

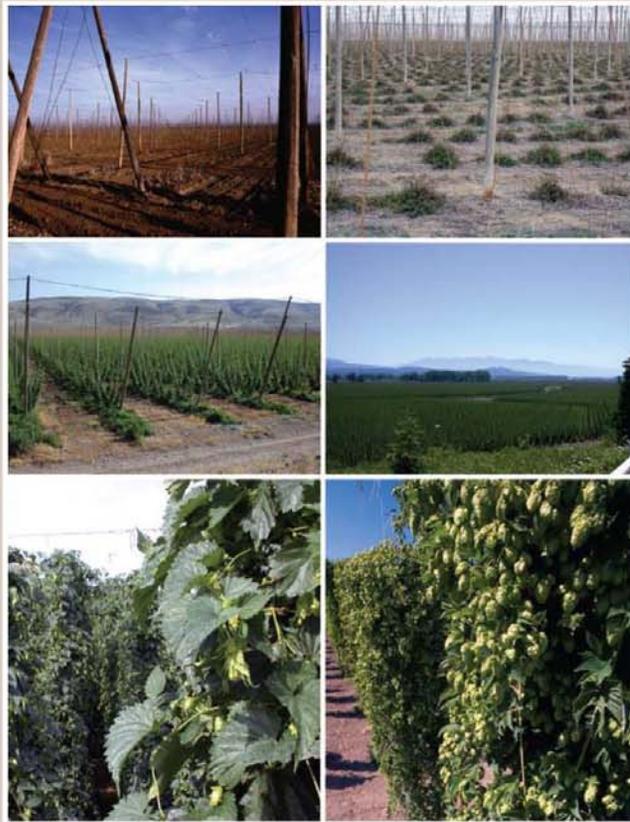
Downy Mildew: Identification, Lifecycle, and Management

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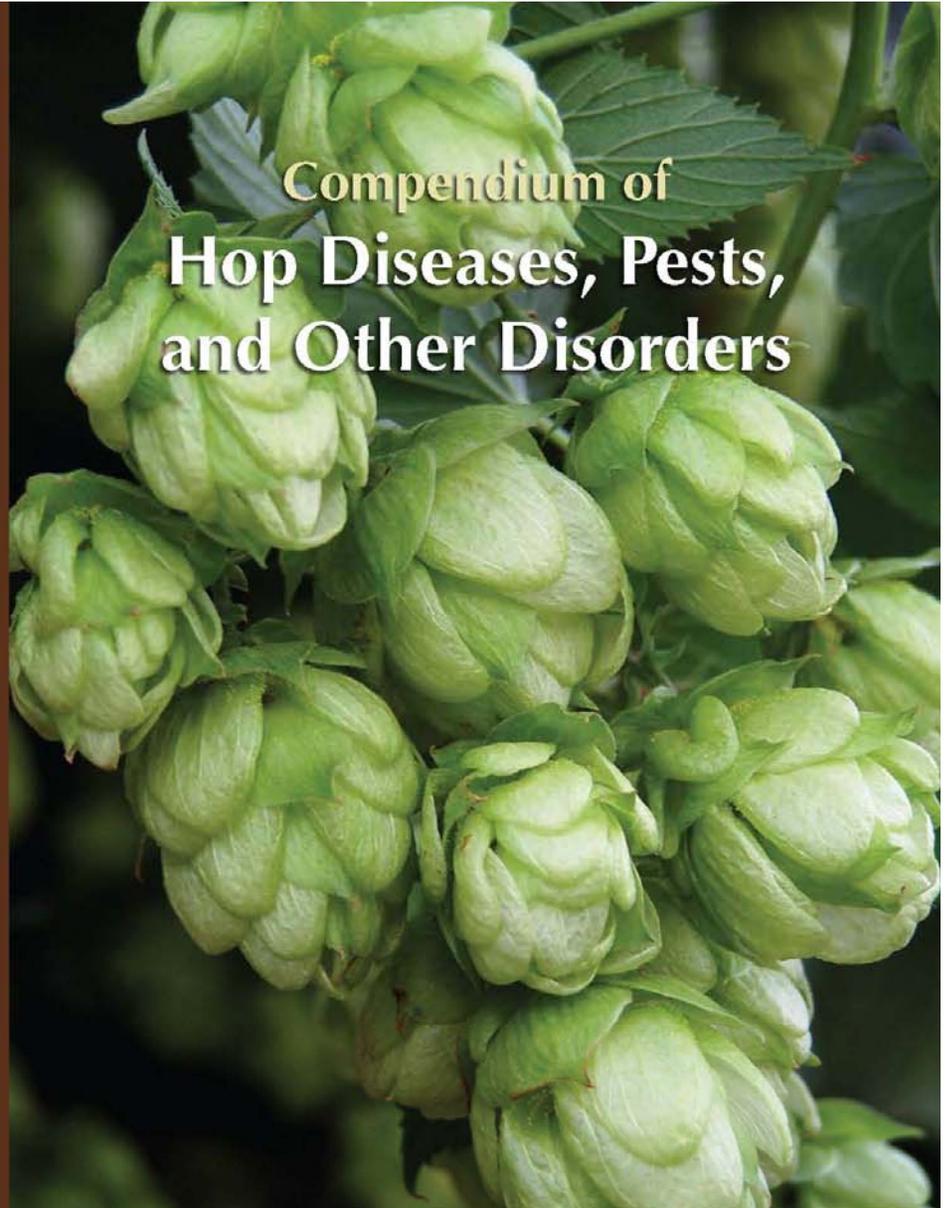




