University of California Cooperative Extension

Vegetable Crops Facts

Merced and Madera Counties

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Meet the New Farm Advisor…

I would like to introduce myself- I am the new vegetable crops Farm Advisor for San Joaquin County. I have recently relocated to the San Joaquin Valley from that "other" valley to the north and I am very excited to be here and working with the vegetable crop industry!

At UC Davis, I worked in the Department of Plant Pathology with Mike Davis and Tom Gordon. I conducted field and laboratory research and participated in the diagnosis of problems in field and vegetable crops from samples submitted from across the state. Among the types of problems we saw were viral, bacterial, and fungal diseases, insect injury, nutrient problems and other abiotic disorders. Although I am a plant pathologist by training, I am anticipating the challenge of tackling whatever crop production problems are faced in this area.

This season I will be participating in the statewide variety evaluation projects for both processing and fresh market tomatoes and I'll be launching some pest management projects, including the evaluation of a powdery mildew model that might help growers predict disease in the San Joaquin Valley. And there will be another bell pepper variety trial in San Joaquin County this year. I look forward to meeting you and working with you! --- *Brenna Aegerter*

Announcement
38th California Nematology Workshop
Tuesday, March 28, 2003, 8 AM - 4:30 PM
University of California Extension Center
1200 University Ave, Riverside, CA

This annual workshop offers pest management professionals and growers the latest information on problems caused by plant-parasitic nematodes and on their potential solutions. Target audience for this program includes pest control advisors and operators, growers, pesticide and biocontrol industry representatives, landscapers, municipal and state employees, parks and recreation personnel, educators and consultants. A superb lineup of speakers and workshop presenters will share their expertise concerning nematode-related issues. Posters will inform about the latest Nematology research activities at the University of California, CDFA, USDA and industry. Breakout session will give the audience an opportunity to sharpen their skill in nematode and identification, disease diagnostics, and sampling procedures. For information and registration: go to www.nematology.ucr.edu or contact antoon.ploeg@ucr.edu, 951-827-3192.

North American Greenhouse Tomatoes Emerge as a Major Market Force

Linda Calvin, Economic Research Service and Roberta Cook, UCCE Marketing Economist, UC Davis

The rapidly growing greenhouse tomato industry has become an important part of the North American fresh tomato industry. Greenhouse tomatoes now represent an estimated 17 percent of U.S. fresh tomato supply. Even though greenhouse tomatoes still constitute a minority share of the U.S. fresh tomato market, their influence is concentrated and growing in retail channels, which represent about half of U.S. tomato consumption. *Around 37% of all fresh tomatoes sold in U.S. retail stores are now greenhouse, compared with negligible amounts in the early 1990s.*

Greenhouse tomatoes are just one more development in a trend toward more differentiated fresh tomato offerings, including more variety in fieldgrown tomatoes. New types of tomatoes, improved varieties and handling, and positive health benefits associated with eating tomatoes have all contributed to a 30% rise in U.S. consumption of fresh tomatoes since 1985, with estimated 2003 annual per capita consumption levels around 19.4 pounds.

Growth in the greenhouse industry has challenged growers of fresh field tomatoes. With rising consumption of all tomatoes, field tomato sales in the U.S. retail market increased through 2001, in part due to new fresh field products, such as grape tomatoes. But in 2002, the combined retail sales volume of all field tomato types began to slip. Field tomatoes still dominate the growing foodservice market (restaurants, schools, hospitals, etc.) where greenhouse tomatoes are scarce. *Foodservice sales are increasingly essential to the health of the field tomato industry.*

While greenhouse tomatoes have higher per unit costs of production and generally higher retail prices than field tomatoes, several other characteristics have contributed to the growth in this sector. Since they are protected from weather and other conditions affecting open field production, greenhouse tomatoes generally have a much more uniform appearance than field tomatoes. They are also less prone to swings in production volumes. These factors lead to greater consistency in quality, volumes, and pricing—issues of particular concern to the retail and foodservice industries.

The United States, Canada, and Mexico have all developed major greenhouse industries. The U.S. is the largest North American market for greenhouse tomatoes, and U.S. imports from Canada and Mexico are larger than domestic production. In recent years, the growth in U.S. imports has exceeded the growth in U.S. production. In 2003, Canada accounted for an estimated 46% of U.S. imports of greenhouse tomatoes. Mexico's share was 45%. *Mexico is the primary foreign winter supplier to the U.S. market and Canada is the primary summer foreign supplier.* As the greenhouse tomato industry has transitioned from niche to mainstream status, it has become part of a more integrated North American market, following the pattern established by the field tomato industry.

The greenhouse industry is facing growing pains. With rapid growth in Canada and the United States during the 1990s, greenhouse tomato prices declined, causing financial problems for some growers. More recently, as the industry has expanded in Mexico, heterogeneity in production methods has increased. Growers in the United States and Canada, and some Mexican growers, have high-technology and high-cost greenhouses. Many of these growers view the growth of lower technology greenhouses and shade houses in Mexico with some alarm. Higher expected year-round production volumes in Mexico portend greater competition in all seasons, and continued downward pressure on price.

