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Vegetable Notes

Fresno, Tulare and Kings 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 ¾ - 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 — Irrigation Cutoff: June 17, 2005
Emergence: March 1, 2005 — Machine Harvest: July 19, 2005
Plot Size: One 66-inch bed x 65' row; 1 seed row

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

Planting Date	Yield (T/A) by Harvest Date					Total Yield
	Aug 29	Sept 12	Sept 19	Sept 26	Oct 3	
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.

EXPT. 1 Seeded April 12, 2005

Harvest 1: AUG 29 (139 DAS) Harvest 2: SEPT 12 Harvest 3: SEPT 19

#	Variety	Yield Tons/A				% Rots				PTAB °BRIX				PTAB pH				Cooked LAB pH			
		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

EXPT. 2 Seeded April 27, 2005

Harvest 1: SEPT 12 (138 DAS) Harvest 2: SEPT 26 Harvest 3: OCT 3

#	Variety	Yield Tons/A				% Rots				PTAB °BRIX				PTAB pH				Cooked LAB pH			
		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

EXPT. 3 Seeded May 17, 2005

Harvest 1: SEPT 26 (132 DAS) Harvest 2: OCT 3 (only 7 days later)

#	Variety	Yield Tons/A				% Rots				PTAB °BRIX				PTAB pH				Cooked LAB pH			
		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.

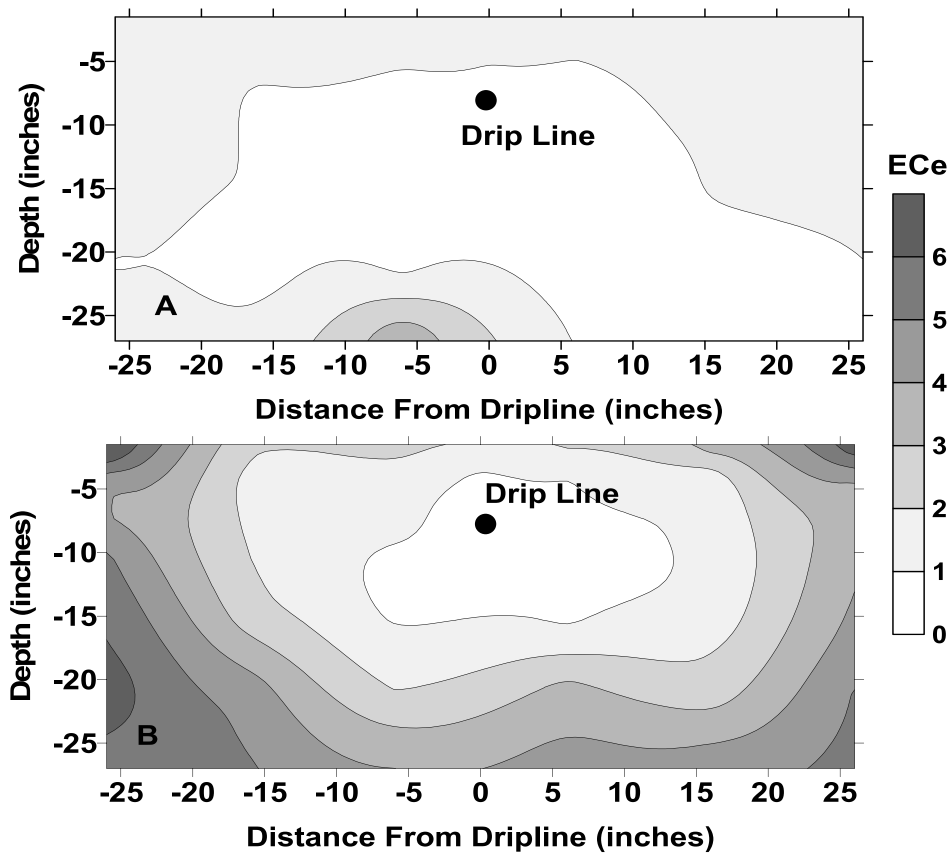

Figure 1. **Patterns of soil salinity for (A) a seasonal water table depth of about 6 feet, and (B) a seasonal water table depth of 2 to 3 feet. Soil salinity is measured as the electrical conductivity of the saturated extract (ECe) in dS/m.**

