University of California Cooperative Extension

Vegetable Notes

Tulare and Kings Counties

SPECIAL EDITION #3: Tomatoes & Peppers

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INTRODUCTION

Michelle Le Strange, Farm Advisor, Tulare & Kings Counties

As the spring growing season starts to heat up, some areas are experiencing more rainfall than others. In higher rainfall areas or where sprinkler irrigation is used, diseases may be more prevalent, whereas in lower rainfall areas efficient irrigation management may be top priority. This newsletter contains UC research based information about peppers and tomatoes (both fresh market and processing). The goal of UC Cooperative Extension is to assist industry to improve production efficiency and product quality. If you have specific questions, your local Farm Advisors are available to assist.

2002 PROCESSING TOMATOES – CA Ag Statistics Service

County	Contracted and Open Market		
	Acres	Tons/Acre	Total Tons
Colusa	18,700	40.84	763,800
Fresno	106,900	39.29	4,200,000
Kings	13,400	37.87	507,400
Merced	18,200	35.91	653,500
Sacramento	3,900	44.62	174,000
San Joaquin	32,600	36.99	1,206,000
Solano	12,600	37.45	471,900
Stanislaus	16,600	36.45	605,000
Sutter	9,100	36.89	335,700
Yolo	41,600	36.18	1,505,000
Other Counties 1/	17,400	36.55	633,700
Total	291,000	37.99	11,056,000

1/ Other Counties = Contra Costa, Glenn, Imperial, Kern, Madera, San Benito, Santa Clara, & Tulare County

2002 FRESH MARKET PRODUCTION – CA Ag Statistics Service

Crop	Harvested Acres	Avg. Yield Cwt.	Production 1,000 Cwt.	Price per Cwt. Dollars	Total Value 1,000 Dollars
FM Tomato	38,500	300	11,550	25.40	293,370
Bell Pepper	21,000	330	6,930	28.60	197,987

Evapotranspiration & Rain – Selected CIMIS Stations – Year 2003

	Real time ET - inches				ET	Rainfall - inches				RAIN
CIMIS Station	Jan	Feb	Mar	Apr 9	Total	Jan	Feb	Mar	Apr 9	Total
Shafter – Kern	1.1	2.0	4.3	1.4	8.7	.24	1.49	.46	.14	2.33
Kettleman – Kings	1.0	2.3	4.9	1.5	9.7	.23	1.01	.65	1.20	3.15
Stratford – Kings	0.8	2.1	4.6	1.5	8.9	.33	.90	1.01	.12	2.36
Westlands – Fresno	0.8	2.14	4.6	1.5	9.0	.32	1.89	.61	.19	3.00
Firebaugh – Fresno	0.7	2.1	4.4	1.3	8.5	.51	1.42	.79	.43	3.15
Madera	0.7	1.9	4.2	1.3	8.1	.53	1.04	.73	.56	2.86
Merced	0.7	1.9	4.1	1.3	7.9	.13	.95	.92	.63	2.63
Patterson – Stanislaus	0.7	2.5	4.3	1.2	8.7	.61	1.22	1.72	.28	3.83
Modesto – Stanislaus	0.7	2.1	3.9	1.2	7.8	.58	.69	1.70	.30	3.27
Lodi – San Joaquin	0.7	1.9	3.6	1.1	7.2	.57	1.15	1.70	.54	3.96
Tracy – San Joaquin	0.9	2.1	4.2	1.3	8.5	.39	.84	.58	.33	2.14
Dixon - Solano	0.8	2.2	3.7	1.2	7.8	1.64	1.63	1.63	.24	5.14
Davis – Yolo	0.8	2.29	3.94	1.27	8.3	1.86	1.33	2.65	0.23	6.07
Zamora - Yolo	0.8	2.2	3.9	1.3	8.2	1.8	1.7	1.6	.46	5.60
Nicolaus - Colusa	0.6	1.7	3.3	1.1	6.7	2.0	1.2	3.0	.56	6.79

Managing Drip Irrigation of Tomatoes

Blaine Hanson, Irrigation and Drainage Specialist, UC Davis
Don May, Farm Advisor Emeritus, Fresno County

Introduction

Efficient irrigation water management involves knowing how much water was used by the crop between irrigations and how much water is applied during irrigation. Knowing the amount of water used requires estimating the crop's evapotranspiration (ET). The amount of water applied depends on the irrigation set time, the field flow rate, and the number of acres irrigated.

Estimating Crop ET

Crop ET between irrigations is estimated using the following equation:

$$ETc = Kc \times ETo \times I_n \qquad (1)$$

where ETc is the crop ET, ETo is the reference (or real time) ET, I_n is the days between irrigation, and Kc is the crop coefficient. The reference ET is obtained from the California Irrigation Management Information System (CIMIS). The crop coefficient depends on many factors such as crop type, canopy size, plant height, and climate conditions. Crop coefficients are found in several University of California publications.

Recent research along the west side of the San Joaquin Valley involved measuring ETc of processing tomatoes in several drip-irrigated fields. At the same time, measurements of canopy coverage were also made, where *canopy coverage is defined as the percent of the soil area shaded by the canopy at mid-day.* These data were used to develop a relationship between canopy coverage and crop coefficient (Figure 1), which shows the data points and the best-fit curved line to the data points. Thus, by measuring the canopy coverage at any time, the crop coefficient can be determined, regardless of planting time. Canopy coverage is estimated by

$$C = 100 \times W / S \qquad (2)$$

where C is the canopy coverage (%), W is the canopy width (measured with a tape measure) and S is the bed spacing. Once the canopy coverage is determined, the crop coefficient can be determined from the curved line in Fig 1.

Reference ET can be accessed over the internet at the web address www.cimis.water.ca.gov. However, historical ET can be used with a minimal error because of the relatively consistent climate from year to year. Historical ET is simply an average value calculated from many years of data. Table 1 contains historical ET (ETo) for several locations in the southern San Joaquin Valley.

How Long Should I Irrigate?

The irrigation set time needed to apply a desired amount of water during irrigation can be calculated from the following equation:

$$T_s = 449 \times A_s \times D / Q \qquad (3)$$

where T_s is the set time in hours, A_s is the acres irrigated per set, D is the desired depth in inches, 449 is a conversion factor, and Q is the field flow rate in gallons per minute. The desired depth (D) is the crop ET between irrigations divided by the irrigation efficiency expressed as a decimal fraction. An irrigation efficiency of about 85% is recommended if the actual value is unknown.

