiments at Edenton, strip tillage implements consisted of in-row subsoiler followed by two sets of coulters and two basket attachments to smooth the tilled zone. The tilled zone was approximately 20 inches wide. At Edenton, a vertical-action tiller, either with or without in-row subsoiler, was used to establish the tilled zone. Peanut was planted within one week following strip tillage. Peanut was harvested using standard equipment designed for small-plot harvesting. The experimental design was a randomized complete block with four replications in each experiment. The average pod yield of conventional tillage and strip tillage into crop stubble or stale seedbeds from each experiment was combined into one data set to determine the overall average. The percent difference in yield was calculated for each experiment based on the higher yield among systems.

RESULTS AND DISCUSSION

When averaged over the 30 experiments, peanut pod yield was 164 lb/acre higher in conventional tillage compared with strip tillage into stubble (Table 1). This correlated into strip tillage yields being 5.0% lower than yields for conventional tillage. Considerable variation in yield was noted among experiments, soil series, and other treatment factors. Differences in pod yield ranged from 1069 lb acre^{-1} lower (29.9%) to 463 lb acre^{-1} higher (10.6%) for strip tillage compared with conventional tillage. When comparing the ranges of percent yield difference between tillage systems, yield was within 5% in 12 of 30 experiments (40% of experiments)(Table 2). The difference in pod yield in 8 of 30 experiments ranged from 5.1 to 10%. The distribution between the highest and lowest yielding systems, either as conventional tillage or strip tillage, was equal. Four experiments fell into the 10.1 to 15% range of percent difference, with half of the experiments within this group having higher yields for conventional tillage compared with yield from strip tillage. Pod yield in six of 30 experiments was higher in conventional tillage compared with yield in strip tillage when the yield difference exceeded 15%.

Peanut yield potential appeared to be maintained at a higher level in conventional tillage rather than strip tillage. This was especially the case when major differences in yield were noted among tillage systems. Soil series, specific tillage practices for conventional tillage systems, the seedbed in which strip tillage was performed, and cultivar selection did not conclusively explain the variation in response. For example, yield on Norfolk sandy loam (NSL) soils for strip tillage yielded 14.7% lower to as much as 10.7% higher than yield in conventional tillage (Table 1). When peanut was planted on a Conetoe loamy sand (CLS) soil, yield in strip tillage was 8.3% higher in one experiment and 3.1% lower in another experiment when compared with conventional tillage. Peanut yield on Craven (CrSL), Perquimans (PSL), and Roanoke (RSL) soils, which are not considered ideal soils for peanut production, were higher for conventional tillage than strip tillage in all eight experiments where these soils were present (Table 1).

In all but one experiment (Tyner in 1999), conventional tillage included bedding or ripping and bedding operations (Table 1). Very little bed remained when peanut was strip tilled into a killed small grain cover crop or stubble from the previous crop. Although peanuts are planted on flat ground with success in North Carolina, most practitioners indicate that peanuts are more efficiently dug when grown on elevated beds compared with digging peanut planted on flat ground or where minimal beds are present. This may be especially true for large-seeded Virginia market type peanut which can experience high digging loss when soil conditions are not optimal for digging. Although not documented in these experiments, lack of beds in strip tillage systems and potential pod loss in the digging process may explain inconsistent yields in strip tillage, especially on finer-textured soils such as the Roanoke and Craven series. Although response differed on more appropriate soils for peanut production (Goldsboro, Norfolk, and Conetoe soils), inconsistent response also may have been influenced by the ability to effectively dig peanut on essentially flat ground. These soils are easier to dig than Roanoke or Craven soils and digging losses are generally lower. This explanation may be only partially complete as the reason for inconsistent response to strip tillage, and additional research is needed to refine these systems in an attempt to improve wide-scale success.

One approach to maintaining yields, if in fact elevated beds improve digging efficiency, would be to prepare beds

Table 1. Year, location, soil series, conventional tillage system, seedbed present during strip-till operation, cultivar, absolute yield difference, and percent yield difference from 30 trials comparing conventional tillage and strip tillage in North Carolina during 1997-2001. A positive value for actual and percent yield indicates that peanut yield was higher in conventional tillage systems compared with strip tillage systems.

