Disease updates on Botryosphaeria (Bot)/Phomopsis, Anthracnose & Walnut Blight

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Yolo/Solano/Sacramento
Annual Walnut Production Meeting
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acknowledgements

- research conducted by
  - Bot/Anthracnose: Themis Michailides, Plant Pathologist, UC Kearney REC
  - Walnut blight: Jim Adaskaveg, Plant Pathologist, UCR
    - Several slides/photos

- Funding:
  - CA Walnut Board
    - 2012-present

- Fungicide donations/support
  - BASF
  - Syngenta
  - Bayer
  - DuPont
Botryosphaeria (Bot)/Phomopsis Canker & Blight
Conditions for infection

✓ Presence of inoculum
✓ Rain: at least 1/4”
✓ Temperature: $\geq 50^\circ F$
✓ Presence of susceptible tissues
A review
Bot main symptom types

- Branch canker & dieback
- Blighted shoots
- Twig blight
- Fruit & shoot blight
- Infected nuts
Phomopsis symptoms

- Leaf spots
- Cankers
- Fruit blight

Phomopsis canker and blight

Pycnidia
**Botryosphaeria** (10 species)

**Phomopsis** (2 species)
Botryosphaeria dothidea

Wind-borne

Perithecia

Sexual stage

Water-borne

Pycnidia

Asexual stage

Oozing pycnidia
Pycnidia of Botryosphaeria

Perithecia of Botryosphaeria
Immature fruit can be infected
- remain symptomless
- lead to fruit blight Aug-Sept

Infected/blighted fruit -
- Infect spur causing canker/kill buds
Infection of intact fruit in the orchard

--- Disease Progress ---

All the species of *Botryosphaeria* and *Phomopsis*

Fruit → Fruit → Peduncle → Infect Spurs/shoots
Fruit ➔ Peduncle ➔ Shoot

Fruit infection in the field

canker
“Botryosphaeria blight” in Butte Co., October

Inoculation of fruit & invasion of spur

Infection moving down the spur
In addition to direct fruit infection, infection courts:

During the season:
- Wounds from hail, freeze, sunburn, wood peckers
- Pruning wounds
- Scale wounds
- Walnut blight lesions (BAN)*

At harvest:
- Scars from peduncles
- Fruit scars
- Leaf scars
- Mechanical wounds

Postharvest:
- Peduncle scars
- Leaf scars
- Husks (remaining on the tree)
- Pruning wounds
- Wounds from freeze damage
- Injuries from wood peckers
- Other type of injuries
Wounds in the field during 1) the season, 2) at harvest and 3) postharvest.
Infection of leaf scars
Infection via scale wounds

walnut scale

Botryosphaeria
Examples of wound infections

- Infection through sunburn
- Infection through hail wound
- Infection through downy spots
Cankers associated with pruning wounds
Susceptibility of pruning wounds after winter pruning of 1-, 2-, 3-, and 4-year-old shoots to infection by Bot

Winter pruning: 9-10 Feb 2015

Measurements: 4-7 March 2016
Susceptibility of pruning wounds after fall pruning of 1-, 2-, 3-, and 4-year-old shoots to infection by Bot

Fall pruning: 27-28 Oct 2015

Measurements: 14 Nov 2016
Prune branch

Walnut branch

Walnut branches
Best Management by Integrating Cultural and Chemical Control Practices

- **Cultural control:** Prune dead branches or blighted shoots (reduce inoculum in the orchard); avoid sprinkler irrigation that wets the canopy

+ 

- **Chemical control:** Apply effective fungicides (resistance in these fungi has not been a problem)
2016 Fungicide Trials
Butte co.

Themis Michailides
D. Morgan, D. Felts, R. Puckett
Efficacy* of treatments against Botryosphaeria fruit blight in a Chandler walnut (Butte Co., 2016)

**Treatment(s)**
- Ph-D 6.2 oz + Tebucon 45 4 oz
- Pristine 14.5 oz
- Fontelis 20 oz + Abound 12 oz
- Badge 4# + Manzate 2.4#
- Regalia 4 qrts
- Quadris Top 14 oz
- Merivon 6.5 oz
- Pristine 14.5 oz + Regalia 4 qrts
- Luna E 10 oz + Serenade Opti 20 oz
- Fontelis 20 oz + Tebucon 45 8 oz
- Quash 3.5 oz
- (Fontelis 20 oz + Tebucon) + Quad
- Luna Exp 10 oz + Movento 9 oz
- Luna Experience 10 oz
- Kenja 17 oz
- Insprie Super 20 oz
- Ph-D 6.2 oz
- Untreated

**Applications**
- May 5-6, 9
- June 10
- July 12
- August 2

Same trts applied 4 times in a row (exceptions noted with green line).

