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Vegetable Crop Facts

Merced and Madera Counties

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Evolution & Implications of Process Tomato Seed Pricing

Mike Murray, Farm Advisor, Colusa, Sutter & Yuba Counties

Trends for processing tomato seed

<1980

- Predominantly open pollinated varieties
- Seed sold by weight
- Essentially no transplanting
- "Typical seeding rates" of 3/4 - 1 #/acre
- "Typical" OP seed costs of $20-25/lb
- UC was in the tomato breeding business

1980-1990

- Shift toward hybrid varieties
- Shift to selling seed by the number
- Increased cost for hybrid seed
- Interest & limited activity in transplanting
- UC exits as a supplier of finished varieties

1990-2005

- Total movement to hybrids
- Transplanting becomes predominant planting option
- Volume of seed sold decreases dramatically
- "Typical seed costs" are $300-$400/100,000 seeds

2006

- Differential seed pricing adopted
- Transplanting expected to increase in popularity
- Seed for direct seeding remains at 2005 prices
- Seed for transplanting increases to $850 - $950/100,000 seeds

What is driving increased seed costs?

- Higher energy costs & increased prices for energy-dependent cropping inputs
- More competition
- Relatively short life for the "typical variety"
- Less volume of seed sold
- Seed company overhead costs
- Bottom-Line: Economics 1A

Here's How it works

- Start with high-quality seed (B grade=90%+ germ)
- Identify another variety of similar size and/or density
- Kill that seed (typically through heat and/or humidity)
- Mix the two varieties in a ratio of 75% high-quality and 25% dead seed
- The buyer only pays for viable seed (i.e. the seed price is $3.25/1000 for 75% viable seed. The purchase price per 1000 viable seeds is $3.25. The actual cost per 1000 seeds of blended product is $2.44).

What's Available in 2006?

A survey of nine major seed providers, representing most varieties grown, suggests there will be 18 lines available as *either* blended or transplant quality seed. An additional 10 will be available as *transplant only*. Remaining lines are available as *direct-seeded only.*

Many early maturity lines are only available as direct-seed. *Many* mid- or late maturity lines are only available as transplant quality. Varieties that go either way, or are on the border of early/mid, are the ones with *either* blended or transplant quality available. The pricing for direct-seed or blended products is likely *to be the same, on a 1000 live-seed basis.*

Top 10 Processing Tomatoes Grown in CA in Selected Years

2004			1999			1994		
Variety	Loads	%	Variety	Loads	%	Variety	Loads	%
H9780	44,000	9.8	3155	116,000	25.2	3155	90,000	20.9
3155	35,500	7.9	H8892	75,000	16.4	Brigade	48,000	11.2
Hypeel 303	30,500	6.8	H9665	20,000	4.4	H8892	32,000	7.5
AB2	29,000	6.5	Hypeel 108	19,000	4.1	Nema 512	22,000	5.2
Nema 113	27,000	6.0	H9492	16,000	3.5	H3044	15,000	3.5
APT410	27,000	6.6	H9557	14,000	3.1	Apex 1000	13,000	3.0
H9557	27,000	6.0	Sun6117	13,000	2.9	La Rossa	12,000	2.8
CSD179	23,000	5.2	H9553	13,000	2.9	Peelmech	11,000	2.6
H9663	21,000	4.7	Hypeel 45	11,000	2.5	CXD 152	9,000	2.0
H9665	21,000	4.6	CXD 179	11,000	2.4	E6203	7,900	1.8
Total		**64**			**67**			**60**
Rest of Varieties		36			33			40

Calculated Seed Costs

<u>2006 assumptions:</u>

- direct-seeding rate of 50,000 seeds/acre
- transplant rate of 7,500 seeds/acre
- direct seed cost is $3.50/1000 viable seeds or $2.63/1000 blended seeds (75/25 blend)
- transplant seed is $9.00/1000 seeds

Cost for direct-seed: 50 x $2.63 = ***$131.50***
Cost for transplant seed: 7.5 x $9.00 = ***$67.50***

The Rest of the Story: Getting the Seed in the Ground

<u>2006 assumptions</u>:

- cost to direct-seed acre of tomatoes is $11.50 *(approximation from 2001 UC cost study)*
- cost to grow transplants is $26/1000 plants *(discussion with greenhouses)*
- cost to transplant is $17/1000 plants *(discussion with greenhouses)*

<u>TOTAL COSTS</u>

Direct seeding = $143.00/acre
($131.50 for seed + $11.50 for planting)

Transplanting = $390.00/acre
($67.50 for seed + 195.00 for growing transplants +$127.50 for planting costs)

A DIFFERENCE OF **$247.00/acre**

Controversy over Production Costs: Stand Establishment at 3 levels

<u>my total growing costs are $1700/acre:</u>
direct seeding is 11%, transplanting is 23% of total

<u>my total growing costs are $2000/acre:</u>
direct-seeding is 9%, transplanting is 20% of total

<u>my total growing costs are $2300/acre:</u>
direct-seeding is 8%, transplanting is 17% of total

How Can We Minimize Planting Costs?

- Go back to open-pollinated varieties *(unlikely)*
- Use more direct-seeding & less transplanting *(bucks the trend)*
- Lower seeding rates *(maybe)*
- Improve transplant technology/efficiency; lower costs *(maybe)*
- Lower seed company expenses through reduced R & D staff, using modern breeding techniques *(genetic engineering, etc.)*

Tomato Seed Business No Different from Any Business

- If your total operating costs are higher than your total income, you lose money.
- If you do this often enough, you go out of business.

Seed Company Options

- Increase volume sold *(unlikely)*
- Reduce overhead costs *(possibly)*
- Increase price received for product *(being implemented)*

Implications for the Greenhouses

- Less transplants grown "on speculation". Make sure you cover your entire needs!
- Greenhouse capacities may be stretched at peak delivery times. Make sure you cover your needs early!
- Double-planted cells still an option, but some greenhouse resistance or concerns. If you double-cell, check with your transplant supplier early to confirm availability/cost.

Bottom-Line

- The issue is not increased seed costs for transplanting. It is actually less than direct-seeding. The issue is the cost of technology to put the seed/transplant in the ground. It raises the question "are the benefits realized by transplanting worth the additional cost"?
- In some ways, direct-seeding costs may be viewed as being "subsidized" by transplant seed pricing. This benefits the entire industry by maximizing the length of the growing season and the processing season.
- Given likely trends, stand establishment is going to be a higher percentage of the total growing costs
- Little short- to medium-term relief seen.

