University of California Cooperative Extension

Vegetable Notes

Tulare and Kings Counties

EDITION #10: Tomato & Pepper Research Update

Volume 3, Issue 1 **March 2007**

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Tomato Spotted Wilt Virus in California Processing Tomatoes

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Most tomato growers, processors, pest control advisers, and allied industries know that since 2003 there has been increased incidence of *Tomato spotted wilt virus* (TSWV) in several tomato growing areas of California. Certain areas of the Westside of Fresno County have been particularly hard hit in 2005 and 2006, but the disease has been showing up in other crops in coastal and desert areas as well. Tomato plant symptoms are characterized by an initial chlorosis of leaves and terminal shoots that may develop into bronzing and necrosis. Fruit symptoms show faint to obvious concentric rings on green and/or red fruit. Sometimes the fruit is severely blotched, deformed, and unmarketable.

What we know about TSWV

The Economic Hosts: This virus is found worldwide and has one of the most extensive host ranges of any known plant virus infecting over 900 species of plants. Most are dicots, but some monocots are also susceptible. The important economic agricultural crops in CA are tomatoes, peppers, potatoes, lettuce, and chicory, but several important floral industries are also threatened by this disease, including ranunculus, chrysanthemum, petunia, impatiens, and zinnia.

The Vector: Worldwide, this virus is transmitted by at least eight thrips species. In CA the western flower thrips (*Frankliniella occidentalis)* is considered the most important vector. The only method of field spread is via the thrips vector; it is not transmitted by contact between plants; it is not transmitted by seed; and it is not transmitted by pollen. It is transmitted by the thrips in a persistent propagative manner meaning that the virus actually infects and multiplies in the thrips, however the thrips adult does not pass the virus on to its progeny (eggs). The virus is acquired only during the thrips larval stages; the instars can transmit the virus before they pupate, but adults more commonly transmit the virus. The thrips lifecycle is approximately 30 days, but fluctuates with temperature. In general thrips are more active under cool to moderate weather conditions (70 - 85 °F).

In the early 1980s the disease became a major threat to peanut, pepper, tobacco, and tomato in nine states in the southern USA and in Hawaii's lettuce, tomato, and pepper crops. Research there showed that lettuce supported large thrips populations. When measured 5 weeks after planting, thrips densities averaged 125-375 thrips per plant (0.5 - 1.5 million thrips per acre). Thrips continued to emerge from the soil for 2-3 weeks after crop residues were plowed and tilled. Cultivation and harvesting activity disrupted and agitated thrips and resulted in considerable intercrop movement. Several important fresh and processing tomato growing areas in the world have TSWV present including Spain, Italy, Brazil, Argentina, and Florida, USA.

Detection Methods

PCR, ELISA, Immuno-assay strips:

There are several sensitive and reliable detection methods for TSWV. These include enzyme-linked immunosorbent assay (ELISA), a serological (antibody)-based method; and polymerase chain reaction, which detects the viral RNA. However, ELISA and PCR are methods that require laboratory facilities. More recently, a test was developed for TSWV that can be conducted in the field in 15-30 minutes. This test, referred to as immunostrips, is serologically-based, but involves only sticking a 'strip' into a plastic bag with plant sap, allowing the sap to move up the strip and observing whether one or two lines appear at a certain point. One line is a control that tells you the strip was functional and the other indicates infections with TSWV. These immunostrips allow for rapid confirmation of infection in the field and require no laboratory facilities.

Immunostrips for TSWV

Management Strategies

Unfortunately TSWV is a complex disease with no rapid, easy solution to alleviate losses. Wherever TSWV has surged to epidemic proportions in agriculturally important host plants the virus remains as a chronic problem. To minimize disease damage requires a multi-disciplined approach.

2005-06 Plant Surveys conducted by Falk, Davis, LeStrange: Crops, ornamentals, and weeds were sampled in 2005-06 from several fields in Fresno and Merced counties to identify plant species that may serve as reservoirs for TSWV. Hundreds of samples from approximately 80 species were collected and tested with ELISA or immunoassay strips for the presence of the virus.

- Crops that tested positive included ones showing obvious symptoms: tomato, potato, pepper, lettuce and radicchio.
- Other crops such as almond leaves, cauliflower, celery, eggplant, pea, and spinach did not test postitive.
- Weeds testing positive for the virus included Russian thistle, black nightshade, ground cherry, dodder growing on an infected tomato plant, and prickly lettuce.
- Many other weeds were sampled but did not test positive, even though they are suitable hosts: cheeseweed, chickweed, groundsel, lambsquarters, London rocket, marestail, prostrate pigweed, shepherds purse, sow thistle, and yellow mustard.
- Only a few ornamental plants tested positive for the virus although several dozen species were sampled: canna lily, calla lily, and a helianthus daisy.

2006 Tomato Field Incidence Surveys: In 2004 and 2005 the Westside of Fresno county experienced tomato and pepper crop and sometimes whole field loss due to TSWV, but the affected fields were limited to a concentrated geographic area. In summer of 2006 tomato damage was more common and widespread over a larger area. Spring weather was characterized by above normal rainfall. TSWV incidence was not uniform over the area - one field would be affected while an adjacent field was not. Growers participated in a voluntary survey conducted through CTRI which asked where they noticed TSWV in 2005 and 2006, when they noticed TSWV, what were the planting/seeding date and the tomato variety? Growers also estimated disease severity in the field. Bryce Falk and Mike Davis analyzed these responses, however no trend was apparent and there was no specific correlation. Incidence seemed more common in spring/early summer and then again in late summer/fall. Incidence was equally common in transplant and direct seeded tomatoes. Incidence ranged from 2-75%.

