PEANUT RESPONSE TO TILLAGE AND ROTATION IN NORTH CAROLINA

David L. Jordan[1], Darcy E. Partridge[2], J. Steven Barnes[3], Clyde R. Bogle[4], Christie A. Hurt[5], Rick L. Brandenburg[5], S. Gary Bullen[6], and P. Dewayne Johnson[1]

[1]Department of Crop Science, North Carolina State University, Raleigh, NC 27695-7620.
[2]Department of Plant Pathology, Box 7616, North Carolina State University, Raleigh, NC 27695-7616
[3]North Carolina Department of Agriculture and Consumer Services, Peanut Belt Research Station, Box 220, Lewiston-Woodville, NC 27849
[4]North Carolina Department of Agriculture and Consumer Services, Upper Coastal Plain Research Station, Rt. 2 Box 400, Rocky Mount, NC 27801
[5]Department of Entomology, Box 7613, North Carolina State University, Raleigh, NC 27695-7613
[6]Department of Agricultural and Resource Economics, Box 8109, North Carolina State University, Raleigh, NC 27695-8109.
*Corresponding author's e-mail: david_jordan@ncsu.edu

ABSTRACT

Research was conducted at two locations in North Carolina from 2000 to 2002 to compare yields of peanut, cotton, and corn grown in various rotation sequences in conventional and strip tillage production systems. Peanut yield was similar when comparing conventional and reduced tillage systems within similar rotation sequences at one location on a Norfolk loamy sand soil. At a second location on a Goldsboro sandy loam soil, peanut yield in a short rotation with cotton was lower when peanut was strip tilled into stubble from the previous crop compared with yield in conventional tillage. When a longer rotation between cotton and peanut was established, peanut yield was similar between the two tillage systems. In both trials during the final year of the study, peanut yield was similar between strip tillage in stale seedbeds (beds established during the early spring prior to planting) and conventional tillage. At one location, peanut yield from both of these tillage systems exceeded that of strip tillage into stubble from the previous crop. It is suspected that peanut pod loss during the digging and inverting operation was greater when peanut was strip tilled into crop stubble than when strip tilled into stale seedbeds. The experiment is being continued for an additional cycle to compare long-term response to tillage and rotation.

INTRODUCTION

Peanut (*Arachis hypogaea* L.) in North Carolina is typically grown in conventionally tilled systems (Jordan, 2003). Peanut response to reduced tillage has been inconsistent, and on average was reported to be 5% lower than yields in conventional tillage in studies conducted in North Carolina from 1997 through 2001 (Jordan et al., 2002). Although yields were similar in many of the trials, when major differences in yield were noted they often occurred on finer-textured soils and favored conventional tillage. Many of these trials were conducted in short-term or transition (from conventional to reduced tillage) circumstances. It is suspected that response to reduced tillage would be more favorable if peanut and rotation crops are grown in reduced tillage cropping systems for multiple years. Therefore, experiments were established in North Carolina to compare pod yield of peanut and rotation crops grown in conventional tillage and strip tillage systems in various rotation systems.

