NARROW AND WIDE STRIP TILLAGE PRODUCTION FOR PEANUT

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ABSTRACT

Increased production costs and potential benefits of maintaining surface residue has renewed interest in conservation tillage systems for peanut (*Arachis hypogaea* L.) production. We initiated a study to determine surface residue cover following two strip tillage systems (narrow vs wide), compare yields and sound mature kernels (SMK) of three peanut cultivars (Anorden, AP-3, and GA 02-C) across each strip tillage system with two row spacings (single vs twin), and evaluate soil moisture between these treatments. Two experimental sites were established on a Malbis fine sandy loam (Fine-loamy, siliceous, subactive, thermic Plinthic Paleudults) in Fairhope, AL and a Dothan loamy sand (Fine-loamy, kaolinitic, thermic Plinthic, Kandiudults) in Headland, AL during the 2004 growing season. First year results indicated that the narrow strip tillage system produced higher surface residue cover at the Fairhope location. Yield differences between cultivars showed that GA 02-C and AP-3 yielded higher than Anorden at Fairhope, while no yield differences were observed at Headland. GA 02-C had higher SMK at both locations, but AP-3 SMK were higher than Anorden at Fairhope, while Anorden SMK were greater compared to AP-3 at Headland. Strip tillage system or row pattern had no effect on yield or SMK at either location. Although not significant, soil moisture contents measured at Headland followed the same trend as measured peanut yields, while row spacing had no effect on soil moisture contents. Preliminary results indicated that peanut conservation tillage practices may not require a wide tillage strip regardless of row pattern.

INTRODUCTION

Peanut tillage operations have typically involved moldboard plowing followed by several other tillage operations to create a smooth seedbed, bury crop residues that may potentially increase disease pressure, and bury weed seeds to inhibit their germination (Colvin and Brecke, 1988; Hartzog and Adams, 1989). However, concerns related to soil and wind erosion and the need to reduce production costs has prompted interest in conservation tillage methods for peanut production (Jordan et al., 2001b; Jordan et al., 2003).

Conservation tillage benefits have been widely reported to enhance soil physical properties and these benefits can be attributed to the build-up of organic matter at the soil surface by maintaining crop residue and planting a cover crop. Residues retained on the soil surface have been shown to improve moisture management by decreasing evaporation and increasing infiltration (Lascano et al., 1994). A typical peanut conservation tillage system involves planting a winter annual cereal cover crop, chemically terminating the cover crop in the spring, utilizing an in-row subsoiler with coulters and baskets (strip tillage) to prepare a seedbed, followed by the planting operation. However, this strip tillage operation typically disrupts approximately 1/3 of the row width.

Some peanut producers in the Southeast have shifted from single row patterns to twin row patterns spaced 7 to 9 in. apart, centered on 36 to 40 in. rows (Jordan et al., 2001a). This shift to twin rows has been attributed to a decreased incidence of tomato spotted wilt tospovirus (TSWV) compared to single row patterns (Baldwin et al., 1998), which may contribute to increased peanut yields of twin row over single row patterns (Jordan et al., 2001a). Twin row peanuts in a conservation system typically utilize the strip tillage system described above which disrupts a wider portion of the row to accommodate the twin rows. A smooth seedbed is created, but the incorporation of beneficial surface residue occurs.

Another form of strip tillage has been utilized for row crops that produce their fruit above ground, such as cotton (*Gossypium hirsutum* L.). The same in-row subsoiler is used, but the coulters and baskets are replaced with rubber pneumatic tires to close the slit created by the subsoiler shank. This type of tillage operation provides belowground disruption of any compacted zones present beneath the row, while maximizing the amount of residue on the soil surface. Therefore, our objectives are to determine surface residue cover following two strip tillage systems, compare yield responses of three peanut cultivars across each strip tillage system with two row spacings, and evaluate soil moisture between these treatments.

MATERIALS AND METHODS

An experimental site was established at the Gulf Coast Research and Extension Center (GCS) in Fairhope, AL and the Wiregrass Research and Extension Center (WGS) in Headland, AL during the 2004 growing season. Treatments consisted of three peanut cultivars, two tillage systems, and two row spacings with a split-split plot arrangement in a randomized complete block design with four replications at GCS and three replications at WGS. Main plots were peanut cultivars, (AP-3, Anorden, and GA 02-C) sub-plots were tillage systems (narrow strip consisting of a coulter, shank, and press wheels; wide strip consisting of a coulter, shank, two sets of coulters, rolling basket, and drag chain), and sub sub-plots were row spacings (single and twin rows). Sub sub-plot dimensions were 12.7 ft. wide (4-38 in. rows) at GCS and 12 ft. wide (4-36 in. rows) at WGS with 30 ft. long rows.

