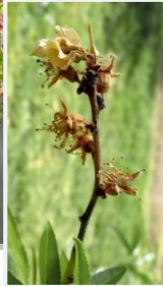




**Disease Management Update
Bacterial Spot – A New
Disease of Almond in
California**

Dr. J. E. Adaskaveg
Department of Plant Pathology
University of California, Riverside

Foliar and fruit diseases of almond in California



Brown rot blossom blight



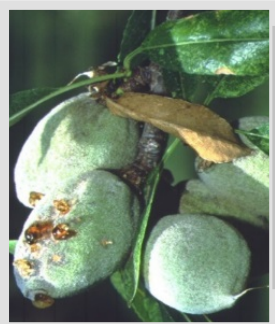
Green fruit rot/Jacket rot



Shot hole



Bacterial spot



Anthracnose



Scab



Alternaria leaf spot



Rust



Hull rot



Fungicides for Managing Almond Diseases

Inorganics and Conventional Synthetics

| | | | | |
|--|--|---|--|--|
| <p>Inorganics</p> <p>Copper, Sulfur</p> <p>M1&2</p> <p>1960s</p> | <p>Dithiocarbamates</p> <p>Ziram, Manzate, Dithane?</p> <p>M3</p> <p>1940s</p> | <p>Phthalimides</p> <p>Captan</p> <p>M4</p> <p>1950s</p> | <p>Isophthalonitriles</p> <p>Bravo, Echo, Equus</p> <p>M5</p> <p>1960s</p> | <p>Guanidines</p> <p>Syllit</p> <p>U12</p> <p>1960s</p> |
| <p>Benzimidazoles</p> <p>Topsin-M, T-Methyl</p> <p>1</p> <p>1970s</p> | <p>Dicarboximides</p> <p>Rovral, Iprodione, Nevado, Meteor</p> <p>2</p> <p>1980s</p> | <p>Sterol inhibitors (DMIs)</p> <p>Elite, Rally, Indar, Tilt, Bumper, Quash, Inspire, Tebucon, Toledo</p> <p>3</p> <p>1970s - 1980s</p> | <p>SDHIs</p> <p>Xemium, Luna Privilege, Fontelis</p> <p>7</p> <p>1960s</p> | |
| <p>Anilinopyrimidines</p> <p>Vanguard, Scala</p> <p>9</p> <p>1990s</p> | <p>QoIs</p> <p>Abound, Gem, Headline</p> <p>11</p> <p>1990s</p> | <p>Hydroxylanilides</p> <p>Elevate</p> <p>17</p> <p>1990s</p> | <p>Polyoxins</p> <p>Ph-D</p> <p>19</p> <p>1960s</p> | <p>Phosphonates</p> <p>ProPhyt, K-Phite, Fungi-phite, Aliette, Linebacker (non-bearing)</p> <p>33</p> <p>1980s</p> |
| <p>Pre-Mixtures</p> <p>Inspire Super</p> <p>3+9</p> | <p>Quadris Top, Quilt Xcel</p> <p>3+11</p> | <p>Pristine, Luna Sensation, Merivon</p> <p>7+11</p> | <p>Luna Experience</p> <p>3+7</p> | <p>Viathon</p> <p>3+33</p> |

New: Luna Products & Merivon (2014), Syllit (2014), Viathon (2015), & new products continue to be evaluated

Why disease monitoring and risk assessment?

- Determine pathogen population size
- Determine possibility of disease outbreaks or increases in disease intensity based on general weather forecasts
- Assess if, when, and where disease management has to be implemented
- Optimize disease management - effective and economical