Mahaffee, Pethybridge, and Gent, editors

Compendium of Hop Diseases, Pests, and Other Disorders

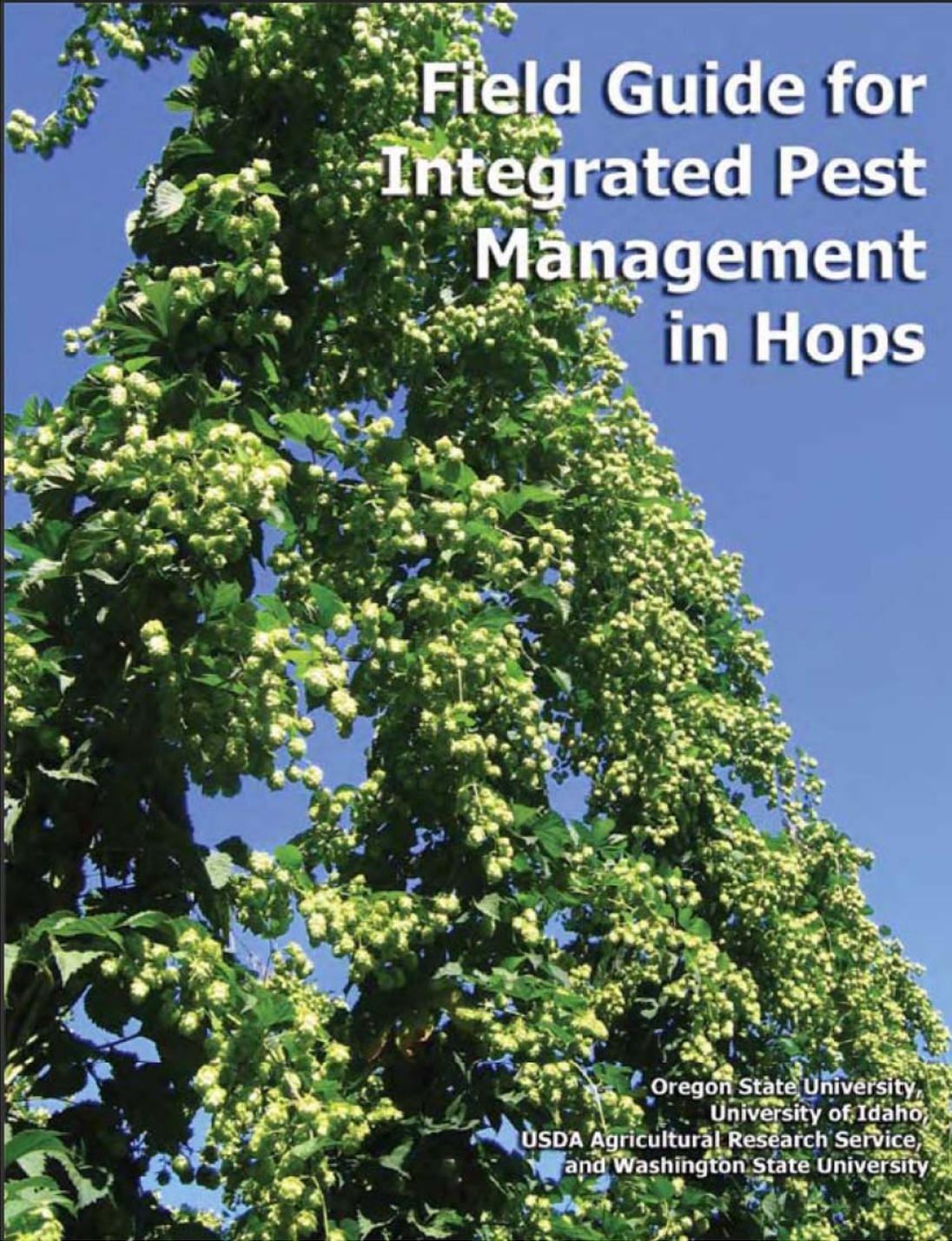
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Compendium of Hop Diseases, Pests, and Other Disorders

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**Field Guide for
Integrated Pest
Management
in Hops**

Oregon State University,
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and Washington State University