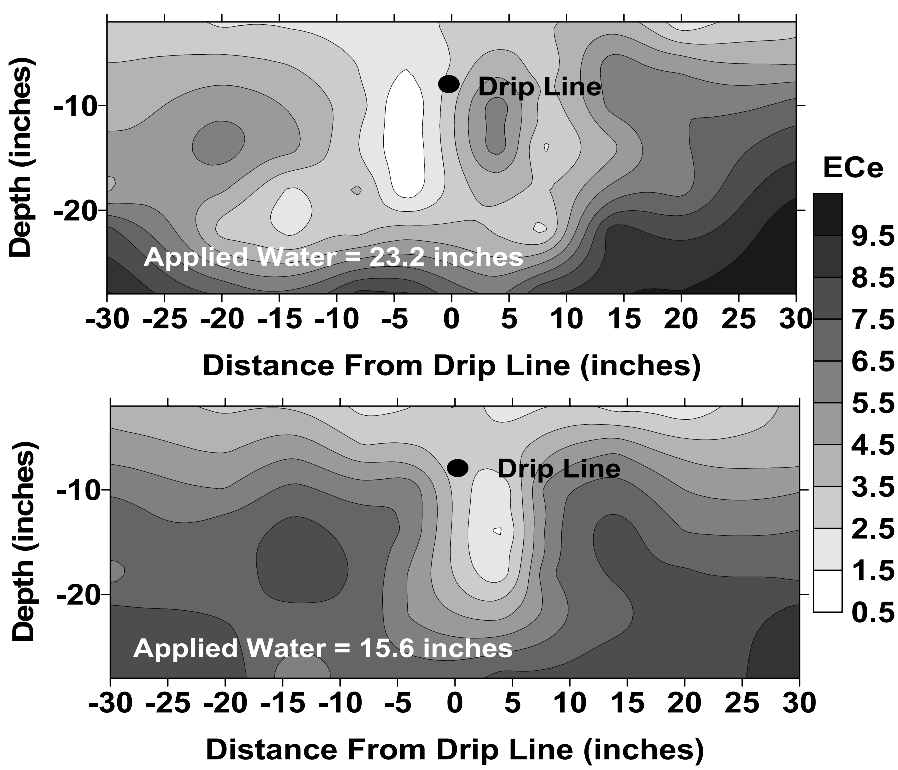

Figure 2. **Patterns of ECe for different amounts of applied water.**

Control of Dodder with Resistant Varieties - 2005

Tom Lanini, Extension Weed Ecologist, University of California, Davis

SUMMARY: Field tests were conducted on processing tomato varieties to confirm dodder resistance previously observed in greenhouse evaluations. Dodder resistant tomato varieties identified in the greenhouse and planted in the field trial included CXD 233, H1100, H9888, H9997, SVR 024 2 0664, SVR 024 2 0665 and SVR 024 2 0662. CXD 234 was also included, as the company had observed this variety to be dodder resistant, however, in our greenhouse tests, it was sensitive to dodder. H9492 was included as the standard and the grower's variety was H9553 (also a dodder resistant variety). The trial was planted on March 15, 2005. Dodder attached to every tomato variety, with the greatest number of dodder attachments on H9553 (growers variety), H1100, and CXD 233. The least number of dodder attachments occurred on H9492, H9997, and SVR 024 2 0664. Two weeks ahead of harvest, dodder cover was nearly 70% on CXD 233 and around 30% on the CXD 234 and H9997. As observed in the greenhouse, dodder was able to attach to seedling of most tomato varieties, but dodder could not form successful attachments to H9492, CXD 233, H1100, H9888, SVR 024 2 0664, SVR 024 2 0665 and SVR 024 2 0662 and eventually the dodder died. H1100 had about 60 dodder attachments, but by harvest, dodder was not visible. Tomato yields averaged about 40 tons per acre (T/A), with dodder reducing yield about 10 T/A on the CXD 233 and H9997 plots, but only about a 4 tons/ac reduction in the CXD 234 plots.

OBJECTIVE: Conduct field tests with tomato varieties to confirm the resistance to dodder previously observed in greenhouse evaluations.

PROCEDURES: In 2004 greenhouse tests, several tomato varieties not previously identified as dodder resistant were observed to have high levels of dodder resistance; these included CXD 234, CXD 233, H1100, H9888, H9997, and SVR 024 2 0664. In 2005, we planted these varieties and also SVR 024 2 0665, SVR 024 2 0662, and H9492 (standard) under field conditions, to confirm dodder resistance. The trial was planted on March 15 in a field north of Davis with a history of dodder infestation. Each variety was planted on a single bed, (9 beds total) and were 250 feet long. Tomatoes were seeded two lines per bed, on standard 60 inch beds. The grower seeded H9553 (also a resistant variety) in the remainder of the field. Tomato emergence was noted approximately 10 days later and initial dodder attachment was observed on April 4. On April 11, 18, 25, May 10, 20, 31, June 10 and 29 tomatoes with attached dodder were marked and counted for the entire plot area (9 beds wide by 250 ft.). On May 10 and 20 the number of dodder infestations that appeared to be increasing in size (growth greater than 1 ft from the initial point of attachment) was also counted. On June 29 and July 18 dodder cover (%) was estimated for each variety. Tomatoes were hand harvested, graded into red, green and rotten fruit, and weighed to estimate yields on August 4. When dodder cover extended at least 10 feet of a tomato row, tomato yields were taken from these areas as well as from areas with no dodder present.

RESULTS: Dodder emerged and was able to attach to all the tomato varieties used in this study **(Table 1)**. The number of dodder seedlings attaching to tomatoes increased over the first 3 or 4 weeks after crop emergence and then declined to varying degrees for all tomato varieties. With CXD 233, CXD 234, H1100, and H9997, the decline in the number of individual dodder infestations was the result of infestations growing together into large patches. In the other 5 varieties, the decline in dodder attachments was the result of dodder death after initial attachment. It is not clear if the dodder growing on H9553 would have declined or continued to grow, since tomatoes, with attached dodder were removed during hand weeding. On May 10, prior to hand weeding, dodder cover on H9553 was increasing in size and were like to survive (**Table 2**). In previous field studies, H9553 has been resistant to dodder.

The number of dodder infestations that were increasing in size was also counted and both CXD varieties, H1100, and H9553, had at least 10 dodder patches that were growing vigorously (Table 2). By May 20th, the number of these patches declined slightly, but this was primarily due to patches growing together to form one large patch for the dodder sensitive varieties and due to dodder decline in the tolerant varieties.

Dodder cover on CXD 233, CXD 234, and H9997 was 28 to 70% **(Table 3).** Dodder cover on the remainder of the varieties was less than 5% for all except H9888 (6%) by July 18th. H1100, which had a large number of attached dodder plants early in the season, had relatively low dodder cover by July, which indicates that this variety was not an ideal host for dodder growth, but dodder attachment was not inhibited. Dodder cover on the three "SVR" varieties and H9492, was near zero for both cover measurements, indicating good levels of dodder resistance.

Tomato yields varied by variety and also by dodder presence **(Table 4).** CXD 234, SVR 024 2 0664, and H1100 all had weak stands at planting, due to large seeds not properly flowing through the planter. Thus, low yield on these plots was not the result of dodder, as much as a weak tomato stand. Dodder appeared to reduce yields 5 to over 10 T/A. Most of this yield loss is probably due to direct competition for resources. However, the dense dodder canopy may also hold in more moisture and possibly increase disease pressure, as we have often noted tomato canopy decline or death, when dodder is dense.

CONCLUSIONS: Based on previous greenhouse studies and this field study, it appears that SVR 024 2 0664, SVR 024 2 0665, SVR 024 2 0662, and H9888 are all resistant to dodder. H1100 may also be resistant, but the large number of infestations early in the season, particularly for a weak stand, still leaves some question on whether this variety is truly resistant. Although the two CXD varieties were observed to be resistant in company conducted field evaluations, they did not appear to be resistant in this trial. However, even the sensitive varieties in this study may be better than other varieties currently available, as dodder infestations only resulted in a 25% yield loss, whereas early work observed as much as 75% yield loss from dodder infestations.

Table 1. Number of tomatoes with attached dodder (# per 250 ft. of row) relative to tomato variety and date. Bold type indicates the time when the maximum number of attachments was observed.

	# of dodder attachments per 250 ft							
Variety	4/11	4/18	4/25	5/10	5/20	5/31	6/10	6/29
CXD 234	9	18	**23**	**23**	9	13	15	10
CXD 233	22	25	**43**	40	16	16	21	14
SVR 024 2 0662	12	21	**23**	19	9	1	0	0
SVR 024 2 0664	4	**12**	7	5	6	1	0	0
SVR 024 2 0665	7	24	**27**	16	3	0	0	0
H9492	11	13	10	**14**	10	4	0	0
H9553	31	40	**51**	45	*	*	*	*
H9888	14	**26**	22	19	18	3	3	2
H9997	7	9	13	**17**	9	9	12	7
H1100	25	56	56	**63**	49	17	13	5

* H9553 was the variety used by the grower and following the May 10 evaluation, a hand crew removed all the dodder infested tomatoes in the growers variety, during the weeding/thinning process.

