WINTER ANNUAL GRAZING AND TILLAGE SYSTEMS EFFECTS ON SWEET CORN

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ABSTRACT

Winter annual grazing can supplement vegetable grower income, but can also decrease vegetable yields through excess soil compaction. We initiated a study to determine the optimal tillage system for sweet corn (*Zea mays*, L.) production on a Wynnville fine sandy loam (Fine-loamy, siliceous, subactive, thermic Glossic Fragiudults), in north central Alabama from 2001-2003. A factorial arrangement in a randomized complete block design of three surface tillage treatments (chisel/disk/level, disk/level, no surface tillage) and three deep tillage treatments (no deep tillage, in-row subsoiling, paratill) with four replications were administered to plots planted to ryegrass (*Lolium multiflorum* L.) cv. 'Marshall' each fall. Winter annual grazing generated an average net income over the 3 yr period of $268.75 ac^{-1} minus labor. Both surface tillage treatments were superior to no surface tillage each year. In-row subsoiling produced higher fresh corn ear weights in 2001, while both deep tillage treatments produced higher yields than no deep tillage in 2003. Leaf temperatures differences of less than 2 F° were observed between surface and deep tillage treatments in 2001 and 2002. Differences of 1/16" were observed in average ear diameters between surface tillage treatments in 2001 and 2002 and between deep tillage treatments in 2002. Preliminary results indicate that a combination of surface and deep tillage is required to maximize sweet corn yields following winter annual grazing.

INTRODUCTION

In Alabama, over 400,000 ac. of winter annuals are grazed prior to planting summer row crops (Ball, 1988). Research indicates profits of $70 to $224 ac^{-1} for cattle grazed on ryegrass pastures over the winter months in Alabama (Bransby et al., 1999). These profits document the potential that exists for growers to supplement their income over the winter months after the summer growing season.

Vegetable growers typically produce higher net returns per acre compared to growers that plant only summer field crops, due to the higher prices received for vegetables. For example, Alabama growers planted 1700 ac. of sweet corn in Alabama with an average yield of 68 cwt ac^{-1} that sold for an average price of $17 cwt^{-1} (NASS, 2003). These statistics indicate an average gross income of over $1100 ac^{-1}. Vegetable growers capable of integrating winter grazing into their operations can potentially increase their profit margins substantially.

Unfortunately, winter grazing creates excessive compaction, which adversely affects yields of subsequent summer crops (Miller et al., 1997). Although, vegetable growers can supplement their income and reduce economic risk by incorporating winter grazing into their operation, this increase in profitability over the winter months should not be at the expense of vegetable yields the following year.

The objective of this study was to determine the optimal tillage system for sweet corn production following winter grazing.

MATERIALS AND METHODS

An experiment was established at the Sand Mountain Research and Extension Center in Crossville, AL. Treatments were a factorial arrangement of three surface tillage treatments and three deep tillage treatments in a randomized complete block design with four replications, established for each of three crops (sweet corn, southern pea (*Vigna unguiculata* L.), watermelon (*Citrullus lanatus* L.)) grown simultaneously. The crops were rotated each year in a southern pea-sweet corn-watermelon sequence for 3 yr. Plot dimensions were 11 ft. wide and 45 ft. long, allowing for a 1 ft. buffer between plots. Data presented will only be for sweet corn production.

Beginning in September of 2000, ryegrass cv. 'Marshall' was planted at 25-30 lb ac^{-1} on a Wynnville fine sandy loam with a no-till drill. Plots were grazed, beginning in late November to early December, at a stocking rate of three cattle ac^{-1} and removed by early to mid-April to facilitate sweet corn planting. Cattle performance was determined each year by weighing each animal prior to grazing and at the time of removal from grazing. Biomass samples were collected after cattle removal by cutting all aboveground ryegrass tissue from two areas, within each plot, measuring 2.7 ft^2 each. Glyphosate was used to terminate ryegrass, tillage treatments were administered, and pre-emergence herbicides (atrazine and s-metolachlor) were applied, prior to sweet corn planting. Typical cultural practices to control weeds and insects were utilized throughout the season to maximize yields.

Sweet corn cv. 'Silver Queen' was planted at 26,000 plants ac^{-1} in mid-April of each year. Sweet corn row spacing was 30" in 2001 and 2002 and 36" in 2003. In 2001, three treatments (no surface tillage and no deep tillage; no surface tillage and in-row subsoiling; no surface tillage and paratill) were replanted on 8 May, due to poor stand establishment. All sweet corn plots were replanted in 2003 because of poor seed germination. Leaf temperatures, an indication of plant stress, were collected from five leaves plot^{-1} on eight different dates in 2001, six different dates in 2002, and four different dates in 2003 beginning immediately prior to silking. Fresh corn ear weights were measured by hand harvesting ears from the two center rows of each plot and summing the weights from three different harvest dates. The length and diameter of two randomly selected ears from each harvest date were measured and averaged to estimate quality.