Optimum timing for implementing management practices

Inoculum-based

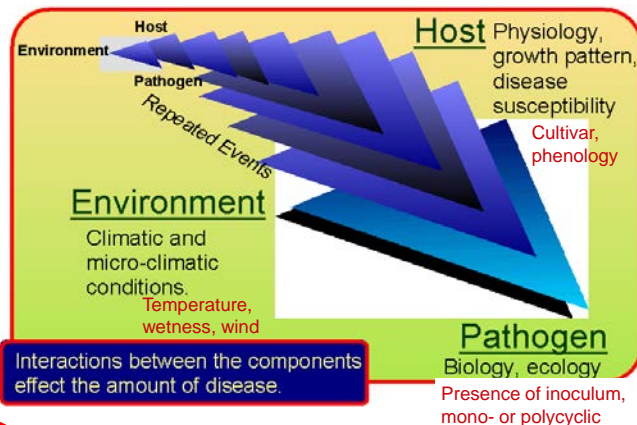
- Inoculum (disease) levels in the current and previous seasons are indicators for risk.
- Inoculum may not be present at high levels and disease progress can be monitored.
- Once inoculum is found, management practices can be implemented.
- Examples: shot hole, scab, rust, bacterial spot

Host phenology-based

- Disease occurs on specific host tissues during a limited time in the season
- Inoculum is commonly present
- Examples: blossom blight, Rhizopus hull rot, bacterial spot

Microclimate-based

- Pathogen inoculum is commonly present.
- Climatic conditions determine disease progress
- Examples: Alternaria, anthracnose, bacterial spot



Bac Spot - History of disease in the orchard, environment, host development.

Examples of diseases where management is based primarily on environmental conditions



Alternaria leaf spot



Alternaria alternata,
A. arborescens,
A. tenuissima

Anthracnose



Colletotrichum
acutatum

Bacterial spot



Xanthomonas
arboricola pv.
pruni



Bacterial spot of almond



- Previously unreported. Little is known about the disease in California
- Bacterial spot of peach (eastern US) occurs during high moisture conditions.
- Fritz is one of most susceptible varieties, but isolations have also been made from Nonpareil, Butte, Carmel, and Price.
- Management strategies are being explored: dormant and springtime applications with bactericides.

Bacterial spot of almond



- Causal agent: *Xanthomonas arboricola* pv. *pruni*
- Was found in spring 2013 on almond, cherry, and possibly other stone fruit crops in Colusa, San Joaquin, Stanislaus, Merced and Madera Co.



Materials for Managing Bacterial Spot of Almond

Inorganics and Conventional Synthetics

Toxicants



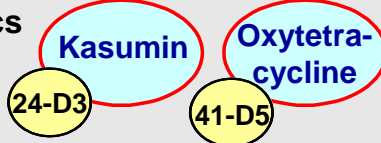
Natural Products and Biocontrols

Regalia, Actinovate, Serenade Max, Serenade Optimum, Taegro

Natural products/biocontrols with antibacterial or SAR characteristics for organic almond production

Experimental Products under Evaluation

Antibiotics



Others



○ Multi-site mode of action ○ Single-site mode of action ○ Reduced-risk fungicides ○ FRAC group

Dormant and In-season copper treatments for management of bacterial spot of almond 2014

| Dormant treatment** | In-season treatment | Timing 1 | | Timing 2 | | Timing 3 | | Timing 4 | | Timing 5 | | Timing 6 | | Trt Avg | |
|---------------------------|-------------------------|----------------|--------|------------|-----|-------------|-----|-------------|-----|---------------------------|-----|----------|-----|---------|-----|
| | | D: 12/17* | | D: 12/17 | | D: 12/17 | | D: 12/17 | | D: 12/17 | | D: 12/17 | | Trt Avg | |
| | | IS: 2/19, 4/24 | | IS: 3/5/14 | | IS: 3/20/14 | | IS: 3/31/14 | | IS: 2/19, 3/5, 3/21, 3/31 | | IS: none | | Trt Avg | |
| | | Dis. ^ | LSD ^^ | Dis. | LSD | Dis. | LSD | Dis. | LSD | Dis. | LSD | Dis. | LSD | Dis. | LSD |
| Control | Control | 55.5 | a | 50.5 | a | 19.5 | ab | 45.8 | a | 52.8 | a | 37.5 | a | 43.6 | A |
| Kocide 3000 6 lb + 1% oil | Kocide 3000 | 6.5 | b | 5 | b | 7.3 | b | 15 | b | 3.8 | b | 29.3 | a | 11.2 | B |
| Kocide 3000 6 lb (no oil) | Champ-Ion ²⁺ | 21.3 | b | 10.5 | b | 4.8 | b | 16.8 | ab | 1.8 | b | 28.3 | a | 13.9 | B |
| Cueva 2 gal + 1% oil | Cueva | 24.8 | b | 61.8 | a | 33.5 | a | 38.3 | ab | 10.8 | b | 24.5 | a | 32.3 | A |
| Badge 7 pt + 1% oil | Badge X2 | 9.3 | b | 8.5 | b | 2.3 | b | 15.8 | b | 2.8 | b | 19.3 | a | 9.7 | B |
| Cuprofix 4.5 lb+ 1% oil | Cuprofix | 6 | b | 19.5 | b | 3.5 | b | 11 | b | 3 | b | 24.5 | a | 11.3 | B |
| | Timing Avg | 20.6 | AB | 26.0 | A | 11.8 | B | 23.8 | A | 12.5 | B | 27.2 | A | | |

