University of California Cooperative Extension

Vegetable Crop Facts

Merced and Madera Counties

SPECIAL EDITION #2: Processing Tomatoes

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UCCE Farm Advisors:

FRESNO
Jesús Valencia, (559) 456-7553

KERN
Joe Nuñez, (661) 868-6222

MERCED & MADERA
Scott Stoddard, (209) 385-7403

TULARE & KINGS
Michelle Le Strange
(559) 685-3309, Ext. 220

IN THIS ISSUE:

Newsletter Editor
Michelle Le Strange
4437-B S. Laspina Street
Tulare, CA 93274

INTRODUCTION

Michelle Le Strange, Farm Advisor, Tulare & Kings Counties

A goal of UC Cooperative Extension is to assist industry to improve production efficiency and product quality. This newsletter was compiled to provide useful reference information to the processing tomato industry. Some topics offer timeless information, while others are season specific. Though it may be too late to implement some practices this year, it may be time to think about changes for next season. If you have specific questions, please call your local Farm Advisor.

Weather and climate become more critical as the fall season approaches. A summary of ET and rainfall from selected CIMIS weather stations is provided for comparison. For more information from the weather station nearest your fields visit www.cimis.water.ca.gov.

Evapotranspiration & Rain – Selected CIMIS Stations – Year 2002 & Historical Data

CIMIS Station	Jan	Feb	Mar	Apr	May	June	July	Aug	ET inches	Rain inches
	YEAR 2002 – real time ET - inches									
Shafter – Kern	1.2	2.4	4.2	5.3	7.5	8.0	7.9	7.0	**43.5**	**2.5**
Kettleman – Kings	1.4	2.8	4.7	6.3	8.5	9.5	9.5	8.3	**51.0**	**2.9**
Stratford – Kings	1.2	2.6	4.4	6.3	8.6	9.5	9.3	8.1	**50.0**	**1.6**
Westlands – Fresno	1.2	2.6	4.4	6.0	8.6	9.7	9.6	8.3	**50.4**	**1.5**
Firebaugh – Fresno	1.2	2.4	4.0	5.5	8.0	9.0	8.8	7.5	**46.4**	**2.7**
Madera	1.1	2.2	3.7	5.3	7.7	8.6	8.7	7.6	**44.9**	**4.4**
Merced	1.1	2.2	3.6	4.7	7.2	8.3	8.3	7.3	**42.7**	**4.1**
Patterson – Stanislaus	1.5	2.4	4.4	5.3	8.6	9.5	8.0	6.9	**46.6**	**3.0**
Modesto – Stanislaus	1.3	2.2	3.7	4.9	8.0	9.1	8.6	7.5	**45.3**	**3.5**
Lodi – San Joaquin	1.2	2.2	4.0	5.5	8.3	9.6	9.1	7.9	**47.8**	**3.2**
Tracy – San Joaquin	1.0	1.9	3.4	4.5	6.4	7.3	7.3	6.3	**38.1**	**5.3**
Davis – Yolo	1.3	2.3	4.1	5.0	6.8	8.4	8.1	7.3	**43.3**	**5.1**
Zamora - Yolo	1.3	2.4	4.0	4.8	6.8	8.2	7.7	6.9	**42.1**	**14.3**

CIMIS Station	Historical ET (30 yr avg) - in.				ET inches	2001 Rainfall - inches				Rain inches
	Sept	Oct	Nov	Dec		Sept	Oct	Nov	Dec	
Shafter	5.8	4.1	2.0	1.2	**13.1**	0	0.2	1.0	0.7	**1.9**
Kettleman	6.1	4.5	2.2	1.1	**13.9**	0	0.2	1.2	1.1	**2.5**
Stratford	5.9	4.1	2.1	1.01.	**13.1**	0	0.2	0.6	0.8	**1.6**
Westlands	5.9	4.3	2.1	1.1	**13.4**	0	0	1.4	1.3	**2.7**
Firebaugh	5.5	3.9	2.0	1.1	**12.5**	0	0	1.7	1.3	**3.0**
Madera	6.4	4.2	2.2	1.3	**14.1**	0.1	0.4	1.9	2.6	**5.0**
Merced	5.4	3.7	1.8	1.0	**11.9**	0.2	0.1	2.6	2.6	**5.5**
Patterson	5.7	4.0	2.1	1.6	**13.4**	0.3	0	1.4	3.2	**4.9**
Modesto	4.9	3.4	1.7	0.9	**10.9**	0.4	0	1.5	4.2	**6.1**
Tracy	5.3	3.6	1.8	1.0	**11.7**	0.3	0.1	1.3	4.0	**5.7**
Lodi	5.1	3.3	1.5	0.8	**10.7**	0.2	0.3	1.8	2.9	**5.2**
Davis	5.8	4.2	2.0	1.2	**13.2**	0	0.4	2.8	6.4	**9.6**
Zamora	5.5	4.0	1.9	1.2	**12.6**	0	0.6	3.4	5.3	**9.3**

Tips for Using Ethephon Effectively

by Mike Murray, Farm Advisor, Colusa County

There are times when processing tomato producers want to advance the crop maturity. One option is the use of ethephon, which breaks down in the plant to the naturally occurring plant hormone ethylene. Timely applications of ethephon *under specific conditions* can result in earlier fruit maturity, but may not be the appropriate strategy in every situation. Field tests to identify varietal responses, determine optimal spray rates and evaluate other important parameters have been conducted throughout California processing tomato production regions over the past ten years. This is a good time to review what we have learned.

