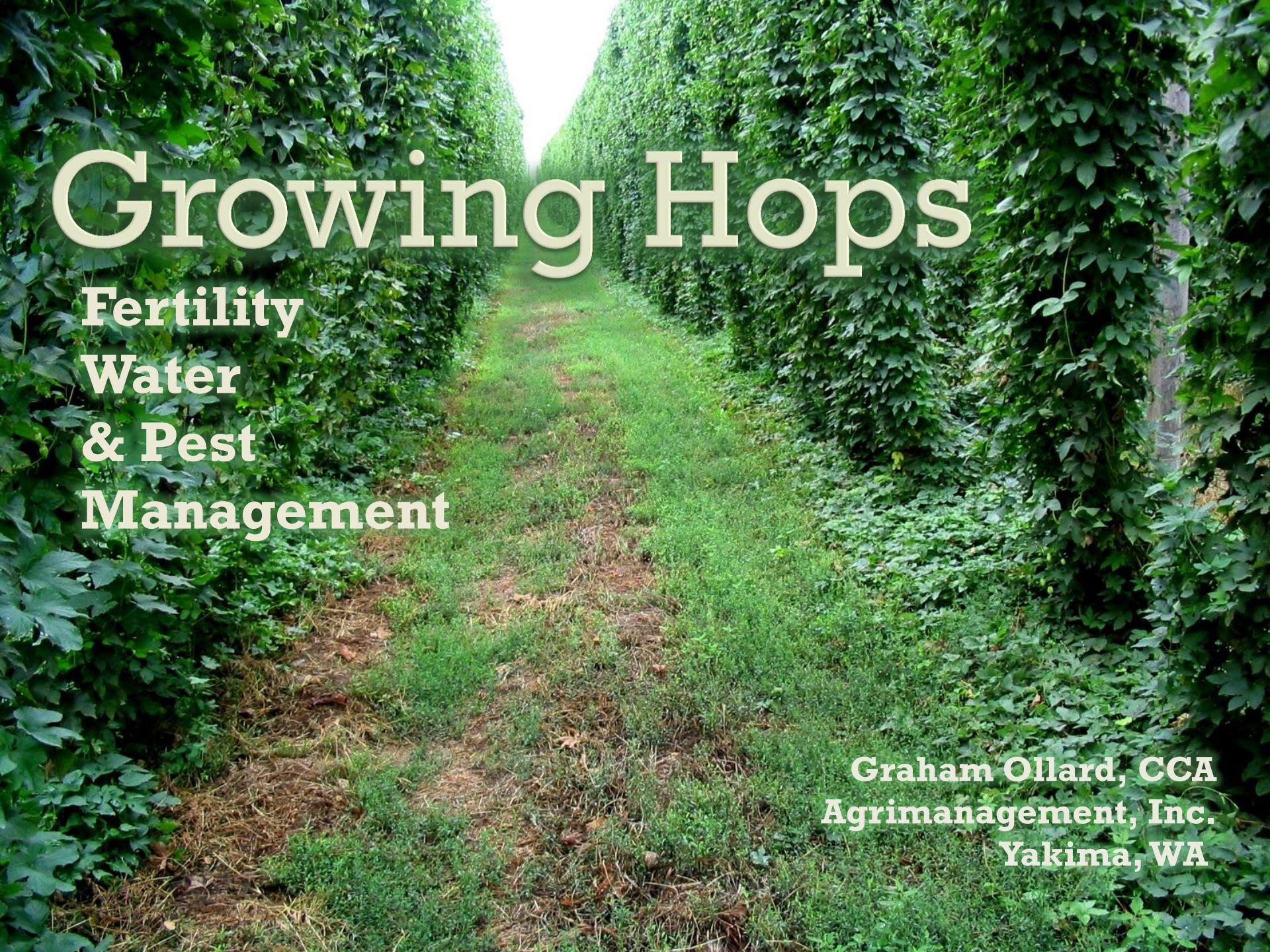

Growing Hops

Fertility
Water
& Pest
Management

Graham Ollard, CCA
Agrimanagement, Inc.
Yakima, WA

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Agrimanagement is an agricultural consulting company that provides production services, independent of product sales, to farmers and orchardists. Our main objective is to enable growers to be more efficient and achieve higher profitability.

- Soil Fertility Sampling
- Irrigation Monitoring
- Pest Management
- In-season Plant Tissue Sampling & Analysis
- Nematode Sampling
- Contract Research

Management

- ~80% of US Hop production is in the Yakima Valley
- Pretty small, isolated industry
- Not much information to be found on growing hops

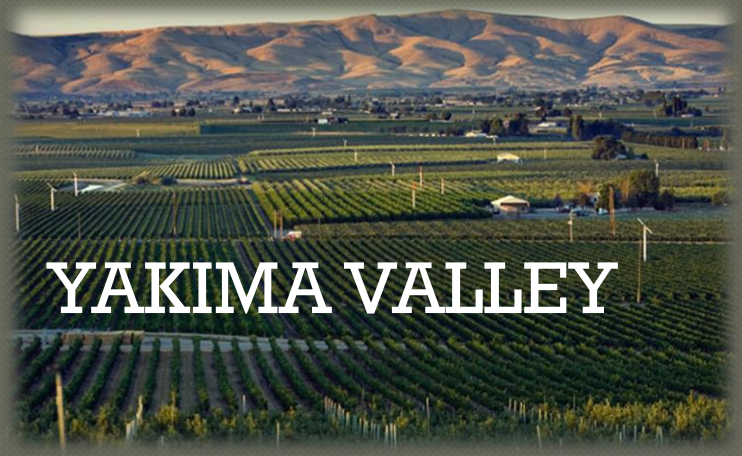
Management

- At 16' The cone branches have been fully determined in the laterals.
- At 12' the apical buds of the vine and the laterals have produced cells predetermined for flowering branches.
- At 3' of growth the apical bud already contains the initial cells for numerous laterals.

Jason Perrault, Perrault Farms, Inc.

Environmental Differences

Environmental Differences



7.98”	Average Annual Precipitation	36.1”
56 - 89˚ F	Average Temperature in July	62 - 81˚ F
23 - 75%	Average Humidity in July	48 - 92%
15.51 hrs	Daylight on Summer Solstice	15.34 hrs
1.5%	Average Organic Matter in Soil	2 - 8%
195 days	Growing Season	120-180 days

Soil Fertility Management

Organic?
Conventional?
Do you work with a consultant or extension agent?

Soil Sampling

- Sample 2-3’ deep
- Fall or Spring
- At least 9-12 cores, more for larger yards
- Account for variation (soil type, topography, field history, etc.)
- Stratified sampling if irrigated by drip or rill
- Keep records!

Fertility

- Expected yields:

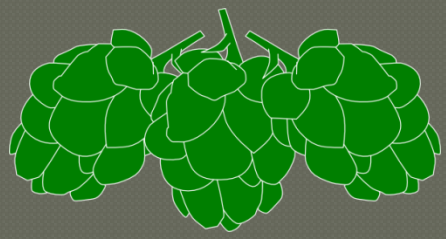
  9-15 bales… big difference

- Crop Removal

Nutrient	10 bales/ac	15 bales/ac
N	245 lbs	275+ lbs
P_2O_5	66 lbs	75 lbs
K_2O	229 lbs	258 lbs

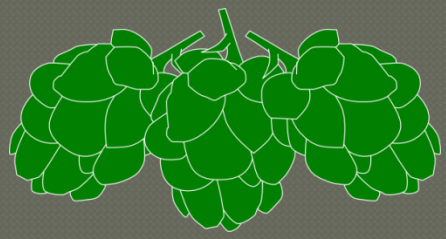
* Roughly 70-75% of nutrient removal is in the vines

- Other Important nutrients to watch
  - Sulfur & Boron: mobile
  - Ca and pH level



Fertility: Nitrogen

- Base level N: 250-275 lbs; VT: 235-250 lbs ?
  - Age: Babies will use a lower base
  - Variety: Aroma vs High Alpha, early cluster vs late
- Deductions
  - Residual N – probably quite low
  - Ammonic N – possibly higher, depending on pH
  - Organic Matter – much higher
  - Efficiency factor of application method
    - Drip
    - Banding or sidecast of fertilizer
  - Returning vines or use of cover crops



Organic Matter & Nitrogen

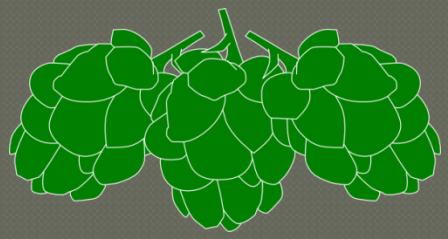
- Yakima Valley:

  [1.5% OM] x [4 million lbs soil (12")] x [5% total N] x [1-5% mineralizing per year] = 30-150 lbs N available

- Champlain Valley:

  [5% OM] x [4 million lbs soil (12")] x [5% total N] x [1-5% mineralizing per years] = 100-500 lbs N available

- Factors to consider for mineralization
  - Maybe only ~50% of applied N is used by crop, other enters N cycle, possibly some loss
  - Soil biology
  - Climate
  - Harvest timing



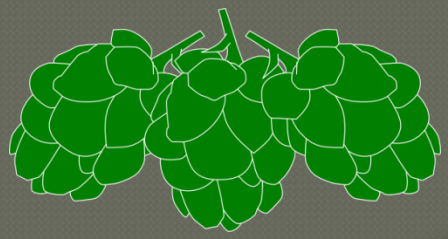
Petiole Sampling

- A general basis for nitrate levels from petiole testing:

  0-6,000 ppm = low
  6,000-10,000 ppm = normal
  10,000+ ppm = plenty

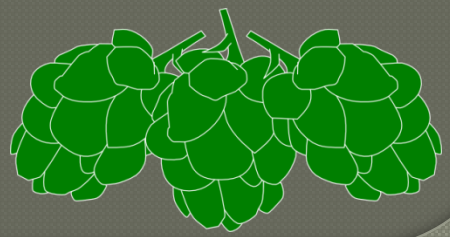
- It is not unusual to see lower or higher numbers in certain varieties, but this is a good basis for varieties like Nuggets.