*- D= dormant treatment, IS = in-season treatment. Copper rates for IS treatments were reduced by half with each sequential application (e.g., Kocide 3000 3.3, 1.5, 0.8 etc.).

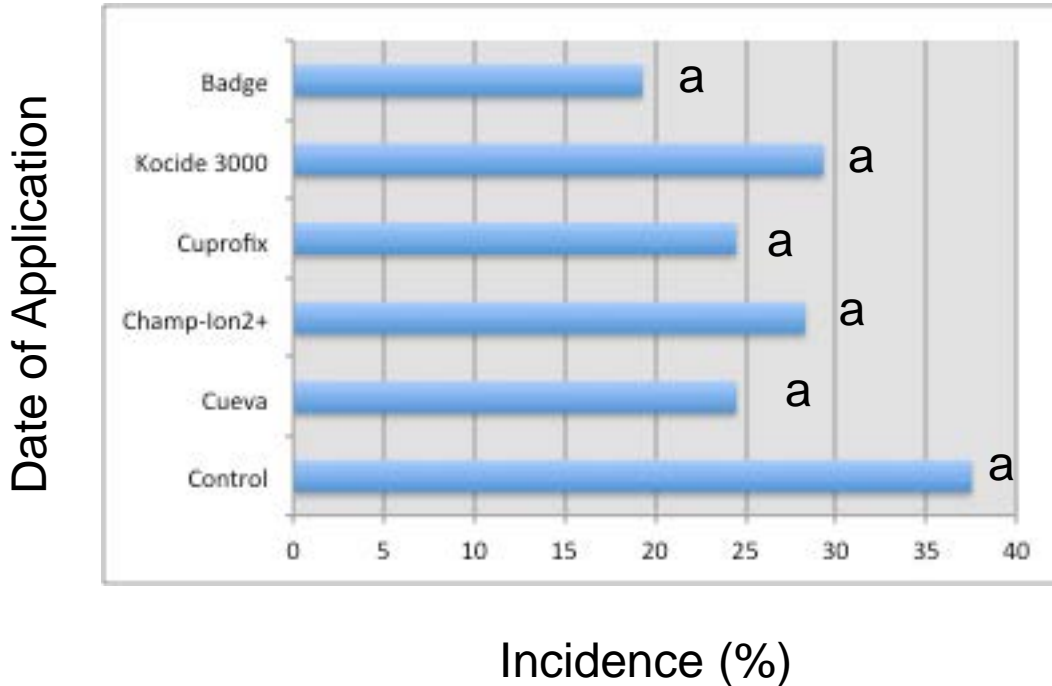
^~ Fruit were evaluated for the presence of bacterial spot on 5-27-14.

^^~ Statistical comparisons for values in the shaded area are by column using lower case letters.

