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Peanut Response to Planting in Stale Seedbeds versus Strip Tillage into Crop Stubble

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Abstract

Peanut (*Arachis hypogaea* L.) yield when strip tilled into stubble from a previous crop can be lower than yield in conventional tillage systems. One alternative to strip tillage into previous crop stubble is preparing seedbeds at some point following harvest of a previous crop but prior to planting peanut. Research was conducted at two locations in North Carolina to compare visual estimates of plant condition, reflecting incidence of tomato spotted wilt (caused by a *Tospovirus*) (TSWV), and pod yield following various preceding crops when peanut was strip tilled into previous crop stubble or into beds established four to six weeks prior to planting peanut (referred to as stale seedbeds). Crop rotation and tillage did not interact for TSWV incidence or pod yield in most instances. However, crop rotation and tillage affected yield independently. Peanut following rotations with more years between peanut plantings yielded higher than peanut planted in shorter rotations. Pod yield was equal to or higher when strip tilled into stale seedbeds compared with stubble from the preceding crop. Results from these experiments indicate that peanut yield may be higher when planted in stale seedbeds rather than previous crop stubble and that response to tillage will be minimally affected by crop rotation.

Introduction

Peanut in the United States is most often planted in conventional tillage systems (16). However, some growers have adopted reduced tillage systems for cotton (*Gossypium hirsutum* L.) and corn (*Zea mays* L.) and more recently peanut (2). In North Carolina, peanut plantings in reduced tillage increased from 10% to 23% from 1998 to 2004 (6). Yield of peanut planted in reduced tillage systems on finer-textured soils is often lower than yield in conventional tillage systems (6,7). Lower yield of peanut strip tilled into stubble from the previous crop compared with conventional tillage or beds prepared the previous fall can be associated with greater pod loss in the digging process (4).

Peanut growers are interested in adopting some form of reduced tillage production. Research has shown considerable variation in peanut response to tillage (3,5,6,7,16,18). Concern over pod loss and lower yield when peanut is strip tilled can be partially overcome by performing some tillage, in particular establishing beds prior to planting (7). Stale seedbed crop production has been successful for a variety of row crops including peanut with beds in these systems prepared the previous fall or winter or during the spring several weeks or months prior to seeding directly into previously established soil without significant disturbance (4,7). This approach to peanut production may be a viable alternative to both conventional tillage systems and strip tillage directly into stubble from the previous crop (4,6,7).

Increasing the number of years a non-peanut crop is planted between peanut often results in decreased disease and plant parasitic nematodes and increased pod yield (1,11,12,13,15). However, research evaluating interactions of crop rotation and tillage is limited when comparing peanut-based cropping systems in the Virginia-Carolina production region. Therefore, objectives of this research were to compare incidence of TSWV and peanut yield when peanut was strip tilled into stale seedbeds compared with strip tilling into stubble from the previous crop in various cropping systems in the coastal plain of North Carolina.

Locations and Treatment Factors

Experiments were conducted in North Carolina at the Peanut Belt Research Station located near Lewiston-Woodville on a Norfolk sandy loam soil (fine-loamy, siliceous, thermic, Typic Paleudults) and at the Upper Coastal Plain Research Station near Rocky Mount on a Goldsboro loamy sand soil (fine-loamy, siliceous, thermic Aquic Paleudalts). Plot size was 12 (Lewiston-Woodville) or 8 rows (Rocky Mount) (36-inch spacing) by 50 ft (Lewiston-Woodville) or 75 ft (Rocky Mount). The experimental unit, however, for each tillage treatment was two rows.

Crop rotations included various combinations of corn, cotton, grain sorghum (*Sorghum bicolor* Meonch.), and peanut (Table 1). In the first experiment initiated at Lewiston-Woodville in 1999, rotations consisted of one year of corn or cotton between peanut plantings, three years of cotton between peanut plantings, and a rotation of cotton-cotton-corn between peanut plantings (Table 1). A second experiment at this location was established in 2004 and repeated in an adjacent field beginning in 2005 and included conventional plantings of corn and grain sorghum followed by peanut (Table 1). The final experiment at Rocky Mount was initiated in 2000 and consisted of cotton-cotton-peanut-cotton-peanut-cotton-peanut (2000-2006) or one year of cotton between each peanut planting during this six year time period (Table 1).