MATERIALS AND METHODS

Experiments were conducted in North Carolina from 2000 through 2002 at two locations in North Carolina near Lewiston-Woodville on a Norfolk loamy sand soil (fine-loamy, siliceous, thermic Aquic Paleudalts) with 2.1% organic matter content and pH 5.8 and near Rocky Mount on a Goldsboro sandy loam soil (fine-loamy, mixed, thermic Arenic Hapludults) with 1.7% organic matter and pH 6.0. Treatments consisted of conventional tillage or strip tillage into stubble from the previous crop (Rocky Mount) or strip tillage into crop stubble with a desiccated wheat cover crop present (Lewiston-Woodville) (Table 1). At Lewiston-Woodville, cotton and corn were included in 1999 for both tillage systems. However, three hurricanes and a severe hailstorm during the summer greatly reduced yield; therefore, data from 1999 are not presented. In the final year of the study, when peanut was planted into all plots (Table 1), elevated beds were prepared in early March on four of the eight plot rows in the reduced tillage system (referred to as stale seedbeds). Stalks from the previous crop had been shredded in the fall following harvest. Rows were reestablished using a disk bedder (subsoiler shanks removed) with no other tillage operations to establish the stale seedbeds. Peanut was strip tilled into stubble from the previous crop and stale seedbeds using a KMC strip tillage implement consisting of in-row subsoiler followed by two sets of coulters and two basket attachments to smooth the tilled zone. The tilled zone was approximately 16 to 18 inches wide. Conventional tillage seedbeds were prepared by disking the field twice and ripping and bedding within one week prior to planting. With the exception of tillage systems, all other production and pest management practices were held constant over the entire test area and were based on Cooperative Extension recommendations. Plot size was eight rows (36-inch spacing) by 50 feet long at Lewiston-Woodville or 75 feet long at Rocky Mount. Peanut and cotton were planted in early May within one week following strip tillage. Corn was planted in early April within one week after strip tillage. Crops were harvested using standard equipment designed for small-plot harvesting. Tomato spotted wilt virus and *Cylindrocladium* black rot (CBR) incidence was determined in the final year of the experiment. Data are referred to, as percent of plants diseased because differentiation between tomato spotted wilt virus and CBR symptoms was difficult to achieve late in the season. Weed species and density, including volunteer peanut, were also determined in early July of 2002. The experimental design was a randomized complete block with four replications. Means were separated using Fisher's Protected LSD Test at $p \leq 0.05$.

RESULTS AND DISCUSSION

No differences in yields for specific crops at either location were noted when comparing tillage system or rotation systems in 2000 or 2001 at either location (Table 2). In contrast, peanut yield differed among rotation systems at Lewiston-Woodville in 2002, the year when all tillage and rotation systems were planted in peanut (Table 3). Peanut yield was generally higher when peanut was rotated with either corn or cotton for a longer period of years. At this location, there was no difference in yield when comparing yields within the same rotation system from conventional tillage and strip tillage systems. At Rocky Mount in 2002, peanut yield was lower when strip tilled in the short rotation sequence compared with strip tillage into a longer rotation, or when peanut was planted into conventional tillage regardless of rotation system (Table 3). Although not substantiated, greater pod loss during the digging process may have contributed to the lower yield when peanut was strip tilled in the shorter cotton-peanut rotation. For this cotton-peanut rotation, peanut was planted into essentially flat ground, whereas in the longer cotton-peanut rotation peanut was strip tilled into partially elevated bed where cotton had been grown for the previous two years. In the shorter rotation, the digging process in 1999 eliminated existing elevated beds, and no additional tillage or bed formation was incorporated into the cotton planting operation in 2001 or in the peanut planting operation in 2002. Results from the comparison of strip tillage into stale seedbeds versus strip tillage into stubble from the previous crop supports this suggestion, at least partially. When peanut was strip tilled into stale seedbeds that were established approximately two months earlier in the spring, peanut yields were higher than those when peanut was strip tilled into crop stubble (Table 4). Although other agronomic and possibly soil fertility factors could have been affected by the bedding operation, it is also plausible that digging and inverting peanut growing on flat ground compared with digging and inverting peanut grown on elevated beds explains partially the difference in yields among these treatments. Previous research (Jordan et al., 2002) indicated that yields in conventional tillage and strip tillage into stubble from the previous crop often differ. When substantial yield differences between these systems were noted, yield in conventional tillage systems were generally higher than yield in strip tillage. Results also suggested that strip tillage into stale seedbeds, where elevated beds were established the previous fall, resulted in yields that approached yields in conventional tillage systems and exceeded those of peanut strip tilled into stubble from the previous crop. In virtually all trials, conventional tillage consisted on ripping and bedding while stale seedbeds were established using a bedder with the ripper shanks removed. In both instances when strip tillage was performed (crop stubble and stale seedbeds), a subsoiler was included at a depth similar to the depth used in conventional tillage bedding operation.