Multiple Plants per Transplant Plug: Is there a benefit?

Gene Miyao, Michelle Le Strange and Mike Murray,
Farm Advisors, Yolo/Solano/Sacramento, Tulare/Kings/Fresno, and Colusa/Sutter/Yuba, respectively

Processing tomato growers have long understood that a desirable target for a direct seeding stand is multiple plants in a clump. Field studies have consistently demonstrated yield increases with multiple plants over single-plant configured stands. Even as seeding equipment became capable of sowing a single seed in a drop, planting multiple seed units per drop remained the norm. Hand weeding and thinning crews were instructed to leave multiple plants rather than thinning to a single plant as a less costly, more productive practice.

As transplanting became popular for establishing a stand of canning tomatoes, the greenhouse-seeding target became a single seed per plug.

While the industry examined multiple plants per cell, the practice did not become the norm. In 2002, a field test in Colusa County was initiated to examine the benefit of multiple plants per plug. In 2004, testing at Fresno's Westside was designed to evaluate the purported benefit of higher plant populations in discouraging beet leafhopper transmission of the curly top virus. The Fresno tests were the most elaborate to include spatial arrangements between plugs within the plant line. Viral disease never materialized and thus did not confound the reported results. Plug population density studies were also conducted in Yolo County. In general, the populations in our tests mimicked commercial rates around 7,000 to 7,500 plugs per acre.

The earliest study demonstrated substantial yield gains of 10 to 15% by increasing to 2 or 3 plants per plug (Table 1). In this Colusa trial, 52.2 tons per acre was the baseline with single plants. As further tests were conducted, the results were both encouraging and substantial at times. However, the results were also very mixed, both within and well as among locations. The results are not consistent with any particular variety as well.

At present, given the highly variable results, no recommendation is being made on the benefit of multiple plants per plug. There has also not been any pattern of influence on any particular fruit quality parameter.

Our plans are to continue the evaluations into 2006. Funding support has been provided by the California Tomato Research Institute for many of the tests.

Table 1. UC Farm Advisor Trials. Plants per plug comparisons, 2002-2005

				Plants per plug			Statistical significance
	Location	**Year**	**Variety**	**single**	**double**	**triple**	**at 0.05**
1	Colusa	2002	H 9492	52.2	57.0	59.9	yes
2	Colusa	2002-04	multiple	35.0	38.5	38.7	maybe
3	Colusa	2003 T3	H 9492	29.6	32.9	35.1	85%*
4	Colusa	2003 T3	Halley	26.6	31.7	27.9	NS
5	Fresno	2004 T1	Halley	22.5	28.6	28.3	yes
6	Fresno	2004 T1	AB 2	20.9	25.2	26.4	yes
7	Fresno	2005 T2	Halley	43.0	41.8	39.7	No
8	Fresno	2005 T2	AB 2	44.1	49.8	49.1	yes
9	Yolo	2003 T1	H 9492	32.4	33.9	-	No
10	Yolo	2003 T1	Halley	30.8	31.0	-	No
11	Yolo	2003 T2	AB 2	55.2	52.5	-	No
12	Yolo	2003 T2	AB 5	53.4	54.0	-	No
13	Yolo	2005 T3	Halley	46.4	45.0	-	No
14	Yolo	2005 T3	AB 2	43.2	45.0	-	No
	AVERAGE	**2002-05**	**various**	**38.2**	**40.5**	**38.1**	**mixed**

* 85% confidence level

Statewide Processing Tomato Variety Trials - Fresno County Results - 2005

Michelle Le Strange, Farm Advisor, Tulare and Kings Counties

Five early and 5 mid-season variety evaluation tests were conducted throughout the major processing tomato production regions of California during the 2005 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.

As in the past, both replicated and observational lines were evaluated. These tests are designed and conducted with input from seed companies, processors, and other allied industry and are intended to generate information useful for making intelligent 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 in one-bed wide by 100 foot long plots (Fresno used 65 and 86 foot long plots). Plot design was randomized complete block with four replications for the replicated trial. 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. 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.

Results: *A complete research report will be found at the VRIC website www.vric.ucdavis.edu. Click on Vegetable Information, Choose Tomato as the crop, scroll down to other and click on 2005 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.*

EARLY Season Processing Tomato Variety Trial - FRESNO County

Seeded & Irrigated: February 14, 2005
Emergence: March 1, 2005
Plot Size: One 66-inch bed x 65' row; 1 seed row
Irrigation Cutoff: June 17, 2005
Machine Harvest: July 19, 2005

Table 1: SINGLE row per bed

Code	VARIETY	Yield Tons/A		Brix %	Brix Yield	PTAB Color	pH	% green	% rot + sunburn	lbs per 50 fruit
3	**H 5003**	48.0 (01)	A	5.9 (01)	2.83 (01)	22.3 (01)	4.35 (06)	3.5	13.7	7.1
5	**H 9997**	45.5 (02)	A B	5.1 (09)	2.30 (03)	23.5 (05)	4.40 (09)	5.6	19.3	8.8
6	**U 250**	43.9 (03)	B C	5.1 (09)	2.22 (04)	26.5 (11)	4.37 (07)	2.6	20.1	9.7
11	**BOS 66508**	41.1 (04)	C D	5.7 (03)	2.34 (02)	23.0 (03)	4.32 (03)	4.5	13.3	8.9
2	**HMX 2853**	38.4 (05)	D E	5.2 (07)	2.00 (09)	24.0 (07)	4.42 (10)	3.2	25.6	9.1
7	**U 446**	37.7 (06)	E	5.5 (06)	2.05 (06)	23.0 (03)	4.38 (08)	4.9	13.2	11.0
8	**HyPeel 45**	37.4 (07)	E	5.8 (02)	2.18 (05)	24.0 (07)	4.29 (01)	3.6	24.1	9.6
4	**H 9280**	37.3 (08)	E	4.9 (11)	1.82 (10)	24.3 (09)	4.33 (04)	3.9	22.7	9.3
1	**APT 410**	36.7 (09)	E	5.6 (04)	2.05 (07)	23.8 (06)	4.35 (05)	3.1	16.7	8.8
9	**PX 740**	36.4 (10)	E	5.6 (05)	2.02 (08)	24.3 (09)	4.30 (02)	3.9	22.0	8.8
10	**HA 3523**	35.2 (11)	E	5.1 (08)	1.79 (11)	22.5 (02)	4.45 (11)	3.3	19.5	9.2
	AVERAGE	**39.8**		**5.4**	**2.14**	**23.7**	**4.36**	**3.8**	**19.1**	**9.1**
	LSD @ 5%	3.2		0.2	0.19	1.3	0.06	NS	NS	
	C.V. %	5.6		3.1	6.2	3.9	1.0	46.4	35.6	8.4