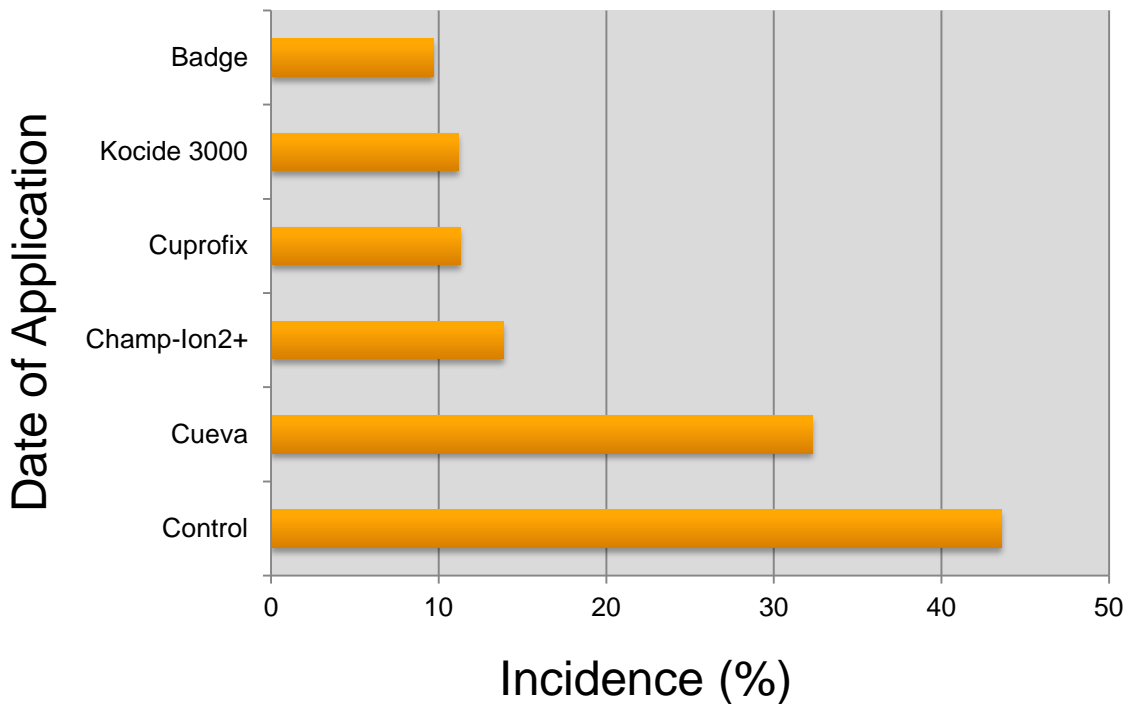
Treatment averages are values for treatments over all timings and are statistically compared by column.

Timing averages are values for each timing for all treatments and are statistically compared within the

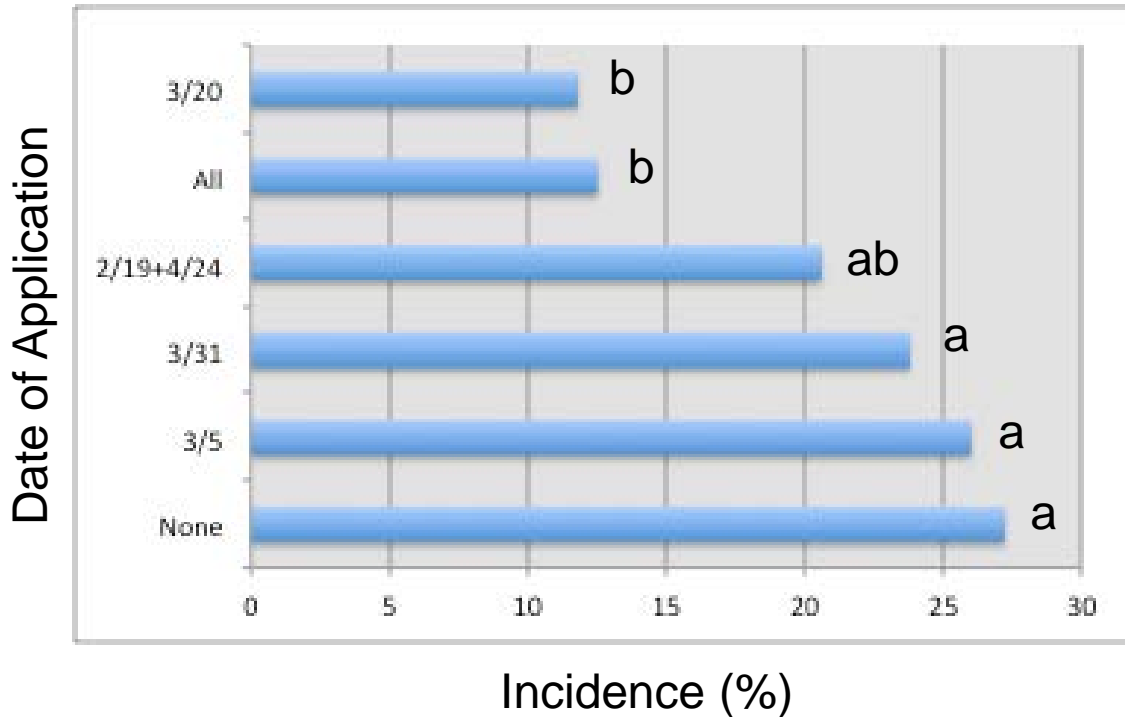
Dormant copper treatments for management of bacterial spot of almond 2014