Table 1. Cropping systems for experiments at Lewiston-Woodville and Rocky Mount.

Location	Experiment (year)	Cropping system
Lewiston-Woodville	Experiment 1 (1999-2006)	cotton-peanut (four cycles)
		corn-peanut (four cycles)
		cotton-cotton-cotton-peanut (two cycles)
		cotton-cotton-corn-peanut (two cycles)
	Experiment 2 (2004-2005 & 2005-2006)	corn then peanut
		grain sorghum then peanut
Rocky Mount	(2000-2006)	cotton-cotton-peanut-cotton-peanut-cotton-peanut
		peanut-cotton-peanut-cotton-peanut-cotton-peanut

Within each crop rotation, peanut was strip tilled into stubble from the previous crop or into stale seedbeds during 2002 and 2006 in the experiments initiated at Lewiston-Woodville (1999) and Rocky Mount (2000) and in the experiments in 2004-2005 and 2005-2006 at Lewiston-Woodville. Stale seedbeds were prepared by bedding rows without other tillage operations following harvest of the preceding crop, four to six weeks prior to planting peanut. Following harvest of the previous crop, stalks of crops were shredded with no soil disturbance prior to bedding the stales seedbeds or strip tilling into crop stubble. Strip tillage into previous crop stubble or stale seedbeds was performed on an 18-inch band on 36-inch rows and included two sets of coulters and basket attachments following an in-row sub-soiling. Sub-soil depth was set at 12 to 16 inches with crops planted within one week following strip tillage. Corn and cotton were strip tilled into stubble from the previous crop in all cases.

The experimental design in all experiments was a randomized complete block with a split plot arrangement of treatments. Crop rotation served as the whole plot unit and tillage system served as subplot units. This design was established to allow more efficient management of crops throughout the growing season. Combinations of crop rotation and tillage were replicated four times.

Experiments initiated in 1999 (Lewiston-Woodville) and 2000 (Rocky Mount) included factors other than the comparison of peanut in stale seedbeds versus stubble from the previous crop as reported in this article (8,9,10). The size of whole plot units allowed comparison of cultivars, fumigation with metam sodium, and inoculation with *Bradyrhizobium* with independent and appropriate controls for each factor (8,9,10). The treatments discussed in this article are unique in that peanut response to stale seedbed and strip tillage into crop stubble are included. Although these treatments have been compared in previous articles with a common preceding crop (6, 7), possible interactions of crop rotation and tillage systems including strip tillage into stale seedbeds and crop stubble have not been compared with peanut in North Carolina.

Peanut Cultivars and Pest Management

The peanut cultivars NC 12C (Lewiston-Woodville) or VA 98R (Rocky Mount) were planted in the experiments initiated in 1999 and 2000, respectively. The cultivar NC-V 11 was planted at Lewiston-Woodville in the experiment initiated in 2004 and 2005 when peanut followed corn or grain sorghum. Peanut was seeded at a rate to obtain a final in-row population of 5 plants/ft.

Emerged summer weeds and winter vegetation were controlled using sequential applications of glyphosate [*N*-phosphonomethyl)glycine] and paraquat (1,1'-dimethyl-4,4'-bipyridinium ion). Seedbeds were weed free at the time of planting peanut and other crops. Disease, insect, and in-season weed management inputs were held constant over the entire test area at each location. Aldicarb [2-methyl-2-(methylthio)propionaldehyde *O*-methylcarbamoloxime] was applied in the seed furrow at 1.0 lb ai/acre prior to seed drop. Early leaf spot (caused by *Cercospora arachidicola* Hori), late leaf spot [caused by *Cercosporidium personatum* (Berk. & M.A. Curtis) Deighton syn. *Phaeoisariopsis personata* von Arx], web blotch (caused by *Phoma arachidicola* Marasas et al.), and southern stem rot (caused by *Sclerotium rolfsii* Sacc.) were the major diseases in these fields and were controlled with routine applications of chlorothalonil (tetrachloroisophthalonitrile) and tebuconazole {alpha-[2-(4-chlorophenyl)-ethyl]-alpha-(1,1-dimethylethyl)}. Plots were not fumigated with metam sodim to control Cylindrocladium black rot (caused by *Cylindrocladium parasiticum*) (CBR).

