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IMPACT OF TILLAGE AND ROW SPACING ON DISEASES AND YIELD OF NON-IRRIGATED CONTINUOUS CORN IN SOUTHWEST ALABAMA

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In recent years, conservation tillage has been adopted by an increasing number of Alabama corn producers. With corn, increased soil tilth and moisture retention along with reduced fuel costs are often cited for the conversion from conventional to conservation till age systems for corn (Blevins *et al.* 1983, Hill and Blevins 1973, Manning and Finster 1983). Residual corn stubble on the soil surface following conservation-tilled corn is, however, a survival site for some plant pathogenic fungi, which may result in an increase in the occurrence of damaging ear rots as well as leaf spot and blight diseases on the following corn crop (Flett *et al.* 1998, Lipps 1985, Payne *et al.* 1987, Sumner and Littrell 1974). Southern corn leaf blight (Sumner and Littrell 1974), northern corn leaf blight (Griffith *et al.* 1977), and gray leaf spot (Payne *et al.* 1987) incidence was higher on corn using conservation compared with conservation tillage practices. Flett *et al.* (1998) linked increased in the incidence of Stenocarpella (Diplodia) ear rot with higher corn stubble mass associated with reduced tillage in South Africa. In contrast, tillage practices had no influence on Fusarium ear rot in corn (Flett *et al.* 1998). In Alabama, it would be important to clarify how reduced tillage in corn production impacts diseases and yield. In addition, the influence of row spacing on the occurrence of corn diseases in the Southeast has not been investigated.

Materials and Methods: The site selected for this trial had been planted to corn using a similar experimental design in 2004 and 2005. In 2006, 2007, and 2008, a rye cover crop was planted in mid- November and then killed with Roundup Originalmax at 22 fluid ounce per acre in mid-February. Approximately one week before planting, 206 pounds per acre of 9-19-19 + 10 pounds of sulfur + 3 pounds of zinc per acre analysis fertilizer or its equivalent was broadcast. In the conservation tillage plots, rows were laid out in early March using a KMC subsoiler + coulter + rolling basket rig. Conventional tillage plots were turned with a moldboard plow and then worked to seed bed condition with a disk harrow. Row spacing included single 30-inch rows or twin rows spaced 7 inches apart on 30-inch centers. The corn varieties DKC 69-72 and Pioneer 33M53 were planted in all three years. Pioneer 31G66, which was sown in 2006, was replaced with Pioneer 31N26 in 2007 and 2008. Planting dates were March 13, 2006, April 3, 2007, and March 17, 2008. Counter 15G at 6.5 pound per acre was applied in-furrow in 2006 and 2007. The experimental design was a split–split plot design with tillage as the whole plot, corn variety as the split plot, and row spacing as the split-split plot. Individual split-split plots consisted of four 50-foot rows. Pre-emergent weed control was obtained with broadcast applications of Dual Magnum at 1.5 pints per acre in 2006, Dual Magnum at 1.5 pints per acre + 2 quarts per acre of Atrazine + 2 quarts per acre of Gramoxone in 2007, and Dual Magnum at 1.5 pints per acre + 1 quart per

acre of Atrazine in 2008. A post-emergent application of Atrazine at 2 quarts per acre and Atrazine at 1 quart per acre + Roundup Originalmax at 22 fl oz/A was made on April 12, 2006 and April 24, 2008, respectively. Approximately 350 to 380 pounds of ammonium nitrate alone or mixed with ammonium sulfate was broadcast as a layby treatment in mid- to late April in each study year.

Severity of southern rust, northern corn leaf blight (NCLB), and Physoderma brown spot was rated June 20, 2006; July 18, 2007; and June 25, 2008 on the ear leaf on a scale of 0 to 10 where 0 = no disease, 1 = 1 to 10%, 2 = 11 to 20%, 3 = 21 to 30%, 4 = 31 to 40%, etc. of the leaf area diseased. Plots were combined on August 8, 2006, August 30, 2007, and August 19, 2008. Yields are reported at 15.5% moisture. Significance of treatment effects were tested by analysis of variance and Fisher's protected least significant difference (LSD) test (P=0.05).