Table 2: DOUBLE row per bed

Code	VARIETY	Yield Tons/A		Brix %	Brix Yield	PTAB Color	pH	% green	% rot + sunburn	lbs per 50 fruit
5	**H 9997**	44.7 (01)	A	5.0 (08)	2.25 (02)	23.3 (06)	4.40 (10)	2.1	21.5	8.5
3	**H 5003**	44.6 (02)	A	5.7 (02)	2.54 (01)	23.0 (04)	4.36 (07)	3.6	18.0	7.1
6	**U 250**	39.3 (03)	B	4.9 (10)	1.91 (07)	25.3 (11)	4.31 (04)	2.4	15.9	9.2
2	**HMX 2853**	38.4 (04)	B C	5.0 (09)	1.90 (08)	24.8 (10)	4.39 (09)	4.4	26.6	8.6
11	**BOS 66508**	37.9 (05)	B C	5.6 (03)	2.16 (03)	22.3 (01)	4.28 (02)	8.0	14.3	8.7
1	**APT 410**	37.7 (06)	B C	5.2 (05)	1.95 (05)	23.0 (05)	4.36 (06)	3.6	20.1	8.4
8	**HyPeel 45**	37.0 (07)	B C D	5.8 (01)	2.14 (04)	24.3 (08)	4.27 (01)	3.1	23.6	9.0
7	**U 446**	36.5 (08)	B C D E	5.3 (04)	1.94 (06)	22.8 (03)	4.38 (08)	4.2	17.6	10.2
4	**H 9280**	35.1 (09)	C D E	4.7 (11)	1.65 (10)	24.0 (07)	4.34 (05)	3.3	17.9	8.7
9	**PX 740**	33.5 (10)	D E	5.2 (05)	1.73 (09)	24.3 (08)	4.29 (03)	2.6	19.0	8.5
10	**HA 3523**	32.5 (11)	E	5.1 (07)	1.65 (11)	22.5 (02)	4.41 (11)	4.2	27.9	9.0
	AVERAGE	**37.9**		**5.2**	**1.98**	**23.6**	**4.35**	**3.8**	**20.2**	**8.7**
	LSD @ 5%	4.1		0.3	0.23	1.0	0.06	NS	NS	
	C.V. %	7.5		3.8	8.0	2.9	1.0	69.1	33.1	9.1

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

Seeded: March 15, 2005 — Cutoff: July 22, 2005
Irrigated: March 18th — Harvested: August 19, 2005
Emergence: April 8, 2005 — Plot Size: One 66-inch bed x 86' row

Code	VARIETY	Yield Tons/A		Brix %	Brix Yield	PTAB Color	pH
5	**PX 345**	61.4 (01)	A	5.1 (10)	3.11 (02)	28.5 (16)	4.40 (05)
7	**H 9665**	60.2 (02)	A B	4.7 (16)	2.83 (11)	26.8 (15)	4.42 (06)
3	**U 232**	60.1 (03)	A B C	5.0 (12)	3.02 (05)	26.3 (12)	4.45 (08)
12	**U 005**	58.0 (04)	A B C D	5.1 (09)	2.97 (07)	26.0 (11)	4.39 (04)
11	**H 2401**	57.3 (05)	A B C D	5.2 (07)	2.97 (06)	26.5 (13)	4.35 (02)
2	**Sun 6366**	57.1 (06)	A B C D	5.5 (05)	3.15 (01)	24.8 (04)	4.47 (12)
6	**H 5803**	56.6 (07)	A B C D	5.5 (06)	3.08 (04)	25.5 (09)	4.45 (09)
9	**H 8892**	56.2 (08)	A B C D	5.2 (08)	2.89 (10)	25.3 (07)	4.42 (07)
13	**H 2601**	55.4 (09)	A B C D E	4.9 (14)	2.71 (13)	26.5 (13)	4.47 (11)
15	**Sun 6360**	54.2 (10)	B C D E	4.9 (13)	2.67 (15)	25.0 (06)	4.48 (13)
16	**Sun 6368**	54.1 (11)	B C D E	5.7 (02)	3.09 (03)	25.8 (10)	4.46 (10)
14	**Red Spring**	53.5 (12)	B C D E	5.1 (11)	2.70 (14)	23.8 (02)	4.55 (16)
8	**UG 151**	53.3 (13)	C D E	4.7 (15)	2.51 (16)	24.3 (03)	4.54 (14)
10	**Halley 3155**	52.9 (14)	D E	5.6 (04)	2.97 (09)	23.8 (01)	4.37 (03)
4	**HMX 3859**	52.5 (15)	D E	5.7 (03)	2.97 (08)	25.3 (07)	4.54 (14)
1	**AB 2**	48.7 (16)	E	5.8 (01)	2.82 (12)	25.0 (05)	4.34 (01)
	AVERAGE	**55.7**		**5.2**	**2.90**	**25.5**	**4.44**
	LSD @ 5%	6.9		0.4	N.S.	1.6	0.06
	C.V. %	8.6		5.3	9.2	4.4	1.0

