Redefining and Refining Hop Production in the North East

Evan Elford
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UVM Hops Conference 2020

A BRIEF INTRODUCTION…

Dr. Melanie Filotas, Horticulture IPM Specialist

Pest management for non-traditional crops (e.g. hops) melanie.filtoas@ontario.ca

Evan Elford, New Crop Development Specialist

Edible, non-traditional horticulture crops (non-traditional fruit, vegetables, grains, mushrooms, and hops evan.elford@ontario.ca

Role: Provincial scope; coordinate extension and applied research on non-traditional crops

OVERVIEW

- Redefining:
  - Changes in Eastern North America
    - Acreage, markets & trends
- Refining:
  - Production practices
  - Resources

THE PAST 10 YEARS…

- Unprecedented increase in number of craft (independent) breweries
- Changes in beer styles introduced and turnover on the market
- International production shortfalls (2002-2008) & loss of inventory in 2006

http://alfredcoterosf.com/wp-content/uploads/2020/01/decade-in-review_editorial.jpg


https://en.facebook.com/OntarioCraftBrewers/

	Year	Vermont	Ontario
# Craft Breweries	2010	26	57 (2011)
	2018	66	356
Percent (%) Increase		154%	525%
Craft Breweries Per 100,000	2018	13.5	2.6
Craft beer volume (hL)	2018	393,349	700,500
Other Notes			8.9% of total beer sales is craft

Sources: Beer Canada; Brewers Association; Ontario Beverage Network; Ontario Craft Brewers