Year	Location	Soil Series†	Conventional tillage	Strip-till seedbed	Cultivar	Yield difference Abs.	Yield difference Rel.
						lb acre^{-1}	%
1997	Tyner	CLS	Disk/Rip/Bed	Wheat	Multiple‡	-327	-8.3
1997	Edenton	RSL	Disk/Chisel/Bed	Cotton stubble	Multiple§	905	21.7
1997	Lewiston	NSL	Disk/Rip/Bed	Corn stubble	NC 10C	-458	-9.7
1997	Rock Mount	GLS	Disk/Rip/Bed	Corn stubble	NC 10C	-463	-10.6
1997	Lewiston	NSL	Disk/Rip/Bed	Cereal rye	NC 7	-438	-10.7
1998	Lewiston	NSL	Disk/Chisel/Rip/Bed	Corn stubble	NC 9	-116	-2.9
1998	Edenton	RSL	Disk/Chisel/Bed	Cotton stubble	NC 7	938	27.1
1998	Edenton	RSL	Disk/Chisel/Bed	Corn stubble	NC 7	148	4.8
1998	Halifax	NSL	Disk/Chisel/Rip/Bed	Wheat	NC-V 11	277	7.2
1998	Lewiston	NSL	Disk/Rip/Bed	Wheat	NC 7	317	11.0
1998	Woodland	CrSL	Disk/Chisel/Rip/Bed	Cotton stubble	NC-V 11	274	9.4
1999	Woodland	CrSL	Disk/Chisel/Rip/Bed	Cotton stubble	NC-V 11	1069	29.9
1999	Scotland Neck	NSL	Disk/Rip/Bed	Wheat	NC-V 11	729	14.9
1999	Halifax	NSL	Disk/Chisel/Rip/Bed	Wheat	NC 12C	-192	-4.2
1999	Rocky Mount	GSL	Disk/Rip/Bed	Cotton stubble	VA 98R	258	9.5
1999	Edenton	PSL	Disk/Chisel/Rip/Bed	Cotton stubble	NC-V 11	115	3.4
1999	Edenton	PSL	Disk/Chisel/Bed	Cotton stubble	NC-V 11	981	24.3
1999	Lewiston	NSL	Disk/Chisel/Rip/Bed	Corn stubble	NC 9	614	17.2
1999	Lewiston	NSL	Disk/Rip/Bed	Cereal rye	NC 7	-258	-6.3
1999	Gatesville	CLS	Disk/Rip/Bed	Cotton stubble	Multiple¶	146	3.1
1999	Williamston	GLS	Disk/Rip/Bed	Corn stubble	Multiple¶	4	0.2
1999	Tyner	CSL	Disk	Cotton stubble	Multiple¶	-162	-4.5
1999	Whitakers	GSL	Disk/Rip/Bed	Cotton stubble	Multiple¶	-149	-4.1
2000	Woodland	CrSL	Disk/Rip/Bed	Wheat	NC-V 11	546	23.2
2000	Lewiston	NSL	Disk/Rip/Bed	Corn stubble	NC 12C	202	4.5
2000	Lewiston	NSL	Disk/Rip/Bed	Corn stubble	Multiple#	-258	-6.3
2000	Lewiston	NSL	Disk/Chisel/Rip/Bed	Wheat	NC 12C	17	0.5
2000	Rocky Mount	GSL	Disk/Rip/Bed	Cotton stubble	NC-V 11	273	7.2
2001	Lewiston	NSL	Disk/Rip/Bed	Corn stubble	Multiple#	53	2.0
2001	Lewiston	NSL	Disk/Rip/Bed	Corn stubble	NC 12C	-120	-4.3
Average						164	5.0

†Abbreviation: CLS, Conetoe loamy sand; CrSL, Craven silt loam; GSL Goldsboro sandy loam; NSL, Norfolk sandy loam; PSL, Perquimans silt loam; RSL, Roanoke silt loam.

‡Averaged over the cultivars NC 7, Gregory, and NC-V 11.

§Averaged over the cultivars NC 7, VA 93B, and VA-C 92R.

¶Averaged over the cultivars Georgia Green, NC 10C, NC-V 11, NC 12C, Perry, and VA 98R.

#Averaged over the cultivars NC-V 11, NC 12C, Perry, and VA98R.

Table 2. Comparison of percent differences in yield between conventional tillage (CT) and strip tillage (ST) into stubble from the previous crop from 30 experiments conducted from 1997-2001 in North Carolina.