Evaluation of EFS Varieties over Time of Harvest

Michelle Le Strange, Farm Advisor, Tulare and Kings Counties

SUMMARY: **Three sequential late-season field plantings of 10 Extended Field Storage (EFS) processing tomato varieties included multiple mechanical harvests to measure effects of delayed harvest on yield and fruit quality. Planting dates were arranged so that the second harvest coincided with the first harvest of the successive planting. This planting and harvest arrangement supplied information on variety performance over a range of time and temperature. The first two plantings set fruit under "normal" temperatures, but the third planting experienced "hotter than normal" temperatures during flowering and fruit set, which had a detrimental effect on yield. Overall average yield decreased by more than 5 tons/acre with each successive planting date. Average yields decreased with each successive harvest of the first two plantings, but not all varieties had a similar response. The third planting experienced a yield gain when harvested a week later, which was attributed to delayed ripening of green fruit. It was observed that the second harvest of the second planting outyielded the first harvest of the third planting by 6.9 tons. This result suggests a benefit of planting earlier to maximize fruit set during favorable temperatures and holding the fruit in the field rather than planting later, especially with some varieties. Samples were collected and sent to PTAB and the UC Davis Food Science Department's laboratory for raw product analysis of soluble solids (°Brix), pH, and color. The UC lab also evaluated cooked samples and lycopene content. Of these parameters pH may be the limiting factor for extended field storage.**

Overview: **Certain processing tomato varieties are bred for Extended Field Storage (EFS). Some are included in UC statewide variety trials, however that harvest protocol does not evaluate a variety's potential for EFS. It is well documented that yields of processing tomatoes decrease during periods when high-sustained air temperatures occur and disrupt fruit set. Perhaps some EFS varieties can set fruit well in heat and/or store well in the field?**

Procedures: Three experiments were established at UC WSREC in Fresno County. Seed companies supplied the EFS varieties they wanted to test. AB2 & Halley 3155 were grown as standards. The experiments were direct seeded on April 12, April 27, and May 17, 2005 and grown with typical commercial practices under furrow irrigation. Plot size was 45' of row on a 66" tomato bed. The trial was arranged in a split plot design for three separate harvest dates. Each variety was replicated four times within each harvest date. Experiments 1, 2, and 3 were grown side by side and were physically located in the same field.

Plots were machine harvested for yield by a commercial crew and samples collected to separate green, sunburn, and rotten fruit. Rotten fruit included broken and soft fruit and results may be inflated due to stricter than normal PTAB grading standards. Yields may slightly overestimate actual yield of sound red fruit, but PTAB reports on Limited Use fruit from harvested loads were never higher than 5% and more commonly averaged 1.5-3%. Representative samples from each plot were collected for PTAB quality determinations and for cooked analysis at the Food Science (Diane Barrett's) laboratory at UC Davis.

Results: It was observed that overall average yield decreased more than 5 T/A with each successive planting date. Average yields decreased with each successive harvest within the April planting dates but increased within the May date, which was attributed to a split fruit set and corroborated with a decrease in % green fruit. In the first two plantings the varieties did not perform the same across harvest dates (see variety results tables). In the earliest planting a couple of varieties increased in yield across harvests (H8504 and PS 345); several varieties remained fairly constant (U37, Hypeel 849, Sun 6368, and Halley 3155); a few varieties held through two harvests, but then dropped significantly (H9780, H9997, AB2, Sun 6374, U886; and one variety dropped significantly in yield at each harvest (U567). In the second planting yields of the majority of varieties decreased with each successive harvest. A few exceptions were H8504 which continued to increase or hold steady in yield; PS 2334 held steady for two harvests and then decreased significantly and AB2 and U567 experienced significant yield loss with each successive harvest. In the third planting although varieties did not perform the same between the two harvests, variability was too great to detect statistical significance Though yields are not exceptional in the first harvest, it appears that H9997, Sun 6368, and U886 had some ability to set fruit during the heat.

PTAB °Brix - It was observed that the average °brix (soluble solids) over combined varieties decreased with each planting date (5.44, 5.32, and 5.27). The overall trend was a decrease in °brix with successive harvests within a planting date, but this trend was not always statistically significant. The earliest planting showed the biggest drop between harvests (5.63, 5.40, and 5.29). Big differences were seen among varieties. The majority had slightly decreased soluble solids levels with date of planting and extended field storage. There were a few exceptions: in all plantings U886 increased (or held steady) with successive harvests; in the second planting several varieties also increased in soluble solids over time of harvest: U567, PS 345, H8504, and H9997. Variety rankings stayed fairly consistent between planting dates. Sun 6374, Sun 6468, AB2, H9780, and Halley 3155 consistently ranked at the top, while H9997, U37, and PS 345 were usually near the bottom.

Varieties

1) Halley 3155*	5) Hypeel 849	9) U 37
2) H 8504	6) PS 345	10) U 567
3) H 9780	7) Sun 6368	11) U 886
4) H 9997	8) Sun 6374	12) AB2*

* standard varieties, not EFS lines

Expt #	Planted (seeded)	Irrigation cutoff	Harvest #1	Harvest #2*	Harvest #3**
1	April 12	July 22	Aug 29 (139 DAS)	Sept 12	Sept 19
2	April 27	Aug 5	Sept 12 (138 DAS)	Sept 26	Oct 3
3	May 17	Aug 22	Sept 26 (132 DAS)	Oct 3***	---

* 14 days after Harvest #1 ** 21 days after Harvest #1 *** only 7 days after Harvest #1

Yield (T/A) by Harvest Date

Planting Date	Aug 29	Sept 12	Sept 19	Sept 26	Oct 3	Total Yield
April 12	38.0	36.8	33.7			**36.2 T/A**
April 27		33.2		28.2	24.9	**28.7 T/A**
May 17				21.3	23.5	**22.4 T/A**

Lab °Brix - *This measures refractive index, which picks up not only soluble solids, but also organic and amino acids. A value greater than 5.0 is desirable.* Lab results (data not shown) were nearly identical to PTAB results with the same trends, i.e. variety rankings changed little between plantings and in the earliest and latest planting °brix slightly decreased with successive harvests. Also varietal differences were readily apparent and °brix decreased with each successive harvest for the majority of varieties.

PTAB pH – *Industry prefers a pH of 4.3 and less than 4.6 is needed to prevent growth of Clostridium botulinum bacteria.* No trend was observed between planting dates: average pH over combined varieties was similar (4.43, 4.49, and 4.42). In the first and second plantings pH tended to increase by one tenth (0.10) in the second harvest and remain steady in the third harvest. Varieties performed similarly over harvest dates, but there were differences between varieties. H8504 had the lowest pH and H9997 had the highest pH on average in the first two plantings, but in the third planting their rankings were mixed with others.