Fresh sweet corn ear weights and average length and diameter of ears were analyzed by analysis of variance using a general linear model procedure provided by Statistical Analysis System (SAS Institute, 2001) within years. Dates of leaf temperatures were analyzed by date within years using the same general linear model procedure provided by Statistical Analysis System. Treatment differences were considered significant if $P > F$ was equal to or less than 0.10.

RESULTS AND DISCUSSION

Combined cattle gain over each grazing period was 2415, 3015, and 2350 lb. for 2001, 2002, and 2003, respectively. This weight gain generated an average net income over the 3 yr period of \$268.75 ac^{-1} minus labor. After cattle were removed, ryegrass biomass production was low due to close grazing by the cattle. In 2001, ryegrass was heavily grazed, so no biomass measurements were collected. Ryegrass biomass, prior to the initiation of tillage treatments, averaged 357 lb ac^{-1} in 2002 and 1214 lb ac^{-1} in 2003.

In 2001, fresh sweet corn ear weights ranged from 73.6 cwt ac^{-1} (no surface tillage; no deep tillage) to 213.1 cwt ac^{-1} (disk level; in-row subsoiling). Fresh sweet corn ear weights ranged from 206.1 cwt ac^{-1} (chisel/disk/level; paratill) to 124.6 cwt ac^{-1} (no surface tillage; paratill) in 2002. Yields across all treatments were lower in 2003 due to wind damage from a tropical storm. Yields ranged from 105.1 cwt ac^{-1} (disk/level; paratill) to 40.9 cwt ac^{-1} (no surface tillage; no deep tillage). Chisel/disk/level and disk/level produced higher yields above no surface tillage, when averaged across all deep tillage treatments for each year of the study (Table 1). In-row subsoiling was superior to no deep tillage when averaged across all surface tillage treatments in 2001 and 2003 (Table 1). No yield differences were detected between deep tillage treatments in 2002. The paratill treatment also produced higher fresh sweet corn ear weights than no deep tillage in 2003.

A significant interaction was observed between surface tillage and deep tillage in 2002 and 2003. A combination of surface and deep tillage produced higher yields than deep tillage alone in 2002 (Fig. 1A). However, the results were not consistent. In-row subsoiling produced higher yields when the disk/level treatment was applied, and the paratill treatment produced higher yields in combination with the chisel/disk/level treatment. Both surface tillage treatments produced higher yields than no surface tillage in combination with no deep tillage and the paratill treatment in 2003 (Fig. 1B). In-row subsoiling with no surface tillage produced similar yields as in-row subsoiling with both forms of surface tillage.

Sweet corn leaf temperatures were similar between tillage treatments within sample dates and years, but small temperature differences of 2 F° or less were detected in 2001 and 2002 (data not shown). No differences in leaf temperatures were observed for any treatments in 2003. Leaf temperatures were different for two sample dates from surface tillage treatments and one sample date for deep tillage treatments in 2001. In 2002, leaf temperature differences were only detected from the deep tillage plots for two sample dates. Generally, leaf temperatures measured from plots with no surface tillage or deep tillage were higher than leaf temperatures measured from plots with surface tillage or deep tillage, indicating more plant stress.

Ear quality measurements included length and diameter of two randomly selected ears from each harvest date, but no differences were observed between any treatments for ear lengths. Small differences (1/16") between average ear diameters were detected for two years (2001 and 2002) between surface tillage treatments and one year (2002) between deep tillage treatments (data not shown).

CONCLUSIONS

Fresh sweet corn ear weights increased all three years with chisel/disk/level surface tillage and two years with disk level surface tillage. In-row subsoiling produced higher fresh sweet corn ear weights in 2001 over no deep tillage and both deep tillage treatments produced higher ear weights over no deep tillage in 2003. Leaf temperatures were higher in plots receiving no surface tillage compared to other surface tillage treatments at two sample dates. Leaf temperatures from no deep tillage plots were also higher than deep tillage treatments at one sample time. Small differences were detected in average ear diameters in 2001 and 2002 for surface tillage treatments and in 2002 for deep tillage treatments.

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Table 1. Fresh sweet corn ear weights for three surface tillage treatments and three deep tillage treatments recorded at the Sand Mountain Research and Extension Center in Crossville, AL during 2001-2003 growing seasons.