% difference in yield		Total #	CT > ST	
from	to	of expts	# expts	% expts.
0.0	5.0	12	6	50
5.1	10.0	8	4	50
10.1	15.0	4	2	50
15.1	20.0	1	1	100
20.1	25.0	3	3	100
25.1	30.0	2	2	100
	>30.0	0	0	
Total		30	18	60

during the previous fall or winter and strip till into these beds prior to seeding peanut. In the eleven experiments where this tillage system was included, pod yield was 11.4% and 6.0 % lower than conventional tillage when peanut was strip tilled into stubble from the previous crop or stale seedbeds, respectively (Table 3). These data suggest that stale seedbed production, a compromise between strip tillage into fields without prior primary tillage versus intensively tilled conventional systems, can be relatively successful. The stale seedbed approach allows establishment of beds, and this may be advantageous from a digging standpoint. In most instances where considerable difference in yield was noted between conventional tillage and reduced tillage, yield in stale seedbeds approached that of conventional tillage (Table 4). However, seeding peanut into conventionally tilled seedbeds yielded consistently higher than reduced tillage systems in 18 of 30 experiments.

When comparing data sets with 30 experiments (strip tillage into previous crop stubble versus conventional tillage) or with 11 experiments (stale seedbed system included), the difference in yield between conventional and strip tillage into stubble was 5.0% and 11.4%, respectively (Tables 1 and 3). This difference in yield between the two data sets may have been a result of the percentage of finer-textured soils within the two data sets. In the stale seedbed experiments, 5 of 11 experiments (46% of experiments) were on Craven, Perquimans, or Roanoke soils. In contrast, only 8 of 30 experiments (26% of experiments) were conducted on these soils in the data set containing all 30 experiments. These data suggest that pea-

Table 3. Year, location, soil series, actual yield difference, and percent yield difference from 11 trials comparing conventional tillage with strip tillage into crop stubble or stale seedbeds in North Carolina during 1997-2001. A positive value for actual and percent yield indicates that peanut yield was higher in conventional tillage systems compared with strip tillage into stale seedbeds or stubble from the pervious crop.

		Soil	Actual difference		% difference	
Year	Location	series†	Stale bed	Stubble	Stale bed	Stubble
			------ lbs acre^{-1} ------		---------- % ---------	
1997	Tyner‡	CLS	-391	-327	-10.7	-8.3
1998	Lewiston	NSL	15	-116	3.9	-2.9
1998	Edenton	RSL	480	938	13.9	27.1
1998	Edenton	RSL	492	148	16.0	4.8
1999	Woodland	CrSL	616	1069	17.2	29.9
1999	Rocky Mount	GSL	39	258	1.4	9.5
1999	Edenton	PSL	684	981	16.9	24.3
1999	Lewiston	NSL	247	614	6.9	17.2
2000	Woodland	CrSL	-162	546	-6.4	23.2
2000	Lewiston	NSL	362	202	8.0	4.5
2001	Lewiston	NSL	-30	-120	-1.1	-4.3
Average			214	381	6.0	11.4

† Abbreviations: CLS, Conetoe loamy sand; CrSL, Craven silt loam; GSL, Goldsboro sandy loam; NSL, Norfolk sandy loam; PSL, Perquimans silt loam; RSL, Roanoke silt loam.

‡ Averaged over cultivars NC 7, Gregory, and NC-V 11.

Table 4. Comparison of percent differences in yield between conventional tillage (CT) and strip tillage (ST) into stale seedbeds or crop stubble from 11 experiments conducted from 1997-2001 in North Carolina.

% difference in yield		Total # of expts.		CT > ST	
from	to	Stale bed	Crop stubble	Stale bed	Crop stubble
0.0	5.0	3	4	2	2
5.1	10.0	3	2	2	1
10.1	15.0	2	0	1	0
15.1	20.0	3	1	3	1
20.1	25.0	0	2	0	2
25.1	30.0	0	2	0	2
	>30.0	0	0	0	0
Total		11	11	8	8

nut response to strip tillage into the previous crop stubble may be more favorable on coarser-textured soils rather than finer-textured soils. These data also suggest that the gap in yield potential in reduced tillage compared with conventional tillage is narrowed when peanut is strip tilled into stale seedbeds.

Although these data suggest that peanut yields in conventional tillage may be consistently higher than yields in strip tillage, these experiments represented a short-term transition into reduced tillage production from conventional tillage. Positive benefits of reduced tillage often require several years of reduced tillage production before being realized.

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