The Problem of Solids in Processing Tomatoes

A concern with drip-irrigated processing tomatoes is unacceptable soluble solids. Earlier studies have reported that by either cutting back on irrigation water or cutting off the water near harvest can increase the solids content however, yield is reduced. Results of a three year study at the UC West Side Research and Extension Center showed that as a compromise between yield reduction and solids increase, cutting the irrigation water application about 60 days before harvest to about 75% of the potential evapotranspiration reduced crop yield by about 6%, but solids were increased to acceptable levels.

This result may not occur where shallow ground water conditions exist or where large amounts of stored soil moisture are available near harvest time. However, other UC research has shown acceptable levels of soluble solids occur under drip irrigation in salt affected soil.

Example: Determine the irrigation set time needed for the following data for a field irrigated every 3 days near Five Points:

Time period: June 1-15 — Bed spacing = 60 inches
Acres irrigated per set = 80 — Canopy width = 36 inches
Field flow rate = 1500 gpm

1. From Table 1, historical ETo equals 0.29 inches per day for the Five Points CIMIS station
2. Canopy coverage equals 100 x 36 in / 60 in = 60%
3. From Figure 1, Kc equals 0.86 for a canopy coverage of 60%
4. Crop ET equals 0.86 x 0.29 inches per day x 3 days = 0.75 inches
5. The desired depth of application is 0.75 / 0.85 (irrigation efficiency) = 0.88 inches
6. The irrigation set time is 449 x 80 acres x 0.88 inches / 1500 gpm = 21 hours.

Figure 1: Relationship between Canopy Coverage and Crop Coefficient

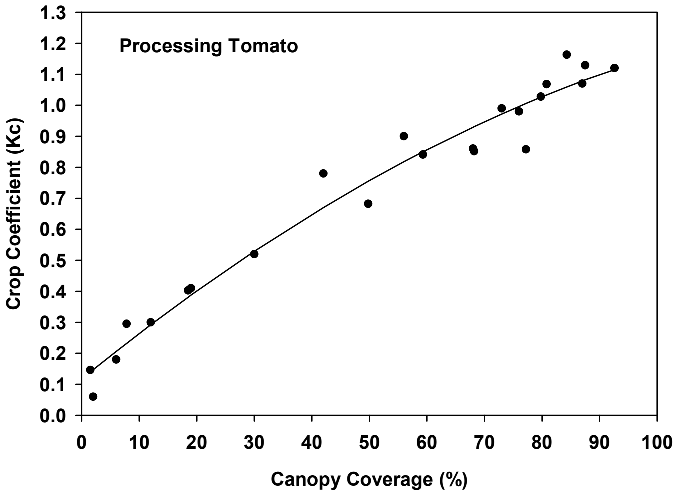

Table 1. Values of Historical ET for Several Locations in the Southern San Joaquin Valley

		SHAFTER	FIVE POINTS	PARLIER
		-- inches of water per day --		
JAN	1-15	.03	.04	.03
	16-31	.05	.05	.04
FEB	1-15	.07	.06	.06
	16-30	.09	.09	.08
MAR	1-15	.11	.11	.10
	16-31	.14	.15	.13
APR	1-15	.19	.20	.17
	16-30	.20	.22	.19
MAY	1-15	.24	.26	.22
	16-31	.26	.27	.24
JUN	1-15	.27	.29	.26
	16-30	.28	.30	.27
JUL	1-15	.28	.30	.27
	16-31	.26	.28	.25
AUG	1-15	.25	.28	.24
	16-31	.23	.25	.22
SEP	1-15	.21	.23	.19
	16-30	.18	.20	.15
OCT	1-15	.16	.17	.13
	16-31	.12	.13	.09
NOV	1-15	.08	.10	.07
	16-30	.06	.07	.04
DEC	1-15	.05	.05	.03
	16-31	.03	.03	.02

California Irrigation Management Information System
www.cimis.water.ca.gov

CIMIS is a state agency that serves the public free of charge. Register your name, enter a password and then you can access detailed weather information and tailor reports to fit your need. It's easy to use.

There are 189 weather stations around the state try a few in your area.

Hourly, daily, weekly, monthly weather information is available. Reports are fast and easy to download. ETo variance report provides a comparative view of ETo for stations and date range you specify and compares it with last year's values and historical average. Very useful.

DUAL MAGNUM® USE IN TOMATOES:
Federal label approved, CA label progresses, Section 24-C granted

The USEPA has recently approved a food tolerance and federal label for Dual Magnum (s-metolachlor) manufactured by Syngenta. California Department of Pesticide Regulation is now able to begin work on a full California label, but the process will take some time.

For the last two years this preemergence herbicide for nutsedge control has had a Sec 18 emergency use label. Now that Sandea, a postemergence herbicide that specifically controls nutsedge has become available, there is no current emergency need for Dual. However since its introduction Dual has gained wide grower interest as it is a very effective preplant treatment for transplants, and an alternative product to use on sandy ground where Eptam (EPTC) cannot be used.

A few days ago CDPR announced that copies of the 24-C label for Dual Magnum will be available from local Agricultural Commissioners beginning Wednesday, April 9th. You can only begin use of Dual Magnum when the supplemental label is in your possession. CA Tomato Research Institute has been instrumental in staying on task with this registration process.

Bacterial Speck Control in Tomatoes

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

Bacterial speck can be a major spring-time foliar disease of tomato. The pathogen, *Pseudomonas syringae* pv *tomato,* favors cool, rainy weather conditions. Disease can develop on young seedlings as well as mature plants. Greater impact appears to occur at earlier crop growth stages. Plant vigor can be reduced along with yield and soluble solids.

The symptoms of the disease on foliage are dark lesions often initially surrounded by yellowing tissue. Margins of the leaves, where moisture collects, may be most affected. While symptoms on leaf margins may be confused with salt burn, speck also infects stems, branches and fruit.

Disease Outbreak and Spread

Major disease outbreaks are usually not the result of a single rain event. A series of storms followed by overcast days with cool temperatures increase risk of outbreaks. Weather conditions that maintain high leaf wetness such as morning dews, extend conditions favorable for disease development. Switching from sprinkler to furrow irrigation during favorable disease conditions is helpful.

In fields with a recent history of speck, rotation out of tomatoes can reduce the incidence of speck in succeeding years. Since the disease can survive in debris of diseased tissue, tillage to cover the residue more thoroughly is helpful.

Resistant varieties offer an effective control measure. However, even when speck resistant varieties are used, remain vigilant when disease conditions are favorable as resistant strains exist. Another reason to continue to monitor fields is other common bacterial pathogens exist, such as bacterial spot (*Xanthomonas campestris*).

