Conservation Tillage Tomato and Cotton Production Systems in California

J. Mitchell[1], W. Horwath[2], R. Southard[2], J. Baker[2], D. Munk[3], K. Hembree[3], K. Klonsky[4], R. DeMoura[4], G. Miyao[5], and J.Solorio[6].

[1]Department of Vegetable Crops and Weed Science, University of California, Davis. USA.

[2]Department of Soils and Biogeochemistry, University of California, Davis. USA.

[3]Fresno County Cooperative Extension, University of California, Fresno, CA. USA.

[4]Department of Agricultural and Natural Resource Economics, University of California, Davis. USA.

[5]Yolo and Solano Counties Cooperative Extension, University of California, Woodland, CA. USA.

[6]West Side Reasearch and Extension Center, University of California, Five Points, CA, USA.

Corresponding author's e-mail: mitchell@uckac.edu

ABSTRACT

Despite increases in conservation tillage (CT) production in other regions of the US during the past decade, less than 0.3% of the acreage in California's San Joaquin Valley is currently farmed using CT practices. Preplant tillage operations typically account for 18 – 24% of overall production costs for annual crops grown in the West Side region of the San Joaquin Valley (SJV). An average of about 9 to 11 tillage-related passes are routinely done during the fall-spring period to *prepare* the soil for summer cropping. These passes represent not only considerable energy, equipment and labor costs, but recent research indicates that tillage reduces soil organic matter (SOM) and emits considerable respirable dust as well. Because SOM is widely regarded as an important attribute of good soil quality and long-term productivity, interest has been growing over the last several years, in developing alternative production systems that reduce costs while at the same time improve the soil resource through greater carbon sequestration. Conservation tillage systems may serve to increase SOM levels, reduce production costs and improve air quality in this critically important agricultural production region. The University of California's Conservation Tillage Workgroup, in conjunction with several Central Valley farmers, has recently initiated a number of research and demonstration evaluations of a variety of CT approaches for crop rotations of this region. Results from these studies are quite preliminary, but have served to reveal a number of new research directions for further evaluations of these alternative systems in California.

KEYWORDS

Soil preparation cost, soil organic matter, dust, Central Valley, San Joaquin Valley

INTRODUCTION

Although the term "conservation tillage" (CT) technically denotes a range of crop production alternatives that typically leave a minimum of 30% of the soil surface covered by residues from previous crops (Reeder, 2000), the development and adoption of CT systems for California's very diverse cropping systems is likely to spawn many tillage system variants that do not fully reflect the classic model systems that have been developed in other regions. Through a wide range of university and public agency research and demonstration activities, as well as private sector trials, there has been a well documented, and rather dramatic increase in interest and innovation related to reduced tillage crop production alternatives during the last five years in California's Central Valley (CT 2001 Proceedings, 2001). This interest has resulted from a number of interrelated factors.

Recent escalating diesel fuel costs (CEC, 2000) have, first of all, resulted in sharp declines in net farm income and threaten long-term economic viability in many Central Valley crop production regions (USDA Economic Research Service, 2000). A medium-sized row crop farm of 4,000 acres in this region may have weekly diesel fuel costs of upwards of $12,000 (Personal communication, Anonymous). Cutting diesel fuel use from 75 to 35 gallons per acre has been identified as a 2001 production target in the northern San Joaquin Valley (Personal communication, Anonymous). Reducing production costs has thus become a compelling and critical goal of growers throughout this region of California, which has historically been an area of phenomenal productivity (Calif. Dep't. Food and Agriculture, 1990).

IN E. van Santen (ed.) 2002. Making Conservation Tillage Conventional: Building a Future on 25 Years of Research. Proc. of 25th Annual Southern Conservation Tillage Conference for Sustainable Agriculture. Auburn, AL 24-26 June 2002. Special Report no. 1. Alabama Agric. Expt. Stn. and Auburn University, AL 36849. USA.

