

Disease-free hops planting stock: prospects for production in the Midwest

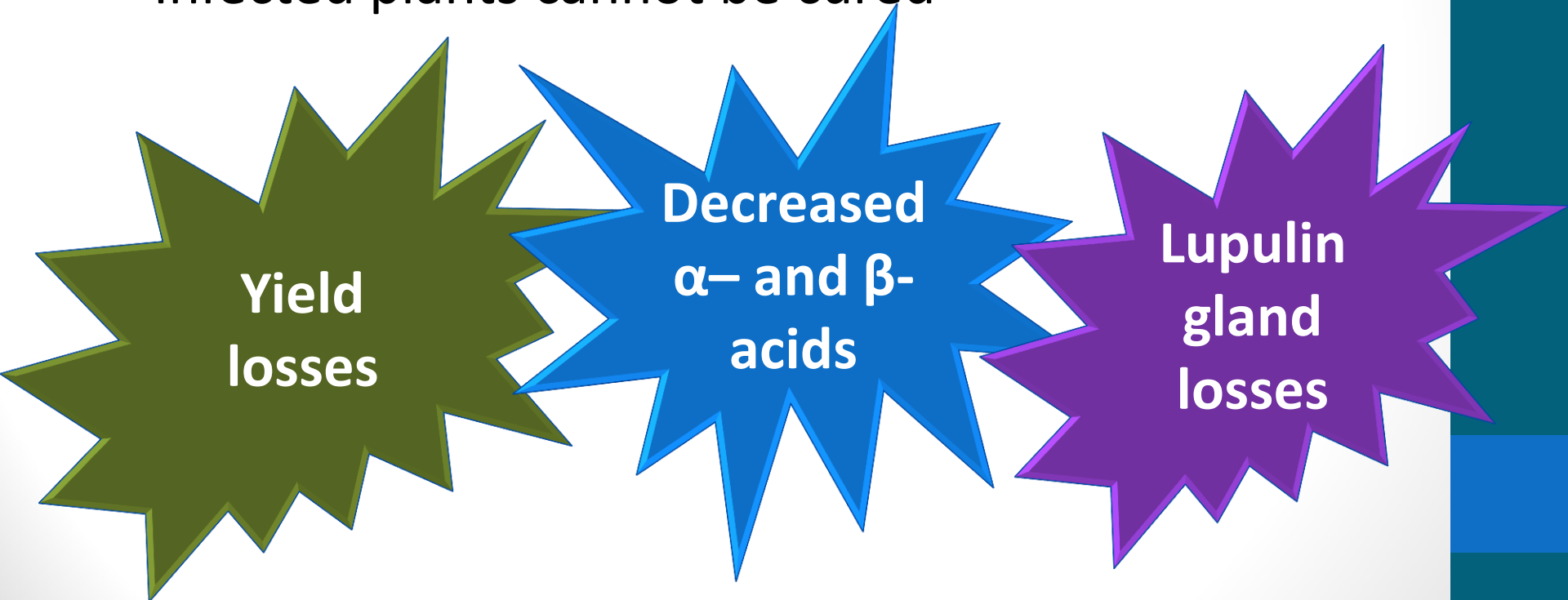
Hop Production for the Wisconsin Craft Brew Industry
4th Annual Seminar, March 2 2013

Talk outline

- Why a clean planting stock system?
- Major diseases transmitted in planting stock
- Certification of planting stock: potato certification as an example
- Steps in setting up a clean planting stock system
- Resources

Need for clean planting stock

- Diseases can be carried in hop rhizomes
 - virus, viroid, oomycete, fungal
- Infected plants cannot be cured



Yield
losses

Decreased
 α - and β -
acids

Lupulin
gland
losses

Diseases transmitted in planting stock

Carlaviruses:

- Hop Latent Virus
- Hop Mosaic Virus
- American Hop Latent Virus

Ilavirus:

- Apple Mosaic Virus

Nepovirus:

- Arabis Mosaic Virus

Viroids:

- Hop Stunt Viroid
- Hop Latent Viroid

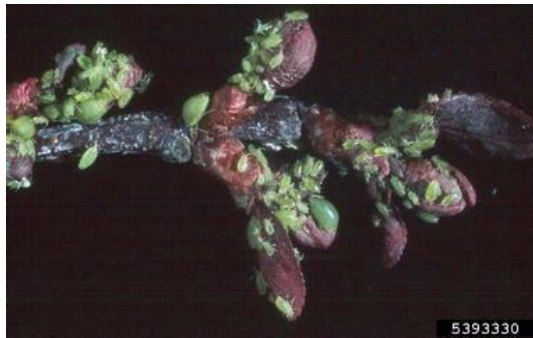
Oomycete:

- Hop Downy Mildew

Fungal:

- Verticillium wilt

Carlaviruses



- Hop Latent Virus, Hop Mosaic Virus, American Hop Latent Virus
- Non-persistent aphid transmission
 - Aphids acquire and transmit virus within seconds of feeding
 - Hop-damson aphid (also direct damage to leaves and cones), Potato aphid, Green peach aphid
- Mechanical transmission
 - Along rows (esp. HpMV)
 - Plant contact (esp. HpLV, AHLV)
- Goldings-type cultivars are susceptible to Hop Mosaic Virus
 - Chinook: 62% yield loss
- Most contemporary cultivars have resistance

Photos: David Gent, USDA Agricultural Research Service, Bugwood.org

Apple Mosaic Virus

- Spread:
 - Infected planting stock
 - Mechanical (in plant sap)
 - Plant contact
 - Root grafting
- Impacts on yield and quality
 - Cultivar dependent
 - UK data (from Pethybridge et al 2008)

Cultivar	Cone yield loss	Alpha acid loss
Fuggle	8	0.5
Cascade	20	3
Bullion	20	2
Wye Northdown	32	8



Photos: David Gent, USDA Agricultural Research Service, Bugwood.org

Arabis Mosaic Virus

- Spread:
 - “dagger nematode” *Xiphinema diversicaudatum* (widespread in Europe, little N. American distribution)
 - infected planting stock
 - mechanically
- No recent reports in US – let’s keep it that way!
- Causes variety of symptoms:
 - Nettlehead, Hop chlorotic disease, barebine, split leaf blotch
- Major yield loss
 - 36-96% (Fuggle)
 - 71-73% (Superalpha)
 - 23-26% (Bullion)
- Variable effects on acids



Photos: A. Eppler,
Justus-Liebig
Universität,
Bugwood.org

Hop Stunt Viroid

- Spread:
 - Infected planting stock
 - Mechanically
- Stunting more severe in warmer climates
- Yield and quality effects
 - Yield losses of 50-80% (Willamette, Glacier)
 - Brewing acid levels 50-70% lower
 - Shift in ratio of α : β -acids



Photos: David Gent, USDA Agricultural Research Service, Bugwood.org

Hop Latent Viroid

- Spread:
 - Infected planting stock
 - Mechanically
- Chlorosis, slow growth, fewer laterals
- Yield and quality effects
 - Very cultivar-dependent
 - Omega – cone yield down 27%, α -acids down 31%, β -acids higher



Photos: www.plantmanagementnetwork.org

Hop downy mildew - oomycete

- *Pseudoperonospora humuli*
- Spread by infected planting stock, airborne spores
- Yield loss can be 100% - plant death and/or poor cone quality
- Some resistant/tolerant cultivars (eg Perle, Fuggle, Willamette)



plantmanagementnetwork.org



B. Engelehard



hopmintstress.wsu.edu

Verticillium wilt - fungal

- *Verticillium albo-atrum* and *Verticillium dahliae*
- Spread by infected planting stock, soil, and plant debris
- Yield loss is cultivar-dependent; can be 100% due to plant death and crop rejection
- Synergistic with hop cyst nematode



Photos: David Gent, USDA Agricultural Research Service, Bugwood.org

Start clean – stay clean!

- Plant disease-free rhizomes and plugs
- Sanitation for pruners and other tools
- Prevent movement of soil/infected plants onto your property
- Plant disease resistant cultivars

What else?

- Downy mildew
 - Pruning and rogueing
 - Manage irrigation and promote air movement
 - Fungicide applications
- Carlaviruses
 - Aphid control?
 - Guard rows/hedgerows

Planting stock production & certification programs

- Self-sustaining programs that serve grower needs
 - Responsive to grower priorities
 - Foster research and education
 - Training opportunities
- Wisconsin Seed Potato Certification Program



Wisconsin Seed Potato Program



PROFESSOR J. G. MOORE
Wisconsin Experiment Station



J. W. HICKS
President Wisconsin Potato Growers'
Assn.



J. W. BRANN
Wisconsin Experiment Station



CARL VROOMAN
Assistant Secretary
U. S. Department of Agriculture

- Started as a collaboration between farmers and scientists in 1905
- First seed potatoes certified in 1914

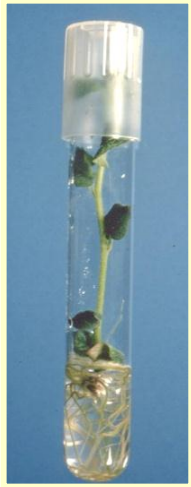
Wisconsin Seed Potato Program



- 100 years later, program runs as a seed potato production cooperative
 - Fee-supported program
 - Grower management board
 - UW administrative and technical staff

WI Seed Potato Certification

Program: ~7.5% of US seed potatoes



UK hop certification programs

- 1943-1955 program: inspection and certification of hop yards
 - free from Verticillium wilt
 - Low incidence of nettlehead (Arabis mosaic virus) and mosaic
- 1955: “A-plus” program
 - Production of virus-free plants
 - “Layer beds” used for propagation (10 years)
 - isolated from commercial hop yards
 - ~20 miles from areas with Verticillium
 - Soil tested free of dagger nematode
 - Wilt-sensitive and wilt-tolerant cultivars at separate locations
 - Inspection twice each season
 - High level of sanitation

