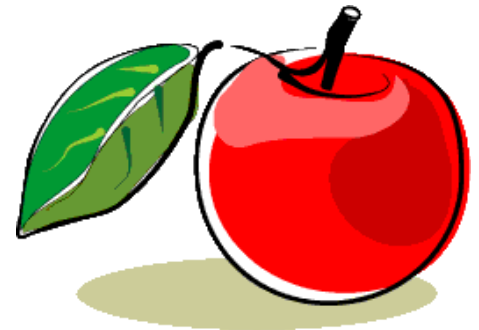
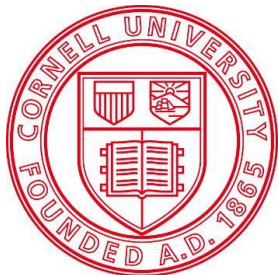


# Fire Blight: What Should We Do Now?

***Kerik D. Cox***  
***NYSAES***

***Plant Pathology and Plant-Microbe Biology Section***  
***School of Integrative Plant Science***  
***Cornell University***



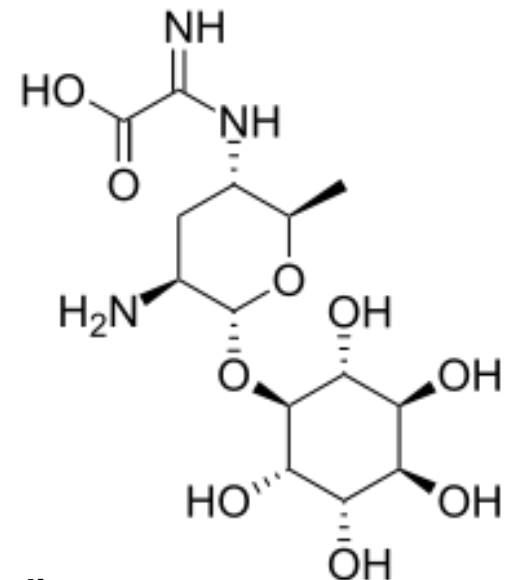
# Outline

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- Updates on chemical management tools
- Streptomycin resistance update
- Managing fire blight
  - Pre & post-season
  - Bloom
  - Post-bloom & Summer

# Kasugamycin (Kasumin 2L)

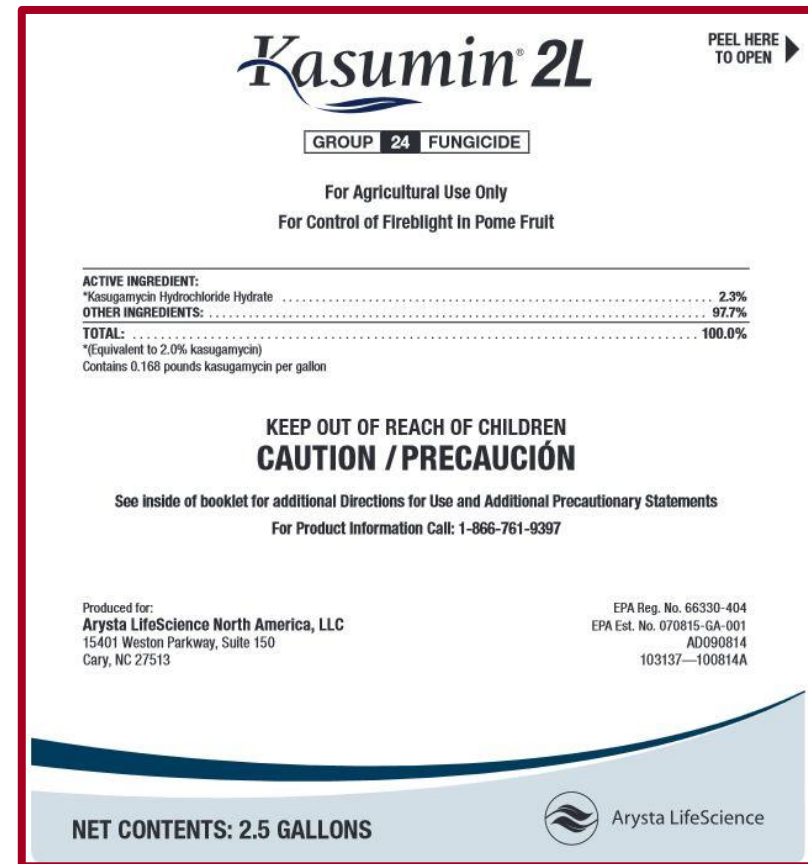
- Aminoglycoside antibiotic developed as rice blast fungicide (**protectant**)
  - Same class but different MoA: inhibits protein production
- Resistance: mutations in 16S rRNA methyltransferase *ksgA* gene
- No resistance reported in *E. amylovora*
  - Resistance found in other environmental bacteria



Wikipedia commons

# Kasugamycin (Kasumin 2L)

- Evaluated in 1980s for fire blight: testing suspended for phytotoxicity
  - Arysta Lifescience's Kasumin 2L: New formulation – safe for apples
- 2010-2014 seasons: section 18 label for MI
- 2015 season: section 3 label for US, NYSDEC is expediting NY request



# Serenade Optimum

- A.I. & MoA: *Bacillus subtilis*-antibiotic metabolites
- Diseases: Fire blight & anthracnose, botrytis, rusts
- My experiences
  - Fungal diseases: sooty blotch, fly speck, & rusts: moderate
  - Fire blight: >50% control at heavy pressure & 100% control light pressure



# DoubleNickel55/LC

- A.I. & MoA/: *Bacillus amyloliquefaciens* strain D747-antibiotic metabolites
- Diseases: Fire blight & foliar & fruit diseases
- My experiences
  - Fungal diseases: sooty blotch, fly speck, & rusts: moderate to high
  - Fire blight: >50% control at heavy pressure & 100% control light pressure





# Blossom Protect

**Blossom Protect™**  
A BIOLOGICAL AGENT  
FOR PREVENTING FIRE BLIGHT IN POME FRUITS AND WALNUT BLIGHT IN WALNUTS

For Organic Production

**Active Ingredients:**  
Aureobasidium pullulans strain DSM 14940† ..... 25.8%  
Aureobasidium pullulans strain DSM 14941† ..... 25.8%  
**Other Ingredients:** ..... 48.4%  
**Total:** ..... 100.0%

\* Contains a minimum of  $8.8 \times 10^6$  ch/gram of active ingredient.

