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Processing Tomato Cost of Production Study (Sacramento Valley)

Gene Miyao, UCCE Farm Advisor, Yolo, Solano, & Sacramento Counties

Editor's note: *The following article describes costs for Sacramento Valley tomato growers. The value for San Joaquin Valley growers is to compare costs and evaluate their own farm operation efficiency. Visit http://coststudies.ucdavis.edu*

A sample cost of production study was produced with UC Ag Economist Karen Klonsky and Pete Livingston for processing tomatoes grown in the Sacramento Valley. A representative group of growers helped develop a list of typical operations, field efficiencies, equipment and labor. The study is that of a hypothetical 2900-acre row crop farm with 900 acres of tomatoes.

Assumptions were many. All land was rented on a % share of the gross basis with tomatoes set at 12%. Expected yield was 35 tons/acre at a $63/ton price. Labor was set to 2008 minimum standards of $8.00 per hour, and then we adjusted machine labor to $10 per hour. All wages were increased by 48% to account for taxes, benefits, insurance, etc. Fuel price was $2.30/gallon for diesel and $2.80 for gasoline. Water cost was $30.61 per acre-foot as a mix of well and canal water. Hand weeding labor was $150 plus additional $50/acre for direct seed, while transplant method was assumed to require only $50/acre. Transplant cost for seed, greenhouse plants, and custom transplanting was $500/acre with 8700 plants. Direct seed expense including replanting 10% of the acreage was $219/acre but included starter fertilizer and a generous 52,000 seeds/acre. Cost of establishing the crop with sprinklers was higher with direct seed method.

Adjustments would be expected to customize the costs to an individual operation as well as to coordinate with the whole enterprise. Overhead might be distributed differently. Equipment mix might be more complex and include a high carryover of older equipment as well as some failed inventions. The issue of retained labor crews during slack periods adds to the farm costs as does various overhead expenses. We did not account for excess acres to cover contractual obligations. Areas of efficiencies that were not considered were use of drip irrigation, wider row crop cultivators and planters beyond 3-row units, and reduced tillage practices.

Table 1. Sample cost ($/Acre) to produce processing tomatoes, Sacramento Valley, 2007

operation	direct seeded	transplanted
ground prep	206	205
growing	1160	1156
harvest	279	277
misc. & interest	92	91
cash overhead & rent	393	393
TOTAL CASH COSTS	2130	2121
non cash overhead	153	136
TOTAL COSTS/Acre	**$2,283**	**$2,257**

There was no attempt to compare direct seed vs. transplants beyond some elementary level. It remains fairly clear that transplants require less attention to seed bed condition, require less finesse to establish the stand, have less hand weeding expense, but have a higher initial cost. Direct seeding will be cheaper given stand establishment is efficient and initial weed control is effective. And within that comparison, adjustment to input levels would change the relative advantages/disadvantages.

Bottom Line: The ability to reduce input costs while increasing fruit yield output is obviously the key to maintaining profitability. Compared to our 2001 study, the cash cost of doing business increased over 30%. Basic input prices have risen: seed, fuel, labor, iron, water, and fertilizer. Further major adjustments are needed for the 2008 season as price of water, fuel, fertilizers and pesticides are clearly on the rise.

Efficient Fertigation Management for Drip-Irrigated Processing Tomatoes

Tim Hartz, Vegetable Crops Specialist, UC Davis

Drip irrigation is revolutionizing processing tomato production. Many growers now routinely achieve 50 ton yields, and 60 ton yields are not uncommon. In light of these higher yield expectations, and given the differences in rooting patterns and wetted zone in drip-irrigated fields, a reevaluation of soil fertility management is appropriate.

Crop nutrient uptake in high-yield fields

In 2007 I intensively monitored two drip-irrigated fields, a commercial field in Yolo County, and a fertigation experiment at UC Davis; in both fields 'AB 2' transplants were planted in early May. In these fields the crop was sampled repeatedly over the season, with whole plants (vine and fruit) harvested so that total nutrient uptake could be tracked, and rates of nutrient uptake at different growth stages determined. Total fruit yield in both fields approached 60 tons/acre.

The pattern of N uptake was quite similar in both fields; at harvest the total N contained in the crop (vine and fruit) averaged 230 lb/acre. The seasonal pattern of N uptake at the UCD site is given in **Fig. 1.** N uptake prior to early fruit set stage (week 5) was slow, but accelerated quickly until full bloom (week 9). During fruit development N uptake slowed, and much of the N was moved out of the vine to support fruit growth. The data given was for plots receiving a seasonal total of 190 lb N/acre, of which 170 was fertigated during the growing season. An 'excessive' N treatment that received a seasonal total of 290 lb N/acre was also monitored, and the N uptake pattern was very similar; at harvest the total crop N uptake had only increased about 30 lb/acre, with no fruit yield advantage over the lower N treatment.

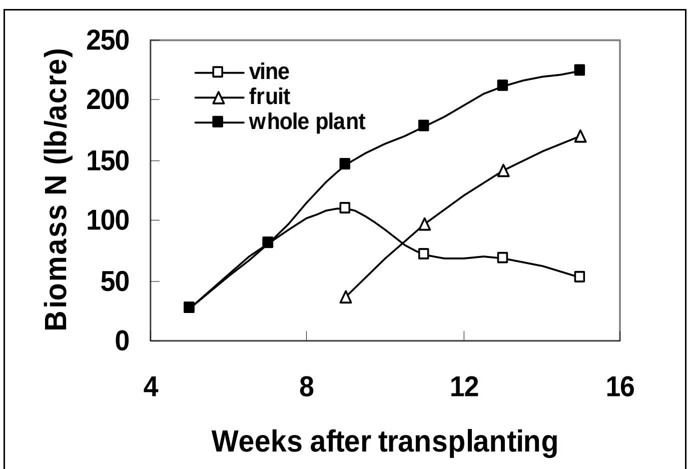

Fig 1. Pattern of crop N uptake over the season, UCD trial.

By measuring the change in crop N content between sampling dates the weekly rate of N uptake was calculated. **Table 1** gives the approximate N uptake rates observed. The pattern of phosphorus uptake was similar to N, but at a much lower level; at harvest total crop P content averaged 35 lb/acre. The pattern of K uptake was also similar between fields, but the total amount of K taken up was highly dependent on soil K supply. At UCD, with exchangeable soil K of 220 PPM, total uptake was 320 lb/acre; the commercial field had much lower soil K (110 PPM), and had only 230 lb K/acre in the crop at harvest.

Nutrient management

From these 2007 trials and a variety of experiments conducted over the last decade some general guidelines for high-yield, drip-irrigated management can be formulated.

Phosphorus: Fields with soil test P >25 PPM (Olsen extraction) are unlikely to require P fertilization for maximum yield, particularly if transplants are used and the transplants come to the field with a high P status (>0.4% P). Below 25 PPM soil P, or where the transplant grower has used P deficiency as a tool to manage transplant size, preplant P banding or at-planting P application in a transplant drench should give a growth response. With adequate preplant or at-planting P application, in-season P fertigation is seldom necessary.

Nitrogen: Regarding N, seasonal fertilization rates should not exceed crop N uptake, and in many fields may be significantly less. All soils will mineralize some N from organic matter during the growing season, and many fields begin the season with significant residual nitrate-nitrogen (NO_3-N). With efficient irrigation management, a seasonal total of 160-220 lb N/acre should be sufficient for high-yield production, provided it is applied in sync with crop demand. **Table 2** contains an N fertigation template that should ensure N sufficiency under most normal field conditions. It assumes early season N availability from residual NO_3-N or at-planting application. N fertigation in the final month before harvest is seldom necessary.

Frequency of fertigations: Although N can be applied with each irrigation, in most cases there is no benefit in fertigating more often than once a week. The fertigation amounts given in **Table 2** can be reduced in fields where significant residual soil NO_3-N is present.

Potassium: In drip-irrigated fields the demand for potassium can be substantially higher than for furrow-irrigated production. This is due not only to the increased yield potential, but also to the smaller, more concentrated root zone from which the plants draw nutrients. This is particularly the case with buried drip because the roots are concentrated in a band around the drip tape (typically 8-12 inches deep). Since available soil K decreases with soil depth, this means that soil K availability is lower than would be suggested by a soil test of a sample of the top foot of soil.

For buried systems that have been in place for multiple years, both P and K availability in the zone around the drip tape can drop considerably, and it is important to soil test this zone to get an accurate assessment of soil fertility.