Table 2. Number of large (>1 ft.) dodder infestations (# per 250 ft. of row) relative to tomato variety on May 10 and May 20, 2005.

	# of large dodder attachments per 250 ft.	
Variety	May 10	May 20
CXD 234	11	8
CXD 233	14	12
SVR 024 2 0662	6	3
SVR 024 2 0664	2	3
SVR 024 2 0665	2	0
H9492	6	1
H9553	17	*
H9888	3	0
H9997	8	6
H1100	33	22

* H9553 was the variety used by the grower and following the May 10 evaluation, a hand crew removed all the dodder infested tomatoes in the growers variety, during the weeding/thinning process.

Table 3. Dodder cover (%) relative to tomato variety on June 29 and July 18, 2005

	% Dodder cover	
Variety	June 29	July 18
CXD 234	32	28
CXD 233	58	70
SVR 024 2 0662	1	0
SVR 024 2 0664	0	0
SVR 024 2 0665	0	4
H9492	0	1
H9888	3	6
H9997	28	40
H1100	6	2

Table 4. Tomato yield (T/A) relative to variety on Aug 4, 2005

	Tons/Acre		
Variety	red	green	rot
CXD 234* – no dodder	32.6	3.8	1.3
CXD 234 – plus dodder	**22.0**	**2.0**	**0.2**
CXD 233 – no dodder	38.7	0.6	2.4
CXD 233 – plus dodder	**34.6**	**0.1**	**2.5**
SVR 024 2 0662	41.4	6.6	2.1
SVR 024 2 0664*	26.9	2.9	1.2
SVR 024 2 0665	42.1	1.8	1.4
H9492	41.5	0.7	1.2
H9888 – plus dodder	**36.8**	**1.2**	**2.7**
H9997 – no dodder	41.7	4.7	2.2
H9997 – plus dodder	**30.5**	**0.1**	**4.5**
H1100* – plus dodder	**22.3**	**0.6**	**3.0**

Rows in bold type are from areas of the crop row which were covered by dodder. These varieties had a poor tomato stand due to planting problems, and thus their yields are lower than what would normally be expected.

Herbicide Control of Nightshade and Nutsedge in Tomatoes

Scott Stoddard, Farm Advisor, UCCE Merced & Madera Counties

Introduction: Yellow nutsedge (*Cyperus esculentus*) and nightshade (both black and hairy, *Solanum nigrum* and *S. sarrachoides*) are two dominant weed problems for tomato growers in Merced and Madera Counties. One of the available herbicides for both of these weeds is metalochlor (Dual Magnum), which received late registration in 2003. While there are a few other herbicides registered to control these weeds, two relatively new chemicals that target these species specifically are rimsulfuron (formerly Shadeout, now marketed under the trade name Matrix) and halosulfuron-methyl (trade name Sandea). Post-emergence sprays of Matrix target nightshades, whereas Sandea is almost exclusively a nutsedge herbicide. Efficacy for both is improved through the use of a non-ionic surfactant or crop oil concentrate. Furthermore, tank-mixes of Sandea + Matrix have given exceptionally good weed control of both nutsedge and nightshades.

One disadvantage with Sandea is potential crop phytotoxicity, especially with certain varieties. This sensitivity is exacerbated with the addition of Matrix. In trials on processing tomatoes in 2004, certain varieties showed up to 80% phytotoxicity symptoms with a Sandea + Matrix combination. Yields were not significantly affected, but fruit quality was not evaluated.

In 2005, eight fresh market tomato varieties were screened for sensitivity to various post-application herbicides. In processing tomatoes, nightshade and nutsedge conrol were evaluated with several different pre and post application materials. In both locations, the standard herbicide was Dual Magnum. The objective of these trials was to compare efficacy and crop sensitivity to various herbicides that suppress nutsedge and nightshade in tomatoes.

Procedure: The trials were located in commercial production fields near Gustine (fresh market) and Firebaugh (processing). Plots were furrow irrigated and managed similarly as the rest of the field with the exception that mechanical cultivation and hand weeding were not performed. At the Firebaugh location, the pre-plant herbicides were incorporated with sprinklers, whereas at the Gustine site Dual Magnum was incorporated with a disc. Post emergent herbicides were applied over-the-top when the crop was near first bloom. Following herbicide application, plots were evaluated for weed control on a 0 to 10 scale, where 0 = no weed growth and 10 would indicate complete weed coverage.

Results: At the Gustine location, Dual Magnum, Sandea, and a tank-mix of Sandea + Matrix did the best job controlling nutsedge, especially by the latest evaluation date on July 18 (Figure 1). At this time, all herbicide treatments provided significantly better control of both nutsedge and broadleaf weeds than untreated check plots. Sencor did not perform as well as the other herbicides on controlling nutsedge, but did significantly reduce broadleaf weeds as compared to the untreated control.

The main weeds in this trial were purslane (*Portulaca oleracea)* and yellow nutsedge, and as a result Matrix alone had significant less nutsedge control than Sandea, Dual, or Sandea + Matrix (Matrix post emergent is predominantly a nightshade control material). Matrix did significantly reduce purslane as compared to the untreated control. Dual Magnum, however, did not suppress purslane as well as the other weeds, especially later in the season. There were few grass weeds in this location, though there was a trend for more grassy weeds in the untreated plots. *No herbicide treatment was found to cause phytotoxicity problems with any of the varieties used in this test. Furthermore, there was no impact on yield or fruit maturity.*

Early season weed growth at the processing tomato trial was dominated by nutsedge. Prior to transplanting at the Firebaugh location, all pre-plant herbicides significantly reduced nutsedge growth as compared to the untreated control treatment, though Dual Magnum did better than Matrix. As a post-emergence herbicide, Matrix is mainly effective on nightshades, but as a pre-emergence offers some suppression of nutsedge as well. At the July 19 rating, all herbicide treatments significantly reduced nutsedge compared to the untreated control, though there was no significant difference between pre-plant or post-emergence (Figure 2). There was a trend for reduced broadleaf weeds (mainly nightshade and purslane) as compared to the check plots, but this was not significant. Overall best weed control was observed with V-10142 at 0.5 lbs ai (unregistered herbicide from Valent), Dual Magnum, and the Sandea + Matrix (post) tank mix.