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Disease and Pest Overview

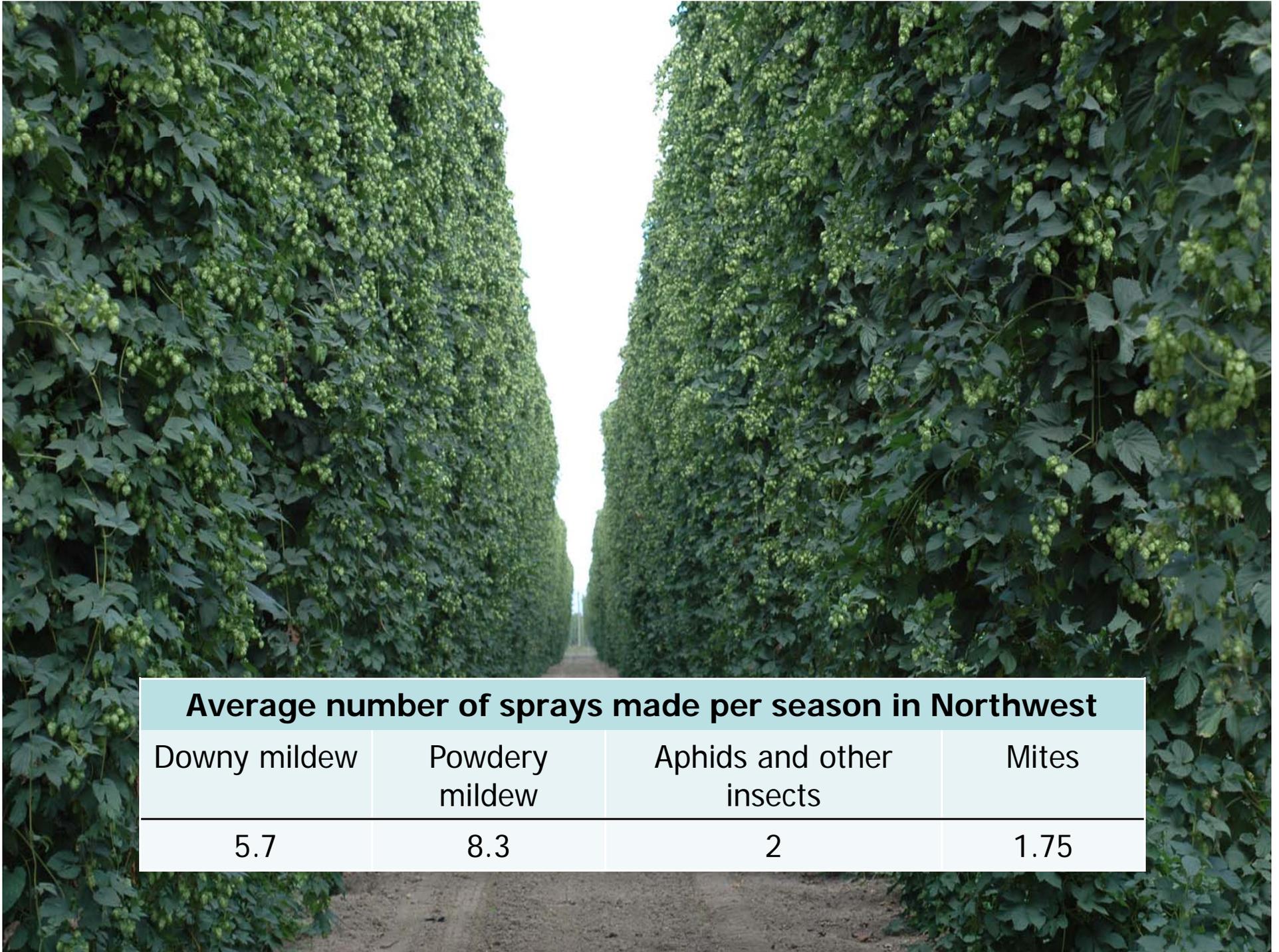
- Get a Positive ID before implementing any controls











Average number of sprays made per season in Northwest

Downy mildew	Powdery mildew	Aphids and other insects	Mites
5.7	8.3	2	1.75

Things to Know

1. Disease status of planting materials
 - Don't buy a perennial problem: obtain materials from Clean Plant Network or otherwise ensure disease-free
2. What you are controlling
 - Get an accurate ID before treating
3. Market
 - Quality standards
 - Organic vs. conventional: may dictate variety

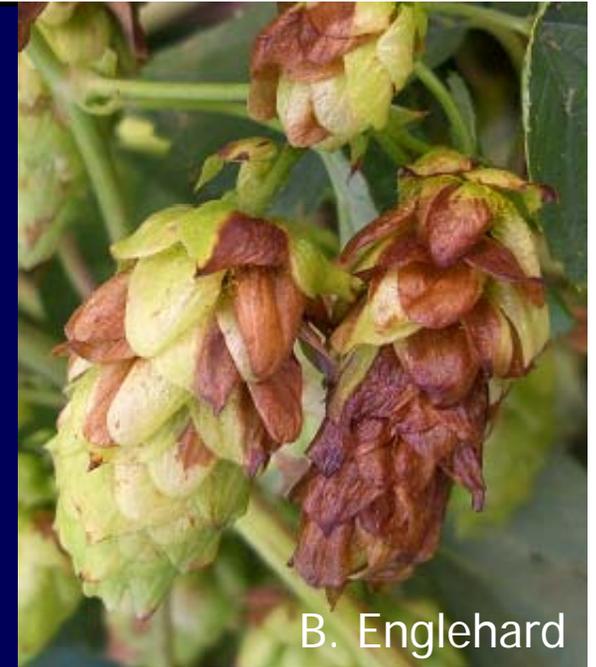
Disease and Pest Overview

	Susceptibility	Downy mildew	Powdery mildew
Brewer's Gold	High	Columbus	Columbus
Cascade		Galena	Glacier
Centennial		Chinook	Galena
Chinook		Glacier	Chinook
Columbus		Mt. Hood	Brewer's Gold
Fuggle		Centennial	Golding
Galena		Golding	Perle
Glacier		Brewer's Gold	Sterling
U.S. Golding		Cascade	Centennial
Mt. Hood		Nugget	Willamette
Nugget	Intermediate	Sterling	Fuggle
Perle		Willamette	Cascade
Sterling		Fuggle	Mt. Hood
Willamette	Low	Perle	Nugget

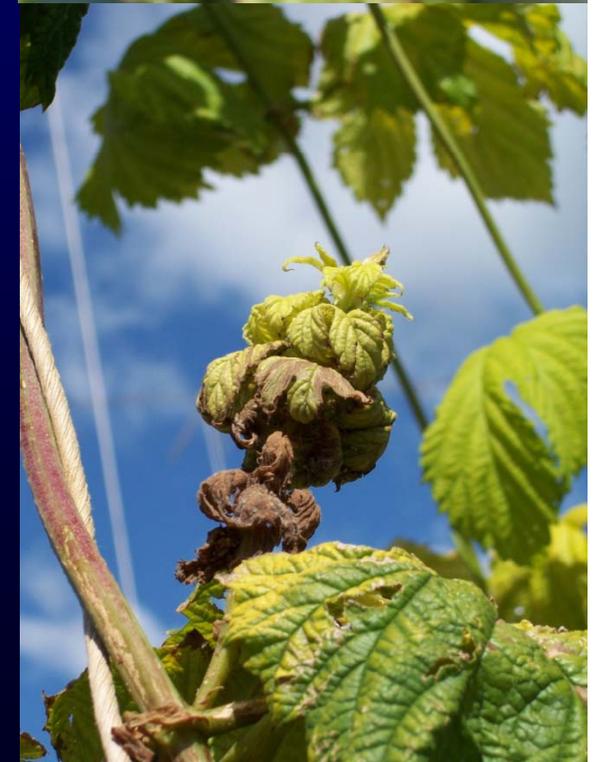


Downy Mildew

- Caused by a fungus-like pathogen related to the cucumber downy mildew pathogen
- May survive in infected plants, perhaps sexual spores in soil
- Spreads easily by airborne spores, infected planting materials, potentially soil/crop debris
- 100% crop loss potential due to plant death, loss of all trained shoots and/or cone infection