Data Collection and Statistical Analyses

Peanut from two rows in the center of each plot were dug and vines inverted to optimize yield and market quality based on pod mesocarp color (17). Peanut pods and vines were allowed to air dry for 4 to 7 days after digging and before harvest and final peanut yield was adjusted to 8% moisture. Yield of crops other than peanut are reported elsewhere for the long-term experiments initiated in 1999 at Lewiston-Woodville and 2000 at Rocky Mount (8,9,10). Yield of corn and grain sorghum was not recorded the year prior to planting peanut in the experiments initiated in 2004 and 2005 at Lewiston-Woodville.

Within two weeks of harvest only during 2002 in the long-term experiments at Lewiston-Woodville and Rocky Mount and during 2005 and 2006 in the short-term experiments following corn and grain sorghum at Lewiston-Woodville, visual estimates of TSWV were recorded using a scale of 0 to 100% where 0 = no symptoms and 100 = the entire canopy expressing symptoms of TSWV (14). Visual estimates of TSWV were not recorded during 2006 in the long-term experiments initiated at Lewiston-Woodville (1999) and Rocky Mount (2000).

Data for peanut yield and TSWV were subjected to analysis of variance appropriate for the factorial treatment arrangement including cropping system and tillage system. Means of significant main effects and interactions were separated using Fisher's Protected LSD Test at $P \leq 0.05$.

Peanut Yield

The interaction of crop rotation and tillage system was not significant for yield in 2002 and 2006 in the long-term experiments at Lewiston-Woodville (initiated in 1999) or at Rocky Mount (initiated in 2000) (Table 2). Main effect of crop rotation was significant for yield at Lewiston-Woodville during both years but not during either year at Rocky Mount (Table 2). Conversely, the main effect of tillage was not significant for yield at Lewiston-Woodville during either year but was significant at Rocky Mount during 2006 (Table 2). Tillage did not affect peanut yield at Rocky Mount in 2002 (Table 2).

Table 2. F-statistic for peanut pod yield and tomato spotted wilt (TSWV) incidence when peanut was strip tilled into stubble from the previous crops (cotton or corn) or stale seedbeds established four to six weeks prior to planting peanut.

	Lewiston-Woodville			Rocky Mount		
	Peanut yield		TSWV	Peanut yield		TSWV
Treatment factor	2002	2006	2002	2002	2006	2002
Cropping system	9.9*	6.7*	1.4	3.2	0.1	2.6
Tillage system	2.8	0.1	10.4*	0.4	16.2*	1.5
Cropping × tillage	0.7	0.6	0.2	2.3	0.1	0.1

* Indicates significance at $P \leq 0.05$.

Yield during both 2002 and 2006 increased at Lewiston-Woodville when the number of years between peanut plantings increased (Table 3). In 2002, yield was similar when one year of corn or cotton separated peanut, and yield in these cropping systems was lower than yield when three years of cotton and corn combinations separated peanut plantings (Table 3). In 2006, a similar response was noted when comparing yield and length of rotation with the exception of similar yields when corn and peanut were rotated each year compared with three years of cotton between peanut plantings (Table 3). No difference in yield was noted when comparing tillage systems during either year in this experiment (Table 3). The percentage of plants exhibiting visual symptoms of TSWV was higher when peanut was strip tilled into stale seedbeds compared with crop stubble during 2002 (Tables 2 and 3). These results are not surprising given that research indicates that incidence of TSWV is often higher in conventional tillage than reduced tillage (5), and stale seedbeds are considered a compromise between these strategies (4,6,7).

Table 3. Peanut yield and tomato spotted wilt virus (TSWV) incidence at Lewiston-Woodville when comparing stale seedbed systems with planting into crop stubble.

		Peanut yield (lb/acre)		TSWV (%)
Treatment factor		**2002**	**2006**	**2002**
Crop rotation (1999-2006)	cotton-peanut (2 or 4 cycles)	2160 b	3100 c	44 a
	corn-peanut (2 or 4 cycles)	2040 b	3800 bc	44 a
	cotton-cotton-cotton-peanut (1 or 2 cycles)	2870 a	4320 ab	29 a
	cotton-cotton-corn-peanut (1 or 2 cycles)	2640 a	4740 a	31 a
Tillage system	strip tillage into crop stubble	2540 a	3950 a	29 b
	stale seedbeds	2320 a	4060 a	45 a