In-season fertility monitoring

(Petiole sampling is "out"; whole leaf sampling is "in")

In the past the most common way to monitor fertility during the season was petiole analysis. Petiole NO_3-N and phosphate-phosphorus (PO_4-P) concentration have been thought to indicate recent crop uptake of these nutrients from the soil, which was assumed to be primarily a function of soil nutrient supply. Unfortunately, it is not that simple. Most of the NO_3-N and PO_4-P in petiole tissue is already stored in plant cells; the rate at which these inorganic ions are assimilated into organic compounds is strongly influenced by environmental conditions in the field, so the connection between petiole concentration and soil nutrient supply is confounded.

Recent research from across the country, and on a range of vegetable crops, has shown that ***petiole NO_3-N and PO_4-P are poor measures of current soil supply, and cannot be reliably used to guide fertigation.***

Furthermore, current 'sufficiency' levels appear to be too high, *particularly for drip-irrigated culture in which fertigation, particularly for nitrogen, continues through most of the season.* ***For N and P, the more reliable measure of crop nutrient status is total N and P concentration of whole leaves.***

To illustrate the limitations of petiole analysis, **Table 3** gives the petiole and whole leaf nutrient analysis for two fertility treatments in the 2007 UCD trial. The 'adequate' fertility treatment received a seasonal total of 190 lb N and 70 lb P_2O_5 per acre; it had equivalent fruit yield and quality to the 'excessive' nutrient treatment, which received 290 and 140 lb/acre of N and P_2O_5, respectively. By whole leaf analysis both treatments were adequately supplied for all nutrients (the correct diagnosis), while petiole analysis wrongly suggested inadequate N at full bloom, and inadequate P at both growth stages.

Table 1. Rate of N uptake by growth stage.

Growth stage	Duration (weeks)	N uptake (lb/acre/week)
transplant - early fruit set	4-5	5-10
early fruit set - full bloom	3-4	20-35
full bloom - early red fruit	2-3	20-25
early red fruit - harvest	4-5	10-20

Table 2. Nitrogen fertigation template for high-yield processing tomato production.

Growth stage	Duration (weeks)	N fertigation rate should be no more than: (lb/acre/week)
2 weeks post-transplant - early fruit set	2-3	10
early fruit set - full bloom	3-4	30-35
full bloom - early red fruit	2-3	20-25

Table 3. Tissue analysis of 'adequate' and 'excessive' fertility treatments, UCD trial.

		PPM in petioles		% petiole	% in whole leaves		
Fertility treatment	Growth stage	NO_3-N	PO_4-P	K	N	P	K
adequate fertility	**Early bloom**	9,600	2,800	6.3	4.7	0.39	3.4
excessive fertility		10,600	3,300	6.0	4.9	0.43	3.5
Sufficiency level		9,000	3,000	6.0	4.6	0.32	2.2
adequate fertility	**Full bloom**	1,700	1,600	5.4	3.6	0.27	3.5
excessive fertility		5,000	2,400	6.0	4.1	0.30	3.5
Sufficiency level		6,000	2,500	4.0	3.5	0.25	2.0

Statewide Processing Tomato Variety Trials - Fresno County Results - 2007

Michelle Le Strange and Tom Turini, UCCE Farm Advisors, Tulare/Kings and Fresno Counties

Three early and 7 mid-season variety evaluation tests were conducted throughout the major processing tomato production regions of California during the 2007 season. The major objective is to conduct processing tomato variety field tests that evaluate fruit yield, °Brix (soluble solids %), color, and pH in various statewide locations. The data from all test locations are used to analyze variety adaptability under a wide range of growing conditions. All major production areas had at least one test to identify tomato cultivars appropriate for that specific region. The tests are designed and conducted with input from seed companies, processors, and other allied industry and are intended to aid in management decisions.

Procedures: Early maturity tests were planted in February or early March and mid-season lines were planted from March to May. New varieties are typically screened one or more years in non-replicated observational trials before being included in replicated trials. Tests were primarily conducted in commercial production fields with grower cooperators, however the Fresno trials were located at the UC West Side Research and Extension Center [WSREC] near Five Points.

Each variety was usually planted one-bed wide by 100 feet long. Plot design was a randomized complete block with four replications. The observational trial consisted of one non-replicated plot directly adjacent to the replicated trial. Seeding or transplanting was organized by the Farm Advisor at approximately the same time that the rest of the field was planted. All cultural operations, with the exception of planting and harvest, were done by the grower cooperator using the same equipment and techniques as the rest of the field. Test locations were primarily furrow irrigated. A field day to view the plots occurred at all sites.

2007 Statewide Results: Trial establishment by transplanting continues to increase over direct seeding (only 2 of the 10 locations were direct seeded), which mirrors changes taking place in the industry. Three of 10 locations were drip irrigated. Spring weather was warm and dry across all locations, and most trials had excellent stand establishment. The exception was the mid-maturity trial in San Joaquin County, where high winds shortly after transplanting resulted in almost complete stand loss. Insect pest pressure was generally low this season, but some of the mid-maturity locations were impacted by high powdery mildew pressure.

The early maturity trials escaped most insect or disease problems and average yield over all three locations was more than 41 tons/acre (data not shown). SUN 6366, H5003, BOS 66509, BOS 1411, and BOS 66508 had significantly better yields than the other entries in this test; SUN 6366 and BOS 1411 had the highest °Brix. Values for pH were high overall (4.48 average), but significant differences between varieties were observed.

In the replicated mid-maturity trial, SUN 6368, H8004, and H2005 yielded best. H2005 also had significantly higher °Brix than the other varieties. Significant differences were observed for color and pH. Like the early maturity trial pH was elevated with an average of 4.45.

Fresno County Results: In the early trial conducted at UC WSREC average yield was 46.3 T/A (**Table 1**). SUN 6366 and H5003 had significantly higher yield than the other entries in this test; they ranked 1st and 3rd in °Brix; they had the best color ratings, and fell in the middle of the pack in pH (however no significant differences were observed between varieties in color or pH in this trial).

Table 1: EARLY Season Processing Tomato Variety Trial - FRESNO County - 2007

Location:	UC WSREC, Five Points		
Seeded:	March 8, 2007	Irrigation Method:	Furrow
Irrigated:	March 9, 2007	Irrigation Cutoff:	July 6, 2007
Emergence:	March 23, 2007	Machine Harvest:	August 7, 2007
Soil:	Panoche clay loam	Plot size:	One 66-inch bed x 100' row

Code	VARIETY	Yield Tons/Acre		°Brix	PTAB Color	pH	% green	% sunburn	% rot	lbs per 50 fruit	TSWV* % plants
9	**SUN 6366**	55.4 (01)	A	6.0 (01)	23.3 (01)	4.50 (05)	1.0	5.8	9.6	8.2	5.3
6	**H5003**	54.4 (02)	A	5.5 (03)	23.8 (02)	4.50 (04)	1.6	8.3	7.6	7.0	6.2
4	**BOS 66509**	48.1 (03)	B	5.2 (07)	25.3 (09)	4.56 (09)	1.4	10.4	17.1	7.9	5.2
3	**BOS 66508**	45.6 (04)	B C	5.4 (04)	24.0 (04)	4.48 (02)	1.8	10.2	13.5	8.3	5.7
5	**H2206**	45.6 (05)	B C	5.4 (05)	24.0 (04)	4.46 (01)	1.7	7.1	10.1	5.4	1.7
8	**HMX 5883**	43.8 (06)	B C	5.1 (08)	24.8 (07)	4.50 (06)	3.2	7.7	12.8	8.7	3.7
1	**APT 410**	42.3 (07)	B C	5.3 (06)	24.8 (07)	4.54 (08)	1.7	7.4	18.1	8.2	3.0
7	**H9280**	41.1 (08)	C	5.0 (09)	23.8 (02)	4.51 (07)	2.5	13.9	15.6	8.4	2.2
2	**BOS 1411**	40.9 (09)	C	5.9 (02)	24.5 (06)	4.48 (02)	5.4	11.9	10.0	9.6	6.2
	AVERAGE	**46.3**		**5.4**	**24.2**	**4.50**	**2.2**	**9.2**	**12.7**	**8.0**	**4.4**
	LSD @ 0.05	5.9		0.3	N.S.	N.S.	2.1	NS	NS	0.7	3.2
	C.V. %	8.7		3.7	3.5	1.1	64.3	56.6	44.2	5.8	49.6

* the percentage of plants with TSWV per 100' row at harvest

Two midseason trials were conducted in 2007. One was seeded March 8 and grown with furrow irrigation (**Table 2**) and the other was transplanted May 22 and grown with furrow and subsurface drip irrigation (**Table 3**). Average yield dropped nearly 20 tons in the later planting due to a combination of factors: varieties performed less ably in the heat; irrigation scheduling did not always meet water demand of the crop; powdery mildew was more of a problem; and TSWV was present. SUN 6368 and H2005 performed consistently in both trials. Two varieties rose to higher ranking in the late planting: AB 8058 (TSWV resistant line) had highest yields, good color, slightly below average °Brix, and slightly higher than average pH. HMX 5839 had good yield performance, average color, below average °Brix, and higher than average pH. Other than those varieties the rankings in the 2 trials hardly changed.