B. Englehard



Downy Mildew

“Spikes” on Nugget



Glacier



Lateral Branch Infection



Severe Late Spring Downy Mildew

Columbus



M. Nelson



Leaf Infections



Spores produced on undersides of leaves





Mahaffee et al. 2009



Survival in Systemically Infected Roots and Plants



Johnson et al. 2009



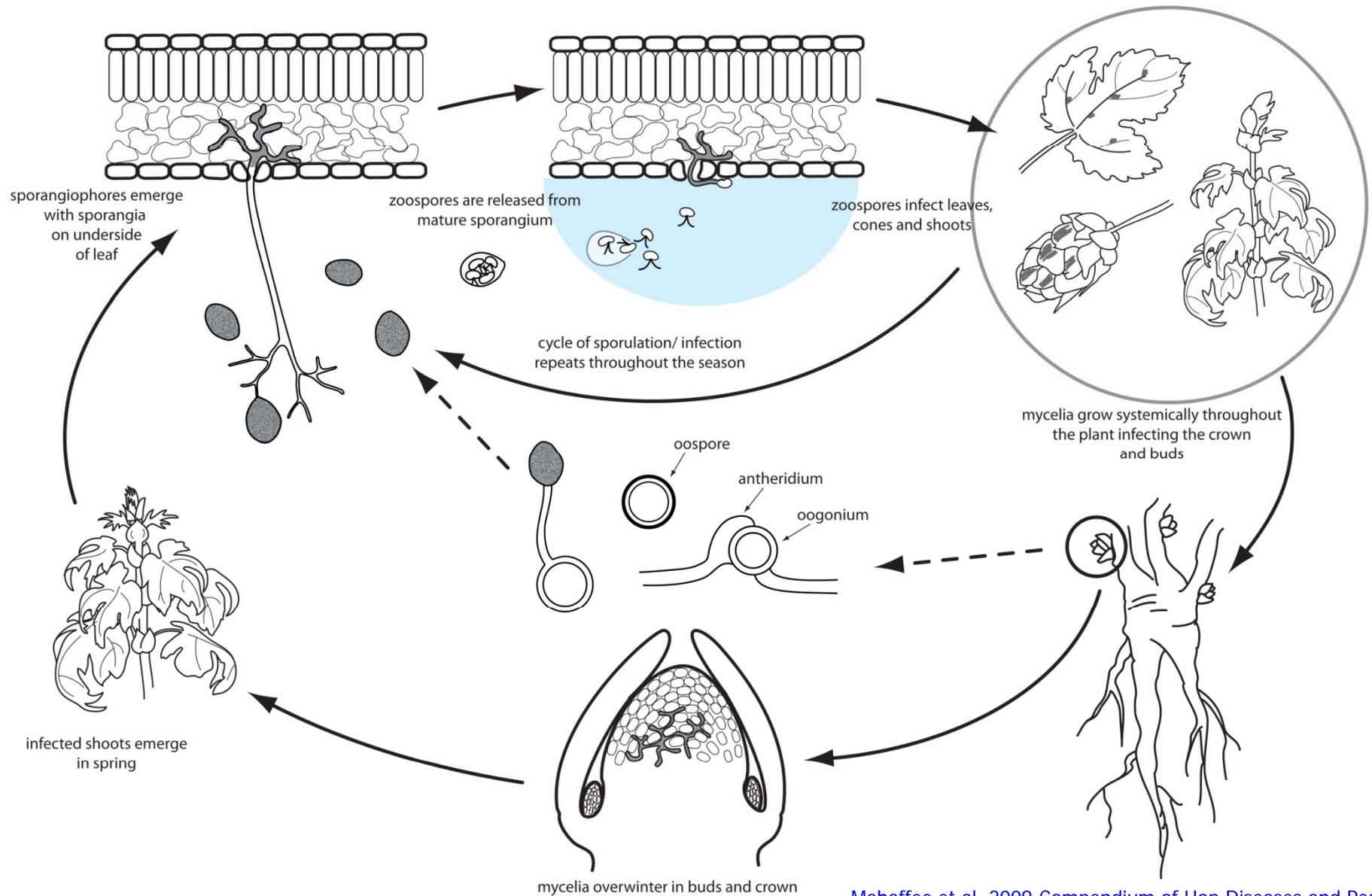
“Primary Infection”



“Secondary Infection”