* Means within a treatment factor and year followed by the same letter are not significantly different at $P \leq 0.05$. Data for each treatment factor are pooled over levels of the other treatment factor

Yield was not affected at Rocky Mount by rotation or the interaction of rotation and tillage (Table 2). Rotations at this location were similar throughout the duration of the experiment with the exception of one year, and this most likely explains lack of differences noted among rotations when compared with results from Lewiston-Woodville. Tillage affected yield in 2006 but not in 2002 (Tables 2 and 4). Yield was higher in 2006 when peanut was planted in stale seedbeds rather than strip tillage into stubble from the previous crop (Table 4). Soil at Rocky Mount can be challenging with respect to digging peanut and minimizing pod loss which may partially explain lower yields when strip tilled into stubble versus stale seedbeds. Previous research has shown lower yields when peanut is strip tilled into crop stubble compared with stale seedbeds and has been attributed in part to pod loss (4). Soil at Rocky Mount has a finer texture than soil at Lewiston-Woodville, and previous research suggests that yield of Virginia market type peanut can be lower in reduced tillage systems than conventional tillage systems when seeded into finer texture soils (6). In contrast to results at Lewiston-Woodville, incidence of TSWV at Rocky Mount did differ when comparing tillage systems in 2002 (Tables 2 and 4).

Table 4. Peanut yield and tomato spotted wilt virus incidence (TSWV) when planted in stale seedbeds at Rocky Mount during 2002 and 2006.

Treatment factor		Peanut yield (lb/acre) 2002	Peanut yield (lb/acre) 2006	TSWV (%) 2002
Crop rotation (2000-2006)	cotton-cotton-peanut-cotton-peanut-cotton-peanut	3770 a	3490 a	18 a
	peanut-cotton-peanut-cotton-peanut-cotton-peanut	3370 a	3640 a	18 a
Tillage system	strip tillage into crop stubble	3490 a	2570 b	15 a
	stale seedbed	3640 a	3620 a	21 a

* Means within a treatment factor and year followed by the same letter are not significantly different at $P \le 0.05$. Data for each treatment factor are pooled over levels of the other treatment factor.

In the short term experiments at Lewiston-Woodville with corn and grain sorghum, no difference in yield was noted in 2005 when comparing previous crop history (Tables 5 and 6). However, the interaction of previous crop and tillage was noted for yield in 2006 (Tables 5 and 6). When comparing within the same previous crop (corn or grain sorghum), peanut yield was higher in stale seedbeds following grain sorghum than when strip tilled into stubble from the preceding crop. No difference was noted when comparing tillage systems following corn. Incidence of TSWV was similar regardless of previous crop or tillage system and was 12% or less (*data not shown*).

Table 5. F-statistic for peanut pod yield and tomato spotted wilt (TSWV) incidence when peanut was strip tilled into stubble from the previous crop (corn or grain sorghum) or stale seedbeds established four to six weeks prior to planting peanut at Lewiston-Woodville during 2005 and 2006.

Treatment factor	Peanut yield 2005	Peanut yield 2006	TSWV 2005	TSWV 2006
Cropping system	0.2	10.3*	1.5	0.8
Tillage system	16.4*	0.1	0.3	1.1
Cropping × tillage	0.1	6.1*	0.5	1.3

* Indicates significance at $P \le 0.05$.

Table 6. Influence of cropping system and tillage on pod yield. Lewiston-Woodville during 2005 and 2006.

Cropping system and tillage		**Peanut yield** (lb/acre)		
			2006	
		2005	grain sorghum	corn
Previous crop (2004 or 2005)	grain sorghum	2510 a	–	–
	corn	2640 a	–	–
Tillage	stale seedbed	2800 a	3840 a	3390 a
	strip till into stubble	2350 a	3130 b	3610 a

* Means within a year, parameter, and treatment factor by the same letter are not significantly different at $P \leq 0.05$. Data for each treatment factor are pooled over levels of the other treatment factor.

Collectively, these data indicate that while growers can expect variable response to previous crop rotation and tillage, these production and management variables most likely will not interact. Additional research is needed to determine the significance of lower yield following grain sorghum when peanut was strip tilled into stubble. These data also suggest that peanut in stale seedbeds yield equivalent to or higher than peanut planted into stubble from the previous crop and offer an alternative to strip tillage into crop stubble or traditional conventional tillage systems.

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