What about Chemical Controls?

Copper is effective in reducing infection when applied as a preventive application. Mancozeb (e.g. Dithane®) tank mixed with copper slightly increases effectiveness, although EBDCs are not allowed by some processors.

Application timing may be the most important factor in controlling bacterial speck. While a preventive spray may not be economically warranted, an application made at first sign of the disease is more reasonable. The ability to accurately forecast weather conditions helps guide management. Repeat applications may be required if rainy weather conditions persist. Note that resistance to copper exists, and at best, copper is only partially effective in reducing the impact of susceptible strains.

The chemical control program is only a temporary mechanism to reduce the disease level until warmer, dryer weather arrests the disease. UC field research funded by the California Tomato Research Institute helped develop this information regarding chemical control of bacterial speck.

For More Information

Visit the UC IPM website for additional information and close-up pictures of disease symptoms in the Tomato Pest Management Guidelines at:
http://www.ipm.ucdavis.edu/PMG/crops-agriculture.html.

Developing an Anti-resistance Strategy against Fungal Pests by Understanding Fungicide Classes and Modes of Action

Jan Mickler, Farm Advisor, Stanislaus County

Tomato Diseases

Tomatoes are susceptible to a number of soilborne and foliar fungal diseases with the potential to reduce fruit yield or quality. Control practices for soilborne diseases causing wilt, corky root, white mold, and southern blight are limited to the use of cultural practices such as crop rotation, resistant varieties, and delayed planting. Soil and seed fungicide treatments are available for use against seed and seedling damping off, caused by *Pythium*, *Phytophthora*, and *Rhizoctonia* spp., and root rot caused by *Phytophthora parasitica*; however, applications are typically used only in fields prone to heavy losses by these pathogens. For the majority of fields, damping off and Phytophthora root rot are managed using non-chemical approaches.

In contrast, fungal diseases affecting tomato foliage or stems are predominantly controlled by fungicide applications. The primary diseases of concern to California tomato growers are early blight (*Alternaria solani*), late blight (*Phytophthora infestans*), powdery mildew (*Leveillula taurica*), black mold (*Alternaria alternata*), and gray mold (*Botrytis cinerea*).

The prevalence and severity of any one of these diseases is dependent upon environmental conditions and plant health. In addition to these diseases, fungicides are also applied to tomatoes for the management of bacterial speck (*Pseudomonas syringae* pv. *tomato*) and bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*).

Develop an IPM Control Strategy

Growers and PCAs will likely be faced with at least one fungal or bacterial disease each season that requires one or more fungicide applications. It's critical to develop a strategy integrating non-chemical and chemical approaches to avoid developing resistance in target pest populations.

Developing an effective strategy requires correct disease identification and knowledge of the:

1. Pathogens typically encountered in the specific production area and their biology,
2. Fungicides labeled for use against these various pathogens,
3. Mode of action, or classification, of the various fungicides, and
4. Application strategies that will maximize fungicide efficacy while avoiding resistance development in one or more pathogen populations.

Improper identification of crop pests (insects, weeds, fungi, bacteria) is the primary reason for pesticide failures. This is because pesticides are developed to control only a specific range of pests. Appropriate fungicide selections can only be made when the disease is correctly identified.

Understanding the biology of tomato fungal pests is invaluable to an integrated pest management program. Knowing the temperature and moisture requirements that favor the pathogen's growth and mode of dispersal (e.g., splash, wind, irrigation water) can assist growers and PCAs in scheduling disease monitoring programs. In the case of late blight, data obtained from weather stations can be used for input into the "blight cast" disease forecasting systems. The information gathered from monitoring and forecasting efforts should provide the information necessary for making chemical disease management decisions.

Fungicide Classes

There are many fungicides labeled for use against the various fungal pathogens of tomato (Tables 1 and 2). *Fungicides are often categorized as either multi-site inhibitors (Table 1) or single-site inhibitors (Table 2).* This differentiation provides us with an idea of the relative risk of resistance developing in a fungal population.

For example, the coppers and the dithiocarbamates, some of the earliest materials used in agriculture, are applied as preventative or contact fungicides. These contact fungicides are considered multi-site inhibitors because they react with a variety of fungal proteins, or enzymes, resulting in their inactivation. *The development of resistance among fungi exposed to multi-site inhibitors has been negligible because the risk of major structural changes occurring in fungal protein, cell wall, or cell membrane chemistry is small.*

Single-site inhibitors have protectant and therapeutic properties. These fungicides move systemically through the plant and inhibit fungal growth by acting at specific molecular sites.

For example, the recently introduced strobilurins azoxystrobin (Quadris), pyraclostrobin (Cabrio), and trifloxystrobin (Flint), act by blocking the oxidation of ubiquinol, a specific site in the respiration process. *The development of resistance to strobilurin-type fungicides in certain fungal populations has been attributed to a single mutation at the respiration site where strobilurins act.*

Resistance development among fungal populations is more of a concern with single-site inhibitor use than multi-site inhibitor use because only a small change in the fungus is necessary to block the action of site specific fungicides.

The rate at which fungal populations develop resistance increases with repeated and widespread use of any one particular single-site fungicide (e.g., metalaxyl).

General Recommendations

To delay or avoid pest resistance to fungicides:

1. Rely on scouting and disease forecasting programs for decision-making.
2. When feasible, use cultural practices, including crop rotation, instead of pesticides for disease control.
3. Use fungicides in a preventative, not curative, spray program.
4. Rotate among the fungicide groups using materials with different modes of action. For example, one would **NOT** want to use a 7-10 day spray schedule of Quadris/Cabrio or Quadris/Flint for late blight control because they share the same mode of action. A Quadris/Bravo or Quadris/Kocide rotation would delay resistance because the compounds differ in site of activity.
5. Use labeled rates.
6. Obtain thorough coverage of foliage. This means ground applications of fungicides on plants with dense canopies.
7. Use tank mixes of different pesticides to control a single pest. Use of mancozeb and maneb in mixes has been used in the past. These compounds will most likely be lost after EPA review because they are considered to be carcinogens and air contaminants.
8. Keep up to date on the status of pest sensitivity to popular single-site fungicides.