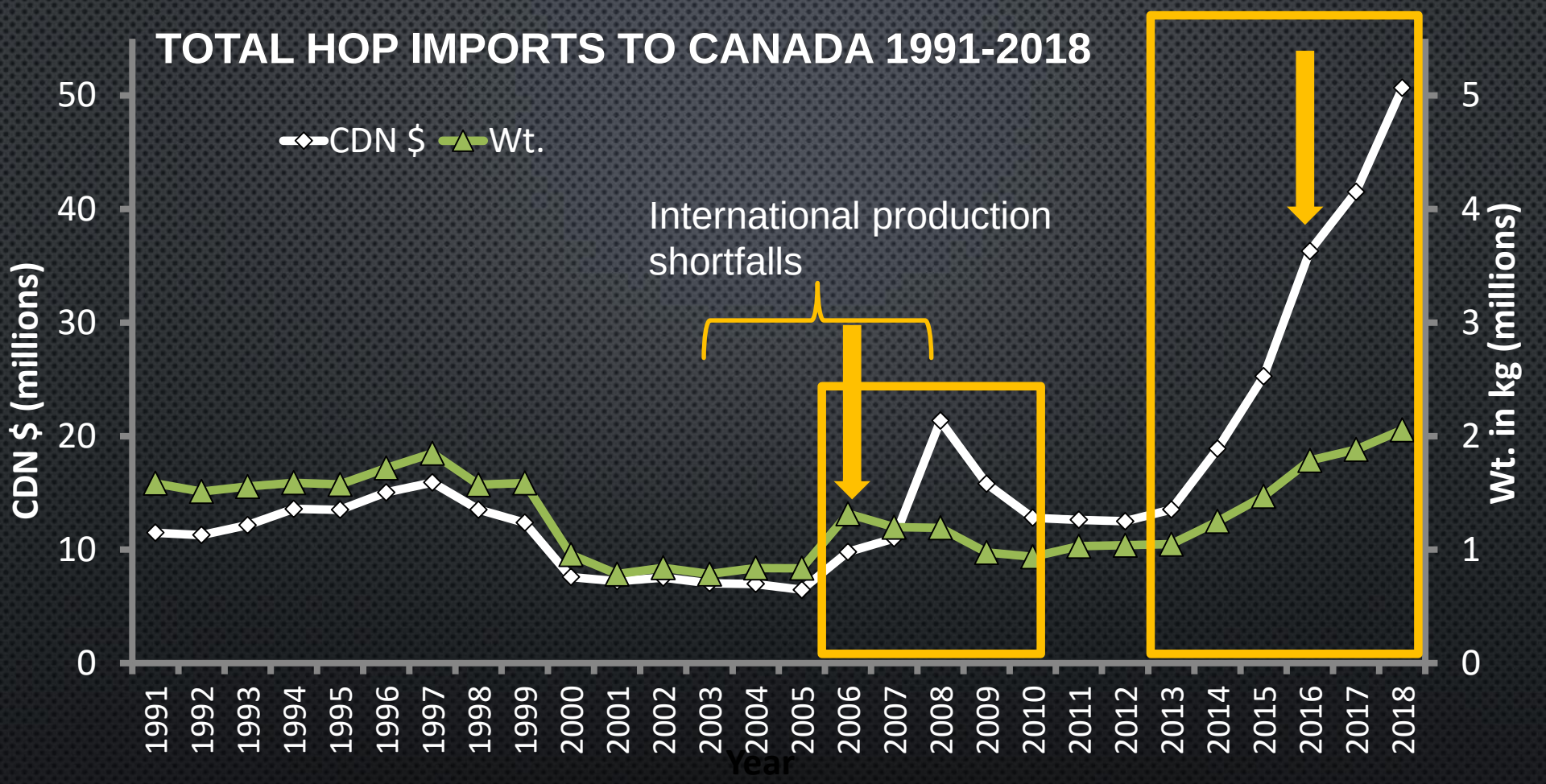
THE PAST 10 YEARS…

- Increase in international acreage (levels not seen since 1996)
- Increased adoption of new proprietary cultivars to the market
  - Private breeding programs for the future?
  - Sales of proprietary cultivars tied to public cultivars?
- Rapid increase in average price paid for imported/proprietary hops

http://alreporterosf.com/wp-content/uploads/2020/01/decade-in-review_editorial.jpg