Lot No.  
Manufactured on:

**KEEP OUT OF REACH OF CHILDREN**  
**CAUTION**  
See back panel for First Aid and additional Precautionary Statements

EPA Reg. No. 96174-4  
EPA Est. No. 96174-AUT-001  
Net Contents: 2.5 Lbs (1.1 kg)

**FIRST AID**

**If swallowed:**

- Call a poison control center or doctor immediately for treatment advice.
- Have person sip a glass of water if able to swallow.
- Do not induce vomiting unless told to do so by a poison control center or doctor.
- Do not give anything by mouth to an unconscious person.

**If on skin:**

- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15-20 minutes.
- Call a poison control center or doctor for treatment advice.

**HOT LINE NUMBER**

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact the National Poison Control Hotline at 1-800-222-1222 for emergency medical treatment information.

**FOR REGISTRATION**

3/20/2014

New York State Department  
of Environmental Conservation  
Division of Materials Management  
Pesticide Product Registration

**PRECAUTIONARY STATEMENTS**  
**Hazards To Humans And Domestic Animals**  
**CAUTION:** Harmful if swallowed or absorbed through the skin. Avoid contact with skin, eyes or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet. Wear chemical resistant gloves and protective eyewear. Remove and wash contaminated clothing before reuse.

**PERSONAL PROTECTIVE EQUIPMENT (PPE)**

Applicators and other handlers must wear:

- long-sleeved shirt and long pants
- protective eyewear
- chemical resistant gloves
- shoes plus socks

Mixer/loaders and applicators must wear a dust/mist filtering respirator meeting NIOSH standards of at least N-95, R-95, or P-95. Repeated exposure to high concentrations of microbial proteins can cause allergic sensitization.

Follow manufacturers' instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

DOC ID 538051



- A.I. & MoA.: *Aureobasidium pullulans* strains x2 = competitive inhibition of stigmatic surface
- Diseases: Fire blight
- Known experiences and concerns
  - 50-80% control of fire blight under high pressure
  - Fruit russetting shouldn't happen – 80% bloom

# Copper products

- **MasterCop:** Copper sulfate pentahydrate 5.4% MCE
- Bloom rate + 1-3 lbs./hydrated lime
- Experiences:
  - Effective on fire blight (50-75% control)
  - Mixing issues with strep
  - Phyto./russeting 1 year



**MASTERCOP®**  
Fungicide / Bactericide

**FOR USE IN: CITRUS, VEGETABLES, TREE CROPS, SMALL FRUITS, VINES, AND FIELD CROPS.**

<p><b>ACTIVE INGREDIENT:</b> Copper sulfate pentahydrate*† ..... 21.46%</p> <p><b>INERT INGREDIENTS:</b> ..... 78.54%</p> <p><b>TOTAL:</b> ..... 100.00%</p> <p>*CAS No. 7758-99-8</p> <p>†Metallic copper content 5.4%</p> <p>EPA Reg. No. 55272-18-66222 EPA Est. No. 55272-MEX-001</p> <p style="text-align: center;"><b>KEEP OUT OF REACH OF CHILDREN</b> <b>DANGER/PELIGRO</b></p> <p style="font-size: small;">Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: center; font-size: small;">FIRST AID</th> </tr> </thead> <tbody> <tr> <td style="width: 20%; font-size: small;"><b>If in eyes:</b></td> <td style="font-size: small;"> <ul style="list-style-type: none"> <li>• Hold eye open and rinse slowly and gently with water for 15-20 minutes.</li> <li>• Remove contact lenses, if present, after the first 5 minutes, then continue rinsing.</li> <li>• Call a poison control center or doctor for treatment advice.</li> </ul> </td> </tr> <tr> <td style="font-size: small;"><b>If swallowed:</b></td> <td style="font-size: small;"> <ul style="list-style-type: none"> <li>• Call a poison control center or doctor immediately for treatment advice.</li> <li>• Have person sip a glass of water if able to swallow.</li> <li>• Do not induce vomiting unless told to by a poison control center or doctor.</li> <li>• Do not give anything to an unconscious person.</li> </ul> </td> </tr> </tbody> </table>	FIRST AID		<b>If in eyes:</b>	<ul style="list-style-type: none"> <li>• Hold eye open and rinse slowly and gently with water for 15-20 minutes.</li> <li>• Remove contact lenses, if present, after the first 5 minutes, then continue rinsing.</li> <li>• Call a poison control center or doctor for treatment advice.</li> </ul>	<b>If swallowed:</b>	<ul style="list-style-type: none"> <li>• Call a poison control center or doctor immediately for treatment advice.</li> <li>• Have person sip a glass of water if able to swallow.</li> <li>• Do not induce vomiting unless told to by a poison control center or doctor.</li> <li>• Do not give anything to an unconscious person.</li> </ul>	<p><b>If on skin:</b></p> <ul style="list-style-type: none"> <li>• Take off contaminated clothing.</li> <li>• Rinse skin immediately with plenty of water for 15-20 minutes.</li> <li>• Call a poison control center or doctor for treatment advice.</li> </ul> <p><b>If inhaled:</b></p> <ul style="list-style-type: none"> <li>• Move person to fresh air.</li> <li>• If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth, if possible.</li> <li>• Call a poison control center or doctor for further treatment advice.</li> </ul> <p><b>Have the product container or label with you when calling a poison control center, doctor, or going for treatment. For emergency information concerning this product, call the National Pesticides Information Center (NPIC) at 1-800-858-7378 seven days a week, 6:30 am to 4:30 pm Pacific Time (NPIC website: <a href="http://www.npic.orst.edu">www.npic.orst.edu</a>). You may also contact CHEMTREC (800) 424-9300 (24 hours) for emergency medical treatment information.</b></p> <p style="text-align: center; font-size: x-small;">For additional precautionary, handling, and use statements, see inside of this booklet.</p> <div style="display: flex; align-items: center; justify-content: center; margin-top: 20px;">  <div style="margin-left: 10px;"> <p style="font-size: x-small;">Manufactured for: <b>Makhteshim Agan of North America, Inc.</b> 4515 Falls of Neuse Road, Suite 300 Raleigh, NC 27609</p> </div> </div> <p style="text-align: right; font-size: x-small;">EPA 030110/Notif 101411/ Rev A</p>
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**Net Contents: 2.5 Gallons**



# Copper products

**Cueva® Fungicide Concentrate**

ACCEPTED  
FOR REGISTRATION

**Flowable Liquid Copper Fungicide**

Oct. 21, 2014

Listed by the Organic Materials Review Institute (OMRI) for use in organic production.