	Surface tillage				Deep tillage			
Year	None	Chisel disk level	Disk level	$LSD_{0.10}$†	None	In-row subsoiling	Paratill	$LSD_{0.10}$
	---------------cwt ac^{-1}---------------				---------------cwt ac^{-1}---------------			
2001	92.9	195.7	185.3	20.7	144.3	174.7	154.9	20.7
2002	127.8	176.1	166.2	13.3	153.3	153.0	163.8	NS‡
2003	74.3	97.7	94.1	12.7	76.2	93.3	96.6	12.7

† Least significant difference at the P=0.10 level of significance.
‡ Not significant.

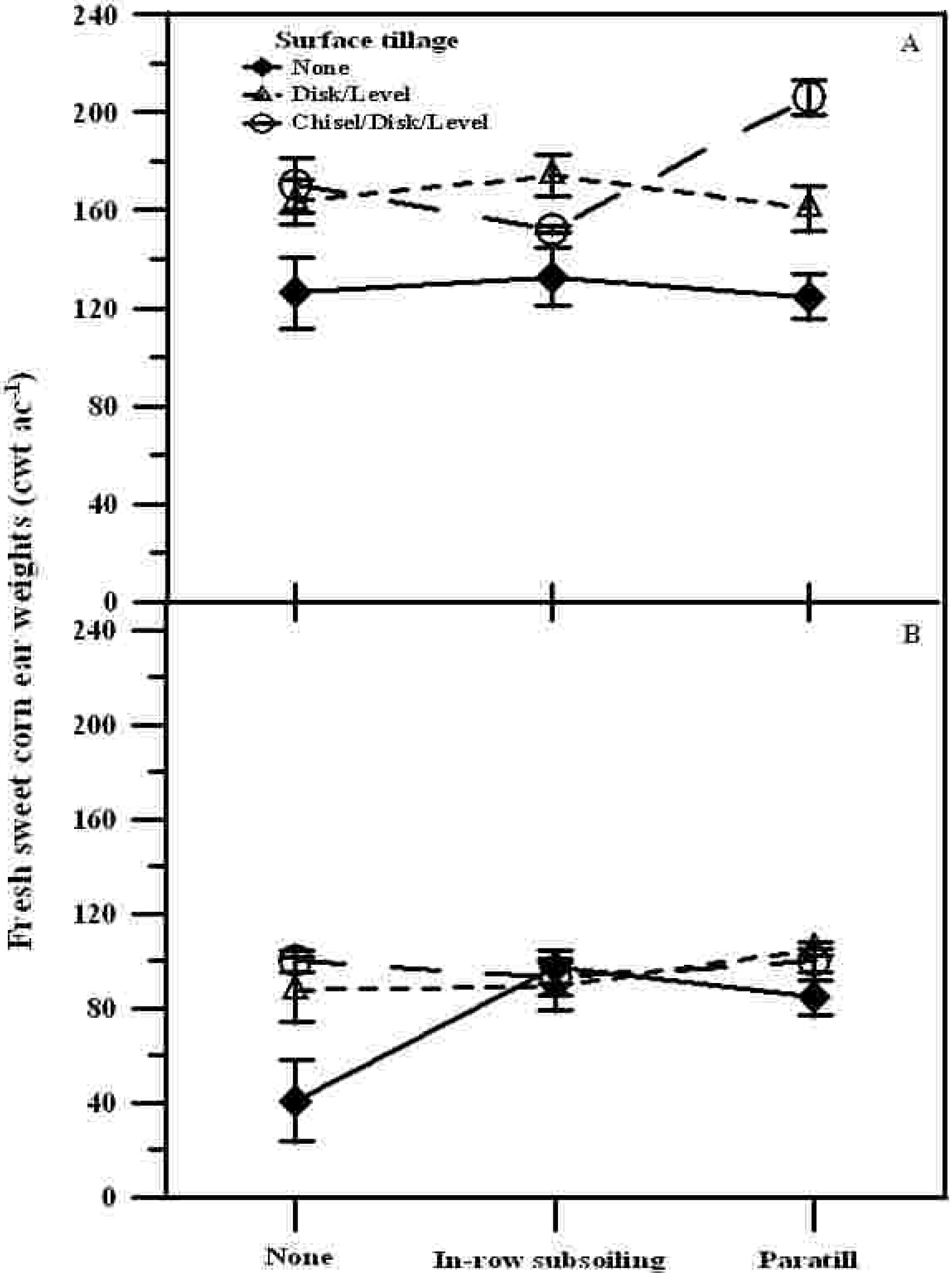

Figure 1. Effect of surface tillage and deep tillage on fresh sweet corn ear weights at the Sand Mountain Research Center in Crossville, AL for 2002 (A) and 2003 (B) growing seasons. Error bars indicate standard errors (n=4).