Comparison of No-tillage, Minimum, and Full Tillage Cultural Practices on Peanuts

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ABSTRACT

The no-tillage system for peanuts (*Arachis hypogaea* L.) was investigated from 1978 to 1981 in comparison with minimum and full tillage. Difficulty in controlling weeds, soil compaction, and reduced yields were problems associated with no-tillage peanut culture. No-tillage plots yielded 600 to 2400 kg/ha less than full tillage each year, while the minimum tillage plots were intermediate in yield. Peanut grades were not different except in 1980 when the no-tillage system graded less than full or minimum tillage. Disease due to southern blight (*Sclerotium rolfsii*) was not affected by tillage system except in 1980 when the full tillage plots produced a lower pod disease rating than minimum or no-tillage. Target hits were lower in the no-tillage plots than full tillage plots when averaged over the four year period.

Key Words: Groundnut, no-tillage, minimum tillage, disease, yield, target sites.

Minimum tillage and no-tillage have reduced production costs of corn, grain sorghum, and soybeans (1,6,10,11,13). However, very limited research has been reported with the use of these cultural practices in peanuts (*Arachis hypogaea* L.). If no-till were a viable alternative in peanut cultures, considerable savings in energy, machinery, and labor requirements could result in increased net returns for the peanut producer. No-tillage systems have not been considered feasible in peanuts due to potential problems of 1) severe disease infestations which can occur from crop residue left on the soil surface, 2) weed competition due to poor control, especially for grass species prior to over the top herbicide availability, and 3) digging problems associated with weeds, crop residue, and soil compaction.

The no-tillage system could be very useful in controlling soil erosion and conserving soil moisture. Its use in peanuts has been primarily confined to studies in Texas (2,3), Virginia (16), Alabama (7), and Florida (4,5,15) with some current usage in commercial peanut production (8,9,12). Varnell *et al.* (15) stated that the practice of no-tillage on peanuts reduced pod yield and quality. In comparison with conventional cultural practices, no-tillage reduced foliage, pod, and kernel yields by 58, 64, and 62 percent, respectively. Poor performance was attributed to at least two factors: 1) an inadequately prepared seed bed with a compacted zone immediately below and to the sides of the row which resulted in shallow planting, and 2) intense competition from grasses in the second half of the season which contributed to lower pod yields. Rajan *et al.* (14) conducted no-tillage research in India and found that no-tillage did not reduce the pod yield. He found that sandy loam soil facilited easy peg penetration and pod development, and higher soil moisture retention in the no-tillage accounted for no yield reduction.

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Surprisingly, in many instances southern blight has not become a severe problem in the no-tillage system. Hartzog and Adams (7) stated that elimination of deep tillage did not affect white mold hits. Colvin *et al.* (5) reported that in 1984 *Sclerotium rolfsii* occurred more frequently in conventional tillage plots than in the strip-tillage or no-tillage treatments while in 1985 disease occurrence was less in the no-tillage and conventional tillage plots.

Pod yields with minimum tillage and no-tillage have varied among locations. Wright and Porter (16) reported that no-tillage peanuts matured later than conventionally tilled peanuts and also produced lower pod yields and grade than peanuts produced with conventional tillage. Colvin *et al.* (4) stated that generally peanut grade was not influenced by minimum tillage. Pod yields were similar in 1983; however, in 1984, pod yields were higher in several minimum tillage systems than those produced with the conventional tillage methods. Hartzog and Adams (7) found that the elimination of deep tillage did not effect either yield or grade.

The objectives of the current study were to evaluate full tillage, minimum tillage, and no-tillage peanut culture in South Central Texas for pod yield, grade, value, disease development, and other factors which may influence peanut production.

Materials and Methods

Minimum tillage, no-tillage, and conventional tillage were compared in small plot tests from 1978 to 1981 on Experiment Station land at Yoakum, Texas. Oats (*Avena sativa* L.) were planted in the fall and grown uniformly during the winter months in the test area. Under full tillage, the cover crop was shredded, soil was turned with a moldboard plow, disced, bedded, beds leveled to planting height, preplant incorporated herbicide applied, and peanuts planted. Cultivation was used to control weeds and maintain good soil structure. In minimum tillage the cover crop was shredded low (8 to 15 cm) or high (31 to 36 cm), double disced, bedded, beds leveled to planting height, preplant incorporated herbicide applied, and peanuts planted. In 1980, the minimum tillage with the high shredded cover crop treatment was not in the test design. In no-tillage, the cover crop was shredded 31-36 cm high, a herbicide was applied to kill all vegetation, peanuts were planted into the stubble, preemergence, and cracking stage herbicide applied. There was no cultivation, but postemergence herbicides were applied as necessary to control weeds.

