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CONSERVATION TILLAGE COTTON AND PROCESSING TOMATO RESEARCH IN CALIFORNIA'S SAN JOAQUIN VALLEY

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Abstract

Less than 1% of row crop acreage in California is currently farmed using conservation tillage (CT) practices. Adoption of CT systems in California has, however, recently been seen as a potential means for improving profitability and reducing energy use and a number of research, demonstration and evaluation initiatives are currently underway to explore a variety of cropping system options for reducing tillage. In the fall of 1999, we established a 3.2 hectare field experiment comparing conservation and standard tillage (ST) cotton and tomato production systems with and without winter cover crops at the University of California West Side Research and Extension Center in Five Points, CA. To date, this study has demonstrated that planting and harvesting crops with conservation tillage systems is possible given some equipment modifications and that yields can be maintained relatively close to those of standard tillage in CT crop residue environments. Data from the second year of this study indicate that tomato yields in the CT $\pm$ cover crop systems were similar to those in the standard till plots, with an elimination of six tillage operations following last year's cotton crop in the CT plots relative to the standard till systems. 2001 cotton yields were reduced 11 and 18% in the CT – cover crop and CT + cover crop systems, respectively, relative to the standard tillage control system, however, there was an elimination of 8 or 9 tillage operations in the CT systems relative to the ST approach following the 2000 tomato crop. Estimated resource use per acre (hours of labor and gallons of fuel) indicate the possibility of the CT systems to reduce these inputs relative to the standard till systems. This study is the first of its kind in California to systematically compare tillage system alternatives through a crop rotation. Longer-term implications of these reduced till regimes in terms of soil compaction, water use, profitability, soil carbon sequestration, insects and diseases are being evaluated as the study progresses through a four-year cycle.

Introduction

Adoption of conservation tillage practices may be a viable means for improving profitability and reducing energy use in SJV cotton production systems (Yancy, 1996). In their many and varied forms, conservation tillage systems aim at reducing primary tillage operations such as plowing, ripping, disking and chiseling. As a result of this deliberate reduction in tractor operations, surface residues accumulate and must be managed. Conservation tillage has been defined as a production system in which 30% or more of the soil surface is covered with residue (Reeder *et al*., 2000). These surface residues may also serve to reduce evaporation from the soil surface and thereby conserve water (Herrero *et al*., 2001). The use of conservation tillage techniques in other parts of the US has evolved over the last several decades largely as an effort to reduce soil erosion (Morrison, 2000). Equipment innovations, herbicides and widespread researcher and farmer experience have contributed to the fact that since 1997, on a nationwide basis, more cropland acres are farmed using conservation tillage practices than using standard tillage practices (CTIC, 1999).

Conservation tillage is virtually nonexistent in California. Less than 1% of row crop acreage in California is currently farmed using CT practices (CTIC, 1999). There is, however, considerable interest in developing management systems that reduce tillage in California as evidenced by participant feedback from conservation tillage conferences we conducted in Five Points, CA and Davis, CA in 1998 that focused on relationships between soil organic matter, tillage and soil quality and from sessions in 2000 that highlighted conservation tillage success stories from around the US. This feedback indicates that conservation tillage will become more widely adopted throughout the state once successful examples are demonstrated. The objectives of research presented here are to compare conservation and conventional tillage practices in crop rotations common to the San Joaquin Valley's West Side in terms of productivity, key soil properties, pest and crop management requirements, and production costs.

Materials and Methods

Field experiments were initiated in the fall of 1999 to compare conservation and standard tillage cotton and processing tomato production systems with and without winter cover crops in Five Points, CA. The study consists of two cycles of both cotton following tomatoes and tomatoes following cotton in adjacent field plots. A mix of triticale, Merced ryegrain and

common vetch is planted in October prior to each summer crop season and this cover crop is then flail chopped and disked into the soil as a "green manure" in the ST + cover crop system and sprayed with *RoundUp*, chopped using a Buffalo Rolling Stalk Chopper (Buffalo Manufacturing, Fleischer, NE) and left on the soil surface in the CT + cover crop system prior to no-till cotton planting with a John Deere 1730 planter (John Deere Company, Moline, IL) and tomato transplanting using a modified Holland transplanter (Holland Company, Holland, MI). ST cotton is planted as single rows on 30 inch beds and CT cotton is planted as two rows on 60 inch beds that remain in place during the course of the study. An herbicide tolerant cotton variety (*RR Riata*) and a common processing tomato variety (Heinz 8892) are used in all systems. Each plot is the equivalent of six 60 inch beds wide and 270 feet long. Adequate buffer rows (six 60 inch flanking each side of tillage system plots) are included in the field experimental design to permit normal tractor tillage operations.

Intercrop tillage differs considerably between the experimental systems (Table 1). Following tomato harvest, no primary tillage is done prior to cotton planting in the CT systems. Following cotton harvest, a one-pass shredder bedder (Interstate Mfg., Bakersfield, CA) is used in conjunction with a furrow sweeping pass in the CT systems compared to the longer sequence of operations used in the ST plots.

Yields are determined by mechanically harvesting and weighing red tomato fruit and seed cotton from each entire plot area.

Results

Data comparing the number of operations and estimated hours of labor and gallons of fuel used in each of the four production systems for 2001 are shown in Table 1. Yield data for cotton and tomato in 2001, the second year of the study following initial establishment of the tillage treatments, are given in Table 2.

Discussion

The following preliminary findings summarize early outcomes of this study:

- CT approaches for both processing tomatoes and cotton may provide economically viable production over the short term.
- Labor and fuel use of these CT alternatives appears to be substantially reduced relative to ST systems.
- Impacts of pests (mites in 2000 and weeds in 2001, *data not shown*) that may be tillage system – dependent need considerable further study, and
- Implications of reduced tillage (i.e. soil compaction, build up of surface residues and maintenance of production beds) on future crop growth and yield are other issues that will need to be evaluated before sustained CT can be used.

References

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Table 1. Comparison of Standard and Conventional Operations

	Cotton 2001			
	Standard Tillage		Conservation Tillage	
Operation	**No Cover**	**Cover**	**No Cover**	**Cover**
Disc	XX	XX		
Chisel	X	X		
List Beds	X	X		
Compact Furrows	X	X		
Spray Treflan	X			
Lilliston	XX			
Chain Beds	X			
Irrigate				
Plant Cover Crop		X		
Mow Cover Crop		X		
Spray RoundUp	X		X	X
Plant Cotton	X	X	X	X
Times over field	11	8	2	3
Hours of labor	15	12	2	4
Gallons of fuel	54	35	7	12

	Tomato 2001			
	Standard Tillage		Conservation Tillage	
Operation	**No Cover**	**Cover**	**No Cover**	**Cover**
Clean Furrows			XX	XX
Shred and Bed			X	X
Shred Previous Crop	X	X		
Undercut Previous Crop	X	X		
Disc	XX	XX		
List Beds	X	X		
Ring Roll	X	X		
Plant Cover Crop		X		X
Mow Cover Crop		X		
Spray RoundUp	X		X	X
Plant Tomatoes	X	X	X	X
Times over field	8	9	5	6
Hours of labor	23	12	8	8
Gallons of fuel	73	57	39	42

Table 2. 2001 Processing tomato (tons/ac) and cotton (bales/ac) yields.

	Processing Tomatoes	Cotton
Standard Tillage		
No cover crop	60.1	3.6
Cover crop	63.4	2.8
Conservation Tillage		
No cover crop	64.4	3.2
Cover crop	60.5	3.0