

# Diseases, Pests and Nutritional Notes

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## DISEASES

### Verticillium wilt on tomato

#### Disease cycle

- Can be infected at any age
- More active at 75 and 83°F.

#### Symptoms

- Leaves wilt on sunny days and recover at night
- Light vascular discoloration (fusarium is darker) and is confined to lower areas of the plant (4" from soil) whereas Fusarium discoloration travels up
- Often, no symptoms are seen until the plant is bearing or during dry periods
- Bottom leaves become pale, then tips and edges die and leaves drop off
- V-shaped lesions
- Often plants are stunted
- One-sided symptoms

## Management

- Many hosts so stick to rotations with cereals/grasses. Many weeds can be a host, too
- Prevent infected tissue from being incorporated in the soil

## Sampling and Diagnosis

- Take stem samples. It's rarely in the petioles/leaflets so need to take a chunk of the main stem
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## Fusarium wilt on tomato *F. oxysporum* f. sp. *lycopersici*

### About

- Race 3 is in Yolo, Solano and Sacramento counties
- Can be spread mechanically (cutting vines with same clippers)
- Specific to tomato
- Warmer temperatures favor Fusarium (28°C/82.5°F) over Verticillium, but Vert symptoms can be more severe at higher temps
- Survives in soil up to 10 years
- Favored by low pH soil

### Symptoms

- Begin as slight vein clearing on the outer leaflets and drooping of leaf petioles
- Later, lower leaves wilt, turn yellow and die
- Dark vascular discoloration (vert is lighter), especially where the petiole joins the stem but are long lines
- One-sided symptoms
- Fusarium discoloration travels up higher in the plant whereas Vert stays quite low
- Yellow flagging. Early on, it's split yellow and green

### Spread

- Soil: farm equipment, on stakes, wind-blown soil, infested seedlings

### Management

- Resistance: Race 1 and 2 use polygenic and monogenic resistance and race 3 is monogenic
- Raise soil pH to 6.5-7
- Steam soil pasteurization

### Sampling and Diagnosis

- Take stem samples. It's rarely in the petioles/leaflets so need to take a chunk of the main stem
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## Fusarium Crown and root rot, *Fusarium oxysporum* f. sp. *radicis-lycopersici* (FORL)

### Symptoms

- Large fruit, and really dark, coffee-colored lesion at base of plant
- Vertical lesion is obvious at the base

- tap root of infected plants often rots entirely
- Plant collapses quickly, 2 weeks
- Plants look exposed, you're thinking "something bad has happened in the root".
- Early symptoms: stunting, yellowing, and premature loss of cotyledons and lower leaves.

#### About

- invades susceptible plants through wounds and natural openings created by newly emerging roots

#### Epidemiology

- Favored by cool temperatures (10°C to 20°C/50°F to 68°F). Low soil pH, ammoniacal nitrogen, and water-logged soil also exacerbate the disease
- Use disease-free transplants. Transplant houses should not be located near tomato production fields. Avoid over watering, which makes the transplants more susceptible to crown and root rot. Disinfect transplant trays by steaming before reuse.
- Use a preplant fumigant. The soil should be of good tilth and adequately moist for at least two weeks prior to fumigation. Use an appropriate chisel spacing and depth, and immediately cover the bed with plastic mulch following fumigation.
- Optimize cultural practices in the field. Avoid injuring transplants when they are set in the field. Physical damage and injury from excessive soluble salts may make young plants more susceptible to crown and root rot. The use of water drawn from wells rather than ditches for watering-in transplants may help to prevent recontamination of fumigated soil. Avoid ammoniacal nitrogen and maintain the soil pH at 6 to 7. Rapidly plow in crop debris following final harvest. Disinfect tomato stakes before reuse, or use new stakes.
- Rotate with a nonsusceptible crop. Incomplete knowledge of the host range of FORL makes precise recommendations in this area difficult. Current research data suggests that leguminous crops should be avoided in favor of corn and similar crops. Rotation and intercropping with lettuce had reduced FORL in greenhouse-grown tomatoes.
- Significant progress has been made in breeding for resistance to Fusarium crown and root rot in field-grown tomatoes. Although the commonly used commercial varieties do not have resistance, some resistant cultivars, such as Conquest, are available for field use.
- Additional management strategies under investigation include the use of biological control, cover crops, and soil solarization alone or in combination with fumigants.
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### Curley Top, Tomato

