Influence of Irrigation and Rye Cover Crop on Corn Yield Performance and Soil Properties

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ABSTRACT

Crops grown in the Macon Ridge region of northeast Louisiana are very responsive to irrigation. In dry years, it is extremely difficult to maintain adequate soil moisture on the Macon Ridge soils because of a shallow root zone. Additionally, when several irrigations are required, high salt accumulation occurs in the root zone because of poor quality irrigation water. An experiment was conducted in 2001 on a Gigger silt loam at the Macon Ridge Research Station near Winnsboro, LA to evaluate the influence of irrigation, cover crop, N rate, and plant population on corn grain yield, soil moisture, and total soil salts. Data suggest that a mulch-forming cover crop such as cereal rye that persists through most of the growing season can improve soil moisture conditions and enhance yield. Further findings suggest that potential salt problems may be alleviated somewhat by the use of a cover crop.

KEYWORDS

Loess, fragipan, pH, perched water table, natural vegetation

INTRODUCTION

Crops grown in the Macon Ridge region of northeast Louisiana are very responsive to irrigation. These loessial silt loam soils have fragipans at 15 to 25 inches deep and have low soil pH values below the Ap horizon. According to Reichman and Trooien (1993), a given site should not be irrigated if it has a barrier at a depth of 60 inches or less. Two potential effects of irrigation when a barrier is present are development of a perched water table and accumulation of excess salts in the root zone. If excessive, either possibility can impair crop root function and decrease yield.

In dry years, it is extremely difficult to maintain adequate soil moisture on the Macon Ridge soils because of the shallow root zone. A negative correlation between the number of furrow irrigations and yield often occurs with yields decreasing as the number of irrigations increase. When several irrigations are required, plants oftentimes have the appearance of dryland corn with a short plant stature and very small ears, suggesting that high salt accumulation in the root zone may be producing an "osmotic" effect. Salt analyses of both the irrigation water and soil have confirmed these suspicions (personal communication).

Winter cover crops can increase N availability and conserve soil moisture for subsequently planted crops in the southeastern U.S. (Munawar *et al*., 1990; Teasdale and Mohler, 1993; Wagger, 1989). Non-legume cover crop residue develops a persistent surface mulch for soil water conservation (Munawar *et al*., 1990; Teasdale and Mohler, 1993). Wilhelm *et al*. (1986) reported a positive linear relationship between grain and stover yield and amount of residue applied to the soil surface. Residue effects on crop yield were mainly through changes in soil water and temperature.

Rye has long been recommended as a winter cover crop because of its winter hardiness (Ditsch and Alley, 1991) and has been shown to provide additional mulch for no-till corn (Moschler *et al*., 1967) and soybean (Eckert, 1988). Gallaher (1977) found that corn planted into killed rye mulch conserved soil water, was more drought tolerant, and showed greater use and earlier depletion of water by roots deep in the soil profile. Corn grain and soybean yields were increased 46 and 30%, respectively, by the rye mulch treatment. Cover crop treatments may also affect the soil salt content. When more water is left in the soil profile to leach or dilute the salts, the electrical conductivity of the soil saturation extract is reduced (Reichman and Trooien, 1993). Other cultural practices that reduce water consumption such as plant population and hybrid may influence yield and soil salinity. The objective of this research was to evaluate the

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influence of irrigation, cover crop, N rate, and plant population on grain yield, soil moisture, and total soil salts.

MATERIALS AND METHODS

An experiment was conducted in 2001 on a Gigger silt loam (fine silty, mixed, thermic Typic Fragiudalf) at the Macon Ridge Research Station near Winnsboro, LA to evaluate the influence of irrigation, cover crop, nitrogen (N) rate, and plant population on yield, soil moisture, and soil salt content. Factors evaluated included irrigation at 1.5- and 2.5-inch soil moisture deficits (SMD), native and cereal rye cover crops, 100 and 200 lbs N acre^{-1}, and 25,000 and 30,000 plants acre^{-1}. Furrow irrigation treatments were scheduled using the 'Arkansas Irrigation Scheduler' (Cahoon *et al*., 1990). The 1.5-inch SMD treatment was considered well watered and the 2.5-inch SMD moderately well watered. 'Elbon' rye was planted November 2, 2001 at a seeding rate of 100 lbs acre^{-1}. Growth of cover crops was chemically terminated with Roundup-Ultra about three weeks prior to planting. Pioneer brand 3223 was over planted and thinned back to 25,000 and 30,000 plants acre^{-1}. Nitrogen as 32% N-solution was knifedin at about the four-leaf growth stage at rates of 100 and 200 lbs N acre^{-1}. The only tillage was bed rehippingin the fall of 2000. The previous crop was cotton.