- Keep records



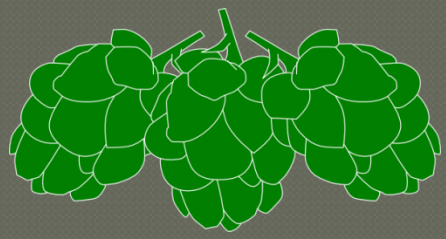
Fertility: P & K

- P: Values over 10 ppm are likely sufficient
  - Soil pH will have some effect P availabiilty
  - Without the return of vines or other amendments, expect a drop of 2 ppm P per year
- K: 190ppm is your critical level for K
  - less than this you will likely want to add anywhere from 100-200 lbs K
  - Without the return of vines or other amendments, expect a drop of 40 ppm K per year.



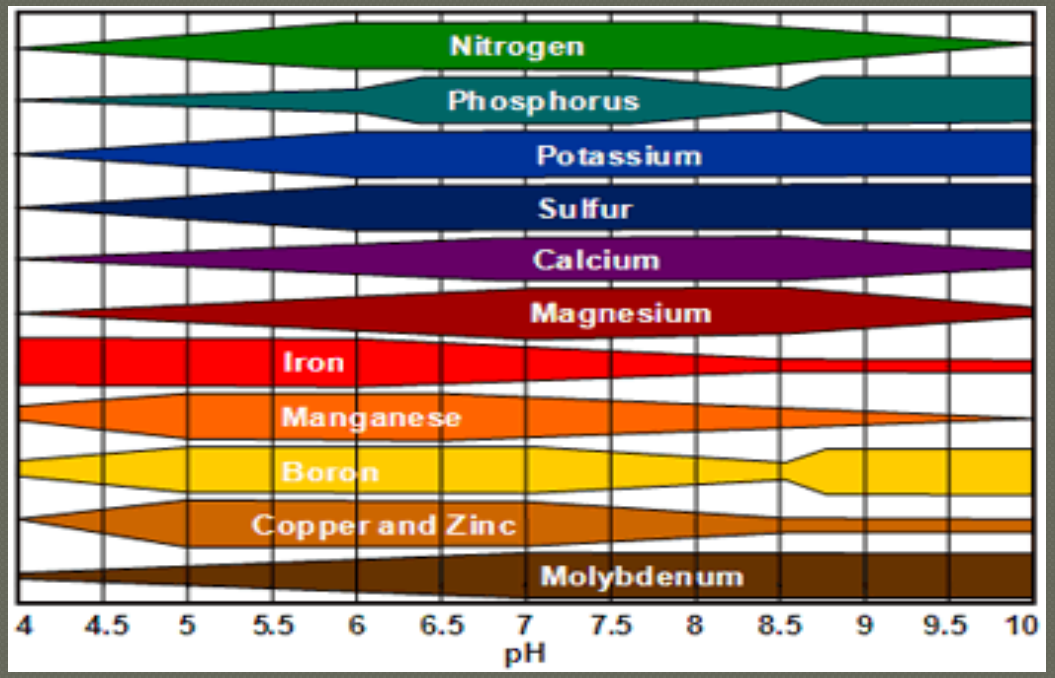
Fertility: Sulfur and Boron

- Mobile nutrients, marginal levels in Fall will likely be even lower come Spring
  - B can be applied as foliar in addition to herbicide spray
  - If B applied as sidecast, watch rates as it will be concentrated over the vine row
  - A good rule of thumb for S is 1/6 of N rate
- High OM can release sufficient levels of nutrients to support crop, but it's important to watch the highly mobile nutrients
- Know your water source if irrigating
  - Some water sources contain a significant amount of S



Fertility: Ca & pH

- Prefer pH: 6.5-7.5
  - pH near 6.0 would consider Ca amendments in form of ag lime
  - UAN-32 commonly applied through drip, 100+ lbs/ season for some growers, based on in-season petiole data



Water Management

Irrigation?
Nitrogation?
Chemigation?

Water-Irrigation

Importance-Use

- Solvent
- Nutrient transport
- Chemical component of photosynthesis and carbohydrate production
- Plant turgidity
- Root growth and distribution
- Evaporative cooling/frost control

Water as an Input Nutrient

- Important considerations:
  - Source
  - Quality
  - Availability

REPORT OF ANALYSIS

Sample Marking: Well water

	mg/l(ppm)	meq/l
Calcium(Ca)	16.7	0.83
Magnesium(Mg)	10.7	0.88
Sodium(Na)	27.2	1.18
Chloride(Cl)	10.2	0.29
Carbonate(CO3)	0.0	0.00
Bicarbonate(HCO3)	210.3	3.45
Sulfate(SO4)	0.2	0.00
Nitrate(NO3)	1.3	0.02

pH @25 C	8.09
Electrical Conductivity(mmhos/cm)	0.38
Total Soluble Salts(ppm)	258.4
Sodium Adsorption Ratio(1)	1.3
SAR-Adjusted(2)	2.2
Total Hardness (as CaCO3) (ppm)	85.8
Bicarbonate Residual	Positive
Boron(B) ppm	<0.1
Potassium(K) ppm	7.2

Soil Properties

Factors affecting the ability of the soil to hold water

- **Texture**: Sand/Silt/Clay
- **Structure**: Aggregation of soil fractions
- **Chemistry**: Amounts of Ca, Mg, K, Na, H, OH
- **Depth**: Rock, compacted zones, high water table…
- **Topography**: Slope

Water-Soil Interactions

- Water Holding Capacity (Soil as a Sponge)
  - There are four levels of soil moisture that reflect water availability
    1. Saturation
    2. Field Capacity
    3. Permanent Wilting Point
    4. Oven Dried (reference)

Soil-Water Interactions

Soil Texture has the greatest affect on a specific soil Water Holding Capacity

Soil Texture	Available Soil Moisture inches/foot
Coarse Sand and Gravel	~0.5
Sands	~0.9
Loamy Sands	~1.1
Sandy Loams	~1.6
Fine Sandy Loams	~2.0
Loams and Silt Loams	~2.4
Clay Loams and Silty Clay Loams	~2.1
Silty Clays and Clays	~1.9