Lab pH – Lab results were typically higher by one to two tenths (0.10-0.20), than PTAB results, but trends were the same: the average pH over combined varieties was 4.59, 4.60, and 4.56. The pH tended to increase with each next harvest within a plant date and some varieties reached undesirable levels. AB2 and H8504 had the lowest pH.

PTAB Color & Cooked Color – *PTAB uses one method and the Lab uses this plus a second method for color evaluation.* PTAB values ranged between 23.2 to 25.7 over all varieties over all planting dates and tended to be slightly less red (the color values increased) with successive harvests within a planting date. Using the USDA color determination, varieties performed consistently between plantings and all varieties fell within an acceptable range of 49.0 to 52.1 for all readings. H9997 was consistently the reddest variety; PS 345 was often least red (data not shown).

Conclusions: The goal of this research project was to evaluate performance of EFS varieties over length of time in the field and to observe differences between planting dates. The grower's main interest would be tonnage, rotten fruit, and soluble solids (°Brix). A processor's interest would be solid red fruit with low pH and high soluble solids. Under the growing conditions of 2005 a later harvest of an earlier planting yielded more tonnage than an earlier harvest in a later planting date. Tonnage and rotten fruit changed significantly over time, whereas soluble solids (°Brix), though they decreased slightly, were fairly stable. In general PTAB pH was very similar at each planting date and tended to increase by one tenth (0.10) with each successive harvest. Green fruit at harvest helped lower pH of the third planting. Lab pH showed similar trends, however pH values were higher and some varieties reached undesirable levels (>4.6) with extended field storage. Better performing varieties for each planting date can be selected from the results tables. None of the varieties were exceptional in setting fruit under hot temperatures, but a few performed better than the majority of others.
A complete report is available on-line at: http://cetulare.ucdavis.edu/Vegetable_Crops or from the UCCE Tulare County office.

		Yield Tons/A				% Rots				PTAB °BRIX				PTAB pH				Cooked LAB pH			
EXPT. 1 Seeded April 12, 2005						**Harvest 1: AUG 29 (139 DAS)**					**Harvest 2: SEPT 12**					**Harvest 3: SEPT 19**					
#	Variety	H1	H2	H3	AVG	H1	H2	H3	AVG	H1	H2	H3	AVG	H1	H2	H3	AVG	H1	H2	H3	AVG
2	**H 8504**	43.7	44.6	49.5	**45.9**	3.6	2.9	6.1	**4.2**	5.45	5.30	5.18	**5.31**	4.28	4.35	4.42	**4.35**	4.24	4.39	4.53	**4.39**
3	**H 9780**	46.0	43.0	38.4	**42.5**	5.9	5.8	19.3	**10.3**	5.68	5.48	5.45	**5.53**	4.29	4.39	4.50	**4.40**	4.34	4.50	4.76	**4.53**
6	**PS 345**	40.6	38.4	43.9	**41.0**	4.2	7.0	17.5	**9.6**	5.30	5.23	5.18	**5.23**	4.34	4.49	4.51	**4.44**	4.73	4.54	4.68	**4.65**
4	**H 9997**	45.0	40.1	35.5	**40.2**	7.2	7.7	25.2	**13.4**	4.90	4.88	4.70	**4.83**	4.43	4.61	4.61	**4.55**	4.56	4.79	4.93	**4.76**
9	**U 37**	37.3	43.3	36.7	**39.1**	8.0	7.3	11.7	**9.0**	5.33	4.98	5.15	**5.15**	4.34	4.49	4.35	**4.39**	4.51	4.55	4.70	**4.59**
5	**Hypeel 849**	36.3	34.5	38.6	**36.5**	4.7	16.1	14.1	**11.6**	5.78	5.00	5.10	**5.29**	4.34	4.51	4.47	**4.44**	4.65	4.55	4.70	**4.64**
7	**Sun 6368**	33.2	34.2	33.2	**33.5**	7.0	8.7	17.8	**11.2**	6.28	5.98	5.45	**5.90**	4.34	4.41	4.50	**4.42**	4.57	4.49	4.67	**4.58**
12	**AB 2**	35.1	35.0	26.7	**32.3**	10.3	13.5	33.2	**19.0**	5.98	5.78	5.65	**5.80**	4.31	4.41	4.39	**4.37**	4.21	4.43	4.58	**4.41**
8	**Sun 6374**	33.6	34.9	26.1	**31.5**	8.4	13.1	28.4	**16.6**	6.20	6.20	6.13	**6.18**	4.31	4.45	4.57	**4.44**	4.45	4.53	4.70	**4.56**
11	**U 886**	33.6	34.6	25.1	**31.1**	9.3	20.3	32.0	**20.5**	5.38	5.35	5.40	**5.38**	4.42	4.56	4.52	**4.50**	4.38	4.61	4.87	**4.62**
1	**Halley 3155**	32.1	29.8	29.6	**30.5**	8.8	14.4	20.6	**14.6**	6.15	5.65	5.13	**5.64**	4.32	4.42	4.39	**4.38**	4.68	4.48	4.66	**4.61**
10	**U 567**	39.2	29.7	20.9	**29.9**	10.0	32.7	31.4	**24.7**	5.10	5.00	4.95	**5.02**	4.45	4.54	4.59	**4.53**	4.64	4.67	4.84	**4.72**
	average	**38.0**	**36.8**	**33.7**	**36.2**	**7.3**	**12.5**	**21.4**	**13.7**	**5.63**	**5.40**	**5.29**	**5.44**	**4.35**	**4.47**	**4.49**	**4.43**	**4.50**	**4.54**	**4.72**	**4.59**
	LSD 5% (Var)				4.2				4.9				0.22				0.06				0.16
	LSD (Har)		2.08				2.43				0.108				0.031				0.080		
	LSD (Var X Har)	7.2				8.4				0.37				NS				NS			
	CV %				14.3				43.8				4.90				1.69				3.7