#### Symptoms

- The "curly tops" appear up high in the plants.
- The leaves fold, 'cup', twist and curl inward
- They often appear purple and have a kind of firmness or thickness to them when you scrunch them
- Phloem rings are necrotic and appear as dark rings
- Fruit ripens prematurely
- Plants are stunted and 'tough'
- \*look for purpling in the tiny leaves (size of pinky nail)
- If you see necrotic spots, you're looking for TSWV symptoms on the leaves and fruit

#### Epidemiology

- Often, the infected, symptomatic plants are scattered so not clustered in an area
- Transmitted by beet leaf hopper
  - can migrate long distances from its breeding grounds in the coastal foothills and desert areas to cultivated areas. The leafhopper overwinters on a wide range of annual and perennial weeds and readily acquires the virus when it feeds on infected plants

## TSWV

### Symptoms

- Spotting on leaves, colored or necrotic (remember the name is spotted wilt!)
  - Necrotic spotting can also be caused by alfalfa mosaic virus so the way to tell the difference is to cut open a stem and look for vascular discoloration. AMV has very dark and pronounced vascular discoloration.
  - Boron toxicity can also cause spotted necrosis and can look like TSWV
- You can see symptoms on green fruit, raised bumps and/or concentric circles, so look for fruit when diagnosing in addition to the leaves
- Bronzing of the leaves
- Look for yellow mosaic flagging (ozgur)
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### Epidemiology

- Spread by western flower thrips, *Frankliniella occidentalis*, onion thrips, among several other species; persistent, propagative (get into salivary gland, and can reproduce in both the plant and vector)
- If there is really early stunting caused by TSWV, then the plant was probably infected at the nursery
- Radicchio was growing in the area, late fall harvest, and was found with TSWV. It had the viral mottling and dark red, small spots. Can be a reservoir.

### Control

- Some resistant varieties
- If its in the greenhouse, you can control thrips populations better (double door, traps)
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- Contact insecticides generally do not reach where the thrips are located on the plant, and systemic insecticides do not act rapidly enough to prevent virus transmission.
- treatments that deter feeding or induce host resistance mechanisms to deter thrips feeding may be used.
  - Ex. In lettuce, Reflective mulches placed over plant beds prior to planting can disorient thrips or impair thrips feeding

### Sampling and Diagnosis

- Immuno-strip test.
  - For fruit, shave 'skin' -thick pieces of symptomatic areas or margin of symptomatic area

- Total amount should be as big as a thumbnail
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## Flar Virus

### Epidemiology

- Pollen-transmitted virus so the point of initial infection is at the pollen. Symptoms travel downward.

### Symptoms

- Long, dark streaks on the stem.
- Looks a lot like mechanical damage from rubbing/scratching the epidermis

## Powdery Mildew

- Main pathogen: *Leveillula taurica* (*Oidiopsis taurica*)
- Emerging pathogen: *Oidium lycopersici*
  - Comparing the two, *L. taurica* sporulation on the underside of the leaf does not grow over the veins whereas *O. lycopersici* will have mycelium/spores cover the entire area
  - *O. lycopersici* arrives earlier than *L. taurica*

## Blossom End Rot

- The uptake and distribution of calcium within the fruit was reduced by increased salinity in the root zone.
- The sensitivity of the cultivars to salinity, rather than salinity per se, seems to be the cause of different incidence of BER among cultivars. However, in response to salinity, neither the plant growth habits (size) nor the calcium accumulation in fruit of these cultivars could be identified as the physiological basis of the susceptibility to salinity-induced BER in tomato.
- Reduction in the uptake of water and calcium by salinity could be the primary cause of BER
- BER was more prevalent when the air temperature was 2°C higher than the 'blueprint' temperature (20°C/68°F day, 17°C/63°F night, even though salinity was low. Therefore, a low capacity of Ca absorption by the roots may not be the common cause of susceptibility to BER.

## Entomology

### Mites

For processing tomatoes and other field grown tomatoes, russet mite control has been primarily achieved with a single sulfur application. And that sulfur is also a preventive measure for tomato powdery mildew control. While dusting sulfur has been the best, there are other formulations used as a liquid spray.