Since TSWV was present in the tomato field, varieties were visually rated for presence of the disease in the March planting of the early and mid-season trials. Early trial ratings ranged from 1.7 to 6.2% and mid-season trial ratings ranged from 0.3 to 18.0% plants showing obvious TSWV symptoms. There were significant differences between varieties and the one resistant line in the trial (AB 8058) showed little to no TSWV symptoms.

A complete research report is posted at the VRIC website www.vric.ucdavis.edu. Click on Vegetable Information, Choose Tomato as the crop, scroll down to other and click on 2007 Statewide Processing Tomato Variety Evaluation trials. OR call a Farm advisor and ask them to mail you a copy. Results from the replicated Fresno trials are shown here.

Table 2: MID Season Processing Tomato Variety Trial #1 - FRESNO County - 2007

Location: UC WSREC, Five Points
Seeded: March 8, 2007 — Irrigation Method: Furrow
Irrigated: March 9, 2007 — Irrigation Cutoff: July 6, 2007
Emergence: March 23, 2007 — Machine Harvest: August 7, 2007
Soil: Panoche clay loam — Plot size: One 66-inch bed x 100' row

Code	VARIETY	Yield Tons/Acre		°Brix	PTAB Color	pH	% green	% sunburn	% rot	lbs per 50 fruit	TSWV* % plants
10	**SUN 6368**	53.2 (01)	A	6.1 (01)	25.0 (05)	4.52 (08)	1.8	6.9	5.8	8.6	6.5
4	**H 2005**	51.5 (02)	A B	5.8 (04)	25.3 (08)	4.51 (07)	0.8	8.9	6.9	8.5	13.3
7	**H 9780**	49.8 (03)	A B C	5.8 (05)	25.0 (05)	4.41 (02)	2.9	12.2	4.7	9.5	6.5
2	**AB 8058**	48.0 (04)	A B C D	5.5 (07)	24.5 (02)	4.42 (03)	0.8	3.4	7.1	9.5	0.3
5	**H 2506**	46.5 (05)	B C D	5.6 (06)	23.5 (01)	4.50 (06)	1.4	11.8	8.5	9.1	7.0
6	**H 8004**	46.2 (06)	B C D	5.9 (02)	24.8 (04)	4.46 (04)	3.8	14.2	4.0	9.0	18.0
3	**HMX 5893**	44.9 (07)	B C D	5.3 (08)	26.0 (10)	4.58 (10)	2.0	12.2	7.3	9.5	4.3
1	**AB 2**	44.6 (08)	C D	5.8 (03)	25.0 (05)	4.37 (01)	2.5	8.5	5.4	10.7	7.0
8	**H 2601**	43.3 (09)	C D	5.2 (09)	25.5 (09)	4.48 (05)	3.7	11.4	3.4	8.9	9.8
9	**RED SPRING**	42.1 (10)	D	5.0 (10)	24.5 (02)	4.58 (09)	4.8	11.1	12.6	9.2	11.5
	AVERAGE	**47.0**		**5.6**	**24.9**	**4.48**	**2.4**	**10.0**	**6.6**	**9.2**	**8.4**
	LSD @ 0.05=	6.7		0.3	N.S.	0.08	2.7	6.7	5.8	1.1	5.8
	C.V.=	9.8		4.1	4.4	1.2	75.3	45.7	61.1	8.5	47.8

* the percentage of plants with TSWV per 100' row at harvest

Table 3: MID Season Processing Tomato Variety Trial #2 - FRESNO County - 2007

Location: UC WSREC, Five Points
Transplanted: May 22, 2007 — Irrigation Method: sprinkler, furrow twice, subsurface drip
Spacing: 14" between plants, 75 plants/plot — Irrigation Cutoff: September 20, 2007
Soil: Panoche clay loam — Machine Harvest: September 25, 2007
Fertilizer: ~180 lbs N/A, 100 lbs P_2O_5 — Plot size: One 66-inch bed x 100' row

Code	VARIETY	Yield Tons/Acre		°Brix	PTAB Color	pH	% green	% sunburn	% rot	% mold	lbs per 50 fruit
2	**AB 8058**	32.5 (01)	A	5.0 (06)	21.8 (02)	4.55 (07)	3.5	5.9	6.9	0.0	9.6
10	**SUN 6368**	31.6 (02)	A B	4.9 (08)	23.5 (10)	4.52 (05)	0.3	12.7	6.1	0.3	8.7
4	**H 2005**	29.5 (03)	A B C	5.6 (01)	22.0 (03)	4.57 (09)	2.5	25.5	5.1	1.1	7.6
3	**HMX 5893**	29.2 (04)	A B C	5.0 (07)	22.3 (04)	4.55 (08)	1.7	13.8	5.3	0.6	7.5
7	**H 9780**	28.2 (05)	B C D	4.9 (09)	23.3 (09)	4.42 (02)	3.0	27.8	7.6	0.0	8.7
6	**H 8004**	27.8 (06)	B C D E	5.1 (05)	22.5 (07)	4.52 (03)	3.6	25.0	1.8	0.0	7.9
8	**H 2601**	27.7 (07)	C D E	5.2 (04)	22.3 (04)	4.54 (06)	9.2	17.4	6.5	0.0	7.6
5	**H 2506**	25.7 (08)	C D E	5.3 (03)	21.0 (01)	4.52 (04)	3.0	15.5	11.7	1.5	7.8
9	**RED SPRING**	25.1 (09)	D E	4.8 (10)	22.3 (04)	4.66 (10)	5.5	23.8	13.3	0.3	7.6
1	**AB 2**	24.2 (10)	E	5.4 (02)	22.8 (08)	4.40 (01)	1.8	13.8	10.6	1.8	9.8
	MEAN	**28.2**		**5.1**	**22.4**	**4.52**	**3.4**	**18.1**	**7.5**	**0.6**	**8.3**
	LSD @ 0.05=	3.9		0.5	0.9	0.07	3.2	10.7	NS	NS	1.5
	C.V.=	9.6		6.4	2.8	1.1	64.1	40.6	63.8	>100	12.8

Western Flower Thrips Abundance and Incidence of Tomato Spotted Wilt on Processing Tomato Fields in the Central Valley of California

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Western flower thrips (*Frankliniella occidentalis*) population densities and tomato spotted wilt (TSW) incidence in processing tomato transplant producing greenhouses and associated fields in the Central Valley of CA were monitored with the aid of yellow sticky cards and indicator plants to improve understanding of disease development to create an effective strategy for disease management.

Objectives. The objectives were 1) to determine thrips populations and TSW incidence associated with greenhouse-produced tomato transplants, 2) determine whether any linkage exists between thrips and TSW and greenhouse-produced transplants and outbreaks of TSW in the field, 3) gain insight into potential sources of TSWV for tomato in the Central Valley, 4) assess various thrips control methods and 5) develop an IPM strategy for TSWV in the Central Valley.

MATERIALS and METHODS

Thrips monitoring in transplant greenhouses. Three transplant greenhouses (California Transplant in Newman, Mezzei in Fresno and West Side Transplant in Huron) were monitored for thrips and TSWV incidence. These greenhouses produce tomato transplants for tomato production in southern Fresno County. Yellow sticky cards were used to monitor thrips. At least 6-10 yellow sticky cards were placed in each greenhouse, and 4 sticky cards were placed outside around periphery of California Transplant. Cards were changed weekly from March to June, however, monitoring continued longer around the periphery of California Transplant. Population densities of thrips were estimated by counting thrips on yellow sticky cards in the laboratory with dissecting microscope at 40x magnification. Thrips were identified to species and numbers of males and females wee recorded.