Downy Mildew Lifecycle

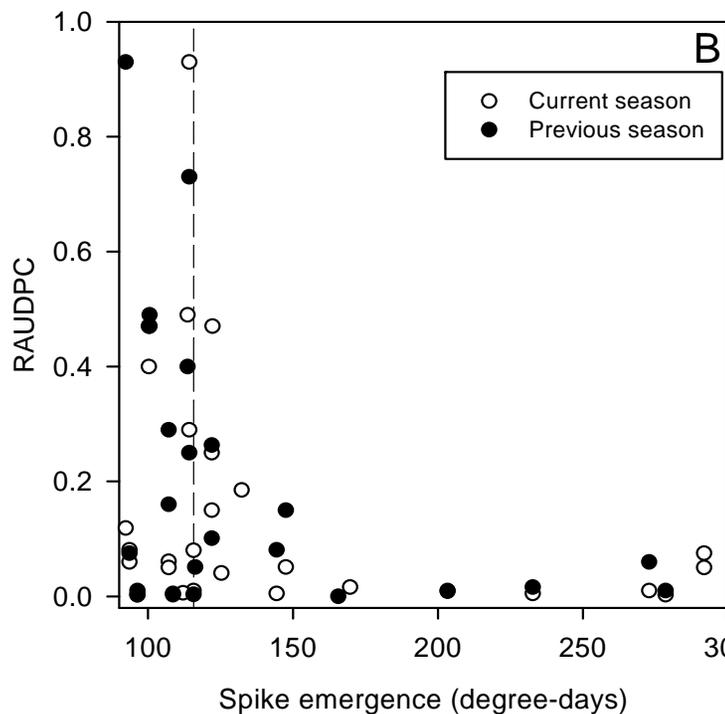
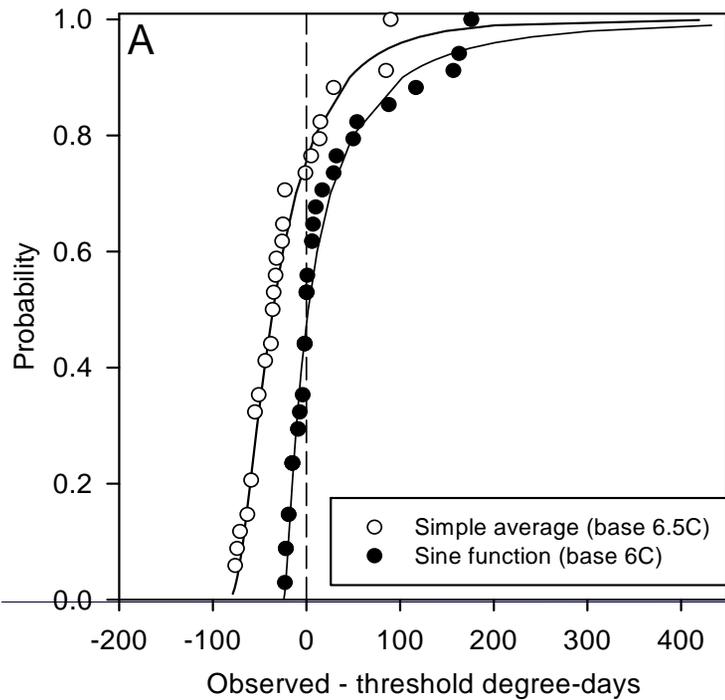


Disease Cycle Begins Shortly After Emergence



Emergence of Spikes Related to Winter/Spring Temperature and Disease Last Year

- On average in OR, first spikes emerge 27 March
- Association between how early spikes emerge and disease severity the previous season

