

Stress, Alcohol, and Opportunistic “Friends”: An Update on Rapid Apple Decline



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What is Rapid Apple Decline?



~2 weeks



Characteristics of **RAD** (Rapid Apple Decline)

- Young (≤ 6 years) dwarfing trees in high density orchards
- Several dwarfing rootstocks involved: Malling (M-series), Budagovsky (B-series), Geneva (G-series)
- Several cultivars involved
- Graft union necrosis: Proceeds up the tree
- Root system usually appears healthy
- Random dispersal of affected trees throughout a block
- Leaves: Chlorotic (pale green/yellow)  red

Apple Tree Decline: Adams County, PA, 2013



Photos: Kari Peter, PSU



- 2013: Massive die-off of 2-yr-old multiple cultivar planting (M.9)
- 2014-2017: Collapse of trees extends to commercial orchards in county

Apple Tree Decline: Western NY, 2013



Mid-season tree collapse on
dwarfing trees in high density
system



Seasonal canker concerns

Tree cankers

- Slow growing wood decay fungi: affect compromised established trees after seasons of cold, roundup, or salt injury
- *Botryosphaeria* & *Schizophyllum*, *Nectria* species
- Slowly expanding sunken cankers in crotch angles and easily injured tissues



Nectria and *Botryosphaeria*

- Causal agent(s):
 - *Nectria cinnabarina* & *Botryosphaeria* spp.
- Symptoms:
 - Dark brown wilted shoots may crook & look like fire blight
 - Doesn't turn as black as FB



Nectria and *Botryosphaeria*

- Signs:
 - Pink/salmon or black stromata filled with spores
- Disease cycle:
 - Infection: late summer or fall by windborne spores infecting leaf scar or summer pruning wounds



Nectria and *Botryosphaeria*

- Disease cycle:
 - *N. cinnabarina* & *Botryosphaeria* spp. infect trees compromised by mild winter injury, shoot blight, herbicide damage, hailstorms, stem borers, or deer browsing in wet seasons
 - Survival: Quiescently in cankers, nursery stock, infected spurs, or pruning's on orchard floor



Nectria and *Botryosphaeria*

- Management:
 - Difficult: fungi protected deep in woody tissue
 - *Neonectria galligena* = aggressive pathogen (wood decay fungus) in Europe (**eastern apples?**)
 - Management research from Europe on *N. galligena* > *N. cinnabarina* & *Botryosphaeria*



Nectria and *Botryosphaeria*

- Management:
 - Prune (summer pruning or dead/disease shoots): cool day following a 24-hr period of dry weather with two days of dry weather forecasted following pruning
 - Infection on leader or trunk of small tree > remove tree and replant



Nectria and *Botryosphaeria*

- Management:
 - Remove cuttings from orchards and burn them or take them offsite > they can still infect from the ground
 - Apply copper fungicides: 20% and 80% leaf drop and after pruning (fruit finish)
 - Kocide 3000 & Badge SC are labeled for *Nectria* (European canker)
 - Summer cover sprays with benomyl or t-methyl

Phytophthora spp.

- Causal agent(s):
 - *Phytophthora* spp.



(system)

Phytophthora spp.

- Causal agent(s):
 - *Phytophthora* spp.
- Symptoms: (dysfunctional root system)
 - Below bark: orange/reddish brown spreading lesions – darkly delineated margin = activating infection
 - Secondary wood decay fungi and bacteria colonize & confound diagnosis



Phytophthora spp.

- Disease cycle:
 - Infection: zoospores release from sporangia in saturated soils in the snows melts in the spring as temperature rises
 - *Phytophthora* is ubiquitous in soils and usually occurs in low lying or poorly drained spots
 - However, heavy rains, infected nursery stock, highly susceptible cultivars, & infected nursery stock > even occur on high ground
 - Survival: Oospores in soil (long-term) sporangia (short-term)

Phytophthora spp.

- Management:
 - Plant on well drained soils/hill sides
 - Select resistant rootstocks (B.9 & Geneva series)
 - Avoid susceptible scion varieties to avoid collar rot ('Topaz' & 'Cox's Orange Pippin')
 - Apply mefenoxam band/broadcast (2qt/A) or soil drench (0.5pt/100 gal – 1-3qt/tree: (\$800/gal)
 - Phosphorous acid fungicides – first flush or foliage, reapply on 60-day interval: (\$33/gal) > damage could be done prior to infection

Winter injury

- Symptom development
 - The last part of the tree to harden off are the lower scaffolds (just above or below the lowest branches)
 - Browning of the phloem (white) & cambium (green/white) under the bark in irregular patches or streaks. Bark may split and peel



Courtesy of Dave Rosenberger

Winter injury

- Symptom development
 - Browning of the phloem (white) & cambium (green/white) under the bark in irregular patches or streaks. Bark may split and peel
 - If cold kills bark, cankers may form over xylem infected by wood decay fungi (e.g. *Schizophyllum commune*)