TSWV in Westside Lettuce and Radicchio Crops: Lettuce was sampled in fall of 2005 and spring of 2006, but TSWV was not apparent. In fall 2006 TSWV was found in several lettuce fields in the Huron and Five Points areas with 2007 spring lettuce germinating in crop fields nearby. This confirmed that TSWV could now be found in a crop virtually all year round and that there was no crop free period without the virus.

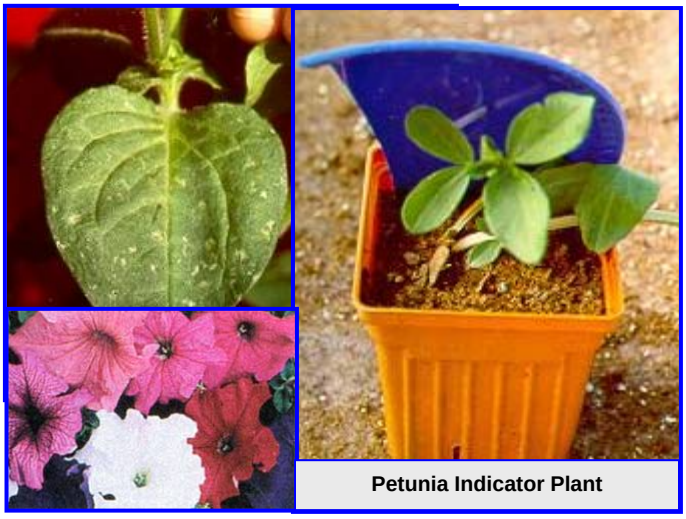
Radicchio crops sampled in fall-winter of 2005, spring - fall of 2006 and most recently in spring of 2007 have continually tested positive for TSWV and are capable of hosting a high population of thrips.

Tomato Spotted Wilt Symptoms in Radicchio

2007 Research Plans: UC researchers (Gilbertson, Ullman, Batuman, LeStrange, and Turini) are embarking on a comprehensive study this spring to determine if transplants could be the source of the virus and to characterize the populations of thrips moving into processing tomato fields over the season. Several tomato transplant greenhouse producers in California have agreed to be monitored for thrips populations.

Additionally tomato fields at three locations along the Westside of Fresno and Kings Counties will be monitored weekly for thrips populations and disease infection, starting prior to planting. We will start in the greenhouse where we will use sticky traps and indicator plants to speed up the virus detection process. We will follow the same transplants to the field and monitor them throughout the course of their growing cycle. Sites are selected based on past incidence of TSWV and current cropping conditions. Sticky traps and thrips/virus indicator plants will be strategically placed at field sites and changed out weekly. We will be monitoring thrips activity in transplanted and seeded processing tomatoes that are planted near spring harvested lettuce and summer harvested onions, wheat or peppers.

TSWV Indicator Plants: A particular variety of petunia, *Celebrity Blue*, has been selected as the indicator plant to monitor for thrips carrying the TSWV. Petunia indicator plants show distinctive local lesions when infective thrips feed on them. These lesions appear as small brown to black spots of the leaves and look different from typical thrips feeding. Local lesions result from a hypersensitive response, which is the strategy used by the petunia as protection from the virus. In a hypersensitive response the tissue around the virus entry site dies rapidly preventing the virus from spreading and causing a system wide infection in the plant. Local lesions are apparent on petunias about 3-7 days after feeding by an infected thrips.



Petunia Indicator Plant

Petunias make an excellent indicator plant because the plants don't support thrips development and seldom become systemically infected. As a result the plants do not serve as a source of the virus or additional thrips. When we see lesions on indicator plants (a sign that the thrips are carrying the virus) then we will start a sampling program to rate disease development in the field.

We will also be monitoring for TSWV/thrips reservoirs at additional sites such as extremely weedy areas, foothills, set aside land, etc. by placing indicator plants to detect TSWV infected thrips. Whenever the indicator plants show us a hypersensitive response with the TSWV, then we search the nearby weed/plant populations and determine where the source of the virus reservoir is for the thrips.

Insecticides: Thrips are not easily controlled by insecticides and can easily develop resistance. To suppress thrips populations in Hawaii, one to two insecticide applications were needed per week. The most effective insecticides included Orthene (acephate), Fury/Mustang (cypermethrin), Mavrik (fluvalinate), Lannate (methomyl), and Phosdrin (mevinphos). Many of these products are no longer registered in CA, but a few others that may have activity against thrips have been registered on tomatoes.

Several insecticide-related issues to be addressed under Westside conditions include:

- the basic question regarding efficacy of available materials against thrips,
- the issue regarding potential benefit of reducing thrips populations for purposes of reducing TSWV incidence or severity, and
- determining if greater benefit is realized with a more intensive thrips control program.

The effect on thrips populations and TSWV of shank injected Platinum (thiomethoxam) at planting with and without foliar insecticide applications will be evaluated. Insecticides used for the foliar applications will be Warrior (Lambda cyhalothrin), Lannate, and Success (spinosad), which represents different modes of action.

In addition, materials that trigger a plant response that reduce damage done by viruses will be tested. Actigard (acibenzolar-S-methyl) has shown promise against a similar virus of onion. Early applications of this material will be evaluated. Other insecticides under consideration include Agrimek (abamectin) and Provado (imidacloprid).

Summary: The goal is to develop an understanding of when and where TSWV infects processing tomatoes in California. The systematic examination of the crop, from start to finish, should provide insight into inoculum sources and viral biology. This information will be used to help develop an integrated pest management strategy for thrips/TSWV in processing tomatoes. As chemical control of thrips will likely be part of this strategy, we will evaluate materials for their efficacy in thrips control. In addition, we will gain important new information about thrips biology and TSWV in Central California.

Statewide Processing Tomato Variety Trials - Fresno Results - 2006

Michelle Le Strange, Farm Advisor, Tulare and Kings Counties

Three early and 7 mid-season variety evaluation tests were conducted throughout the major processing tomato production regions of California during the 2006 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. These tests are designed and conducted with input from seed companies, processors, and other allied industry and are intended to generate useful information for the industry.