**Conclusion:**
Disease incidence was much higher in 2016 than 2015 – better breakout from Untreated.

* Ratings are % Blighted fruit

Single tree plots, replicated 5 times. Disease assessments were performed on 7-20-16

% Blighted fruit
## Efficacy of registered fungicides against Botryosphaeria canker and blight of walnut

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Active ingredient</th>
<th>Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quash</td>
<td>metconazole</td>
<td>++++</td>
</tr>
<tr>
<td>Merivon</td>
<td>fluxopyroxad+pyraclostrobin</td>
<td>++++</td>
</tr>
<tr>
<td>Pristine</td>
<td>boscalid + pyraclostrobin</td>
<td>+++</td>
</tr>
<tr>
<td>Quadris Top</td>
<td>difenoconazole + azoxystrobin</td>
<td>+++</td>
</tr>
<tr>
<td>Switch</td>
<td>cyprodinil + fludioxonil</td>
<td>++++</td>
</tr>
<tr>
<td>PhD</td>
<td>Polyoxin-D</td>
<td>+++</td>
</tr>
<tr>
<td>Viathon</td>
<td>tebuconazole + phosphite</td>
<td>+++</td>
</tr>
<tr>
<td>K-Phite</td>
<td>Pollyphosphite</td>
<td>++++</td>
</tr>
<tr>
<td>Luna Experience</td>
<td>fluopyram + tebuconazole</td>
<td>++++</td>
</tr>
<tr>
<td>Luna Sensation</td>
<td>fluopyram + trifloxystrobin</td>
<td>+++</td>
</tr>
<tr>
<td>Fontelis</td>
<td>penthiopyrad</td>
<td>+++</td>
</tr>
<tr>
<td>Copper+Manzate</td>
<td>copper+mancozeb</td>
<td>++</td>
</tr>
</tbody>
</table>

+ = poor; ++++ = excellent

[http://www.ipm.ucdavis.edu](http://www.ipm.ucdavis.edu)
2015-16 efficacy of timing of single spray

✓ Saving $ trmt
✓ Best time for one-time spray spray
✓ Mid-June to early July
✓ Both years
✓ 2016 – 38% blighted nuts in unsprayed
Best-timing of a single spray of Merivon® in a Chandler orchard in Butte Co. - 2015

- **Best-timing**: Apr 9 (bloom); May 12; Jun 12; Jul 10; Aug 10; Nov 3 (PH)
- **Nonsprayed**: 8%
Best timing of single spray with Merivon® in reducing Chandler blighted fruit (Butte Co. 2016)
2015-16 Leaf wetness model (LWM)

✓ Triggered 3 sprays (≥50° F, ¼” wetness)
  ✓ Both years
  ✓ Spray 2-3 days after rain
✓ Assume 2 week residual for most fungicides
**2015: Leaf wetness model (LWM) where rain exceeded threshold in Chandler (Butte Co)**

- April 8-9 (8 mm)
- April 24-25 (18 mm)
- Sept. 16-17 (3 mm)

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Temperature, °C

Leaf wetness, hours

- High Risk
- Medium Risk
- Low Risk

- **sprayed**
2016: Leaf Wetness Model (LWM) where rain exceeded threshold in Chandler (Butte Co.)

Sprays: 26 April, 23 May, 20 June 2016
2016 Leaf wetness model (LWM)

✓ Disease control similar to 4 spray calendar program
  ✓ Bloom (Mar 31), May 5, June 10, July 12
  ✓ % blighted fruit: unsprayed 38.1 b
     4 spray 8.3 a
     LWM 12.9 a
Bot management summary

✓ The pathogens (*Botryosphaeria* & *Phomopsis*) produce **easily and abundantly** both water-spread and airborne spores.

✓ Spores can infect intact fruit (latent infection) and wounds during the season and/or postharvest.

✓ Management of the disease requires both sanitation (pruning) and fungicide sprays.
  – Remove dead and infected wood in the summer or fall when not raining (pruning cut wounds susceptible to infection for **4 months** after wounds made)
  – disinfect pruning equipment
Sanitation by *pruning* is a necessary step *to remove disease*, decrease future infection.
What to do with all that pruned wood?
Orchards - Heavy infection-saturated (>50%): Prunings need to be chipped and may be left in the orchard; annual full spray fungicide program (bloom, May, Jun, July, & postharvest). **WATCH FOR RAINS**

Orchards – Moderate infection (20% - 50%): Prune or hedge these orchards first and then move into more infected orchards; prunings need to be removed out of the orchard; (bloom, May, June, & July sprays). **WATCH FOR RAINS**

Orchards – Light infection (6% - 20%): Prune or hedge these orchards first and then move into more infected orchards; prunings need to be removed out of the orchard; (bloom and June spray). **WATCH FOR RAINS**

Orchards – No Botryosphaeria yet (0%): Prunings can be chipped and left in the orchard; no spray(s) are needed.
Bot management summary

✓ Fungicide sprays from bloom through July reduce Botryosphaeria/Phomopsis infections.
  ✓ Check: http://www.ipm.ucdavis.edu

✓ Spraying before or after an infection event (rain) is very effective: WATCH FOR RAINS

✓ The best-timing for one spray seems to be around mid-June to early-July (we need to refine this…)

✓ A postharvest spray may also help (we need to confirm…).
2017 Bot Research plans