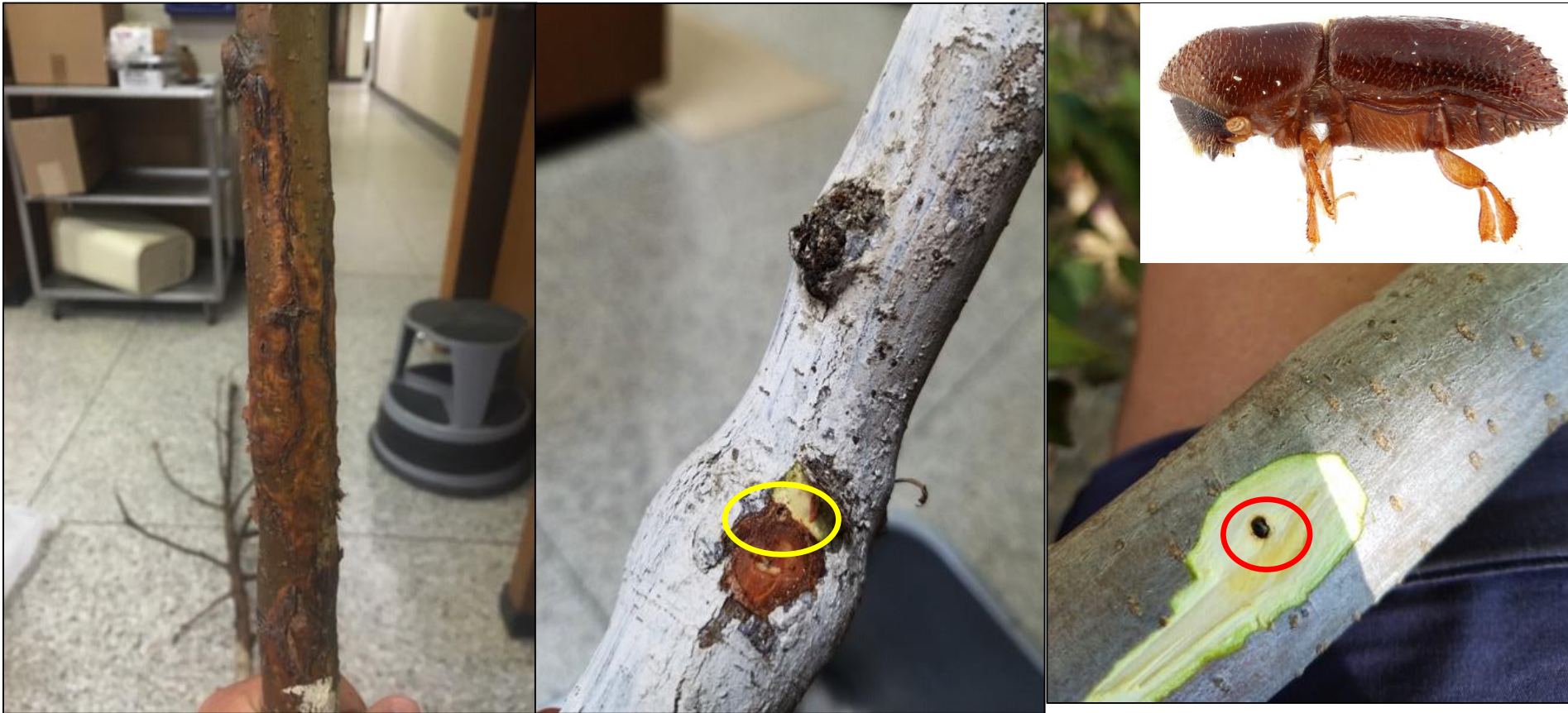
Winter injury

- Cold temperatures or rapid changes in temperature
 - Low lying areas: colder & poorly drained soils – keep trees growing & harden off later
 - Southwest injury (trunk > 3" dia.): light warms bark >30° and cools down at night or 55° day in winter followed by 25° day
 - Ice collars: trees settle leaving a depression that allows water to collect in the depression and refreeze during winter temperature changes

Winter injury

- Management
 - Avoid poorly drained and low-lying areas
 - Irrigation/fertilizer management: too much water or fertilizer > trees growing late into fall
 - Take care with herbicide use > mild damage may decrease cold hardiness
 - Late summer pruning > decrease cold hardiness
 - Rootstock selection: MM.106 slow hardening: Geneva series G.935 good cold tolerance
 - Scion variety: 'Empire', 'Fuji', and 'Rome' vs 'McIntosh' and 'Gala'

Apple Tree Decline: Henderson County NC, 2016



- Tests (-) for Phytophthora, Fire Blight
- Borer holes in scion and rootstock: *Xyleborinus saxeseni*

Apple Tree Decline in the Eastern U.S. Henderson County, NC: Aug-Dec 2016



- Sporadic distributions throughout orchards
- Budagovsky + M9/26/106 rootstocks
- Rapid Apple Decline (RAD) reports: NY, PA, New England, Canada

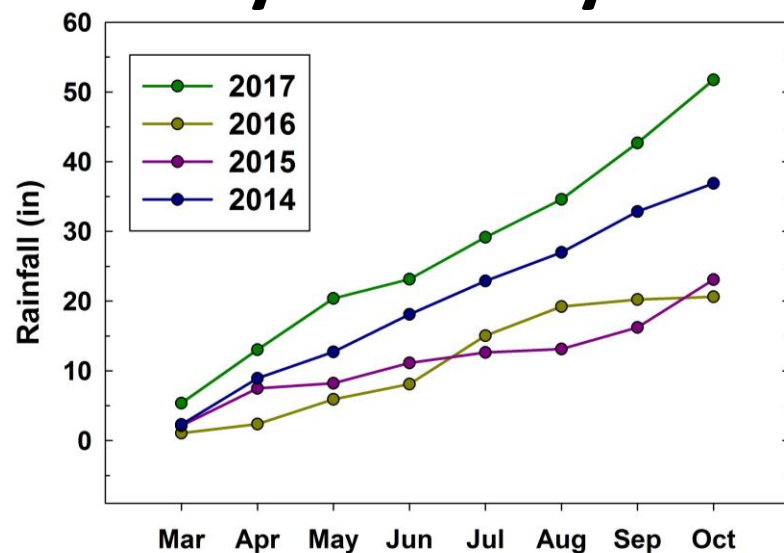
Apple Tree Decline: Western NC: April-May 2017