The oat cover crop in the no-tillage and minimum till shredded high plots were shredded at a height of 31 to 36 cm with a flail shredder to approximate stubble size after harvesting of the grain. Glyphosate [(N-phosphonomethyl) glycine] at 2.4 kg ai/ha or Paraquat (1, 1'-dimethyl -4,4'-bipyridinium ion) at 0.84 kg ai/ha in 187 L/ha of water was sprayed broadcast over the no-till areas to kill all existing vegetation prior to seeding peanuts. A tank mix of trifluralin [2,6-dinitro-N,N-dipropyl-4-(trifluoromethyl) benzenamine] at 0.56 kg ai/ha plus vernolate (S-propyl dipropylcarbamothioate) at 2.8 kg ai/ha were preplant incorporated 7.6 cm deep with a power tiller in the full tillage and minimum tillage plots. In the no-till plots, a ground cracking treatment of dinoseb [2-(1-methylpropyl)-4,6-dinitrophenol] + naptalam (N-1-naphthylphthalamate) at 3.36 + 1.68 kg ai/A or alachlor [2-chloro-N-(2,6-diethylphenyl)-N-(methoxymethyl) acetamide] + dinoseb at 3.4 + 1.7 kg ai/ha was used to kill emerged weed seedlings and for preemergence + weed control. 2,4-DB[4-2,4-dichlorophenoxy)butyric acid] and bentazon [(3-)1-methylethyl)-(1H)-2,1,3-benzothiadiazin-4(3+1)-one,2,2-dioxide] were applied post-emergence as needed to control broadleaves and yellow nutsedge (*Cyperus esculentus* L.) in all tillage system plots. In 1980 and 1981, sethoxydim{2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one} at 0.56 kg ai/ha plus crop oil concentrate at 2.3 L/ha was sprayed over the top of the no-till for postemergence grass control.

The Florunner cultivar was used with seeding rates of 90 kg/ha except in 1981 when the seeding rate was 73 kg/ha.

A randomized complete block design test was conducted with six rows per tillage treatment. Each treatment was replicated 5 times. All test rows were dug at harvest time, but data were collected only from the two center rows of each plot. Plots were 12.2 mm long and rows were spaced on 97 cm centers.

Soil type was a Tremona loamy fine sand (clayey, mixed, thermic Aquic Arenic Palenstalfs) with pH of 7.4 and 1% organic matter.

Approximately 14 days prior to digging, southern blight disease development was monitored by counting southern blight hits (a hit is 31 cm or less of row which has been killed by the southern blight fungus, *Sclerotium rolfsii.*

Pod samples for disease assessment were handpicked after digging and prior to combining. In 1978, soil was passed through a 0.64 cm mesh screen to separate out pods left in the soil after digging. These were rated for disease to determine differences in pod disease from those which remained on the plant. Visual ratings for pod disease assessment were used to determine the amount of southern blight damage to pods. A rating scale of 0 = no disease to 10 = completely diseased was used to determine pod disease. After combining, foreign material was removed from samples, pod weights recorded, grade analysis run on each plot, and values per kilogram and per hectare were calculated based on the support price schedule for the respective year. Net dollar value per hectare was determined by using the support price schedule for the respective year minus deductions for sound splits and damaged kernels and multiplying the value by metric ton of yield per hectare. All data were subjected to analysis of variance and Duncan's new multiple range tests.

Results and Discussion

Some difficulty in digging the no-tillage plots occurred in 1978 and 1979 due to grass problems and poor soil moisture, resulting in significant pod loss. The digging difficulty was partially reduced by sprinkler irrigation one day prior to digging in 1980. Grassy weed species, especially large crabgrass (*Digitaria sanguinalis* (L.) Scop.), broadleaf signalgrass (*Brachiaria platyphylla* (Griseb.) Nash), and Texas panicum (*Panicum texanum* Buckl.), were not controlled with postemergence grass herbicides in the no-tillage plots until 1981. This also contributed to the digging problem. However, now that sethoxydim has been cleared for use in peanuts, grassy weeds should not become a late season problem in peanut fields, thus eliminating the problem associated with digging.

In all test years Florunner yields were statistically higher for full tillage plots than for the no-tillage plots (Table 1.). Pod yield from minimum tillage shredded low was not significantly different from full tillage, but pod yield in minimum tillage shredded high plots was significantly lower than pod yield from full tillage. The highest pod yields were in 1978 when yields were 4114 and 5080 kg/ha for no-tillage and full tillage, respectively.

Percentage sound mature kernels (% SMK) were not significantly different for the different tillage systems in 2 of the 4 test years (Table 2). In 1980, no-till graded 71.7% SMK as compared with 73.8% for full tillage and 74.0% for minimum till plots. In 1981, with the minimum tillage shredded high plots, % SMK was significantly lower than full tillage and minimum tillage shredded low plots. However, there was no significant difference in SMK values between the no-tillage and minimum tillage shredded low plots.

Table 1. Yield of peanuts from the various tillage systems.

