

Summary: Septoria spot is a fungal disease that occurs on leaves, twigs, and in rind injuries of fruit of several species of citrus. The disease has historically been considered a minor disease with <3% detections in grower lots in the most severe outbreaks. Recent research has indicated that:

- The pathogen cannot infect healthy tissue and needs injuries for infection.
- The disease requires a minimum of 3-4 weeks to develop under constant incubation temperatures (e.g., 20C) and longer under fluctuating temperatures.
- Fruit on trees are free of the disease going into the harvest season (cold, rainy season).
- Cold injury is one of the most common injuries correlated with the incidence of disease.
- Cold injury of rind tissue has been reproduced experimentally.
- Severity of disease has been correlated with increases in precipitation after cold injury to fruit
- A risk assessment model has been developed based on the accumulated exposure to temperatures less than 1 C and total precipitation after the first freeze event.
- Implementation of the model on a large-scale has been employed for the last four seasons to identify periods of high risk for infection and timing of fungicide applications.
- Efficacy data has been developed identifying effective new preharvest fungicide treatments, and both pre-and postharvest fungicides are being registered for preventing and suppressing the disease on fruit.
- Chronological graphs indicate most of the disease develops between Feb. and April and GPS data indicates that the distribution of the disease for the seven harvest seasons is mainly between Kern Co. and Madera Co., with most detection in Tulare Co.
- A web-based database should be used for submitting samples by each of the participants in the program that was viewed by the NAVEK lab personnel to recognize incoming samples without errors associated with re-entering information from submitted forms.
- Detection of Septoria is currently based on the use of a real-time PCR-based method using a portion of the beta-tubulin DNA sequence from *Septoria citri*.

I) Management of the disease: Removal of dead branches and twigs that harbor the pathogen and designing irrigation systems to minimize wetting of foliage are fundamental practices for managing the disease. Fungicide applications are protective treatments. Copper-zinc-lime treatments or registered alternatives (Abound, Quadris Top) should be applied prior to winter rains and, if necessary, secondary applications during the winter (e.g., January) and early spring Late Feb. or March). Copper-zinc-lime treatments are preventative (apply before seasonal rain events) and have been part of management guidelines for the disease in California for the past 65 years.

A) Fungicide Treatments:

- 1) The first field-application of the fungicide treatment of zinc-copper-lime or registered alternative is **highly recommended** for all oranges planned for exportation to Korea.
- 2) The treatment **should be applied between October 15 and November 30** for all California oranges (Navels and Valencias) shipped to Korea.
 - (a) Specifically, **the zinc-copper-lime treatment can be made as follows (see Table 1):** When using zinc sulfate (neutral and acidic forms) and copper hydroxide, copper oxide, or basic copper sulfate (i.e., **fixed or basic coppers**):
 - i. The rate of metallic zinc equivalent (mze) should contain a minimum of 2.5 lbs mze per acre. The rate of metallic copper equivalent (mce) per acre should be a minimum of 1.65 lbs mce per acre. A minimum of 2 lbs hydrated lime should be added when using 1.65 lbs copper (mce) and a minimum of 4 lbs hydrated lime

when using 4 lbs copper (mce) per acre. The material should be applied as a dilute application of no less than 400 gallons per acre.

- ii. Higher rates of zinc, copper and lime may be used as local conditions warrant or if higher disease levels were experienced last season. Field observations of Septoria spot symptoms on fruit or a positive detection of the disease based on the NAVEK report last season indicates potentially higher inoculum levels going into this growing season. Rates should not exceed manufacturers' labeled rates (See the attached Tables).
- (b) **Bordeaux sprays** with the addition of zinc also meet the preharvest requirements for exporting oranges to Korea in accordance with UC guidelines. If zinc-copper Bordeaux applications are used, 3.3 lbs metallic zinc, 1.65-2.45 lbs metallic copper, and 20-67 lbs hydrated lime per acre in dilute application of no less than 400 gal/acre will meet the minimum requirement. (See Table 2)
- 3) **The mix order of these ingredients: zinc, then copper, followed by lime.**
- 4) **Adjusted spray requirements for young trees** (6 years old or less). If the orange trees have been planted less than or equal to six years ago, the following modification to the copper spray may be applied. Using the zinc-copper-lime formulation instructions posted on the CCQC website, you may apply 200-400 gallons to blocks of young trees (one to six years after planting). It is suggested that you turn off the nozzles that would have gone over the top of the young trees. Full tree coverage is, however, still required.
- 5) **The spray should cover the entire tree canopy.** Skirt sprays are not acceptable and would render any block treated by this procedure ineligible for the Korea program. All active ingredients in the spray mix (i.e., zinc, copper, and lime) are required to be reported to the county.