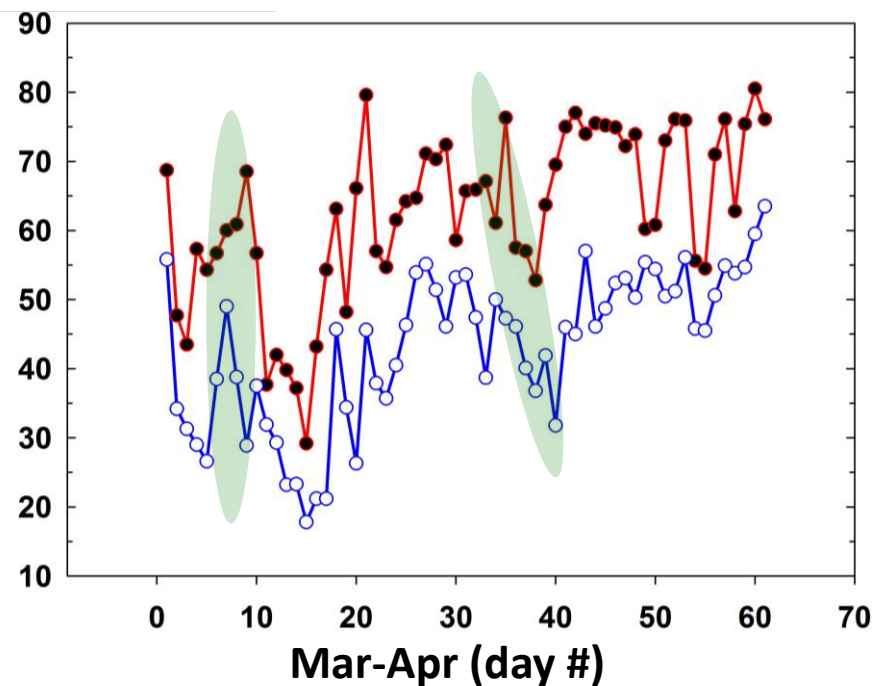
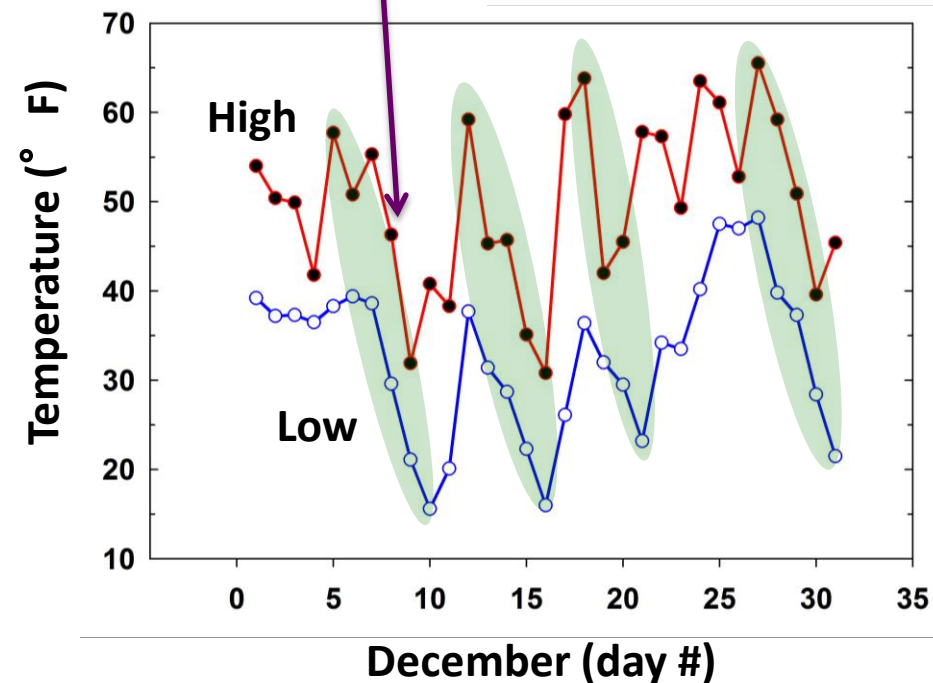
Apple Tree Decline: Western NC: April-May 2017



Why Us? Why Now?