		Yield Tons/A				% Rots				PTAB °BRIX				PTAB pH				Cooked LAB pH			
EXPT. 2 Seeded April 27, 2005						**Harvest 1: SEPT 12 (138 DAS)**					**Harvest 2: SEPT 26**					**Harvest 3: OCT 3**					
#	Variety	H1	H2	H3	AVG	H1	H2	H3	AVG	H1	H2	H3	AVG	H1	H2	H3	AVG	H1	H2	H3	AVG
2	**H 8504**	33.2	34.4	36.3	**34.7**	4.7	7.8	21.9	**11.5**	5.03	5.25	5.20	**5.16**	4.29	4.39	4.42	**4.37**	4.36	4.60	4.53	**4.50**
4	**H 9997**	44.0	30.3	28.0	**34.1**	7.6	30.2	49.3	**29.0**	4.83	4.85	4.95	**4.88**	4.51	4.66	4.59	**4.59**	4.63	4.90	4.84	**4.79**
6	**PS 345**	34.6	36.7	26.7	**32.7**	7.9	12.5	38.3	**19.5**	5.18	5.13	5.25	**5.18**	4.41	4.54	4.51	**4.49**	4.46	4.70	4.58	**4.58**
7	**Sun 6368**	36.6	32.2	28.8	**32.5**	6.0	17.5	31.3	**18.3**	5.73	5.75	5.28	**5.58**	4.39	4.51	4.57	**4.49**	4.38	4.67	4.58	**4.54**
9	**U 37**	35.0	29.4	29.9	**31.4**	4.3	10.3	19.1	**11.2**	5.10	5.03	4.98	**5.03**	4.40	4.50	4.49	**4.46**	4.46	4.70	4.59	**4.58**
3	**H 9780**	35.8	31.5	26.2	**31.2**	5.6	12.6	25.4	**14.5**	5.58	5.38	5.45	**5.47**	4.37	4.45	4.46	**4.43**	4.42	4.62	4.55	**4.53**
8	**Sun 6374**	32.7	30.4	27.4	**30.1**	11.0	22.5	31.7	**21.7**	6.05	5.93	5.45	**5.81**	4.42	4.55	4.58	**4.52**	4.46	4.64	4.71	**4.60**
5	**Hypeel 849**	32.1	26.4	23.8	**27.4**	5.3	19.3	38.6	**21.0**	5.20	5.33	5.15	**5.23**	4.46	4.60	4.53	**4.53**	4.50	4.78	4.72	**4.67**
11	**U 886**	30.2	25.3	19.6	**25.0**	15.7	24.2	38.1	**26.0**	5.28	5.30	5.43	**5.33**	4.50	4.59	4.55	**4.55**	4.53	4.80	4.75	**4.70**
1	**Halley 3155**	28.0	24.7	19.8	**24.2**	7.6	26.4	51.8	**28.6**	5.50	5.20	5.23	**5.31**	4.39	4.52	4.47	**4.46**	4.43	4.67	4.55	**4.55**
12	**AB 2**	27.4	16.4	19.8	**21.2**	14.1	34.5	45.7	**31.4**	5.65	5.60	5.55	**5.60**	4.36	4.43	4.49	**4.43**	4.38	4.64	4.47	**4.49**
10	**U 567**	28.5	20.9	12.3	**20.6**	23.5	40.5	50.2	**38.1**	5.00	5.33	5.45	**5.26**	4.53	4.65	4.62	**4.60**	4.62	4.86	4.64	**4.71**
	average	**33.2**	**28.2**	**24.9**	**28.7**	**9.4**	**21.5**	**36.8**	**22.6**	**5.34**	**5.34**	**5.28**	**5.32**	**4.42**	**4.53**	**4.52**	**4.49**	**4.47**	**4.72**	**4.63**	**4.60**
	LSD 5% (Var)				3.2				6.8				0.15				0.04				0.07
	LSD (Har)		1.60				3.41				NS				0.018				0.033		
	LSD (Var X Har)	5.6				NS				0.26				NS				NS			
	CV %				13.8				37.3				3.50				0.94				1.6

		Yield Tons/A				% Rots				PTAB °BRIX				PTAB pH				Cooked LAB pH			
EXPT. 3 Seeded May 17, 2005						**Harvest 1: SEPT 26 (132 DAS)**					**Harvest 2: OCT 3 (only 7 days later)**										
#	Variety	H1	H2		AVG	H1	H2		AVG	H1	H2		AVG	H1	H2	H3	AVG	H1	H2	H3	AVG
4	**H 9997**	28.5	24.9		**26.7**	7.5	16.4		**11.9**	5.03	4.98		**5.00**	4.44	4.50		**4.47**	4.63	4.61		**4.62**
7	**Sun 6368**	24.0	28.6		**26.3**	11.6	11.6		**11.6**	5.63	5.33		**5.48**	4.42	4.38		**4.40**	4.69	4.51		**4.60**
11	**U 886**	25.8	25.2		**25.5**	8.2	15.7		**11.9**	5.33	5.40		**5.36**	4.46	4.45		**4.46**	4.71	4.56		**4.64**
12	**AB 2**	23.1	26.4		**24.8**	10.5	20.1		**15.3**	5.53	5.48		**5.50**	4.39	4.41		**4.40**	4.57	4.45		**4.51**
9	**U 37**	19.0	27.1		**23.1**	10.0	13.2		**11.6**	5.25	4.85		**5.05**	4.40	4.45		**4.43**	4.56	4.51		**4.53**
2	**H 8504**	23.2	20.2		**21.7**	6.9	10.0		**8.4**	5.28	5.05		**5.16**	4.37	4.42		**4.40**	4.53	4.51		**4.52**
6	**PS 345**	19.5	22.4		**20.9**	5.2	8.0		**6.6**	5.10	5.05		**5.08**	4.42	4.36		**4.39**	4.52	4.51		**4.52**
10	**U 567**	16.7	21.1		**20.4**	10.7	14.0		**12.3**	5.20	4.98		**5.09**	4.48	4.49		**4.48**	4.66	4.54		**4.60**
3	**H 9780**	18.1	22.2		**20.2**	5.1	9.4		**7.3**	5.20	5.08		**5.14**	4.39	4.40		**4.39**	4.56	4.46		**4.51**
5	**Hypeel 849**	16.9	23.4		**20.1**	4.2	8.2		**6.2**	5.28	5.18		**5.23**	4.41	4.44		**4.42**	4.61	4.62		**4.62**
8	**Sun 6374**	21.0	18.5		**19.7**	11.1	13.7		**12.4**	5.83	5.75		**5.79**	4.43	4.46		**4.45**	4.63	4.52		**4.58**
1	**Halley 3155**	16.8	21.6		**19.2**	10.4	18.3		**14.4**	5.50	5.28		**5.39**	4.43	4.35		**4.39**	4.51	4.53		**4.52**
	average	**21.3**	**23.5**		**22.4**	**8.4**	**13.2**		**10.8**	**5.34**	**5.20**		**5.27**	**4.42**	**4.43**		**4.42**	**4.60**	**4.53**		**4.56**
	LSD 5% (Var)				4.9				5.6				0.19				0.04				0.10
	LSD (Har)		2.01				2.28			0.079				NS				0.040			
	LSD (Var X Har)	NS				NS				NS				0.06				NS			
	CV %				22.1				51.8				3.68				1.06				1.8

Is Drip Irrigation a Sustainable Practice in the Valley's Salt Affected Soil?