Table 1. 2003 Registered Fungicides with Multiple Sites of Activity

Fungicide Class	Common Name	Trade Name	Disease Controlled	Mode of Action
Inorganic	Sulfur	Sulfur	Powdery Mildew	Inhibits respiration
Copper	Copper hydroxide Copper oxychloride + copper sulfate	Kocide C-O-C-S	Anthracnose Early blight Late blight Bacterial speck Bacterial spot Gray Mold Early blight Late blight Bacterial spot	Inactivates enzyme systems
Dithiocarbamate (polymeric)	Mancozeb Maneb	Dithane Manex, Manzate	Anthracnose Early blight Late blight Gray Mold Bacterial speck and spot (must mix with fixed copper) Damping-off (seed treatment) Anthracnose Late blight	Inactivates enzyme systems
Pthalimide	Chlorothalonil	Bravo	Early blight Late blight Gray Mold	Inactivates enzyme systems
Chlorophenyl	Dichloran PCNB	Botran Terrachlor	Botrytis stem canker Rhizoctonia damping off White mold	Unknown

Table 2. 2003 Registered Fungicides with Single Site of Activity

Fungicide Class	Common Name	Trade Name	Disease Controlled	Mode of Action
Triazole	Myclobutanil	Rally	Powdery mildew	Inhibits sterol synthesis (at different site than Acrobat)
Acylamine	Mefenoxam (previously metalaxyl)	Apron Ridomil Gold	Pythium damping off (seed treatment) Phytophthora fruit & root rot Pythium damping off Late blight	Inhibits RNA synthesis
Carbamate	Propamocarb-HCl	Previcur	Late blight	Unknown
Benzimidazole	Benomyl	Benlate	Gray mold White mold	Inhibits nuclear division
Strobilurin	Azoxystrobin Trifloxystrobin Pyraclostrobin	Quadris Flint Cabrio	Anthracnose Black mold Phytophthora fruit rot Early blight Late blight Powdery mildew Early blight Late blight Anthracnose Early blight Late blight Powdery mildew	Inhibits respiration
Morpholine	Dimethomorph	Acrobat	Late blight	Inhibits sterol synthesis (at different site than Rally)
Organo-tins	Fosetyl-Al	Aliette	Phytophthora root rot Damping off (*Pythium*)	Plant defense activator
Unclassified	Acibenzolar-S-Methyl	Actigard	Bacterial speck Bacterial spot	Plant defense activator

Cultural Control of Tomato Late Blight

Joe Nuñez, Farm Advisor, Kern County

Late blight is a destructive disease of potato and tomato in all growing regions of the world. This disease first gained notoriety 150 years ago as the cause of the "Potato Famine of Ireland and Northern Europe." Today it is again causing widespread problems as new strains of the fungus have begun to appear in North America and Europe. With the development of these more aggressive strains, growers need to use all methods of control to their fullest potential.

Cultural control is a method that can greatly reduce the impact of late blight and should be part of every grower's disease management strategy. The goals of a good cultural control program are to prevent introduction of inoculum, reduce inoculum buildup, reduce infection rate, and create conditions *unfavorable* for disease development. Growers can achieve these goals by incorporating several different techniques into their farming operation.

Inoculum Sources

For transplant tomatoes it is important to make sure that the initial source of disease is not infected transplants. Check transplants before planting and refuse plants that show signs or symptoms of late blight. Early signs of late blight on transplants can be difficult to identify and may need confirmation by a qualified expert.

Other potential sources of inoculum are potato cull piles and volunteer potatoes and tomatoes. Although not common in most parts of the San Joaquin Valley, infected tubers from potato cull piles can produce a tremendous amount of air borne spores that move by wind to shower onto nearby fields. Volunteer potatoes and tomato plants can be overwintering sites and are another important source of the pathogen. Eliminating any near-by potato cull piles and destroying volunteer tomato and potato plants helps limit the initial source of inoculum in a region.

Early Detection is Critical

Late blight is a very explosive disease that can appear suddenly and move through a field or area very quickly. Regularly scouting tomato fields is important for early detection. Early detection of late blight allows time for quick appropriate action before the disease has a chance to spread to other parts of the field or release an incredible amount of spores into an even wider area.

The use of late blight computer models may be beneficial as an early warning system of potential late blight development. The use of models helps time fungicide applications just before late blight actually appears and when repeat applications are needed, thus reducing the risk of crop loss and the number of fungicide applications.

Diagnostic kits are another tool that can be used for early detection of the disease. Kits are available which help quickly confirm or refute whether a questionable lesion is caused by the late blight fungus. Regular field scouting, computer prediction models, and diagnostic kits are all methods of early detection so appropriate action can be taken quickly.

Act Quickly

Spot killing infected plants when the disease first appears will slow the spread of spores to other parts of the field. Plants can be quickly destroyed by burning or with the use of a fast acting herbicide. This method of cultural control will only be effective when blight first appears in a field or region. Once late blight is established in an area then the likelihood of influencing the amount spores in that area becomes negligible.

Crop Management Strategies

Changing the climatic environment around the plant so that it is less conducive to late blight can also help reduce late blight severity. Late blight spreads and develops when conditions in the canopy are moist and humid. Sprinkler irrigation creates an ideal environment by keeping the canopy wet for long periods of time. If possible, avoid sprinkler irrigation after stand establishment. Dense canopies also prevent fungicides from penetrating down into the lower leaves and stems of plants.

Excessive nitrogen is a negative factor because it promotes large dense canopies which prevent air movement for drying of leaves. Fertilizer management can be used to a grower's advantage by making sure that the plant canopy is not unnecessarily inviting to this fungus.

Excessive nitrogen also increases the susceptibility of tomato plants to infection. The late blight fungus prefers lush, young, actively growing tissue over stressed, senescing tissue. Excessive nitrogen will promote lush vegetative growth and delays maturity, which increases the chance of infection and prolongs the period that the crop is susceptible to late blight infection.

Unfortunately, plant resistance is not currently available in any commercial tomato plants.

Summary

These are all examples of cultural control methods that help manage this destructive disease. Although it may not be possible to incorporate all of them, the more cultural control methods employed then the more effective overall disease management will be.

Tomato Late Blight: Disease Facts and Observations

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

Late Blight is an aggressive, destructive disease of tomato. When weather conditions are mildly warm with rainy or wet conditions, fungicides are needed to keep the disease under check. Early timed, preventive treatments are essential, as is follow up with another fungicide application within a week or so, if favorable conditions persist. UC Extension Plant Pathologist Mike Davis stresses these key tips in a late blight spray program, arranged in order of importance:

- Thorough spray coverage,
- Frequent fungicide applications when disease pressure is high, and
- Selection of effective fungicides.