Like the fresh market trial, no crop phytotoxicity was observed (field variety was H9665). Yield was not measured at this location.

Summary: In the trials conducted in 2005 in commercial tomato fields, yellow nutsedge was a greater problem than nightshade. At both locations, Dual Magnum pre-plant incorporated significantly reduced nutsedge as compared to not applying any herbicide. In plots without pre-plant herbicides, best weed control was seen with the Sandea + Matrix tank mix. In three years of trials in various tomato production fields, a tank-mix of Sandea + Matrix has consistently provided excellent weed control as a post-emergence herbicide treatment. A few processing varieties have been found to be sensitive to this mix, but in general most tomato varieties tolerate this tank-mix well and yield nor fruit development are significantly impacted.

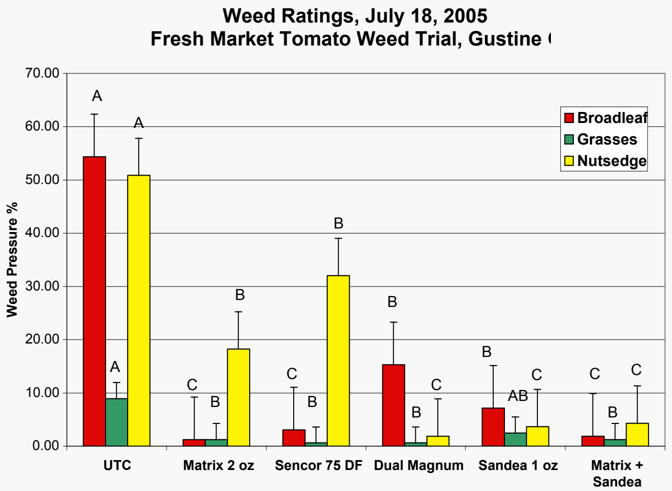

Figure 1. Weed pressure in fresh market tomatoes as affected by herbicide treatment. All herbicides except for Dual Magnum were applied post emergent to the weeds when the crop was near first bloom. UTC = untreated control. Weed categories (broadleaf, grass, and nutsedge) with the same letter are not significantly different at the 95% confidence level. Main broadleaf weed was purslane.

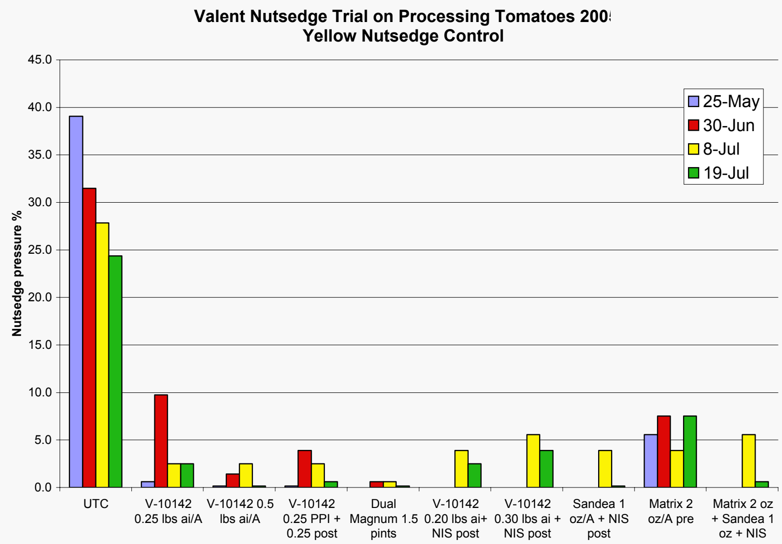

Figure 2. Yellow nutsedge control on various dates as affected by herbicide treatment in processing tomatoes. All herbicide treatments significantly reduced nutsedge growth as compared to the untreated control (UTC). V-10142 is an unregistered herbicide from Valent Corp. Post-emergent treatments were evaluated only after June 30.

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Subsurface Drip Irrigation as a Weed Management Tool

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Statewide IPM Advisor-UC KAC, Vegetable Crops Specialist-UC KAC, Extension Weed Ecologist-UC Davis

Cropping systems that use water more efficiently, conserve the soil, and reduce dust emissions are being developed in the San Joaquin Valley (SJV). Sub-surface drip irrigation (SDI) and conservation tillage (CT) are two examples of techniques being included in these systems design for processing tomato production. Several agronomic, soil, economic, and engineering aspects of these techniques have been evaluated by many, but data on weed populations under these systems is lacking.

We conducted a two-year field study at the UC West Side Research and Extension Center, Five Points. Weed densities, species composition, and weed biomass in processing tomatoes grown under different irrigation and tillage systems were evaluated. The experimental design was a split-split plot with four replications. The main plots were irrigation [SDI or furrow irrigation (FI)], split-plots were tillage [standard tillage (ST) or conservation tillage (CT)] and split-split-plots were weed control system [weed control (WC) or no weed control (NWC)]. The furrows of all the plots were cultivated with a Sukup cultivator.

Results summary: The furrows of the FI plots required two cultivations during the growing season to control emerged weeds whereas the SDI plots had to be cultivated only once because of no weed emergence after the first cultivation. Weed emergence and growth in the furrows of SDI treatments were almost eliminated whereas weed density on the beds was up to 96% lower in the SDI than FI plots. Weed biomass on the bed was not affected by the irrigation system. However, weed biomass in the furrows was reduced by more than 90% by SDI compared to FI. Tillage did not affect weed density or biomass. A combination of SDI and CT, one-time cultivation in the furrows, and a weed control treatment on the crop beds could form an ideal weed management system for processing tomatoes in the SJV.

Tomato Spotted Wilt Virus (TSWV)

Bryce Falk and Mike Davis, Plant Pathology, UC Davis, Michelle Le Strange and Scott Stoddard, Farm Advisors

TSWV is a relatively recent and non-uniform problem in CA. It is transmitted from plant to plant by at least 10 specific thrips vectors, including the western flower thrips (*Frankliniella occidentalis)*, the most widespread and important vector for TSWV worldwide.

The TSWV:Thrips Vector Transmission relationship is different than most insect-transmitted plant viruses, and must be considered for any disease control strategy. Only the 1st or 2nd instar larvae (first stages after egg hatch) can acquire the virus from infected plants and then as adults transmit the virus to plant hosts. Adult thrips cannot acquire the virus; they can only spread it along IF they acquired it when young. Another fact is that the virus is not passed along from the adult to the egg. Thus, the eggs giving rise to the young nymphs must be on plants that are already TSWV infected. Inoculum sources must be hosts for both the thrips vector and the TSWV.