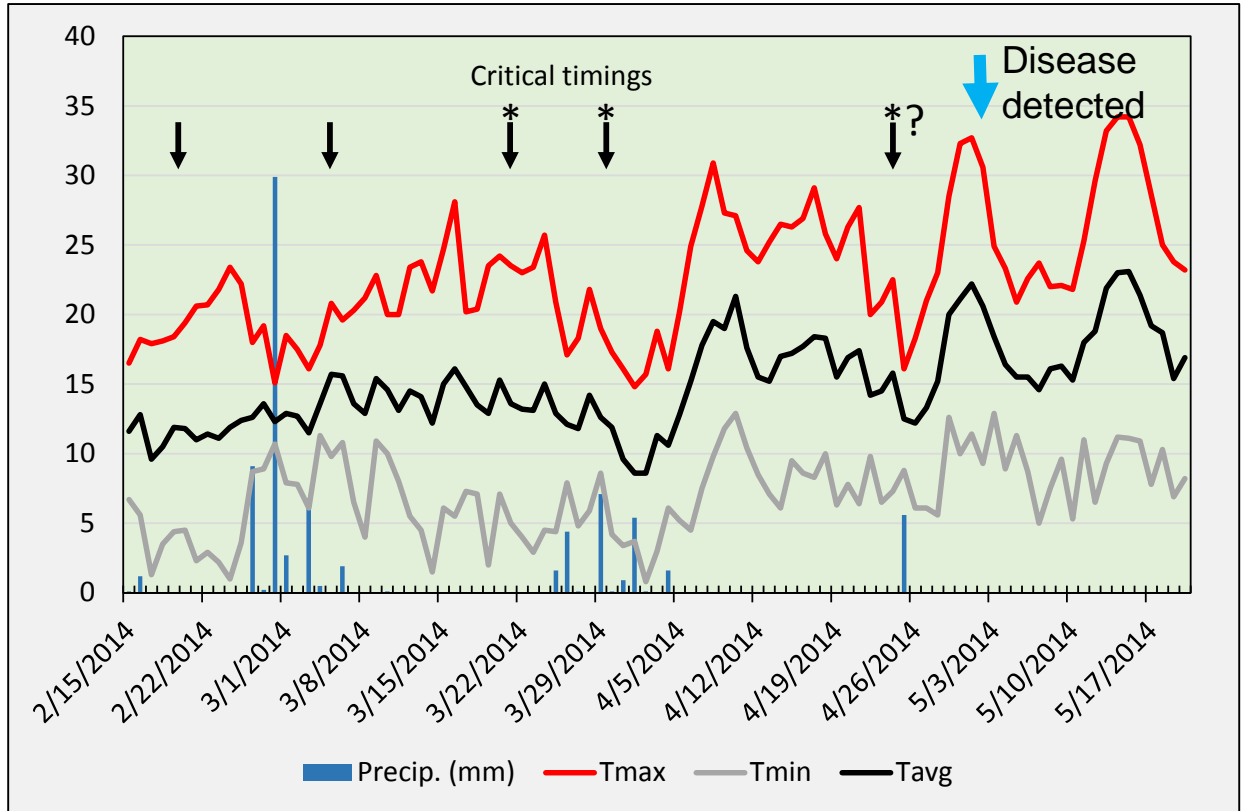
In-season copper treatments for management of bacterial spot of almond 2014



