Mulches for Weed Control in Tomatoes
Work in Progress

(Principles, Promises and Problems of No-Till Transplanted Vegetable Production)

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Abstract

Although reduced tillage production systems have been successfully developed and used with advantage in a number of cropping contexts throughout the world, very little work has been carried out on these techniques in California. Our research is evaluating the effectiveness of surface organic mulches in reduced tillage transplanted tomato production systems for suppressing weeds, improving production efficiencies in terms of nutrient inputs, providing optimal soil temperature regimes for crop growth and conserving soil moisture. Field experiments are underway in Sacramento and San Joaquin Valley tomato production regions.

Introduction

Weeds are frequently ranked as the number one pest problem in tomato production systems of California's Central Valley (Flint and Klonsky, 1985). Nightshades are the most serious weed problem statewide, thought barnyard grass and yellow nutsedge are also common problems in San Joaquin and Sacramento Valley production areas. For conventional growers, herbicide applications and cultivation tillage are currently the primary means of weed control. Hand weeding costs in organic tomato production can range from $150 to $200 per acre.

Losses in soil quality due to intensified crop production with resulting impacts on productivity are also becoming major concerns in a number of tomato production areas. A number of the cropping practices in these systems suggest the development of a "spiralling feedback loop" (Stirzaker and White, 1995). Intensification of cropping necessitates increased need for increadsed cultivation, irrigation and perhaps fertilizer inputs. Information on alternatives for improving the quality of the soil resource base as well as for managing weeds, the primary pest in tomato production sytems is therefore critical for sustained economically viable production, resource conservation and environmental preservation in California's vitally important tomato production regions.

One possible option ofr achieving the dual purposes of sustaining soil quality/nutrient cycling while accomplishing economically adequate weed control, may be to use surface organic mulches derived from "off-season" grown cover crops. The winter annual legume hairy vetch for example, has been used successfully as both a cover crop and as a mulch in fresh-market tomato production systems on the east coast (Abcul-Baki and Teasdale, 1993; Abdul-Baki, Stommel and Teasdale, 1995). As a cover crop, the vetch fixes N, recycles nutrients, reduces soil erosion and adds organic matter to the soil. When mowed and converted to a mulch, the vetch reduces weed emergence, lowers soil temperature during the hot summer months, reduces water loss from the soil and acts as a slow-release fertilizer (Abdul-Baki and Teasdale, 1993). Recent work in Australiz by Stirzaker (1992) with subterranean clover has shown similar benefits in lettuce and tomato production systems (Stirzaker, Sutton and Collis-George, 1992; Stirzaker, Passioura, Suttona and Collis-George, 1993). There may be however, problems associated with using cover corps in this way: land is put out of production, soil moisture may be depleted during the cover crop growing season relative to a winter fallow, and early summer season temperatures may be cooler under a surface mulch than bare soil. There may also be problems related to the management of cover crop residues that can be phytotoxic to certain crops that follow a green manure mulch (Lovett and Jessop, 1982).

There is clearly sufficient evidence however, to support testing of cover crops that are used as surface organic mulches as a non-chemical option for weed control and to improve soil physical properties and nutrient cycling. The objective of our current research in this area is:

- to evaluate the effectiveness of surface organic mulches in reduced-tillage tomato production systems for:
  - suppressing weeds
  - improving production efficiencies in terms of nutrient inputs
  - providing optimal soil temperature regimes for crop growth and
  - conserving soil moisture

Procedures

Field experiments are being conducted at the University of California West Side Research and Extension Center (*WSREC*) in Five Points, CA, the Kearney Agricultural Center (*KAC*) in Parlier, CA and at the Sustainable Agriculture Farming Systems (*SAFS*) Project on the University of California, Davis campus to evaluate various aspects of the use of cover crop mulches in no-till tomato production systems. The experimental cover crop treatments at the *WSREC* are:

winter fallow / summer + herbicide
winter fallow / summer - herbicide
Sava "Snail" Medic
Sephi "Barrel" Medic
Triticale / Lana vetch
Merced rye / Lana vetch

The cover crop treatments at the UCD *SAFS* site are:

winter fallow / summer + herbicide
winter fallow / summer - herbicide
Magnus pea / Oat / Common vetch
Common vetch
Subclover
Snail Medic cv Kelson
Snail Medic cv Sava
Barrel Medic
Triticale / Lana vetch

These treatments permit a testing of mulches with different growth and cover attributes and cover crop mixtures of different seed costs. Each mulch / fallow plot at the WSREC and at KAC is split into 3 subplots. In each subplot one bed is fertilized at 100 lbs N / acre and one at 200 lbs N / acre and one is not fertilized to evaluate the potential for reducing fertilizer inputs in this system. The mulch / fertilizer treatments are repllicated four times in a split plot design with fertilizer applications as main plots and mulch treatments as subplots. Common tomato varieties are transplanted using a single-row machine transplanter that has been modified by B & B No-Till of Laurel Fork, VA. The modifications are based on a successfully-used no-till transplanter that has been developed by R. Morse at Virginia Polytechnic Institute (Morse, 1995). Changes in soil water content during the tomato season are monitored by neutron hydroprobe (Campbell Pacific Nuclear) readings in access tubes installed in the planted row before and after irrigations. Fruit yield determinations are accomplished by machine harvesting using field weighing gondolas at the *WSREC* site, and by hand harvesting the *KAC* and *SAFS* sites.