Seasonality Drives Market

Much of the U.S. greenhouse tomato industry began in the northeast in the early 1990s, with production in the same months as Canadian producers. Eventually, several producers moved west and south, lured by the prospect of producing tomatoes year-round and capturing a slice of the high-priced winter market. *The four largest greenhouse tomato firms in the U.S. are located in Arizona, Texas, Colorado and coastal southern California, and represent 67% of domestic production.*

Expanding winter production in Mexico will likely reduce greenhouse tomato prices and increase competitive pressure on year-round U.S. growers. Mexico's greenhouse tomato industry is the fastest growing in North America and the most varied. In Mexico, large field tomato grower-exporters in Sinaloa on the northwest coast and Baja California peninsula are experimenting with protected culture, either shade houses or greenhouses, near their field operations. *In contrast, U.S. field tomato growers usually have no connections to the greenhouse industry.*

Several clusters of greenhouses are also emerging in temperate, higher altitude areas in central and north central Mexico, and in Imuris in northern Sonora, near the U.S. border. *As greenhouse production in these areas expands, Mexico will become more of a competitive force in all seasons.*

Greenhouse Tomato Prices Fall

Despite rising demand for greenhouse tomatoes, the industry is facing downward price pressures, as demand growth has sometimes been outpaced by expanding supply. Production of the leading greenhouse tomato products -beefsteak and cluster- has now grown to the point where they are becoming mainstream commodities. As the industry matures, greenhouse tomato growers strive for continual product innovation as a strategy for adding value, stimulating consumer interest, and maintaining margins and profitability. The expanding product line currently consists of smaller cluster tomatoes (cocktail tomatoes, including Campari), roma and mini roma cluster tomatoes, heirloom, and different-colored tomatoes. *Greenhouse tomato producers tend to be closer to the pulse of consumers because they market a retail- and consumer-ready product. Also, they increasingly market directly to retailers, and not through intermediaries, such as repackers and wholesalers, as most field tomato shippers do.*

Impacts on Field Tomatoes

Competition from greenhouse tomatoes has brought major changes in the quantity and composition of field tomato sales. While

Canada leads North American greenhouse tomato production in 2003

Item	United States	Canada	Mexico	North America
Greenhouse tomato production (1,000 metric tons)	160	220	148	528
Greenhouse tomato area (hectares)	330	446	950	1,726
Average greenhouse tomato yield (metric tons/hectare)	484	494	156	378
Fresh field tomato production, excluding processing (1,000 metric tons)	1,594	27	1,804	3,425
Average fresh field tomato yield (metric tons/hectare)	32	15	28	25
Greenhouse share of total fresh production, by country (percent)	9	89	8	13
Estimated greenhouse exports to U.S. (1,000 metric tons)[1]	NA	130	126	256

[1]Official imports of greenhouse tomatoes are thought to be underreported for Mexico due to tariff code misclassification; 58,357 metric tons of greenhouse tomato imports from Mexico were reported by the U.S. Department of Commerce in 2003. The figure shown here includes estimated additional miscoded imports, based on information from industry sources obtained by Cook and Calvin. This figure may include some production from shade houses.

NA=Not applicable.

Sources: Statistics Canada, Ontario Greenhouse Vegetable Producers' Marketing Board, British Columbia Vegetable Marketing Commission, U.S. Department of Commerce, interviews by Cook and Calvin, USDA's National Agricultural Statistics Service, USDA's Foreign Agricultural Service.

total retail quantity sold of all fresh tomatoes increased from 1999 to 2003, the volume of field tomatoes declined after 2001, with the share falling from 69 to 63%. *Over the same years, the share of all round tomatoes (mature green and vine ripe) declined from 43 to 31%. The roma share fell from 23 to 19%, but the grape and cherry category grew from 3 to 13%. Most grape and cherry tomatoes are field grown, mitigating the impact of greenhouse tomatoes on the field-grown category. Within the declining round category, the share of mature green tomatoes fell from 78 to 39%, with vine ripe tomatoes benefiting.*

While mature green tomatoes are being forced out of the retail market by competition from both greenhouse and other field tomato types, they still dominate the expanding foodservice market, which represents about half of U.S. tomato consumption. With declining retail sales, the mature green industry is increasingly dependent on the foodservice market, where greenhouse tomatoes have not yet made significant inroads. However, this could change. *Some greenhouse firms have begun to experiment with developing acceptable products for foodservice use.* If foodservice demand falters, mature green tomato growers would need to consider other alternatives, with serious industry structural adjustments likely. Growers could continue to attempt to reposition field tomatoes through new varieties, products, and packaging with more commercial appeal. Alternatively, the industry could diversify into the greenhouse industry, either through alliances with existing producers or through direct investment. However, greenhouse tomato production is very capital- and technology-intensive, creating barriers to entry. In addition, the rapid greenhouse expansion in the United States was accompanied by mixed profitability results; thus, most field tomato growers did not consider the greenhouse industry an attractive alternative. But recent profitability in the California field industry caused by weather-induced high prices may provide the financial where-withal for some field growers to explore greenhouse production. If they were to invest, they would be new entrants in a maturing industry.