At Lewiston-Woodville when data were pooled over rotation systems, 69, 59, and 70% of plants presented symptoms characteristic of tomato spotted wilt and/or CBR during mid August in the conventional tillage system and systems where peanut was strip tilled into stubble from the previous crop or stale seedbeds, respectively (data not shown). When pooled over tillage systems at this location, 71, 70, 60, and 64% of plants expressed disease symptoms for peanut-cotton-peanut, peanut-corn-peanut, cotton-cotton-peanut, and cotton-corn-peanut rotation systems, respectively. Stale seedbeds were established in early spring, and therefore very few winter weeds and emerged summer weeds and crop residue were present when peanut emerged. This may explain partially similar disease levels in stale seedbed and conventional tillage systems. In contrast, less disease was noted when peanut was strip tilled into stubble from the previous crop when compared with either stale seedbed or conventional tillage systems. Attractiveness of thrips to reduced tillage fields with crop residue or desiccated cover crop is suspected to play a role in tomato spotted wilt virus incidence when compared with conventional tillage systems. While the majority of disease appeared to be caused by tomato spotted wilt virus, less disease when peanut was included in longer rotations suggests that disease ratings also were composed of CBR. Although crop rotation has not been shown to be affect incidence of tomato spotted wilt, rotation can have a major impact on incidence of CBR. Additionally, incidence of CBR is generally not affected by tillage system. Utilization of immunoassay techniques would have assisted in differentiation among these diseases. At Rocky Mount, there was no difference in incidence of tomato spotted wilt regardless of tillage system or rotation sequence (data not presented).

No differences in weed density were noted when comparing rotation sequences at Lewiston-Woodville (data not shown). When pooled over rotation sequence at this location, higher numbers of smooth pigweed were noted when peanut was strip tilled into stubble from the previous crop when compared with strip tillage into stale seedbeds or conventional tillage (data not shown). No differences in densities of yellow nutsedge, eclipta, and broadleaf signalgrass were noted among tillage systems at Lewiston-Woodville (data not shown). At Rocky Mount, density of volunteer peanut was higher in strip tillage than in conventional tillage but was similar to density in stale seedbeds (data not shown). Tillage did not affect density of yellow nutsedge, entireleaf morningglory, or pitted morningglory at this location. A higher density of pitted morningglory was observed in long rotations compared with the shorter rotation. In contrast, a higher density of volunteer peanut was noted in the peanut-cotton-peanut rotation compared with the cotton-cotton-peanut rotation.

Collectively, results from these studies suggest that cotton and corn yields will often be similar when comparing reduced tillage and conventional tillage systems. Many practitioners have adopted reduced tillage systems for these crops in North Carolina. While peanut yield was often similar in strip tillage and conventional tillage, some variation in yield was noted at one location when compared tillage systems, with conventionally tilled peanut yielding higher than strip tilled peanut in the peanut-cotton-peanut rotation. The stale seedbed approach in this rotation overcame the yield differential between conventional tillage and strip tillage into stubble from the previous crop. While yields were similar between both tillage systems within a rotation system at the other location when peanut was strip tilled into crop stubble or stale seedbeds, this may have been partially attributed to soil characteristics. The Norfolk loamy sand soil at Lewiston-Woodville is considered to be a better peanut soil than the finer-textured and more poorly drained Goldsboro sandy loam soil at Rocky Mount. It is possible that the importance of having peanut on elevated beds would be more critical on the Goldsboro soil series than on the Norfolk soil series, and hence the positive response to stale seedbeds.

These studies are being conducted for additional cycles, with peanut being planted in the entire test during 2006. Along with monitoring of pest development and crop yield, a more complete measure of soil characteristics will be quantified. Results from these studies continue to document the advantages of extending rotations in peanut production.

ACKNOWLEDGMENTS

Appreciation is expressed to staff at Peanut Belt and Upper Coastal Plain Research Stations for assistance with these experiments. Carl Murphy provided technical assistance. The North Carolina Peanut Growers Association provided partial funding for these studies.

REFERENCES

Jordan, D. L. 2003. Peanut production practices. Pages 7-25 *in* 2003 Peanut Information. North Carolina Coop. Ext. Ser. Series AG-331.