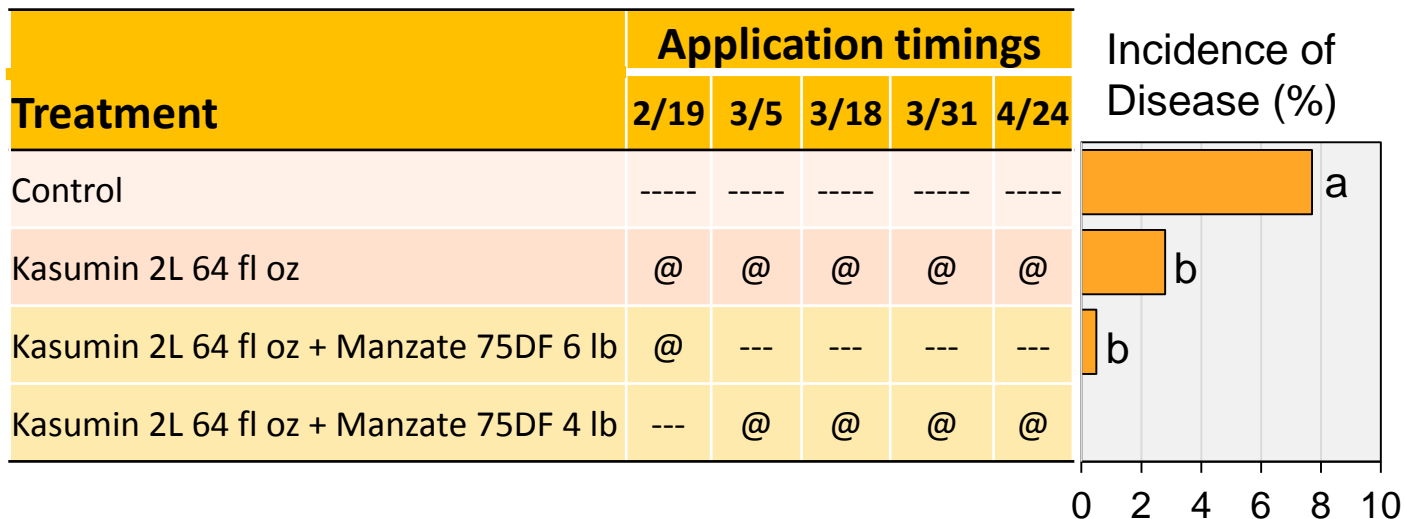
In-season copper treatments for management of bacterial spot of almond 2014



Environmental conditions at trial sites in San Joaquin Co. 2014



Effect of Kasumin, a new experimental in-season treatment, on the incidence of bacterial spot of cv. Fritz almond - 2014



^Fruit were evaluated for the presence of bacterial spot on 5-27-14.

^^- Values followed by the same number are not significantly different based on an analysis of variance ^^- Values followed by the same number are not significantly different based on an analysis of variance

Kasumin submitted to the IR-4 program for registration on almond – Sept. 2014

- The most promising new bactericide for control of bacterial diseases
- This aminoglycoside antibiotic is not used in medicine
- Antifungal and antibacterial activity
- Different mode of action from other antibiotics
- Registered on crops in Asia, Europe, & Central America
- US-EPA approved an import tolerance in 2005
- US-EPA approved registration on pome fruit in Sept. 2014

Delayed dormant and In-season treatments for management of bacterial spot of almond 2014

