WINTER COVER BIOMASSS PRODUCTION AND SOIL PENETRABILITY

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ABSTRACT

Winter cover crops can benefit production systems in the southeastern US. Winter cover crops, such as rye (*Secale cereale*) can reduce weed pressure, increase water infiltration, and improve soil quality over a long period of time. Although several studies have focused on the effects of having a winter cover present, none have focused on studying the effect of different biomass amounts. The objective of this study was to determine the effect of rye biomass amounts on soil penetrability. Using different rye planting dates and termination times, several levels of biomass were obtained. Soil penetrability, as measured with a penetrometer, was improved with increasing biomass amount. Low rye biomass amounts did not result in decreased cone index values. Winter cover crops can effectively be used to improve soil conditions for crop production in combination with other conservation agriculture practices, such as non-inversion tillage.

INTRODUCTION

Winter cover crops are widely accepted in the southeastern US as part of conservation agriculture systems. Benefits from winter cover crops include weed suppression, increased infiltration, reduced erosion, and others (Endale et al., 2002; Baldwin et al., 1985; NeSmith et al, 1985). Rye is commonly used as a winter cover because seed is readily available, can produce large amounts of biomass, and it is somewhat easy to establish. Benefits can include crop yield increases, decreased weed pressure, and runoff reductions under conservation tillage, therefore reducing non-point source pollution

Work conducted by Raper et al. (2000a) has shown that rye is as effective as non-inversion tillage in reducing the effects of consolidated soil on cotton yields for Piedmont soils. They showed that the use of a cover crop almost eliminated excessive soil strength and increased cotton yields when compared to strict no-till. The use of a subsoiler did not increase crop yields significantly compared to the cover crop.

In other work conducted by Raper et al. (2000b) it was reported that spring non-inversion tillage was more effective than fall tillage in reducing soil strength. They also reported that a combination of shallow (~7 in) non-inversion tillage with rye as a winter cover crop was more effective in increasing yields when compared to no-till and deep tillage.

Although the effect of winter cover biomass on soil properties, including soil penetrability, has been studied, no work to date has addressed the impact of different amounts of cover biomass. Thus, the objective of this study was to determine the effect of different rye biomass amounts on soil penetrability.

MATERIALS AND METHODS

The study was conducted at the Row Crops Unit of the E.V. Smith Research and Extension Center near Shorter, AL in a Compass loamy sand (Coarse-loamy, siliceous, subactive, thermic Plinthic Paleudults) in 2005. Different amounts of rye biomass were obtained by planting and terminating the cover crop at different times during the fall and spring, respectively. These included five different planting times and four termination dates arranged in a strip plot design with three replications. The planting dates were established to be four and two weeks prior to the week when the first average frost typically occurs, the week of the first average frost, and two and four weeks after first average frost. Termination dates included four and two weeks prior to the average planting date for that region, the week of the average planting date, and one week after the average planting date.

Rye was planted in plots 13.3 ft wide by 25 ft long in the fall with a no-till drill at a 40 lb ac^{-1} seeding rate. Sixty lb ac^{-1} of ammonium nitrate were applied in the fall after cover crop establishment. The rye cover was terminated with glyphosate and flattened with a roller equipped with flat bars. Two 2.7 ft^2 areas were harvested from each plot at termination time to determine rye biomass production. Rye biomass was placed in a bag and dried in an oven at 131° F for 48 hours.

Four rows of cotton (Gossypium hirsutum L.) were planted in each plot with a 40 in spacing. The two middle rows of each plot were harvested with a cotton picker to determine yields.

A penetrometer system equipped with five rods was used to determine soil penetrability (Raper, 1999). The middle rod of the penetrometer was centered over the planting row, with two other rods on each side. Distance between rods was 10 inches. The penetrometer system was mounted to a small tractor. Penetration force and depth were recorded with a portable computer. Because of time and labor constrains, seven plant and termination dates were chosen for penetration resistant measurement. This gave a good range of rye biomass production to evaluate penetration resistance. Penetrometer readings were taken one day after a significant rainfall event (>0.50 in) shortly after planting.

RESULTS AND DISCUSSION

Biomass production between the planting and termination dates varied greatly, providing a good range of available biomass for evaluating the effect of winter cover biomass on soil penetrability (Fig. 1). Generally, early planting dates produced greater rye biomass with termination date having less of an effect. Average dry biomass production for the first planting date was 4,744 lb ac^{-1}, followed by the third planting date (2,322 lb ac^{-1}) and the last planting date (189 lb ac^{-1}).