New York State Department  
of Environmental Conservation  
Division of Materials Management  
Pesticide Product Registration

Intended for Commercial Use Only

DOC ID: 540398

**ACTIVE INGREDIENT:**  
Copper Octanoate (Copper Soap) .....10.0%  
CAS Reg. No. 20543-04-8

**OTHER INGREDIENTS** .....90.0%  
**TOTAL** .....100.0%

metallic copper equivalent 1.8%  
one gallon contains 0.16 lbs. metallic copper equivalent


**KEEP OUT OF REACH OF CHILDREN  
CAUTION**


See Inside Booklet for Additional Precautionary Statements, Directions for Use, and  
Storage and Disposal Instructions

Net Contents: 2.5 gallons (9.46L)  
250 gallons

EPA REG. NO. 67702-2-70051  
EPA EST. NO. 48498-CA-1  
BATCH CODE

Manufactured for  
Certis USA L.L.C.  
9145 Guilford Rd, Suite 175  
Columbia, MD 21046  
Cueva® is a trademark  
of W. Neudorff GmbH KG

  
Sold under a license of  
W. Neudorff GmbH KG  
Postfach 1209 An der Mühle 3  
D-318680 Emmerthal, Germany

  
For Organic Use

- **Cueva:** Copper Octanoate (Copper Soap)  
1.8%MCE, OMRI
- Bloom rate, but issues with label text
- Experiences:
  - effective on sooty blotch flyspeck late season, no  
phyto. issues

# Copper products

- **Badge X2 (OMRI):**  
Copper Oxychloride & Hydroxide 28% MCE
- Bloom rate + 1-3 lbs./hydrated lime
- Experiences:
  - Effective on fire blight (75% control) and fly speck sooty blotch late season
  - No mixing or phyto. issues
  - Enhanced strep

OCT 06 2014 Doc ID: 540222

New York State Department  
of Environmental Conservation  
Division of Materials Management  
Pesticide Product Registration

**Badge<sup>®</sup>X<sub>2</sub>**

**DRY FLOWABLE  
FUNGICIDE/BACTERICIDE FOR AGRICULTURAL USE**

**ACTIVE INGREDIENT:**  
Copper Oxychloride (CAS No. 1332-40-7)\* 23.82%  
Copper Hydroxide (CAS No. 20427-59-2)\* 21.49%  
**OTHER INGREDIENTS:** 54.69%  
**TOTAL:** 100.00%  
\*Metallic Copper (Cu) Equivalent is 28% by weight

**KEEP OUT OF REACH OF CHILDREN  
WARNING - AVISO**

See Attached Label (back) for Additional Precautions and Directions for Use.  
Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.  
(If you do not understand the label find someone to explain it to you in detail.)

FIRST AID	
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**NOTE TO PHYSICIAN:** Possible mucosal damage may contraindicate use of gastric lavage.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment.  
You may also contact 1-800-222-1222 for emergency medical treatment information.  
For Chemical Emergency Spill Leak Fire Exposure or Accident Call CHEMTREC Day or Night  
Domestic North America 800-424-9300 International 703-527-3863 (collect calls accepted)

EPA Registration No.: 80288-12 EPA Establishment No.: 79556-ITA-1

 **FOR ORGANIC PRODUCTION**

# Outline

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- Updates on chemical management tools
- Streptomycin resistance update
- Managing fire blight
  - Pre & post-season
  - Bloom
  - Post-bloom & Summer

# Managing FB: product efficacy

- Orchard site
  - 4-5 year old 'Idared' trees on B.9
- Artificial inoculum (Ea 273 at  $1 \times 10^{7-8}$  CFUml<sup>-1</sup>)
  - Spray for BB or Scissor dip for SB



# Managing FB: product efficacy

- Blossom blight application timing
  - Pre-bloom timings for biopesticides
  - All antibiotics & biopesticides @ 80% bloom
- Blossom blight incidence: percentage of blighted blossoms (5 reps)