A rye (*Secale cereale* L.) cover crop was established in fall 2003 with a no-till drill on a Malbis fine sandy loam at GCS and an oat (*Avena sativa* L.) cover crop was established with a no-till drill on a Dothan loamy sand at WGS. Both cover crops were seeded at 90 lb ac^{-1} and chemically terminated the following spring. Biomass samples were determined from each plot, immediately prior to termination, by cutting all aboveground tissue from two areas, each measuring 2.7 ft^2.

Approximately 3 wk after cover crop termination, each strip tillage configuration was performed in the appropriate plot and subsequent peanut cultivars were planted at 6 seed ft^{-1} for single and twin rows. Surface residue was determined for each plot using the line transect method (Morrison et al., 1993), prior to peanut emergence. Soil water content was monitored during the growing season using ECH$_2$O-20 probes (Decagon Devices Inc., Pullman, WA[1]) at WGS. The probes were installed vertically in the row centers, with measurements taken between 3- and 11-in of depth from the soil surface. Data was collected every 15-min using self-contained dataloggers.

Peanuts were mechanically harvested from the two center rows of each plot to determine yield and SMK. Yield was determined by weighing freshly harvested nuts in the field and adjusting the weight based on a subsample that was dried to 10% moisture. That subsample was shelled and graded to determine SMK. Cultural practices to control weeds, diseases, and insects were based on Alabama Cooperative Extension recommendations.

Data were analyzed using a mixed model procedure provided by the Statistical Analysis System (SAS Institute, 2001). Treatment differences were considered significant if $P > F$ was less than or equal to 0.05. Comparison among more than three treatment means were separated by the least significant difference (LSD).

RESULTS AND DISCUSSION

Surface residue cover was higher for the narrow strip tillage system at both locations; however, the difference was only significant at GCS (Fig. 1). Residue cover was greater for both strip tillage systems at GCS compared to WGS (Fig. 1). This may be attributed to higher amounts of biomass produced by rye at GCS compared to oat biomass at WGS. Previous research has shown that rye was superior to other cereal and legume cover crops, as well as, selected mixtures of cereals and legumes (Daniel et al., 1999).

Peanut populations measured 3 wk after planting were between 3.5 and 4.0 seeds ft^{-1} (data not shown). No interactions were observed for peanut yields or SMK between cultivars, strip tillage systems, and row pattern, therefore each of these effects will be presented separately.

Peanut yields of AP-3 and GA 02-C were superior to Anorden at GCS, but they were not different from each other (Table 1). These two cultivars also produced higher yields compared to Anorden at WGS, but no significant differences were observed (Table 1). Peanut yields of all cultivars were higher at WGS than yields observed at GCS, although SMK were generally higher at GCS than WGS (Table 1). The cultivar GA 02-C produced the highest SMK at both locations, but AP-3 SMK were higher than Anorden at Fairhope, while Anorden SMK were greater compared to AP-3 at Headland (Table 1).

The strip tillage system utilized at each location had no effect on peanut yields or SMK (Table 2). These preliminary results indicate that the row pattern should not dictate which type of strip tillage system is used. Coulters and baskets used behind the shank for a wide strip tillage system may not be necessary for twin row peanuts, allowing beneficial residue to remain on the soil surface.

First year results indicated no differences existed between yields or SMK for single and twin rows at either location (Table 3). Jordan et al. (2001a) showed inconsistent yield responses for twin rows over single rows across seven site-years, but seeding rates were higher for twin rows and all plots were planted with conventional tillage practices. The lack of yield response for twin rows compared to single rows in our study may be attributed to the two conservation tillage systems used in the experiment. Conventional tillage practices that leave the soil bare may attract thrips, which vector TSWV compared to soil covered with crop residue (Marois and Wright, 2003). Since cover crop residues were retained in all plots, yield reductions associated with TSWV were diminished.

Soil moisture was affected by peanut variety (Fig. 2). Greater soil water contents were recorded with the AP-3, followed by the GA 02-C and Anorden, respectively. Although yield differences were not significant, the soil water contents corresponded to observed yields at this location (Table 1). These differences in soil water content possibly reflect differences in water use efficiency by the three peanut cultivars.