Thrips monitoring in representative fields. Thrips monitoring was carried out in 8 representative fields. Five yellow sticky cards were placed at the corners and center of each field just above the canopy. Cards were changed weekly beginning in April up to harvest. Thrips were counted as described above. Population densities of thrips were also estimated weekly by randomly collecting samples of 10 flowers per site in these same monitored fields from May until harvest. Flower samples (10 per site) were collected from same sites where yellow sticky cards were placed (five sites per field). Flowers were placed in vials containing 70% ethanol and returned to the laboratory for processing. Total numbers of thrips adults and larvae were counted and identified to species.

Indicator plants. In order to detect TSWV early in the growing season (i.e., before tomatoes start showing obvious symptoms) two types of TSWV-sensitive indicator plants (fava beans and petunia plants) were placed near each yellow sticky card in greenhouses and fields. Indicator plants were seeded and grown in an insect-free greenhouse at UC Davis. The potted 10-day-old indicator plants were changed weekly along with the yellow sticky cards. Indicator plants were brought to laboratory at UC Davis, kept for 10 days, and then symptom development and thrips populations on indicator plants were followed.

TSWV incidence and detection. Percent TSW incidence in tomato fields was determined by visually examining plants at the 5 locations per field. At each location, all plants in a 20 foot randomly selected section of 5 rows (each separated by 5 rows) were examined. An overall incidence of tomato spotted wilt at each site of the field (five per field) was calculated (presented as number of infected plants per 100 row feet and % incidence). Disease incidence was assessed weekly and was tested for using ImmunoStrip (AgDia) and RT-PCR by using *N* gene-specific primers.

Isolate collection and genetic diversity of TSWV. Symptomatic plants were also randomly collected from different locations. In order to assess the genetic diversity of TSWV isolates from the Central Valley, the fragment of RNA encoding the *N* gene was amplified by PCR and the sequence of the *N* gene determined and compared among isolates.

RESULTS - Transplant Monitoring. Thrips and TSW monitoring was initiated in mid-March 2007 in transplant houses. Thrips populations were detected in these houses, but levels were relatively low (~60-360 thrips/card). For example, at California Transplant, the average total thrips count per card was ~45-150, and this number did not change throughout the season. However, cards outside of the greenhouses had much higher counts through mid-April (~300-2500 thrips/card), but numbers decreased by early July (**Fig. 1**). Average thrips counts per card for West Side Transplant (WSTP) and Mezzei transplants was higher than CA Transplants (~60-800 thrips/card), and the number of thrips increased throughout the season (Fig. 1). The higher populations of thrips on transplants at Mezzei and WSTP can be attributed to not being enclosed, whereas greenhouses of CA Transplants were enclosed.

Thrips recorded from all these greenhouses were identified as western flower thrips, and the numbers of female thrips were three fold higher than male thrips. No obvious thrips damage was observed on transplants, nor were obvious symptoms of TSWV infection detected on plants from any of the transplant greenhouses. Consistent with this observation, no symptoms were observed on indicator plants. These results indicated very low populations of thrips on transplants and no evidence of TSWV infection in surveyed greenhouses.

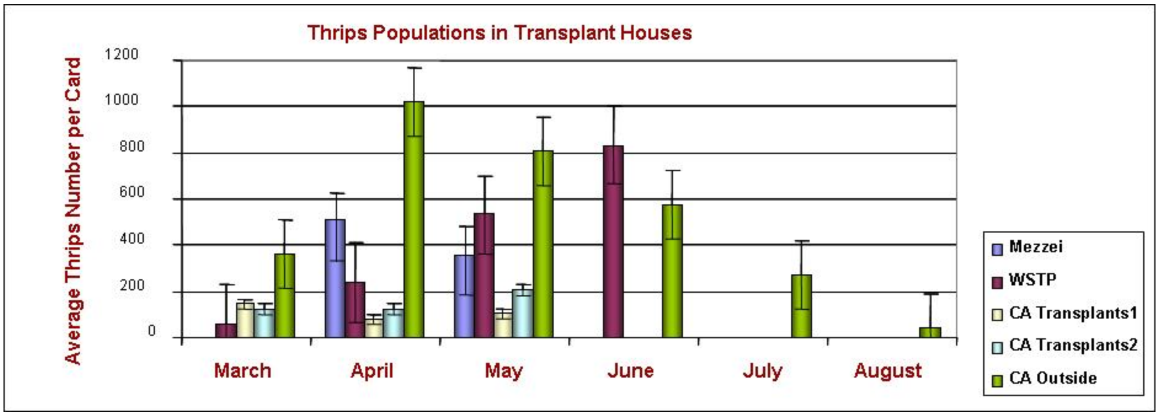


Figure 1. Average thrips counts on yellow sticky cards in tomato transplant greenhouses.

Field Monitoring. Field monitoring for thrips and TSW was initiated in transplanted and direct-seeded fields late March 2007. Overall, average thrips counts per card for direct-seeded tomato fields were slightly higher than for transplanted tomato fields. Overall thrips population was low, and in some fields no significant increase in thrips populations was observed throughout the season (**Fig. 2**). Similar to the situation in the transplant greenhouses, thrips captured in the field were also identified as western flower thrips, and female thrips populations were three fold higher than male thrips populations. Flower sampling was initiated when plants started to produce flowers. *Average thrips numbers in flowers were 5-20 per 10 flowers (0.5-2/flower) and populations persisted throughout the growing season.* The presence of thrips larvae in flower samples indicated possible reproduction of thrips in tomato flowers which in turn, indicated the possibility of secondary virus spread within the field.

Thrips populations and TSWV incidence was also monitored in a few lettuce fields (visually) and a radicchio field (with yellow sticky cards) in Huron. Whereas the spring-planted lettuce had little or no TSWV, high populations of thrips and TSWV infection were found in the radicchio field. This field was planted in late November and, when first surveyed, visual inspection revealed high populations of thrips and numerous plants showing spotted wilt-like symptoms. Testing with ImmunoStrips confirmed that these symptomatic plants were infected with TSWV. Thrips monitoring with yellow sticky cards confirmed high thrips populations in this radicchio field up to harvest (>5000/card in March and >1000/card in April). Collected thrips samples were also identified as western flower thrips. Interestingly, the direct-seeded Lassen&Jayne field, which was closest tomato field to the radicchio field, had the highest thrips counts especially in early April (Fig. 2). *These results may indicate that Lassen&Jayne tomato field was under continuous exposure to thrips coming from the radicchio field.*

The first detection of TSWV in tomato plants also was observed on 20 April in the Lassen&Jayne direct-seeded tomato field in Huron. TSWV infection was confirmed by testing with ImmunoStrips and by RT-PCR. The number of symptomatic tomato plants in the field was low and no TSW was observed in the other monitored tomato fields in late April. The initial detection of TSWV in the next field, Five Star direct-seeded tomato, was based on the fava bean indicator plants from this field. The following week, tomato plants with TSW symptoms were detected in this field. While TSW eventually appeared in all monitored fields by May, the overall incidence was low (<3%) (Fig. 2). *Overall incidence was slightly higher in direct-seeded versus transplanted tomato fields, which was consistent with the concept that transplants did not bring the virus into the fields.*

Genetic diversity of TSWV Isolates in Central Valley. Tomato, pepper, radicchio, lettuce and various weeds showing virus-like symptoms were collected and tested for TSWV. The amplified *N* gene DNA fragment from different TSWV isolates was cloned and sequenced to determine genetic diversity of the TSWV in Central Valley of California. Sequence analysis of TSWV *N* genes did not reveal any major differences among the strains irrespective of the host and location. Thus these strains represented a fairly homogenous group (TSWV-Fresno) with only a few nucleotide changes (data not shown). We were also able to successfully detect TSWV in thrips. Moreover, sequence analysis of these strains revealed that they were similar to strains detected in plants.