Knowing these facts we presume that important sources of TSWV inoculum are host plants that also support thrips populations. Unfortunately TSWV has one of the widest host ranges of any plant virus, infecting at least 168 plant species in 29 families. Economic hosts include tomatoes, peppers, celery, legumes, lettuce and many ornamentals; whereas weed hosts include nightshade, tree tobacco and jimson weed. Research is underway to determine the TSWV/thrips inoculum sources in some areas of the SJV. Please call a farm advisor, if you see significant incidence of this disease this season.

Symptoms of the disease vary, but young leaves tend to turn bronze, develop necrotic spots and streaks, and eventually, young shoots dieback and entire parts of the plant collapse and seem to wilt. One of the most diagnostic characteristics is the development of chlorotic or yellow ringspots on fruit; these rings are most obvious on red fruit, but also occur on green.

Potato Aphid Research in Tomatoes

Frank Zalom and Corin Pease, Department of Entomology, UC Davis

CHEMICAL CONTROL STUDIES

For the past several years, we have been evaluating alternative pesticides which could serve as a replacement for the organophosphate dimethoate for potato aphid (*Macrosiphum euphorbiae)* control. Insecticides tested include pyrethroids, neonicotinoids, insect growth regulators (IGR), and tank mixes of products. The study and data presented below come from an experiment conducted in 2004 on the UC Davis Vegetable Crops farm.

Procedures: Potato aphid populations were allowed to establish naturally, until the end of the first week of July when it was determined that the aphid populations would remain low. On July 9, potato aphid infested leaves were picked from a heavily infested tomato field near Woodland. Ten of these leaves were placed within the plant canopy of the tomato plants in each of the 60 plots to help augment the naturally occurring population. The insecticides tested were applied on July 12 (Fulfill and Platinum, only) or August 1 (all other treatments). All treatments but Platinum were applied using an Echo Duster/Mister air assist sprayer at a volume equivalent to 50 gal./acre. Platinum was applied by spraying the product on the soil at the base of each plant in 4.25 oz. of water per plant using a Hudson pump sprayer. The plots were furrow irrigated the day after the soil application was made. Treatments were assigned to plots in a completely randomized design, with three replicates per treatment. There were six replicates of the untreated control.

Results: Pre-treatment aphid counts were taken July 29, with post-treatment samples occurring August 5, 12, and 19, respectively. All aphid counts were conducted by sampling 30 leaves per replicate, using the leaf below a highest open flower among plants throughout the replicate, to achieve a sample of 30 leaves. Potato aphid density in the last pretreatment evaluation averaged 22% infested leaves, and there was no significant difference between plots as indicated by 1-way ANOV. The treatment threshold for potato aphids is 25% to 50% infested leaves depending on variety, so the densities at the time of treatment were relatively low. Potato aphid densities in the untreated control plots remained relatively stable following the pretreatment sampling date during this experiment. Significant treatment differences were found on all sampling dates after treatments were applied **(Table 1)**. *All treatments with the exception of Fulfill, Activol, Platinum alone, and the Knack plus Danitol combination significantly reduced potato aphid densities relative to the untreated control by the first sampling date. However, the Knack plus Danitol combination significantly reduced the potato aphid densities in the subsequent sampling periods. Further, the potato aphid densities recorded in the Fulfill treatment plots were noticeably reduced in the subsequent sampling periods, but the differences were not statistically significant.*

Discussion: This was the first year that we tested Platinum and Knack, and the first year that we tested Fulfill at an earlier treatment date relative to a treatment based on approaching the control action threshold. Perhaps Fulfill and Knack would have been more effective treatments had they been applied earlier, since both seemed to have more impact on potato aphid densities as the sampling dates progressed. Timing Platinum treatments is more challenging. The efficacy of thiamethoxam (Platinum and Actara) against potato aphid as illustrated by the success of Actara applications is indisputable, yet the soil applied Platinum formulation did not provide acceptable control. It is likely that the thiamethoxam was not taken up by the plant in time for it to affect control in our study, and it is not known whether Platinum applied at transplanting would remain in the plant long enough to provide effective control later in the season when the potato aphids first move to the crop.

Summary: Data collected support our prior observations that foliar applied neonicotinoid insecticides and many pyrethroid insecticides can give equivalent control to dimethoate. The pyrethroids Warrior and Mustang Max, the neonicotinoids Actara and Assail, and various pyrethroid and neonicotinoid combinations all provided excellent control. The IGR Knack in combination with a pyrethroid also gave excellent control, but took longer to reduce aphid densities.

Table 1. % potato aphid infested tomato leaves/ plot, UC Davis, Yolo County, 2004

Treatment	Rate (ai/ac)	Aug 5	Aug 12	Aug 19
Untreated	--	0.23	0.23	0.16
Dibrom 8	1 pt*	0.10 **	0.09	0.13
Fulfill[1]	2.75 oz*	0.18	0.11	0.08
Activol	3.00%	0.20	0.31	0.16
Warrior	3.84 oz*	0.03 **	0.01 **	0.00 **
Actara	4.0 oz*	0.04 **	0.00 **	0.02 **
Warrior + Actara	3.84 oz* + 4.0 oz*	0.02 **	0.01 **	0.00 **
Platinum[1]	8.0 oz*	0.25	0.19	0.19
Warrior + Platinum[1]	3.84 oz* + 8.0 oz*	0.01 **	0.00 **	0.00 **
MustangMAX (L)	0.018 lb	0.03 **	0.02 **	0.02 **
MustangMAX (H)	0.025 lb	0.09 **	0.08	0.03 **
F1785 (L)[2]	0.054 lb	0.07 **	0.00 **	0.02 **
F1785 (H) [2]	0.071 lb	0.05 **	0.01 **	0.01 **
MustangMAX (H) + F1785 (H) [2]	0.025 lb + 0.071 lb	0.01 **	0.01 **	0.00 **
Assail 70WP	2.39 oz*	0.02 **	0.06 **	0.02 **
Warrior + Assail	3.84 oz* + 2.39 oz*	0.01 **	0.00 **	0.01 **
Dimethoate 4EC	1.5 pts*	0.00 **	0.01 **	0.01 **
Lannate + Danitol	0.9 lb + 0.2 lb	0.00 **	0.03 **	0.03 **
Knack (IGR) 0.86 EC + Danitol	0.054 lb + 0.2 lb	0.11	0.04 **	0.02 **

[1] Application date for this product: July 12. [2]Not registered for use on tomatoes.
* Formulated rate/acre Treatments applied on August 1, except as indicated.
**Means are significantly different (p<0.05) from untreated by t-test following arcsin transformation.