Seeding rates were the same for the single and twin row, and plant populations measured 3 wk after planting were between 3.5 and 4.0 seed ft^{-1}. For this reason the plant water demand should have been similar for both treatments. This was apparent in the soil water content between the single and twin row spacing, which showed no differences (Fig. 3).

CONCLUSION

Preliminary results indicate that the narrow strip tillage system produced higher surface residue cover at GCS. Yield differences between cultivars showed that GA 02-C and AP-3 yielded higher than Anorden at GCS, while no yield differences were observed at WGS when averaged over tillage systems and row patterns. The highest percentage of SMK for both locations were found in GA 02-C, but AP-3 SMK were higher than Anorden at GCS, while Anorden SMK were greater compared to AP-3 at WGS. Yield and SMK were not influenced by strip tillage or row pattern at either location. Although not significant, soil moisture contents measured at WGS followed the same trend as measured peanut yields, while row spacing had no effect on soil moisture contents. First year results indicate that peanut conservation tillage practices may not require a wide tillage strip, regardless of row pattern, but continuing research will help confirm these findings.

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Table 1. Peanut yields and sound mature kernels (SMK) measured for three cultivars averaged across two tillage systems and two row patterns at two locations during the 2004 growing season.

Cultivar	Gulfcoast†		Wiregrass	
	Yield	SMK	Yield	SMK
	---lb ac^{-1}---	---%---	---lb ac^{-1}---	---%---
Anorden	2690	67.3	3330	66.6
AP-3	3530	68.2	4750	64.0
GA 02-C	4080	70.2	4550	71.3
$LSD_{0.05}$	580	1.9	NS	1.6

† Four replications for Gulfcoast; three replications for Wiregrass.

Table 2. Peanut yields and sound mature kernels (SMK) measured for two tillage systems averaged across three peanut cultivars and two row patterns at two locations during the 2004 growing season.

Strip tillage	Gulfcoast†		Wiregrass	
	Yield	SMK	Yield	SMK
	---lb ac^{-1}---	---%---	---lb ac^{-1}---	---%---
Narrow	3430	68.1	4290	67.8
Wide	3440	69.0	4130	66.7
P > F	0.9944	0.2612	0.4697	0.0911

† Four replications for Gulfcoast; three replications for Wiregrass.

Table 3. Peanut plant populations and yields measured for two row patterns across three peanut cultivars and two strip tillage systems at two locations during the 2004 growing season.

Row pattern	Gulfcoast†		Wiregrass	
	Yield	SMK	Yield	SMK
	---lb ac^{-1}---	---%---	---lb ac^{-1}---	---%---
Single	3600	69.0	4160	67.7
Twin	3270	68.1	4260	66.9
P > F	0.1313	0.2612	0.5688	0.2291

† Four replications for Gulfcoast; three replications for Wiregrass.