Plant Health

In order for ethephon to function properly, the tomato plants must be healthy and not under stress. Factors such as drought, insect or disease injury, nutritional disorders, etc., render the plant unsuitable for ethephon applications. *Avoid treating stressed or damaged fields with ethephon as there is a high likelihood of causing additional plant injury and fruit yield losses, often exceeding any maturity benefits received.*

Application Timings

A common mistake is treating the plants too late. The most practical way to determine the optimal time is to shake all of the fruit from several plants chosen randomly from different *representative* parts of the field. The fruit should be separated into three groups: red/breaker, green, and cull fruit.

1) Include fruit with *any* color (pink, etc.) into the red/breaker group.
2) Only put "mature-green" fruit into the green group. *Mature green are typically described as fruit that do not exhibit any color, have gel formed in the seed cavity and the seed can not be cut when slicing the fruit.*
3) Put immature green (i.e. green fruit, but no gel formation in the seed cavity and seeds can be cut) and any damaged/diseased fruit into the cull group.

Weigh the three groups. ***When you find 5-15% red/breaker fruit (by weight), the field is ready for an ethephon application. This is considered the optimum time.***

Tomatoes normally ripen at a rate of 2½ - 3% fruit per day. So a field that has 10% red fruit needs to ripen an additional 80% to be harvested at 90% maturity. This takes 27-32 days to occur "naturally". ***However, a timely ethephon application can advance harvest 6 to 10 days.***

It appears that many local fields are treated with ethephon considerably later than this optimum. I have observed fields treated at 35-50% red/breaker fruit. If left on their own, these fields will reach 90% maturity in 13-18 days. Although ethephon applications may advance the maturity several days when treated late, the dramatic effects noted with an earlier spray will not be obtained. The plant simply does not have the ability to respond fast enough when fields are treated too late.

Ethephon decisions must be made up to a month before anticipated harvest to attain the maximum benefits of the material.

Rates

Ethephon is labeled for use on tomatoes at rates ranging from 1¼ to 6½ pints of material per acre, depending on the season and location. High temperatures immediately following an ethephon application can result in plant injury, premature defoliation and sunburned fruit. High temperatures are poorly defined for these purposes, but sustained maximum air temperatures in excess of 95°F can be problematic. Tests have indicated that early-season application of more than 1½ pints of product per acre may result in crop injury. At these rates, maturities may be advanced by 6-10 days, ***if*** treatments are made at the 5-15% red/breaker fruit stage, as outlined above. Higher product rates can cause additional maturity, but the risk of injury increases substantially.

Varietal Effects

It is clear that different varieties respond differently to the same rate of ethephon. In one field test, fruit maturity was advanced 4 to12 days, depending on the variety. Additionally, some varieties have lusher foliage, which helps minimize fruit sunburn. *The bottom line is to know your variety and how it responds to ethephon before making large-scale applications.* Always be prepared for a timely harvest, since the field-holding capabilities of many varieties are reduced when treated with ethephon.

Miscellaneous Factors

Evening vs. morning applications: Tests have shown that ethephon applications cause less crop injury if made going into a cooling trend (i.e. in the evening) than if made going into a warming trend (i.e. in the morning). So always try to apply in the late afternoon or evening.

Surfactants: The question of adding surfactants is occasionally asked. I don't have a definitive answer, but will note that the efficacy of ethephon is increased when foliage coverage is improved. However, a safer way of accomplishing good coverage may be the use of higher water rates and/or improved spray delivery technology instead of using a surfactant. Applications with ground rigs and directed spray nozzles generally result in better plant coverage than aerial applications.

Timely harvest: Plants treated with ethephon do not hold as well in the field compared to untreated plants, so timely harvesting is needed to prevent fruit decay and losses. The maturity process that ethephon triggers ultimately results in senescence and fruit breakdown, so fruit needs to be removed and processed in a timely fashion.

Fruit color: There is a question of the effects of ethephon on fruit color. My experience has been that ethephon does not alter the color of sound fruit. However as previously mentioned, ethephon applications must be timely for several reasons. High temperatures immediately following application and/or applications to stressed plants can result in premature plant defoliation and sunburn. Poor color in loads treated with ethephon result from sunburned fruit being mixed into that load. The sunburned fruit is co-mingled with the undamaged fruit and the fruit color of the load is graded lower in color.

Whitewash Fruit Protectant: Looks good, but does it work?

by Gene Miyao, Farm Advisor, Yolo/Solano/Sacramento Counties

The principle of using a white reflective coating to protect exposed tomato fruit has merit. On those 105°F summer days, clearly your personal outdoor experience between wearing a dark-colored or a white polo shirt is a simple experiment that provides compelling logic to whitewash those tomatoes.

Simple measurements of internal fruit temperature show that whitewash does reduce fruit temperature by several degrees. However, the question remains. *What is the maximum temperature and conditions before fruit begin to sunburn and sunscald?*

While I do not know the answer, the temperature threshold question remains important. Temperature is not the only controlling factor, but is a primary one. Although it may seem like a contradiction in proper management decision making, the following holds true. *The higher the temperature, the more likely whitewash will fail to protect fruit. Why? Because whitewash is only an aid, not a temperature insulator. Whitewash is not a canopy replacement should vines collapse.*

Fruit temperature measurements I've taken demonstrate that even a dead leaflet provides more protection to a fruit than 300 lbs. per acre of whitewash. **So, establishing and maintaining a canopy is far superior to a whitewash application for thermal protection of the fruit.** With few exceptions, in numerous replicated tests conducted in grower fields, yields were not improved with whitewash at rates up to 300 lbs. per acre.

Irrigation Strategies to Balance Tomato Yield and Soluble Solids Content

by Mike Cahn, Tim Hartz, Enrique Herrero and Gene Miyao, UCCE

Irrigation management is a crucial factor in profit or loss for processing tomato growers. Increasing water costs and reduced water availability encourage conservation, but insufficient irrigation can result in lost yield; maintaining high soil moisture availability maximizes fruit yield, but can result in undesirably low brix levels. It is generally acknowledged that minimizing water stress through the main fruit setting period is appropriate, but the opinions differ on irrigation management strategies for the final 6-8 weeks before harvest. Research conducted over the last 5 years provides some guidelines to consider.