| | | Timing 1 | | Timing 2 | | Timing 3 | | Timing 4 | | Timing 5 | | Timing 6 | | Trt Avg | |
|---------------------------------|---------------------|------------------|-------------------|----------|-----|----------|-----|----------|-----|---------------------------------|-----|----------|-----|---------|-----|
| | | D: 1/24* | | D: 1/24 | | D: 1/24 | | D: 1/24 | | D: 1/24 | | D: 1/24 | | | |
| Dormant treatment | In-season treatment | IS: 2/19, 4/24 | | IS: 3/5 | | IS: 3/18 | | IS: 3/31 | | IS: 2/19, 3/5, 3/18, 3/31, 4/24 | | IS: none | | | |
| | | Dis [^] | LSD ^{^^} | Dis | LSD | Dis | LSD | Dis | LSD | Dis | LSD | Dis | LSD | Dis | LSD |
| Control | Kas-Man | 12.3 | a | 18.8 | a | 8 | a | 19 | a | 4.3 | a | 37.8 | a | 16.7 | A |
| Kocide 3000 6 lb | Kas-Man | 12.8 | a | 31.3 | a | 7.3 | a | 7 | a | 6 | a | 16.8 | b | 13.5 | AB |
| Kocide 3000 6 lb + Manzate 6 lb | Kas-Man | 11 | a | 14.8 | a | 7.5 | a | 11.8 | a | 3.8 | a | 9.5 | b | 9.7 | B |
| | Timing X | 12.0 | B | 21.6 | A | 7.6 | BC | 12.6 | B | 4.7 | C | 21.3 | A | | |

*- D= dormant treatment, IS = in-season treatment with 64 fl oz Kasumin + 3.5 lb Manzate 75DF/A

[^]- Fruit were evaluated for the presence of bacterial spot on 5-21-14.

^{^^}- Statistical comparisons for values in the shaded area are by column using lower case letters.

Treatment averages are values for treatments over all timings and are statistically compared by column. Timing averages are values for each timing for all treatments and are statistically compared within the row.

In-season treatments for management of bacterial spot of almond 2014



| Treatment | Rate (/A) | FB 2/18 | PF 3/5 | 2 wk APF 3/20 | 4 wk APF 4/3 | Disease incidence (%) |
|--------------------------------------|-----------------|------------|-----------|---------------------|--------------------|--------------------------|
| Control | ---- | ---- | ---- | ---- | ---- | 18 a |
| Kphite + Widespread | 96 + 8 fl oz | @ | @ | @ | @ | 12 ab |
| Actinovate | 12 oz | @ | @ | @ | @ | 8 abcd |
| Actinovate + Buffer | 12 + 86 oz | @ | @ | @ | @ | 6 bcd |
| Serenade Optiva | 20 oz | @ | @ | @ | @ | 3 cd |
| Taegro | 5 oz | @ | @ | @ | @ | 10 abc |
| MycoShield + Champ-Ion ²⁺ | 16 oz + 3.3 lb | @ | --- | --- | --- | 8 abcd |
| | 16 oz + 1.6 lb | --- | @ | --- | --- | 0 |
| | 16 oz + 0.8 lb | --- | --- | @ | @ | 0 |
| Kasumin 2L + Manzate 75DF | 64 fl oz + 6 lb | @ | --- | --- | --- | 2 d |
| | 64 fl oz + 4 lb | --- | @ | @ | @ | 0 |
| Kocide 3000 + Manzate 75DF | 3.3 + 6 lb | @ | --- | --- | --- | 6 bcd |
| | 1.6 + 4 lb | --- | @ | --- | --- | 0 |
| | 0.8 + 4 lb | --- | --- | @ | @ | 0 |
| Kocide 3000 + Tanos | 3.3 lb + 10 oz | @ | --- | --- | --- | 4 cd |
| | 1.6 lb + 10 oz | --- | @ | --- | --- | 0 |
| | 0.8 lb + 10 oz | --- | --- | @ | @ | 0 |
| Magna Bon + Manzate 75DF | 64 fl oz + 6 lb | @ | --- | --- | --- | 4 cd |
| | 27 fl oz + 4 lb | --- | @ | @ | @ | 0 |

0 5 10 15 20

Orchard 2 - cv. Fritz, San Joaquin Co. Evaluation on May 21, 2014

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Toxicants



Natural Products and Biocontrols

Regalia, Actinovate, Serenade Max, Serenade Optimum, Taegro

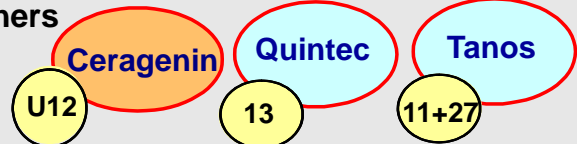
Natural products/biocontrols with antibacterial or SAR characteristics for organic almond production

Experimental Products under Evaluation

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Others



○ Multi-site mode of action ○ Single-site mode of action ○ Reduced-risk fungicides ○ FRAC group

Summary Bacterial Spot Management

The pathogen *Xanthomonas arboricola* pv. *pruni* overwinters in fruit mummies on the tree. Isolates evaluated to date were all copper-sensitive.