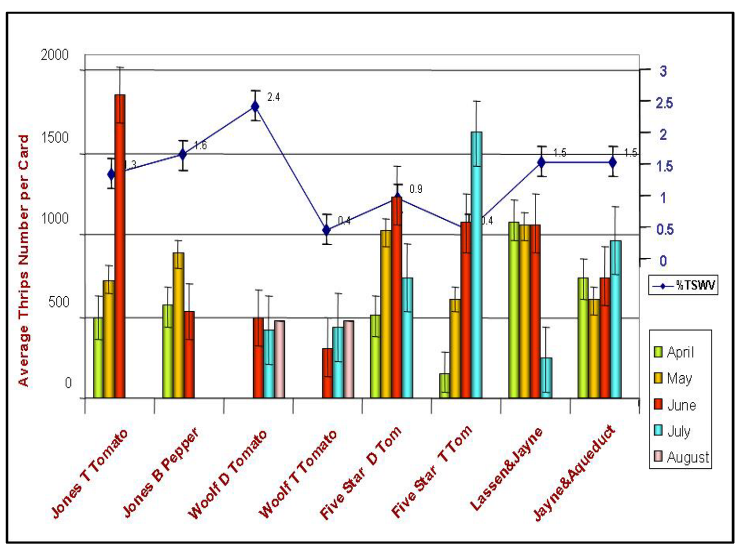


Fig 2. Average thrips counts per yellow sticky card and % TSWV incidence in monitored fields.
(T= transplant; D= direct seeded; B= bell; Tom= tomato)

2007 Progress Report:
Efficacy of Foliar-Applied Insecticides on Thrips on Processing Tomatoes

Tom Turini and Michelle Le Strange, UCCE Farm Advisors, Fresno and Tulare/Kings, and Bob Gilbertson, UC Davis

Introduction: Thrips, primarily Western flower thrips, *Frankliniella occidentalis,* are very common and numerous in tomatoes. Insecticides have been used to reduce thrips levels when population densities are very high in this crop, but usually, processing tomatoes would not be treated due to direct feeding damage caused by thrips. Within the last three years, a thrips-transmitted virus, *Tomato spotted wilt virus*, has caused substantial losses in tomatoes in Fresno County. Therefore, more attention has been focused on thrips control.

Methods: In 2007, a study to compare efficacy of insecticides against Western flower thrips was conducted at UC WSREC at Five Points in Fresno County. On 8 Mar, the processing tomato variety 'H9997' was sown on a Panoche clay loam and irrigated with sprinklers. Treatments are listed in Table 1. Each plot consisted of three 66-inch beds, 25 feet long. Treated areas were separated by 5 feet between plots within a row. The experimental design was a randomized complete block with four replications. On 1 June, materials were applied in the equivalent of 25 gallons of water per acre with a CO_2-pressurized backpack sprayer at 30 psi. All materials were applied with the adjuvant, Induce 0.25% v/v. A spray boom with three Teejet 8002 flat fan nozzles spaced 18-inches apart was used for all applications.

Four, 7 and 11 days after treatment, 10 randomly selected flowers from the center bed of each plot were collected and placed in vials containing 70% denatured ethanol. Number

of thrips per vial was recorded. Log transformed data was subjected to analysis of variance. Least Significant Difference on transformed data ($P \leq 0.05$) was used for mean separation. Non-transformed means are presented as number of thrips per 10 flowers.

Results: Four days after treatment, thrips counts were significantly lower ($p<0.05$) than the untreated control in plots treated with Lannate SP, Radiant, and Mustang with Beleaf. Counts from plots treated with Assail 30SG, Dimethoate 4EL Mustang, Success and Success with Ecozin Plus were not different than the best performing materials. While there were differences observed among treatments 7 days after the applications were made, none of the treated plots had significantly lower counts than the untreated control. No differences among treatments were observed 11 days after the applications were made.

The best performing insecticides reduced thrips counts by 38 to 41%, which was only observed in the samples collect 4 days after the treatment was made.

While greater initial reduction in thrips population densities would be very desirable, the lack of duration of control or activity of an insecticide does not necessarily negate the potential utility of an insecticide treatment as a component of a TSWV management program.

Table 1: Effect of Insecticide Treatments on Thrips Counts in Tomato Flowers

Trade name (rate of formulated product/acre)	Thrips counts/10 flowers[z]				
	4 DAT[y]		7 DAT		11 DAT[x]
Assail 30SG 4.0 oz………………………………	9.500	abc[w]	10.250	cd	15.250
Dimethoate 4EL 1pt……………………………..	9.007	bc	15.750	ab	13.000
Lannate SP 1 lb………………………………....	9.203	c	17.250	ab	13.750
Microthiol 6.0 lbs……………………………..	16.500	a	19.750	a	20.750
Movento 5.0 oz………………………………….	16.250	a	13.750	abc	19.500
Radiant 6.0 fl oz…………………………………	8.750	c	11.000	cd	14.500
Mustang 4.3 fl oz + Beleaf 50SG 2.8 oz………..	9.250	c	12.000	bcd	13.250
Mustang 4.3 fl oz……………………………..	15.203	abc	13.250	bcd	15.500
Success 6.0 fl oz…………………………………	13.250	abc	19.558	a	13.250
Success 6.0 fl oz + Ecozin Plus 8.0 oz…………..	11.500	abc	9.000	d	12.750
Venom 70DG 4 oz………………………………	14.500	ab	17.000	ab	12.000
Untreated Control……………………………..	14.870	ab	12.589	bcd	13.250

[z] All materials applied 1 June with adjuvant, Induce 0.25% v/v, in equivalent of 25 gal/A water with a CO_2-pressurized backpack sprayer at 30 psi.
[y] Days after treatment [x] No significant differences among treatments at 11 days after treatment.
[w] Means followed by same letter not significantly different as determined by LSD on log transformed data ($P \leq 0.05$). Non-transformed means presented.

2007 Progress Report:
Foliar Applied Plant Activators & Nutrients on TSW Incidence & Tomato Yield

Tom Turini and Michelle Le Strange, UCCE Farm Advisors, Fresno and Tulare/Kings, and Bob Gilbertson, UC Davis

Introduction. Plant activators, materials that cause a response in the plant that decreases disease incidence, severity or damage done by a pathogen, have shown promise against viruses and some plant activators are being used commercially.

Methods. A field study to assess the effect of 3 plant activators applied at several treatment intervals on incidence of TSWV, % of TSWV-symptomatic fruit and yield of processing tomatoes was conducted at UC WSREC at Five Points, CA.

On May 22, processing tomato variety 'AB2' was transplanted on Panoche clay loam and irrigated. The materials tested included Actigard 0.3 oz/a (acibenzolar-S-methyl: Syngenta Crop. Protection), Messenger 4.0 oz/a (harpin protein, Plant Health Care, Inc.) and Nutri-Phyte 1.5 qts/acre (phosphite, Biagro Western). Each material was applied on 4 different schedules:

1) 1 early application made prior to transplanting on 21 May (Messenger, Nutri-Phyte) or to plants on 25 May (Actigard)
2) 4 applications: early, 14 Jun, 3 Jul and 3 Aug
3) 7 applications: early, 6 Jun, 20 Jun, 3 Jul, 19 Jul, 3 Aug and 16 Aug
4) 4 applications: early, Suc**cess spinosad insecticide** 6.0 fl oz on 14 Jun, 3 Jul, 3 Aug and 16 Aug

A treatment with **Success** 6.0 fl oz applied on 14 Jun **and no plant activators**, and an untreated control were also included.

Each plot consisted of one 66-inch bed 70 feet long. Treated areas were separated by 5 feet between plots within a row. The experimental design was a randomized complete block with four replications. All materials were applied in the equivalent of 25 gallons of water per acre with a CO_2 pressurized backpack sprayer at 30 psi. A spray boom with three Teejet 8002 flat fan nozzles spaced 18-inches apart. The adjuvant, Induce 0.25% v/v was included in all applications. On 18 Jul and 15 Aug, the number of plants exhibiting TSW-symptoms was recorded. The incidence of symptomatic plants is presented as a percentage of total plants. On 25 Sep, each 70 ft plot was harvested with a commercial harvester and weighed. An 18 to 22 lb sub-sample was taken from each plot. The fruit in each sub-sample was sorted by healthy red fruit, healthy green fruit, sun burned fruit, rotten fruit, TSW-symptomatic fruit. Fruit in each category were weighed and a weight percentage is presented below.