### Stinkbug

A problem especially in his area (Ray Yeung)(West Sac)

Ex. PyGanic and grandevo (?)

## Diorders

### Puffiness

Durst: It is puffiness. My understanding is that it's cause by low nitrogen/potassium levels as the fruit is forming causing incomplete gel formation. It makes the fruit unmarketable. Even though there was still quite a bit of fruit in the field, it is almost impossible to separate the full from the incomplete fruit. You can tell by weight but this test is not accurate.

In future years, where there is a heavy fruit load, I would continue to water run amendments to fill out the upper fruit on the plants. Adding nitrogen during the growing cycle can delay ripening so it needs to be used with that in mind. In this case, we were trying to get the fruit to ripen up so I was reluctant to run more N. I think weekly petiole sampling is the best practice to stay ahead of this issue. In fact, I think weekly petiole sampling is important in all vegetables to monitor nutrient levels before they show up in plant or fruit quality. Jim

## NUTRIENTS and FERTILITY

### Phosphorus demand

- Phosphorus (P) application rates of 60 to 120 pounds per acre (67–134 kg/ha of P<sub>2</sub>O<sub>5</sub>) are adequate for the majority of tomato fields, but actual application rates often range from 80 to 160 pounds per acre (90–179 kg/ha).

### Phosphorus deficiency

Tomato

- One key symptom is that the veins are purple on the underside of the leaf. So just purple leaves is not indicative. Look for the veins on the underside.
- If P is low in the soil, we would expect to see it in the seedling. Often times, they can grow out of it, even when they show symptoms in the beginning. P demand doesn't really increase over the course of the season. It's not like at flowering or fruit set, there's a spike in P, so you don't expect for P-deficiency to suddenly show up in mature plants. In the case of Jim Durst/Yanor, that's what they saw, so Gene doesn't think that it's P deficiency (also because the photos didn't have purple veins). When young plants are P deficient, as I said they outgrow the purple symptom, but so the next symptom would be that the plant is smaller. The leaves are necessarily stunted, but the whole plant is smaller.

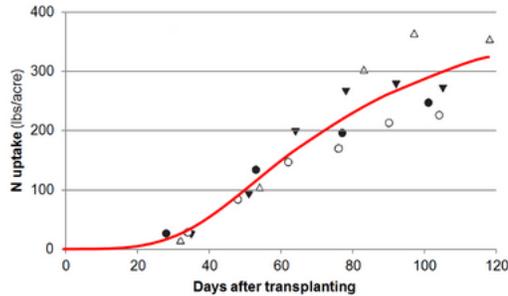
- Overall, the look is chlorotic, too. Seems like there's some N relationship. Or that the look of the plant can be improved when N is added.
- Gene showed me some slides of P-def seedlings and in the field, too.

## NITROGEN

- 150 to 350 pounds per acre (168–392 kg/ha) of nitrogen for pole-grown tomatoes.
- University of California research has shown that under normal conditions, maximum yield in either bush or pole-grown tomatoes can be obtained with approximately 100 to 180 pounds per acre (112–202kg/ha) of nitrogen up until the first harvest.
- For pole tomatoes with an elongated harvest season, maintenance applications of up to 10 pounds per acre (11 kg/ha) of nitrogen per week may be necessary.
- Where drip irrigation is used, nitrogen is applied in numerous, small fertigations throughout the season. In furrow-irrigated fields, nitrogen is applied preplant and in one or more sidedressings; late-season, water-run applications are also common. If potassium is needed, it is applied in a manner similar to that of nitrogen.
- [https://apps1.cdfa.ca.gov/FertilizerResearch/docs/N\\_Tomato.html](https://apps1.cdfa.ca.gov/FertilizerResearch/docs/N_Tomato.html)

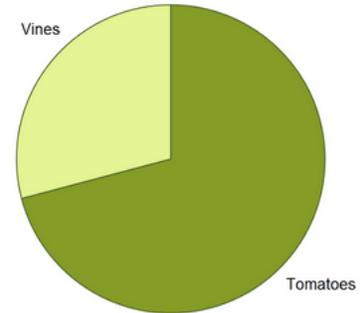
# Tomato Nitrogen Uptake and Partitioning

**Seasonal N Uptake**



Nitrogen uptake curve of processing tomatoes grown in research plots at UC Davis and in commercial fields. Uptake was determined by harvesting the aboveground biomass at different times during the season (Hartz and Bottoms, 2009). Early in the season, N uptake was low. The period of low uptake is shorter with transplants compared to seeds. The N uptake remained relatively high until harvest.