80% Defoliation



2017 Western NC RAD Survey: Field Evaluations

1. Determine progression of tree decline during 2017 growing season



Healthy



Decline



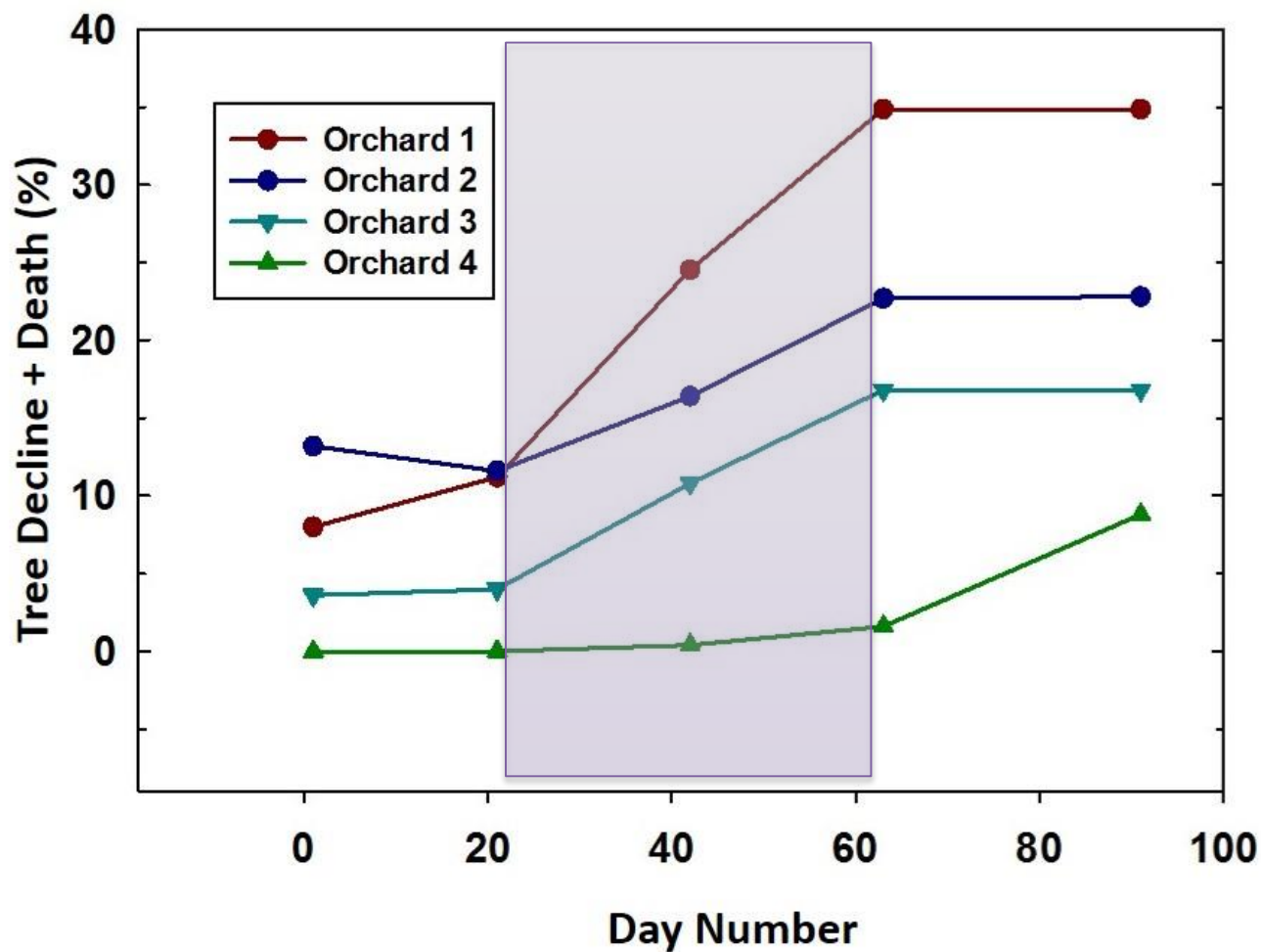
Decline



Dead

10 to 15 reps of 25 trees at 7 NC high-density orchard locations in Henderson and Haywood counties

2017 Western NC RAD Survey: Tree Decline and Death



- Additional orchard sampling locations followed similar trend

2017 Western NC RAD Survey: Field Evaluations

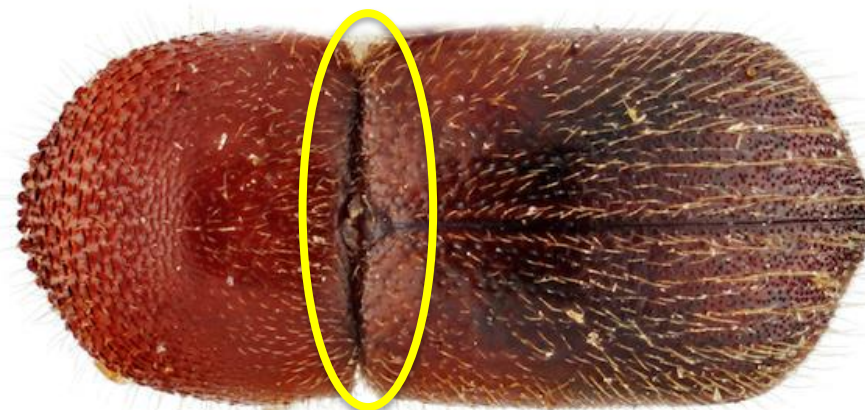
2. Determine ambrosia beetle species and flight timings
 - Ethanol baited traps set at row adjacent to wood edge; 30 m, and 60 m into orchard
 - Traps set at 5 HD orchard locations 7 June and monitored weekly