Table 1: Influence of foliar applications of plant activators/foliar nutrients on TSWV incidence & process tomato yield, 2007

Material, rate/acre	No. of plant activator applications	% Plants with TSWV symptoms		Fruit Rating (%)					Yield
		18 Jul	15 Aug	Red (%)	Grn (%)	Rot (%)	Sun-burn (%)	TSW (%)	T/A 25 Sep
Actigard 0.3 oz	4	6.7	29.3	56.7	4.0	16.9	21.8	0.5	19.4
Actigard 0.3 oz	7	5.9	23.2	59.0	2.3	21.3	14.4	3.0	16.4
Actigard 0.3 oz	1	12.0	29.3	52.7	2.4	26.8	15.5	2.6	23.3
Actigard 0.3 oz **Success** 6.0 fl oz on 14 Jun	4	4.7	23.6	56.7	2.6	25.7	13.3	1.6	23.8
Messenger 4.0 oz	4	4.7	21.4	56.1	1.6	22.6	18.8	1.4	21.0
Messenger 4.0 oz	7	6.0	24.6	50.2	1.4	23.0	22.9	2.5	19.4
Messenger 4.0 oz	1	8.7	29.3	55.4	2.0	22.5	18.8	1.3	19.3
Messenger 4.0 oz **Success** 6.0 fl oz on 14 Jun	4	7.0	28.6	51.9	4.3	24.7	17.4	1.7	16.9
Nutri-Phyte 1.5 qts	4	5.3	26.1	53.8	2.0	21.6	20.9	1.7	18.2
Nutri-Phyte 1.5 qts	7	10.7	25.4	55.0	3.2	20.0	17.4	4.4	17.7
Nutri-Phyte 1.5 qts	1	6.3	24.3	55.0	2.0	24.3	13.2	5.5	14.6
Nutri-Phyte 1.5 qts **Success** 6.0 fl oz on 14 Jun	4	4.7	27.1	60.6	2.1	23.7	11.3	2.3	26.0
Success 6.0 fl oz on 14 Jun		8.7	28.6	56.5	2.0	20.9	18.9	1.7	23.1
Untreated		10.7	33.6	60.0	1.5	20.3	17.5	0.7	19.6
LSD (P=0.05)		**5.4**	**8.3**	**NS**	**NS**	**NS**	**NS**	**NS**	**8.6**

Results. Some plant activator treatments had lower TSW-symptom incidence than the untreated control. On 18 Jul, treatments with significantly (*p=0.05*) lower disease incidence than the untreated control included 4 applications of Actigard with Success, 4 applications of Messenger and 4 applications of Nutri-Phyte, with or without Success. On 15 Aug treatments with significantly lower disease incidence (*p=0.05*) than the untreated control included 7 applications of Actigard with Success, 4 applications of Actigard with Success, 4 and 7 applications of Messenger, and 1 and 7 applications of Nutri-Phyte. *Yields were low and fruit rot and sunburn were high due to a late harvest schedule and rains prior to harvest. There were no differences among treatments in fruit ratings and there were no differences in yield between any of the treatments and the untreated control.*

2007 Progress Report:
Effect of Thrips Control Programs on TSWV Incidence & Tomato Yield

Tom Turini and Michelle Le Strange, UCCE Farm Advisors, Fresno and Tulare/Kings, and Bob Gilbertson, UC Davis

Introduction: Recent commercial production losses of processing tomatoes due to the thrips-transmitted virus, *Tomato spotted wilt virus* (TSWV), has resulted in an increased importance of thrips, which was previously considered a minor pest in this crop. Among other approaches that must be evaluated, is potential of the use of insecticide programs to reduce TSWV incidence and severity.

Methods: In 2007, a study to assess the effect of insecticide programs on the incidence of TSWV, percentage of TSWV-symptomatic fruit and yield of processing tomatoes was conducted at UC WSREC at Five Points, CA. On May 4, variety H9553 was seeded and sprinkler irrigated on 7 May. Experimental design was a split block with 3 replications.

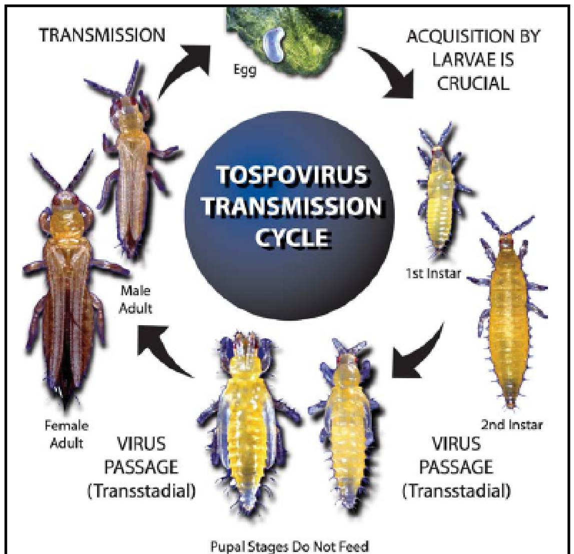
MAIN plot treatments were shank applied at 3-in depth to one 66 in bed, 315 ft long on 1 May 2007.

1. Platinum 8 fl oz
2. Platinum 11 fl oz
3. Admire Pro 10.5 fl oz
4. Untreated

SUB-plot treatments were applied to the foliage.
The insecticides, rates and application dates were:

1. Success 6.0 fl oz on 15 Jun
2. Dimethoate 4EL 1 pt on 15 Jun
3. Dimethoate 4EL 1 pt on 15 Jun, Mustang on 17 Jul
4. Mustang 4.3 fl oz on 17 Jul
5. No foliar treatment

All foliar materials in the sub-plot treatments were applied in the equivalent of 25 gallons of water per acre with a CO_2 pressurized backpack sprayer at 30 psi. A spray boom with three Teejet 8002 flat fan nozzles spaced 18-inches apart was used. The adjuvant, Induce 0.25% v/v was included in all applications. Each sub-plot consisted of one 66-inch bed 45 feet long. Treated areas were separated by 5 feet between plots within a row.



ONLY ADULTS THAT ACQUIRE AS LARVAE CAN TRANSMIT

From A.E. Whitfield, D.E. Ullman, and T.L. German. 2005. Tospovirus -Thrips Interactions. Annu. Rev. Phytopathol. 2005. 43:459-89.

Ten flowers were collected randomly and placed in vials with 70% ethanol one week following the foliar applications. Number of thrips from each vial was recorded. On 29 Jul, the number of plants exhibiting TSW-symptoms was recorded. The incidence of symptomatic plants is presented as a percentage of total plants. On 10 Sep, each 45 ft sub-plot was harvested with a commercial harvester and weighed. An 18 to 22 lb sub-sample was taken from each plot. The fruit in each sub-sample was sorted by healthy red fruit, healthy green fruit, sun burned fruit, rotten fruit, TSW-symptomatic fruit. Fruit in each category were weighed and a percentage is presented. A Factorial Analysis of Variance was used and Least Significant Difference ($P \leq 0.05$) is shown.

Results: No differences in thrips counts or yield were present. In addition, there was no consistent effect of the soil applications nor the foliar applications in terms of TSW-symptoms on the plants or on the fruit. The TSW-symptom incidence was numerically lowest for the plots receiving soil-applied treatment of Platinum 11.0 oz/A and a foliar application of Success 6.0 fl oz on 15 Jun. However, this treatment was not significantly lower than 10 other treatments, which includes several treatments receiving no foliar applications (see table).

These results suggest that under the virus pressure and other conditions of this study, the programs evaluated were not sufficient to observe an effect. In future studies, more intensive insecticide programs will be evaluated.

Influence of insecticide programs on TSW incidence and yield in processing tomato, WSREC- 2007