Managing Drip Irrigation

By using drip irrigation, processing tomato growers have been able to save on water, energy, and labor, while often attaining equal or higher fruit yields than obtained under furrow or sprinkler irrigation. In addition, drip irrigation has allowed growers to produce tomatoes in 'problem' fields that were difficult to irrigate conventionally. Despite these benefits, lower brix levels of fruit grown using drip irrigation, and processor reluctance to contract drip-irrigated fruit, has limited the adoption of drip. We conducted six field trials to evaluate strategies for increasing brix levels while maintaining acceptable yield.

All trial fields were fully irrigated (full replacement approximately 8 weeks before harvest. At that point various irrigation cutoff and cutback treatments were compared. These treatments ranged in severity from a cutoff of irrigation 8 weeks preharvest, to full irrigation until cutoff 3 weeks before harvest; between those extremes our treatments involved either a period of deficit irrigation, or an intermediate cutoff date.

While results differed significantly among fields (due mostly to soil texture or the presence of a shallow water table), Table 1 shows a typical result. Increasing the degree of plant moisture stress by deficit irrigation or early cutoff did raise fruit brix level, but at a clear sacrifice of yield. Cutting off irrigation 8 weeks before harvest significantly increased ^{o}brix, but at the cost of a significant yield reduction (5.5 ton/acre). This was the only treatment that showed significantly reduced brix yield (fruit yield x soluble solids concentration), indicative that this level of moisture stress actually reduced crop productivity. All other treatments had statistically equivalent brix yield, with fruit yield tending to increase and ^{o} brix to decrease with increased late irrigation. *In other words, across this range of intermediate stress treatments, there was simply a proportional tradeoff between yield and* ^{o} *brix.*

These results are consistent with those from the other drip trials. Early irrigation cutbacks were less likely to reduce brix yield than total cutoffs. However, it should be noted that deficit irrigation can lead to root intrusion into the drip tape, so preventative maintenance may be necessary.

Table 1. Effect of drip irrigation management on fruit yield and quality, 2001 Yolo County trial.

Irrigation treatment	Inches applied last 8 weeks	Fruit yield (tons/acre)	Soluble solids (^{o} brix)	Brix yield (tons/acre)
Cutoff @ 60 days preharvest	0	37.8 *	6.02 *	2.09 *
75% cutback @ 60 days ^{z}	2.8	40.3	5.94	2.21
Cutoff @ 40 days	5.1	41.7	5.78	2.21
75% cutback @ 40 days ^{z}	6.6	43.2	5.60	2.31
Cutoff @ 30 days	7.8	43.9	5.46	2.2
50% cutback @ 40 days ^{z}	8.2	42.4	5.58	2.16
Cutoff @ 20 days	11.3	43.4	5.52	2.24

^{z} all irrigation cutback treatments cut off at 20 days preharvest
* significantly different from the standard treatment (20 day cutoff)

Managing Conventional Irrigation

With conventional irrigation (sprinkler or furrow) the same principals apply. Fully meeting crop ET through the main fruit setting period is necessary for maximum yield. End-of-season irrigation can be manipulated to increase soluble solids concentration, but at the cost of some yield. Table 2 summarizes the results of 4 trials in conventionally-irrigated fields in which an early irrigation cutoff was compared to the grower's standard practice. In two of the fields fruit ^{o} brix was increased by early cutoff, with an approximately proportional decrease in fruit yield. In the other two fields the early cutoff did not induce sufficient stress to increase ^{o} brix, and no reduction in yield was seen.

Monitoring Water Stress

Imposing water stress to increase soluble solids can be tricky, because severe stress can cause more yield loss than the proportional gain in ^{o} brix. We have evaluated a number of plant and soil monitoring techniques and have found that, in general, monitoring soil moisture (by neutron probe or resistance blocks) has been more useful than plant based measurements (leaf water potential or leaf temperature). In general, increasing soluble solids concentration required that soil moisture be significantly depleted to a depth of 3 feet during fruit ripening. Additional field trials are being conducted this year across a range of soil types and conditions to develop guidelines for soil moisture management.

Table 2. Effect of early irrigation cutoff on yield and soluble solids in conventionally-irrigated fields.

Field	Fruit yield (tons/acre)		Soluble solids (^{0}brix)		Brix yield (tons/acre)	
	normal cutoff	early cutoff	normal cutoff	early cutoff	normal cutoff	early cutoff
1	50.4	43.8 *	5.48	5.73 *	2.76	2.51
2	38.3	34.7 *	5.83	6.33 *	2.23	2.20
3	38.1	39.8	5.70	5.53	2.17	2.20
4	36.7	36.0	5.66	5.71	2.08	2.06

*significantly different from normal cutoff at $p < 0.05$

Maintaining Drip Irrigation Systems to Prevent Clogging

by Blaine Hanson, Irrigation and Drainage Specialist, UC Davis

Drip irrigation systems have the potential of applying water uniformly and precisely. However, achieving this potential requires good system maintenance to prevent clogging of emitters.

Causes of clogging include:

- Suspended materials in irrigation water.
- Chemical precipitation caused by:
  - Irrigation water quality,
  - Fertilizer injection, or
  - Evaporation in emitters.
- Biological growth in drip lines and other pipelines.
- Root intrusion (buried laterals).
- Soil ingestion (buried laterals).

Suspended Materials

Sand, silt, plant material, algae, fish, and other materials suspended in the irrigation water must be removed before - water enters the drip line. Removal of these materials is accomplished by filtering the water. Any particles larger than about one-tenth the size of the emitter orifice or flow passage should be filtered out to prevent particles from bridging.