Jordan, D.L., P.D. Johnson, A.S. Culpepper, J.S. Barnes, C.R. Bogle, G.C. Naderman, G.T. Roberson, J.E. Bailey, and R.L. Brandenburg. 2002. Research in North Carolina withReduced tillage systems for peanut (1997-2001). Pages 336-340 *in* E. van Santen (ed.) 2002. Making Conservation Tillage Conventional: Building a Future on 25 Years of Research. Proc.of 25th Annual Southern Conservation Tillage Conference for Sustainable Agriculture. Auburn, AL 24-26 June 2002. Special Report No. 1. Alabama Agric. Expt. Stn. and Auburn University, AL 36849. USA.

Table 1. Tillage and rotation systems at Lewiston-Woodville and Rocky Mount.

	Rotation system*			
Tillage systems	1999	2000	2001	2002
Conventional	Cotton	Peanut	Cotton	Peanut
Conventional	Cotton	Cotton	Cotton	Peanut
Strip tillage	Cotton	Peanut	Cotton	Peanut
Strip tillage	Cotton	Cotton	Cotton	Peanut
Conventional	Corn	Peanut	Corn	Peanut
Conventional	Cotton	Cotton	Corn	Peanut
Strip tillage	Corn	Peanut	Corn	Peanut
Strip tillage	Cotton	Cotton	Corn	Peanut

*Rotation systems including corn were present only at Lewiston-Woodville. Tillage and rotation systems were not established until 2000 at Rocky Mount.

Table 2. Crop yield at Lewiston-Woodville as influenced by tillage and rotation systems.

Tillage systems	Rotation system 1999	2000	2001	2002*
	lb/acre			
Conventional	250 (Cotton)	3370 (Peanut)	1030 (Cotton)	2020 (Peanut)
Conventional	260 (Cotton)	960 (Cotton)	950 (Cotton)	2560 (Peanut)
Strip tillage	210 (Cotton)	3420 (Peanut)	880 (Cotton)	2300 (Peanut)
Strip tillage	240 (Cotton)	1040 (Cotton)	960 (Cotton)	2780 (Peanut)
Conventional	2180 (Corn)	2980 (Peanut)	6550 (Corn)	2030 (Peanut)
Conventional	270 (Cotton)	890 (Cotton)	6660 (Corn)	2420 (Peanut)
Strip tillage	1900 (Corn)	2910 (Peanut)	6440 (Corn)	2000 (Peanut)
Strip tillage	230 (Cotton)	1020 (Cotton)	7060 (Corn)	2790 (Peanut)
LSD (0.05)	NS (within crops)	NS (within crops)	NS (within crops)	LSD=493

Table 3. Crop yield at Rocky Mount as influenced by tillage and rotation systems.

Tillage systems	Rotation system 2000	2001	2002*
	lb/acre		
Conventional	3770 (Peanut)	860 (Cotton)	3830 a (Peanut)
Conventional	920 (Cotton)	840 (Cotton)	3820 a (Peanut)
Strip tillage	3490 (Peanut)	820 (Cotton)	3120 b (Peanut)
Strip tillage	870 (Cotton)	800 (Cotton)	3870 a (Peanut)
LSD (0.05)	NS (within crops)	NS	

*Means followed by the same letter are not significant according to Fisher's Protected LSD Test at $p \leq 0.05$.

Table 4. Peanut yield in 2002 at Lewiston-Woodville and Rocky Mount when peanut is strip tilled into stubble from the previous crop or stale seedbeds established in early spring.

	Lewiston-Woodville		Rocky Mount	
Rotation system*	Crop stubble	Stale seedbed	Crop stubble	Stale seedbed
	lb/acre			
CT-PN-CT-PN	2300	2010	3120	3610†
CT-CT-CT-PN	3050	2700	3870	3670
CR-PN-CR-PN	2000	2090	-	-
CT-CT-CR-PN	2790	2500†	-	-

*Abbreviations: CR, corn; CT, cotton; PN, peanut.
†Significant for comparison of strip tillage into crop stubble or stale seedbed within a location and rotation system.