Soil application rate/acre	Foliar applications	TSW plants (%)	Thrips counts/ 10 flowers		Fruit rating					Yield
		29 Jul	22 Jun	24 Jul	Red (%)	Grn (%)	Rot (%)	Sun-burn (%)	TSW (%)	Tons per Acre
Platinum 8 fl oz	Success 6.0 fl oz 6/15	6.7	2.3	21.3	79.4	0.3	4.8	8.1	7.4	45.4
	Dimethoate 4EL 1 pt 6/15	6.7	6.0	23.7	80.8	0.7	3.7	9.2	5.5	44.2
	Dimethoate 4EL 1 pt 6/15, Mustang 7/17	5.9	5.0	23.7	79.4	3.4	4.8	7.9	4.5	42.9
	Mustang 4.3 fl oz 6/15	4.4	5.3	20.7	78.8	3.7	5.8	5.6	6.1	43.5
	Untreated	3.7	6.3	23.7	72.4	1.7	5.8	9.1	11.0	43.9
Platinum 11 fl oz	Success 6.0 fl oz 6/15	2.2	3.7	20.3	76.1	2.4	8.6	9.2	3.8	41.7
	Dimethoate 4EL 1 pt 6/15	5.9	2.0	21.7	68.8	2.2	2.9	6.2	4.7	41.6
	Dimethoate 4EL 1 pt 6/15, Mustang 7/17	5.2	3.0	18.0	70.1	2.6	10.8	8.7	7.7	41.6
	Mustang 4.3 fl oz 6/15	8.9	4.0	20.0	75.5	1.9	7.0	8.5	7.1	43.4
	Untreated	8.1	2.7	17.0	75.5	1.6	8.1	10.2	4.6	42.5
Admire Pro 10.5 fl oz	Success 6.0 fl oz 6/15	3.7	4.3	24.3	78.2	1.6	2.0	12.4	5.8	42.3
	Dimethoate 4EL 1 pt 6/15	5.9	2.0	16.3	76.5	0.9	5.0	11.7	5.8	41.4
	Dimethoate 4EL 1 pt 6/15, Mustang 7/17	5.9	1.3	25.7	81.3	0.9	6.4	5.9	5.7	43.3
	Mustang 4.3 fl oz 6/15	3.0	5.0	20.7	78.7	0.6	3.7	9.1	7.9	45.4
	Untreated	5.2	4.0	16.0	73.2	1.7	3.5	15.4	6.2	37.6
Untreated	Success 6.0 fl oz 6/15	5.2	3.0	26.3	73.0	2.2	7.4	9.3	8.1	37.0
	Dimethoate 4EL 1 pt 6/15	3.0	4.3	19.7	78.6	1.8	5.2	7.8	6.5	43.2
	Dimethoate 4EL 1 pt 6/15, Mustang 7/17	5.2	2.0	12.3	74.9	1.7	6.9	6.9	9.7	46.1
	Mustang 4.3 fl oz 6/15	3.7	4.3	17.7	79.2	3.5	3.8	7.2	6.3	44.7
	Untreated	5.9	4.7	16.0	71.0	4.3	7.4	10.4	7.0	43.1
LSD (P=0.05)		**3.7**	**NS**[x]	**NS**	**NS**	**NS**	**NS**	**NS**	**6.0**	**NS**

[z] All soil applications were shank applied at a depth of approximately 3inches in 15 gal water/acre on 1 May.
[y] All foliar applications made with the adjuvant, Induce 0.25% v/v, in the equivalent of 25 gal/acre water with a CO_2 –pressurized backpack sprayer at 30 psi.
[x] No significant differences among treatments (P=0.05)

POWDERY MILDEW of Tomato: What happened in 2007?

Brenna Aegerter, UCCE Farm Advisor, San Joaquin County

Many people have been asking why powdery mildew in tomatoes was so difficult to control this past season of 2007. We do know that the summer weather was very conducive for the disease and that some of the newer tomato varieties appear to be more susceptible. And… fungicide resistance has been reported from some powdery mildew isolates from tomatoes in 2007. Hopefully, we will find that mildew goes back to being less of a problem this coming season.

WEATHER: Weather during much of the 2007 season was conducive to tomato powdery mildew. Although the model uses many weather factors to arrive at its spray recommendations, one of the key factors is that tomato powdery mildew is suppressed by temperatures over 90° F. The lack of really high temperatures (with the exceptions of July 4th and late August/early September) made most of July and August quite conducive for disease development.

OPTIMIZING CHEMICAL CONTROL AND AVOIDING FUNGICIDE RESISTANCE: Fungicide resistance has been reported from some powdery mildew isolates from tomatoes in 2007. The powdery mildew fungi as a group are considered to have a high potential for resistance development. And, the newer fungicides, while effective, are at higher risk for developing resistance than the older protectant or contact fungicides. While we don't yet know how widespread resistance might be, it is <u>always</u> wise to keep this risk in mind and to apply fungicides in such a way that we lengthen their useful life.

EARLY TREATMENT: Applications should begin at the very first sign of disease, or even before you see symptoms if weather conditions are favorable.

GOOD COVERAGE: Maximize the utility of fungicides by getting the best coverage possible. In most cases, this means spraying by ground. Although we have not evaluated dusting sulfur in our small-plot trials, many people feel that sulfur dust applied by air provides good control due to its fuming activity. Applying group 3 and 11 fungicides by air may result in reduced product performance.

TANK MIXES and ROTATIONS: Unfortunately, we don't have many different classes of chemicals to work with in controlling mildew in tomatoes. However, we must make use of what we do have registered and try to prolong their useful life by using them carefully. Rotating between different groups **(see table 1)** is very important. In particular, group 11 fungicides should not be used in consecutive fungicide applications, and their use within a season should be minimized. Tank mixes with a contact material are another way to reduce the risk of resistance to group 3 & 11 fungicides. Dow's current recommendations for the use of Rally in tomatoes are that 1) All applications be tank-mixed with sulfur and 2) that each Rally application be follow by a Group 11 application.

LATER SEASON TREATMENT: Once the disease is established in a field, group 3 and 11 will be less effective and their continued use in these situations will increase the risk of resistance development. Once the disease is established, contact materials such as sulfur, potassium bicarbonate, or others should be used. Again, maximize control obtained with contact fungicides by getting good coverage of the crop.

Table 1. Materials for powdery mildew control, categorized by Fungicide Resistance Action Committee (FRAC) group code. Always check registration status prior to use.

Group Code	Chemical group name	Common names	Product examples (melon & tomato)	Risk
11	Quinone outside Inhibitors (QoI)	azoxystrobin trifloxystrobin pyraclostrobin	Quadris Flint Cabrio	**HIGH** follow label restrictions
3	Demethylation Inhibitors (DMI)	myclobutanil	Rally	**MEDIUM**
M	M2 - Inorganic	sulfur	Microthiol Thiolux	**LOW**
Not classified	Biofungicides	*Bacillus spp.* (bacteria)	Sonata, Serenade	resistance not known, presumably **VERY LOW** risk
	Mineral salts	Potassium bicarbonate	Kalligreen, Armicarb, Milstop, etc.	
	Various others	various	JMS stylet oil Prev-AM Oxidate	

Tomato Yellow Leaf Curl: A New Disease in CA Tomatoes

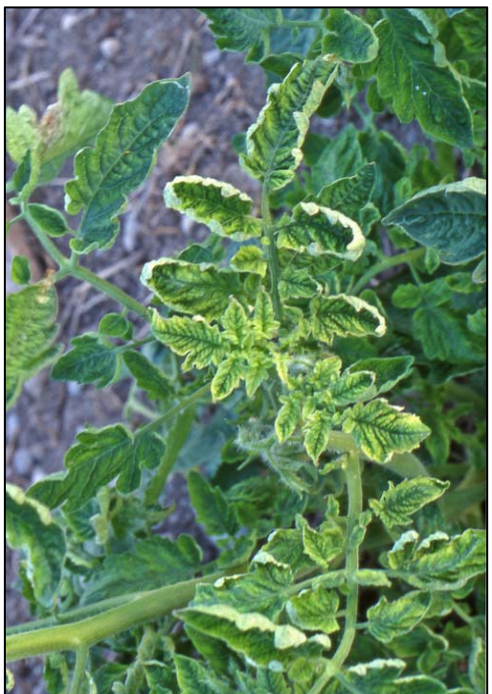
Bob Gilbertson and Maria Rojas, Dept of Plant Pathology, UC Davis and Eric Natwick, UCCE Imperial County

When was TYLCV first found in California?

In March 2007, the virus that causes tomato yellow leaf curl was identified in greenhouse tomatoes from Imperial County. Because this disease is potentially devastating for tomato production in California, it is critical to limit its spread. This article is intended to inform growers and PCAs about the disease, how to identify it and what to do if they find diseased plants.

Symptoms

Tomato plants infected with *Tomato yellow leaf curl virus* (TYLCV) are stunted, grow abnormally upright, and take on a bush appearance because internodes are shortened. Flowers on infected plants commonly fall off before fruit set and fruit production is dramatically reduced. Losses can be 100% in fields with heavily infected plants.



Typical foliar symptoms of TYLC

Leaf symptoms are the most diagnostic for this disease. Leaves of infected plants are small, strongly crumpled, curl upward, and turn yellow at the edges and between veins.

Host Range and Spread

TYLCV is a geminivirus, a family of viruses that are spread by whiteflies or leafhoppers. Whitefly transmitted geminiviruses are classified in the genus Begomovirus and infect certain broadleaf plants. Hosts of TYLCV include solanaceous crops (tomatoes, peppers, and some tobacco species) and a range of weed species. Common bean is also a host for this virus and may develop leaf curl symptoms if infected.