Soil penetrability, as measured by cone index (CI), was affected by rye biomass (Fig. 2). Decreasing CI values were observed with increasing biomass to approximately 12 in of depth. Lower CI values were observed for the first planting date down to 20 in of depth.

Rye biomass production affected soil penetrability for most of the soil profile (Figs. 3, 4 and 5). Less dense soil conditions, as measured by the penetrometer, were present in the row and between row locations with greater rye biomass production (Fig. 3). Cone index values were low in the row for all biomass levels. These lower CI levels were probably caused by the non-inversion tillage practice (i.e. strip-till) conducted a few weeks before cotton planting, which is a common practice in this region. The value of strip-tilling these soils is evident in the CI data presented here, where lower CI values are associated with the location tillage was conducted (Fig. 4 and 5). Nevertheless, even after non-inversion tillage, relatively large CI values were observed between rows in areas with low rye biomass (Fig. 5). Although strip-tilling created an adequate environment for root growth in the row, cotton roots could have been restricted to grow laterally in areas with low rye biomass production. Therefore, to fully take advantage of rye as winter cover crop it must be managed for maximum biomass production.

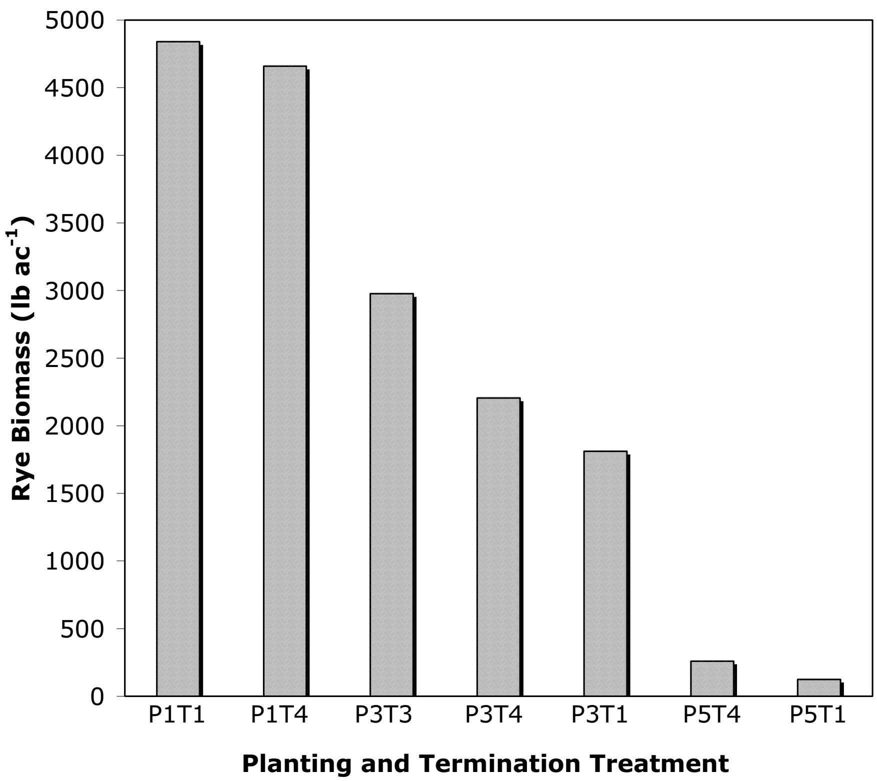

Figure 1. Rye biomass as a function of planting and termination date. The 1st planting date is listed as P1, 3rd as P3, and last plant date as P5; T1 is 1st termination, T3 the 3rd, and T4 the last.