2017 Western NC RAD Survey: Field Evaluations



**Xylosandrus
crassiusculus
(M. Bertone)**



**Xyleborinus saxeseni
(M. Bertone)**

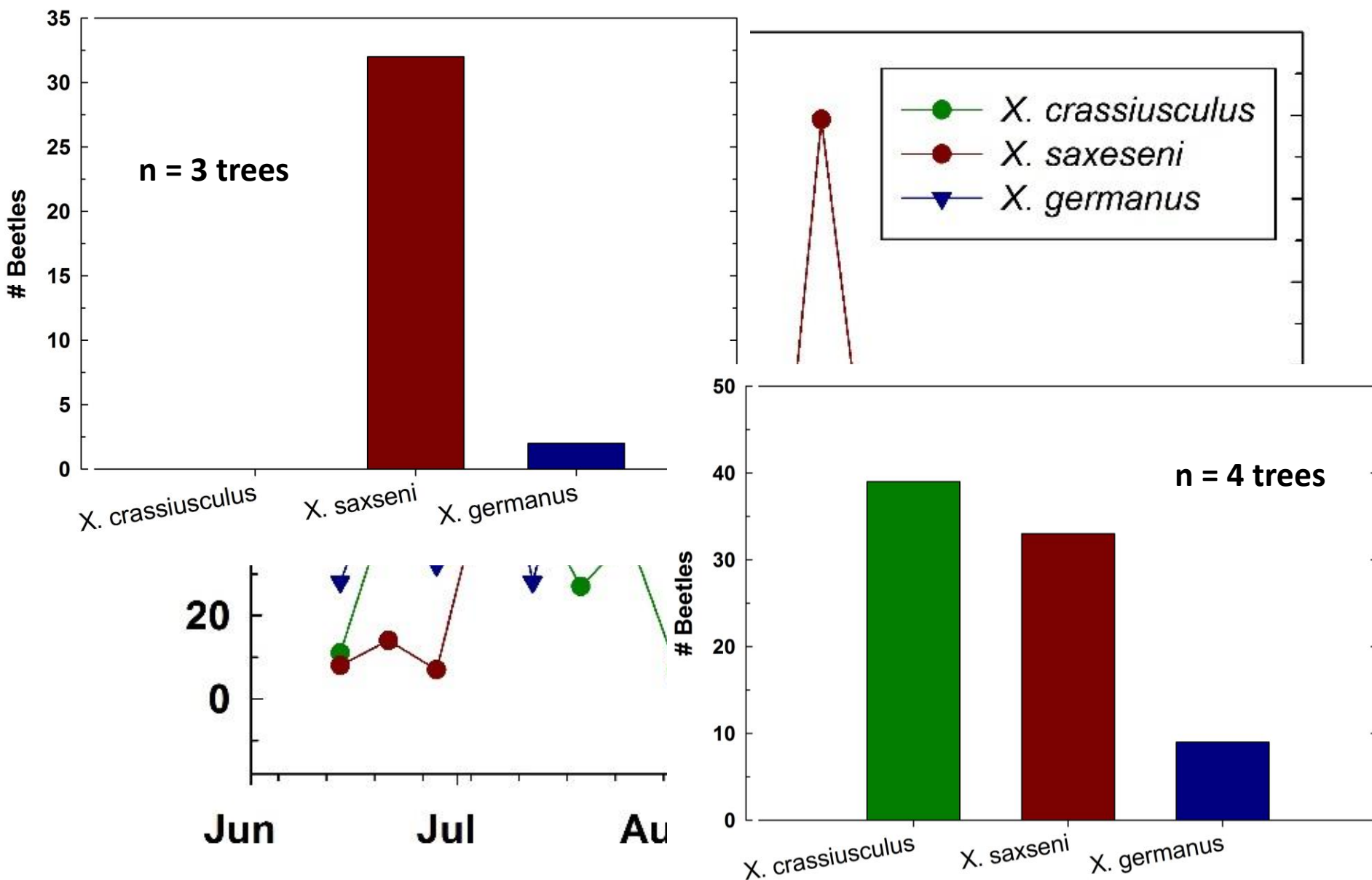


**Xylosandrus
germanus**



**Xyleborous ferrugineous
(SM Smith, MSU)**

2017 Western NC RAD Survey: Trap Catches



2017 Western NC RAD Survey: Trap Catches



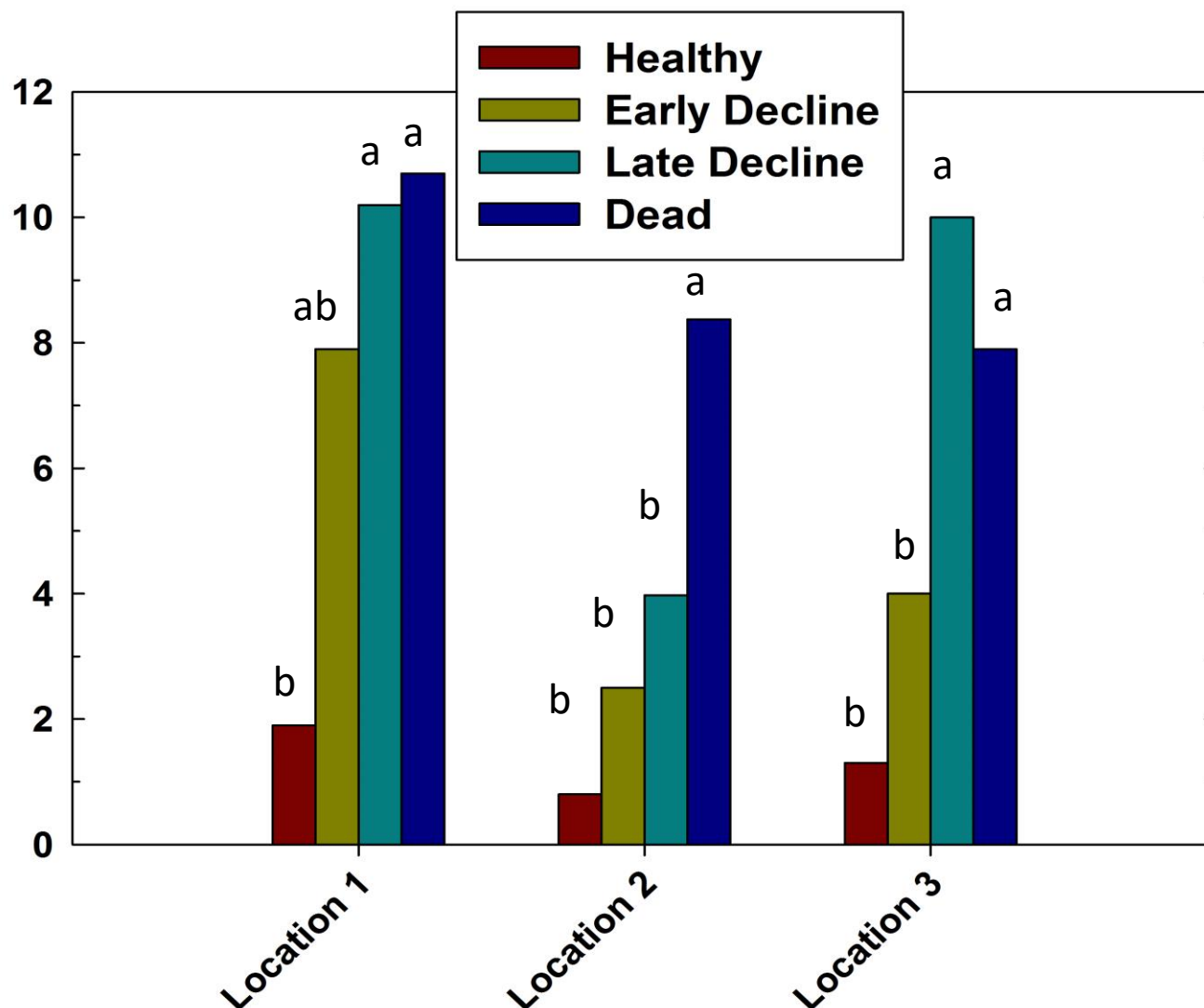
Orchard #	Orchard Type	<i>X. germanus</i>	<i>X. crassiusculus</i>	<i>X. saxeseni</i>
1	Commercial	203	176	501
2	Commercial	19	211	77
3	Commercial	332	68	126
4	Research	30	75	58
	Total	584	530	762

2017 Western NC RAD Survey: Field Evaluations

3. Evaluate association between ambrosia beetle attack and apparent tree health status
 - Single assessment (Aug 2017) 10 single-tree replicates per tree health status 4 orchards evaluated



