Response of Corn Hybrids Differing in Root Morphology to Conservation Tillage Systems

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Introduction

In recent years, research has begun to address the possibility that corn hybrid performance can vary with tillage practice. The majority of these studies, however, have been conducted in the Midwest and not in the southern United States.

Mock and Erbach (1977) evaluated the performance of eight corn genotypes in Iowa under conventional and three conservation tillage systems, including till-plant and no-till ridge with and without stalk shredding. Genotypes that produced the most vigorous seedling and juvenile plant growth resulted in the highest grain yields regardless of tillage system. Similar studies, also in Iowa, demonstrated no interaction between hybrid and tillage (Hallauer and Colvin, 1985).

Newhouse and Crosbie (1986) tested 60 commercial hybrids from northeastern Iowa in field experiments with no-till and conventional tillage. They found no hybrid x tillage interaction and concluded that evaluation of hybrids in conventional tillage environments was adequate for selection of hybrids for use with conservation tillage.

In a later study (1987), Newhouse and Crosbie did find significant interactions with tillage for hybrid lines derived from one corn synthetic (BS22(R)C1). They recommended that corn selection trials be conducted using conservation and conventional tillage in the proportions expected to be used in the targeted commercial environment.

Kaspar et al. (1987) tested four corn hybrids in Iowa under no-till, moldboard plowing, and disking. Although hybrids responded differently to tillage systems during vegetative growth, there were no differences among hybrids caused by tillage for mature plant height, final stand, grain moisture, or yield.

In Wisconsin, Carter and Barnett (1987) tested 15 hybrids under conventional tillage and no tillage. Superior yielding hybrids under conventional tillage also performed well with no tillage, but yield potential of later maturing (100-115 days) hybrids was reduced with no tillage. The reduction in yield potential was attributed to delayed growth with no tillage.

Generally, differential effects of tillage on hybrids in studies in the cornbelt are related to the tolerance of hybrids to the colder, wetter soils found with no-till. For conservation tillage systems in the southern United States, however, soil compaction and resultant water stress from restricted root growth are probably more limiting than reduced soil temperature and increased soil moisture associated with no tillage. When soil compaction is a limiting factor, the morphology and orientation of a crop's root system can affect the uptake of water and nutrients by the manner in which it exploits the soil.

Williams et al. (1981) demonstrated that the performance and survival of tall fescue *(Fescue arundinacea* Schreb.) genotypes in a soil containing a tillage pan was affected by inherent morphological differences in the genotype's root system.

Irwin et al. (1985) identified distinct morphological differences in root systems of corn hybrids from field evaluations conducted by the Alabama Agricultural Experiment Station. The degree of variation among hybrids suggested that these inherent characteristics could play a role in the adaptation of corn hybrids to specific tillage practices common in the southern United States. A field study was initiated in 1986 to determine if these inherent variations in root systems would cause differential responses under conservation tillage practices common to highly compactible soils in the South.

Materials and Methods

This ongoing study has been conducted for 2 years (1986 and 1987) on a Norfolk sandy loam (fine, loamy, siliceous, thermic Typic Paleudultsl located near Shorter, Alabama. The soil has a 1 to 2.5-inch thick tillage pan located 7 to 10 inches below the surface.

The experimental design is a split plot with five replications. Main plots are tillage treatments and subplots are corn hybrids. Tillage treatments are: (1) strict no-till, (2) no-till with in-row subsoiling (14-inch depth), and (3) conventional tillage (disk-chisel plow-disk + in-row subsoiling).

Corn hybrids are Stauffer S7759, Sunbelt 1827, and Ring Around 1502M. The three hybrids were selected from a preliminary study which identified differences in root morphology and anatomy. Stauffer ,57759 and Ring Around l502M have nodal roots oriented horizontally to the stem axis while Sunbelt 1827 has roots oriented vertically to the stem axis. When grown in nutrient solution, mean root diameter and metaxylem diameter were largest in Stauffer S7759. Sunbelt 1827 and Ring Around l502M were equal in root diameter although Ring Around 1502M had a larger mean metaxylem vessel diameter than Sunbelt 1827.