The degree of filtration is expressed as the mesh size or equivalent mesh size. The mesh size is the number of openings per inch. A 200-mesh filter has 200 openings per inch. A common recommendation for filtration is a 200-mesh filter.

Two sets of filters are recommended. The primary filters remove suspended material from water. A secondary filter installed downstream from the primary filter is recommended to protect the irrigation systems if the primary filter should fail.

Generally, sand-media filters are used for surface water containing algae and other suspended organic matter, while screen/disc filters are used for ground water, which may contain suspended sand, silt, and clay. Screen/disc filters can be used for surface water containing suspended organic matter, but they may require frequent backflushing compared to sand-media filters.

Filters remove some but not all of the suspended matter. Fine particles of algae, silt, and clay can pass through filters and settle in the drip lines. So a periodic flushing should be done to prevent excessive accumulation of settled-out material along the lower part of drip lines.

Chemical Precipitation

Precipitation of calcium carbonate (a white precipitate) and iron (a reddish-brown precipitate) in emitters is a problem with ground water. Iron precipitation is not a usual problem in the Central Valley, but does occur in some coastal areas.

Calcium carbonate precipitation can occur in emitters due to changes in the pH of the water (sometimes a result of pumping ground water), temperature increases as the water flows throughout the irrigation system, evaporation, and chemical reactions with some types of fertilizers.

The potential for carbonate clogging exists when the bicarbonate concentration in the water exceeds 2 meq per liter and pH exceeds 7.5, based both on theoretical approaches and on the experience of the drip irrigation industry. Recommended treatments to prevent carbonate clogging are:

1. Inject acid continuously to maintain the pH between 5 and 7.

2. Inject acid intermittently to maintain the pH at 4 or less for 30-60 minutes.

Biological Growth

Micro-organisms such as algae, bacteria, and fungi can grow in drip lines and cause clogging problems. Chlorine is often added to irrigation water to oxidize and destroy biological microorganisms.

Dissolving chlorine in water produces hypochlorous acid and hypochlorite — referred to collectively as the *free available chlorine.* Hypochlorus acid, however, is by far the most effective chlorine form for controlling bacteria, algae, etc. The amount of hypochlorus acid depends on the pH of the water. The lower the pH, the more the hypochlorus acid. Maintaining the pH at about 7 results in about 70 percent of the chlorine being in the form of hypochlorus acid.

Acid may need to be injected at the same time as the chlorine injection for pH control. Use separate injection ports for each chemical. **CAUTION: Do not mix chlorine compounds and acid in the same container unless you want to die**. The most common sources of chlorine are sodium hypochlorite (liquid), calcium hypochlorite (powder or granules), and chlorine gas.

Root Intrusion

Root intrusion can be a serious problem for drip systems used for processing tomato. Plant roots tend to grow in the soil areas with the highest water content, which in subsurface drip systems is near the emitters. Because of this tendency, roots can grow into and clog emitters. *This may be a particular problem for processing tomato because deficit irrigation (applying less water than the potential crop water demand) is sometimes recommended to increase the solids content. This practice reduces the soil moisture around the drip line to levels less than required for the potential water demand, which may encourage more root activity near the drip line where the soil moisture content is relatively higher compared to elsewhere in the soil profile.*

Various strategies have been used to combat root intrusion, including water management, chemical treatment, and drip tape emitter design, but very little research has been conducted to evaluate their relative effectiveness. Some practices used by growers to prevent or correct root intrusion problems include:

- weekly acid injections to discourage root intrusion by lowering the pH of the irrigation water to less than 4 (which may damage some irrigation system components), and
- superchlorination (injecting chlorine at very high concentrations such as 100 to 400 ppm after harvesting).

Does It Make a Difference?

Does maintaining a drip system make a difference? Emitter discharge measurements made along a buried drip line of a tomato field showed little emitter clogging for a system with periodic maintenance after three years of use (see Figure 1). *(Note: the trend of decreasing discharge rate with distance was caused by pressure losses along the drip line.)* In a field where root intrusion severely clogged emitters along the lower end of the field, tomato yield was about 10 tons/acre less at the lower end compared to the upper end of the field