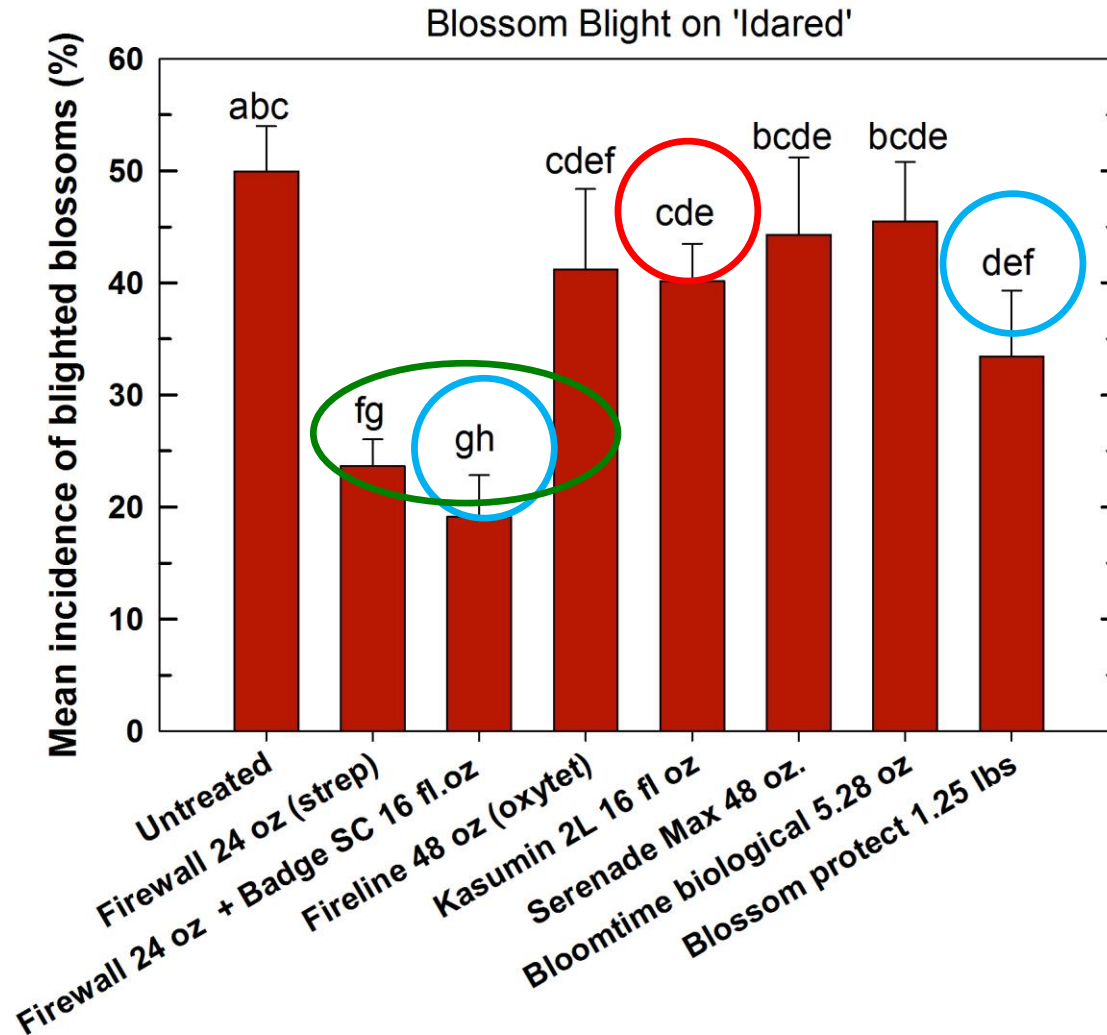
# Managing FB: product efficacy

- Shoot blight application timing
  - Active terminal growth (5-7"): 24 hours after inoculation (trauma)
  - Apogee (PF/1-2") or 5-days prior: Actigard
- Shoot blight: progression of canker of 20 shoots (5 reps)



