Understanding and Managing Walnut Botryosphaeria/Phomopsis Canker and Blights
(Influence of El Niño on the Sleeping Giant)

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Winter 1994-1995 “winter storms”

The Bot disease started in 1983, probably in the oldest pistachio orchard in the State (Butte Co., CA)


Winter 1994-1995 “winter storms”

Botryosphaeria Blight in Pistachio Orchards 1995

- Winter 1994-1995 “winter storms”
Bot epidemic of 1998
... because of Botryosphaeria blight
Winter 2015-2016 “El Niño?”
Botryosphaeria /Phomopsis of walnuts in Spain
Symptoms we expect to see in walnut orchards in an El Niño year in California
Latent infection of fruit:
Blighted fruit and pathogen isolation from kernels of walnut fruit inoculated with *Lasiodiplodia citricola*
Infection of intact fruit in the orchard

All *Botryosphaeria* & *Phomopsis* species

Fruit → Fruit

Peduncle

Infect spurs/shoots
Spurs with cankers covered with sporulation (pycnidia)
Susceptible walnut cultivars

Ashley
Chandler
Howard
Tulare
Vina
Serr
Hartley
Payne
Dixon
Livermore
Distribution of “Botryosphaeria” spp. in walnut orchards

N. mediterraneum = widespread
Lasiodiplodia spp.

Botryosphaeria dothidea
Neofusicoccum spp.

Diplodia seriata

Neoscytalidium**
Botryosphaeria dothidea

perithecia

sexual stage

wind-borne

pycnidia

asexual stage

water-borne
Oozing pycnidia of Botryosphaeria on walnut spurs
The majority of spores will be released within 30 minutes.
Spores of *Botryosphaeria*

they germinate within 1.5 hours of wetness!
Germination under adverse (wet/dry/wet) conditions and surviving mechanisms
Botryosphaeria spread

- rain & moving water in the orchard  ++++* 
- air (airborne ascospores)  ++ 
- pruning equipment  + 
- insects  ? 

*rain, dew, sprinkler irrigation
Conditions for infection events

- Presence of inoculum
- Rain: at least 1/4”
- Temperature: ≥ 50°F
- Presence of susceptible tissues
Cankers associated with pruning wounds
Susceptibility of pruning wounds of 1-, 2-, 3-, & 4-year-old wood to infection by Bot

Pruning on 9 & 10 Feb 2015
Prune branch

Walnut branch

Walnut branches
Susceptibility of pruning wounds to infection by Bot as affected by age

**Average canker length (cm)**
- 0
- 2
- 4
- 6
- 8
- 10
- 12
- 14
- 16

**Age of inoculated shoots**
- 1 year
- 2 year
- 3 year
- 4 year

**Pruning on 9 & 10 February 2015**

- 5-6 inches
- up to 2 inches
Treatment of pruning wounds with fungicides and then inoculation with *Neofusicoccum parvum*
Wounds in the field during 1) the season, 2) at harvest and 3) postharvest

Peduncle scars

Leaf scars

Canker

Fruit scars when walnuts drop
Infection Courts of *Botryosphaeria* and *Phomopsis*

### During the season:
- ✓ Wounds from hail, freeze, sunburn, wood peckers
- ✓ Pruning wounds
- ✓ Scale wounds
- ✓ Walnut blight lesions

### At harvest:
- ✓ Scars from peduncles
- ✓ Fruit 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
Leaf scar infections
Injuries (wounds) by walnut scale & Botryosphaeria

More than 50% of necrotic lesions had *Botryosphaeria* spp.!
Management of Botryosphaeria canker and shoot blight:

1. Assessment of Bot inoculum risk: BUDMON, or CANCERED SPURS (... in progress).

2. Cultural control: Sanitation: prune infected shoots to remove cankers and reduce spore inoculum; avoid wetting the tree canopy.

3. Chemical control: Apply fungicide sprays.

Best control...

Integrated disease control: Use all of the above (1 + 2 + 3).
BUD MONitoring (= BUDMON) Technique

Bud collection: February/March

Results in 6-7 days

% of buds with Bot
Sanitation by pruning
Bot survival in chipped wood

Presence of pycnidia with viable spores

- 11-May
- 21-Jul
- 27-Aug
- 9-Sep

Unchipped vs Chipped

Unchipped (blue) vs Chipped (red)

11-May: 100
21-Jul: 100
27-Aug: 90
9-Sep: 70

Presence of pycnidia with viable spores decreases over time.