At one month intervals following tomato transpslanting, weed cover and species composition are assessed in each subplot. In both the *WSREC* and *KAC* experiments the average time taken by hand weeding crews is determined in each plot.

Companion screening trials at the *WSREC* are being conducted to evaluate 15 prospective fall and winter-growing cover crops and cover crop mixtures for growth, nitrogen productivity and potential utility as surface mulches in no-till systems.

Results

The following summary of 1997 results is quite preliminary and very much reflects the embryonic stage of development and refinement of no-till techniques in California tomato production systems. Results to date indicate that individual cover crop species that are used as mulches require specific management within the overall production system to optimize potential benefits. Sava snaial medic, for example, can be effectively killed by mowing alone, while Sephi barrel medic, rye / vetch and Triticale / vetch seem to require herbicide treatment prior to transplanting tomatoes. In 1997, we used a combination of sickle mowing and *Roundup* herbicide to kill the rye / vetch and Triticale / vetch cover crops. This was quite successful except for vetch plants that were on the shoulder of beds.

Monitoring of photosynthetically active radiation (PAR) using a Decagon Ceptometer below cover crop mulches in April and May indicated that the mulches intercpet aobut 70 - 80% of the light that reached the experimental field. The grass / vetch mixtures typically intercpeted more PAR than either of the Medic species.

Weed density data were collected in May, June and July of 1997 at the *WSREC* and *KAC* sites. Preliminary data from the *WSREC* site indicate relatively low % weed cover in the Triticale / vetch relative to both the cultivated $\pm$ herbicide treatments early in the season (Figure 1).

The WSREC experiment is evaluating the potential of cover crop mulches to provide part of the nitrogen requirement for tomatoes by evaluating productivity in plots with 0, 100 and 200 lbs N. In 1997, there was no clearcut benefit of the cover crop mulches in terms of supplying N relative to the fallow plots at 0 and 100 lbs N (Table 1).

Preliminary data from soil temperature sensors placed at 10 cm depths indicate that soil temperatures were about 2 degrees cooler under the Triticale / Lana vetch and Ryegrass / Lana vetch mulches relative to fallow soils early in the 1997 season.

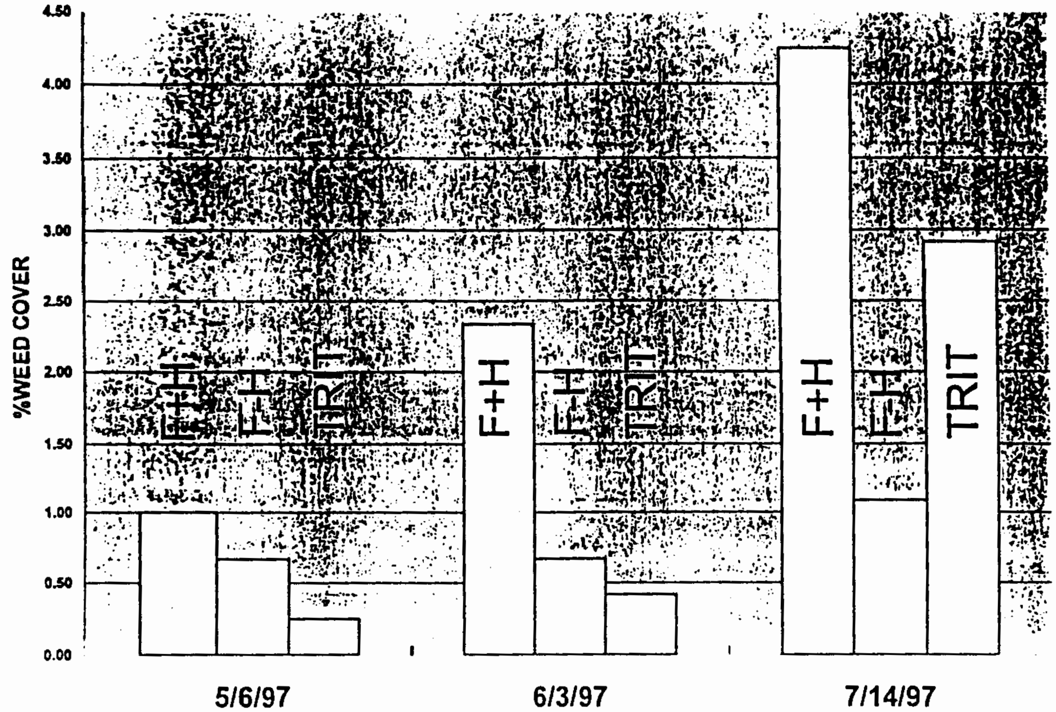
Changes in soil water storage under the Triticale / Lana vetch mulch relative to a fallow were monitored during July. Preliminary data show that volumetric water content was higher under the Triticale / vetch mulch than the fallow (Figure 2).