Greenhouse and Field Tomato Market Interactions Increase

In the early days of the evolution of greenhouse tomatoes, the greenhouse and field tomato sectors operated on a relatively independent basis. Now that they are a major market force, greenhouse tomatoes are increasingly influenced by supply and demand trends in the fresh field tomato industry, and vice versa. In fall 2004, a weather-induced period of short supplies of fresh field tomatoes enabled greenhouse producers to benefit from a brief period of extraordinarily high prices as buyers substituted greenhouse for field tomatoes, where possible. In contrast, earlier in summer 2004, a record-high supply of greenhouse tomatoes caused greenhouse prices to decline, making them even more attractive to retail buyers, and placing a damper on demand for fresh field tomatoes. With greater supply has come an increased willingness on the part of consumers, retailers, and foodservice users to experiment with tomato types.

Mexico Will Shape the Future

Notwithstanding brief periods of abnormally high prices, average grower prices for greenhouse tomatoes have been trending downward. If this trend continues, some parts of the North American greenhouse tomato industry may become less viable. Growers will continue to seek the lowest cost production regions and form marketing alliances to build year round supply. Greater competition means that new entrants have less room for error; the learning curve is shorter than in the 1990s, when the industry was in its infancy and average prices were higher. *The greatest source of uncertainty for the future of the North American greenhouse tomato industry will be the changing structure of the Mexican industry, which is still seeking out the best locations, technology packages, and management practices.* U.S. and Canadian growers will be following developments in Mexico closely when making their future investment and marketing decisions.

This article is drawn from . . .

Greenhouse Tomatoes Change the Dynamics of the North American Fresh Tomato Industry, by Roberta Cook & Linda Calvin, ERR-2, USDA/ERS, Apr. 2005, available at: www.ers.usda.gov/publications/err2/

Statewide Fresh Market Tomato Variety Field Evaluations for 2005

Scott Stoddard, Michelle Le Strange, Bob Mullen (Emeritus) and Jan Mickler, UCCE
Farm Advisors, Merced & Madera, Tulare & Kings, San Joaquin, and Stanislaus Counties

Introduction

UCCE conducts fresh market tomato variety trials in three areas in the San Joaquin Valley to evaluate the performance of new varieties and breeding lies from commercial plant breeders for the mature green market. These variety trials evaluate and compare fruit quality characteristics and yield in commercial production fields with different types of soil, management, and growing conditions. This market includes both round and "roma" type tomatoes.

Procedure

Trials are laid out as randomized complete block designs with 4 replications (observation lines are not replicated but are planted adjacent to the replicated plots). Plots are transplanted and managed concurrently as the commercial field in which they are located. Harvest is done by hand at the same time as the rest of the field, picking from a 10 foot section from the center of the plot. At harvest, fruit are sorted by culls, color, and size. Small fruit (2 – 2.25") are picked but are not included in the total market yield.

Results

Replicated Lines: Results for marketable yield and fruit size for Fresno, Merced, and San Joaquin Counties are shown in Figure 1. Shady Lady and Quali T-21 are the standards to which the other varieties are compared. In Fresno, BHN 580 was the clear standout with regard to yield, with a mean yield over 2400 boxes/A. This was largely a result of an over-production of jumbo sized fruit.

Merced also had a clear winner with AT-37, at over 2500 boxes per acre. Overall, the production of XL fruit was much lower in Merced compared to the other locations.

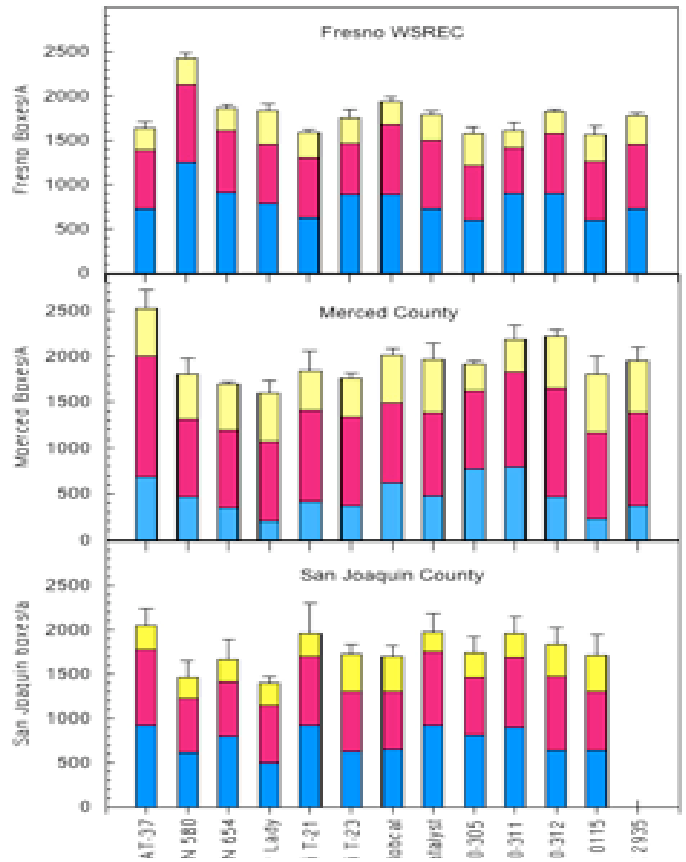
There was no variety in San Joaquin County that was so markedly higher yielding than the rest. AT-37, Q-21, Catalyst, and RFT 500-311 all yielded similar to each other at around 2000 boxes per acre.