C/o Katherine Pope, UCCE Yolo/Solano
Botryosphaeria .......... 40%
Phomopsis ................. 30%
Botryosphaeria + Phom..... 20%
No pycnidia................... 10%

Botryosphaeria .......... 0%
Phomopsis ................. 0%
Botryosphaeria + Phom.. 0%

Compost
Effects of fungicides on Botryosphaeria in Chandler walnut shoots/spurs (Butte Co.) - 2014

SPRAYS: May 8, June 12, and July 10

Blighted spurs (%)

- Merivon
- Quash
- Ph-D + Tebucon
- K Phite
- Fontelis + OR009
- K Phite + Latron
- EXP 1 + EXP 3
- EXP1 + EXP 2
- Luna Sensation 7.6 oz
- EXP 1
- Pristine
- Luna Experience 10 oz
- Fontelis + Tebucon
- Luna Experience 6 oz
- Badge + Manzate
- Ph-D
- Fontelis
- Quadris Top
- Viathon
- Luna Sensation 5 oz
- Control

Bar charts showing the efficacy of different fungicides.
Nuts at harvest

- Black kernels
- Brown kernels
- Isolations on agar media
- No discoloration
Effects of fungicides on Botryosphaeria in Chandler walnut (black and brown kernels) (Colusa Co.) - 2014
Efficacy of four calendar sprays of fungicides in a Chandler walnut orchard in Butte Co. (Sacramento River) - 2015

**SPRAYS:** May 12, Jun 11, Jul 10, Aug (4X SPRAYS)
Leaf wetness model (LWM) where rain exceeded threshold in a Chandler walnut orchard in Butte County.

- April 8-9 (8 mm) sprayed
- April 24-25 (18 mm) sprayed
- Sept. 16-17 (3 mm) sprayed
Various timings of Merivon® fungicide in a Chandler walnut orchard in Butte Co. - 2015

**SPRAYS:**
- **Calendar:** May 12; Jun 12; Jul 10 = 3X
- **Bloom:** Apr 9 = 1X; Postharvest: Nov 3 = 1X
Best-timing of a single spray of Merivon® in a Chandler orchard in Butte Co. - 2015

SPRAYS: Apr 9 (bloom); May 12; June 12; July 10; Aug 10; Nov 3 (PH)

Nonsprayed = 8%

Blighted spurs (%)

Merivon: bloom
Merivon: May
Merivon: June
Merivon: July
Merivon: August
Merivon: post: harvest

Postharvest (PH)

Bloom

Best timing

ab

ab

ab

ab

ab

ab
FUNGICIDES, BACTERICIDES, AND BIOLOGICALS
FOR
DECIDUOUS TREE FRUIT, NUT,
STRAWBERRY, AND VINE CROPS
2015

ALMOND
APPLE
APRICOT
CHERRY
GRAPE
KIWIFRUIT
PEACH/NECTARINE
PEAR
PISTACHIO
PLUM
POMEGRANATE
PRUNE
STRAWBERRY
WALNUT

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www.ipm.ucdavis.edu
## Efficacy of registered fungicides against Botryosphaeria canker and blight of walnut

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Active ingredient</th>
<th>Efficacy</th>
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</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>bosalaid + 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>Polyphosphite</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>pentyiopyrad</td>
<td>+++</td>
</tr>
<tr>
<td>Manzate</td>
<td>copper-mancozeb</td>
<td>++</td>
</tr>
</tbody>
</table>

**Efficacy:** + = poor; ++++ = excellent

http://www.ipm.ucdavis.edu
Scenarios for sanitation & sprays

- **Orchards - Heavy infection (>50%)**: Prunings need to be chipped and they may be left in the orchard; apply 3-5 fungicide sprays ((bloom, May, Jun, July, and postharvest).

- **Orchards - Moderate infection (21% - 50%)**: Prune or hedge these orchards first and then move into heavily infected orchards; prunings need to be moved out of the orchard; at least 3 sprays (bloom and June spray, & July – depending on weather conditions).

- **Orchards – Light infection (6% - 20%)**: Prune or hedge these orchards first and then move into more infected orchards; prunings need to be moved out of the orchard; two sprays (bloom and mid June to early July).

- **Orchards – Very light infection (1% - 5%)**: Prune infections and destroy them out of the orchard; no spray(s) needed, unless it rains.

- **Orchards – No infection: no Botryosphaeria yet (0%)**: Prunings can be chipped and left in the orchard; no spray(s) are needed.
For best management we need all: a) assessment of inoculum risk; b) sanitation; and c) fungicide sprays.

Sprays during May through July/August reduce Botryosphaeria (confirmed in 2014 & 2015).

Bloom sprays and postharvest sprays seem to reduce disease (we need to repeat in 2016).

Sprays after a rain/infection event seem to be very effective (we need to repeat in 2016).

The best-timing spray seems to be around mid-June to early/mid July (we need to repeat in 2016).
Acknowledgments

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Thank you
Effect of walnut scales on infection of walnut by Botryosphaeriaceae (cv. Vina)

![Graph showing percentage of walnut branches infected with different treatments and scales present or not.]

- **Inoculation Without wounding – spore suspension**
  - **Shoots w/ scales**
  - **Shoots w/ scales**

**Treatment**
- Lasiodiplodia citricola
- Neofusicoccum parvum
- Neofusicoccum mediterraneum
- Control

**Results**

- 60-75% more shoots were infected when scales were present than when scales were not present.
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