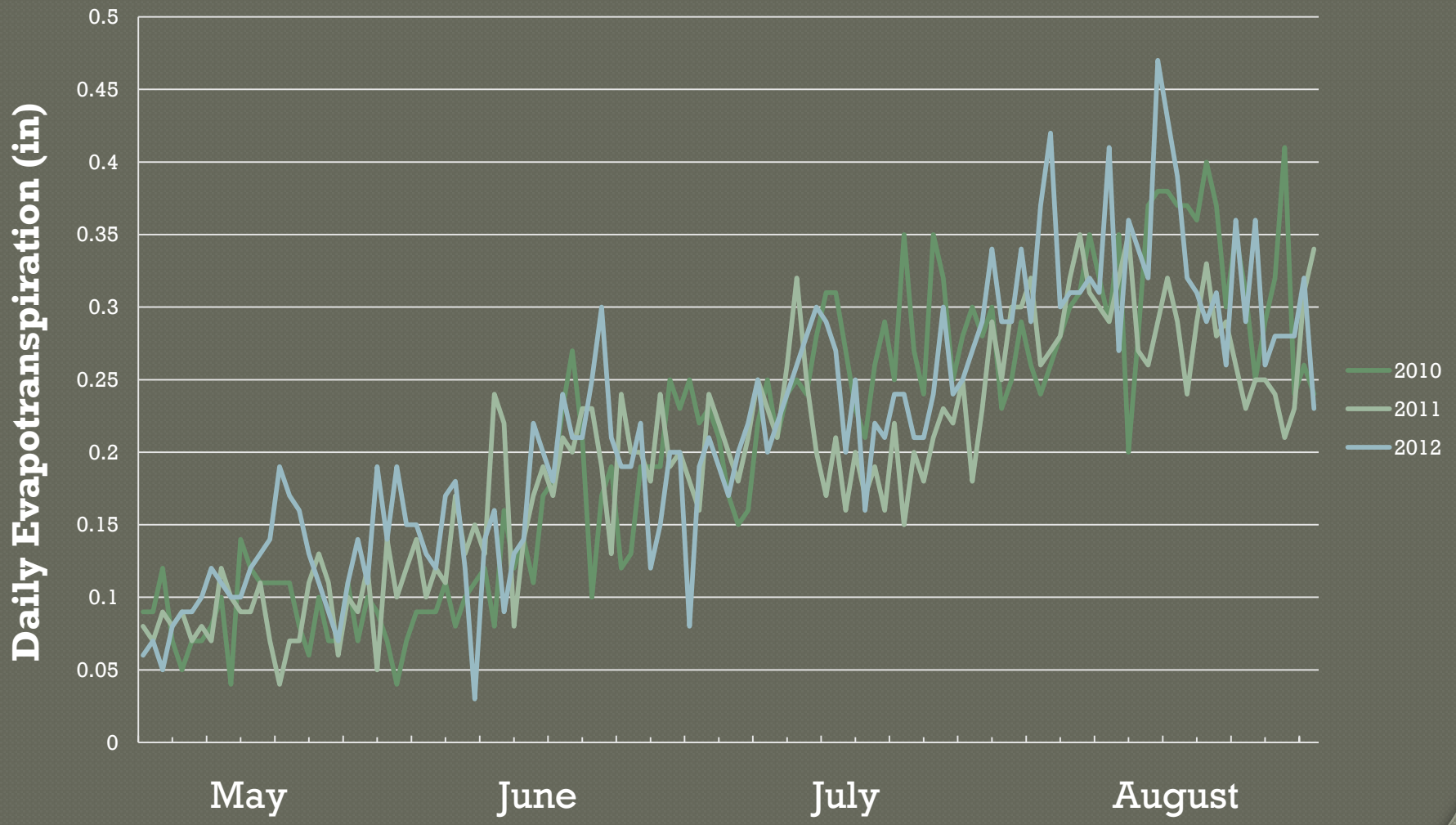
Water Use in Hops

- Early spring (before mid April)
  - No water needed (deep root zone)
- Pre-bloom through early bloom (up to early July)
  - Very little water needed before mid June (75% of water use after mid June)
- Bloom to early cone development (after early July)
  - Mid July (over the wire) = 0.25"/day
- Cone maturation (July 25 to Aug 15)
  - Crop coefficient can be up to 1.15 or 0.45-0.55"/ day
- Total season drip use = 20-28 ac.-in water or 300-450 gal/lb of hop cones.
- Acc. ET: 2010 = 24.97", 2011 = 23.7", 2012 = 26.41"
- Est. for VT based on old Pan Evap. data* = 16.24"

* Data from NOAA website http://www.nws.noaa.gov/oh/hdsc/PMP_related_studies/TR34.pdf

Historical Evapotranspiration Rate

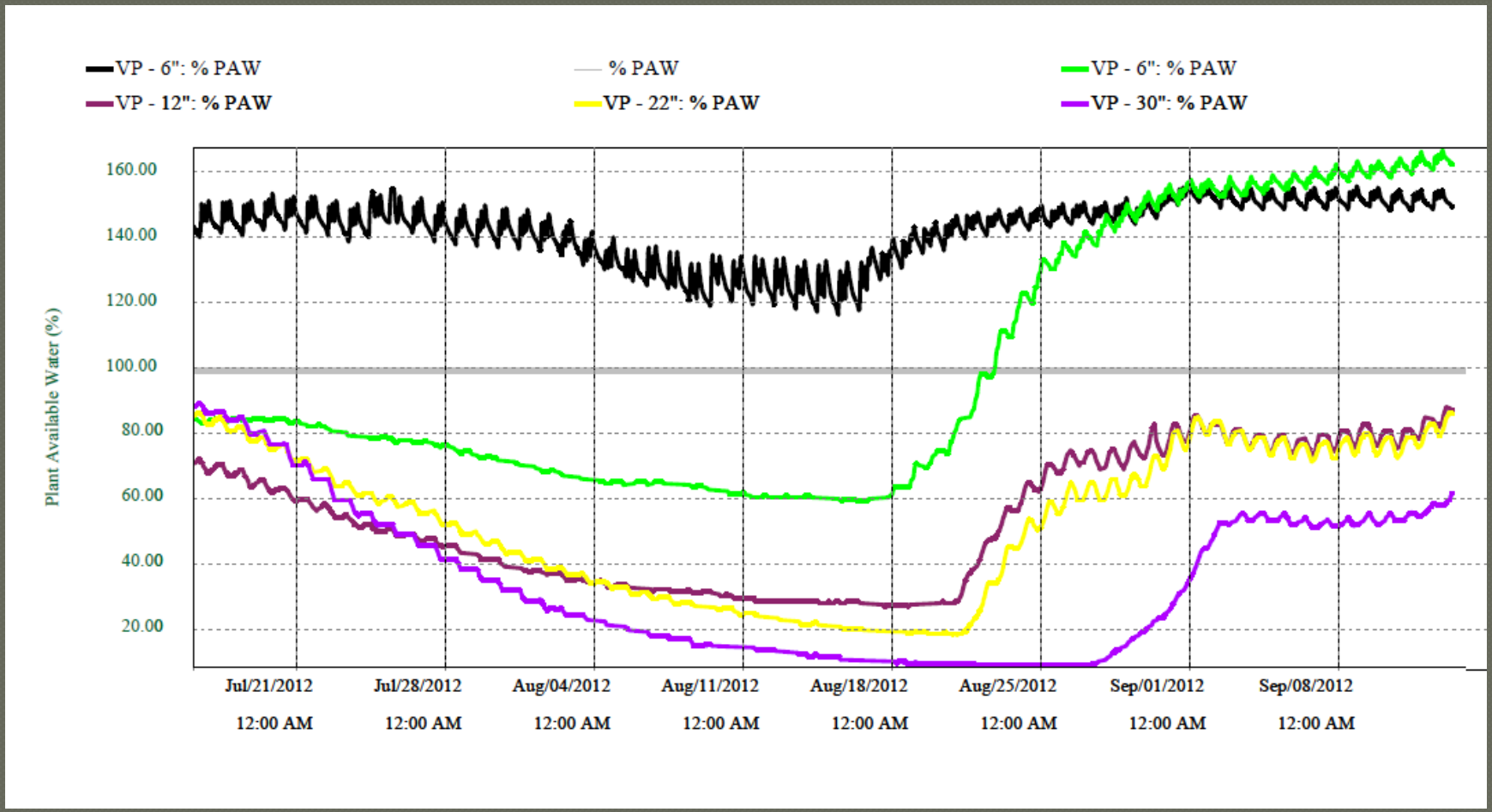
Hops Moxee, WA



* This is the daily ET with a crop coefficient to represent Hops. Data taken from AgWeatherNet.