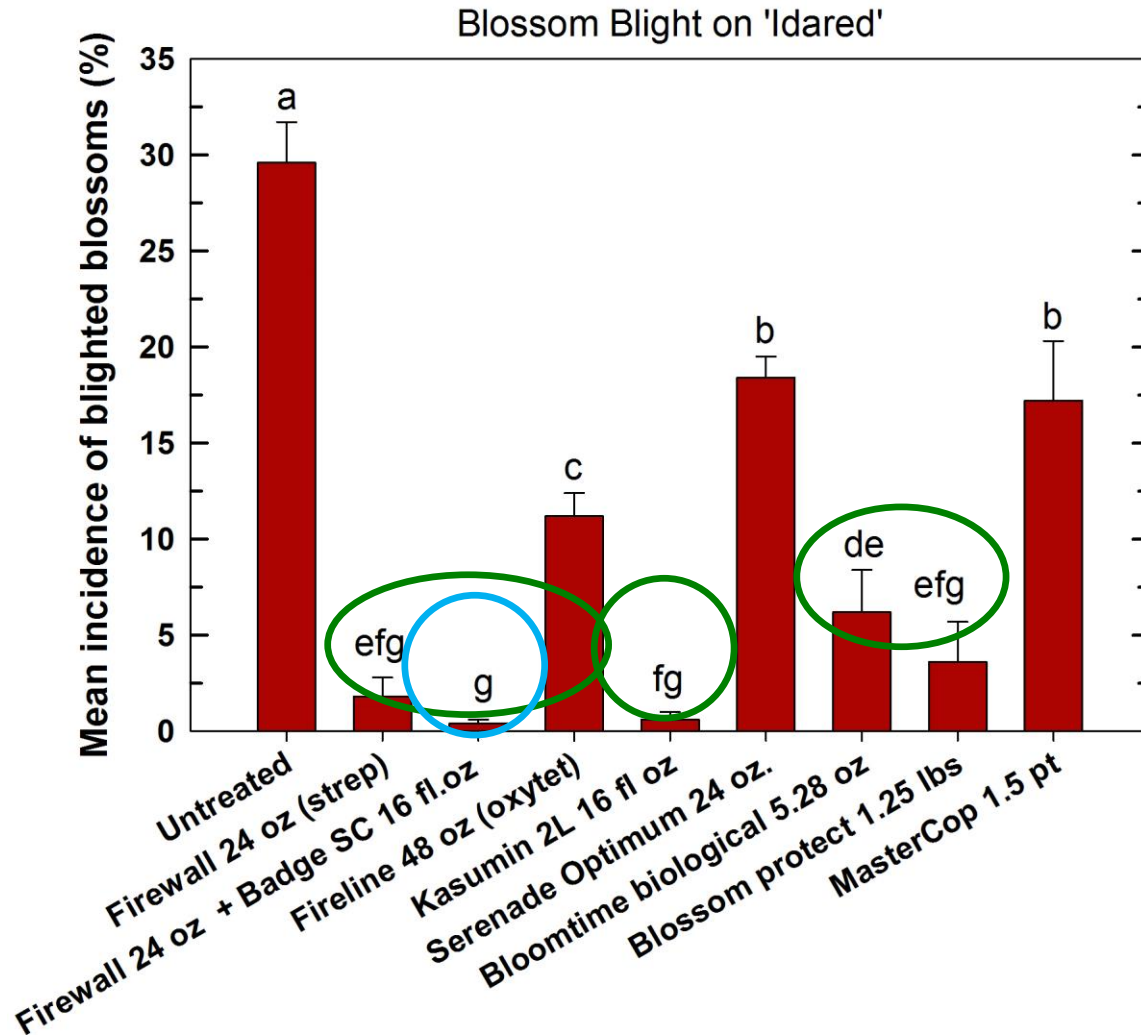


# 2012 Blossom Blight Trial



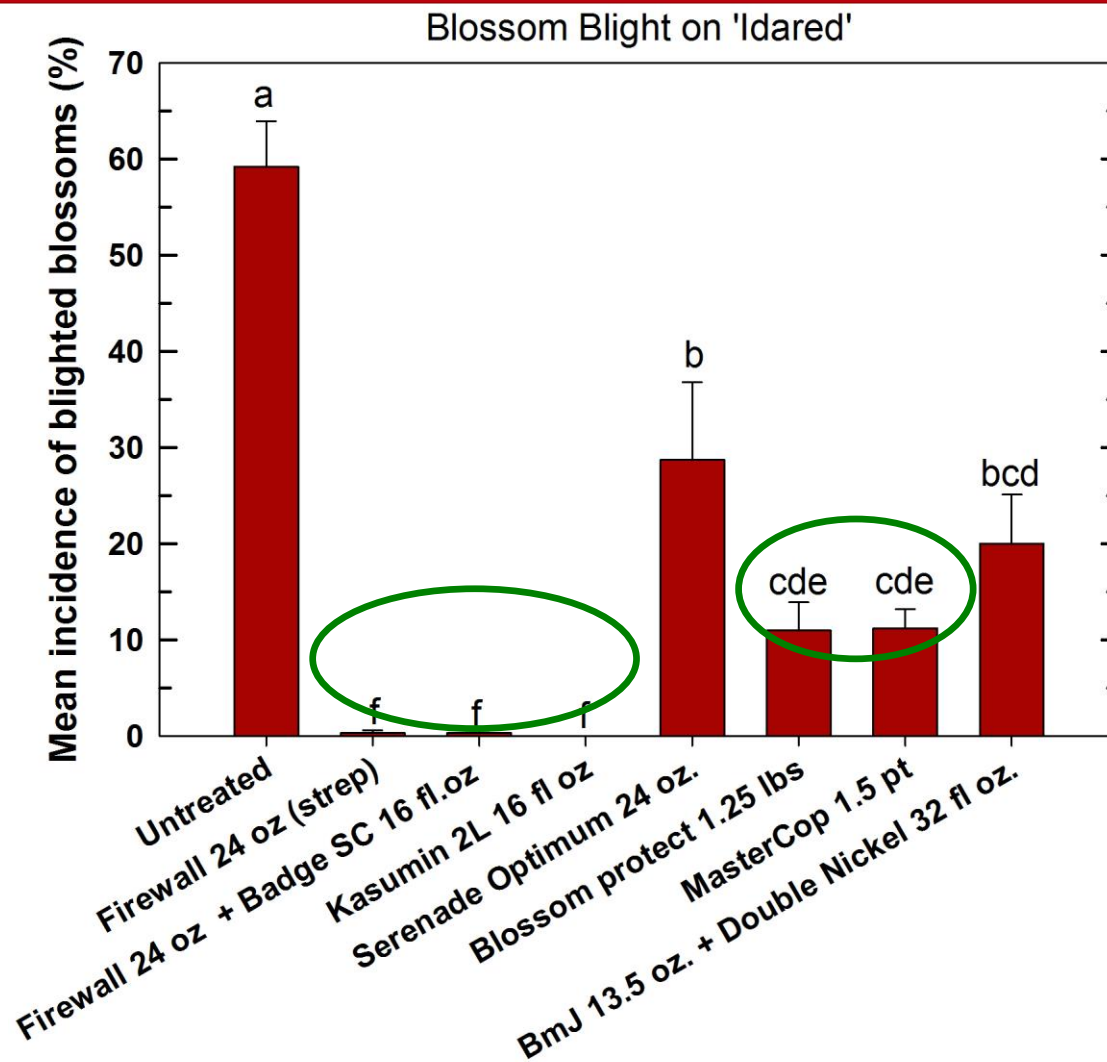
- **High pressure year:** Streptomycin programs, Strep + low copper, Kasumin 2L, Blossom Protect

# 2013 Blossom Blight Trial



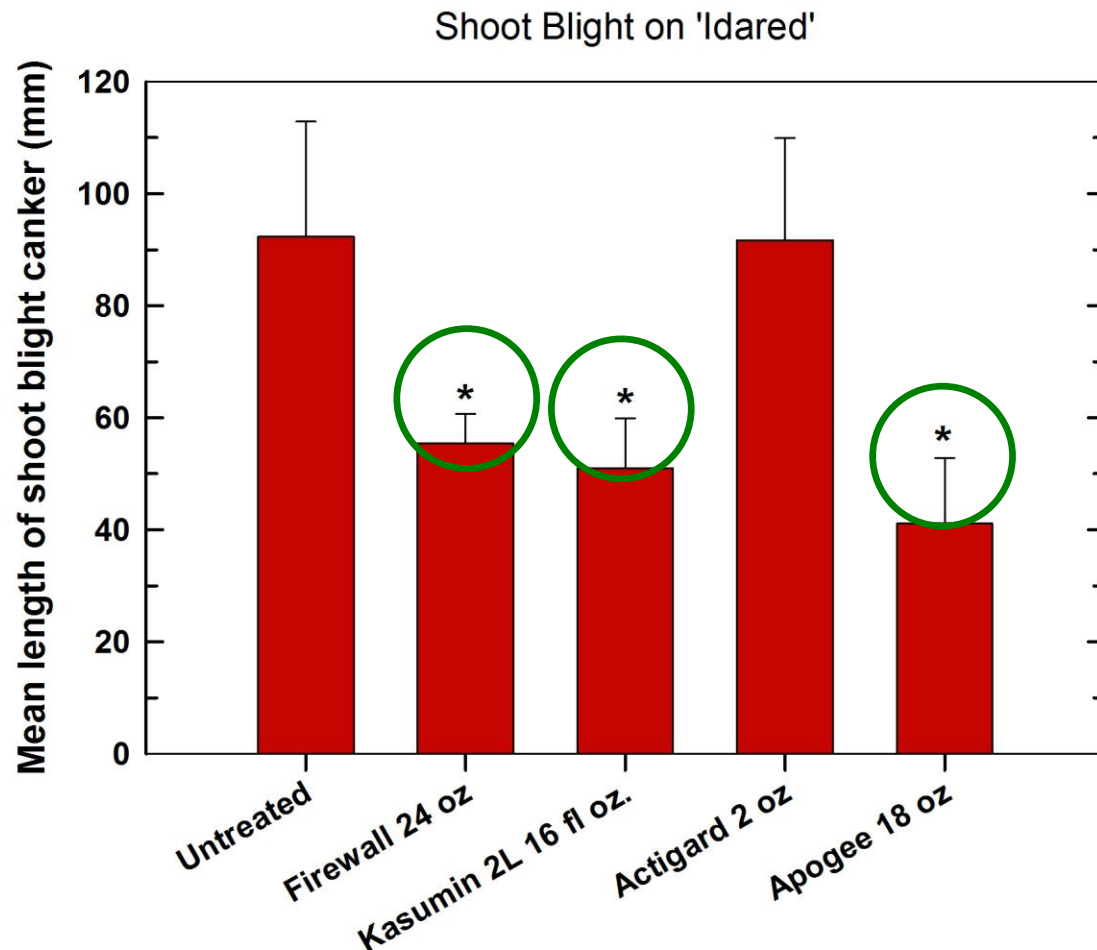
- **Low pressure year:** Streptomycin programs, Strep + low copper, Kasumin, Blossom Protect, Bloomtime Biological