Late dormant treatments with copper, copper-mancozeb, or copper-mancozeb-captan significantly reduced the disease.

In-season treatments in the weeks following petal fall were most effective when timed around rain events and before temperatures started to rise.

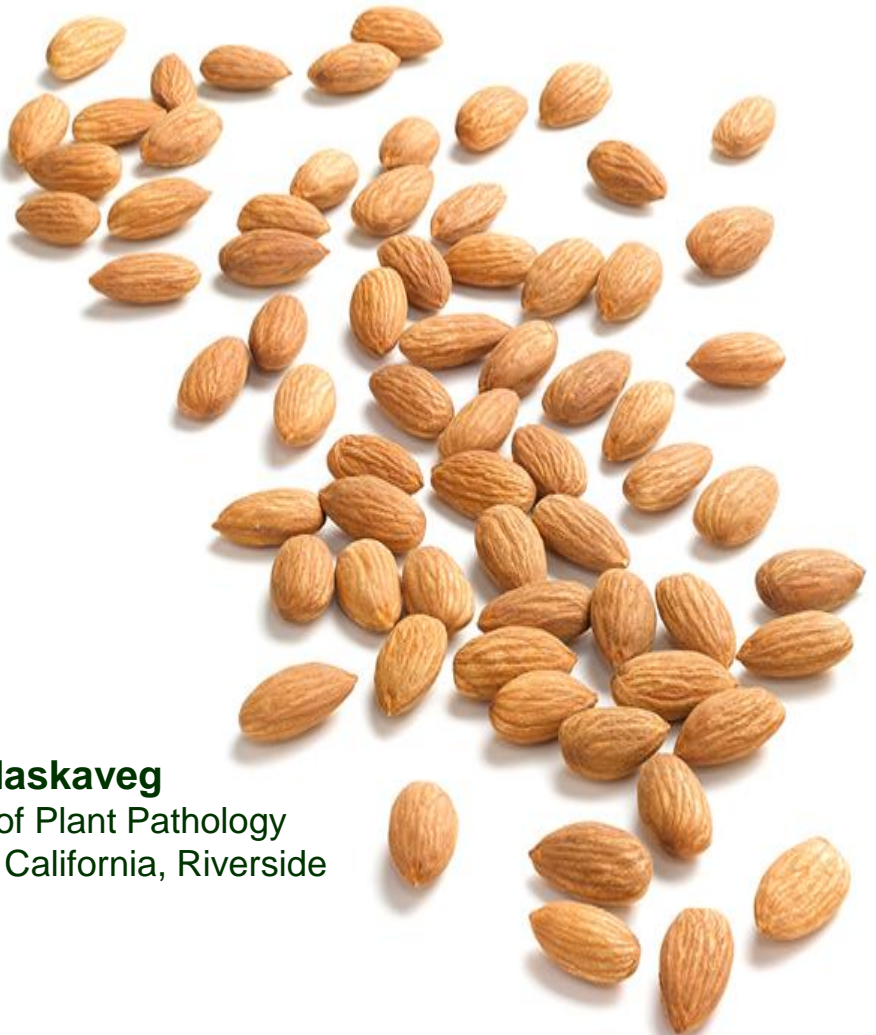
All copper products significantly reduced disease. Kasumin (accepted in IR-4), Fireline/Mycoshield, and Serenade Optiva were also effective.

The most effective management program in 2014 (last season):

- 1) A late dormant application to reduce inoculum;
- 2) At least one or two in-season applications around rainfall events and rising temperatures to prevent new infections.



Thank you
Danke
Gracias
Merci
Cheers
谢谢
ありがとう
धन्यवाद
спасибо
شكرا



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