When the management strategy calls for early, frequent fungicide treatments with the possibility of a long duration of disease pressure, low-cost materials become critical for economical and effective control programs. Multiple fungicide applications are required if disease pressure extends over a couple of weeks. Once the disease builds within a field, effective chemical control is much harder to achieve.

El Niño brought substantial rainfall during 1998 including favorable conditions for late blight. In fields near Woodland in Yolo County, the general patterns I observed included:

1. Fields treated with Dithane combined with copper to control bacterial speck had much lower late blight severity than non-treated fields.
2. Earlier planted fields with larger canopies were more impacted than later plantings.
3. Stem lesions were very prevalent.
4. Infestations were hard to stop with fungicides once disease became widespread in a field.
5. Withholding irrigation during the high disease period reduced disease level.

That same season Mike Davis reported that lab results from late blight samples collected statewide indicated 100% of the isolates were resistant to Ridomil (metalaxyl) and that the predominant strain was US-11.

Recent Research Results in Tomato Late Blight Control with Fungicides

Bob Mullen, Farm Advisor, San Joaquin County

Late blight (*Phytophthora infestans*) is a recurring problem in tomato growing areas of the Central Valley. Concern is heightened with regard to field infection in 2003 due to the presence of aggressive metalaxyl – resistant strains of the disease (like US-11) and the prospect of weather conditions favorable for disease development this spring and summer. Consequently, the need for evaluation of new chemical and/or biological fungicides that might provide protective and/or systemic control of late blight has become increasingly urgent.

Field Trials

For the past 7 years trials have been conducted in the Northern San Joaquin Valley near Stockton, California. What follows is a brief summary of trials in 1998, 1999 and 2000 where the disease occurred in the field. There were virtually no reports of field infection in 2001 and 2002 because climatic conditions did not favor disease development.

Trial initiation in all three years relied on the use of a disease forecasting weather station. Once a "Blight Cast" occurred, treatments were begun using a handheld $C0_2$ backpack sprayer with 8004 nozzles at 30 psi and a spray volume of 50 gallons per acre water. Fungicides were applied alone or alternated with another material on a seven-day spray schedule.

Data in the following table focus on registered fungicides – Bravo Ultrex (chlorothalonil), Dithane/Manzate (mancozeb), Quadris (azoxystrobin), and the recently registered Acrobat (dimethomorph) and Cabrio (pyraclostrobin).

Other effective materials were also evaluated over the period (1998 – 2000) including Previcur (propamacarb), Gavel (zoxamide + mancozeb), Tanos (famoxadone + cymoxanil), KQ667 (famoxadone + mancozeb), and Reason (fenamidone), but these products are <u>not currently registered for use on tomatoes in CA.</u>

Results and Discussion

The 1998 trial had the most severe late blight infection. This proved to be an El Niño year, where infections occurred from the mid Sacramento Valley to Fresno County on both fresh market and processing tomatoes. Almost all treatments in the trial demonstrated good efficacy against the disease and gave greater fresh market tomato yields than the untreated control.

The 1999 trial experienced only a light to moderate occurrence of late blight but again almost all treatments showed good disease control with superior yields compared to the untreated control.

The 2000 trial only resulted in light to moderate late blight infection; but all treatments gave good to excellent disease control and outyielded the untreated control. Yields were lower than the previous two trials as a result of the presence of some powdery mildew infection as well. While the newly registered Acrobat and Cabrio only appear in one of the three trials, studies elsewhere have demonstrated very good efficacy in controlling late blight.

What about This Year?

As the 2003 tomato season unfolds, a number of effective fungicides are available to growers. They should be used in conjunction with a weather station that monitors relative humidity, temperature and leaf wetness to optimize spray applications as conditions for favorable disease development occur.

A particular fungicide should not be applied as a "stand alone" treatment but rather alternated with other fungicides having a different mode of action. This will help prevent the development of fungicide resistant strains of a disease like late blight. For example strobilurin fungicides like Quadris and Cabrio could be alternated with Bravo, a pthalimide (also called isothalonitrile) fungicide, or Dithane/Manzate, a dithiocarbamate fungicide. Acrobat, another fungicide choice, is in the morpholine class (also called a cinnamic acid derivative).

Also, if at all possible, apply fungicides with ground sprayer equipment and adequate spray volume (50 gallons per acre water for example) to ensure maximum tomato plant coverage. Aerial applications are only partially effective with most fungicides due to the difficulty of getting materials down into the plant canopy because of the low spray volumes used with aircraft, thereby reducing efficacy against pathogens like late blight.

Research will continue on the investigation of current and new fungicide chemistry that will insure a strong preventative and curative program for Late Blight management in both processing and fresh market tomatoes.

Table 1. Selected Fungicide Efficacy Results on Tomato Late Blight (1998 – 2000)

Treatment	Rate lb/Acre a.i.	Crop Disease Rating [1]			Market Yield T/A [2]		
		1998	1999	2000	1998	1999	2000
Bravo Ultrex	1.40 or 1.50	1.6	1.4	1.0	18.6	18.4	11.4
Bravo Ultrex/ [3] Quadris	1.40 or 1.50/ 0.10	1.4	1.1	1.3	19.8	16.9	15.1
Quadris	0.10	1.4	---	---	22.1	---	---
Acrobat	0.20	---	1.3	---	---	21.2	---
Bravo Ultrex/ Acrobat [3]	1.40/ 0.20	---	1.1	---	---	18.1	---
Cabrio	0.15	1.9	---	---	19.5	---	---
Dithane or Manzate	1.50	1.8	---	1.9	18.1	---	14.6
Untreated Control	---	4.6	2.4	3.1	15.4	15.8	11.0
		LSD @ 5%:			5.0	3.4	4.1
		CV=			18.3%	13.0%	21.1%

[1] Average of four replications and the following disease severity rating scale:

Disease Severity Rating – Barratt / Horsfall System

Scale	0	1	2	3	4	5	6	7
% Plants Infected	0	0-3	3-6	6-12	12-25	25-50	50-75	75-88
% Plants Healthy	100	97-100	94-97	88-94	75-88	50-75	25-50	12-25

[2] Average of four replications

[3] Fungicides were alternated during the 7 day application schedule

Root-Knot Nematodes in Tomato

Antoon Ploeg, Extension Nematologist, UC Riverside
Antonio, Lopez-Perez, Visiting Postgraduate Researcher, UCR

Tomatoes can be attacked by a wide variety of plant-parasitic nematodes, but in CA, problems are almost always caused by root-knot nematodes. Root-knot nematodes (*Meloidogyne* spp.) are economically the most important nematodes of numerous crops, in California and the world. Nematodes are "sedentary endoparasites", meaning that they stop moving after having entered the root tissue. Other vegetable crops that host root-knot nematodes are eggplant, potato, sweet potato, pepper, carrot, cucumber, and melon.