ORGANIC INSECTICIDES & ADJUVANTS

The objective of this study was to assess efficacy of reduced-risk products, including those which are organically acceptable, for control of the potato aphid.

PROCEDURES: Field experiments were established at the UC Davis Vegetable Crops Farm to evaluate organically approved products with and without 3 types of adjuvants intended to enhance their efficacy. Tomatoes were transplanted to 60 inch beds on April 27, 2005, and managed by standard practices except that no insecticides other than the experimental treatments were applied during the season. The field was furrow irrigated. Plots were 23 feet long and 5 feet wide, and were separated by 2 foot fallow skips along tomato rows (by pulling up plants once it was confirmed that an acceptable plant stand had been established). All treatments were replicated 4 times. The experiment was bordered by an untreated row on each side and a 15 foot buffer on each end.

Tomato plants were monitored weekly starting in June to determine the date when natural potato aphid infestations began to develop. Aphids were found on plants the last week of June. Aphid counts consisted of sampling 30 leaves per plot, using the leaf below the highest open flowers among plants. The number of leaves with one or more aphids was divided by 30 to obtain percent aphid-infested leaves per plot.

Products tested: Organically approved products included Agroneem (azadirachtin in a less purified form of neem), Neemix (more highly refined azadirachtin), Pyganic (pyrethrum), and Ecotrol (rosemary oil). Each was applied alone and with either an organically approved sticker/ extender, spreader/penetrant, or spreader/sticker/extender **(Table 1)**. The specific adjuvants were selected based on conversations with the companies producing the insecticides. Also tested were Organocide (sesame oil), Trilogy (neem oil), and Natural Plant Wash (potassium soap). Efficacy of these organically approved products were compared to an untreated control and a treated control consisting of a single application of the conventional pyrethroid insecticide Warrior (lambda cyhalothrin) applied at each of the treatment dates at which the organically approved products were applied. All treatments were replicated 4 times.

Applications: The first applications of the organically approved products were made at an average density of 32.7% infested leaves on July 8 followed by a second application on July 15. There was no significant difference between plots pretreatment (Table 1). The conventional material (Warrior) served as a check on the application methodology, and was applied once at the first treatment date and once to a separate set of plots on the second treatment date. All applications were made using an air assist sprayer with the first application made at a volume of 50 gallons per acre, and the second application of the organically approved products made at a volume of 100 gallons per acre to achieve better coverage. Both applications of Agroneem were applied at 100 gallons per acre as recommended by its manufacturer. All treatments were buffered to pH 5 using distilled white vinegar.

Optimal Coverage: In order to determine the effect of the organic treatments under conditions of optimal coverage, leaves were treated directly with aliquots of the same insecticide + adjuvant solutions that were applied on July 15, using a hand sprayer and at volume sufficient to result in runoff of the solution from the leaves being treated. Leaves to be evaluated were selected prior to application so that each had a minimum of 10 aphids present. Pretreatment counts of aphids per leaf were made on July 16. These leaves were sprayed *in situ* and to runoff on July 17 with the saved insecticide + adjuvant solutions. Potato aphid mortality was evaluated on July 20, and percent mortality compared to pretreatment counts.

RESULTS & DISCUSSION: Potato aphid densities in the untreated control plots increased during the first and second weeks following the initial application, but declined on the final sampling date **(Table 2)**.

On the first sampling date (July 11) no significant differences in leaf infestation were found following the first application. We would not expect to see an impact of Neemix and Agroneem treatments in this first post treatment sample. The active ingredient in these treatments is azadirachtin, which is classified as an insect growth regulator (IGR). Therefore, observed effects on molting and consequently aphid densities might be expected to be somewhat delayed. There were no significant differences between the untreated control and the contact insecticide treatments, Pyganic and Ecotrol, during this first period.

On the second sampling date (July 18) following the second treatment on July 15, results indicated significant differences among treatments. All of the treatments, with the exception of Ecotrol and Trilogy alone, were significantly different from the untreated control. Organically acceptable treatments that reduced the number of infested leaves by 55-65% relative to the untreated control included: Ecotrol + Green Cypress Spreader, Ecotrol + Biolink spreader/sticker, Pyganic + Biolink spreader/sticker, Pyganic + Natural Plant Wash, and Agroneem + Natural Plant Wash. Ecotrol + all adjuvants tested (Green Cypress Spreader, Natural Plant Wash and Biolink spreader/sticker) provided significantly greater control than Ecotrol alone.

On the final sampling date (July 25) the untreated control decreased to 36.3% infested leaves. In addition to the Warrior early and late spray treatments, seven organic treatments resulted in significantly lower percentages of aphid infested leaves compared to the untreated control *Of particular note, each insecticide combined with an oil adjuvant (A-Plus, Trilogy, Organocide or Green Cypress Spreader) resulted in significantly fewer aphid infested leaves when compared to the untreated control.* Plots treated with Ecotrol + Biolink spreader/sticker and Ecotrol + Green Cypress spreader had significantly fewer aphid infested leaves than did plots treated with Ecotrol alone.

In addition to the conventionally-treated check (Warrior), twelve organic treatments had significantly greater aphid mortality than the untreated control. Organic treatments producing greater than 85% aphid mortality included: Pyganic alone, Pyganic + Organocide, Pyganic + Biolink spreader/sticker, and Ecotrol + Natural Plant Wash. t-test results of insecticides + adjuvant vs insecticide alone comparisons are shown on **Table 3.** Pyganic + Biolink spreader/sticker resulted in significantly greater aphid mortality compared to Pyganic alone. Ecotrol + Natural Plant Wash and Ecotrol +Biolink surfactant/penetrant performed significantly better than Ecotrol alone. Also of note, Natural Plant Wash alone at the full rate resulted in 81.82 ± 11.88% mortality. Potassium soaps such as Natural Plant Wash are commonly used alone to control aphids, but performance of other products using potassium soaps as an active ingredient were not evaluated and therefore can not be directly compared.