The experiment design was a randomized complete block with a split-split plot arrangement of treatments. Irrigation was the main plot, cover crop the split-plot, and N rate and plant population treatments the split-split plots. Treatments were replicated four times. Measurements included grain yield, yield components (ears acre^{-1}, kernel weight, and kernels ear^{-1}), soil moisture, and total soil salt concentration. In one replication, three tensiometers/plot were placed in each treatment at the 10-inch depth. Within a plot, tensiometers were 6-inches apart. Tensiometer readings in cb were collected daily and plot data were determined from the average of three tensiometers. Soil samples (0-8 inch depth) were collected in one replication on June 26 and July 27. The LSU AgCenter's Soil Testing Lab determined total salts. All data were analyzed with the GLM procedure using the SAS package (SAS Inst., 1985). The LSD (P = 0.05) test was used to evaluate differences among treatments when the F-test indicated significance (P = 0.05).

RESULTS AND DISCUSSION

Cover crop was the only treatment that significantly affected grain yield or yield components (Table 1). The lack of response between irrigation treatments was probably due to several rainfall events in June during the critical pollination and early grain fill growth stages. There were seven irrigations for the 1.5-inch SMD, beginning May 29 and ending July 23, compared to four irrigations for the 2.5-inch SMD, beginning June 19 and ending July 25. Similar yields between irrigation treatments also may have been related to the minimal level of tillage utilized in this study. The only tillage performed was the rehipping of beds in the fall of 2000.

Corn yields following rye were significantly higher than following native vegetation for both irrigation treatments (Table 1). Averaged across irrigations, the rye cover crop increased corn yields 21%. The yield component that most affected the cover crop response was kernel weight. Following rye, 100 kernel weight was 12% higher than native vegetation for the 1.5-inch SMD and 14% higher than native vegetation for the 2.5-inch SMD. Although not significant, kernels per ear followed similar trends.

Table 1. Influence of irrigation and cover crop on grain yield and kernel weight at Winnsboro in 2001, averaged across N rate and plant population treatments. Irrigation means and irrigation x cover crop interaction means did not differ at P = 0.05.

Irrigation	Cover crop	Grain yield	Kernel weight	Kernels ear^{-1}
		bu acre^{-1}	g (100 kernels)$^{-1}$	No. ear^{-1}
1.5-in. SMD	Native	126.8	28.0	439
	Rye	154.1	31.6	460
2.5-in. SMD	Native	124.8	27.1	433
	Rye	151.1	30.9	461
$LSD_{0.05}$				
Irrigation (I)		NS[†]	NS	NS
Cover crop (C)		17.2	2.1	NS
I x C		NS	NS	NS

[†]NS-Not significant at P = 0.05

Tensiometer data indicated that the rye cover was providing a mulch which enhanced soil moisture (Fig. 1). This effect was most pronounced for the 1.5-inch SMD treatment, particularly early in the season. Samples taken prior to corn planting indicated that there was approximately 3100 lbs acre^{-1} of rye cover and 650 lbs acre^{-1} of native vegetation.

Influence of irrigation and cover crop on the total soil salts is presented in Table 2. Treatments from one replication were evaluated so data cannot be statistically analyzed. However, some interesting trends occurred among treatments for total soil salts. Averaged across irrigation and cover crop treatments, total soil salts increased from 544 ppm for the June 26