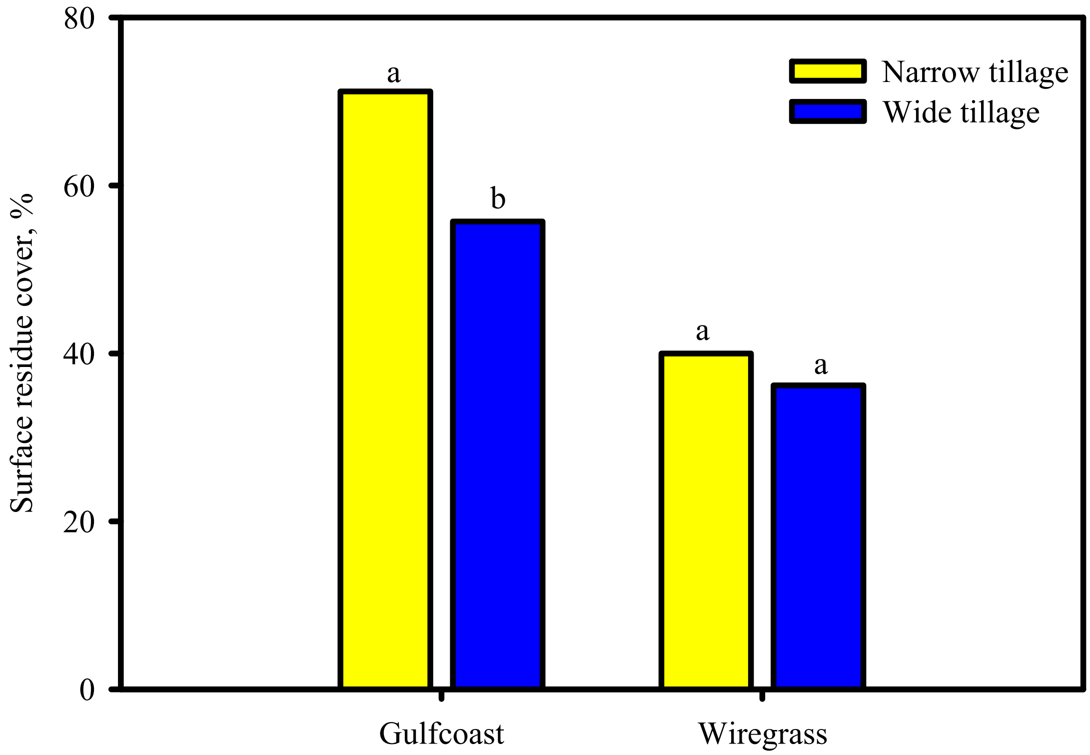

Figure 1. Surface residue cover measured immediately after peanut planting in narrow and wide strip tillage systems for a rye cover crop at the Gulfcoast Research and Extension Center in Fairhope, AL and an oat cover crop at the Wiregrass Research and Extension Center in Headland, AL during the 2004 growing season. Means followed by the same letter within a location are not significantly different from each other at the 0.05 significance level.