https://m.facebook.com/OntarioCraftBrewers/

TOTAL HOP IMPORTS TO CANADA 1991-2018

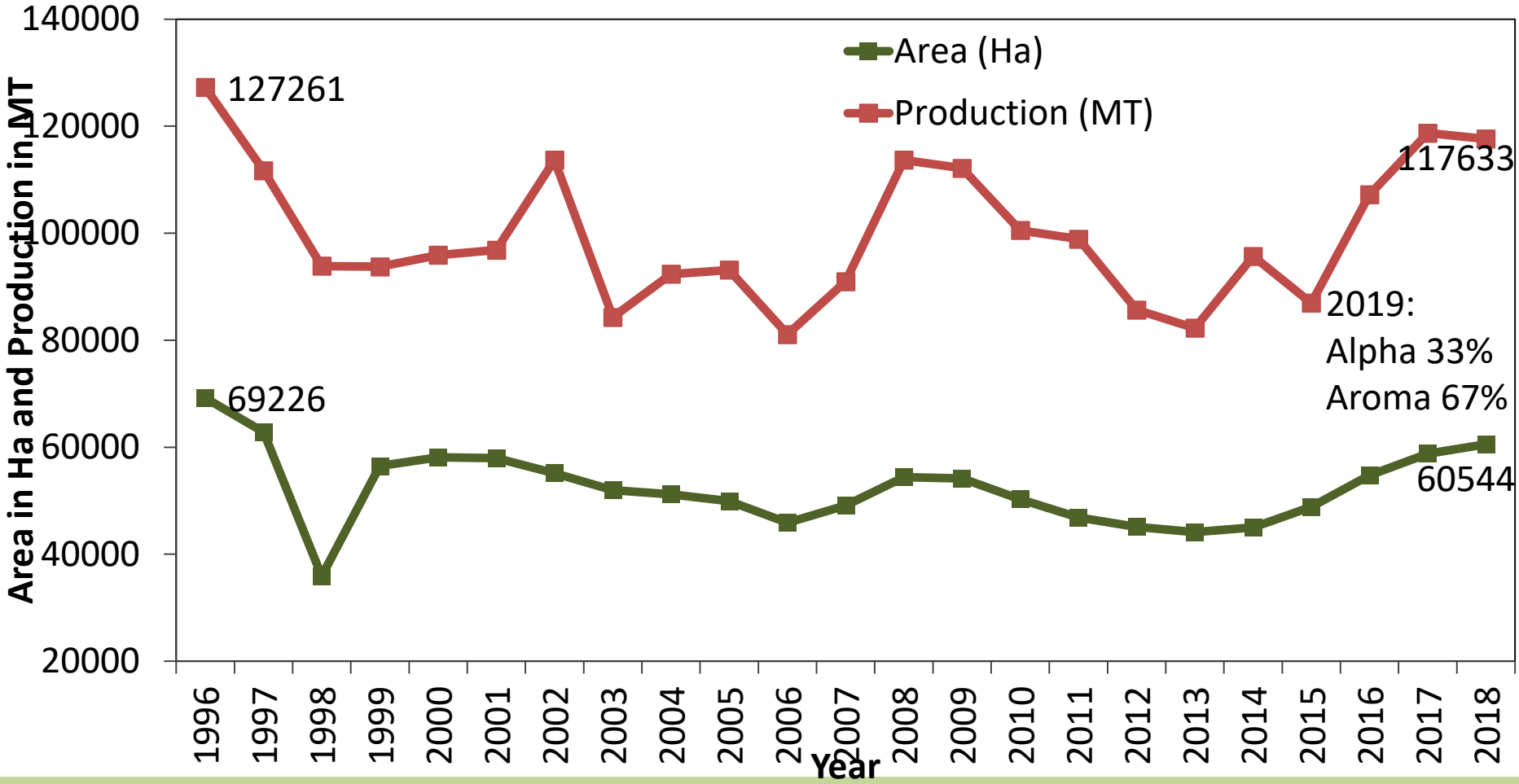


Source: Statistics Canada; OMAFRA Economic Analysis Unit

† Includes all line items for hops such as hop cones (whole or partial), hop powders, hop pellets, etc. and resin products