Results: The 2006 and 2007 growing season was unusually dry throughout much of the spring and early summer (Table 1). In addition, temperatures in May and June 2006 were above average. As a result of the dry spring and summer weather patterns in 2006, minimal disease development was noted (data not shown). Rainfall and temperature patterns in 2008 were closer to the historical average for the study location.

When compared with 2006 and 2008, elevated southern rust and Physoderma brown spot damage that was seen in 2007 could be attributed to the early April rather than mid-March planting date in the former two years. Negligible levels of southern rust, Physoderma brown spot, and Northern corn leaf blight that were found on the ear leaf of all corn varieties in 2008 may also be related to drier than average June and July weather patterns.

Table 1. Monthly rainfall totals during the study period at the GCREC in 2006, 2007, and 2008.

	2006		2007		2008	
	Rainfall		Rainfall		Rainfall	
Month	Total*	Δ**	Total*	Δ**	Total*	Δ**
March	0.34	-5.74	--	--	4.26	-1.82
April	6.18	+2.05	3.35	-0.78	4.72	+0.59
May	3.48	-1.88	1.86	-3.50	8.79	+3.43
June	1.27	-5.29	5.97	-0.59	2.98	-3.58
July	3.23	-4.06	6.47	-0.82	5.33	-1.96
August	6.71	+0.05	5.12	-1.54	13.04	+6.38

*Monthly rainfall total in inches.
**Δ = difference from 30-year rainfall average for study location.

Despite the low disease pressure, Physoderma brown spot severity was higher in 2007 on the conservation than conventionally tilled corn (Table 2). Severity of southern rust in 2007 and 2008 as well as NCLB in 2008 was not influenced by tillage practices (Table 1). Row spacing did not influence the severity of any of the above diseases in either year.

Table 2. Influence of tillage and row spacing on the severity of diseases of corn.

Management Inputs	Disease rating[z]			
	2007		2008	
Tillage	Brown spot	Rust	NCLB[y]	Rust
Conventional	0.6 b[x]	1.3 a	0.1 a	0.1 a
Conservation	1.1 a	1.4 a	0.1 a	0.1 a
Row Spacing				
Single (30 inch)	0.8 a	1.3 a	0.1 a	0.1 a
Twin	0.9 a	1.4 a	0.1 a	0.1 a

[z]Severity of the above diseases was rated on the ear leaf on a scale of 0 to 10 where 0 = no disease, 1 = 1 to 10%, 2 = 11 to 20%, 3 = 21 to 30%, 4 = 31 to 40%, etc. of the leaf area diseased.
[y]NCLB = Northern corn leaf blight.
[x]Means in each column that are followed by the same letter are not significantly different according to Fisher's least significant difference (LSD) test (P=0.05).

In 2008, tillage practices had a significant impact on Physoderma brown spot severity on one of three corn varieties. Pioneer 31N26 had higher Physoderma brown spot ratings under conservation than conventional tillage (Table 3). In contrast, tillage practices had no influence on the severity of Physoderma brown spot on Pioneer 33M53 or DKC 69-72 corn varieties in 2008.

Table 3. Impact of tillage on Physoderma brown spot on three corn varieties in 2008.

Tillage	Physoderma brown spot rating*		
	Pioneer 33M53	Pioneer 31N26	DKC 69-72
Conventional	0.3 a**	0.1 b	0.1 a
Conservation	0.1 a	0.3 a	0.1 a

*Severity of brown spot was rated on the ear leaf on a scale of 0 to 10 where 0 = no disease, 1 = 1 to 10%, 2 = 11 to 20%, 3 = 21 to 30%, 4 = 31 to 40%, etc. of the leaf area diseased.
**Means in the each column that are followed by the same letter are not significantly different according to Fisher's least significant difference (LSD) test (P=0.05).

Although Physoderma brown spot severity in 2007 was lower on Pioneer 33M53 than Pioneer 31N26 and DKC 69-72, Southern rust severity was similar on three corn varieties (Table 4). In 2008, occurrence of NCLB and Southern rust, which was very low on the three corn varieties, did not significantly differ (Table 4).

Table 4. Disease ratings by corn variety for 2007 and 2008.