# 2014 Blossom Blight Trial



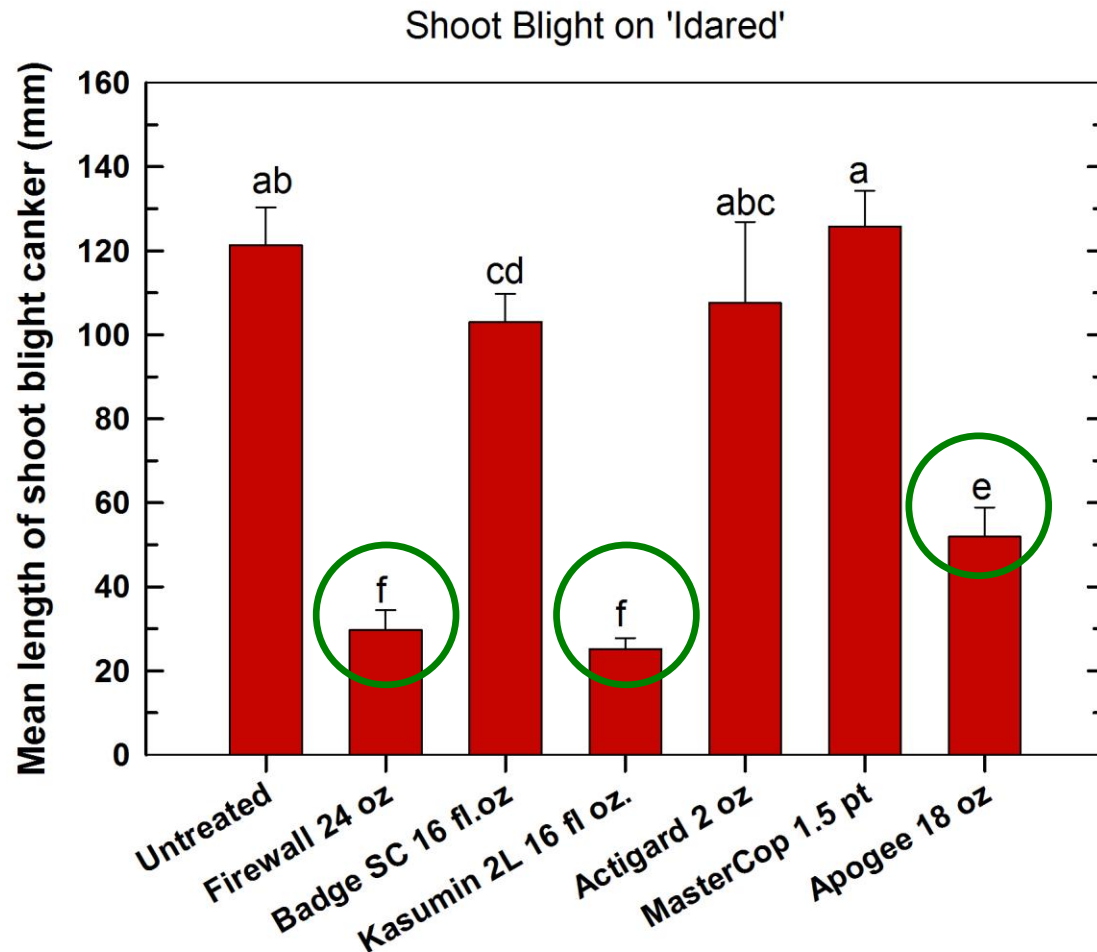
- **Moderate pressure year:** Antibiotic programs, Blossom Protect, MasterCop, BmJ & Double Nickel

# 2012 Shoot Blight



- 2012: Only Apogee and the **two antibiotics** provided a significant reduction of shoot blight progression