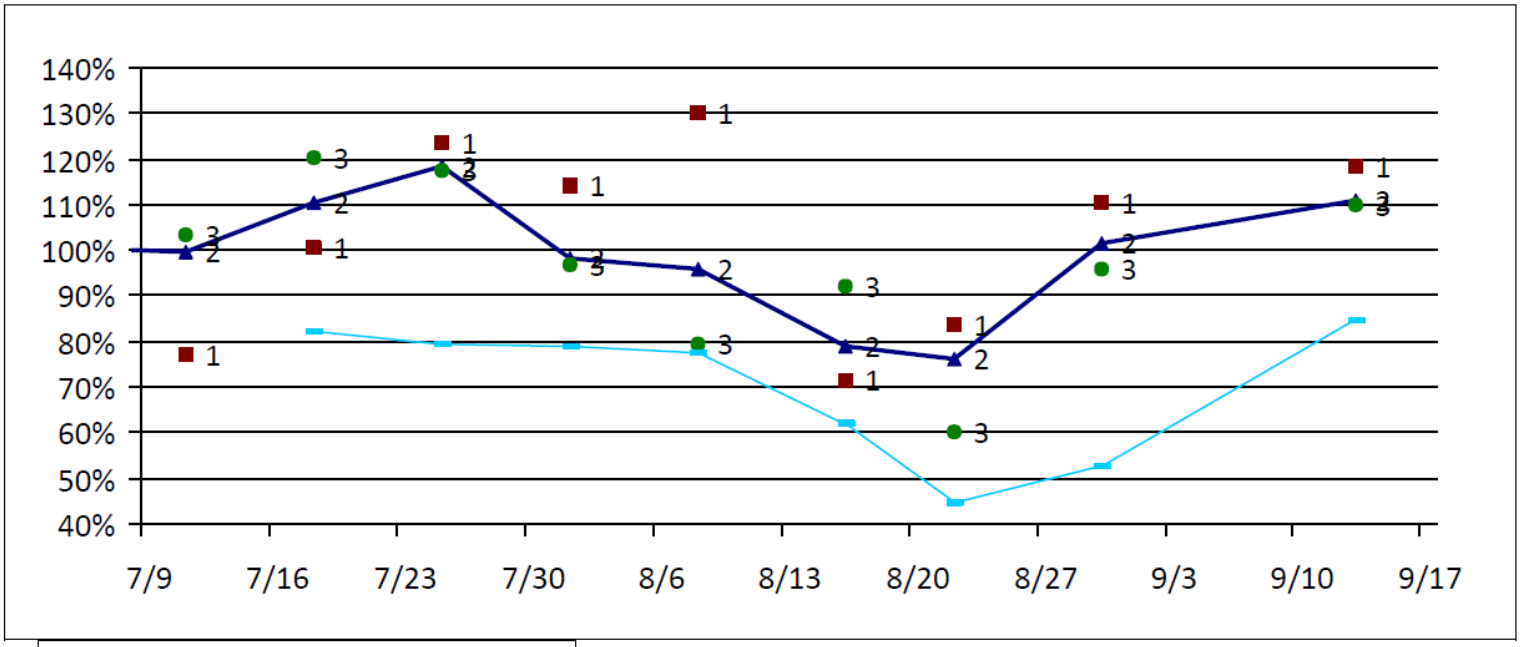
Case Study

Yard 09+10 – Ech2o



Case Study

Yard 09+10 - Gravimetric



Out 24"

Depth	% AW
1'	84%

Sample Strip

Depth	% AW
1'	118%
2'	111%
3'	110%

Out 24"

0.35 in. depletion in ASD

0.35 in. depletion in ERD

Sample Strip

0.77 in. surplus in ASD*

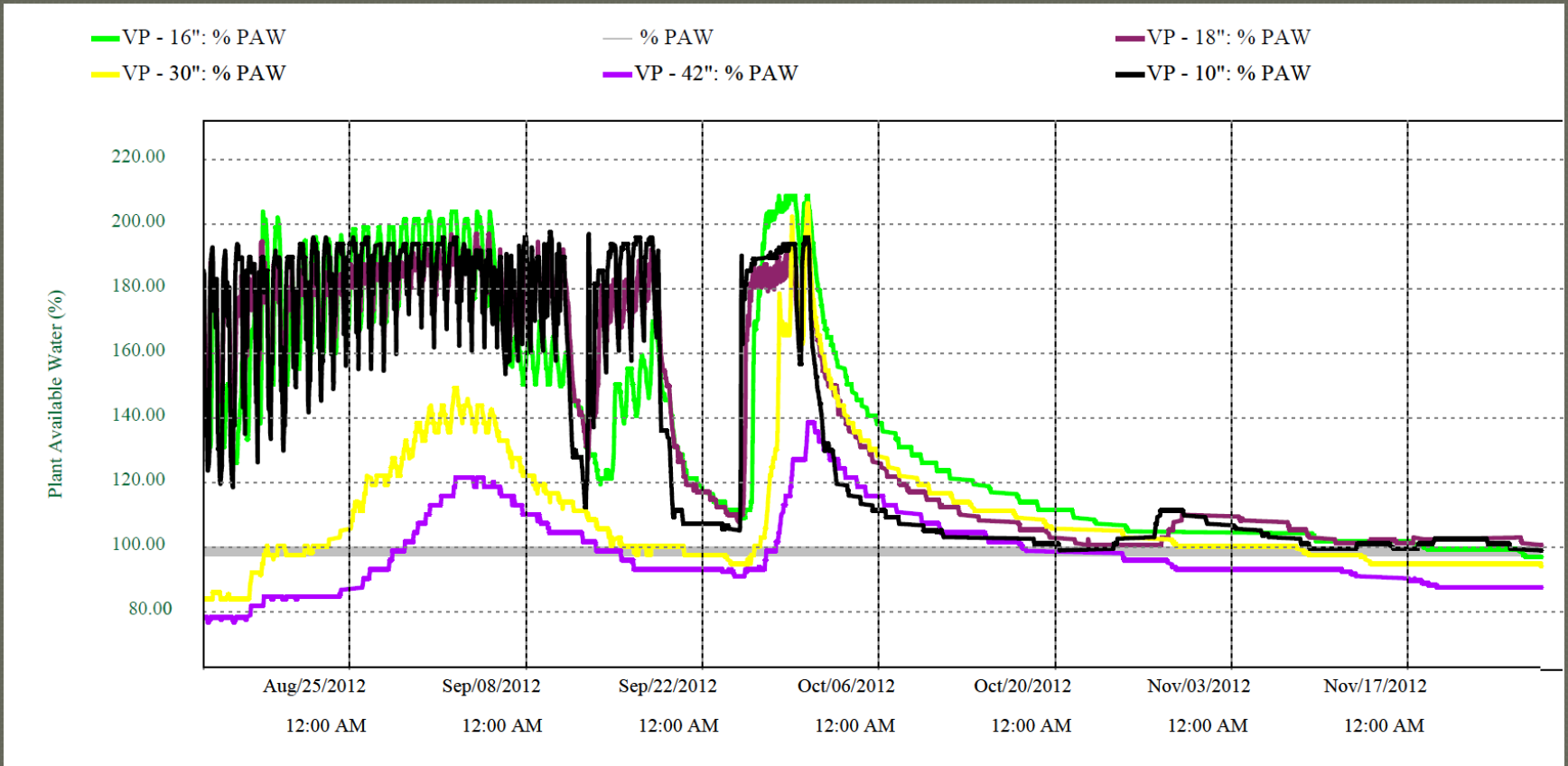
0.88 in. surplus in ERD*

* Surplus above 100% AW.

Avg Sampling Depth (ASD):	2.5
Effective Rooting Depth (ERD):	3.0
Projected Daily Consumptive Use (DCU):	0.16
Projected Weekly Consumptive Use:	1.12

Case Study

Post Harvest



Integrated Pest Management

Pests?
Beneficials?
Organic?

Hop Pests

- Insects:
  Mites and Aphids

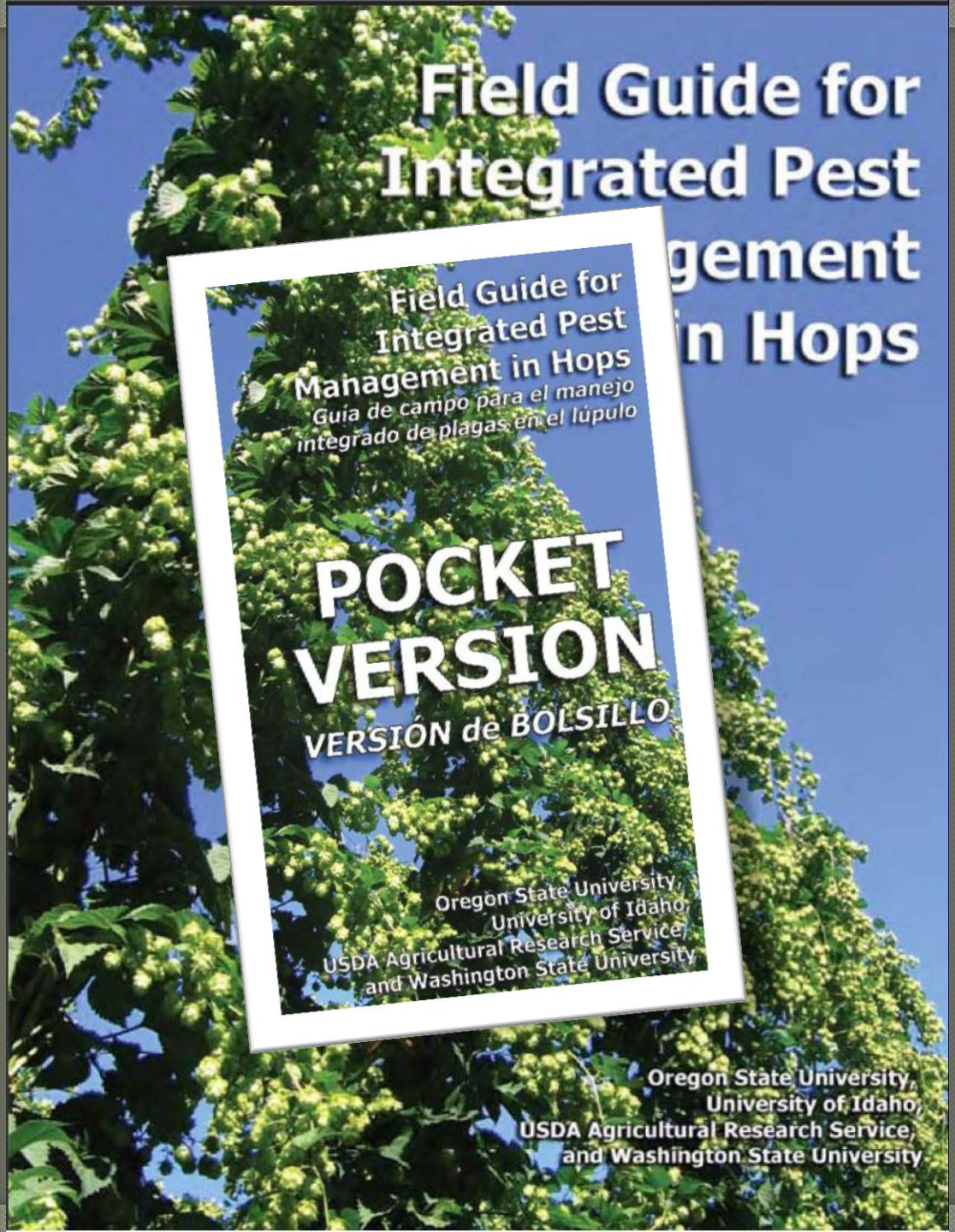
- Fungal:
  Downy Mildew, Powdery Mildew, Fusarium canker, Verticillium wilt, *Alternaria alternata*