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 planted in one-bed wide by 100 foot long plots (Fresno used 75-foot plots). Plot design was a randomized complete block with four replications. The observational trial consisted of one non-replicated plot 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. All test locations were primarily furrow irrigated. A field day or arrangements for interested persons to view the plots occurred at all of the tests.

2006 Conditions: Weather played a dominant role in the results of these trials. An extended cool and wet spring resulted in delayed planting in many locations, which was exasperated by a very hot summer. The mid season trials were particularly impacted by severe heat in July when daytime temps exceeded 100°F throughout the Central Valley for about two weeks. This severe heat resulted in poor pollination and fruit set, and a drop in yield.

The early trials escaped most of the extreme heat and yielded very well in Yolo and Contra Costa Counties, averaging 48 and 55 tons/acre respectively. In the early trial, H5003, Sun 6366, BOS 66509, 66508, and APT 410 had significantly better yields than the other entries in this test; HyPeel 45 had the highest °Brix and lowest pH. Most varieties in the mid season trial yielded less than 40 tons/acre in all locations, except in Merced County which was drip irrigated. Averaged across location, no significant differences were found in the mid-season observation trial for yield or °Brix; in the replicated trial best yields occurred with DRI 8058 and Sun 6368, while Sun 6374 had significantly higher °Brix than the other varieties.

Results: *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 2006 Statewide Processing Tomato Variety Evaluation trials. OR call a Farm advisor and ask them to mail you a copy. Results from the Fresno trials are below.*

Table 1: EARLY Season Processing Tomato Variety Trial - FRESNO County - 2006

Seeded: February 17, 2006
Irrigated: February 18, 2006
Emergence: March 13-17

Irrigation Cutoff: June 23, 2006
Machine Harvest: July 20, 2006
Plot size: One 66-inch bed x 73' row
Double plant rows/bed - 12" between plant rows

Code	VARIETY	Yield Tons/A		°Brix	PTAB Color	pH	% green	% rot + sunburn	lbs per 50 fruit
6	**Sun 6366**	38.7 (01)	A	6.1 (01)	29.3 (12)	4.31 (08)	15.3	18.2	7.6
2	**H 5003**	38.4 (02)	A	5.5 (07)	23.3 (02)	4.29 (06)	13.0	9.7	6.7
8	**BOS 66509**	36.4 (03)	A B	4.8 (12)	25.3 (04)	4.28 (04)	12.2	28.0	7.4
7	**BOS 66508**	35.5 (04)	A B	5.6 (06)	19.0 (01)	4.25 (03)	12.9	19.1	7.7
9	**BOS 7026**	34.3 (05)	B	5.6 (05)	27.5 (08)	4.28 (05)	11.6	25.5	8.0
10	**APT 410**	34.2 (06)	B	5.9 (04)	25.3 (04)	4.25 (02)	9.6	30.1	7.4
3	**H 9280**	34.1 (07)	B C	5.1 (11)	26.5 (07)	4.30 (07)	12.9	15.9	7.8
11	**HyPeel 45**	33.5 (08)	B C	6.0 (03)	27.8 (09)	4.20 (01)	17.1	21.3	7.4
4	**U 250**	33.4 (09)	B C	5.2 (10)	28.0 (10)	4.34 (10)	11.2	26.3	8.6
5	**U 462**	32.9 (10)	B C	5.4 (08)	26.3 (06)	4.34 (09)	6.6	37.8	7.9
1	**HMX 5883**	30.4 (11)	C D	5.3 (09)	28.8 (11)	4.34 (11)	13.3	24.7	8.3
12	**PS 438**	26.7 (12)	D	6.1 (02)	25.0 (03)	4.36 (12)	17.8	14.7	7.6
	AVERAGE	**34.0**		**5.5**	**26.0**	**4.29**	**12.8**	**22.6**	**7.7**
	LSD @ 5%	3.7		0.7	5.0	0.07	NS	12.8	NS
	C.V. %	7.6		8.7	13.3	1.1	36.7	39.5	9.8

Table 2: MID-Season Processing Tomato Variety Trial #1 - FRESNO County - 2006

Seeded: March 16, 2006
Irrigated: March 17, 2006
Emergence: April 3, 2006

Irrigation Cutoff: July 7, 2006
Machine Harvest: August 10, 2006
Plot size: One 66-inch bed x 73' row