Lifecycle of Root-Knot Nematodes

The life-cycle of all root-knot nematodes is very similar. Nematode eggs are in the soil and can survive for several months without a host. Soil temperature largely determines the time of egg-hatch. Second-stage juvenile, worm-shaped nematodes (J2's) hatch from eggs and start moving through the soil. They must find a host plant within a few weeks or their energy supply runs out. When they do find a host root, they enter it, usually close to the root-tip. This area of root is actively growing and provides an excellent supply of food for the nematodes.

Once inside roots, juveniles stop moving and establish a specialized "feeding site", consisting of several enlarged cells. Roots respond to nematode invasions by forming galls, a typical symptom of root-knot nematode infestation. As nematodes develop in the roots their shape changes from worm-like juveniles (J2's) to melon-shaped females.

Females deposit a cluster of eggs (200 to 400) that bursts through the outside of the roots. Eggs are contained in a gelatinous material, which prevents the eggs from drying out and protects them from infection by fungi and bacteria in the soil. If soil temperatures are still favorable, the next generation of juveniles will hatch or the eggs can remain in the soil long after the crop is harvested and remain alive until the next season.

During fallow periods, nematodes survive and multiply on several common weed species such as velvetleaf, lambsquarter, nightshade, and London rocket.

Three Species are Important in CA Tomato

Within the root-knot nematode group, there are many different species, but in CA three species are important in tomato: *M. hapla* (or the Northern root-knot nematode), *M. incognita*, and *M. javanica*, All three species are found more frequently in light to medium-light soil types, but they also occur in heavier soils.

There are some important differences between *M. hapla* and the other two species. Symptoms by *M. hapla* are generally less dramatic, consisting of small (3-6 mm) but numerous galls. Small lateral roots often grow from the galls, giving the roots a hairy or "bearded" appearance. *M. hapla* is found primarily in the cooler climates of coastal areas in the south and in the Northern part of the state.

Symptoms by the other two species are very similar and, on tomato, consist of severe galling, that may encompass the entire root system. Both *M. javanica* and *M. incognita* prefer warmer conditions, and are widely distributed in the inland areas of Southern and Central California.

Plant Symptoms

Diagnosis of root-knot nematode infestations on above-ground symptoms is difficult. Plants may be stunted, chlorotic, wilt in spite of sufficient soil moisture, and die prematurely. In addition, root-knot nematodes make plants more susceptible to other diseases like *Fusarium* wilt.

Symptoms of root-knot nematode infestation in tomato after 3 months. From left to right: no nematodes, 100, 1000, & 10,000 eggs per pot.

Tomato roots 3 months after inoculation with 10,000 M. incognita eggs per 1 gallon pot

susceptible **resistant var. 1** **resistant var. 2**

Resistant Varieties

Tomato is one of the few crops where resistant varieties are available to control or manage root-knot nematode. These varieties all originate from a single crossing, and therefore they rely on the same mechanism of resistance (*Mi*-gene). Nematodes still enter the roots, but are unable to establish a proper feeding site once inside. Without nourishment the nematodes are unable to complete their development and die before they mature into females.

Resistant varieties are resistant against root-knot nematode species M. incognita and M. javanica, but NOT against M. hapla. Also, the resistance fails when tomatoes are grown at relatively high soil temperatures (> 81° F). In addition, a high nematode pressure may still result in galling and some nematode reproduction, even in resistant varieties. We have observed a considerable difference in the degree of root galling and nematode reproduction between different "resistant" varieties.

Alternative Strategies - No Easy Solution

Apart from using nematicides to control root-knot nematodes, a variety of alternative strategies can be used, but each has drawbacks. Examples include;

- crop rotation (difficult due to the wide host range of the nematodes),
- soil solarization and/or biofumigation (dependent on weather, therefore not suitable in all areas),
- nematicidal or antagonistic cover crops or trap crops (land out of production, direct costs of water, fertilizer, seeds),
- "bio-rational" nematicides (mostly only experimental data available),
- adjustment of planting dates (not feasible for all crops).

Although these methods have been shown to control root-knot nematodes, they may need to be combined or alternated with other practices (such as using resistant varieties) to achieve long term nematode control.

Time of Weed Emergence and Critical Periods in Crops

Anil Shrestha, IPM Weed Ecologist, Kearney Agricultural Center

A crop is usually planted at an *optimum time* during the year to obtain *optimum yields*. This *optimum time* is based on environmental factors that influence crop growth and development. Weeds, on the other hand, emerge at different times during a crop's growing season. This occurs because:

- weeds include many plant species with different lifecycles, emergence patterns, and environmental requirements for growth,
- weeds are adapted to a wide range of temperature, moisture and light conditions which enables them to germinate and emerge in several flushes,
- weed seeds (or other reproductive parts) are distributed at different soil depths and emergence can be influenced by soil type, and
- weed emergence is influenced by crop rotation and weed control history (e.g. residual herbicide persistence).

In day-to-day farming operations a "logistics engineer" is sometimes needed to plan equipment and labor assignments to various fields. Questions arise like:

- Is time of weed emergence important for success in weed control?
- How long can we let weeds grow in a crop before they cause yield loss?
- Do weeds cause yield loss throughout the entire crop growing season?

Time of weed emergence is very important

The general finding in annual crops is that time of weed emergence compared to crop emergence is important. From a crop-weed competition standpoint, the most important phase of a weed's lifecycle is at its time of emergence. At this time weeds exhaust the nutrients in their seeds or underground storage organs and start to rapidly take up nutrients and moisture from the soil. Weeds that emerge with or just before the crop cause greater yield losses than weeds of the same species emerging later. Weeds that emerge after the crop is established are less competitive for light, water and nutrients. There are some exceptions to the rule, because not all weed species are equally competitive.

In general, early emerging weeds pose the greatest threat to crop yields and should be controlled chemically or mechanically before planting or at an early stage of crop growth. Later-emerging weeds are less competitive but are still a concern because of their interference with harvest operations and their seed production.

Proper timing of weed control

The success of weed control operations depends on the time of weed seedling emergence, weed species and stage of crop growth. If the operation (mechanical or chemical) is too early, there could be a lot of 'weed escapes' because of a loss in the effectiveness of the preemergence herbicide, or very few weeds may have emerged for either postemergence herbicide or mechanical control to be successful. If the operation is too late, weeds may be too mature to be susceptible to herbicides or mechanical control, the crop may be too big for mechanical control to be feasible, or the crop may be at a very sensitive stage to chemicals.