- Virus and viroid:
  Apple mosaic virus, Necrotic ringspot, Hop stunt viroid

Properly Identify Issue

Nutrient Issue vs Pest Issue

Download for free!



USAhops.org

Things to Consider

- In general, factors that promote high yield also promote the major diseases and pests
  - High density plantings
  - Heavy fertility and irrigation
  - Rapid plant growth rates that favor flushes of young, succulent tissue
  - High yielding, but susceptible cultivars demanded by brewers

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

David Gent

Things to Consider

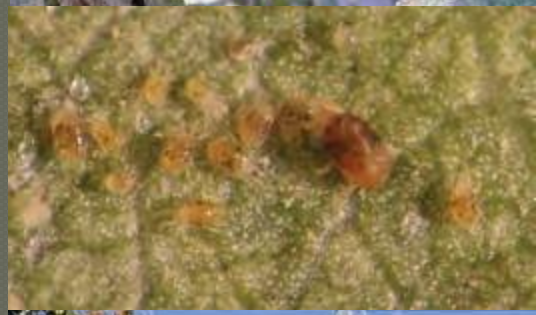
May affect yield and quality; quality defects are more common than yield loss

- Yield impacts:
  - Generally, downy mildew and certain viruses/viroids most likely to cause yield loss
  - Powdery mildew, spider mites, and hop aphid generally reduce yield only in severe outbreaks
- Quality impacts:
  - More difficult to assess; subjective depending on brewer demands and market conditions

Twospotted Spider Mites

Tetranychus urticae

- Survival: Wide host range (180+ species); overwinter as diapausing females (red) on hop crowns and plant/soil debris
- Spread: Can begin laying eggs in as early as 2 days and hatch 2-5 days later
- Yield loss: feeding on leaves and cones mostly lowers quality, but can lead to brewer rejection



Twospotted Spider Mite

Scouting

- Identification:
  - Adult females 1/50" in size; males 3/4 the size of females; eggs clear spheres 1/200" in size
  - Two black spots
  - Overwintering females turn orange-red in fall and lose spots
  - Other signs: webbing and stippling
- Scouting:
  - Hand lens (10x – 20x power); possibly pole pruner
  - Found on underside of leaves and on cones
  - Weekly sampling starting mid to late May
  - Leaves taken 3-6' height in early season; move up towards wire in late June
  - Take several leaves from 10-30 plants depending on field size
  - Focus on known problem areas: areas near roads or areas bordering other problem fields, etc.

Twospotted Spider Mite

Management

- Threshold: (No economic threshold; grower based)
  - June to Early July: 1-2 females per leaf
  - After Mid July: 5-10 adults per leaf
- Cultural Management:
  - Avoid excessive N fertility and water
  - Reduce dust; especially in hot weather
  - Pruning and stripping
  - Support beneficial predatory insects
- Chemical Control
  - Treat to prevent cone infestations
  - Use selective miticides
  - Non-selective miticides/pesticides should be a last resort option
  - Rotate chemical miticide classes to avoid development of resistance
  - Limit use of certain products that "flare" mites (i.e. Sulfur, Rally, Admire)

Twospotted Spider Mite

Chemical Control

Miticide-Class	Efficacy	Notes
Agri-Mek* - 6	Excellent	Older chemical; resistance issues could be a concern
Envidor* - 23	Excellent	Motile stage affected
Acramite* - UN	Good-Excellent	Less residual; Resistance problems seen with poor egg kill
Kanemite - 20	Moderate	
Omite 6 - 12	Excellent	Basal treatment w/ burndown
Fujimite* - 21	Moderate-Good	More effective on low numbers (before 5/leaf)
Savey* - 10	Moderate-Good	Poor effect on adults; quickly degrades in hot weather
Zeal* - 10	Good-Excellent	Better efficacy at higher rates

* Products commonly used in the PNW

Products in the works: Magister (Gowan), Nealta (BASF), Athena (FMC)

Twospotted Spider Mite

Organic Chemical Control

Fungicide	Efficacy	Notes
Sil-MATRIX	Poor-Moderate	Potassium-silicate
Grandevo	Unknown	New; Bacterium; Efficacy relatively unknown
Trilogy	Moderate	Oil-type product
Biomite	Moderate-Good	Poor efficacy in hot weather; also use as for resistance prevention in conventional
Ecotec	Moderate	Oil-type product
Neemix	Moderate	Oil-type product
GC Mite	Moderate	Oil-type product
Insecticidal Soaps	Moderate	
Oils	Moderate	

Hop Aphid

Phorodon humuli

- Survival: overwinter as eggs on ornamental and agricultural species of the genus *Prunus,* (plum, cherry plum, sloe, and damson)
- Spread: winged aphids arrive to hop plants in early May and produce wingless asexual females
- Yield loss: feeding on leaves and cones affects quality and severe infestations can reduce yield; they also vector viruses

Hop Aphid
Scouting

- Identification:
  - Small (1/20 – 1/10”), pear-shaped, soft-bodied insect in winged and wingless form
  - Wingless: pale lighter green
  - Winged: darker green to brown or black
  - Cornicles or “tailpipes” on abdomen

- Scouting:
  - Pole pruner for mid-late season
  - Often found on underside of leaves and on cones, but in high density can be on petioles and tops of leaves as well
  - Can use yellow sticky traps for early detection, otherwise start weekly sampling in May once minimum daytime temperature exceed 58-60° F
  - Same sampling procedure as for mites and can be done in conjunction

Hop Aphid
Management

- Threshold: (No economic threshold; grower based)
  - Average 5-10 adults per leaf warrants some form of control
- Cultural Management:
  - Avoid excessive N fertility and water
  - Pruning and stripping
  - Support beneficial predatory insects
  - Avoid having winter host species nearby

- Chemical Control
  - Time sprays for prevention
  - Use selective pesticides
  - Non-selective pesticides should be a last resort option
  - Rotate chemical classes to avoid development of resistance
  - Superior-type oil applied to winter hosts during the dormant or delayed-dormant period may reduce the number of spring migrants into hop yards

Hop Aphid

Chemical Control

Aphicide-Class	Efficacy	Notes
Fulfill - 10	Excellent	Apply before damaging levels; possible side effects on mites
Neemix -	Good-Excellent	
Ultor- 23	Good	Also has mite and nematode suppression
Onyx - 3	Excellent	
Beleaf - 10	Good-Excellent	
Platinum - 4	Excellent	Long PHI (65 days)
Admire Pro* - 4	Excellent	Long PHI (60 days); possible side effects on mites; was Admire and Provado
Insecticidal Soaps	Moderate	Continued use necessary for effectiveness

* Most common use in PNW

Beneficials Insects

Beneficial Insects

- Rely on selective miticides to reduce impact on natural enemies.
- Use of attractants: Herbivore-Induced Plant Volatiles (HIPVs)
  - methyl salicylate, (Z)-3-hexenyl actetate, etc. are NOT organic!
- Release (usually 2-3 times every 1-2 weeks):
  - Lady Beetles: $80/gal = 72,000
  - Predators Mites: $6/1,000
  - Aphidius: $40-60/ 500 or 1,000
  - Aphid Midge: $40-50/ 1,000
  - Lacewings $6/ 1,000 eggs, $55/500 adults