Summary

A potential issue that will need to be addressed if cover crop mulches have utility in processing tomato production systems is how they are managed during machine harvesting. In 1997, the *SAFS* site was hand harvested and the *WSREC* field was machine harvested over the course of two days. On the first afternoon, no serious difficulties were encountered in terms of having the harvester go through the mulch that was on the soil surface at the end of the season. However, early in the morning of hte second day of harvesting, the harvester, which was a sickle mower bar type, jammed repeatedly in the grass / vetch mixture plots because the mulch residue wrapped around the spindle mechanism at the top of the harvester. Why this happened only on the second dya of harvesting is not clear at this time, however it may be due to the fact that the residue was quite moist from dew on this morning and this may have resulted in the residue being more resistant to cracking during the machine harvest. This may be remedied perhaps, by mowing the mulch into finer pieces or perhaps by not mowing at all, but merely leaving the mulch intact and fixed to the soil. We will evaluate these options in the spring of 1998.

This work will be continued through the next several years to thoroughly evaluate the potential of mulch production systems in a variety of cropping contexts in California. Research objectives that will be addressed during the coming two years include mulch species mix optimization, operations for killing mulches in spring, control of winter weeds and cost benefit analyses of the entire system of production.

WEED COVER (N=200)



F+H (Winter fallow with spring herbicide and cultivation)
F-H (Winter fallow without spring herbicide)
TRIT (Triticale cover crop without spring herbicide)

SOIL WATER STORAGE(0-45)

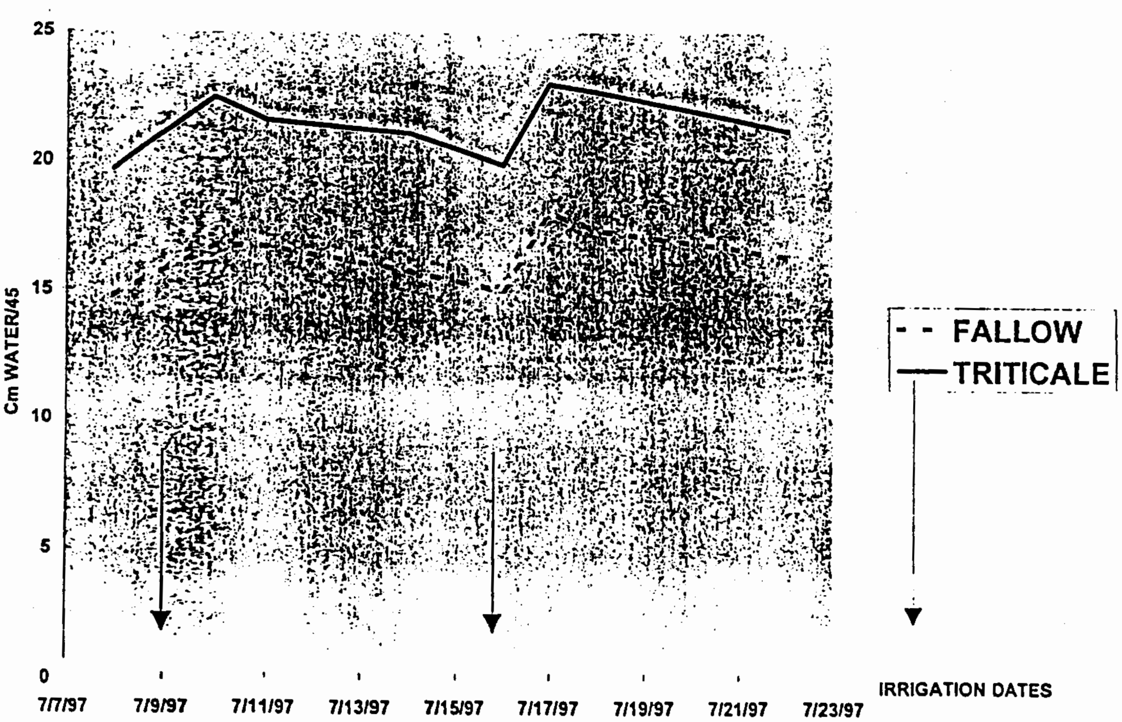


Table 1

WSREC Mulch Experiment: Yield at different nitrogen fertilization levels

Nitrogen=0 lb/acre

Treatment	Yield (tons/acre)	st dev
Fallow+H	39.23	4.39
Fallow	31.41	13.03
Tritic.+Vetch	28.00	3.57
Sava	26.87	1.68
Rye+Vetch	24.21	2.61
Sephi	18.08	5.79

Nitrogen=100 lb/acre

Treatment	Yield (tons/acre)	st dev
Fallow+H	37.59	5.53
Sava	36.22	6.47
Fallow	35.09	6.93
Tritic.+Vetch	34.69	0.49
Rye+Vetch	33.79	7.82
Sephi	23.70	5.35

Nitrogen=200 lb/acre

Treatment	Yield (tons/acre)	st dev
Tritic.+Vetch	37.98	6.18
Fallow	37.53	9.38
Fallow+H	36.68	8.65
Rye	36.32	4.54
Sava	34.01	4.29
Sephi	28.48	10.28