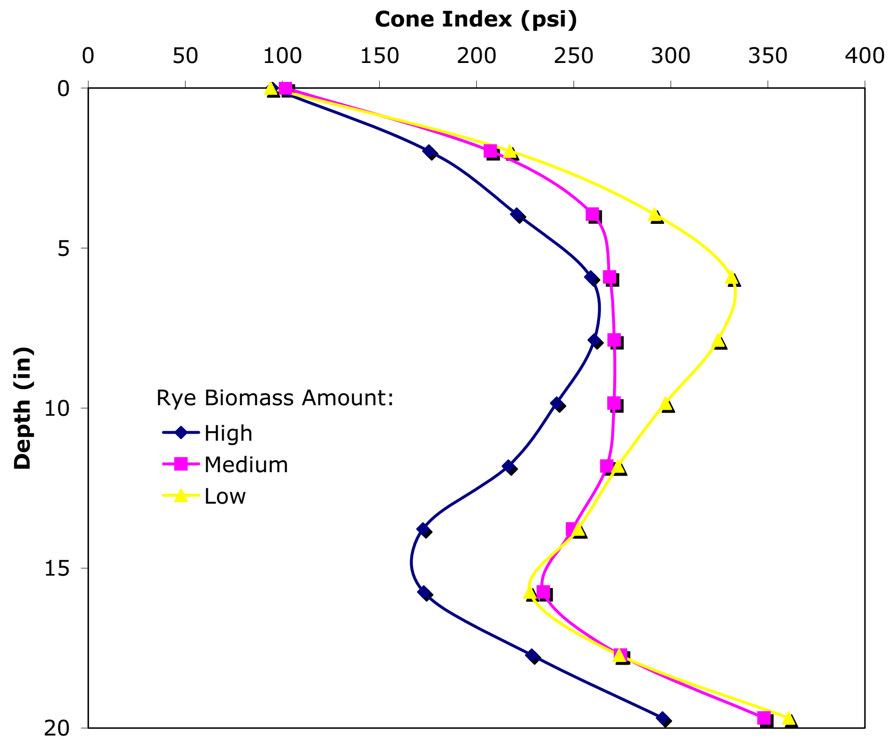

Figure 2. Cone index values averaged over high, medium, and low rye biomass amounts (4,744; 2,322; and 189 lb ac^{-1}, respectively).

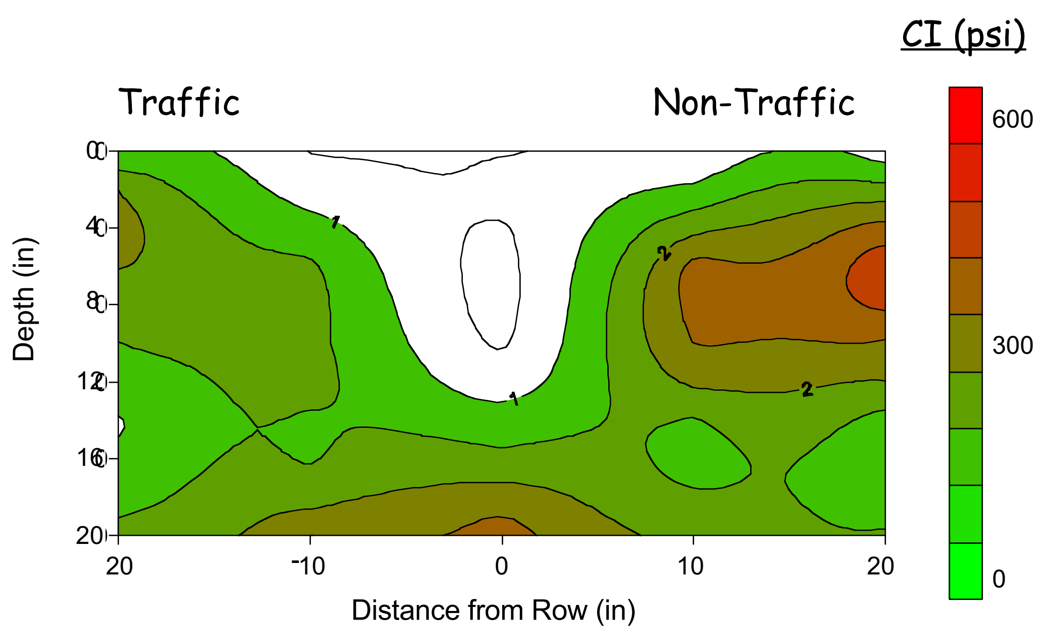

Figure 3. Average soil penetrability for the soil profile under the high (4,744 lb ac^{-1}) rye biomass production treatment.