The LSD's for Fresno, Merced, and San Joaquin Counties were 211, 424, and 360 boxes per acre, respectively. Additional information about this trial can be found in the full report posted on the Merced County website at http://cemerced.ucdavis.edu.

Observed Lines: The combined market yields for each county are shown in Figure 2. Because there is no replication in the observed lines, statistical analysis could be performed only on the combined data set. SRT 6784 did particularly well in Fresno, while BHN 525 and PX 2942 yielded well in Merced and San Joaquin locations. Combining locations, no significant differences among varieties were found for yield or size, mainly because of the large amount of variability in the data

Romas: A replicated roma trial was conducted in San Joaquin County. At that location, Miroma performed better than the other lines. Contact Jan Mickler or Bob Mullen for more information. Six roma varieties were observed in Fresno (visit http://cetulare.ucdavis.edu/Vegetable_Crops/)

Figure 1. Yield by size class for all three locations. Stacked bars show medium fruit on top, large in middle, and extra-large on bottom. Error bars are standard error of the mean for each variety. Total height of the bar is the total market yield.



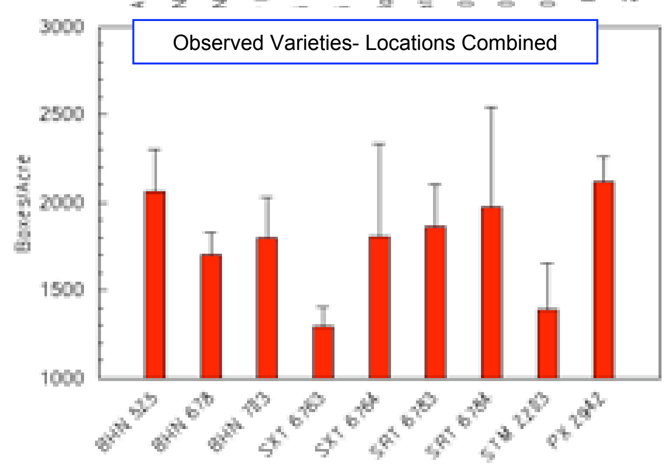


Figure 2. Total market yield results. Error bars represent one standard error of the mean. Variety yields are not significantly different.

2005 Bell Pepper Variety Evaluation Trial

Benny Fouche and Bob Mullen (Emeritus), Farm Advisors, UCCE San Joaquin County

Now that there are a number of new pepper cultivars available to producers, information on yield and fruit quality, as well as disease resistance or tolerance is desirable for the local industry. This year's trial at Biglieri Farms on the Borden Ranch near Dry Creek, east of Galt, California was transplanted on June 10th. The soil type at the trial site was a Wyman silt loam and the trial field was alternate-row furrow-irrigated throughout the season. The resulting crop stand was excellent with vigorous early plant growth. A very hot July and August caused some plant stress, loss of fruit set and a subsequent delay in fruit maturity. Hand harvest of the trial was on September 10th.

The trial included fifteen replicated varieties arranged in a randomized complete block design. In addition to marketable red and green yield figures, data on crop maturity and fruit size were taken (Table 1). Best quality fruit, including blocky shape and good fruit color and size was led by Double Up, Encore, Mercado, Red Bell, RPP 9650, Affinity, RPP 16900, and Baron. Fruit size for most of the lines evaluated was predominately jumbo and extra-large. Other than some fruit sunburn and blossom end rot and some cat-faced fruit, there were no other fruit defect problems. There was virtually no worm damage in the trial and none of the fruit had Pepper Spot (STIP).

The same varieties were evaluated in Morgan Hill by Aziz Baameur. His report is available at UCCE Santa Clara Co. website (http://cesantaclara.ucdavis.edu/).