Optimal Coverage Results: A field bioassay, conducted to determine efficacy when the insecticide solutions were applied to runoff (optimal coverage), produced the best results of all treatments with some approaching 100% mortality **(Table 4).** *This work demonstrates that because organic insecticides work primarily by contact action, good coverage is essential to improve their efficacy.*

Our first field application at 50 gallons/acre was ineffective. The second application at 100 gallons per acre resulted in a reduced infestation level for many of the products and combinations. The field bioassay was applied to drip to achieve thorough coverage, and results indicated up to 100% mortality of aphids was possible. It is possible that the extremely high volumes may have caused some of the insecticide/adjuvant combinations to run off without adhering to either the aphids targeted or the leaf surface, thus reducing their efficacy. This may explain our observations that some combinations that performed well in the field trial (e. g. Ecotrol + Green Cypress spreader, and Ecotrol + Biolink spreader/sticker) performed poorly in the bioassay. In addition to volume, adjuvants may also affect coverage. Although addition of adjuvants resulted in significantly greater efficacy in some cases, all combinations tended to increase effectiveness of the insecticides. Besides increasing coverage, the addition of oil adjuvants may reduce the photo-degradation of these organic insecticides, thus extending their activity. Finally, we were not able to detect synergistic activity resulting from addition of the adjuvants, but other products may act in this way.

CONCLUSION: Our results suggest that a well timed spray of many of the treatments tested and at sufficient volume (≥100 gal/acre) will provide acceptable control of potato aphids, and can reduce populations below damaging levels.

Table 1. **Products and rates applied for control of potato aphid, UC Davis, 2005.**

Insecticide	Active ingredient	Rate (Insecticide) Form. /acre	Adjuvant	Active ingredient	Adjuvant type	Rate (Adjuvant) v/v
Untreated	na	na	na	na	na	na
Warrior (Early Spray)	lambda cyhalothrin	3.84 fl. oz.				
Warrior (Late spray)	lambda cyhalothrin	3.84 fl. oz.				
			Organocide	Sesame Oil	sticker / extender / synergist	0.78% v/v
			Trilogy	Neem Oil	sticker / extender	1% v/v
			Natural Plant Wash	Potassium Soap	spreader / penetrant	1% v/v
Agroneem	Azadirachtin	64 fl. oz				
Agroneem	Azadirachtin	64 fl. oz	A-plus	Vegetable Oil	sticker / extender	0.13% v/v
Agroneem	Azadirachtin	64 fl. oz	Natural Plant Wash	Potassium Soap	spreader / penetrant	1% v/v
Agroneem	Azadirachtin	64 fl. oz	Biolink spreader sticker	alkylphenol ethoxylate, polysaccharide	spreader / sticker / extender	0.05 % v/v
Neemix	Azadirachtin	7 fl. oz				
Neemix	Azadirachtin	7 fl. oz	Trilogy	Neem Oil	sticker / extender	1% v/v
Neemix	Azadirachtin	7 fl. oz	Natural Plant Wash	Potassium Soap	spreader / penetrant	1% v/v
Neemix	Azadirachtin	7 fl. oz	Biolink spreader sticker	alkylphenol ethoxylate, polysaccharide	spreader / sticker / extender	0.05 % v/v
Pyganic 5.0	Pyrethrins	13.5 fl. oz				
Pyganic 5.0	Pyrethrins	13.5 fl. oz	Organocide	Sesame Oil	sticker / extender / synergist	0.78% v/v
Pyganic 5.0	Pyrethrins	13.5 fl. oz	Natural Plant Wash	Potassium Soap	spreader / penetrant	1% v/v
Pyganic 5.0	Pyrethrins	13.5 fl. oz	Biolink spreader sticker	alkylphenol ethoxylate, polysaccharide	spreader / sticker / extender	0.05 % v/v
Ecotrol EC	Rosemary oil	1% v/v				
Ecotrol EC	Rosemary oil	1% v/v	Green Cypress Spreader	Jojoba oil	sticker / extender	0.13% v/v
Ecotrol EC	Rosemary oil	1% v/v	Natural Plant Wash	Potassium Soap	spreader / penetrant	1% v/v
Ecotrol EC	Rosemary oil	1% v/v	Biolink spreader sticker	alkylphenol ethoxylate, polysaccharide	spreader / sticker / extender	0.05 % v/v

Table 2. **Percent potato aphid infested leaves per plot, UC Davis, Yolo Co., 2005.**

			% Leaves Infested with Potato Aphids			
	Rate		Pre-treatment	Post Treatment 1	Post Treatment 2	
Insecticide	**Form. /ac**	**Adjuvant**	**7/5**	**7/11**	**7/18**	**7/25**
Untreated	na	na	**38.8** ± 3.8	**40.0** ± 5.4	**61.3** ± 4.3	**36.3** ± 5.2
Warrior (Early)	3.84 fl. oz.		**30.0** ± 4.1	**13.8** ± 7.7	**6.3** ± 4.7 *	**5.0** ± 2.9 *
Warrior (Late)	3.84 fl. oz.		**Na**	**45.0** ± 7.9	**6.3** ± 2.4 *	**1.3** ± 1.3 *
		Organocide	**30.0** ± 4.6	**35.0** ± 2.9	**40.0** ± 7.4 *	**28.8** ± 11.3
		Trilogy	**35.0** ± 3.5	**42.5** ± 9.7	**48.8** ± 3.8	**22.5** ± 6.0
		Natural Plant Wash	**28.8** ± 2.4	**22.5** ± 3.2	**36.3** ± 3.8 *	**22.5** ± 7.5
Agroneem	64 fl. oz		**27.5** ± 6.6	**47.5** ± 10.3	**42.5** ± 8.5 *	**13.8** ± 5.2 *
Agroneem	64 fl. oz	A-plus	**36.3** ± 7.2	**32.5** ± 9.2	**32.5** ± 1.4 *	**18.8** ± 5.2 *
Agroneem	64 fl. oz	Natural Plant Wash	**37.5** ± 4.3	**33.8** ± 7.7	**27.5** ± 2.5 *	**21.3** ± 3.2
Agroneem	64 fl. oz	Biolink spreader sticker	**42.5** ± 3.2	**31.3** ± 4.3	**33.8** ± 2.4 *	**25.0** ± 2.0
Neemix	7 fl. oz		**33.8** ± 3.2	**31.3** ± 7.5	**38.8** ± 6.6 *	**21.3** ± 5.5
Neemix	7 fl. oz	Trilogy	**28.8** ± 3.8	**23.8** ± 7.5	**30.0** ± 7.1 *	**11.3** ± 3.2 *
Neemix	7 fl. oz	Natural Plant Wash	**32.5** ± 2.5	**52.5** ± 13.6	**33.8** ± 5.5 *	**23.8** ± 6.6
Neemix	7 fl. oz	Biolink spreader sticker	**35.0** ± 3.5	**33.75** ± 10.9	**32.5** ± 7.5 *	**21.3** ± 8.0
Pyganic 5.0	13.5 fl. oz		**25.0** ± 2.0	**32.5** ± 6.3	**33.8** ± 5.5 *	**26.3** ± 3.2
Pyganic 5.0	13.5 fl. oz	Organocide	**35.0** ± 4.1	**32.5** ± 5.2	**28.8** 2.4 *	**11.3** ± 6.6 *
Pyganic 5.0	13.5 fl. oz	Natural Plant Wash	**32.5** ± 4.3	**32.5** ± 4.3	**27.5** ± 9.7 *	**17.5** ± 3.2 *
Ecotrol EC	1% v/v		**33.8** ± 2.4	**35.0** ± 2.0	**52.5** ± 3.2	**36.3** ± 7.7
Ecotrol EC	1% v/v	Green Cypress Spreader	**33.8** ± 3.8	**27.5** ± 4.3	**20.0** ± 6.1 *	**12.5** ± 6.0 *
Ecotrol EC	1% v/v	Natural Plant Wash	**31.3** ± 2.4	**33.8** ± 5.9	**31.3** ± 6.3 *	**25.0** ± 11.4
Ecotrol EC	1% v/v	Biolink spreader sticker	**30.0** ± 2.0	**33.8** ± 9.0	**26.3** ± 6.6 *	**16.3** ± 2.4 *