Production possibilities

<http://healthyplants.wsu.edu>



<http://www.plantlabs.com>



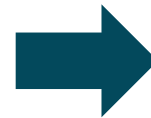
Growers

- Multiplication
- Hop Production



Growers (hoophouse/ greenhouse)

- Multiplication
- Hop Production



Growers

- Multiplication
- Hop Production

Cultivar availability

- National Clean Plant Network – “*Start clean, stay clean*”
 - <http://nationalcleanplantnetwork.org/>
 - grapes, nuts, fruit trees, citrus and berries...
 - And hops, in 2010
 - Clean Plant Center of the Northwest
<http://healthyplants.wsu.edu/>
- National Clonal Germplasm Repository
 - Corvallis , OR
 - 185 cultivars and selections listed
 - Not all virus-free



Photo: www.ars-grin.gov

First steps

- Grower association/cooperative
 - Grower priorities? Hop production &/or rhizome production?
- Researcher contacts
 - Ruth Genger <rkgenger@wisc.edu>
- Coordination with other states?
 - harmonize state certification and quarantine laws?
- Start-up funds - Specialty Crops grants
 - <http://datcp.wi.gov/>
- Research grant applications
 - Grower support is critical

Organic?

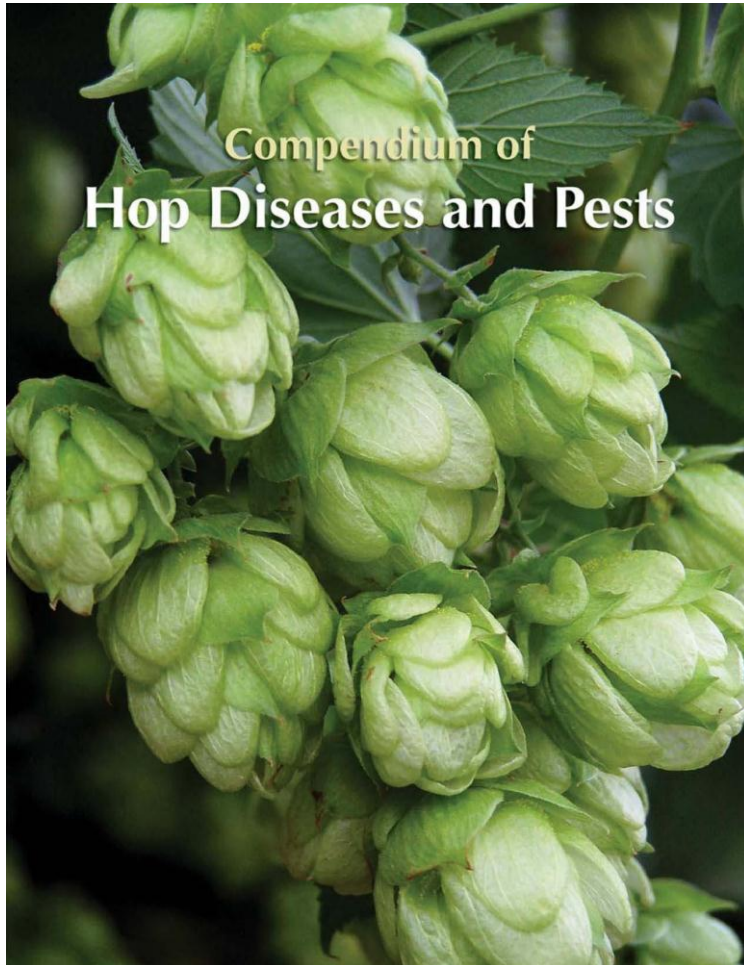
“NOP§ 205.204 Seeds and planting stock practice standard.

(a) The producer must use organically grown seeds, annual seedlings, and planting stock: Except, That,

(1) Nonorganically produced, untreated seeds and planting stock may be used to produce an organic crop when an equivalent organically produced variety is not commercially available”

- All vegetative crops use tissue culture to maintain clean stocks
- Tissue culture uses synthetic ingredients (amino acids, vitamins) disallowed for organic use
- Planting stock that is one step removed from tissue culture – eg potato minitubers or hop rhizomes - is acceptable to plant on certified organic land if “an equivalent organically produced variety is not commercially available”
- A concerted effort to clarify these regulations may be needed

Recommended resources



- Compendium of Hop Diseases and Pests (shopapspress.org)
- Field guide for Integrated Pest Management in Hops (ipm.wsu.edu/field/pdf/HopHandbook2010.pdf)
- Online presentation by David Gent, USDA-ARS, Corvallis OR: "Diseases of Hop: Identification and Management"

Thank you!

Questions?