Table 1. Yield, maturity, and fruit size percent for 15 bell pepper varieties – Galt, CA 2005

	Marketable yield/acre (red + green)		Crop maturity at harvest (%)			Fruit size (%)[2]					Total yield/ acre
Variety	Tons[1]	Boxes	Red	Green	Culls	Jumbo	Extra-large	Large	Med	Small	Tons
Red Bell	16.0	1,281	1.5	58.5	40.0	34.2	25.9	23.6	9.9	6.4	26.8
Double Up	15.9	1,272	9.8	56.0	34.2	30.3	20.1	28.5	10.5	10.6	24.3
Encore	146	1,167	9.1	55.2	35.7	55.8	18.8	10.6	7.4	7.4	22.6
RPP16900	13.8	1,103	14.4	49.1	36.5	3.3	19.6	28.9	22.7	25.5	21.7
Mercado	13.5	1,080	4.3	57.2	38.5	66.3	17.3	9.7	2.9	3.8	22.1
RPP9650	13.4	1,074	8.4	47.1	44.5	64.5	21.8	10.9	1.1	1.7	23.7
RPP9661	13.4	1,071	5.3	57.3	37.4	53.1	14.4	8.9	9.7	13.9	21.3
Baron	13.4	1,068	12.1	48.7	39.2	4.1	27.7	32.7	21.7	13.8	22.1
Wizard	13.1	1,049	4.7	54.7	40.6	47.0	23.3	10.3	6.1	13.3	21.9
Affinity	12.7	1,016	11.3	46.0	42.7	51.0	21.9	14.8	3.6	8.7	22.9
Stiletto	12.1	967	3.4	50.2	46.4	9.5	31.7	27.2	19.1	12.5	22.1
Crusader	10.7	857	2.7	52.3	45.0	34.4	25.8	12.8	13.6	13.4	19.2
Excel	10.1	804	3.0	47.7	49.3	24.9	19.9	32.4	7.0	15.8	19.8
Jupiter	9.7	778	1.6	42.1	56.3	51.1	23.3	14.9	3.7	7.0	22.1
Escarlata	7.4	590	6.4	29.3	64.3	20.0	10.2	20.0	24.5	25.3	21.4
Average	**12.7**	**1,012**									
LSD[3]	4.2	336									
C.V.	23.3%	23.3%									

[1]Values represent the average of four replications
[2]Pepper fruit sizing data: Jumbo: >8.5 oz; Extra-large: 7 – 8.5 oz; Large: 6 – 7 oz; Medium: 5.3 – 6 oz; Small: <5.3 oz
[3]Least significant difference at 5% significance level

Many thanks to the cooperators and to the participating seed companies for their support of this work!

Water Requirements of Irrigated Bell Peppers

Tom Trout and James Ayars, USDA/ARS, Water Management Research Laboratory, Parlier

Introduction

There has been a shift in cropping from long season high water requirement crops (tomato, cotton) to short season vegetable crops (lettuce, pepper, broccoli, onion) on the west side of the San Joaquin Valley (SJV). There has also been in a shift in irrigation systems from surface irrigation to pressurized systems i.e. sprinkler and microirrigation. There is very little information describing the crop water requirements for vegetable crops grown in this region using sprinkler and microirrigation. This is a report of the results of a field study that determined the crop water requirements for a bell pepper crop grown on the westside of the SJV using drip and furrow irrigation.

Materials and Methods

Three different irrigation systems were installed at the West Side Research and Extension Center to evaluate and compare irrigation methods commonly used to grow vegetable crops on the west side. These include:

1) a furrow irrigation system,
2) a surface drip irrigation system, and
3) a subsurface drip irrigation system with drip laterals installed 12 inches deep.

Water was applied with each system at four different irrigation levels in order to determine the application amount needed to obtain maximum yield. Amounts of applied water were equal to 50, 75, 100 or 125% of the crop evapotranspiration rate determined from water use in a well watered crop lysimeter. *(Lysimeter is a device for measuring the percolation of water through soils.)*

The 12 irrigation treatments were arranged in a split-plot experimental design with four replicate plots per treatment. Each plot was 300 feet long and consisted of four crop beds spaced 40 inches from center to center; outside beds served as borders between treatments.

An irrigation control system applied all drip irrigations automatically in response to crop lysimeter water use. The lysimeter (which has drip tubing installed 12 inches deep) and all drip irrigation treatments in the field were watered after 0.08 inch of crop evapotranspiration was measured by the lysimeter. This resulted in several applications each day to match peak water use. Furrow irrigated plots were watered weekly based on the accumulated water use over the previous 7 days.

Bell peppers (var Baron) were planted on April 25, 2005 as transplants with a planting density of 17,000 plants/ac (10-inch in row spacing by 40-inch row spacing). Harvest was in July and early August. Plants were grown following normal cultural practices, which included pre-plant and irrigation applied nutrients. Sprinkler irrigation was used to establish seedlings.

Water applied to each treatment was recorded automatically using electronic flow meters installed in the irrigation manifold. Crop evapotranspiration was measured with a lysimeter and with a Bowen Ratio system installed in the pepper field. A second Bowen Ratio system was installed in the grass field next to the pepper field. Crop ET measured by the Bowen Ratio system in the peppers was divided by the grass ET measured by the Bowen Ratio system in the grass field to calculate daily crop coefficient Kc values.

Peppers were harvested 3 times from a 30 foot section of the center 2 rows of each treatment. The peppers were sorted into green and red market peppers and culls.

Results and Discussion

The applied water for each of the treatments is summarized in **Table 1.** The ET measured by the crop lysimeter was 20-inches and the data show that the target ET levels were met for the drip systems and approximately 5% higher in the furrow systems.