Beneficial Insects

Release Schedule

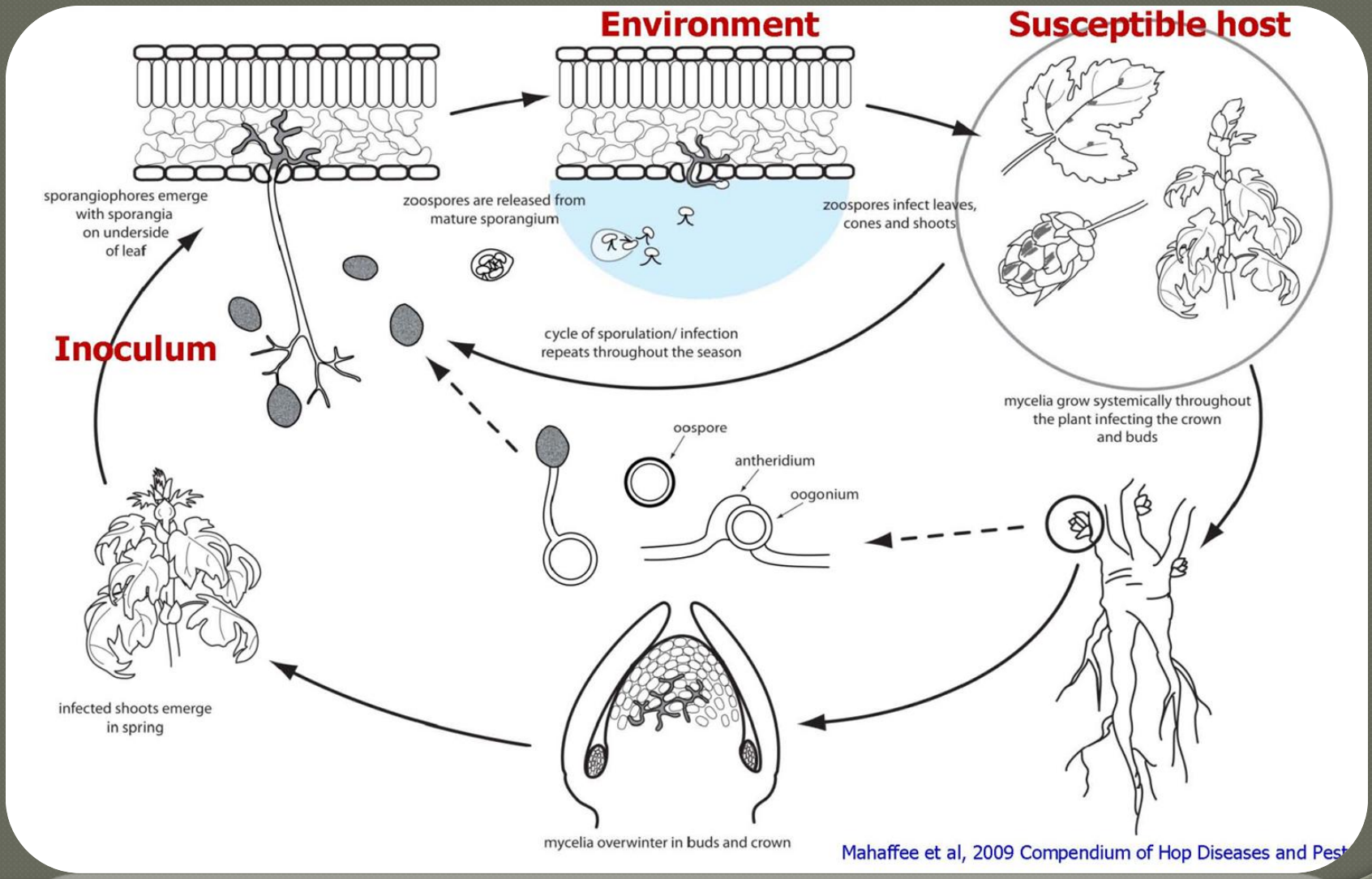
Lady Beetle Insertion Dates			Lacewing Insertion Dates			Predator Mite Insertion Date		
	$40-100/ac			Eggs $3-10/ac			$25-80/ac	
6/28/2012			**6/28/2012**			**6/29/2012**		
DH048 (6 ac)	4 gallons		DH048 (6 ac)	10K		DH048 (6 ac)	80K	
RH043 (37 ac)	9 gallons		RH043 (37 ac)	20K		RH042* (40 ac)	75K	
DH060 (20 ac)	9 gallons		DH060 (20 ac)	20K		RH043 (37 ac)	150K	
						DH060 (20 ac)	150K	
7/12/2012						RH069* (28 ac)	115K	
DH048 (6 ac)	4 gallons							
RH043 (37 ac)	9 gallons					* Baby fields in 2012, may not all be inserted in one visit but at a couple weeks apart.		
DH060 (20 ac)	9 gallons							

Downy Mildew

Pseudoperonospora humuli

- Survival: Overwinters in infected dormant buds and crowns, perhaps sexual spores in soil
- Spread: Airborne spores, infected planting materials soil/crop debris
- Yield loss: Yield and quality loss can vary from undetected to nearly 100% loss with significant cone infection or plant death from crown rot.

Downy Mildew



Downy Mildew

PRIMARY INFECTION

- Systemic
- Soil/plant debris
- Appears as "spike" on crowns
- Environment: Range 48-74° F, 3-6 hr wetness (most rapid near 70° F)

SECONDARY INFECTION

- Airborne spores
- Appears on leaves and cones
- Environment: Range of 41-86 ° F, 24-1.5 hr wetness (most rapid at 60-76° F & >90% humidity)

Downy Mildew

Management

- Plant disease-free rootstock
  - National Clean Plant Network (www.usahops.org)
- Avoid highly susceptible varieties
  - Susceptible: Columbus, Galena, Centennial, Northern Brewer
  - Tolerant: Perle, Magnum, Fuggle, Willamette
- Remove and destroy severely diseased plants
- Early control measures key
  - Thorough pruning (remove all basal foliage) as late as possible, timely first spray, stripping, train early to prevent contact with soil
- Canopy management to reduce wetness/humidity
  - Remove basal growth, stripping, weed control, careful use of cover crops and irrigation (no overhead use until July)
- Fungicide applications during disease conducive weather, particularly wet weather > about 42-46F

Choosing Hop Varieties

Susceptibility	Downy Mildew	Powdery Mildew	Verticillium Wilt
High	Columbus	Columbus	Willamette
	Galena	Glacier	Fuggle
	Nugget	Galena	Nugget
	Glacier	Chinook	Mt. Hood
	Mt. Hood	Perle	(Columbus)
	Centennial	Centennial	(Centennial)
	Golding	Golding	(Golding)
Intermediate	Chinook	Brewers Gold	(Sterling)
	Cascade	Sterling	(Glacier)
	Brewers Gold	Willamette	Cascade
	Sterling	Fuggle	Brewers Gold
	Willamette	Mt. Hood	Perle
	Fuggle	Cascade	Galena
Low	Perle	Nugget	Chinook

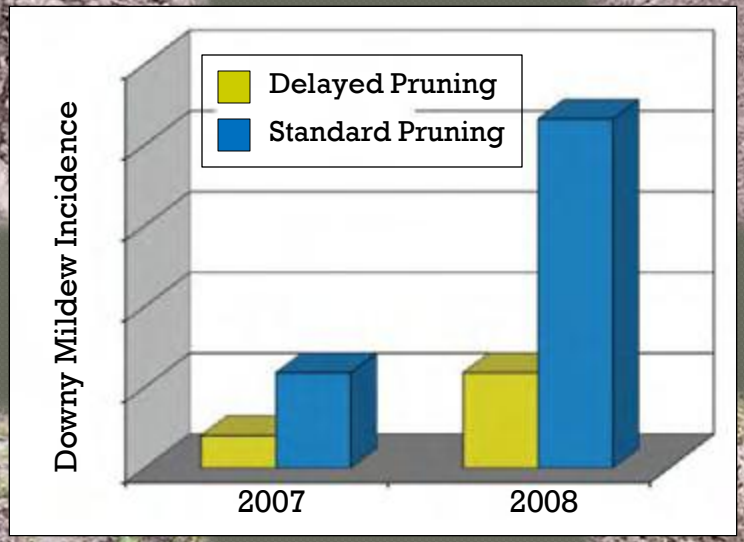
Derived from Field Guide for Integrated Pest Management in Hops and David Gent, OSU