2018 data Jan-Nov 2018; December values not reported as of 28 Feb 2019

International Acreage and Production (MT) 1996-2018



Source: IHGC Economic Commission Summary Reports, 1996-2018

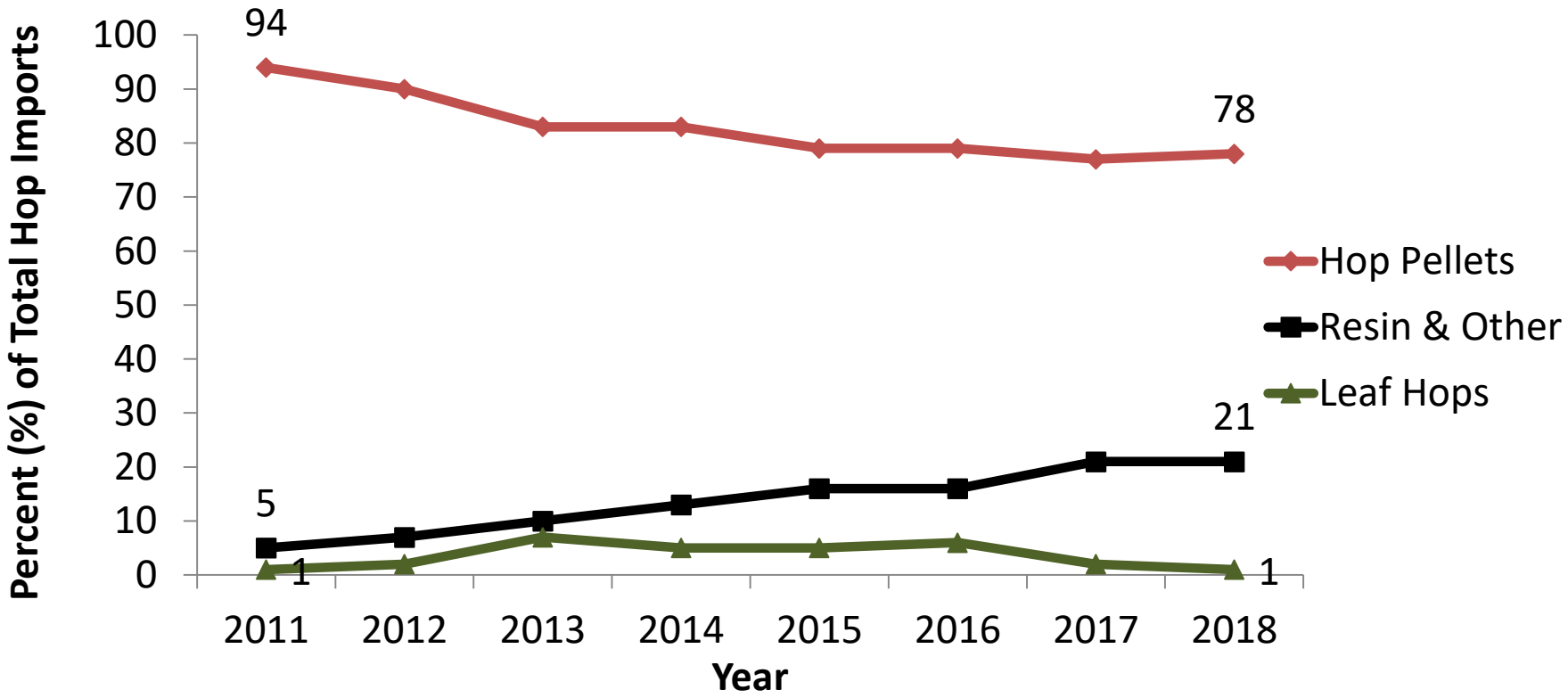
THE PAST 10 YEARS…

- Adoption of hop extracts by the brewing industry
  - Reclaim higher percentage of usable resins;
  - More shelf stable;
  - Less storage space required
  - Potential value added opportunity???

http://alreporterosf.com/wp-content/uploads/2020/01/decade-in-review_editorial.jpg