The daily evapotranspiration for the crop and the grass reference are plotted in **Figure 1**. The data show that there was approximately 0.3-0.4 inch of water lost per day in the grass and pepper crop during July and August with the pepper crop ET being higher than the grass. These data were used to calculate the bell pepper crop coefficient shown in **Figure 2**. The K_c in July and August was between 1 and 1.2 for the pepper crop and was an average across all the treatments.

The yield results for the 2005 experiment are summarized in **Table 2**. The data show that the two drip treatments had the similar yields at three of the irrigation levels. Furrow irrigation yields were less than either of the drip treatments at both 100% and 125% irrigation levels. At the 50% level there was no significant difference across the system type. Comparing the mean values of the water treatments, the data show that the yields for the 50% treatments are less and the mean yield for the 125% water treatment was statistically greater than the intermediate treatments.

The water use efficiency data (**Table 3**) were generally lowest for the furrow treatments and highest for the subsurface drip treatments with the exception being the 125% treatment.

Table 1. **Applied irrigation water (inches) on bell pepper irrigation trial at WSREC in 2005.**

	Irrigation levels			
Irrigation Methods	**50% ET**	**75% ET**	**100% ET**	**125% ET**
Furrow	10.7	15.7	20.8	26.0
Surface Drip	10.0	14.9	19.9	24.7
Sub Surface Drip	9.9	14.9	19.7	24.7

Table 2. **Pepper market yield (Tons/acre) at WSREC experimental sited during 2005 growing season.**

	Irrigation levels				
Irrigation Methods	**50% ET**	**75% ET**	**100% ET**	**125% ET**	**Mean**
Furrow	9.5 **ef**	11.7**df**	10.1 **def**	11.9 **d**	**10.8 b**
Surface Drip	8.5 **f**	11.9 **d**	15.4 **c**	19.9 **a**	**13.9 ab**
Sub Surface Drip	10.1 **def**	15.5 **c**	17.5 **bc**	18.0 **ab**	**15.3 a**
Mean	**9.4 c**	**13.1 b**	**14.3 b**	**16.6 a**	**13.6**

LSD(0.05) for irrigation methods = 3.4 T/A LSD (0.05) for irrigation levels = 2.2 T/A LSD (0.05) for interaction (M x L) = 2.3 T/A

Table 3. **Water use efficiency in Tons/Acre/inch of applied water**

	Irrigation levels			
Irrigation Methods	**50% ET**	**75% ET**	**100% ET**	**125% ET**
Furrow	0.89	0.75	0.49	0.46
Surface Drip	0.85	0.80	0.77	0.81
Sub Surface Drip	0.95	1.04	0.89	0.73

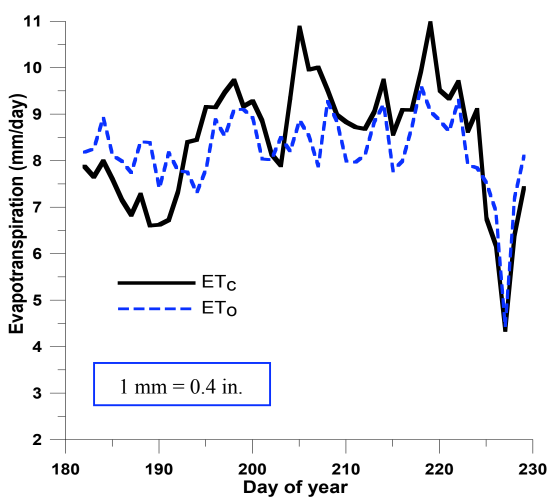


Figure 1. Daily evapotranspiration of grass (ET_o) and pepper (ET_c) at the West Side Research and Extension Center in July 1 to August 17, 2005 measured by the Bowen Ratio technique.

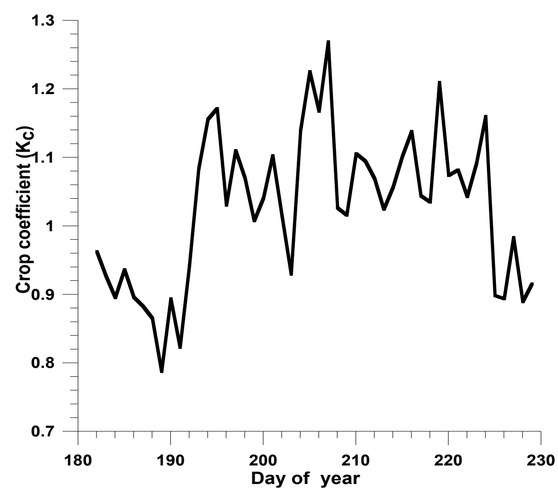


Figure 2. Pepper crop coefficient calculated using Bowen Ratio data from July 1 to August 17, 2005.