2017 Western NC RAD Survey: # of Ambrosia Beetle Attacks



- Early Decline: 3-8 attacks/tree; Late Decline: 4.0-10 attacks/tree

2017 Western NC RAD Survey: RAD Tree Evaluations

1. Determine fungi and other pathogens (*Phytophthora*, *E. amylovora*, viruses) associated with rapid apple decline in North Carolina
 - *Phytophthora* and fire blight: Graft union/rootstock region only
 - Associated fungi: Graft union/rootstock, ambrosia beetle galleries, scion (682 isolates characterized)

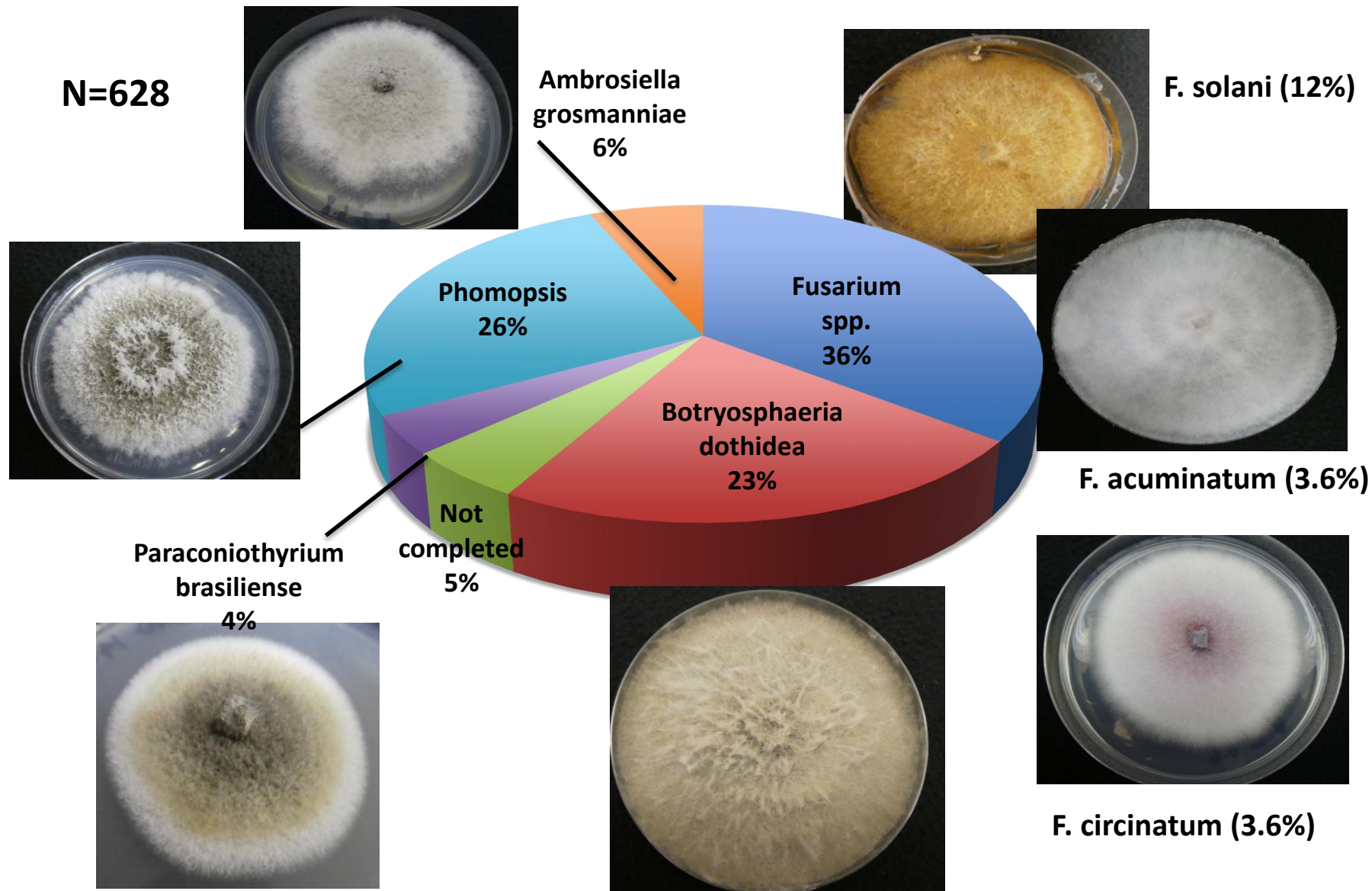


2017 Western NC RAD Survey: Phytopathogen/Fungal Associations

- 29 high density “orchards” (1 research, 28 commercial), 3 NC Counties: 163 trees total
- Rootstocks: M-9 (NIC 29, 337), -26; G-11, -30, -41; B-9, -118; EMLA-26
- Cultivar: Cameo (2), Gala (5), Fuji (3), Red Delicious (1), Honeycrisp (7), JerseyMac (1), Granny Smith (1), Newton Pippin (1), Crimson Crisp (1), Mixed/unknown (6)
- 23 of 28: No irrigation used
- Maximum 10 trees evaluated per orchard