Code	VARIETY	Yield Tons/A		°Brix	PTAB Color	pH	% green	% rot + sunburn	lbs per 50 fruit
15	**PS 345**	41.6 (01)	A	5.2 (14)	27.3 (15)	4.35 (06)	4.9	4.8	8.9
8	**H 9780**	41.3 (02)	A B	5.5 (10)	25.3 (09)	4.34 (05)	3.4	9.7	9.2
12	**Sun 6368**	40.1 (03)	A B C	5.7 (06)	25.5 (11)	4.40 (10)	3.8	8.6	7.9
14	**BOS 67374**	37.5 (04)	A B C D	5.7 (07)	24.3 (04)	4.32 (03)	3.6	12.0	8.7
7	**H 8004**	36.9 (05)	A B C D	5.6 (08)	26.3 (14)	4.35 (07)	7.0	7.4	8.5
3	**DRI 8058**	36.5 (06)	A B C D	5.6 (08)	24.0 (01)	4.39 (09)	6.5	14.9	8.1
10	**U 886**	36.3 (07)	B C D	5.3 (12)	24.0 (01)	4.48 (13)	3.9	14.7	8.5
2	**DRI 4610**	35.4 (08)	C D	6.1 (01)	24.8 (07)	4.31 (02)	5.2	10.2	8.4
5	**H 2005**	34.9 (09)	C D	5.8 (05)	25.0 (08)	4.48 (14)	3.0	12.6	8.3
6	**H 2601**	34.2 (10)	D E	5.1 (15)	25.5 (11)	4.47 (12)	3.6	13.2	8.4
1	**AB 2**	33.4 (11)	D E	6.0 (03)	24.3 (04)	4.29 (01)	4.2	10.8	8.9
16	**PS 384**	32.6 (12)	D E F	5.9 (04)	27.5 (16)	4.35 (08)	4.3	15.8	8.5
9	**U 567**	32.5 (13)	D E F	4.9 (16)	24.3 (04)	4.48 (15)	2.8	13.5	9.2
13	**Sun 6374**	32.4 (14)	D E F	6.1 (02)	25.3 (09)	4.32 (03)	4.8	14.6	7.8
4	**HMX 4802**	29.0 (15)	E F	5.3 (11)	25.5 (11)	4.46 (11)	4.7	17.7	8.6
11	**Red Spring**	27.4 (16)	F	5.2 (13)	24.0 (01)	4.52 (16)	5.2	30.8	8.1
	AVERAGE	**35.1**		**5.6**	**25.2**	**4.39**	**4.4**	**13.2**	**8.5**
	LSD @ 5%	5.3		0.4	1.9	0.06	NS	6.8	0.9
	C.V. %	10.5		5.1	5.2	0.9	42.7	36.1	7.0

Table 3: MID-Season Processing Tomato Variety Trial #2 - FRESNO County - 2006

Seeded: May 4, 2006
Irrigated: May 4, 2006
Emergence: May 17, 2006

Irrigation Cutoff: August 11, 2006
Machine Harvest: September 12, 2006
Plot size: One 66-inch bed x 73' row

Code	VARIETY	Yield Tons/A		°Brix	PTAB Color	pH	% green	% rot + sunburn	lbs per 50 fruit
3	**DRI 8058**	38.8 (01)	A	5.1 (12)	22.8 (01)	4.45 (08)	13.6	10.3	8.4
12	**Sun 6368**	34.0 (02)	B	6.1 (02)	23.8 (04)	4.47 (12)	14.3	13.0	7.2
10	**U 886**	32.6 (03)	B C	5.2 (11)	23.5 (02)	4.46 (11)	19.3	9.1	7.9
6	**H 2601**	31.2 (04)	B C D	5.1 (15)	24.8 (10)	4.51 (13)	14.3	17.2	7.4
13	**Sun 6374**	30.3 (05)	C D E	6.2 (01)	23.8 (04)	4.43 (06)	18.7	13.4	7.3
15	**PS 345**	29.5 (06)	C D E	5.2 (09)	25.8 (13)	4.45 (09)	19.1	12.1	8.4
1	**AB 2**	29.3 (07)	C D E	5.6 (06)	24.3 (08)	4.34 (01)	15.8	12.6	7.6
5	**H 2005**	28.8 (08)	C D E	5.6 (04)	24.3 (08)	4.56 (14)	19.2	16.1	8.3
7	**H 8004**	28.2 (09)	D E F	5.6 (05)	23.5 (02)	4.45 (07)	22.2	14.0	7.1
16	**PS 384**	26.8 (10)	E F G	5.9 (03)	27.5 (16)	4.42 (05)	15.7	11.4	7.4
8	**H 9780**	24.9 (11)	F G H	5.2 (09)	25.8 (13)	4.42 (04)	34.2	4.2	8.5
9	**U 567**	24.8 (12)	F G H	5.1 (13)	25.0 (12)	4.45 (09)	15.1	17.4	7.8
14	**BOS 67374**	24.7 (13)	F G H	5.5 (07)	24.0 (06)	4.39 (02)	20.9	14.8	7.3
11	**Red Spring**	24.3 (14)	G H	5.1 (14)	24.8 (10)	4.57 (15)	20.8	22.4	7.5
2	**DRI 4610**	23.9 (15)	G H	5.0 (16)	24.0 (06)	4.41 (03)	20.6	10.6	7.7
4	**HMX 4802**	22.8 (16)	H	5.2 (08)	26.5 (15)	4.57 (16)	18.0	17.8	7.9
	AVERAGE	**28.4**		**5.4**	**24.6**	**4.46**	**18.9**	**13.5**	**7.7**
	LSD @ 5%	3.7		0.6	1.3	0.06	8.2	8.2	NS
	C.V. %	9.3		7.5	3.8	1.0	30.5	42.6	9.2

Statewide Fresh Market Tomato Variety Trials, 2006

Scott Stoddard, Michelle Le Strange, and Brenna Aegerter
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Summary: As part of a long-term project with the California Tomato Commission, fresh market tomato variety trials were conducted in commercial tomato production fields in Fresno, Merced, and San Joaquin Counties in 2006 to evaluate field and postharvest performance. At each location, "round" lines were grown in both replicated and observation plots, while "roma" lines were limited to a replicated trial. New varieties were compared to the standards Shady Lady, QualiT-21, and Monica, and evaluated on marketable yield, size breakdown, color, and cull percentage. Varieties performed differently depending on location/time of planting. The early trial in Fresno had excellent yields, while the late trial in San Joaquin County suffered through the July heat wave, which significantly reduced yield and quality of the harvested fruit. Averaged across locations, significant differences were found for marketable yield, fruit size, and red fruit in the replicated round and roma trial; no significant differences were found between varieties in the round observation trial. Round lines with overall best marketable yield were PS2935 and PS2942, QualiT-21, and Wolverine. Roma varieties Monica, PX739, Mi Roma, and Mi Rey all yielded well.

Introduction: UCCE conducts fresh market tomato variety trials in three areas in the San Joaquin Valley to evaluate the performance of new varieties and breeding lines from commercial plant breeders for the mature green market. These variety trials provide the opportunity to evaluate and compare fruit quality characteristics and yield in commercial production fields with different types of soil, management, and growing conditions.