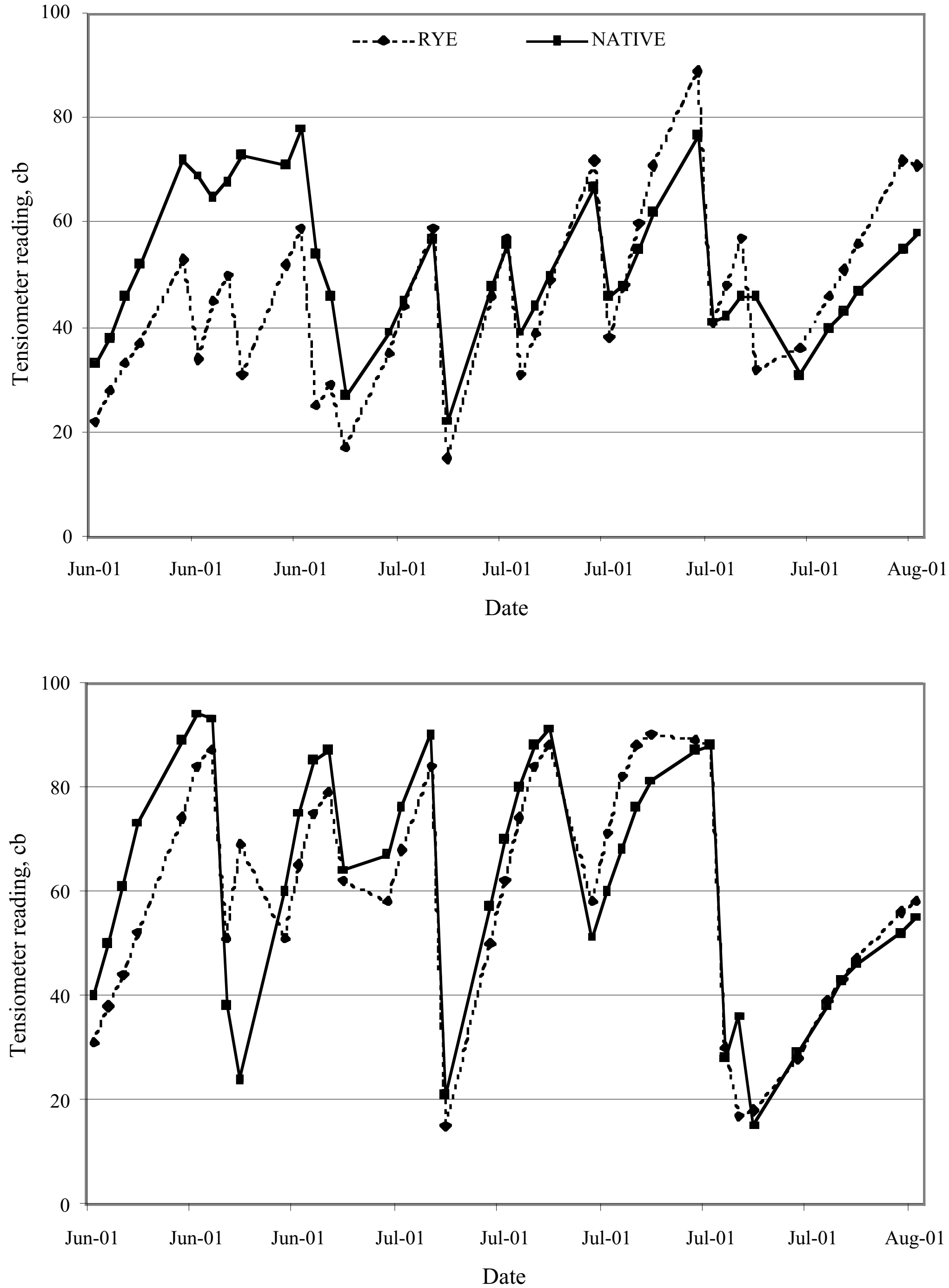

Fig. 1. Influence of cover crop on tensiometer readings at Winnsboro in 2001. The top panel depicts the response when irrigation was applied at 1.5-inch soil moisture deficit (SMD). The bottom panel is for 2.5-inch SMD.

sampling date to 1919 ppm for the July 27 sampling date. At each sampling date, the lowest salt levels occurred for the rye cover crop treatment. The highest salt level of 3266 ppm occurred at the July 27 sampling date for the 1.5-inch SMD and native vegetation treatments. Since most of the irrigations occurred between the two sampling dates, the increase in salts at the later sampling date was probably due to irrigation water. Indeed, the salt content of the irrigation water was greater than 1500 ppm. The Louisiana Cooperative Extension Service considers total soil salts > 1500 ppm as very high.

Table 2. Influence of irrigation and cover crop on total soil salts in the Ap horizon of Gigger silt loam at two sampling dates at Winnsboro in 2001.

Irrigation	Cover crop	Total salts
		ppm
June 26, 2001		
1.5-in. SMD	Native	719
	Rye	523
2.5-in. SMD	Native	503
	Rye	429
July 27, 2001		
1.5-in. SMD	Native	3266
	Rye	1498
2.5-in. SMD	Native	1614
	Rye	1296

CONCLUSIONS

The data from this one-year study suggest that a mulch-forming cover crop such as rye that persists through most of the growing season can improve soil moisture conditions and enhance yield. Further findings suggest that potential salt problems may be alleviated somewhat by the use of a cover crop. This study will be continued in 2002 with the addition of a non-irrigated control.

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