Many weed hosts do not develop symptoms, and it is not known how well whiteflies can acquire the virus from symptomless hosts. However, these hosts may allow the virus to survive in the absence of tomatoes, and may help the virus become permanently established. **Tomato is by far the most important TYLCV host;** it will show diagnostic symptoms and be the key to the development of the disease in the field.

TYLCV is spread by the sweetpotato whitefly, *Bemisia tabaci* biotype B (**= silverleaf whitefly**, *B. argentifolii)*, and other *B. tabaci* biotypes, **but not by other whitefly species.** The virus is not transmitted in seed nor spread mechanically or by touch.

Silverleaf whitefly adult
Bemisia argentifolii

Silverleaf whitefly pupae

The Greenhouse whitefly and nymphs

Trialeurodes vaporariorum

Whiteflies acquire the virus by feeding at least 5 to 10 minutes on an infected plant. After about 10 hours they can spread the virus by feeding on uninfected plants for at least 5 to 10 minutes. Once whiteflies acquire the virus, they can infect plants for life, but they do not pass the virus to their progeny nor does the virus replicate in the insect.

TYLCV is spread over long distances by the movement of infected plants, especially tomato transplants, and by movement of virus-carrying whiteflies either on host plants or by wind currents. Because infected plants may take up to 3 weeks to develop symptoms, the virus can be spread in symptomless, infected transplants.

Origins: Tomato yellow leaf curl was first described in Israel and was known only in Old World locations until the early 1990s, when it was introduced into the Dominican Republic. It has since spread to other Caribbean islands, is now established in Florida, and has been found in Georgia, Louisiana, and North Carolina.

A severe outbreak of TYLCV occurred in northern Mexico during the 2005-2006 season. In fall 2006, TYLCV was found in Texas and Arizona. The virus was first identified in California in March 2007, in diseased tomato plants from a non-commercial greenhouse in Brawley, California. Researchers think these greenhouse plants were infected by whiteflies that acquired the virus from host plants outside the greenhouse, and that the virus most likely came from northern Mexico.

Tomato plant infected with TYLCV

Identification: Because the TYLCV symptoms can be confused with those caused by other viruses, symptoms alone cannot be used for definitive identification. Rapid, accurate tests for identifying the virus are available at UC Davis and CDFA.

Anyone finding tomatoes with the TYLCV-like symptoms should contact

- Their local UCCE Farm Advisor, or
- UCD pathologist Robert Gilbertson (rlgilbertson@ucdavis.edu) or
- CDFA scientist Tonyan Tian (TTian@cdfa.ca.gov).

Management: CDFA has contained the initial outbreak of TYLCV and is monitoring tomatoes in commercial fields, retail stores, and backyard gardens to determine the spread and establishment of the virus in southern CA.

Should the virus become established, long-term approaches that may be needed are a tomato free period in Imperial County and a restriction on the movement of transplant from locations where TYLCV is know to occur to virus-free tomato-producing areas. TYLCV-resistant tomato varieties are available and an effective IPM program has been developed for the virus in area where it is endemic.

Will the virus become established in the SJV and pose an economic threat to tomato production?

There are a number of factors that **may not** favor establishment of the virus in the major tomato-producing areas of California, including the Central Valley.

- First, Bemisia whiteflies are not typically as abundant in these tomato-producing areas as in the desert because lower winter temperatures do not favor survival of this insect.
- Second, the winter season provides a "natural" tomato-free period, usually from November through early February. This break would eliminate the primary host of the virus.
- Even if the virus were able to overwinter in other (weed) hosts, it would probably do so less efficiently thereby minimizing economic damage.

For more detail on management strategies

Visit the UC IPM website at www.ipm.ucdavis.edu and in the Pest Management Guidelines: Tomato, there is more information about Tomato Yellow Leaf Curl Virus.

Pete Goodell, UC IPM Advisor, Statewide, will be conducting field surveys of whitefly populations in vegetable crops during 2008 and is seeking involvement of AG professionals in the SJV.
If interested, please contact Pete at (559) 646-6515 or E-Mail: IPMpbg@UCKAC.edu

The Vegetable Notes Newsletter is available ONLINE

To download this or previous editions go to
UCCE Tulare County website:
http://cetulare.ucdavis.edu/Vegetable_Crops/
You can also sign up to receive this newsletter online from the Fresno or the Tulare websites.
We welcome your comments. Send to newsletter editor:
mlestrange@ucdavis.edu or taturini@ucdavis.edu

Other UCCE county vegetable websites in the Valley:
Fresno County: http://cefresno.ucdavis.edu
Kern County: http://cekern.ucdavis.edu
Merced County: http://cemerced.ucdavis.edu
San Joaquin County: http://cesanjoaquin.ucdavis.edu
Stanislaus County: http://cestanislaus.ucdavis.edu
Yolo County: http://ceyolo.ucdavis.edu

SOURCES OF INFORMATION – PROCESSING TOMATOES

PUBLICATIONS FROM UC

Many items are available at no cost from local UCCE offices or the World Wide Web.

UC Vegetable Research & Information Center
(UC VRIC) http://www.vric.ucdavis.edu
Statewide variety trial and Fertilizer/Irrigation results are listed under Tomato Information

UC IPM (homepage)
http://www.ipm.ucdavis.edu

UC IPM (tomato section)
www.ipm.ucdavis.edu/PMG/selectnewpest.tomatoes.html

UC Postharvest Technology
http://postharvest.ucdavis.edu/
(be sure to browse the Produce Facts)

UC Ag Economics: Cost of Production Guidelines
http://coststudies.ucdavis.edu or (530) 752-1515

UC Ag & Natural Resources Catalogue
http://anrcatalog.ucdavis.edu

INDUSTRY ORGANIZATIONS

CA Tomato Research Institute (CTRI)
www.tomatonet.org/ctri.htm
A voluntary assessment by growers to support research for processing tomato crop improvement.

CA Tomato Growers Association (CTGA)
www.ctga.org
Represents growers in the bargaining, economic, public policy and business leadership arenas.

CA League of Food Processors (CLFP)
www.clfp.com
Represents and promotes processors in California

Processed Tomato Foundation (PTF)
www.tomatonet.org/ptf.htm
Partnership of CA tomato growers & processors to address food safety and environmental issues.

Processing Tomato Advisory Board (PTAB)
www.ptab.org
Establishes CA fruit quality standards and conducts grading program to assure high fruit quality.

PESTICIDE LABELS

CDMS – Ag Chemical Information Services http://www.cdms.net/LabelsMsds/LMDefault.aspx?t=
Greenbook http://www.greenbook.net/

WEATHER & IRRIGATION

CIMIS - CA Irrigation Management Information System
CA Dept Water Resources - www.cimis.water.ca.gov
UC IPM - Weather, day degree modeling and CIMIS
http://www.ipm.ucdavis.edu/WEATHER/weather1.html%AO%AO

GOVERNMENT

CDFA - www.cdfa.ca.gov
CDPR - www.cdpr.ca.gov
CA AG Statistics Service- http://www.nass.usda.gov/ca
Curly Top Virus Control Program - (559) 445-5472

CALIFORNIA TOMATO PROCESSORS

Campbell Soup Company, Sacramento
Con-Agra Food Products Co., Hanford
Con-Agra Grocery Products Co.
Oakdale & Helm
Del Monte Corporation, Hanford
Escalon Premier Brands, Inc., Escalon
Ingomar Packing Co., Los Banos
John Potter Specialty Foods, Inc.,Modesto
Los Gatos Tomato Products, Huron
Pacific Coast Producers, Woodland
Patterson Vegetable Co. , Patterson
Pictsweet Frozen Foods, Inc., Santa Maria
Rio Bravo Tomato Co. LLC, Buttonwillow
San Benito Foods, Hollister
SK Foods, Inc., Lemoore and Colusa
Stanislaus Food Products Co., Modesto
The Morning Star Packing Co.
Los Banos, Liberty & Williams
Toma Tek, Firebaugh
Unilever Foods- NA, Stockton

Driers/Dehydrators

Bonacich Orchards, Patterson
Borello Farms, Inc., Morgan Hill
Culinary Farms, West Sacramento
Gilroy Foods, Hanford
Lester Farms, Winters
Mariani Nut Company, Winters
Traina Foods, Patterson
Valley Sundried Products, Inc., Newman

PTAB maintains a list of California Tomato Processors and their contact Information
http://ptab.org/proclist07.htm

Water Quality
Measurement

Vegetable Notes

UCCE Tulare/Kings and Fresno Counties

Michelle Le Strange and Tom Turini, Farm Advisors

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