Fertilization technologies for conservation tillage production systems in California

FREP Contract # 01-0123

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Introduction

Despite a 300% increase in conservation tillage (CT) production in the Midwestern United States during the past decade, less than 0.3% of the acreage in California's Central Valley (CV) is currently farmed using CT practices. Preplant tillage operations typically account for 18 – 24% of overall production costs for annual crops grown in this region. An average of 9 to 11 tillage-related passes are routinely done during the fall-spring period just 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 improving soil resources through greater carbon sequestration.

Recent pioneering studies by Reicosky and Lindstrom (1993) involving a variety of tillage methods indicate major gaseous losses of carbon (C) immediately following tillage, but point to the potential for reducing soil C loss and enhancing soil C management through the use of conservation tillage (CT) crop production systems. Though these practices have been developed over the past several decades primarily for erosion control in other parts of the US, recent concerns regarding the need to sustain soil quality and profitability have prompted an examination of CT practices in California.

Tillage in most annual cropping systems in California's Central Valley is typically done in a "broadcast" manner through a field, without deliberate regard to preserving dedicated crop growth or traffic zones. Studies by Carter (1991) over the last several decades, however, have confirmed the potential to eliminate deep tillage, decrease the number of soil preparation operations by as much as 60%, reduce unit production costs, lower soil impedance, and maintain productivity in a number of CV cropping contexts using reduced, precision, or zone tillage practices that limit traffic to permanent paths throughout a field. Using this approach can reduce soil compaction and preserve an optimum soil volume for root exploration and growth. No systematic studies have been conducted in California, however, that evaluate optimal fertilization strategies for these reduced tillage systems. Horwath *et al*., (1999) has shown that changes in fertilizer use efficiency occur when soils are managed for C sequestration in California. Additional work in other regions of the country has shown that the selection of nitrogen fertilizer rates, source, and application methods requires management decisions in CT systems that differ from those used in conventionally tilled systems (Touchton *et al*., 1995). Factors such as the type or quality of surface residue, residual soil fertility levels, soil temperatures, planting dates, crop variety, and soil moisture (Touchton *et al*., 1995) determine optimal fertilization programs in CT systems. Soils in conservation tillage tend to be cooler, wetter, more firm, and higher in organic matter near the surface than in conventional tillage (Denton, 1993). The likelihood of obtaining a yield response to starter fertilizer increased rapidly as tillage operations decrease (Touchton *et al*., 1995).

In this project, we are adapting fertilization equipment that is currently used in CT systems in the midwest and southeast US, and determining fertilizer use efficiency using CT practices under development for San Joaquin and Sacramento Valley row crop systems. The hypothesis that we are testing is that CT practices will promote an increase in soil organic matter (SOM), which in turn will lead to a greater nutrient cycling potential in the soil. This increased potential may then result in a lower fertilizer use efficiency, but a correspondingly lower rate of required fertilization.

Objectives
The objectives of this research are:

1. Evaluate the effectiveness of various fertilization practices in conservation tillage tomato, corn, and cotton production systems,

2. Determine the fertilizer use efficiency in these production systems transitioning to CT,

3. Compare crop tissue nitrogen status in standard and conservation tillage production systems, and

4. Extend information developed by the proposed project widely to Central Valley row crop producers via field days, equipment demonstrations, and written summaries.

Project Description
Two four-year field research and demonstration sites, one at the UC West Side Research and Extension Center (WSREC) in Five Points, CA, and one that is part of the Sustainable Agriculture Farming Systems (SAFS) Project on the UC Davis campus, are being used for this project. The WSREC experiment consists of a comparison of a standard tillage (ST) cotton-tomato-cotton-tomato production system with and without off-season rye/vetch/triticale cover crops and a conservation tillage (CT) cotton-tomato-cotton system with and without cover crops. The comparison is conducted using 60” beds that will be maintained throughout the course of the project in conservation tillage plots and managed as would routinely be done under West Side conditions in the conventional tillage plots. Tillage plots are 6 beds wide, and run the entire length of a 270 ft field which facilitates tractor operations. Each plot of the two tillage systems

(with and without cover crops) is replicated four times, and there are “turn rows” for postharvest tillage and land preparation in the standard tillage plots between CT and standard tillage plots. 60-inch beds were selected because they provide the greatest inter-crop flexibility for current and anticipated Central Valley (CV) rotations. Existing and prototype equipment is accessible for this row spacing, because of the interest in developing more standard, but flexible row configurations in the CV (M. Borba*, personal communication*). The comparison at the SAFS site consists of both standard and conservation tillage systems in a corn/tomato/corn/tomato rotation with and without a faba bean/rye grain/common vetch/subclover cover crop mixture that will be grown on 60-inch beds that will permit ridge-till planting, and cultivation using a *Buffalo 8000* planter and a high residue cultivator.

Baseline soil sampling has been completed at each site to determine residual levels of total N and C, NO_3^-, particulate organic matter (POM), Olsen P, and exchangeable K at 0 – 15 cm and 15 – 30 depths. Experimental protocols and treatments are being imposed this fall at the WSREC site and in the spring of 2002 at the Davis site. No findings are available at this time.

Literature Cited

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