Blaine Hanson, Dept. of Land, Air and Water Resources, UC Davis and Don May, Farm Advisor Emeritus

Many areas in the San Joaquin Valley experience excessive levels of soil salinity due to upward flow of saline, shallow ground water. Drainage of the land is not possible because no economically, technically, and environmentally feasible drain water disposal method has been identified to date for the valley. Thus, the drainage problem must be addressed through other options such as better management of irrigation water to reduce drainage below the root zone; increased crop water use of shallow ground water without yield reductions; and drainage water reuse for irrigation. *One option for improving irrigation water management is to convert from furrow or sprinkler irrigation to drip irrigation.*

Four Field Experiments: Experiments in four commercial fields showed subsurface drip irrigation of processing tomatoes to be highly profitable under shallow saline ground water conditions. Drip lines were buried 8 to 12 inches deep. Over a three-year period, the average yield of three drip-irrigated fields was 40.5 T/A vs. 33.9 T/A under sprinkler irrigation. The average difference in soluble solids between the 2 irrigation methods was not statistically significant.

Drip irrigations occurred every two to three days. Yield was unaffected by the range of soil salinity in these fields. Small-scale randomized replicated plots in the drip-irrigated fields showed yield to decrease with decreasing seasonal water applications, while soluble solids increased as applied water decreased. At one of these sites, depth to the water table was about 6 feet during the crop season, while at the other two sites, water table depth generally ranged between 2 and 3 feet deep. Irrigation water was provided by the Westlands Water District at two sites, while well water was used at the third site. More details about these experiments are in Hanson and May (2003); see reference at end of article.

At the fourth site, a small-scale randomized replicated experiment showed tomato yield to range from 34.6 T/A for 15.6 inches of applied water to 42.8 T/A for 23.2 inches. Daily irrigations occurred here because of high levels of soil salinity due to a very shallow water table. Depth to the water table ranged between 18 and 24 inches during the crop season, which resulted in a saturated saline soil below 12 inches deep. Westlands Water District irrigation water was used at this site.

Soil Salinity: Soil salinity around drip lines was found to depend on the depth to the ground water, salinity of the shallow ground water, salinity of the irrigation water, and amount of applied water. For water table depths of about 6 feet, relatively uniform soil salinity was found around the drip lines **(Fig. 1A).** For water table depths less than about 3 feet, soil salinity varied considerably around drip lines with the smallest levels near the drip line **(Fig. 1B).** The larger the amount of applied water, the larger the volume of low salt soil near the drip line **(Fig. 2).**

Salinity Control: *One component of a sustainable practice is its profitability.* The key to the profitability of drip irrigation of tomatoes in the valley's salt affected soils is salinity control. Salinity control requires leaching or flushing of salts from the root zone by applying irrigation water in excess of the soil moisture depletion. The leaching fraction, defined as the percent of applied water that percolates below the root zone, is used to quantify the amount of leaching. For sprinkler and furrow irrigation, the field-wide leaching fraction historically has been calculated as the difference between the seasonal amount of applied water and the seasonal crop evapotranspiration.

Data from these experiments showed that based on the historical approach to calculating leaching fractions, little or no field-wide leaching occurred. *This raises questions about the sustainability of drip irrigation in these salt affected soils. Yet, considerable localized leaching occurred around the drip lines, as seen in Fig. 1 & 2. This localized leaching appears to be the main contributor to the high yields previously mentioned. Thus, the historical approach to estimating leaching fractions may be inappropriate for drip irrigation.* The localized leaching appears to be the controlling factor, not field-wide leaching. However, it is difficult to estimate the localized leaching fraction under drip irrigation because leaching fraction, soil salinity, soil moisture content, and root density all vary with distance and depth around drip lines.

Recommendations for Successful Drip Irrigation Under Saline Soil Conditions: Based on these experiments, the following are recommended for successful drip irrigation of processing tomatoes under saline shallow ground water conditions:

- Sufficient leaching must occur near drip lines to maintain profitable yields.
- Seasonal water applications should be about equal to the seasonal crop water use. These water applications appear to provide sufficient localized leaching. Higher applications could raise the water table; smaller applications could decrease tomato yield due to reduced leaching and possibly, decreased soil moisture content.
- Periodic leaching of salt accumulated above the buried drip lines will be necessary with sprinklers for stand establishment if winter and spring rainfall is insufficient to leach the salts.
- Periodic system maintenance must be performed to prevent clogging of drip lines. Clogging will not only reduce the applied water needed for crop ET, but also reduce the leaching. Where surface water or ground water stored in farm reservoirs is used for irrigation, chlorination is necessary to prevent emitter clogging from biological growths in drip lines/emitters.

Reference: Hanson, B. R. and D. M. May. 2003. Drip irrigation increases tomato yields in salt-affected soil of San Joaquin Valley. *California Agriculture* 57(4): 132-137.