Therefore, the strategy should be to control early emerging weeds and not wait for late weed flushes. Weeds that emerge later in the season will have minimal impact on crop yield and their seed production will also be reduced by crop competition.

Critical Period for Weed Control

To prevent yield loss it may not be necessary to control weeds for the entire crop growing season. There is a certain window during the crop's life cycle when it is most susceptible to competition from weeds. *This "critical period for weed control" is defined as the time-interval during which weeds must be controlled to prevent unacceptable yield losses.* Weed control outside this window may not be necessary other than to prevent possible interference in harvest operations and/or weed seed production.

Critical periods for weed control vary by crops and weed species present

Critical periods for weed control differ between crops and are based on their competitiveness with weeds. Crops like carrot, lettuce, pepper, cole crops, and onion establish very slowly and/or do not have the necessary architecture to rapidly shade out weeds. Whereas, crops like squash, beans, and cucurbits grow rapidly and do shade out weeds. Method of planting also influences critical periods for weed control. Transplanted crops have an early start over weeds and are more competitive than direct seeded crops.

Critical period for weed control in transplanted tomatoes: The critical period for weed control in transplanted tomatoes varies from 6 to 8 weeks. During this period, weed competition should be avoided to prevent yield loss. After 6 to 8 weeks, tomatoes become more competitive and are usually less affected by late germinating weeds. This period can be influenced by the type of weed species present. For example, a study in Florida showed that tomatoes had to be kept free of purple or yellow nutsedge for 2 to10 weeks after transplanting to avoid yield losses above 5%. To prevent yield losses greater than 10%, purple nutsedge had to be suppressed 3 to 6 weeks after transplanting, whereas yellow nutsedge had to be suppressed 4 to 9 weeks.

Critical period for weed control in peppers: Peppers, whether transplanted or direct-seeded, are very poor competitors with weeds early in the season. The critical period of weed control in direct-seeded bell pepper extends past 8 weeks, i.e. up to the flowering and fruit set period. Crops like bell pepper have to be kept weed-free for almost its entire growing season to avoid significant yield loss.

Critical period for weed control in cucurbits: Cucurbits are good competitors with weeds because the vines grow rapidly and shade the weeds. The critical period for weed control in cucumbers, for example, has been found to extend only up to 3 weeks after emergence.

The Bottom Line

Time of weed emergence relative to the crop is important in determining the outcome of crop-weed competition. There is a critical period in a crop's life cycle when it is most susceptible to competition from weeds. This critical period varies by crop and by weed species' present. The success of a weed management program depends on matching control strategies to the relative crop and weed growth stages. In general early weed removal is essential to minimize yield losses.

Weeds emerging after the critical period may only be a concern for interference in harvest operations and weed seed production. Therefore, weed management is a continuous process that involves an assessment of the types of weed species present, their dynamics of emergence, their distribution, their stage of development, and their potential for seed production.

Sandea® Herbicide for Nutsedge Control: Approved for Use in CA Tomatoes

Sandea (halosulfuron) marketed by Gowan Company received label approval for use in California tomatoes in 2003. Several UC Farm Advisors and Weed Specialists tested this product at several rates in various vegetable crops for nutsedge and broadleaf weed control in 2000-2002.

Sandea may be applied post emergence over the top to direct-seeded tomatoes and post-transplant to tomato transplants. The herbicide may also be applied between rows of direct-seeded or transplanted tomatoes. Low use rates and no requirement for mechanical incorporation make it easy to use. A non-ionic surfactant is needed to improve herbicide efficacy. Several use precautions including timing of organophosphate insecticide applications are listed on the label. Some plant back restrictions apply.

Weed resistance: Repeated use of herbicides with similar modes of action can result in the development of resistance in weed populations. Sandea, a member of the sulfonylurea family, is an ALS enzyme inhibiting herbicide. To minimize the potential for resistance development use a variety of cultural, mechanical, and chemical weed control tactics and rotate with herbicides having other modes of action.

The label can be downloaded from several websites:
Crop Data Management Systems: http://www.cdms.net/pfa/LUpdateMsg.asp
Gowan Co.: http://www.gowanco.com

2002 Bell Pepper Variety Evaluation Trial

Bob Mullen, Farm Advisor, San Joaquin County

The Central Valley is a major area of bell pepper production in California. The requirement for varieties that have high yield potential and possess excellent horticultural characteristics is essential to the continued economic health of the pepper industry.

Pepper Problems

Most production occurs during midsummer into late fall. Because a substantial acreage of the crop is harvested during a period of shorter days with cool, humid nights, diseases (*black mold, gray mold (Botrytis cinerea), phytophthora root rot*, etc.) and physiological disorders (*sunburn, pepper spot, blossom-end rot*) are always potential problems for producers. More recently, a complex of virus diseases (*cucumber mosaic, pepper mottle, tobacco etch, potato virus Y, ring spot, and/or tobacco mosaic virus*) have occurred, resulting in serious losses. Frustration with the virus problem has led some growers to reduce or completely get out of pepper production.

Additionally, *pepper spot/black spot (STIP*) has been a problem on some varieties grown under short day, cool night conditions, i.e., late summer/fall, and along the coast. A calcium nutritional imbalance in the peppers may be contributing to the pepper spot problem. Circular, gray-black spots develop under the skin in the fruit wall of some pepper varieties about the time fruit attain a size diameter of three or more inches. As fruit ripen, the spots slightly enlarge and turn green or yellow, rendering the affected fruit unmarketable. Some newer hybrid varieties show some resistance or tolerance to the physiological problem.

Variety Evaluation Trial

Since there are new pepper cultivars available to producers, information on yield, fruit quality, and disease resistance or tolerance levels, is useful for the industry. A field trial was conducted at Biglieri Farms in northeast San Joaquin County, near Dry Creek, to look at yield and fruit quality of established and new bell pepper lines (including some yellow-fruited lines and one multi-colored line) from commercial seed company breeders. Fruit wall thickness and pepper spot (STIP) incidence were also evaluated.

The variety trial was transplanted on June 18, 2002, and the field variety was Baron. The soil type at the trial site was a San Joaquin loam, and the field was furrow irrigated throughout the season. The resulting crop stand was excellent with vigorous plant growth and very good fruit set. Climatic conditions over the growth period were warm with a few hot days. The trial contained 12 replicated varieties, including the field variety, along with 12 additional lines in single replication observation plots. The trial was hand harvested on September 18, 2002. In addition to marketable yield, data on crop maturity and fruit size were taken, as well as fruit wall thickness by averaging 5 cut fruit per sample.