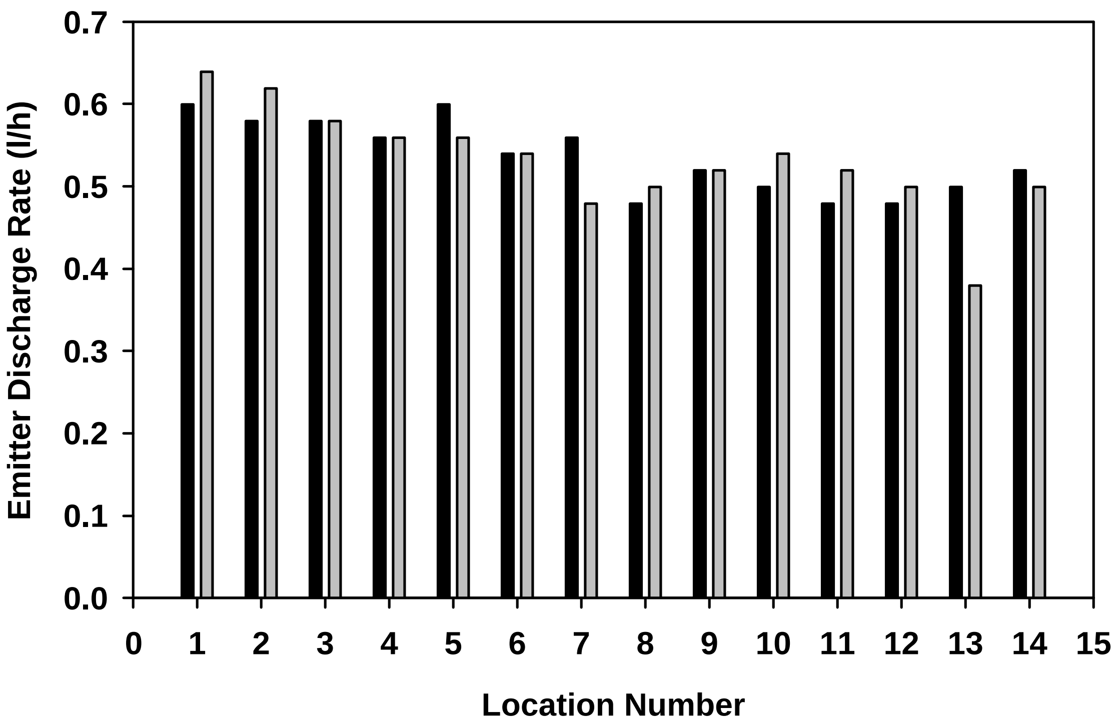

Figure 1. Emitter discharge rates along a drip line after three years of use. Sampling locations were about 100 feet apart. At each sampling location, discharge rates of two emitters were measured. The distribution uniformity was 88%, considered good.

Dodder Management Strategies in Tomatoes

by Kurt Hembree, Farm Advisor, Fresno County

Dodder is an annual parasitic weed that infests thousands of acres of processing tomatoes yearly in California. Other crops that are also susceptible to attack include alfalfa, carrots, melons, onions, safflower, and sugar beets. Numerous broadleaf weeds also serve as hosts to dodder. In other words, it has many opportunities to thrive within California's numerous agricultural production systems.

Dodder germinates from seed, begins emerging from the soil as early as February, and continues emerging for several months. The majority of dodder emerges from February through late May. Since dodder is a rootless plant, it must attach to a suitable host plant within 2 to 3 days of emergence or it dies.

As a parasitic weed in tomatoes, it attaches to the plant (usually the stem), penetrates the epidermis, and enters the vascular tissue to obtain water and nutrients for survival. As long as the host plant remains alive, so does the dodder. Feeding off the tomato host plant, it grows rapidly, and envelops the original host and surrounding plants with its wiry orange strands.

Young tomato plants may be killed or severely retarded in growth during a short period of time. Eventually, entire fields may be blanketed with dodder, reducing stand and yields. Dodder produces hard-coated seed that remain dormant in the soil for more than 20 years. Therefore, it is essential that some sort of management be implemented to sustain tomato yields and reduce future dodder outbreaks.

There are no magic bullets for dodder control in tomatoes, but there are options that reduce dodder survival or eliminate the impact dodder has on tomato production. Try using combinations of the following.

- Plant after May 15th to avoid the period when most dodder germinates and emerges. Select varieties that can be planted and grown later in the season to reduce risk of damage caused by high temperatures.

- Use transplants to minimize risk of early stand loss compared to direct-seeded tomatoes which are easily killed by dodder attack. Rapid growth of transplants helps reduce yield loss.

- Plant varieties H9492, H9553, and H9992, which have been previously shown to have a large degree of dodder resistance. These varieties have similar growth and production characteristics to H8892, already commonly grown in California. In most instances, these varieties will significantly reduce the amount of new dodder seed that would normally be produced with non-resistant varieties.

- Use early post-emergence sprays of Shadeout® to help reduce the growth of dodder. While Shadeout® alone will not control dodder, it can delay its growth by 21 days or more. This gives the tomatoes a head start before dodder growth really begins to expand.

- Timely hand removal of infested tomato plants will help reduce dodder populations. Hand-weeding crews should be used when a significant number of attached plants can be seen (usually about the 2-leaf stage). A second walk-thru is needed 7 to 10 days later to pick up the missed plants. Infested plants can be moved to furrow bottoms or hauled from the field in burlap sacks, to be buried or burned. To get the most efficiency for your buck, use weeding crews that are conscientious about chopping out as many infested plants as possible the first time around. Then, come back with the same crew a second time to remove the missed plants. Sending weeding crews through the field later in the season as the only means of dodder removal usually leads to a significant loss of plants, leaving large gaps in the field.

- Practice good weed control techniques in and around known dodder-infested fields. Since dodder readily survives on many weed hosts (including nightshade, pigweed, lambsquarters, and field bindweed), it is imperative that these and other weeds be controlled early in the season. This will reduce the likelihood of supporting dodder survival. Timely herbicide sprays and close cultivation should be used to reduce dodder attachment sites.

- Rotating to non-host crops like cotton or cereals will reduce dodder populations, since they do not attach and produce additional seed. Rotating to host crops like melons, onions, safflower or sugar beets only encourages dodder survival.

While there is no one sure-fire method of controlling dodder in tomatoes, there are several options that can help reduce the amount of new seed produced and the impact on tomato production.

Dodder seed can survive in the soil for many years, so planning for the long-term is the only way of managing dodder effectively. While the old saying goes "nothing is guaranteed in life except death and taxes", some may argue death, taxes, and dodder.

Weed Seed Banks and Their Role in Future Weed Management

by Anil Shrestha, IPM Weed Ecologist, Kearney Agricultural Center

"One year's seeding leads to seven years' weeding" - an old adage

The weed seed bank in the soil is the main source of weeds in agricultural fields. Most weeds start their life cycle from a single seed in the soil. If these weeds escape control, they grow and produce thousands of seeds, depending on the species. These seeds are returned to the soil seed bank and become the source of future weed populations. Therefore, knowledge of seed return and seed bank dynamics can help in future weed management.

What is a soil weed seed bank?