Tillage System	Test Years 1978	1979	1980	1981	Avg.
	(kg/ha)				
Full Tillage	5080 a[1/]	3331 a	3331 a	3927 a	3917
Minimum Tillage Shredded low	4461 ab	3900 a	3165 ab	3015 a	3635
Minimum Tillage Shredded high	4095 b	1823 b	--	1318 b	2412
No-tillage	4114 b	2126 b	2726 b	1548 b	2629

[1/]Means within a column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Table 2. Percentage sound mature kernels from various tillage systems.

Tillage System	Test Years 1978	1979	1980	1981	Avg.
	%				
Full Tillage	69.8 a[1/]	72.9 a	73.8 a	72.7 a	72.3
Minimum Tillage Shredded low	69.1 a	75.5 a	74.0 a	72.0 a	72.7
Minimum Tillage Shredded high	66.7 a	71.6 a	--	68.2 b	68.8
No-tillage	67.2 a	70.8 a	71.7 b	70.2 ab	70.0

[1/]Means within a column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Net dollar value per hectare (Table 3) for full tillage was significantly higher than no-tillage in all years. The minimum tillage low shredding produced significantly more dollars per hectare than high shredding in all years except 1978. No-tillage gave the lower dollar value per hectare because of reduced yield.

Table 3. Net dollar value from various tillage systems.

Tillage System	Test Years 1978	1979	1980	1981	Avg.
	Dollars/ha				
Full Tillage	1055 a[1/]	697 a	791 a	931 a	869
Minimum Tillage Shredded low	919 ab	855 a	752 a	704 a	808
Minimum Tillage Shredded high	834 b	384 b	--	294 b	378
No-tillage	812 b	436 b	625 b	353 b	557

[1/]Means within a column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Infection sites (hits) of *Sclerotium rolfsii* were recorded in 1978 to 1980 (Table 4). In 1978 full tillage with only 4.2 hits per plot had a significantly lower level of disease than shredded low or no-tillage. In 1979 there was no difference in number of hits among tillage systems. In 1980, however, the no-tillage system had significantly fewer hits than other treatments with only 20.7 hits per plot compared with 35 hits for full tillage and minimum tillage when monitored prior to harvest. This difference was easily observed in the field. An explanation for this was the large number of fire ant (*Solenopsis invicta*) hills found in no-tillage plots. Full tillage had 0.33 hills per plot, minimum tillage, 1.2 hills, and no-tillage, 3.2 hills per plot. Visual observation and target site data indicate that fire ants reduced disease develolpment, probably by feeding upon the *S. rolfsii* fungus and reducing the amount of inoculum.

Table 4. Target sites in plots under various tillage systems.

Tillage System	Hits/Plot (No./24.4 m row) 1978	1979	1980	Avg.
	Number/Plot			
Full Tillage	4.2 b[1/]	12.4 a	35.2 a	17.3
Minimum Tillage Shredded low	10.2 a	10.8 a	35.5 a	18.8
Minimum Tillage Shredded high	6.6 ab	14.0 a	--	10.3
No-tillage	12.2 a	11.4 a	20.7 b	14.8

1/Means within a column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Pod disease was assessed on pods handpicked from plants prior to combining (Table 5). Significant differences in pod disease ratings attributable to tillage methods were observed only in 1980. Full tillage plots had a lower pod disease rating (1.9) than the minimum tillage (3.1) or the no-tillage plots (3.4). In 1978 pods were screened from the soil after harvesting and pod disease ratings were made on pods left on the vine and those screened from the soil at digging. In all cases the pods left in the soil after digging were more severely diseased than those which had been handpicked from plants prior to combining. This indicated that pod loss was probably a result of pod diseases. When averaged over the five ratings, the no-tillage plots produced a higher pod rating of 3.3 compared with 2.5 for full tillage plots.

Table 5. Pod disease ratings from various tillage systems.

Tillage System	Disease Ratings[1/] 1978		1979	1980	1981	Avg
	W[2/]	S	W	W	W	
Full Tillage	1.7 a[3/]	3.0 a	3.3 a	1.9 b	2.8 a	2.5
Minimum Tillage Shredded low	2.1 a	4.6 a	3.3 a	3.1 a	2.8 a	3.2
Minimum Tillage Shredded high	2.9 a	4.4 a	2.6 a	—	2.6 a	3.1
No-tillage	3.0 a	4.9 a	2.5 a	3.4 a	2.8 a	3.3

1/Pod Disease Index: 0=no disease; 10=completely diseased.

2/W=pod samples taken from windrow; S=pod samples screened from soil after harvest.

3/Means within a column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

The profitability of no-tillage peanut culture in Texas is questionable on the basis of the results of these multiyear field plot tests. Consistently low yields, poor weed control, and problems with digging due to soil compaction are some of the problems that must be solved before no-tillage is practical. However, the weed problem, particularly grass species, may be minimized in the future with promising new postemergence over-the-top grass herbicides. Now that sethoxydim has been cleared for use in peanut culture, much better weed control will be possible in a no-tillage system, thus reducing problems associated with pod losses due to weeds at digging time. With more research, the existing problems may be solved and no-tillage will become a profitable option for peanut producers.

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