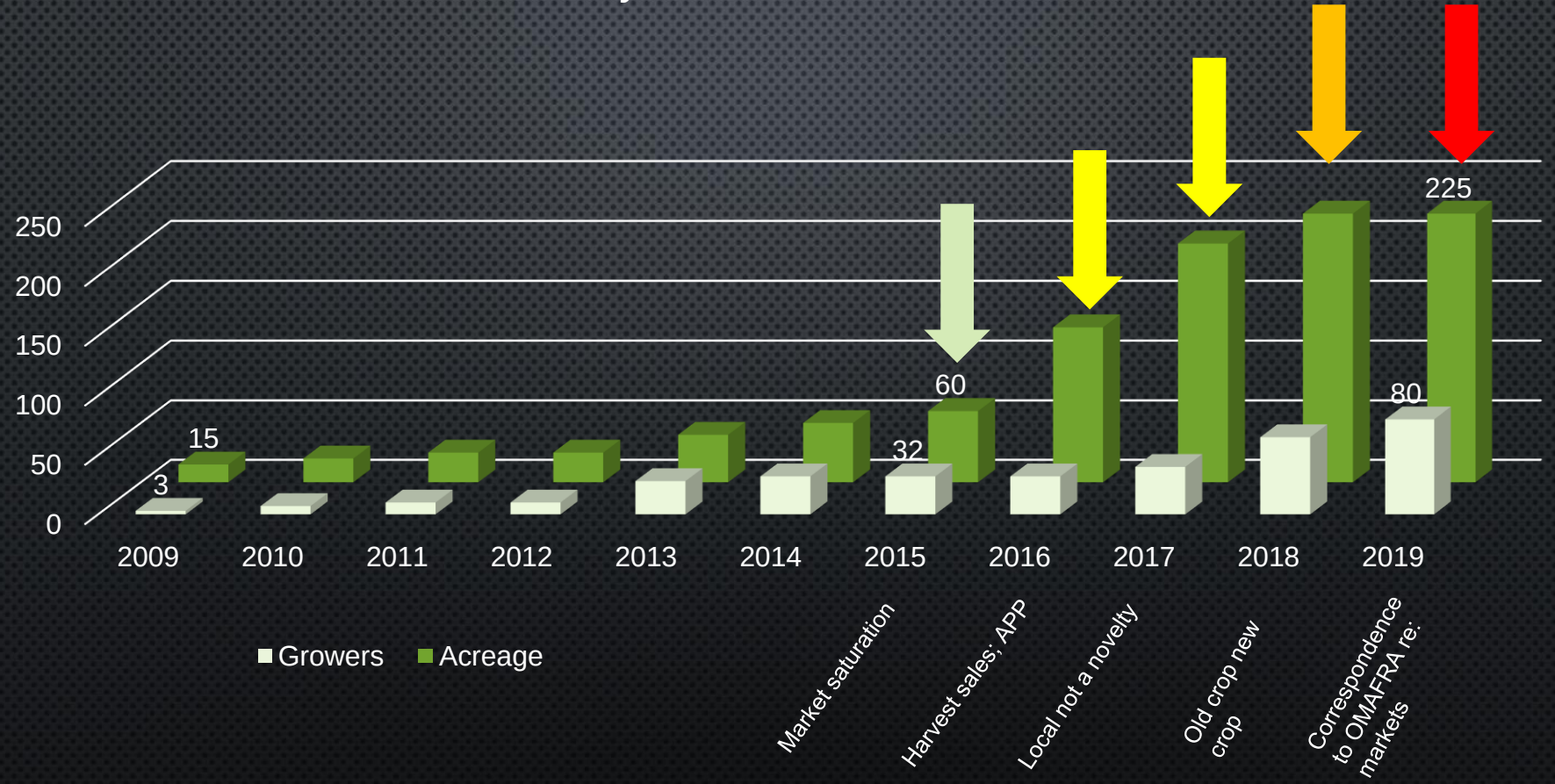

https://en.facebook.com/OntarioCraftBrewers/

Categorization of Hop Imports to Canada



Source: Statistics Canada

Estimated Number of Hop Growers and Total Acreage in Ontario by Year 2010-2019



REDEFINING HOP PRODUCTION

2020 - A time of change …

- Highly competitive
- Lower prices
- High inventory
- Acreage retraction /exiting production in 2019 & 2020

https://www.roque.com/stories/farms/hopyard-string-theory

PATH FORWARD: 2020+

- Growers creating new markets for hops (aside brewing)
- Identify and address industry priorities
- Optimizing hop production and quality (reduce COP)
  - Cultural management & pest management
  - Post harvest practices

REFINING PRODUCTION IN THE NORTH EAST

Increasing Yield with Better Management

- Rainfall (& Irrigation)
- Temperature

} Environmental Management

- Age of Plant
- Mulch
- Fertility
- Plant spacing
- String angle

} Cultural Management


ENVIRONMENTAL MANAGEMENT

Variable	Yield	Alpha / Resins	General Recommendation
Rainfall / Irrigation	Yes	Yes	Very high correlations between water and yield/resin production. ~55-60 L (14.5-16 US gal)/plant/week • 7.5 L (2 US gal)/plant/day • Up to 19 L (5 US gal)/plant/day at peak ET
Temperature	Unknown	No (decrease)	• Air temperature 40-60 days pre-harvest • α highly correlated to air temp from May 24-June 21 • Temp and sunlight during cone ripening (Aug) impacts some cultivars • Highest α accumulation 15-18C (59-65F) • Low temps during cone ripening (below 12C (54F)) reduce α accumulation