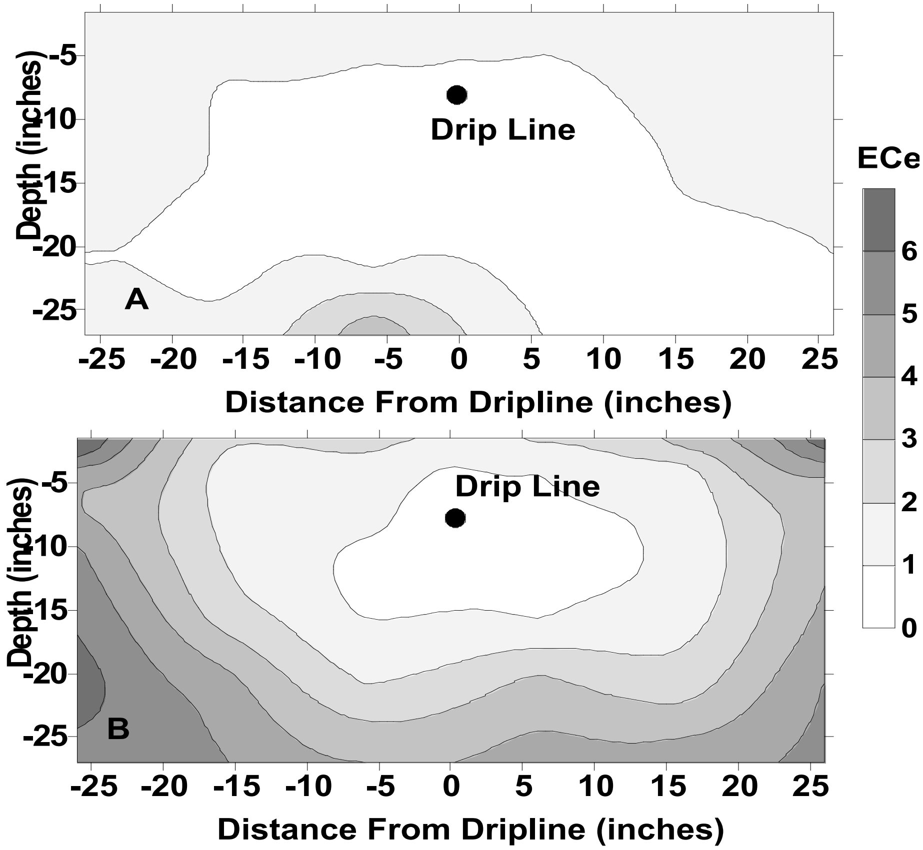

Figure 1. **Patterns of soil salinity for (A) a seasonal water table depth of about 6 feet, and (B) a seasonal water table depth of 2 to 3 feet. Soil salinity is measured as the electrical conductivity of the saturated extract (ECe) in dS/m.**

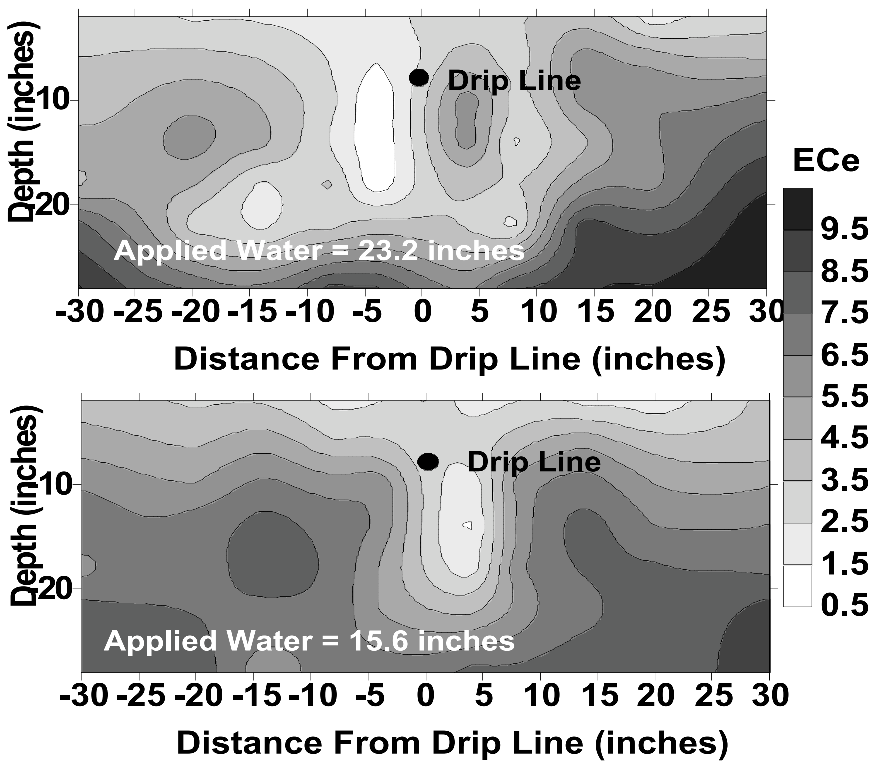

Figure 2. **Patterns of ECe for different amounts of applied water.**

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) www.vric.ucdavis.edu

UC IPM (homepage)
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

PESTICIDE LABELS

CDMS – Ag Chemical Information Services
http://www.cdms.net/pfa/LUpdate.Msg.asp
Greenbook – http://www.greenbook.net/

INDUSTRY ORGANIZATIONS

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

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

CA League of Food Processors
www.clfp.com
Represents and promotes processors in CA.

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

Processing Tomato Advisory Board
www.ptab.org
Established CA fruit quality standards and conducts grading program to assure high fruit quality.

WEATHER & IRRIGATION

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

GOVERNMENT

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

CALIFORNIA TOMATO PROCESSORS

Authentic Specialty Foods, Inc., Rosemead
Campbell Soup Company, Sacramento
Con-Agra Grocery Products Co. (Hunt's), **Oakdale and Helm**
Del Monte Corporation, Hanford
Escalon Premier Brands, Inc., Escalon
Ingomar Packing Co., Los Banos
Los Gatos Tomato Products, Huron
Morning Star Packing Co., Los Banos, Riverbank, Volta, and Williams
Pacific Coast Producers, Woodland
Patterson Frozen Foods, 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
Toma Tek, Firebaugh
Unilever Bestfoods, Stockton & Merced

Driers/Dehydrators

Borello Farms, Inc., Morgan Hill
Culinary Farms, West Sacramento
Gilroy Foods, Hanford
John Potter Specialty Foods, Inc., Patterson
Lester Farms, Winters
Mariani Nut Company, Winters
Timber Crest Farms, Healdsburg
Traina Dried Fruit, Patterson
Valley Sundried Products, Inc., Newman

Vegetable Crops Facts

UCCE Merced and Madera Counties

Scott Stoddard, Farm Advisor

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