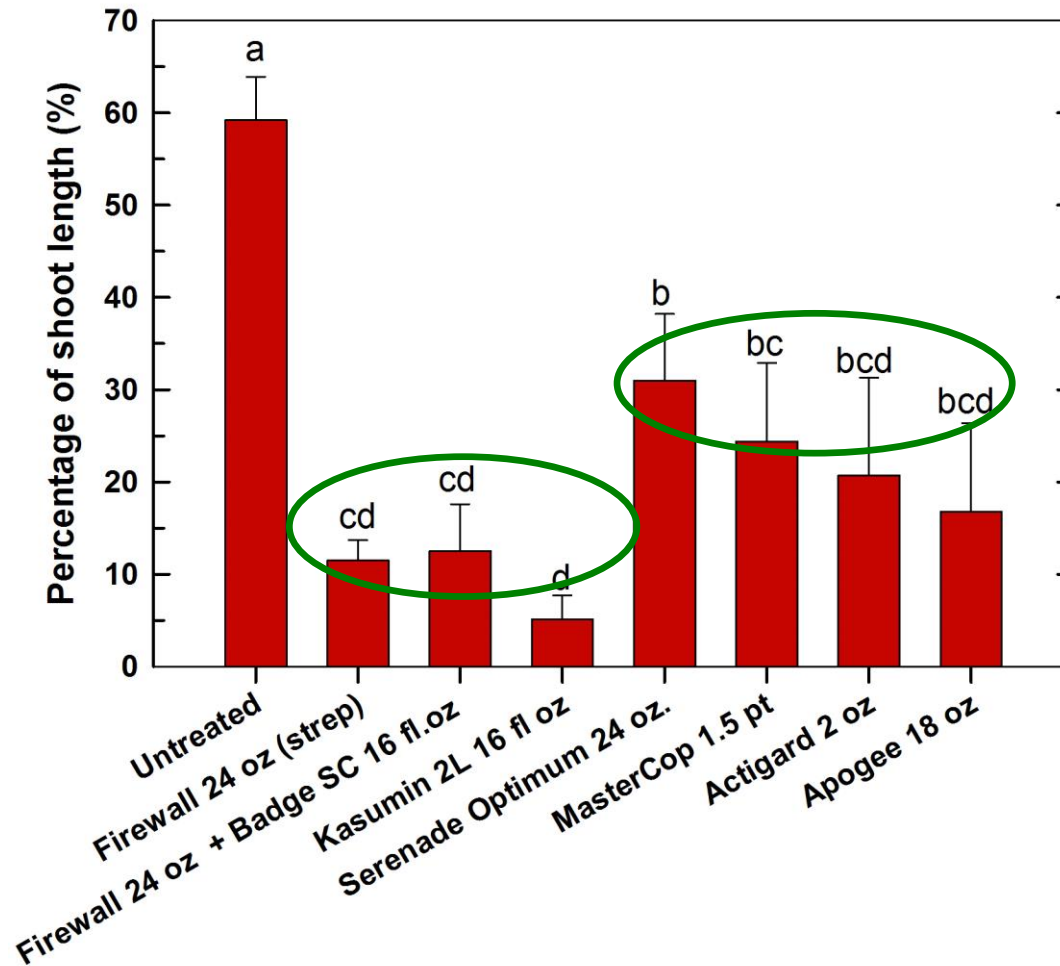
# 2013 Shoot Blight



- 2013: Only Apogee and the **two antibiotics** provided a significant reduction of shoot blight progression

# 2014 Shoot Blight

Shoot Blight on 'Idared'



- 2014: **Antibiotics** provided strongest reduction of shoot blight progression; biologicals, Apogee, and Actigard > good effect



# Blossom Blight Summary

---

- Streptomycin greatest activity against BB
  - Improved by bloom rate of buffered copper: No phyto!
- Kasumin 2L (protectant): effective as strep
  - Resistant management: not necessary in region where SmR Ea not conformed or suspected
- Biologicals & Low MCE coppers
  - They work, but more effective against lower inoculum levels & variable in performance
  - Often equivalent to oxytet **(does not kill)**

# Shoot Blight Summary

---

- Antibiotics greatest effect on trauma shoot blight
  - Don't use antibiotics for shoot blight outside trauma events
- Apogee
  - Even single application provides considerable control: important for high vigor varieties
- Copper & Actigard
  - Variable in performance, and strongest effect against realistic inoculum levels

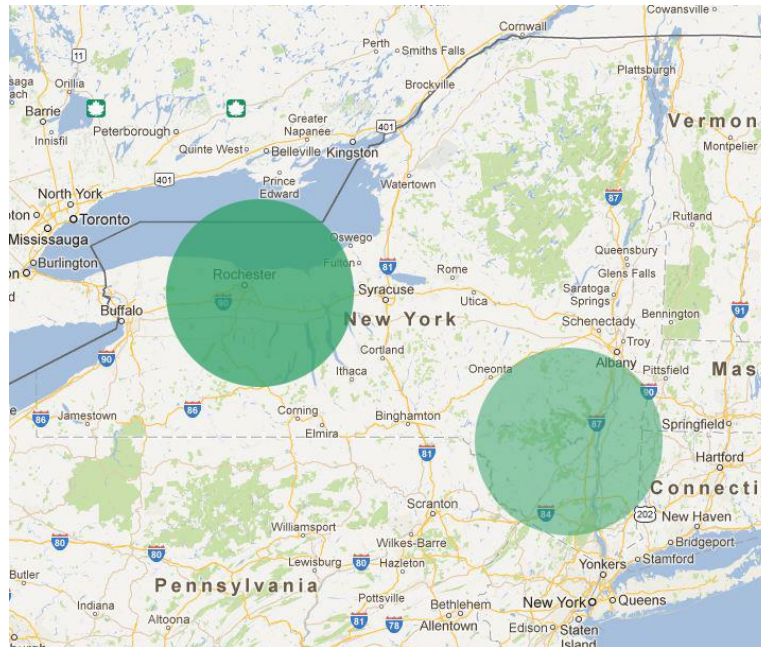
# Outline

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- Updates on chemical management tools
- Streptomycin resistance update
- Managing fire blight
  - Pre & post-season
  - Bloom
  - Post-bloom & Summer