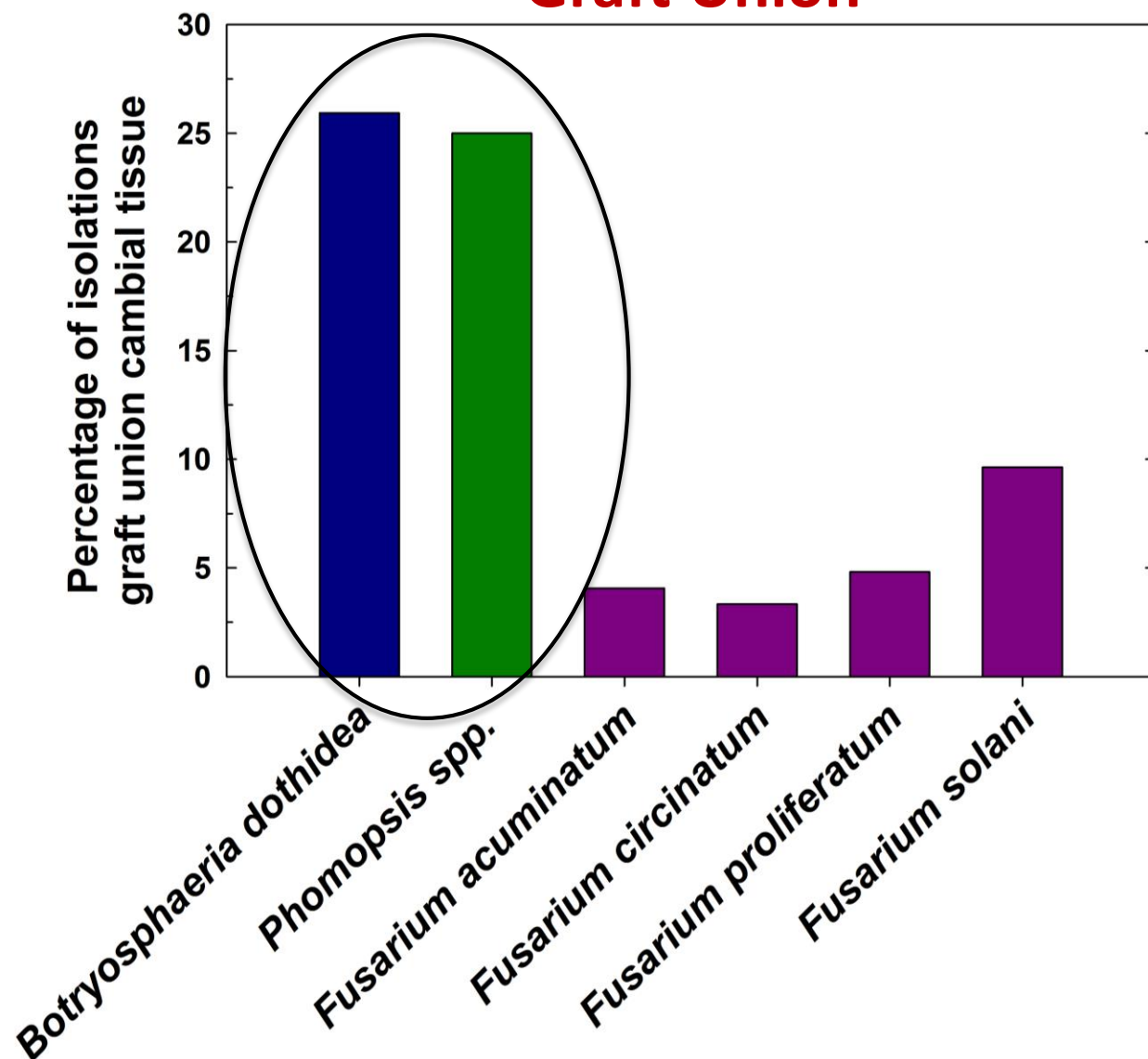
2017 Western NC RAD Survey: Recovered Fungal Species

N=628



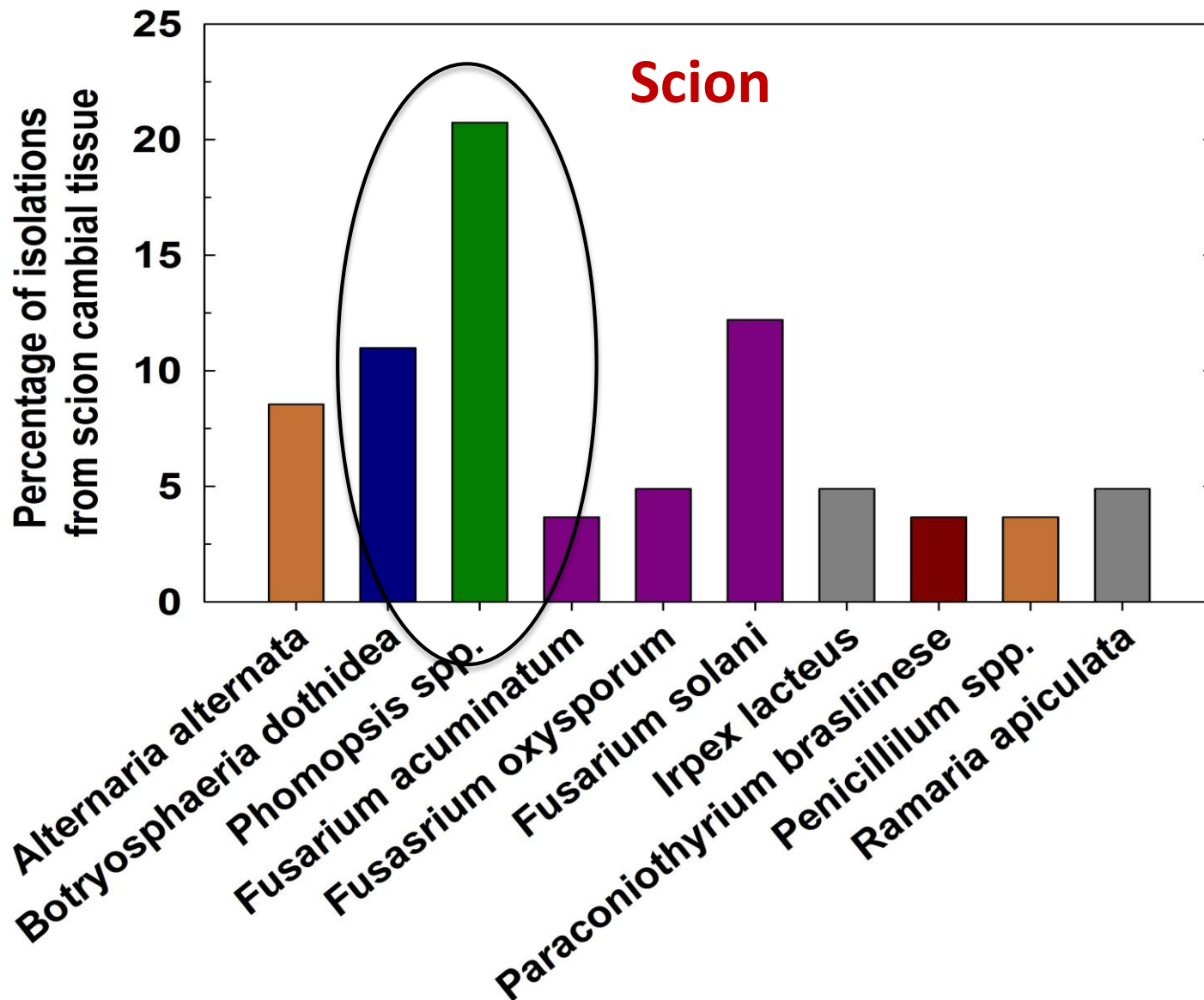
2017 Western NC RAD Survey: Recovered Fungal Species