**Nitrogen Partitioning**



Approximately 70% of the total aboveground N was in tomatoes, with the rest being in the vines (Hartz and Bottoms, 2009).

## Nitrogen Removed at Harvest

Yield and N removed at harvest of processing tomatoes grown in research plots at UC Davis. The seasonal N application was 190 lbs.

Study location	Years	Yield (lbs/acre) (tons/acre)	Aboveground N (lbs/acre)	Harvested N (lbs/acre)	Source
Yolo County	2007-08	108,000 54	295	210	3.9 Hartz and Bottoms, 2009

## IRRIGATION

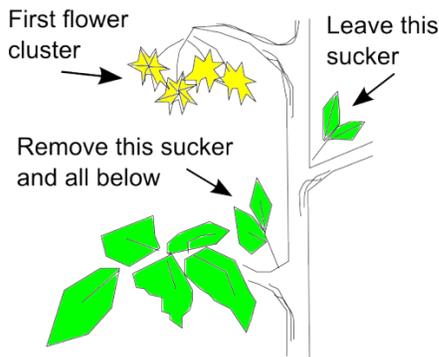
- The amount of drip irrigation applied is generally calculated by considering crop growth stage and using reference evapotranspiration (ET<sub>o</sub>) data available from the California Irrigation Management Information System (CIMIS). Drip-irrigated fields are kept near field capacity throughout the season. Soil moisture is monitored with sensing devices, such as tensiometers. Frequency of irrigation may vary from once or twice a week to daily, depending upon season, climate, soil type, and plant growth stage.
- Throughout the season, an average of 20 to 24 and 30 to 36 acre-inches (2,060
- to 2,470 m<sup>3</sup> and 3,090 to 3,710 m<sup>3</sup>) of water are applied to bush- and pole grown tomatoes, respectively.

- Tomatoes have a relatively deep root system and thrive on deep infrequent irrigation. Watering less frequently reduces root-rot diseases and favors weed control.
- Regardless of irrigation technique, most phosphorus is applied preplant or at transplanting in a banded application.
- Where drip irrigation is used, nitrogen is applied in numerous, small fertigations throughout the season. In furrow-irrigated fields, nitrogen is applied preplant and in one or more sidedressings; late-season, water-run applications are also common. If potassium is needed, it is applied in a manner similar to that of nitrogen.

#### Durst

- Cleans drip lines using vinegar (had done this on 5/26/16- after some fertigations(?) of the tomatoes.)
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## Pruning



<http://articles.extension.org/pages/18647/training-systems-and-pruning-in-organic-tomato-production>

Pruning is usually started as the plants are first being staked or supported, sometimes before stringing them to avoid interference with the lines. Tomato plants are pruned by selectively removing suckers, the shoot that grows between the main stem and a leaf. Suckers should be broken off while they are still small, between 2-4 inches in length. Prune plants only when the leaves are dry to reduce the spread of disease.

Plants in the trellis system are generally trained to two stems: the main stem and the stem that develops from the sucker just below the first flower cluster. Suckers below this one should be removed. The remaining two stems should be twined around the vertical string support as the plant grows. If very vigorous plants grow above the top of the stake system, they may need to be topped.

## SYMPTOMS

### Purpling

- Tomato: look under Phosphorus, TSWV and Curly Top

### Commercial Production of Heirlooms

Single layer packing

Common varieties

Cherokee purple

Brandywine

Marvel stripe

Accumulation of 1100 growing degree days (before 50% of fruit was harvested)

Fruit cracking, cat-facing, blossom-end rot and insect damage, TSWV

Seed saving is common

Raoul Adamchak

7 lbs of fruit per plant

4 planting dates

\*Early girls are a good standard (non-heirlooms)

Heirlooms: lots of variability

Additional packaging to prevent bruising

Susceptible to cracking when the nights get cool and there is heavy dew