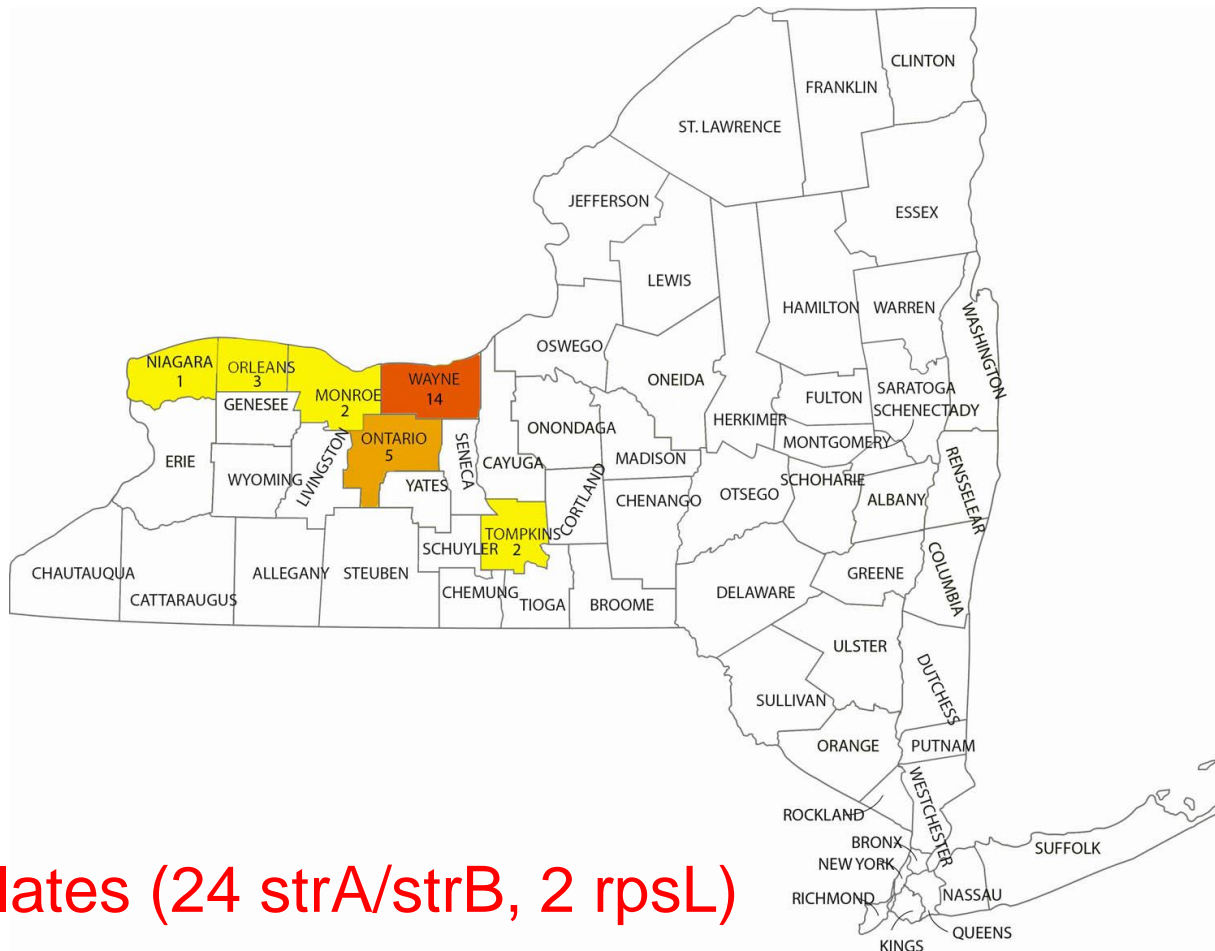
# Status of streptomycin resistance

- 2012: 175 isolates from 43 commercial sites
- 2013: 320 isolates from 32 commercial sites
- 2014: 800 isolates from 32 commercial sites
  - Majority of sampling: Lake Ontario & Hudson Valley



# Status of streptomycin resistance

- 2012-2013: 16 apple production operations had SmR Ea



26 Sm<sup>R</sup> Isolates (24 strA/strB, 2 rpsL)

# Trends & implications

---

- 2014: Lots of Ea, but no SmR Ea
  - Other tree declines present (1/3 samples > BSB, winter injury, & fungal decay blights)
- SmR Ea seems to be restricted to western NY
  - Closest to regions of previous outbreaks
  - Eastern NY appears to be SmR Ea free
- 16 apple production operations had SmR Ea
  - Disproportionate ratio of SmS to SmR strains
  - All strains have plasmid-borne resistance



# Outline

---

- Updates on chemical management tools
- Streptomycin resistance update
- Managing fire blight
  - Pre & post-season
  - Bloom
  - Post-bloom & Summer

# Managing fire blight

- Post season: Clean up inoculum to reduce spread within and between trees
  - Prune out strikes and small cankers:



# Managing fire blight

- Pre season: Clean up inoculum to reduce spread within and between trees
  - Scout and prune out oozing cankers:
    - Large - depressed discolored cracked bark: main scaffolds can't prune
    - Small – blossom & shoot infections, summer pruning cuts: numerous & hard to see/find



Courtesy of Debbie Breth

# Managing fire blight

---

- Pre season
  - Apply full rate of copper at silver/green tip
    - Warm weather causes cankers to ooze > fire flight inoculum increases greatly
- Bloom (had or have history of fire blight)
  - Watch for CCE alerts and disease model forecasts for fire blight infection periods (NEWA & MaryBlyt 7.1)
  - Since **SmR Ea** has **not** been confirmed in eastern NY, use highest rate of strep for each forecast infection

# Managing fire blight

---

- Bloom
  - Concerned about effectiveness of strep, use highest rate of Kasumin 2L at the 2<sup>nd</sup> or 3<sup>rd</sup> forecast infection
- Bloom (Organic with susceptible varieties)
  - No antibiotics (Oct 20, 2014), Highest rate of Double Nickel with Cueva, Badge X2 with hydrated lime, Serenade Optimum, or Blossom Protect
  - Run MaryBlyt 7.1 with 60-75% efficiency with forecast data to plan spray interval – use local data

# Managing fire blight

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- Additional bactericide considerations
  - Streptomycin: locally systemic & Oxytetracycline & Kasugamycin protectants
- Post-Bloom & Summer: Copper (protectant)
  - Can cause fruit russet: not a concern in nursery or during establishment - survival
  - Apply with adequate drying time
  - Protectant: reduces surface bacteria
  - Terminals can outgrow protective residues of copper
  - Low rate fixed copper program: 7-10 day schedule until terminal bud set



# Managing fire blight

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- Post-Bloom & Summer: **Apogee**
  - Retards vigorous shoot growth in young trees & is best protection against shoot blight
  - Make two applications: 6-12 oz/100 gal (3-6 oz/100 gal for tree <5 years) beginning at 1-3" shoot growth & 14-21 days later

# Managing fire blight

---

- Post-Bloom & Summer: Pruning newly developed strikes
  - Remove as soon as noticed
  - Prune on a cool dry day
  - Cut into last season's growth - At least 12" into healthy tissue
  - Young trees: if 12" is into the main scaffold
    - remove/replant

# Acknowledgments

- State, federal, and institutional funds appropriated to the New York State Agricultural Experiment Station
- Funding support by the NYS Apple Research and Development Program
- New York State Department of Agriculture & Markets - Specialty Crop Block Grant
- Summer Crew!



# Questions?