Soil weed seed banks are reserves of viable seeds present on the surface and in the soil. The seed bank consists of new seeds recently shed by a weed plant as well as older seeds that have persisted in the soil for several years. The seed bank is an indicator of past and present weed populations. There are enormous numbers of viable weed seeds in the soil. Although a great number of buried seeds die within a few years, seeds of some species can remain viable for decades. It has been estimated that only 1-9% of the viable seeds produced in a given year develop into seedlings; the rest remain viable and will germinate in subsequent years depending on the depth of their burial.

What happens to the seeds in the bank?

Seeds are dispersed both horizontally and vertically in the soil profile. It's reported that about 95% of seeds entering the bank are from annual weeds, while only about 4% come from perennial weeds. Estimates for some weed species in California are shown in Table 1. Data from other States also show that individual weed plants are capable of producing thousands of seeds. Seed bank input is the number of seeds produced and shed by weed plants.

Several things happen to these weed seeds (Figure 1). They may

- be preyed upon by insects or vertebrates;
- die due to physiological reasons;
- be attacked by pathogens;
- get buried deep into the soil profile causing them to go into dormancy;
- go into dormancy due to physiological reasons;
- be physically damaged by ag. implements; or
- germinate, emerge, grow & produce more seeds.

The horizontal distribution of weed seeds in the soils seed bank generally follows the direction of crop rows whereas the vertical distribution is influenced by type of tillage. The greatest diversity of weed species is observed on field edges and headlands.

In terms of vertical distribution, reports from several states have shown that the majority of weed seeds in a no-till system were located in the top 2 inches of the soil profile. In an annual plow system, seeds were distributed in the upper 12 inches of the soil profile with 25% of the seed in the upper 0 to 3 inches. Under reduced tillage systems such as ridge till and chisel plow, 50% of the weed seeds were located in the upper 3 inches of the soil profile.

The size and composition of the seed bank reflects the past and present weed management systems applied in the field and determines future weed populations. So, it is important to limit current contributions to the weed seed bank for future weed management. ***In summary, prevent weeds from producing seeds.***

Table 1: Examples of seed production of some weed species in California

Species	Common name	No. of seeds/m^2	Remarks
Amaranthus powellii	Powell amaranth	709,500	Fertilized plots
Amaranthus retroflexus	Redroot pigweed	1,038,000	Fertilized plots
Echinochloa crus-galli	Barnyardgrass	300,000	In high density (50 plants /meter row)

Bacterial Canker Disease in Tomato

by Mike Davis, Extension Plant Pathologist, UC Davis

What causes the disease?

The disease is caused by a bacterium named *Clavibacter michiganensis* subsp. *Michiganensis* (formerly called *Corynebacterium michiganense*).

What are the symptoms?

On seedlings – usually none.

On young plants – poor growth and temporary wilting of branches. Lower leaves yellow and shrivel. However, symptoms may not show until flowering.

On mature plants – two kinds, those resulting from systemic infections, i.e., the bacteria enter the vasculature and invade much of the plant, and those resulting from secondary infections, i.e., the bacteria cause local infections of leaves, stem, and fruit.

> In systemic infections, leaflets of the oldest leaves curl, yellow, wilt, and finally turn brown and collapse (known as firing). Sometimes, only one side of a leaf is affected. Plants grow poorly and wilt. Pith of stems becomes yellow and later reddish brown, especially at the nodes, and has a mealy appearance. The pith may later become somewhat hollow. In advanced infections, cankers may or may not form at the nodes. Light and later dark streaks may develop on stems. Branches break off easily. Plants may die.
>
> In secondary infections, infection of the margins of leaves is common. Lesions are dark brown. Round to irregular spotting of leaves also occurs. Fruit may be spotted, especially near the calyx.

On fruit – Yellow to brown spots, slightly raised, surrounded by a persistent white halo ("bird's eye"). Spots are usually less than ¼ inch diameter. Vascular tissue under calyx scar and leading to seeds may be brown.

What is the primary source of the bacteria?

In California, probably seed and transplants. Overwintering in our soils does not seem to be important. However, bacteria can overwinter in California on tomato residue that was not incorporated into the soil.

Can assayed seed eliminate the disease?

Seed contaminated with only a few bacterial cells, apparently below the level of detection, can result in relatively high numbers of infected transplants. For that reason, certified seed reduces the chance of infections, but is no guarantee of contaminated-free seed. A seedlot contaminated with very few infested seeds can cause serious problems in a greenhouse.

How does the disease spread?

When the seed germinates, the bacteria enter the seedling through leaf hydathodes (pores) or small wounds in the cotyledon, probably through broken trichomes (hairs). The bacteria move systemically through the xylem and then invades the phloem, pith, and cortex. In a highly favorable environment, like a greenhouse, bacteria on the surface of infected plants are then splashed to surrounding plants during overhead irrigation. This kind of spread accounts for the occurrence of groups of diseased plants in the greenhouse and subsequent rows of infected transplants in the field. During field planting, which invariably causes wounds, transplants may be inoculated after a contaminated plant is handled, especially if plants are wet.

Secondary spread occurs in splashing water, on contaminated equipment, during clipping, cultivation, or vine training operations, and other activities. In the field, such spread usually results in only local infections, i.e., leaf, stem, and fruit spots. In the greenhouse, these sources can lead to local and systemic infections.

How long do bacteria survive?

In the field, the bacteria will survive indefinitely in tomato tissue. Once that tissue has decomposed in the ground, however, the bacteria will die since they are **not** soil inhabitors. *Thus, it is very important to turn under infected plant residue at the end of the season. Once that residue decomposes, the bacteria will die and the field does not pose a problem for subsequent plantings.* It is prudent however, to rotate to another crop for at least one season to assure that the tomato residue is completely gone.

In research trials, bacteria have survived as long as 10 months on contaminated wooden stakes. Hence, in the greenhouse it may be extremely important is disinfest the surface of benches and equipment after cleaning to prevent spread to subsequent trays of transplants. In fields of more mature plants, disinfesting equipment is not as critical since any spread to other plants would probably result in local, and not systemic, infections. It is cautious to wash equipment that has been through a heavily infested field.