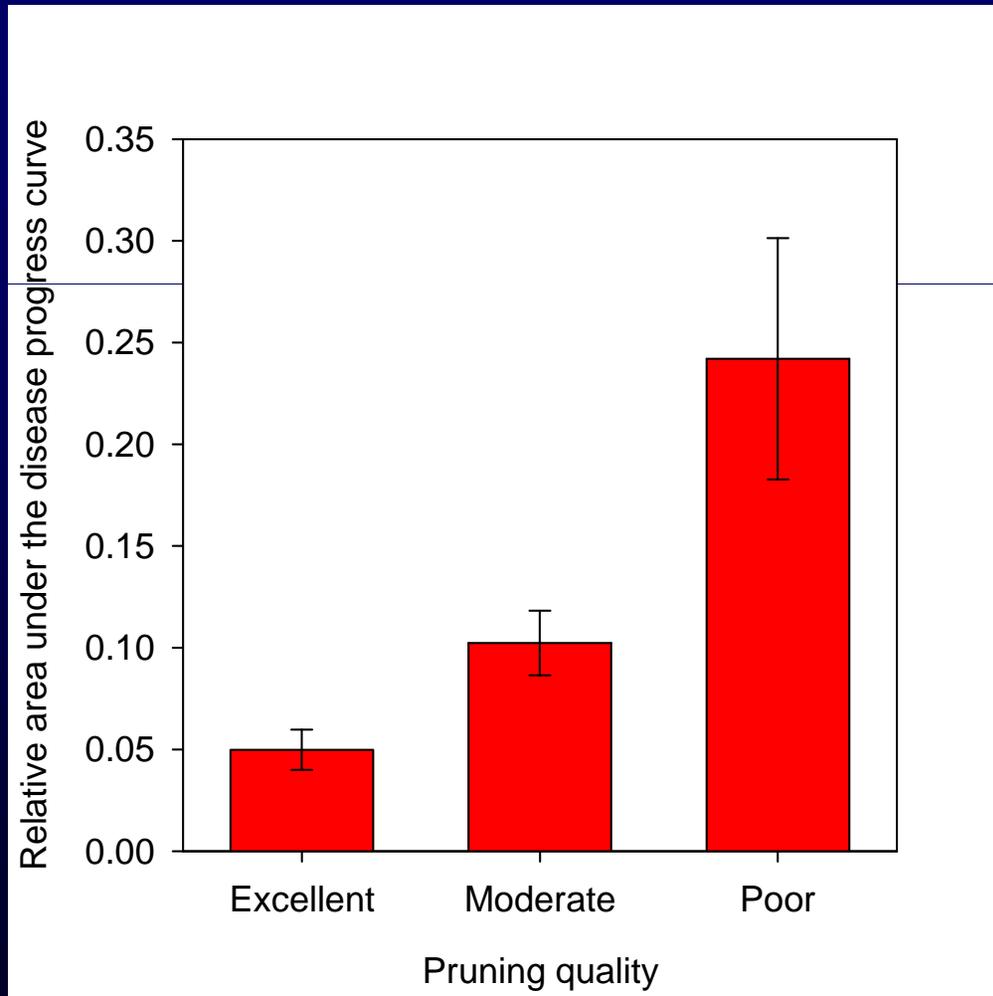




Examples of Pruning Quality



Association of Pruning Quality and Downy Mildew Severity



110 hop yards in Oregon; 2005 -2010



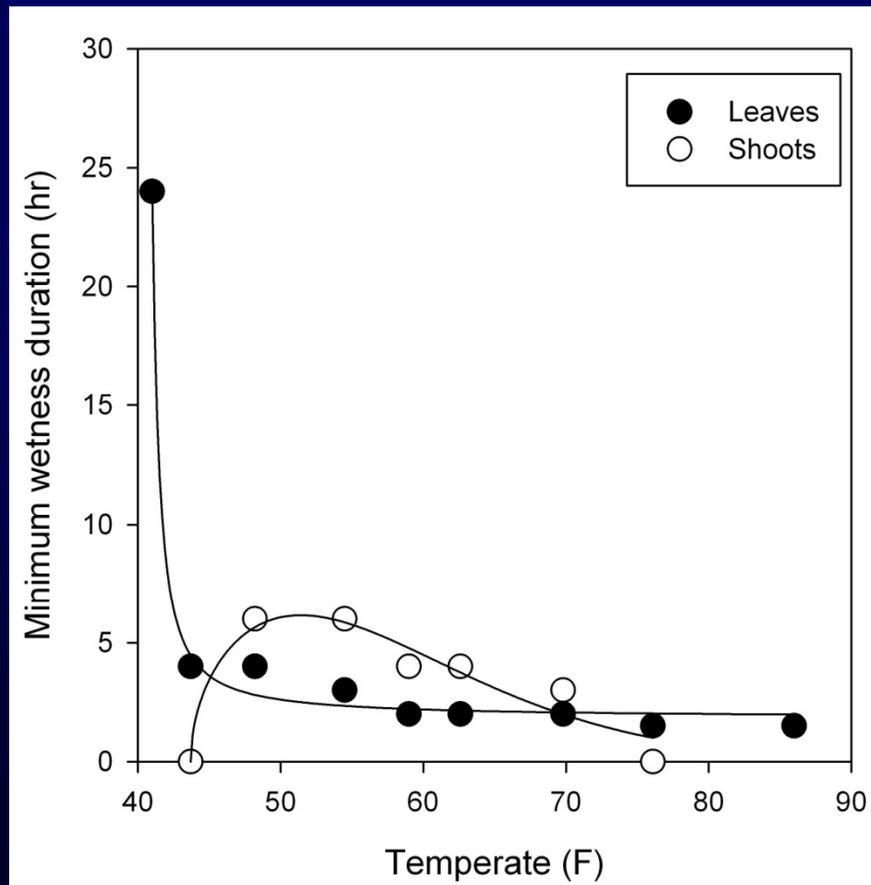


2014 Season: Grand Rapids

- Predicted first spikes emerge in late April; widespread by late May

Date	DDs	Event
4-24-14	174	1% probability of spike emergence
4-30-14	221	50% probability of spike emergence
5-22-14	528	95% probability of spike emergence