Downy Mildew

Management: Pruning Quality and Timing

Good Mechanical Pruning

Bad Mechanical Pruning



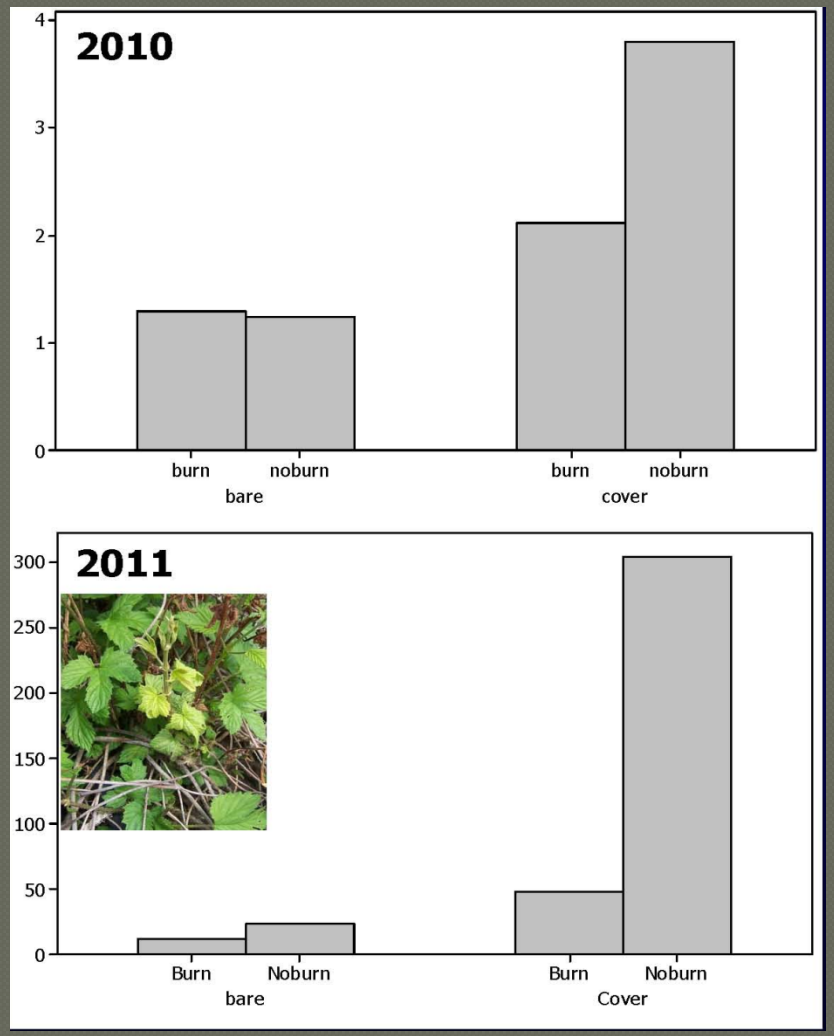
David Gent, OSU

Good Chemical Pruning

Bad Chemical Pruning

Downy Mildew

Management: Stripping and Burning



David Gent, OSU

Downy Mildew

Chemical Control

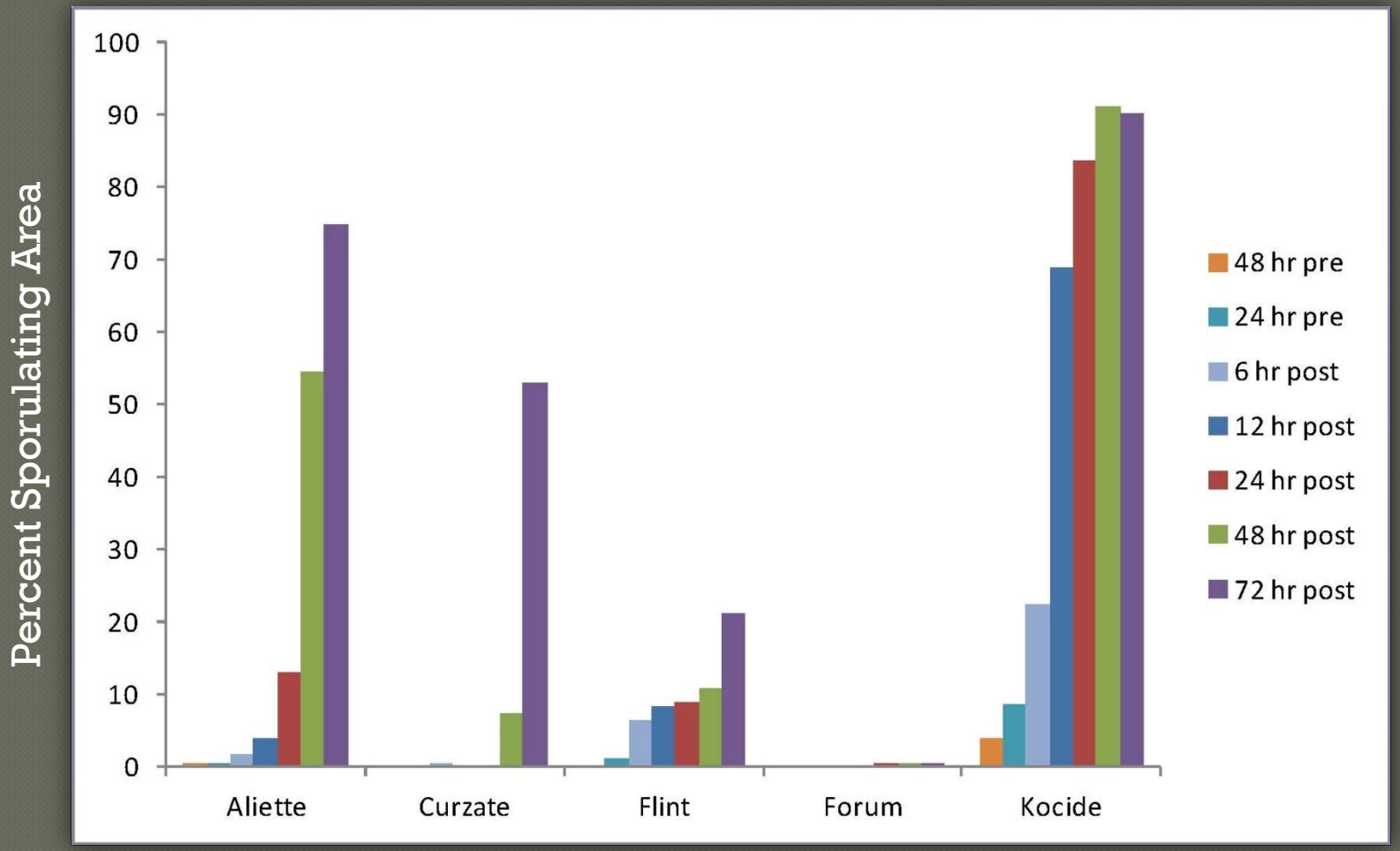
Fungicide	Efficacy	Notes
Copper*	Moderate	Various formulations; organic
Curzate*	Good-Excellent	Timing Critical; pH sensitive
Phosphorous acid*	Good	Many products; cross resistance with Aliette; high rates effective
Tanos*	Excellent	
Aliette	Good-Excellent	Resistance problems in OR
Forum/Acrobat*	Excellent	
Flint	Moderate	Suppression only
Pristine	Moderate	Suppression only
Regalia	Good	Organic/OMRI approved
Ridomil	Excellent	Various formulations; resistance widespread in parts of PNW

* Products used extensively in the PNW

David Gent, OSU

Downy Mildew

Chemical Control Timing



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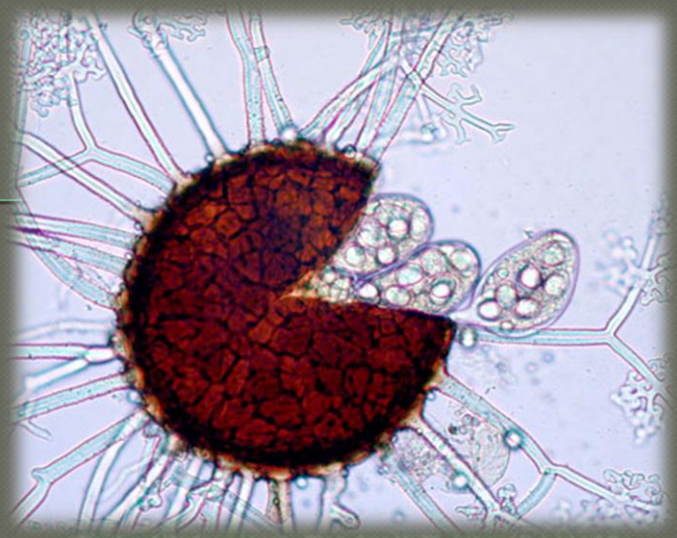
Powdery Mildew

Podosphaera macularis

- Survival: In the PNW it only overwinters on infected dormant buds and crowns (live tissue), but where sexual mating occurs there is potential for over wintering structures, called cleistothecia, to form and survive in and on crop debris and soil.
- Spread: Airborne spores, leaf/buds of infected planting material, and where mating occurs, on soil/crop debris
- Yield loss: 20-80% but PM is mostly a quality problem on aroma hops

Powdery Mildew

Cleistothecia = Sex Structure



- PM Spore types:
  MAT 1 and MAT 2
- MAT 1 + MAT 2 = Cleistothecia
- PNW: 183 isolates tested (41 from Nugget (R6) Variety); only MAT 1 found
- Other hop PM isolates tested from Maryland, New York, England, & Germany
  - Isolates tested pretty much 1:1 ratio of MAT 1: MAT 2