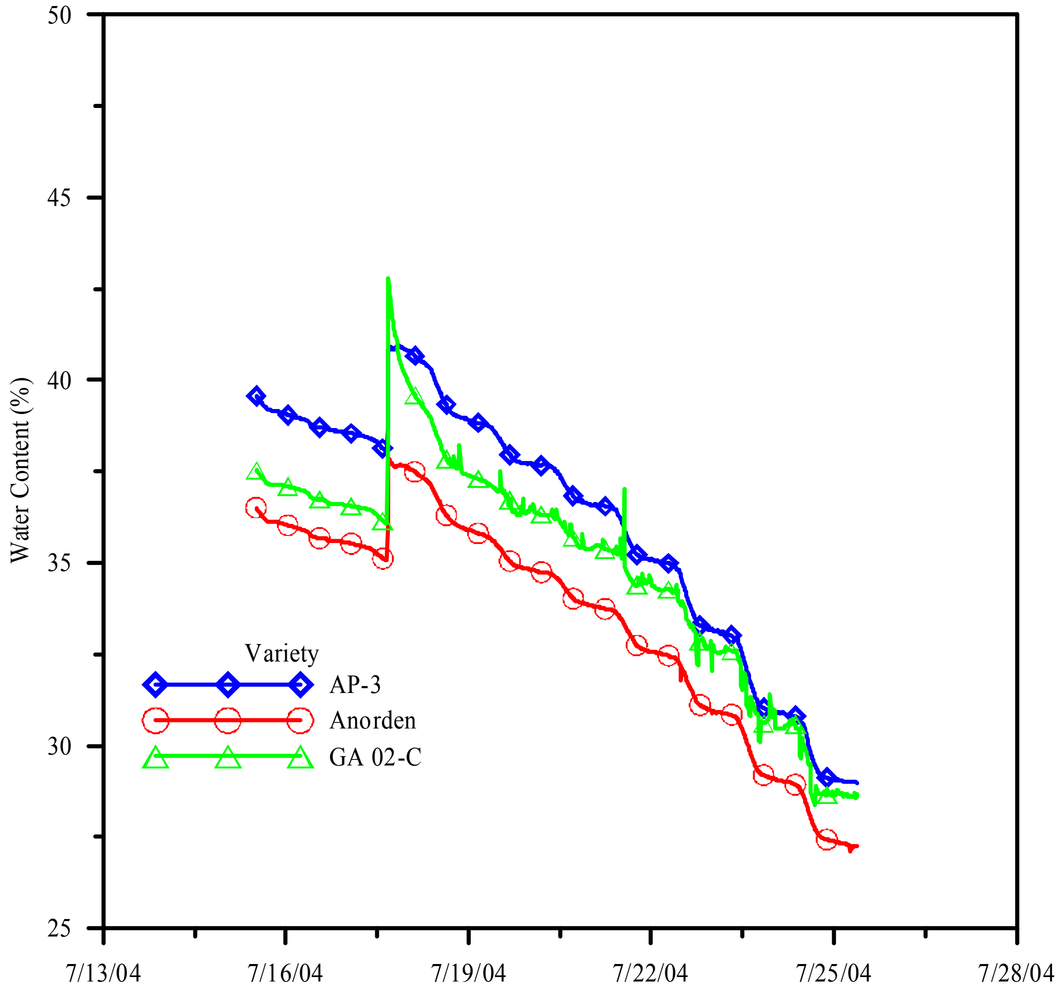

Figure 2. Soil water content measured during the growing season of 2004 for three peanut cultivars at the Wiregrass Research and Extension Center.

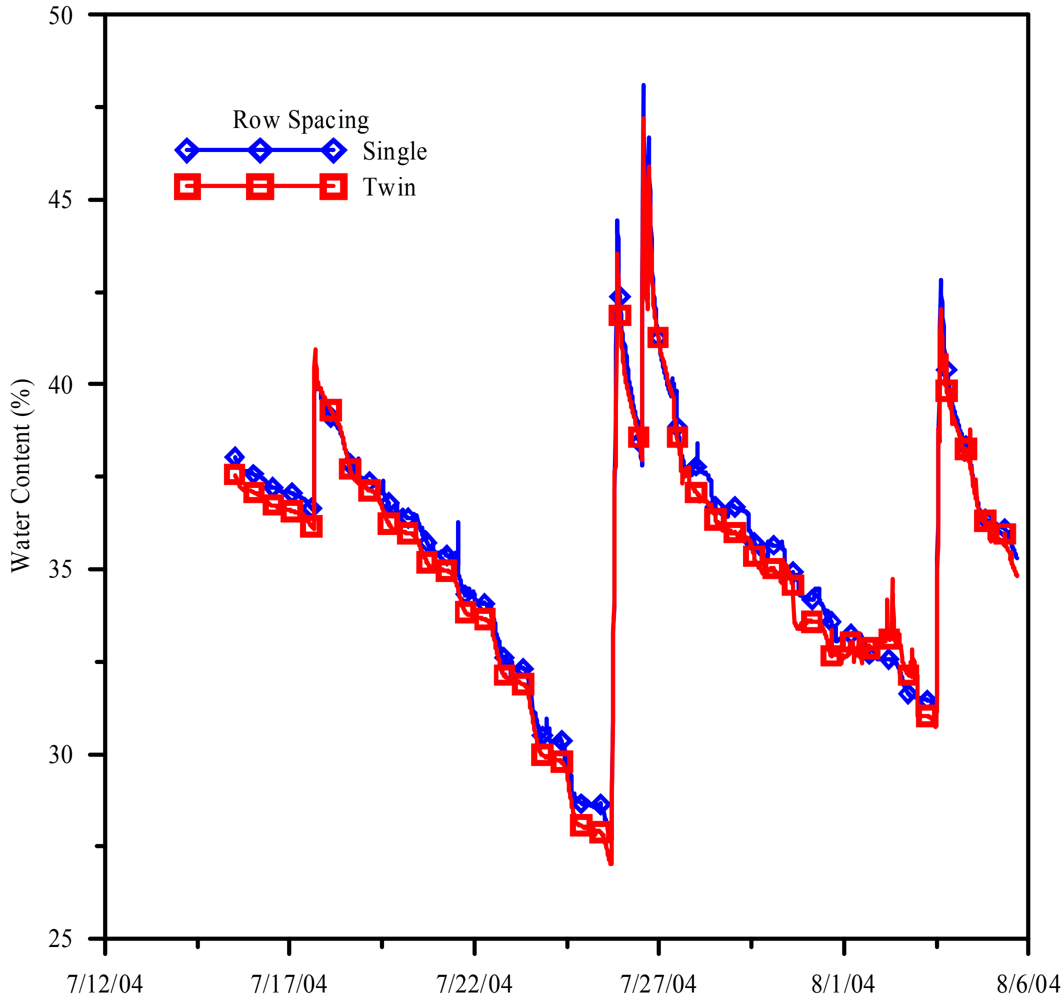

Figure 3. Soil water content measured during the 2004 season for single and twin row patterns at the Wiregrass Research and Extension Center.