Pepper Virus Diseases: A Review

Steven Koike, Richard Smith, and Aziz Baameur, UCCE Farm Advisors, Monterey and Santa Clara Counties

Introduction and Significance: Pepper is susceptible to a large number of virus pathogens. Worldwide, over 70 such agents have been documented to some degree, and other virus-like diseases have yet to be fully characterized. Some of these virus diseases are economically important throughout the world, while others are significant in only specific, limited areas. For pepper growers in California, perhaps ten viruses are of regular or periodic concern (see Table 1). The particular set of viruses that might be of economic importance can change over time. In the early to mid-1990s, cucumber mosaic, pepper mottle, and tobacco etch viruses were perhaps the most commonly encountered pepper virus problems. Now in the 2000s, that situation may have changed significantly.

Symptoms and Diagnostic Features: For any particular pepper virus, the incidence and expression of disease symptoms will vary greatly depending on the strain and virulence of the virus, pepper species and cultivar, age of pepper plant when infected, means of inoculation (e.g. whether the virus entered the plant by mechanical abrasion or was initially in the pepper seed), vector type and strain, population of the vector, and environmental conditions. With few exceptions, symptoms caused by different viruses often resemble each other, thereby making field diagnosis difficult and ill advised. Virus disease diagnosis is further complicated when more than one viral agent infects the pepper plant. Clinical tests are required to positively identify viral agents in plants.

Disease Cycle: Disease cycles of the various pepper viruses are similar. Primary inoculum mostly comes from infected weed hosts, volunteer Solanaceous plants, or existing pepper plantings. However, for the few pepper seedborne viruses, the germinating seedling or infected transplant will be the inoculum source. Insect or nematode vectors then move the viruses from infected plants to healthy plants. Vector movement generally dictates pathogen distribution for most of these diseases. Some of these pepper viruses can be readily transmitted by mechanical means such as handling by workers and pruning tools.

Control: Virus diseases tend to be difficult to control. The use of resistant cultivars would be the best option for growers; however, for the California pepper industry we do not yet have suitably resistant peppers that have the necessary horticultural features. Remove reservoirs of virus pathogens by controlling weeds, volunteer peppers, and other Solanaceous volunteers near fields. Plow under old pepper fields soon after harvest is completed. Carefully inspect and remove any transplants that show virus symptoms and vector activity. Crop rotation is a good practice in general, though such rotation usually does not assist in virus disease management unless the vectors are soilborne nematodes. For seedborne pepper viruses, use seed that has been tested and found to not have detectable levels of the pathogen, or that has a pathogen level below significant thresholds.Controlling the vector does not prevent virus infections from taking place. However, management of insect vectors is important and should be attempted by applying insecticides and other insect control materials, planting crops on reflective mulches to repel vectors, or planting crops under netting, fabric, or plastic tunnels to exclude vectors. Soilborne nematode vectors can be managed by using soil-applied fumigants, rotating crops, and cultivating regularly to reduce the growth of host weeds and volunteers.

Pepper Virus Survey: Because of severe crop losses in 2004 due to pepper viruses, we conducted field surveys in coastal California pepper growing regions to identify pepper virus incidence. Symptomatic pepper plants were randomly collected from fields in the Gilroy, Hollister, and King City areas. Various pepper types (Anaheim, ancho, bell, jalapeno) were collected and tested using serological assays. The survey was conducted in 2004 and 2005. Results were similar for both years. The great majority of samples were infected by either cucumber mosaic virus (CMV) or tomato spotted wilt virus (TSWV). Many samples were co-infected with CMV and TSWV. Other pepper viruses were found but were very low in incidence and clearly were not important factors. Such incidental finds included the following: alfalfa mosaic virus, potato virus Y, tobacco etch virus, tobacco mosaic virus.

Summary: Pepper viruses will continue to be a long-term concern for pepper growers. In some seasons, such as 2004, virus diseases will cause significant crop losses. In other seasons the viruses will be less important and disease incidence will be low. Continued research efforts will be warranted to further understand and define the causes of such virus problems and to develop suitable resistant cultivars. With the worldwide movement of plant materials, it will be certain that sometime in the future new virus pathogens will make their way into California. Growers, field personnel, and extension researchers should therefore monitor pepper virus situations and be aware of such new developments. Contact the Farm Advisor in your region, if you see outbreaks of virus symptoms on peppers.

Table 1. Summary of some pepper viruses found in CA

Pathogen	Acronym	Virus group	Primary transmission
alfalfa mosaic virus	AMV	alfamovirus	Aphid
cucumber mosaic virus	CMV	cucumovirus	Aphid
pepper mottle virus	PepMoV	potyvirus	Aphid
potato virus Y	PVY	potyvirus	Aphid
tobacco etch virus	TEV	potyvirus	Aphid
pepper mild mottle virus	PMMoV	tobamovirus	seed, mechanical
tobacco mosaic virus	TMV	tobamovirus	seed, mechanical
tomato mosaic virus	ToMV	tobamovirus	seed, mechanical
tomato spotted wilt virus	TSWV	tospovirus	Thrips
beet curly top virus	BCTV	geminivirus	Leafhopper

Tomato Spotted Wilt Virus (TSWV)

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

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

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

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

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

Pepper Stip

Joe Nuñez, UCCE Farm Advisor, Kern County

What is Stip?