CULTURAL MANAGEMENT

Variable	Yield	Alpha / Soft Resins	General Recommendation
Age of Plant	Yes	Yes	Shorten life of hop yard
Mulch	Dependent	Dependent	Results depend of type of mulch Straw: 10 tonnes/ha (2 yr interval); no effect on α acids Grass cover crop can reduce yields (competition) but increase α acids
Fertility	Yes	Dependent	N, P, K and B most studied; increase yields (to a point) and cultivar dependent results for resin synthesis
Plant Spacing	Yes	Yes	Optimal in-row spacing 114 cm (3.75”); 2 strings per hill, 2 bines per string
String Angle	Yes	Unknown	Cultivar dependent. Shorter cultivars string at 90^{o}; taller cultivars string at 72-78^{o}

FERTILITY GUIDELINES

Table 7.16 Nitrogen in established hops (second and subsequent years afte establishment)

Deep silty soils	
Clay soils	
Other mineral soils	

Table 7.17 Phosphate, potash and magnesium in establishe

	P, K, or Mg Inde			
	0	1	2	3
	kg/ha			
Phosphate (P_2O_5)	250	200	150	100
Potash (K_2O)	425	350	275	200
Magnesium (MgO)	150	100	50	0

NITROGEN:

Table 2: Nitrogen Guidelines for Hops

Plant Age	kg N/ha	Notes
New Yard	65-135	Apply fertilizer in split applications after plants emerge approximately every two weeks with no more than 25 k ha in any one application. Gradually decrease N applica the beginning of July through to harvest.
Established Yard	135-165	

PHOSPHORUS AND POTASSIUM:

Table 3: Phosphate Guidelines for Hops Based on OMAFRA Accredited Soil Tests for Similar Vegetative Perennials (based on OMAFRA Publication 360, Guide to Fruit Production, 2016-2017)

Soil Phosphorus (ppm)*	Rating	Phosphate (P_2O_5)	
		New Plantings	Established Plantings
0-3	HR	140	100
4-5		130	90
6-7		120	80
8-9		110	70
10-12	MR	100	
13-15		90	
16-20	LR	70	
21-25		60	
		50	
		40	
		0	
		0	
		0	
		0	

Table 4: Potassium Guidelines for Hops Based on Accredited Soil Tests for Similar Vegetative Perennia OMAFRA Publication 360, Guide to Fruit Production,

Potassium Soil Test (ppm)*	Rating	Potassium (K_2 (kg/
0-15		13
16-30	HR	12
31-45		11
46-60		10
61-80	MR	90

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Hops fertility: Part 1

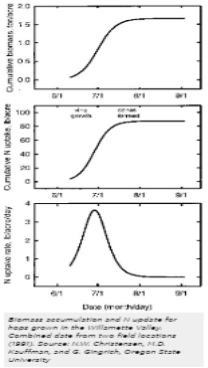
Proper nitrogen application and timing is crucial for maximizing hop yields.

June 23, 2014 - Author: Rob Sirrine, Michigan State University Extension

According to Sullivan et al. 1966, during the active growing season, nitrogen (N) uptake can be divided into three phases in hops production. During Phase I, which occurs in early spring, N uptake is slow and corresponds with slow plant growth. Phase II corresponds with rapid N uptake and pronounced biomass accumulation. Phase III is a time of minimal N uptake.

In Phase I, initial spring growth is slow and primarily fueled by reserves stored from the previous year; only around 10 percent of total biomass is accumulated through mid-June. In the Willamette Valley, OR, the rapid N uptake associated with Phase II generally occurs mid-June through mid-July, and is responsible for the generation of 2-4 lbs. of plant biomass/acre/day. Through the end of July, a typical hop yard will have accumulated 80-150 lbs./N/ac in the trained biomass, depending upon cultivar and age of the hop yard.