B) The Second and Third Fungicide Treatments

- 1) The second and third field-application of the zinc-copper-lime treatments (additional tables similar to Tables 1 and 2 will be provided to the industry as the season progresses) or USDA-APHIS approved efficacious alternatives (e.g., Abound, Quadris Top) will be recommended **if the model for Septoria spot indicates sufficient risk for disease.** Additional applications may be recommended depending on the occurrence of favorable environmental conditions for disease development. Notifications to the industry will be made if conditions are conducive. Follow label and regulatory instructions for registered materials.
- 2) **Timing of the second and third fungicide treatment will be based on the accumulation of temperatures below -1°C and subsequent accumulation of precipitation (mm). Categories 1 to 4 represent increasing risk for disease. Advisories will be made at category 1 (green) or 2 (yellow) based on actual or highly probable, forecasted weather conditions. The following is the risk assessment table that will be followed:**

Numerical Risk Model for forecasting Septoria Spot

Hrs with T< -1 C	Precipitation (mm)				
	31-60	61-90	91-120	121-150	151-180
<10	0	1	2	3	4
10-20	1	2	3	4	4
21-30	2	3	4	4	4
>30	3	4	4	4	4

- 3) **Timing of the second and third applications based on environmental monitoring is critical for effective management.** If favorable environmental conditions continue to occur, the application of additional preventative treatments should be made within a reasonable period (approximately **30-45** days). Please monitor for industry announcements by checking e-mail and visiting CCQC and CCM websites frequently in December, February, and March.
- 4) Environmental conditions will dictate the need for submitting samples of oranges for voluntary determination of Septoria spot in grower lots.

II) Pesticide Use Reports **should** be available.

III) **Evaluation and sampling guidelines:**

- A) **All grower lots should be evaluated by field scouting and suspect samples should be collected and submitted to the NAVEK lab. Submitted samples of fruit must have symptoms.**
 1. Follow the guidelines for Categories I, II, III, and IV (refer to the Septoria Symptom Handout on CCQC's website at www.citrusresearch.com). Do not submit fruit with Category V (other than mechanical injuries for early season fruit) or fruit that are symptom-less. Any lot found positive for Septoria spot in previous years should be evaluated and sampled rigorously (i.e., 2X sampling of fruit for the first collection sample).
- B) **All samples must be submitted using the online form which includes GPS information, as well as helpful prompts and multiple choices that assist packinghouses in filling out and submitting the form correctly. Using this form reduces overall costs of the NAVEK program to the industry.**
- C) **Evaluation and collection of fruit. Fifty fruit on 20 trees in each grower lot should be directly evaluated on the tree for Septoria spot following symptom Categories I-IV.**

Fruit samples should also be taken as follows:

1. **For fruit shipments to Korea through Feb. 7th:**
 - a) **Normal sampling practice:** For grower lots shipped to Korea that were negative for Septoria spot previously, samples should consist of 20 fruit (as described in 1A above).
 2. **For fruit shipments to Korea after Feb. 7th:**
 - a) **Normal sampling practice:** For grower lots shipped to Korea that were negative for Septoria spot last year, samples should consist of 30 fruit (as described in 1 A above).
- E) **Sample frequency, incubation duration, and longevity of test.** Upon submission of the sample, fruit will be pre-screened for signs of the pathogen. Fruit tissue with symptoms will then be subjected to a 7-day incubation test or a molecular assay.
1. If Septoria spot is found in a grower lot, then the lot is considered **positive** and thus, fruit harvested from this grower lot **should not** be shipped to Korea.
 2. If Septoria spot is not found in a grower lot, then the lot is considered **negative** and thus, fruit harvested from this grower lot can be shipped to Korea. Remember that it is

suggested that re-sampling should be done within **45 days** from the date the report is issued from the incubation lab.

3. **It is highly recommended that shorter intervals be used (e.g. 35 days) for fruit sampled in Feb. and March if conducive conditions occur for disease development.**

F) Sampling method (trees and fruit to evaluate in the field) and design.

1. **Total number of trees to be evaluated per grower lot = 20.**
2. **Total number of fruit to be evaluated per tree = 50.**
3. Fruit numbers to collect (see above IC)
 - a) **Normal sample:**
 - i. Through Feb. 7: Total number of fruit to collect with symptoms = 20 (C1a) or **1 fruit per tree.**
 - ii. After Feb. 7: Total number of fruit to collect with symptoms = 30 (C2a) or **1 fruit for odd-numbered trees and 2 fruit for even-numbered trees.**
4. **Sampling design:**
 - a) Count the total number of rows and divide by 4 (e.g., $100/4 = 25$). Rows 25 and 75 will be sampled. For fractions, round up.
 - b) Count the total number of trees/row and divide by 10 (e.g., $100/10 = 10$). Thus, every 10th tree will be sampled.
 - c) Number fruits collected 1-20 or 1-30 for normal sample.
 - d) **Summary:** A "U" shaped walking pattern can be done through the grove to bring the person sampling back to or near the starting point.