Planting dates were March 28, 1986 and April 16, 1987. Rye *(Secale cereale* L.) was grown as a cover crop both years. Row width was 36 inches and stand was thinned to 24,000

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plants per acre 2 weeks after emergence. A starter fertilizer consisting of 60 Ib/acre ammonium nitrate, 120 Ib/acre potassium-magnesium sulfate, 45 Ib/acre triple superphosphate, 14 Ib/acre zinc sulfate, and 8.75 lb/acre Solubor® was applied over the row. Nitrogen rate was 180 Ib/acre in addition to the 20 Ib-N/acre in the starter. One third of the N was applied at planting and the remainder was applied 4 weeks after emergence. Plots were irrigated, except during the period from tasseling through silking, to supply a minimum of one inch of water per week during 1986. In 1987, plots were only irrigated twice, early in the season, in order to obtain a stand.

Data collected included whole plant samples for dry weight and tissue nutrient analyses at 2, 4, 6, and 8 weeks after emergence and at black layer. Grain yield and stomatal conductance from tasseling to late silking (a measure of the plants water stress) were also determined.

Table 1. Corn dry matter accumulation during the 1986 and 1987 growing season as affected by tillage.

	Days after planting				
Tillage	**21**	**41**	**51**	**63**	**93**
	----------lb/acre----------				
1986					
Conventional + subsoiling	51	938	3,580	5,802	17,849
No-till + subsoiling	44	691	3,540	5,105	16,780
No-till	36	455	2,256	4,489	15,766
LSD (0.10)	6	188	492	252	1.223
1987					
Conventional + subsoiling	31	628	2,610	4,266	16,196
No-till + subsoiling	29	575	2,507	4,828	14,761
No-till	20	367	1,394	3,435	16,608
LSD (0.10)	7	92	356	578	*2,090*

Table 2. Corn dry matter accumulation during the 1987 growing season as affected by hybrid selection.

	Davs after planting				
Hvbrid	**21**	**41**	**51**	**63**	**93**
	----------lb/acre----------				
Sunbelt 1827	30	647	2,252	4,511	18,467
Ring Around 1502M	26	453	2,043	3,581	14,927
Stauffer S7759	23	468	2,215	4,115	14,172
LSD (0.10)	5	88	300	472	1.320

Table 3. Corn grain yield in 1987 as affected by tillage and hybrid selection.

	Hybrid		
Tillage	**Stauffer S7759**	**Sunbelt 1827**	**Ring Around 1502M**
	---------- bu/aere ----------		
Conventional + subsoiling	136	156	128
No-till + subsoiling	128	149	134
No-till	128	129	121
LSD (0.10) for any two values = 13 bu/acre			

Results and Discussion

Plant growth, as indicated by dry matter accumulation, was influenced by tillage in both years Table 1). In general, strict no-tillage produced less dry matter over time than in-row subsoiling. There was little difference in dry matter accumulation between corn grown with conventional tillage + in-row subsoiling and corn grown with no tillage + in-row subsoiling.

In 1987, when soil moisture was limited, the selection of hybrid was important. Sunbelt 1827, a cultivar with small diameter, vertically oriented roots, consistently had the greatest production of dry matter regardless of tillage treatment (Table 2). In this year, dry matter production was also a good indicator of grain yields produced by the three hybrids.

In 1986, when moisture was not limiting because of supplemental irrigation, grain yield was not affected by tillage or hybrid (average yield, 120 bu/acre). Without supplemental irrigation, in 1987, there was a tillage x hybrid interaction (Table 3) . Sunbelt 1827 demonstrated the largest yield potential of the three hybrids. The vertically oriented, small diameter root system of this hybrid responded dramatically to subsoiling with a 15 percent yield increase. Additional surface tillage resulted in another 5 percent yield increase for Sunbelt 1827.

There was a nonsignificant trend for the horizontally oriented root system of Stauffer S7759 to respond to surface tillage in the conventional + in-row subsoiled plots. This hybrid did not respond to subsoiling. No-tillage + in-row subsoiling resulted in maximum yields for Ring Around 1502M, while strict no-tillage resulted in the lowest yields for this hybrid. Ring Around 1502M, with horizontally oriented, small diameter roots,generally maintained greater stomatal conductances from silking through black layer formation than either Stauffer S7759 or Sunbelt 1827 (data not shown). This evidence of plant water status was not indicative of hybrid performance for grain yield production, however.

Conclusions

Preliminary results from this test suggest that variation in inherent root characteristics can affect corn hybrid performance in different tillage systems. The effect of this variation may be especially notable when corn is subjected to periods of drought stress, which is frequently the case for corn grown in the southern United States. Although factors other than root characteristics are crucial to hybrid performance, our results suggest that root characteristics could serve as important criteria for selection of corn hybrids adapted to reduced tillage systems developed for highly compactible soils.

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