* Signifies statistical significance. Arcsine transformed treatment means (n=4) (± SE) differ significantly from untreated by t-tests at $P<0.05$.
7/5 df (20,83) F=1.1797 P=0.301; **7/11** df(21,87) F=0.9991 P=0.4765; **7/18** df(21,87) F=5.2463 P=<.0001; **7/25** df(21,87) F=1.9887 P=0.0182

Table 3. T-test analyses for organic insecticide vs. insecticide + adjuvant comparisons of potato aphid % mortality in a field bioassay on tomato leaves, UC Davis, Yolo Co., 2005.

TREATMENT COMPARISON	df	t	*P*=
Agroneem vs Agroneem & A-plus	6	0.776	0.4675
Agroneem vs Agroneem & Natural Plant Wash	6	1.793	0.1232
Agroneem vs Agroneem & Biolink Spreader Sticker	6	0.845	0.4307
Neemix vs Neemix & Trilogy	6	0.433	0.6800
Neemix vs Neemix & Natural Plant Wash	6	1.026	0.3445
Neemix vs Neemix & Biolink Spreader Sticker	6	-0.311	0.7664
Pyganic vs Pyganic & Organocide	6	1.294	0.2432
Pyganic vs Pyganic & Natural Plant Wash	6	0.222	0.8314
Pyganic vs Pyganic & Biolink Spreader Sticker	6	13.527	<.0001*
Pyganic vs Pyganic & Biolink Surfactant and Penetrant	6	1.026	0.3445
Ecotrol EC vs Ecotrol EC & Green Cypress Organic Spreader	6	0.938	0.3842
Ecotrol EC vs Ecotrol EC & Natural Plant Wash	6	3.544	0.0122*
Ecotrol EC vs Ecotrol EC & Biolink Spreader Sticker	6	-0.791	0.4591
Ecotrol EC vs Ecotrol EC & Biolink Surfactant and Penetrant	6	3.126	0.0204*
GC-Mite vs GC-Mite & Biolink Spreader Sticker	6	0.670	0.5277

*Signifies statistical significance. Arcsine transformed treatment means (± SE) differ significantly from untreated by t-tests at $P<0.05$.

Table 4. Percent potato aphid mortality evaluated in the field bioassay, UC Davis, Yolo Co., 2005.

Insecticide	Rate Form. /ac	Adjuvant	Rate Form. /ac	% Mortality July 20 Mean	±	SE	
Untreated				**23.2**	±	8.4	
Warrior	3.84 fl. oz.			**100.0**	±	0.0	*
		Organocide	0.78% v/v	**54.4**	±	13.6	
		Trilogy	1% v/v	**39.9**	±	14.1	
		Natural Plant Wash	1% v/v	**40.5**	±	22.5	
Agroneem	64 fl. oz			**44.3**	±	14.8	
Agroneem	64 fl. oz	A-plus	0.13% v/v	**58.8**	±	9.2	
Agroneem	64 fl. oz	Natural Plant Wash	1% v/v	**77.1**	±	10.4	*
Agroneem	64 fl. oz	Biolink spreader sticker	0.05 % v/v	**60.4**	±	11.0	
Neemix	7 fl. oz			**32.6**	±	23.0	
Neemix	7 fl. oz	Trilogy	1% v/v	**57.8**	±	14.1	
Neemix	7 fl. oz	Natural Plant Wash (half rate)	1% v/v	**72.5**	±	12.2	*
Neemix	7 fl. oz	Biolink spreader sticker	0.05 % v/v	**32.5**	±	14.0	
Pyganic	13.5 fl. oz			**88.4**	±	1.7	*
Pyganic	13.5 fl. oz	Organocide	0.78% v/v	**92.7**	±	4.3	*
Pyganic	13.5 fl. oz	Natural Plant Wash (half rate)	1% v/v	**81.5**	±	14.6	*
Pyganic	13.5 fl. oz	Biolink spreader sticker	0.05 % v/v	**100.0**	±	0.0	*
Pyganic	13.5 fl. oz	Biolink surfactant & penetrant	0.5 % v/v	**79.1**	±	18.1	*
Ecotrol EC	1% v/v			**36.0**	±	8.7	
Ecotrol EC	1% v/v	Green Cypress Organic Spreader	0.13% v/v	**48.4**	±	10.3	
Ecotrol EC	1% v/v	Natural Plant Wash (half rate)	1% v/v	**87.5**	±	9.5	*
Ecotrol EC	1% v/v	Biolink spreader sticker	0.05 % v/v	**29.2**	±	2.4	
Ecotrol EC	1% v/v	Biolink surfactant & penetrant	0.5 % v/v	**73.7**	±	8.4	*
GC-Mite	1% v/v			**82.1**	±	11.2	*
GC-Mite	1% v/v	Biolink spreader sticker	0.05 % v/v	**81.4**	±	4.0	*
Natural Plant Wash	2 % v/v			**81.8**	±	11.9	*

Treatment means are significantly different from untreated control by t-test using arcsine transformed data at $p<0.05$

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 Notes

UCCE Tulare & Kings and Fresno Counties

Michelle Le Strange and Shannon Mueller, Farm Advisors

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Research Progress Reports

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