The objective of this trial is to identify dependable, higher yielding and higher quality lines that can be grown in a wide geographic area and varying environmental conditions characteristic of central California. The main commercial market is for mature green tomatoes. Varieties are typically semi-determinant, bush-type grown without support and hand harvested. This market includes both round and "roma" type tomatoes.

Procedure: In 2006, round and roma variety trials were conducted in Fresno, Merced, and San Joaquin Counties in commercial production fields and managed using standard production practices. The Fresno trial was drip irrigated, the others, furrow. The Fresno, Merced, and San Joaquin trials were planted one month apart, to reflect early, mid, and late season production fields, respectively.

Postharvest samples from all the replicated varieties were collected by Marita Cantwell from all trials at the time of harvest and taken to the Mann Laboratory at UC Davis for color, firmness, and fruit composition analysis at the mature-green and table-ripe stage. A complete summary of the both the field evaluation and postharvest results can be found at http://cemerced.ucdavis.edu.

Results: Results for marketable yield for Fresno, Merced, and San Joaquin Counties are shown in Tables 1, 2, and 3. Significant yield differences were found at each location, with QualiT-21 yielding the most in Fresno and San Joaquin, and PS 2942 in Merced County. When the data for all three locations were combined, significant differences occurred for yield, size, and amount of red fruit. Extra large (XL) fruit were significant higher percentage of the market yield in Fresno as compared to the other locations (Fig. 1). In general, Shady Lady had consistently smaller fruit at each location. Shady Lady also had the highest percentage of red fruit.

The significant variety by location LSD found for yield, M%, XL%, small, cull %, and red % indicates that varieties are performing differently at different locations. This makes sense, because some lines are better adapted for early or late season growing conditions. The implications are that it is better to use the individual location results for determining variety fit rather than the combined analysis.

Observed Lines: Because there is no replication in the observed lines, statistical analysis could be performed only on the combined data set (Table 2). SXT 6783 and SXT6784 did particularly well in Fresno, while HMX 5790 yielded well in Merced. None of the Seeds of Change varieties performed well relative to the others at either the Merced or San Joaquin location. Combining locations, no significant differences among varieties were found for yield, size, or color, mainly because of the large amount of variability in the data. As with the replicated trial, the Fresno location had more XL fruit than the other locations.

Roma Trial: Roma trials were conducted in all three locations for the first time in 2006. There were not enough entries for both an observation and replicated trial, so only a replicated trial was conducted (Table 3). In general, yields were very good for all lines except BSS 526, which over produced small fruit. Neither the Merced nor San Joaquin location had any XL fruit.

Acknowledgements: Many thanks to the following seed company representative for their participation: Yair Askira, LSL Seed; Rod Jorgenson, Syngenta/Rogers Seed; Carl Hill and Susan Peters, Nunhems; Doug Heath, Seminis, Greg Styers, Bejo Seeds; Mark Beoshanz, Harris Moran; Erica Renaud, Seeds of Change; and Jeff Zischke, Sakata Seeds. Additional thanks to the cooperators who helped with these trials, and to the California Tomato Commission for financial support.

Table 1. Fresh market tomato (round) variety trial yield results by location and combined, 2006. REPLICATED varieties.

Code	Variety	TMY Fresno Tons/A	TMY Fresno Boxes/A	TMY Merced Tons/A	TMY Merced Boxes/A	TMY San Joaquin Tons/A	TMY San Joaquin Boxes/A	TMY combined Tons/A	TMY combined Boxes/A	
2	PS 2935	45.1	3608	27.9	2232	10.2	813	29.3	2344	A
1	PS 2942	42.9	3430	28.0	2242	11.5	921	28.9	2312	A
4	Quali T-21	46.8	3746	22.6	1809	12.9	1034	28.8	2304	A
7	Wolverine	47.8	3823	22.1	1767	7.4	596	27.4	2192	A B
3	Bobcat	42.9	3432	22.8	1827	8.0	639	26.1	2088	B
6	Scout	44.4	3552	19.3	1543	6.8	547	25.0	2000	B C
5	Quali T-23	32.2	2576	23.7	1899	8.4	670	22.6	1808	C D
8	Shady Lady	38.5	3077	15.1	1206	6.2	493	21.1	1688	D
	Average	42.6	3405.8	22.7	1815.6	8.9	714	26.2	2093	
	LSD 0.05	4.6	364	5.0	401.0	4.0	322	2.6	208	
	CV %	7.3	7.3	15.0	15.0	25.8	26	11.6	11.6	
	VAR X LOCATION LSD @ 0.05 (Between Merced and Fresno)							4.3	345	
	VAR X LOCATION LSD @ 0.05 (Between SJC and Merced or Fresno)							4.7	373	

See notes following Table 2.