Graft Union

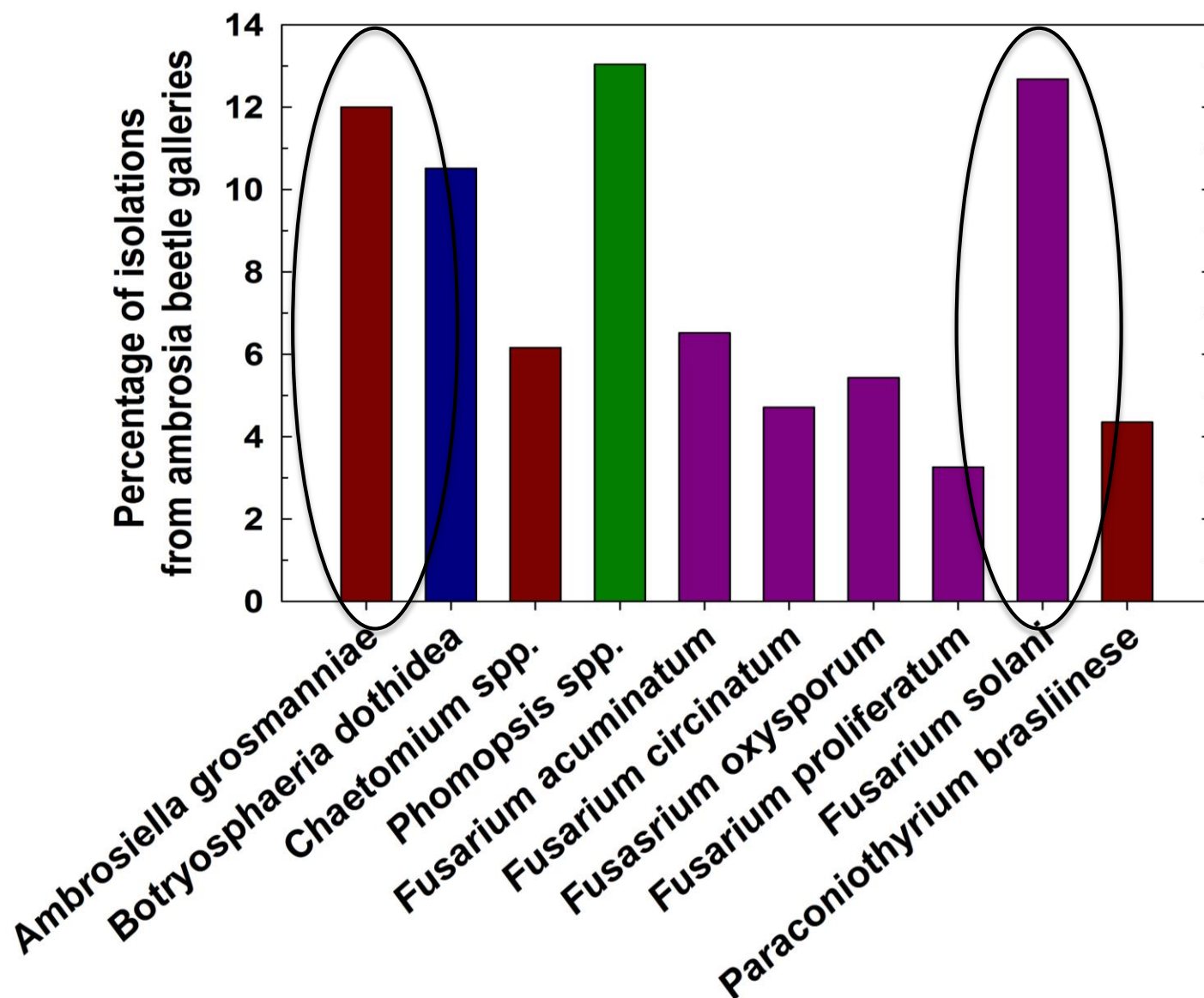


B. dothidea and *Phomopsis* recovered from 80% of RAD trees (all sampling locations)

2017 Western NC RAD Survey: Recovered Fungal Species



2017 Western NC RAD Survey: Recovered Fungal Species



Estimated Impact of Tree Loss on Economics of High Density Apple Orchards

		Cumulative Income (\$/A)	
Tree Loss	Break even year	10 years	15 years
0	6.8	38,080	110,008
10%	7.2	30,711	94,254
20%	7.5	23,351	78501
40%	8.7	8,632	46,994
40% (10%/yr)	8.6	9,438	47,800

Assumptions: \$15,000/acre establishment cost, 'Gala' cultivar, \$13.43/bushel return, all healthy trees reach yield potential.

What to do in 2018

- Biggest issue with management program: Several factors involved in tree decline in the SE
- In general: Keep trees happy: Proper irrigation, plant high quality trees-early, mindful nutrition and pruning practices, reduce weed competition, etc.
- Ambrosia beetles: Chemical control difficult and not consistent (pyrethroids)
 - 3 to 4 beetle species with different flight timings and possibly 3 generations/year
 - Flights: March-October?
- Fungi: Do not provide opportunities for entry
 - Avoid pruning during heavy dew or precipitation
 - Consider fungicide application after pruning (Topsin?)
- We are continuing to apply for funding and plan to conduct insecticide and fungicide trials in 2018

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Acknowledgements