Results

Replicated Varieties - Table 1: Highest yield of red and green colored marketable fruit occurred with Double Up, followed by Encore, HA-959 (Golden Sun), a nice semi-long yellow-fruited line, Mar Rojo, HA-535 and Karma. Other yellow-fruited cultivars in the replicated trial were Shemesh and HA-831 (Labrador).

Best quality fruit, including blocky shape, fruit shape and good fruit wall thickness, was led by Gusto, Mar Rojo, Double Up, Encore, HA-959 (Golden Sun) and Shemesh. Karma, HA-535 and HA-959 (Golden Sun) are semi-long to long fruited lines.

The majority of the replicated lines were free of pepper spot (STIP) but Grande Rio had a significant problem with 16% of the fruit affected, followed by much lower levels in Karma, HA-831 (Labrador), Shemesh, HA-959 (Golden Sun), Mar Rojo and Baron.

Best fruit wall thickness was obtained by Gusto (6.6mm), followed by Mar Rojo, HA-535 and HA-959 (Golden Sun). Complete data on the replicated lines (yield, crop maturity, fruit size and fruit wall thickness) are provided in Table 1.

Observation Lines: In the observation trial the best yield of marketable fruit was achieved by HA-1038 (El Charro) at 33.4 tons/acre, followed by HA-744 (Alexandra) at 31.5 tons/acre, HA-2112 (30.2 tons/acre), Tequila, a multi-colored specialty line (29.0 tons/acre) and XPP-1136 and HA-1195 (Paso Real), both at 28.7 tons/acre.

In terms of fruit quality, the best lines were HA-744 (Alexandra), XPP 0132, a yellow-orange fruited line, HA-1195 (Paso Real), HA-2112, RPP 8530 and RPP 8532. There was no pepper spot (STIP) detected in any of the fruit of any of the observation block varieties. Best fruit wall thickness occurred with HA-744 (Alexandra) and RPP 8532, followed by HA-2112, HMX 0648, XPP 1135 and RPP 8530.

The reader is cautioned that data for observation lines represent only single plot evaluations. Data on yield, crop maturity, fruit size, and fruit wall thickness are not shown in this article.

A complete report is available upon request.
Call UCCE San Joaquin County (209) 468-2085.

Table 1. 2002 Bell Pepper Variety Trial – San Joaquin County

Replicated Variety	Market Yield[1] (red+green fruit) T/A	Market Yield[1] (red+green fruit) Boxes	Crop Maturity at Harvest (%)[1] Red	Green	Pepper Spot[4]	Culls	Fruit Sizing Date (%)[2] Jumbo	XL	L	Med	Sm	Wall Thick-ness[3] (mm)
Double Up	30.5	2440	12	74	0	14	50	22	20	1	7	5.6
Encore	28.4	2274	1	83	0	16	74	6	14	0	6	5.4
HA-959	25.5	2044	8	79	1	12	22	29	26	6	17	6.0
Mar Rojo	25.3	2026	1	90	1	8	51	14	8	7	20	6.4
HA-535	24.6	1966	17	75	0	8	38	22	6	14	20	6.4
Karma	23.2	1856	8	60	4	28	50	4	12	21	13	4.0
HA-831	21.7	1734	24	53	2	21	15	25	24	18	18	5.0
Shemesh	21.3	1702	17	68	1	14	43	21	22	3	11	5.4
HA-1972	20.4	1634	3	80	0	17	24	15	27	24	10	5.0
Baron	20.2	1616	6	82	1	11	46	10	21	13	10	5.4
Guston	18.9	1514	16	73	0	11	41	21	10	8	20	6.6
Grande Rio	18.0	1438	2	67	16	15	7	26	32	26	9	5.4
Average:	23.2	1854										
LSD @ 5%:	5.6	446										
C.V.=	16.7%	16.7%										

[1] Average of four replications (rounded to nearest whole number, e.g. 11.9 = 12%
[2] Fruit sizing data: Jumbo > 240 grams; Extra Large 200 – 240g; Large 170 – 200g; Medium 150 – 170g; Small < 150g
[3] Fruit wall thickness = Average of 5 cut fruit per sample
[4] Pepper Spot - % Affected Fruit

FIELD DAY

May 8, 2003 9:30 am – 2:30 pm

"The Effects of Colored Mulch Film on Vegetable Production in the San Joaquin Valley"

UC Westside Research & Extension Center, Five Points, CA
(corner of Lassen and Oakland Avenues)
Traveling from out of town? Call Chris for directions (559) 884-2411

UCCE Farm Advisors Jesús Valencia, Richard Molinar, & Don May are showing melon and bell pepper crops grown under various colors of plastic mulch. Please join them for a field tour and discussion.

Melons were direct seeded on March 10, 2003
Peppers were transplanted on March 12, 2003

A BBQ Lunch is sponsored by AmpAcet Corporation
Please RSVP for lunch – 1 800-809-8077, ext. 2365

SOURCES OF INFORMATION – TOMATOES & PEPPERS

PUBLICATIONS FROM UC

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

IPM Tomato Manual, #3274
IPM Tomato Pest Management Guidelines
Identification & Management of Complex Tomato Diseases (available through UC VRIC)
Fresh Market Tomato Publication in CA, #8017
Processing Tomato Production in CA, #7228
Bell Pepper Production in CA, #7217
Scheduling Irrigation: When & How Much, #3396

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

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

INDUSTRY ORGANIZATIONS

CA Tomato Research Institute
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.

CA Tomato Commission
www.tomato.org - *Fresh Market Tomato Industry*

Bell Pepper Commission – (559) 445-5472

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
CA Tomato Products, Colusa
Campbell Soup Company, Sacramento
Colusa County Canning Co., Williams
Con-Agra Grocery Products Co. (Hunt's), Oakdale and Helm
Del Monte Corporation, Hanford
Escalon Premier Brands, Inc., Escalon
H. J. Heinz Company, Stockton
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
Stanislaus Food Products Co., Modesto
Toma Tek, Firebaugh
Uni Lever Best Foods, 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

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April 2003

Special Edition of Vegetable Notes #3:

Tomatoes and Peppers
South San Joaquin Valley

Field Day & BBQ: Plastic Mulches in Melons & Peppers – May 8, 2003 WSREC
Details Inside

Michelle Le Strange
Michelle Le Strange
Farm Advisor
Tulare & Kings Counties