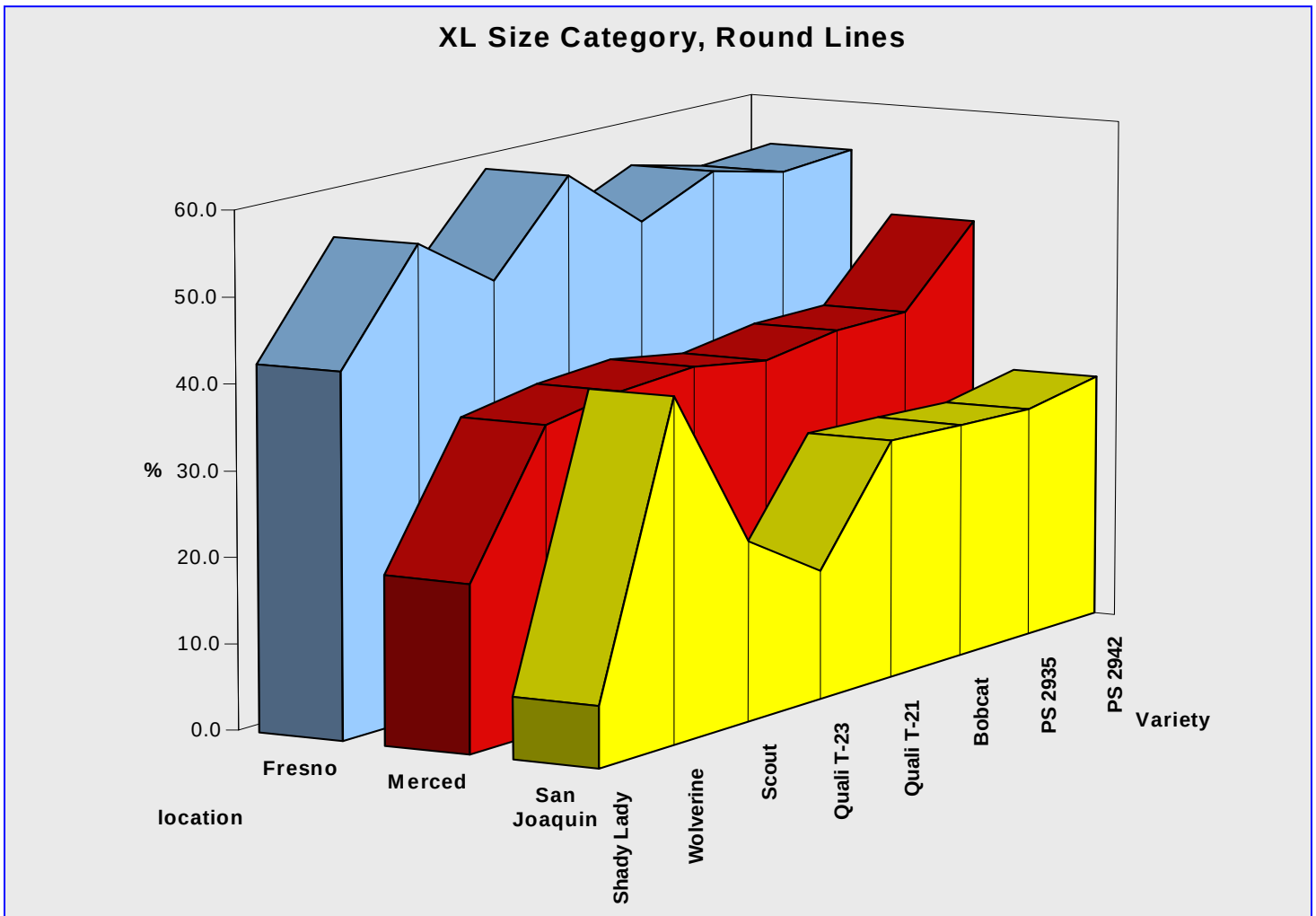


Figure 1. Extra large (XL) sizes for the fresh market round replicated varieties at the different test locations.

Table 2. Fresh market tomato (round) variety trial yield results by location and combined, 2006. OBSERVATION varieties.

Code	Variety	TMY Fresno Tons/A	TMY Fresno Boxes/A	TMY Merced Tons/A	TMY Merced Boxes/A	TMY San Joaquin Tons/A	TMY San Joaquin Boxes/A	TMY combined Tons/A	TMY combined Boxes/A
13	SXT 6783	51.8	4140	18.9	1515	7.8	622.0	26.2	2096
14	SXT 6784	47.5	3801	23.4	1868	5.2	414.7	25.4	2032
9	HMX 5790	35.9	2873	30.9	2472	4.8	383.3	24.5	1960
16	11091	---	---	11.6	925	16.7	1339.9	23.2	1856
10	HMX 6812	31.1	2489	27.8	2225	8.2	656.9	22.9	1832
12	SXT 6782	40.7	3260	13.8	1107	7.4	592.4	20.6	1648
11	SXT 6764	38.0	3043	12.5	1000	9.3	740.5	19.9	1592
17	5151	---	---	9.3	748	9.6	768.4	18.5	1480
15	10442	---	---	3.4	268	8.0	643.3	14.8	1184
18	6260-D	---	---	5.1	407	4.9	393.8	14.1	1128
	Average	40.8	3267.7	15.7	1253	8.2	656	18.7	1496
	LSD 0.05							NS	NS
	CV %							40.0	40.0

Market yield = XL + L + M size fruit, average of four replications. One box = 25 lbs.
LSD 0.05 = least significant difference at the 95% probablility level.
Var x Location LSD = least significant difference between the same variety at different locations.
NS = not significant at the 95% probability level.
CV = coefficient of variation, a measure of the variability in the experiment.

Table 3. Fresh market tomato ROMA variety trial yield results by location and combined, 2006. REPLICATED ROMA varieties.

Code	Variety	TMY Fresno Tons/A	TMY Fresno Boxes/A	TMY Merced Tons/A	TMY Merced Boxes/A	TMY San Joaquin Tons/A	TMY San Joaquin Boxes/A	TMY combined Tons/A	TMY combined Boxes/A	
R1	Monica	40.8	3264	25.9	2070	19.9	1590	29.7	2376	A
R6	PX 739	37.2	2979	25.8	2062	20.3	1628	28.5	2280	A
R4	Mi Rey	38.9	3114	21.6	1731	17.4	1392	26.8	2144	A B
R5	Mi Roma	35.1	2809	24.1	1927	19.3	1544	26.8	2144	A B
R3	SD257	32.6	2608	19.7	1578	19.7	1579	24.4	1952	B
R2	BSS 526	21.9	1750	13.7	1094	8.0	640	15.1	1208	C
	Average	34.4	2754	21.8	1744	17.4	1395	25.2	2016	
	LSD 0.05	6.6	525	4.2	336	6.0	477	3.1	246	
	CV %	12.7	12.7	12.8	12.8	18.8	18.8	14.2	14.2	
	VAR X LOCATION LSD @ 0.05 (Between Merced and Fresno)							NS	NS	
	VAR X LOCATION LSD @ 0.05 (Between SJC and Merced or Fresno)							NS	NS	

Market yield = S + M + L + XL size fruit, average of four replications. One box = 25 lbs.
LSD 0.05 = least significant difference at the 95% probablility level.
Var x Location LSD = least significant difference between the same variety at different locations.
NS = not significant at the 95% probability level.
CV = coefficient of variation, a measure of the variability in the experiment.