Favored by Moderate Temperatures and Wetness

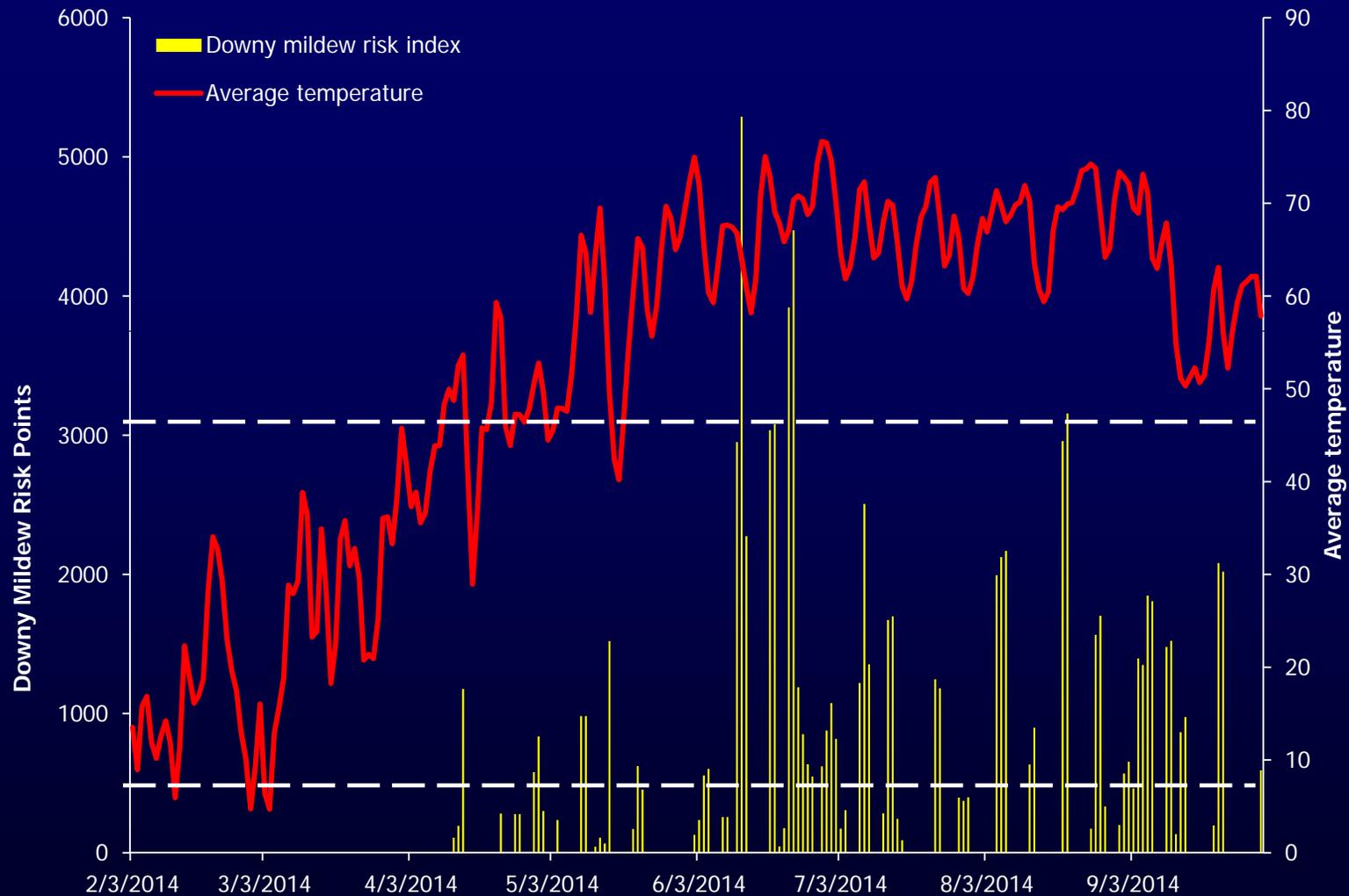


- Leaves:
 - Range of 41-86F
 - 24-1.5 hr wetness
 - Most rapid at 60-76 (1.5-2 wet hr)
- Shoots:
 - Range 48-74F
 - 3-6 hr wetness
 - Most rapid near 70 (3 hr wetness)

Derived from data reported by Royle (1970)



2014 Season: Hudsonville

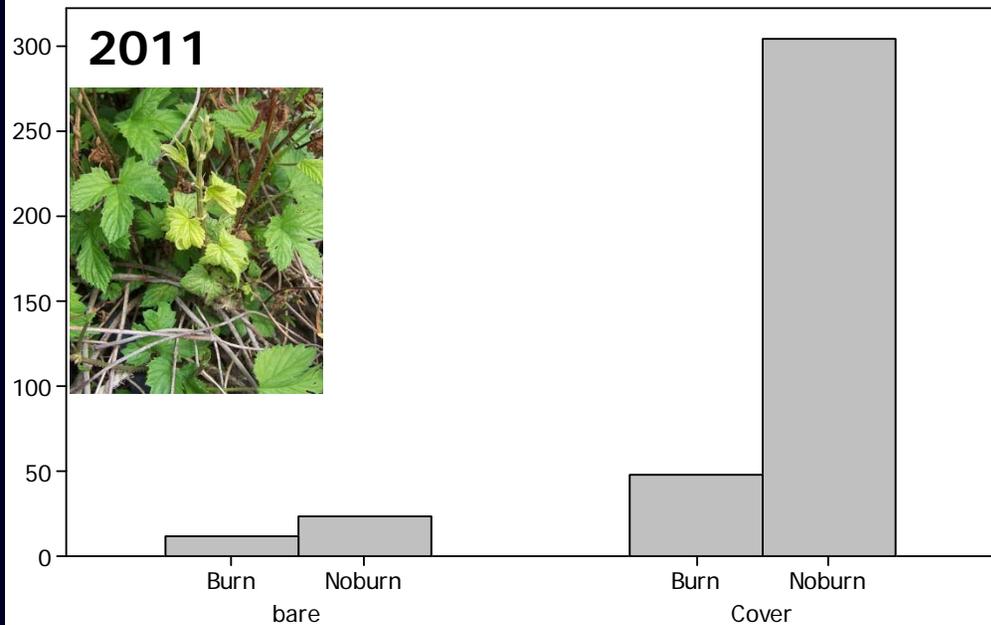
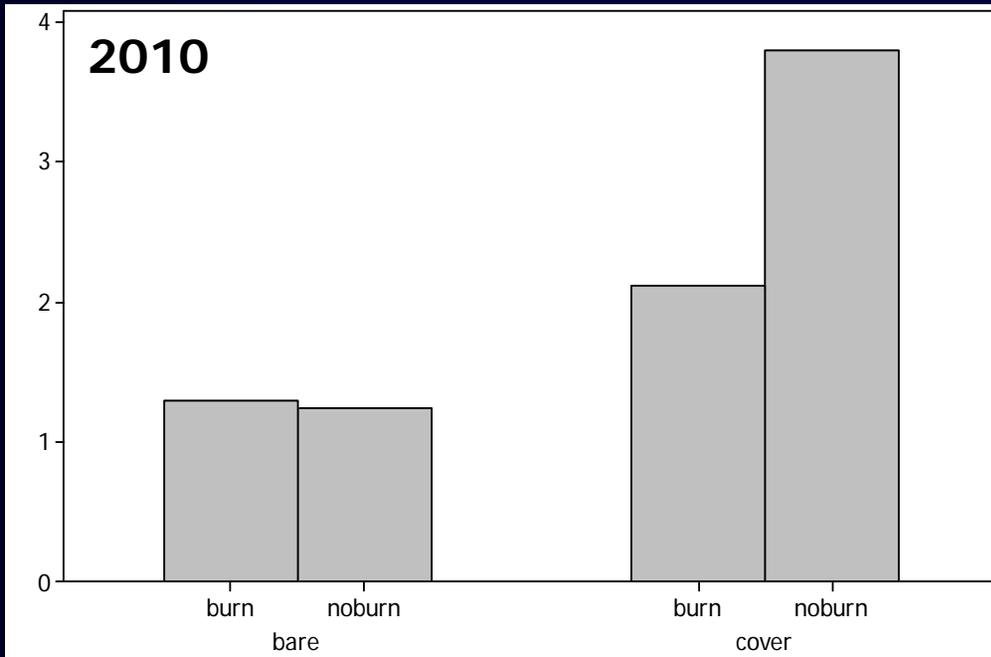