Powdery Mildew
Management

- Select resistant varieties, if possible
  - Susceptible: Columbus, Glacier, Perle, Galena, Northern Brewer
  - Resistant/Tolerant: Nugget, Fuggle, Cascade
- Early control measures key
  - Thorough pruning as late as possible, timely first spray, stripping
- Canopy management to reduce humidity and increase light
  - Avoid excessive nitrogen fertility
  - Mid- and late-season basal growth control
  - Increase light penetration—plant spacing/orientation
- Fungicide applications during flowering and cone development helpful to minimize cone infection
- Early harvest can minimize crop loss when powdery mildew is present

Powdery Mildew

Chemical Control

Fungicide	Efficacy	Notes
Flint*	Good-Excellent	Downy Mildew Suppression
Orius/Folicur*	Good	Possible plant growth regulator
Pristine*	Excellent	Downy Mildew Suppression
Qunitec*	Excellent	July 15-20 cutoff for EU hops
Rally/Sonoma	Good	Possible plant growth regulator; side effects on mites
Procure	Good	
Regalia	Good	Organic/OMRI approved
Sulfur*	Good-Excellent	Timing and interval critical; side effects on mites; organic
Bicarbonates	Moderate	
Oil	Moderate	Possible phytotoxicity

* Products used extensively in the PNW

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Powdery Mildew

Chemical Control Timing

Average Color

3.8	4.1	7.6	6.3	8.0

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10
9
8
7
6
5
4
3
2
1

Virus and Viroids

- Many in EU that are not in the U.S. yet
- Plants can be infected without showing symptoms for several years
- Symptoms often brought on by environmental influence (drastic changes in temp.)
- Most spread through propagation; some vectored by insects, or spread by cultural practices (mechanical pruning)
- Management:
  - Use certified planting stock
  - Chemical pruning (contact herbicides) vs. mechanical
  - Sanitize equipment
  - Aphid control
  - Remove and destroy infected plants

Resources

- Agrimanagement, Inc. Library

  The Agrimanagement library is an accumulation of knowledge and experience gained over the years involved in the industry.
- Field Guide for Integrated Pest Management in Hops. A Cooperative Publication Produced by Oregon State University, University of Idaho, U.S. Department of Agriculture - Agricultural Research Service, and Washington State University, (2009)
- David H. Gent, Research Plant Pathologist USDA-ARS Forage Seed and Cereal Research Unit Department of Botany and Plant Pathology Oregon State University
- Neve, R.A. Hops. (1991)
- www.USAhops.org
- Hop Research Council Annual Reports

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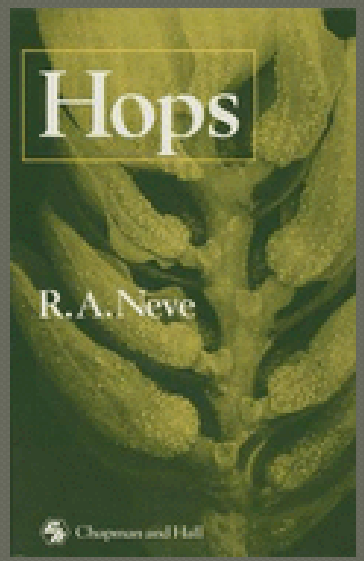

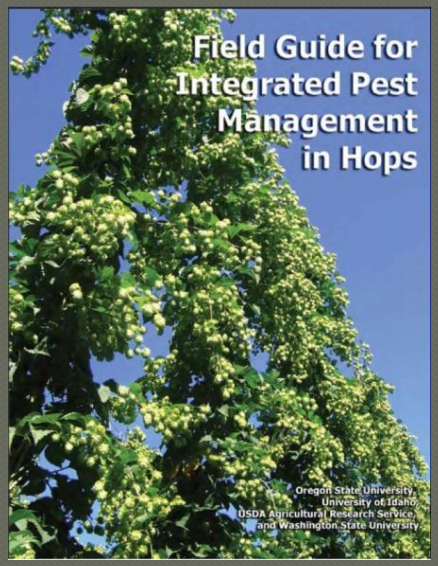


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Fusarium Canker

Fusarium sambucinum

- Survival: fungal disease that is widespread in soil and also can be found in association with plant debris, diseased crowns, and apparently healthy planting materials.
- Spread: the pathogen infects hop plants primarily through wounds created by mechanical damage (e.g., wind, tractors) at or below the soil line; insect feeding may also create wounds that allow the pathogen to gain entry into the hosts.
- Yield loss: disease is often present at a low incidence in hop yards and yield losses have not been quantified rigorously

Fusarium Canker

Fusarium sambucinum

- Symptoms:
  - Early cone development
  - Lower leaves yellow
  - Bine wilt or necrosis
  - Base of an affected bine is swollen and tapers near the point of attachment at the crown
  - Severely affected plants may be killed during the winter, particularly when the disease occurs on young plants
- Management:
  - Remove diseased tissue and avoid propagation from diseased hills
  - Mound soil around the base of bines to promote growth of healthy roots and reduce wilting.
  - Reduce free moisture near the crown
  - Minimize injury to bines during field operations and from pests
  - Manage pH near crown to avoid being overly acidic
  - There are no registered fungicides for Fusarium

Verticillium Wilt

Verticillium albo-atrum & V. dahliae

- Survival: fungal disease that is widespread in soil and a wide range of hosts
- Spread: produce long-lived survival structures that can persist in soil; *V. albo-atrum* can survive 3-4 years in soil and *V. dahliae* for 15 years or longer; the pathogens are spread in hop yards during soil cultivation, in hop trash, and in planting materials from infested yards
- Yield loss: not quantified; invades hop roots, and later grows into water-conducting tissues; fungal growth and plant toxins produced by the pathogen disrupt the movement of water and nutrients, leading to the wilt symptoms that affect cone formation and development

Verticillium Wilt

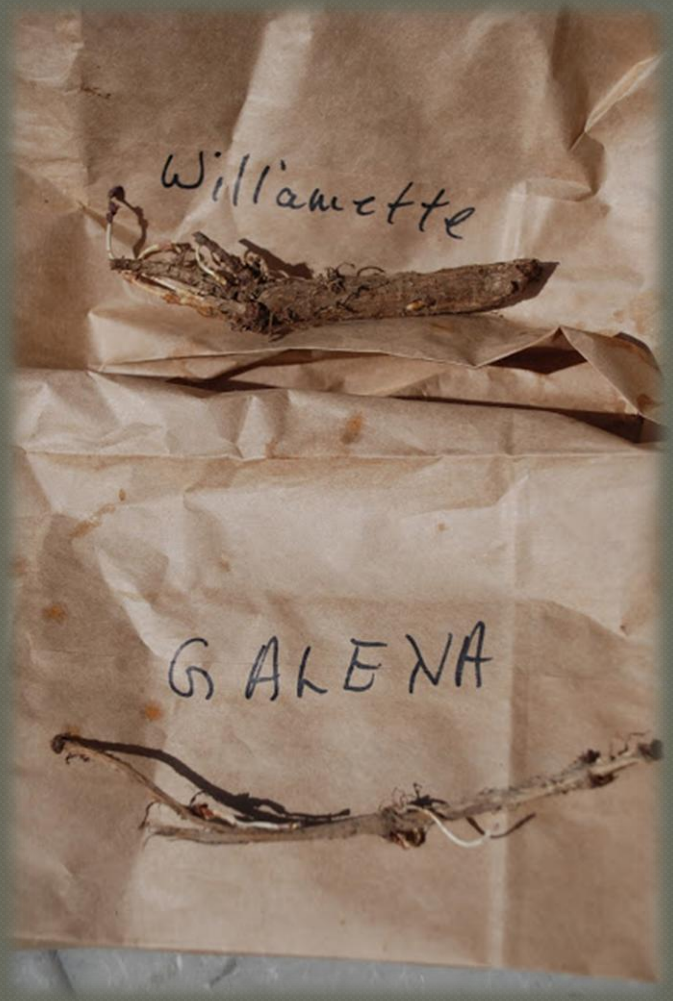
Verticillium albo-atrum & V. dahliae

- Symptoms:
  - Disease symptoms vary depending on the aggressiveness of the Vert.
  - Initial yellowing of lower leaves, death of tissue between major veins, and/or upward curling of leaves
  - Affected bines become noticeably swollen and when these stems are cut open the vascular tissue is discolored a medium to dark brown
  - Eventually, one or all of the bines on a hill harboring the infection completely wilt and may lead to death

Verticillium Wilt

Verticillium albo-atrum & V. dahliae

- Management:
  - Plant resistant varieties from disease-free rhizomes or cuttings
  - Clean equipment between yards to minimize spreading the pathogen
  - Do not return hop trash or compost from yards with Vert.
  - Control weeds with herbicides and reduce cultivation where possible
  - Reduce nitrogen fertilization as much as possible




Thanks again!
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