Pepper stip, or color spotting, has become a serious problem for many bell pepper growers the past few seasons. There has been a lot of confusion as to what stip is and what it looks like. Pepper stip causes greenish-brown spots that are about 1/4 inch in diameter, slightly sunken below the surface on the fruit. They are most commonly seen on the mature red fruit but occasionally occur on green fruit as well. The spots appear just as the fruit begins to turn red.

Here in the southern San Joaquin Valley, stip has been prevalent on hybrid elongated red bell types or the so called "Maccabi" types. It also seemed to occur in early summer after a warm spring. This is contradictory to the report of stip in other pepper growing regions of the state. Along the coast and in Northern California, pepper stip is described as occurring after a cool period during the short days of fall on blocky open pollinated green bell types. Stip is apparently a mysterious disease of which very little is known.

Some things can be said about pepper stip. It is a physiological disorder that seems to be dependent on the environment for it to occur. Here the warm spring weather may have triggered it; in other parts of the state short, cool days are required before stip appears. It also appears to be a calcium imbalance, similar to blossom end rot. However, some reports say it is due to lack of calcium in the fruit while others report too much calcium in the fruit. There is also a difference in varietal susceptibility. In the southern San Joaquin Valley and in the southern deserts we know that the elongated Maccabi types are very susceptible to stip while blocky types are resistant. Other parts of the state report that it is on the blocky types that stip is found.

Earlier trials

Stip research trials conducted in San Benito and San Joaquin Counties by Farm Advisors Richard Smith and Bob Mullen, in 1998 showed some interesting results. They learned two important things that may be beneficial to pepper growers here. First, that there are differences in susceptibility to stip between varieties and secondly that the incidence of stip could be reduced in the most susceptible varieties with calcium applications.

A variety trial evaluating open pollinated varieties for tolerance to pepper stip was conducted in San Benito County. The cultivar Gusto was nearly completely resistant and it was followed by varieties that were intermediated in susceptibility to pepper stip: Taurus and Cal Wonder 300. The remainder of the varieties tested (Yolo Wonder A and B, Jupiter, Keystone Resistant Giant, Grande Rio 66, Mercury, Pimlico, Loribelle, Capistrano, Merced, Emerald Giant, D-93, and Pip) were susceptible to stip. Foliar calcium applications beginning at first flower and continuing weekly until fruit began to turn red did not affect the incidence of pepper stip in San Benito County. However foliar applications did reduce the incidence of pepper stip in San Joaquin County. Five applications of foliar calcium at 0.5 gallon per acre of Cal Max reduced the incidence of pepper stip on Grande Rio and Yolo A by 85 and 60%, respectively.

Because so little is known about stip it is difficult to make management recommendations. Right now the only recommendations can be made are to plant varieties that are less susceptible to the disorder and maintain adequate but not excessive amounts of calcium.

SOURCES OF INFORMATION – TOMATOES & PEPPERS

PUBLICATIONS FROM UC

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

UC Vegetable Research & Information Center
(UC VRIC) www.vric.ucdavis.edu

UC IPM (homepage)
www.ipm.ucdavis.edu

UC Weed Research & Information Center:
(UC WRIC) www.wric.ucdavis.edu

UC Postharvest Technology:
http://postharvest.ucdavis.edu
(be sure to browse the Produce Facts)

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

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

IPM Tomato Manual, #3274
IPM Tomato Pest Management Guidelines #3470
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
IPM Pepper Pest Management Guidelines #3460
Scheduling Irrigation: When & How Much, #3396

INDUSTRY ORGANIZATIONS

California Tomato Commission
www.tomato.org
Fresh Market Tomato Industry
1625 E. Shaw Avenue, Suite 106
Fresno, CA 93710
(559) 230-0116

California Pepper Commission
531-D North Alta Avenue
Dinuba, CA 93618
(559) 591-3925

WEATHER & IRRIGATION

CIMIS - CA Irrigation Management & Info System
CA Dept Water Resources - www.cimis.water.ca.gov

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

PESTICIDE LABELS

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

MARKET NEWS

http://www.produceforsale.com/producemarkets.htm

The Vegetable Notes Newsletter is available ONLINE.

To download this or previous editions go to
UCCE Tulare County website:
http://cetulare.ucdavis.edu/Vegetable_Crops/
You can also sign up to receive this newsletter online.
We welcome your comments. Send to newsletter editor:
mlestrange@ucdavis.edu

Other UCCE county websites in the SJV:
Fresno County: http://cefresno.ucdavis.edu
Kern County: http://cekern.ucdavis.edu
Kings County: http://cekings.ucdavis.edu
Merced County: http://cemerced.ucdavis.edu
San Joaquin County: http://cesanjoaquin.ucdavis.edu
Stanislaus County: http://cestanislaus.ucdavis.edu

Vegetable Crops Facts

UCCE Merced and Madera Counties

Scott Stoddard, Farm Advisor

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Research Progress Reports

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