There is also a body of research evidence from other regions of the United States (largely untested yet in California, however) suggesting that conventional tillage practices disrupt soil aggregates exposing more organic matter to microbial degradation and oxidation (Reicosky, 1996) and are one of the primary causes of tilth deterioration (Karlen, 1990) and subsurface compaction (Personal communication, Taylor) over the long-term. Finally, because intensive tillage typically leads to decreased soil carbon (C) via gaseous CO_2 emissions (reviewed by Reicosky *et al.*, 1995), and because there is concern that this C source has been a significant component in the historic increase in atmospheric CO_2 (Wilson, 1978; Post *et al.*, 1990) and the potentially associated greenhouse effect (Lal *et al.*, 1998), there is increased interest in investigating cropping systems opportunities for mitigating these emissions. While these factors have gained greater "currency" in recent years, the fundamental motivation for reducing tillage remains economic; California growers are investigating a range of minimum tillage options primarily for reducing production costs.

CT RESEARCH AND INFORMATION DEVELOPMENT INITIATIVES

To respond to the needs for information on reduced tillage production alternatives, the University of California's Division of Agriculture and Natural Resources established the Conservation Tillage Workgroup in 1998 to develop knowledge and exchange information on CT production systems and to coordinate related research and extension education programs. Current Workgroup membership includes over 80 University of California researchers, USDA Agricultural Research Service and Natural Resource Conservation Service scientists, farmers, private industry affiliates and other public agency representatives. The Workgroup's 1998, 2000, and 2001 conferences, which were held as two back-to-back daylong sessions in Five Points and Davis in each year and which focused on successful conservation tillage systems in other parts of the US, have been attended by over 850 participants. Workgroup member research and demonstration sites have expanded from one in 1996 to over twenty in 2001.

CONSERVATION TILLAGE AND HERBICIDE RESISTANT CROPS

Running parallel to these CT research and extension education efforts has been the use of transgenic herbicide tolerant crops throughout a number of production valleys in California. Production of herbicide tolerant cotton in the San Joaquin Valley, for instance, began with about 500 experimental acres planted in 1997, and has increased steadily to upwards of 250,000 acres in 2001 (Vargas *et al.*, 2001), with adoption expected to increase in the future. Acreage shifts within the herbicide tolerant lines have favored those varieties that are closely related to existing successful Acala parentage. Potential benefits of transgenic cotton result from reduced hand weeding costs, elimination of one or more in-season weed cultivations for standard bed planting systems, as well as irrigation levee establishment costs for ultra narrow row cotton which can be flood irrigated (Personal communication, H.Wu). To date, however, transgenic seed technologies have not been coupled with production practices that reduce intercrop tillage, at least at any wide scale, primarily because of current postharvest cotton plowdown regulations for pink bollworm management. Other issues related to these transgenics, including weed resistance and crop yield and quality concerns, are the focus of considerable ongoing study (Vargas *et al.*, 2001).

TILLAGE REDUCTION OPPORTUNITIES IN SAN JOAQUIN VALLEY COTTON AND PROCESSING TOMATO ROTATIONS

In the fall of 1999, we began a four-year comparison study of conservation tillage and conventional tillage practices with and without winter cover crops in cotton and tomato rotations in Five Points, CA at the University of California's West Side Research and Extension Center. The study consists of a 3.23 hectare field experiment with four replications of these tillage / cover crop systems and both crops in each year.

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 our 2001 tomato harvest indicate that yields in the CT $\pm$ cover crop systems were similar to those in the standard till plots

Table 1. Yield of processing tomato and cotton for the 2001 crop year.

Tillage / cover crop	Processing Tomatoes	Cotton
	tons acre^{-1}	bales acre^{-1}
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

with an elimination of six tillage operations following last year's cotton crop in the CT plots relative to the standard till systems (Table 1).

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. 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 standard till systems, however, these data are quite preliminary and are subject to further analysis. 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.

OTHER CONSERVATION TILLAGE INITIATIVES IN CALIFORNIA

During the last two years, there have been a number of other CT evaluation projects that have been initiated in California. These range from a large-scale UC Davis campus-based comparison of reduced and standard till systems for crops common to the Southern Sacramento Valley that is being conducted by a large group of UCD researchers, UC Cooperative Extension Farm Advisors, and farmers, to smaller-scale farm demonstrations of reduced till planting and postharvest cotton management systems in Riverdale, CA in the Central San Joaquin Valley.

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