Research Update: Weed Control Evaluations in Peppers, 2006

Michelle Le Strange, Farm Advisor, Tulare& Kings Counties

Peppers are long-season vegetables that have several weed control challenges: They compete weakly with weeds for the first 40 to 60 days following transplanting. They are a long-season crop in many production districts that can be subject to flushes of both winter and summer weeds over the course of their growing cycle. The preemergence herbicides registered for peppers have gaps in the spectrum of weeds that they control. As a result, growers may spend from $200 to $350/acre on weed management. Field selection, field sanitation, cultivation and the use of plastic mulches are cultural practices that reduce weed pressure in production fields. Devrinol, Prefar and Treflan are registered preemergence herbicides in peppers. Dual Magnum is registered under a 24C and provides good control of hairy nightshade (*Solanum sarrachoides*) and yellow nutsedge *(Cyperus esculentus)* which are not controlled by the other preemergent materials. However, late season weed control is also an important issue in this crop. The objective of this study was to examine at transplant (Goal Tender 4F, Dual Magnum, and Outlook) and layby (Dacthal – standard, Dual Magnum, and Outlook) herbicides. Postemergence evaluations of Sandea and V-10142 (Valent Corp.) were also evaluated.

Field Trial Methods: The 2006 field trial was conducted on a Panoche clay loam soil at the UC West Side Research and Extension Center (WSREC) near Five Points in Fresno County. On April 27, the bell pepper variety "Baron" was transplanted in single rows into 40" beds. Within row plant spacing was 10". Plot size was two 40-inch beds x 70 feet of row length and replicated 4 times in a Randomized Complete Block Design. All herbicide applications were applied to the entire plot with a CO_2 backpack sprayer at 30 psi and XR 8003evs Teejet nozzle tips mounted on a two nozzle boom with a water volume of 30 gallons per acre.

- Preplant applications of Goal Tender were made onto shaped beds on April 18, 9 days prior to transplanting the peppers.
- The at-planting treatments of Dual Magnum were applied two different ways: as a directed spray post transplant and over-the-top post transplant.
- Outlook was applied pre-transplant one hour in advance of planting the peppers.

The field was sprinkler irrigated applying 0.50 inch of water immediately following transplanting. Sprinkler irrigation continued as needed for a few weeks and then switched to furrow irrigation. On May 31 the whole field was hand weeded and machine cultivated. On June 5 the layby applications of the preemergence herbicides (Dacthal, Dual, and Outlook) were made as directed sprays to the base of the plants. Sandea, Staple, and V-10142 were applied 15 days later as directed sprays and evaluated as postemergence herbicides. Either a non-ionic surfactant or a crop oil concentrate was used with these products. The experiment included an untreated check. Weed pressure in the field (especially purslane) was substantial throughout the entire season.

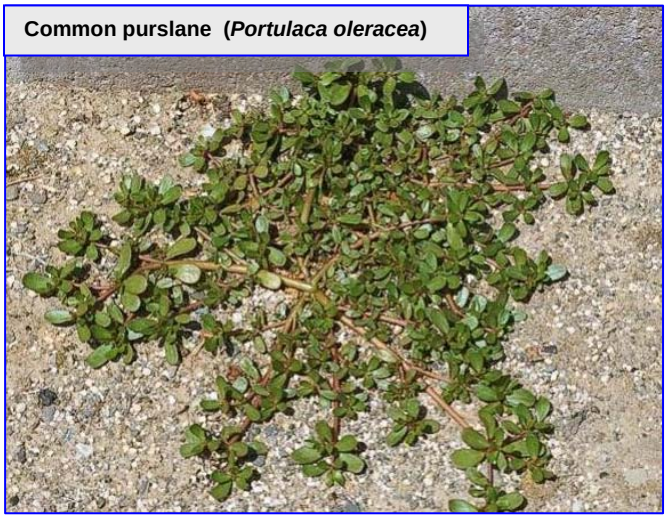
Plots were evaluated for phytotoxicity to the peppers and weed control on May 26 (30 Days after transplanting [DAT]), July 13 (78 DAT), and August 3 (99 DAT). Throughout the season the pepper stand was very uniform and did not appear to be affected by the herbicide applications, so stand counts were not collected. A portion of each plot (25' row) was hand harvested on August 3 (west bed only).

RESULTS

Untreated plots rapidly became were very weedy. At layby weeds were removed but new seedlings continued to germinate. Particularly troublesome this year was purslane, but there was also substantial pressure from black and hairy nightshade, tumble and redroot pigweeds, nutsedge and barnyardgrass. Lambsquarters, groundcherry, puncturevine, and sowthistle were also present, but were not as uniformly distributed throughout the field. The purslane sawfly built up substantial populations after layby and was able to reduce some of the leaf surface area of the purslane, however substantial weed competition had already occurred. Towards the end of the season pepper plants in the untreated plots were yellower, weaker, and stunted compared to plants where herbicide applications were made; this result was listed in the category of phytotoxicity rating even though no chemical application was made. At harvest there was no phytotoxicity result from herbicide applications (data not shown).