What are the hosts of the causal organism?

Almost exclusively tomato. Several nightshades, including perennial nightshade (*Solanum douglasii*), black nightshade (*S. nigrum*), and *S. triflorum,* are naturally infected. Pepper and eggplant can be successfully artificially inoculated, but they are probably not important in the epidemiology of the disease on tomato. It is not known how long the bacterium can persist on nightshade.

Does canker cause problems in direct-seeded tomato fields?

In California, economic losses in direct-seeded fields are probably very uncommon. During unusually wet weather or sprinkler irrigation, however, secondary spread can occur. Also, frequent vine-training, cultivation, or other operations when the foliage is wet may cause extensive leaf loss. Canker probably occurs at a low incidence in many direct-seeded fields but almost always goes unnoticed.

What are some control measures?

Planting clean transplants is the most important control measure. Seed fields should be vigilantly monitored and strict quality control measures implemented. Seeds should be assayed for detectable levels of contamination and lots discarded if the bacterium is found. It may be prudent to soak all seed in a dilute solution of hydrochloric acid as an extra precaution, although this does not guarantee complete elimination of the bacterium. Sodium hypochlorite (bleach) also fails to completely eliminate the bacterium from seed. In the greenhouse, potting mix and flats should be steamed or washed with a 1% solution of sodium hypochlorite or other surface disinfectant.

Sanitation

Greenhouses should be emptied between crops of transplants to allow time to clean and disinfest benches, irrigation hoses, etc. Overhead water pressure should be low to prevent wounding. Applications of streptomycin or copper (check registrations) may be necessary to reduce the efficient, yet unnoticeable spread between plants.

In the field, special measures should be taken once canker has been identified. Do not work fields when the foliage is wet. Frequent field operations at the wrong time can result in spread of the disease throughout the entire field. Unless the number of infected plants is small, it may do more harm than good to try to remove the symptomatic plants.

Bactericides

Copper or streptomycin applications offer limited benefits since systemic infections can not be affected and localized infections (the most probable scenario if other precautions are taken) pose a small economic threat. During wet weather, however, bactericides are probably justified. At the season's end, incorporate all plant tissue. Tissue that remains on the surface and doesn't decompose is a real risk to subsequent tomato crops. Once the tomato residue decomposes, however, canker is no longer a threat. To be absolutely certain that the bacterium has been eliminated from the field, rotate out of tomatoes for at least one year.

Blackmold Disease Control

by Gene Miyao, Farm Advisor, Yolo/Solano/Sacramento Counties

Anticipating wet weather? In the Sacramento Valley, fungicide applications are targeted on fields to be harvested in mid September or later when threat of rainfall increases and morning dews contribute to fruit rot activity.

Blackmold fungicide trials conducted in our local area generally showed:

- Preventive applications about 4 to 6 weeks before anticipated harvest reduced mold levels.
- Fruit rot levels were reduced about 50% compared to non-treated controls.
- Single applications were sufficient under moderate disease pressure.

Fungicides used in the trials were Bravo®, Quadris® and Dithane®. While we have the most experience with Bravo, all these materials were effective (with a slight advantage with Bravo). None of the materials eliminated blackmold rots.

Preventive timing is critical. In a field test with ripe fruit at UCD, an application made 12 hours *after rainfall* was not effective in reducing blackmold. *Coverage may also be important.*

Fruit maturity is clearly a factor in disease development. Fruit are susceptible to blackmold when ripe. The most susceptible fruit are the over-ripe ones. Sunburn damage also increases risk to blackmold. Timely harvest to limit the level of overripe fruit is helpful when blackmold conditions are favorable.

Monitoring Consperse Stink Bug with Pheromone Traps

Eileen Cullen and Frank Zalom, Entomology Dept., UC Davis

Introduction

Several stink bug species are associated with tomatoes in the San Joaquin Valley. The most important are:

- the consperse stink bug which has a gray to brown coloration,
- the Say's or Uhler's stink bugs which are green in coloration and have both a yellow margin on the sides of the abdomen and 3 spots spaced horizontally on it's ventral side,
- and the red-shouldered stink bug which is smaller than the other species and is typically green with a horizontal red line across the 'points' of it's pronotum.

All of these species may be found in any growing area, but the consperse stink bug tends to be most common in the northern San Joaquin Valley and the Say's or Uhler's stink bug on the west side. Red shouldered stink bugs are typically less prevalent than the other species, but are found in all areas.

Stink bug populations build up during the spring on roadside, riparian and other wild host vegetation, moving into nearby cultivated crops in summer as wild hosts become unpalatable. Affected vegetable crops include, but are not limited to, fresh market and processing tomato fruit, snap beans, cowpea seeds, peppers, pumpkins melons, asparagus stems, okra pods, and corn.

All stink bug species share the same life cycle (egg – 5 nymphal stages – adult) and cause feeding damage by injecting salivary fluid with piercing sucking mouthparts. In addition, bacteria and yeast can be carried on bug mouthparts, causing rapid vegetable and fruit decay in the field.

Stink bug sampling

Canopy shake sampling is the most effective way to assess stink bug densities in low growing vegetable crops. Research in tomatoes has indicated that about half of all stink bugs present will be found beneath the plant on the soil, rather than on the foliage. Therefore, following each shake sample, scan the soil around the beating tray for additional bugs and include these in the sample count.

Consperse stink bug pheromone trap

A pheromone trap attractive to consperse stink bug male and female adults is commercially available from several sources to simplify the labor-intensive shake sampling protocol. Pheromones are not commercially available for other stink bug species, but research is currently underway to identify these pheromones and to determine synthesis approaches.