• Adapt predictive assay methods for forecasting Bot/Phomopsis
• Continue investigating latent (symptomless) infections to predict disease risk
• Determine interactions of Bot and Phomopsis in walnut fruit
• Continue fungicide efficacy and best timing testing
• Determine infection of pruning wounds and managing disease using fungicides and/or biological control agents/wound treatments
  – Nickels Field Day May 10
Pruning wound fungicide & wound sealant efficacy treatments on Bot/Phomopsis canker development

Nickels Soil Laboratory
# Treatments

**April 7, 2016**

<table>
<thead>
<tr>
<th>Fungicide or wound sealant</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>-----</td>
</tr>
<tr>
<td>Quadris Top</td>
<td>14 fl oz/ac</td>
</tr>
<tr>
<td>Quadris Top + Viti-Seal</td>
<td>14 fl oz/ac; 1:50</td>
</tr>
<tr>
<td>Quadris Top + Spur Shield</td>
<td>14 fl oz/ac; 1:50</td>
</tr>
<tr>
<td>Tilt</td>
<td>8 fl oz/ac</td>
</tr>
<tr>
<td>Tilt + Viti-Seal</td>
<td>8 fl oz/ac; 1:50</td>
</tr>
<tr>
<td>Tilt + Spur Shield</td>
<td>8 fl oz/ac; 1:50</td>
</tr>
</tbody>
</table>

-fungicides were hand sprayed to run-off on pruning wounds using spray bottles

- natural infection (Bot now in Chandler no prune plot & nearby old Chandler/Howard hedgerow)
Pruning cuts on former no prune Chandler trial at NSL (March 28, 2016)

• Hedging trial

• Whisking trial
2016 Weather conditions
NSL weather station

• No rain between pruning cuts (March 28) and treatments (April 7, 2016).
• April 9-10 .07 in
• Remainder of April .26 in
• May .84 in over 8 days
• Max temps >50°F
• 2017
  – Will evaluate in April
  – Nickels Field Day May 10
Anthracnose
Conditions for infection

- Presence of inoculum
- Extended rain periods: when leaves & nutlets developing
- Temperature: exact unknown; usually favorable
- Presence of susceptible tissues
Anthracnose on Serr leaves
Sutter County  2012
2016: Severe anthracnose of walnut in San Benito Co.
Anthracnose of walnut fruit

Pathogen spore structure
Efficacy* of treatments against Anthracnose of walnut leaves (*Marssonina juglandis*) (San Benito County 2016)

### Treatment(s)
- Ph-D 6.2 oz + Tebucon 45 4 oz
- Merivon 6.5 oz
- **Luna Exp 10 oz + Movento 9 oz**
- Quash 3.5 oz
- **Luna E 10 oz + Serenade Opti 20 oz**
- **Luna Experience 10 oz**
- Ph-D 6.2 oz
- Pristine 14.5 oz
- Kenja 17 oz
- Quadris Top 14 oz
- Untreated

### Applications
- April 5
- April 28
- June 1

Same trts applied 3 times in a row.

### % Leaves with anthracnose lesions

- **Badge 4#**+**Manzate 2.4#**
- Single tree plots, replicated 3 times.
- Disease assessments were performed on 7-20-16

Note: Kenja NOT registered in walnut
Walnut Blight
Conditions for infection

✓ Presence of overwintering inoculum/susceptible tissues

✓ Use XanthoCast model as guideline

✓ The Xanthocast index for walnut blight is a 7-day cumulative index based on temperature and leaf wetness.

Epidemiology and Management of Walnut Blight

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University of California, Riverside

Cooperating:
R. Buchner
UC Cooperative Extension, Tehama Co.

D. Thompson, D. Cary, H. Forster, K. Nguyen, C. Leslie, L. Wade
Objectives in 2017

• Evaluate bacterial pathogen populations using molecular approaches
• Evaluate methods to identify blight resistance in walnut varieties/new walnut genotypes
• Continue to test New treatments
  – Standard copper + Manzate
New treatments

• New copper products (CS 2005-Magna Bon)
• Enhancers of copper activity: ZTD, SBH
• Optimize the performance of antibiotics kasugamycin and oxytetracycline in mixtures
• Food preservatives: Niprosin or nisin, €-poly-L-lysine, calcium propionate, lactic acid (combinations with other bactericides)
• Biocontrols (Actinovate, Botector with nutritional additives) and natural bactericides (EXP-1552)
Registration update for antibiotics

- Kasumin (Trade name) federally registered on pome fruit in Sept. 2014.
  - Walnut: Environmental Toxicology – More data provided and reviewed by DPR (2016).
  - Full registration on walnut is pending.
  - Walnut Commission of California has encouraged CDFA and EPA to register Kasumin in a timely manner.
Registration update for antibiotics

• Oxytetracycline accepted into the IR-4 program -9/16 for 2017 residue studies

• Request to EPA by MCFA, university researchers, agrochemical industry, and commodity groups to facilitate registration of antibiotics for plant agriculture.
Thank you

Questions?