Planting to layby results: At planting **Dual Magnum** was applied as a directed spray post transplant and an over-the-top post transplant spray, then again at layby. Weed control of nightshades, nutsedge and grasses was excellent at layby. A few pigweed and purslane plants and an occasional punturevine were observed in the plots. There was no crop phytotoxicity that was potentially damaging.

Goal Tender is labeled for application 30 days prior to transplanting with soil incorporation prior to transplanting. Applications at 30, and 15 days ahead of transplanting have been previously tested with no phytotoxicity problems. In 2006 Goal Tender applied 9 days with no soil cultivation prior to transplanting showed some pepper phytotoxicity for about 6 weeks after planting, but there was no crop symptoms at harvest and crop yields were not affected. Weed control (up to layby) of all broadleaves and grasses was excellent with the exception of nutsedge, which was not controlled. Goal Tender was not applied as a layby application.



Common purslane (*Portulaca oleracea*)

Outlook was applied pre transplant over the entire bed top and at layby as a directed spray to the base of the peppers. No crop phytotoxicity was observed with these applications. Broadleaf weed control was very good, but not excellent with this application method. There were high amounts of purslane within the plant row. Grass and nutsedge control was excellent. Yields were equal to those plots receiving Dual and Goal applications.

Layby to harvest results: Dacthal, Dual and Magnum were applied or reapplied at layby. Final weed control ratings at layby indicated that all products provided excellent weed control with no effect on yield or crop phytotoxicity. Sandea, Staple, and V-10142 were also included, but were not the major emphasis of this project. We were however, curious about investigating V-10142.

V-10142 - is a new Valent product for which we are still looking for a fit in peppers. It was tried as a postemergence application at layby, where we saw some temporary crop phytotoxicity. We may be interested in testing it as a preemergence application next season. Pepper yields were lower with this product, mainly because the weeds were not controlled and because weed control prior to layby was not as weed-free as is customary under commercial production.

Summary: The utility of Dual Magnum 7.62, Goal Tender 4F, and Outlook 6.0 herbicides applied preplant, at plant, and at layby were evaluated in transplanted bell peppers. All at-planting and layby applications of these preemergent herbicides were very effective in providing excellent weed control with little crop phytotoxicity, certainly nothing that affected pepper yield. Post-emergence applications of several other herbicides ten days after layby were less effective and need further evaluations.

Table 1. 2006 Herbicide Study in Peppers, WSREC. Weed control, Phytotoxicity ratings, and Pepper yield.

					May 20 (24 DAT)				July 13 (78 DAT)		August 3 (99 DAT)	
	Translant		Layby		Control Ratings[6]			Phyto	Purse	Phyto	Brdlf	Peppers
Code	Application*	Lbs ai/A	Application[5]	Lbs ai/A	Brdlf	Grass	Sedge	Rating[7]	Control	Rating	Control	Lbs/plot
1	Dual Magnum 7.62[1]	1.43	Dacthal 75W	7.00	8.6 c	10.0	10.0	0.5	9.0 a	0.0	9.1 a	40.1 abcd
2	Dual Magnum 7.62[2]	1.43	Dual Magnum 7.62	1.43	9.5 b	10.0	9.5	0.0	9.4 a	0.0	9.7 a	53.4 a
3	Dual Magnum 7.62[2]	1.43	Outlook 6.0	0.60	9.5 ab	10.0	10.0	0.4	9.1 a	0.1	9.6 a	48.9 a
4	Goal Tender 4F[3]	0.50	Dual Magnum 7.62	1.43	9.9 ab	9.9	1.0	6.3	9.7 a	0.0	9.1 a	46.1 abc
5	Goal Tender 4F[3]	0.50	Outlook 6.0	0.60	9.9 a	10.0	1.0	6.0	9.5 a	0.0	8.6 a	45.9 abc
6	Outlook 6.0[4]	0.60	Dual Magnum 7.62	1.43	7.9 d	10.0	9.5	0.5	8.9 a	0.0	8.6 a	47.3 ab
7	Outlook 6.0[4]	0.60	Outlook 6.0	0.60	7.5 d	10.0	9.8	0.0	9.0 a	0.0	8.6 a	43.8 abc
8	---	---	Sandea + NIS	0.047 + 0.25%					3.0 cd	1.8	6.1 c	34.9 bcde
9	---	---	V-10142 FL + COC	0.15 + 1.0%					3.5 c	1.0	7.1 bc	24.9 e
10	---	---	V-10142 FL + COC	0.30 + 1.0%					3.3 cd	1.0	7.4 b	32.6 cde
11	---	---	V-10142 WD + COC	0.15 + 1.0%					2.5 d	1.1	6.3 bc	29.8 de
12	---	---	V-10142 WD + COC	0.30 + 1.0%					3.8 c	1.0	7.0 bc	28.4 de
13	---	---	Staple (pyrithiobac) + NIS	0.15 + 1.0%					7.8 b	0.6	8.6 a	32.7 cde
14	**Untreated**	---	**Untreated**	---	1.0	1.0	1.0	1.0	1.0 e	2.3	4.0 d	24.7 e
	LSD (0.05)				0.46	0.05	0.73	1.06	0.86	0.98	1.22	13.62

* types of application sprays differed with product and are outlined below

1 - applied as directed spray post transplant; 2 - applied over-the-top post transpalnt; 3 - applied 9 days prior to transplanting to shaped beds; 4 - applied pre-transplant;

5 - all layby applications were post directed sprays; 6 - weed control ratings (1=no control; 10=very good control; 7 - phytotoxicity ratings (1 = no injury; 10 = dead pepper plants)

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 Counties

Michelle Le Strange, Farm Advisor

Newsletter Volume 3, Issue #1

March 2007

Tomato & Pepper Research Progress Reports

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