G) Limits on samples submitted to the incubation lab per week.

Sample allocations will be determined by CCQC and will be sent individually and confidentially to each packinghouse by e-mail.

V) Postharvest Management Guidelines:

- A. **Fruit treatments** - All fruit destined for Korea upon arrival in the packinghouse should have the following treatments:
 1. **Wash with chlorinated water.**
 - a) Free chlorine must be 100-200 ppm.
 - b) Recommended pH of 7-8.
 2. **Treated with postharvest fungicides.**
 - a) TBZ and/or azoxystrobin should be applied in an aqueous application prior to a fruit coating and/or in a fruit coating or wax. The fruit coating may also include either imazalil (e.g., Fungaflor, Deccocil, Freshgard, etc.), fludioxonil (e.g., Graduate), pyrimethanil (e.g., Penbotec). A pre-mixture of pyrimethanil-imazalil (e.g., Philabuster) **should** include TBZ or azoxystrobin. The pre-mixture of fludioxonil and azoxystrobin known as Graduate A+ (azoxystrobin and fludioxonil) may be used with or without TBZ in an aqueous application and/or in the fruit coating treatment.
 - b) TBZ rates: Aqueous (200 – 400 ppm) or fruit coating (3500 – 5000 ppm).
 3. **Residues of greater than or equal to 1 ppm of each fungicide should be obtained.**
 4. **Current United States, Korea, and Codex tolerances of postharvest fungicides on orange:**

Crop	Fungicide	US	Codex	Korea
Orange	Azoxystrobin	10	15	5 Pending ¹ .
	Fludioxonil	10	7	5 Pending ¹ .
	Imazalil	10	5	5
	Difenoconazole	1	---	1
	Thiabendazole	10	7	10

¹ This MRL is under review by KFDA. It is expected to be approved by Jan. 1, 2012, but it could be longer. Until it is officially approved the MRL is 1 ppm.

5. Records for sanitation and fungicide use should be available.

B. Grading - All fruit destined for Korea should be graded.

1. Fruit found in Categories I-II may be evaluated at the NAVEK incubation lab or by an inspector with the County Agricultural Commissioner to determine if the lot should be further considered for Korean export.
2. Lots containing ice-marked fruit as shown in Category IV F-J should not be shipped to Korea and should be diverted to other markets.

C. Fruit Storage – Recommendations for fruit destined for the Korean market are as follows:

1. Fruit should be stored at 3-5 C
2. Fruit should not be stored more than one week following packing.
3. Note: Freezing fruit (storage temperatures of 0 to -1C) will result in increased susceptibility for Septoria Spot.
4. Packed fruit destined for Korea Export should be stored separate from domestic or other Export shipments to avoid mixing of the load.

TABLE 1

**Zinc-Copper-Lime Applications
Fixed coppers (e.g., copper hydroxide and copper oxide)**

Application Volume		Metallic Zinc/100 gal	Metallic Copper/100 gal	Hydrated Lime/100 gal
400	gal/A	0.63-1 lb	0.41-0.75 lb	0.5-1.0 lb
600	gal/A	0.42-0.67 lb	0.28-0.5 lb	0.33-0.67lb
800	gal/A	0.31-0.5 lb	0.21-0.38 lb	0.25-0.5 lb
Total*	lb/A	2.5-4	1.65-3	2-4 lbs

* - If the disease was observed or a positive NAVEK report was issued for Septoria spot in a grower lot last season, use a higher rate of each spray component (e.g., 4 lb metallic zinc, 3 lb metallic copper, and 4 lbs of lime per acre) within the range provided.

TABLE 2

**Zinc-Copper Bordeaux Applications
(Zinc monohydrate + Copper pentasulfate)**

Application Volume		Metallic Zinc/100 gal	Metallic Copper/100 gal	Hydrated Lime/100 gal
400	gal/A	0.83 lb	0.41-0.62 lb	5-17 lb
600	gal/A	0.55 lb	0.28-0.41 lb	3.3-11 lb
800	gal/A	0.41 lb	0.21-0.31 lb	2.5-8.4 lb
Total*	lb/A	3.3	1.65-2.45	20-67

* - If the disease was observed or a positive NAVEK report was issued for Septoria spot in a grower lot last season, use a higher rate of each spray component (e.g., 3.34 lb metallic zinc, 2.45 lb metallic copper, and 67 lbs of lime per acre) within the range provided.