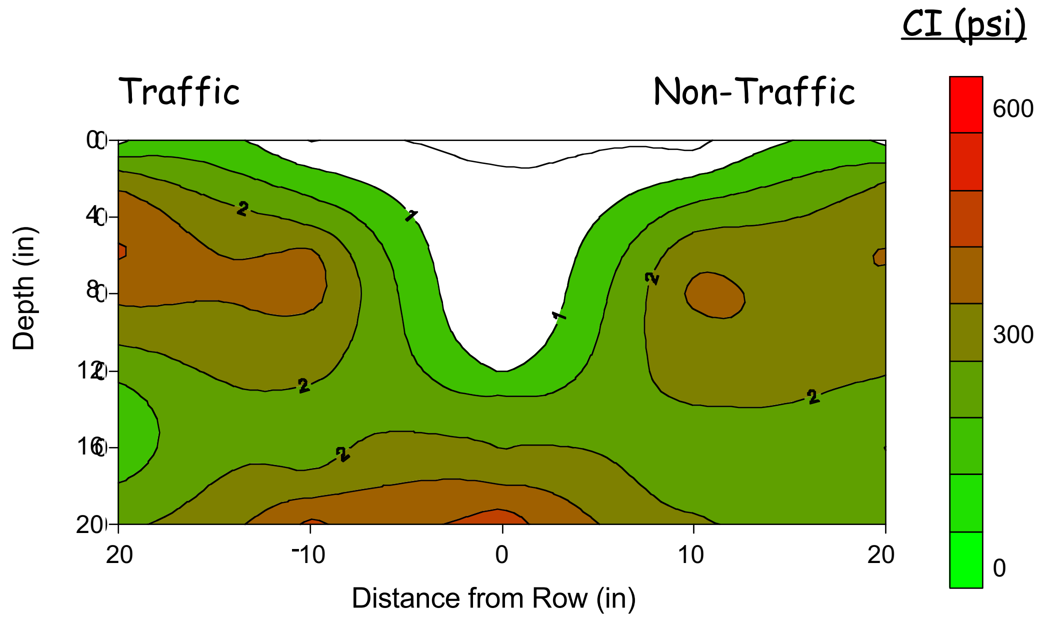

Figure 4. Average soil penetrability for the soil profile under the medium (2,322 lb ac^{-1}) rye biomass production treatment.

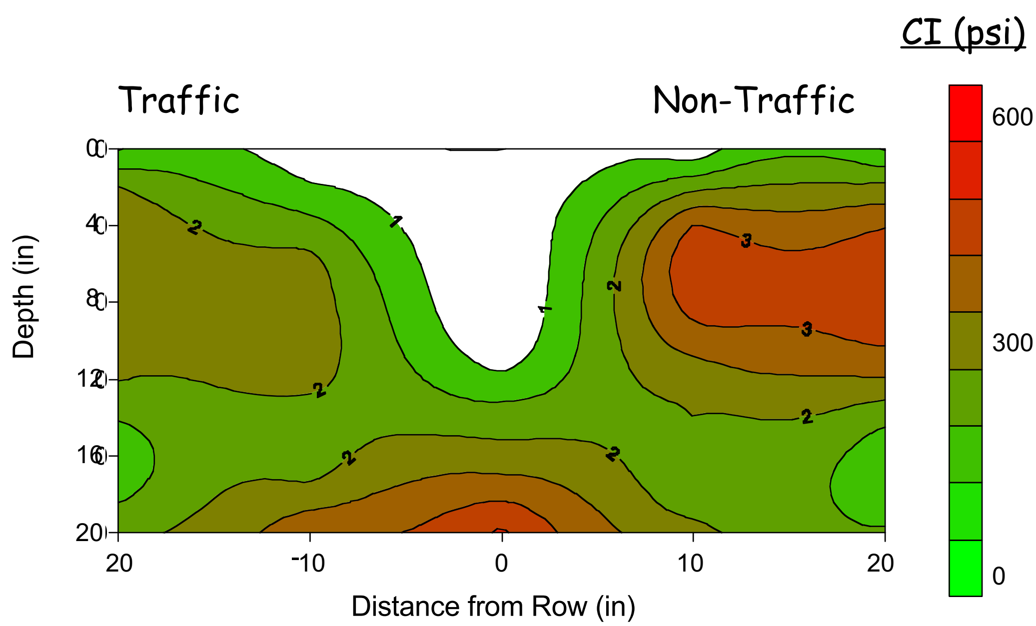

Figure 5. Average soil penetrability for the soil under the low (189 lb ac^{-1}) rye biomass production treatment.

CONCLUSIONS

The use of different winter cover planting and termination dates had a significant impact on rye biomass production. Early planting times resulted in greater rye biomass production when compared to latter planting dates. Termination dates had a less pronounced effect.

Rye biomass production had a significant impact on soil penetrability. Greater rye biomass amounts resulted in reduced CI values. Strip-tilling created adequate conditions for root growth in the row, but high residue from the winter cover resulted in improved overall soil conditions for root development. The root action of the winter cover helped loosen the soil most of the profile, where non-inversion tillage only targets the row. Thus, winter cover crops should be managed to maximize biomass production to fully benefit from their use. Further research in this area should include below ground biomass production, other cover crop species, and soil conditions.

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