Corn Variety	Disease rating[z]			
	2007		2008	
	Brown spot	Rust	NCLB[y]	Rust
Pioneer 33M53	0.3 b[x]	1.5 a	0.1 a	0.1 a
Pioneer 31N26	1.2 a	1.2 a	0.1 a	0.1 a
DKC 69-72	1.1 a	1.3 a	0.1 a	0.1 a

[z]Severity of Physoderma brown spot, southern rust, and NCLB were rated on the ear leaf on a scale of 0 to 10 where 0 = no disease, 1 = 1 to 10%, 2 = 11 to 20%, 3 = 21 to 30%, 4 = 31 to 40%, etc. of the leaf area diseased.
[y]NCLB = Northern corn leaf blight.
[x]Means in the each column that are followed by the same letter are not significantly different according to Fisher's least significant difference (LSD) test (P=0.05).

Since the interactions for tillage x cultivar and row spacing x cultivar for yield were not significant in 2006, 2007, and 2008, data presented in the table for tillage and row spacing effects were pooled. In two of three years, yields were higher for the conservation than conventional tilled corn (Table 5). Over the three year study period, corn yields were not significantly impacted by row spacing.

Table 5. Impact of tillage and row spacing on the average yield of corn.

	Corn yield (bu/A)*		
Management Inputs	2006	2007	2008
Tillage			
Conventional	84.2 b**	139.0 a	114.9 b
Conservation	99.4 a	133.6 a	125.1 a
Row Spacing			
Single (30 inch)	93.4 a	137.7 a	120.6 a
Twin	89.1 a	134.8 a	119.4 a

*Yields are reported at 15.5% moisture.
**Means in the each column that are followed by the same letter are not significantly different according to Fisher's least significant difference (LSD) test (P=0.05).

In two of three years, significant differences in the yield of the three corn varieties were noted (Table 6). For 2007, Pioneer 33M53 yielded higher than Pioneer 31N26 and DKC 69-72. In the following year, yield for Pioneer 33M53 and Pioneer 31N26, which were similar, were higher compared with DKC 69-72.

Table 6. Corn variety yields for 2006, 2007, and 2008.

	Yield (bu/A)*		
Corn Variety	2006	2007	2008
Pioneer 33M53	95.3 a**	142.4 a	128.5 a
Pioneer 31G66	91.0 a	--	--
Pioneer 31N26	--	133.3 b	122.5 a
DKC 69-72	87.5 a	132.8 b	108.9 b

*Yields are reported at 15.5% moisture.
**Means in the each column that are followed by the same letter are not significantly different according to Fisher's least significant difference (LSD) test (P=0.05).

While planting date and rotation were not included as independent variables in this study, early-planted continuous corn apparently is not particularly vulnerable to damaging diseases such as Southern rust and Northern corn leaf blight. Due to a two- to three-week delay in planting, elevated but not yield reducing levels of Southern rust and Physoderma brown spot were seen in 2007.

Physoderma brown spot was the only disease impacted by tillage practices. Disease severity was higher under conservation than conventional tillage on all corn varieties in 2007 and one of three varieties in 2008. Previously, Burns and Shurtleff (1973) associated increased incidence of Physoderma brown spot on corn with reduced tillage practices. As noted above, brown spot damage levels were, however, so low in both years that corn yields were not affected. In contrast to previous studies (Griffith et al 1977), tillage had no impact on the severity of Northern corn leaf blight. Since the primary inoculum (uredospores) for Southern rust in the US originates in Central American, the absence of any influence of tillage or row spacing on the development of this disease on early corn was expected. Row spacing had no impact on the severity of Physoderma brown spot. Southern rust, or Northern corn leaf blight.

In two of three years, yields were higher for dryland corn grown using conservation rather than conventional tillage practices. Previously, Hill and Blevins (1973) associated higher yields for dryland no-till compared with conventional-till corn with reduced soil water loss during early vegetative growth. In a dryland corn

monoculture, similar to higher yields were noted at recommended nitrogen rates for no-till than conventional till corn (Blevins et al 1983). On 30-inch centers, similar yields were observed for corn planted on twin and single rows in the current study. Similar results with single and twin row corn planted on 30-inch centers were reported by Sorensen et al. (2006) and Kratochvil and Taylor (2005) for an irrigated and dryland production system, respectively. In contrast to Kratochvil and Taylor (2005), no increase in the occurrence of stalk rot diseases was noted in the twin row corn. Of the three corn varieties, Pioneer 33M53 had higher yields than DKC 69-72 in two of three years and Pioneer 31N26 in one of two years.

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