Early season trap catch is used to detect consperse stink bug migration into the crop and identify areas within the field where canopy shake samples should be concentrated later in the season, during fruit development. Traps are placed on the center of the bed, between two plants, and marked with flags tall enough to indicate trap position later in the season as the canopy develops.

Stink bugs typically migrate into crops from habitat adjacent to field edges and remain aggregated in patchy distributions, rather than spreading uniformly throughout the field. Consperse stink bug pheromone traps should be located within the field along sides and corners at a distance of 20-160 feet from the edge.

Degree-day accumulation from trap "biofix"

Insect development is temperature-dependent with each species requiring a specific measure of heat accumulation (degree-days = DD) between lower and upper developmental thresholds to complete its life cycle from egg to adult emergence. DD accumulation begins from a "biofix", typically the first catch of adults or peak of adults in a set of traps. DD can be used to forecast subsequent developmental events such as egg hatch, nymphal development and adult emergence.

Consperse stink bug pheromone traps attract reproductively active adults, both females containing mature eggs and males. Consperse stink bug requires between 756 and 993 DD (Fahrenheit) to go from egg to adult. On average, egg incubation through 1st, 2nd and 3rd instar development are complete at 558 DD. From the early season trap peak observed in your area, begin accumulating DD until approximately 558 have been accumulated. It is at this time that intensive shake sampling should begin to confirm nymphal hatch in the field and determine if sufficient numbers are present to warrant treatment.

Pheromone-based pest forecasting

Stink bug shake sampling is time consuming under commercial conditions, often resulting in a trade-off between time spent sampling and accuracy of the resulting population estimate. Employing pheromone trap catch as an indicator of consperse stink bug migration and field distribution, using DD to forecast population development in the field, and limiting intensive shake sampling efforts to the period of nymphal hatch are likely to reduce total field monitoring time. A nymphal management focus should increase treatment efficacy, as nymphs are more susceptible to insecticides than are adults. *The consperse stink bug phenology model is available on the UC IPM website at http://www.ipm.ucdavis.edu.*

Have You Visited UC VRIC?

by Kitty Schlosser, Program Representative, UC Davis

The Vegetable Research and Information Center was established as a service unit dedicated to communication, coordination and leadership in all areas of UC involvement in vegetable biology, production, postharvest handling, marketing and consumption. It is a focal point for vegetable information and issues for clientele inside and outside the University.

The center's web site (http://vric.ucdavis.edu) offers a wealth of information about vegetable crop production. *The "vegetable information" section is organized so information may be accessed by crop, topic or postharvest information.* For example, information about tomato diseases would be found under *"crop-tomato"* or *"topic-disease"*.

The tomato web page has links to California production guidelines for fresh market and processing tomatoes. These publications are also available in Spanish. There is additional information about production costs, variety trial results, Integrated Pest Management, diseases, etc.

The web site offers similar information for many other vegetable crops. The "useful links" page has a comprehensive list of web sites from government to seed companies.

Check it out and feel free to offer suggestions on how to improve it. We hope this will become one of your most visited web sites.

PTAB (Processing Tomato Advisory Board) QUALITY STANDARDS

The State grading standards program is designed to provide objective and impartial fruit inspection prior to processing. Maximum tolerance levels are optional and may be waived by your processor. Processors may impose lower maximum tolerances than the State levels listed below.

Definitions of Defects and Tolerances
From the Processing Tomato Inspection Manual published June 1997

Worm/Insect: Any load of tomatoes which is offered for delivery to a processor shall be rejected and turned back to the producer if in excess of two percent, by weight, is affected by worm or insect damage. A tomato is scoreable when a worm or insect has penetrated the flesh. Open holes, which have no worm, insect or excreta present, shall not be considered as worm/insect damage.
Maximum Tolerance: 2.0% of Load

Mold: Black, brown, watermold and blight are scoreable when the mold penetrates through the wall of the tomato into the seed pocket or when spots of mold that penetrate into but not through the wall affect more than 10% of the weight of the tomato. If white mold clings to a split in a tomato's skin, score it without cutting. (Pick white mold out before washing sample.) Blossom end rot is not mold, but active mold extending from the rot into the seed pocket is scoreable. *Maximum Tolerance: 8.0% of Load*

Green: A tomato is scoreable for green when the external surface of the red tomato is green, white, or yellow, with no pink, orange, or red. Do not cut these tomatoes to check the internal color.
Maximum Tolerance: 4.0% of Load

M.O.T.: Material other than tomatoes includes dirt and extraneous material (detached stems, vines, rocks, or debris). Score dirt that can be picked up by hand, not sweepings from the table. Check dirt or extraneous, and if there is a significant amount of both, check both boxes. Attached stems are not scoreable, but stems 3" or more are vines and shall be pulled and scored.
Maximum Tolerance: 3.0% of Load

SOURCES OF INFORMATION – Processing Tomatoes

PUBLICATIONS FROM UC

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

Processing Tomato Production in CA, #7228
Mechanized Growing & Harvest of Processing Tomatoes, #2686 (currently out of print)
IPM Tomato Manual, #3274
IPM Tomato Pest Management Guidelines
Identification & Management of Complex Tomato Diseases (available through UC VRIC)
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.

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

Special Edition of Veg Crops Facts #2:
Processing Tomatoes in the South San Joaquin Valley

September 2002

Greetings! I'd like to introduce myself as your new Farm Advisor for Merced and Madera Counties, having been at the position since April. This newsletter is full of information for this and upcoming seasons that I hope you find useful. UCCE is here to assist you and the farming community. Please feel free to contact me about field problems, program suggestions, or research ideas.

Scott Stoddard
Farm Advisor – Vegetable Crops and Limited Resource Farms
Merced and Madera Counties

U.S. Department of Agriculture, University of California, and Merced County Cooperating