Basal Foliage Removal and Stripping of Lower Leaves





Downy mildew severity



Downy Mildew Control with Canopy Management

- Factors that increase duration of leaf wetness may increase severity of downy mildew





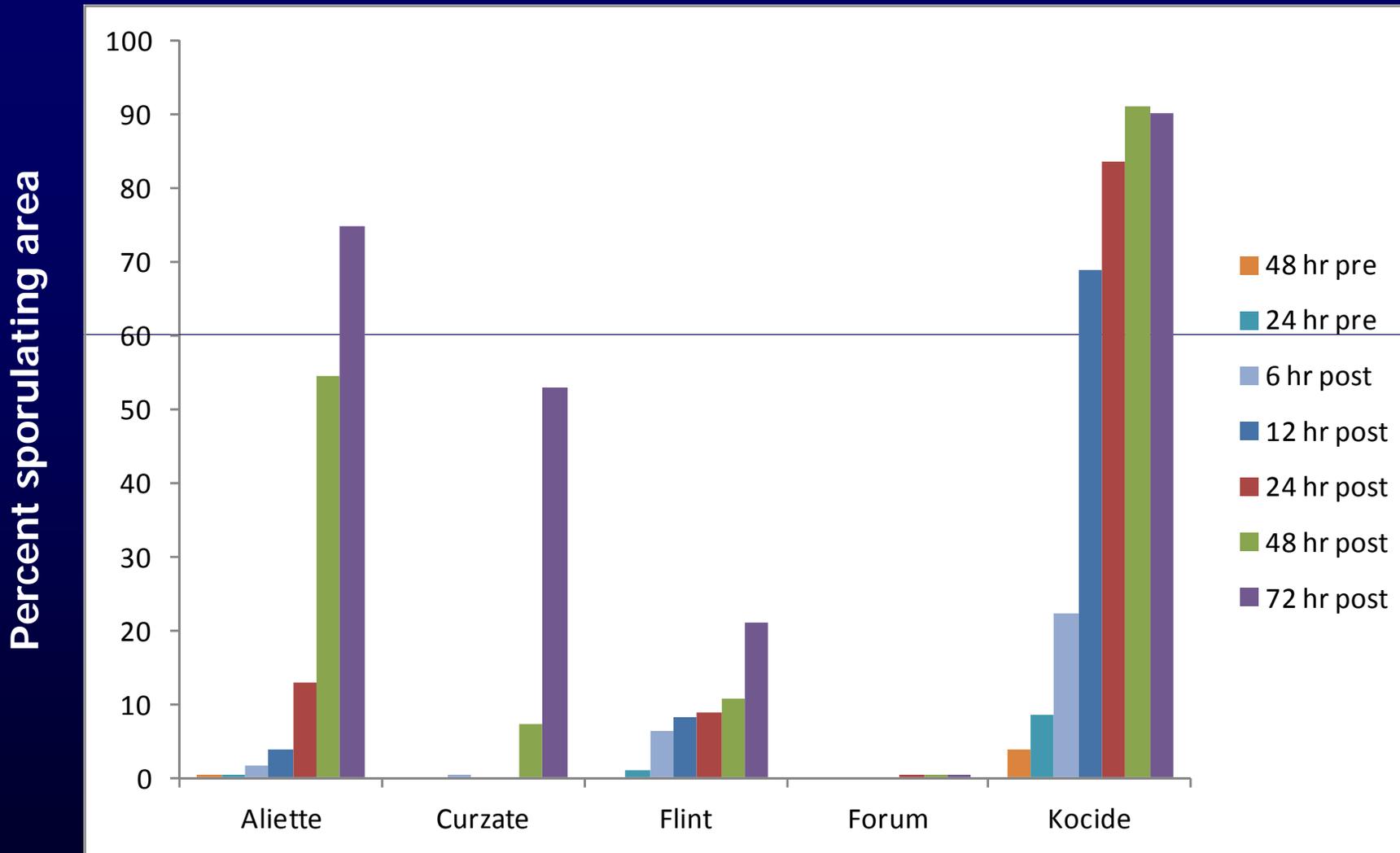
Downy Mildew Fungicides (in PNW)

plant-disease.ippc.orst.edu

Fungicide	Efficacy	Notes
Aliette	Good-Excellent	Resistance problems in Oregon
Copper*	Moderate	Various formulations; organic
Curzate*	Good-Excellent	Timing critical; pH sensitive
Flint	Moderate	Suppression only
Folpan	Moderate	Side effects on powdery mildew
Forum/Acrobat*	Excellent	
Phosphorous acid*	Good	Many products; cross resistance with Aliette, high rates effective
Pristine	Moderate	Suppression only
Ranman	Excellent	
Revus	Excellent	
Ridomil	Excellent	Various formulations; resistance widespread in PNW
Tanos*	Excellent	
Zampro	Excellent	

* Used extensively in PNW

Fungicide Timing is Important



Downy Mildew Management

- Early control measures key
 - Thorough pruning in well establish yards, timely first spray
- Plant disease-free rootstock
 - National Clean Plant Network (www.usahops.org)
- Avoid highly susceptible varieties
 - Susceptible: Columbus, Galena, Centennial, Northern Brewer
 - Tolerant: Perle, Magnum, Fuggie, Newport
- If disease is not widespread, remove severely diseased plants
- Canopy management to reduce wetness/humidity
 - Remove basal growth, weed control, careful use of cover crops, irrigation
- Fungicide applications during disease conducive weather, particularly wet weather > about 42-46F



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270X 10 KV

100u

W. Britton