Rates, Timing, and application method



Biomass accumulation and N uptake for hops grown in the Willamette Valley. Combined data from two field locations (1981). Source: Kirk Christensen, M.D. Kauffman, and G. Gingrich, Oregon State University.

FERTILIZERGuide
FG 79
Reprinted January 2000

Hops

C. Gingrich, J. Hart, and N. Christensen

Fertilizing hops improves yield and quality by supplying the crop with ample nutrition in advance of demand. Producers must combine this goal with production costs and environmental stewardship. Fertilization should be based on yield and quality response, experience, and economics. Unfortunately, limited experimental data exist linking modern cultural practices, current varieties, and hop yield in Oregon. The recommendations given in this guide are based on Oregon research, publications from other hop-producing areas, and grower experience.

This fertilizer guide provides general information for hop fertilization. Growers, with the assistance of county Extension agents and field representatives, should consider the fertilizer needs of individual hop yards. Routinely sample soil and petioles (stems) for analysis. Record soil and tissue data as well as other management practices, weather records, yield, quality, disease problems, and fertilizer rates and timing. Long-term production records then can be compared to changes in fertilization or other practices.

Fertilization is only one practice a grower must consider in hop production. The fertilizer recommendations in this guide assume adequate weed, insect, and disease control, and timely irrigation.

Soil and Tissue Sampling

Sample soil around the hill for routine analysis. Obtain a core from the soil surface to a depth of 12 inches in 15 to 20 locations throughout each hop yard. Combine individual cores into a single sample for analysis. No specific time of the year is recommended for sampling. However, soil pH will vary seasonally. Lowest soil pH values usually are found in the late summer or early fall. The highest values are obtained in the late winter or early spring before fertilization. Obtain soil samples at the same time each year and in sufficient time for analysis and planning for fertilization or liming.

In addition to routine soil sampling described above, sample soil from the surface to a depth of 5 or 6 feet one time during the life of the hop yard. Ideally, this sample should be taken before the hop yard is established, but it can be obtained any time after planting. Take samples from between rows in an established hop yard. Soils with subsurface gravel or sand layers are common in some hop yards. Knowing the extent of these layers in a yard will aid in optimum fertilizer and irrigation management.

Tissue analyses can be used to monitor plant nutrient concentration or compare areas of good and poor growth. Although no tissue standards for hops are available, petiole nutrient levels, especially for nitrogen (N), can be used to evaluate the current-year fertilizer application when tissue levels are compared to previous years' analyses. Take 30 petioles from throughout the hop yard. Choose mature leaves and petioles from the main stem 5 to 6 feet from the ground.

Hop Plant Growth

A general description of hop plant growth is helpful in understanding both tissue sampling and nutrient needs. Rapid spring growth produces long shoots with little leaf area and depends on rootstock reserves. After leaf expansion, carbohydrates are produced in excess of growth requirements and accumulate in the rootstock. Accumulation of carbohydrates is most rapid during August and September when vine growth has ceased.

Seasonal accumulation in the dry weight of the above-ground portion of mature plants is illustrated in Figure 1. Rapid dry matter accumulation in the aboveground portion

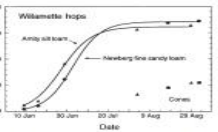


Figure 1.—Trained biomass for two yards producing 'Willamette' hops during 1992.

Gale Gingrich, Extension agent, Marion County; John Hart, Extension soil scientist; and Neil Christensen, professor of soil science; Oregon State University.

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FACTORS AFFECTING FERTILITY

- Weather
- Soil temperature
- Bine age
- Seasonal stage of development
- Soil fertility & cover crop history
- Soil type
- Soil organic matter
- Water availability

Mg, Compendium of Hop Diseases and Pests, 2009

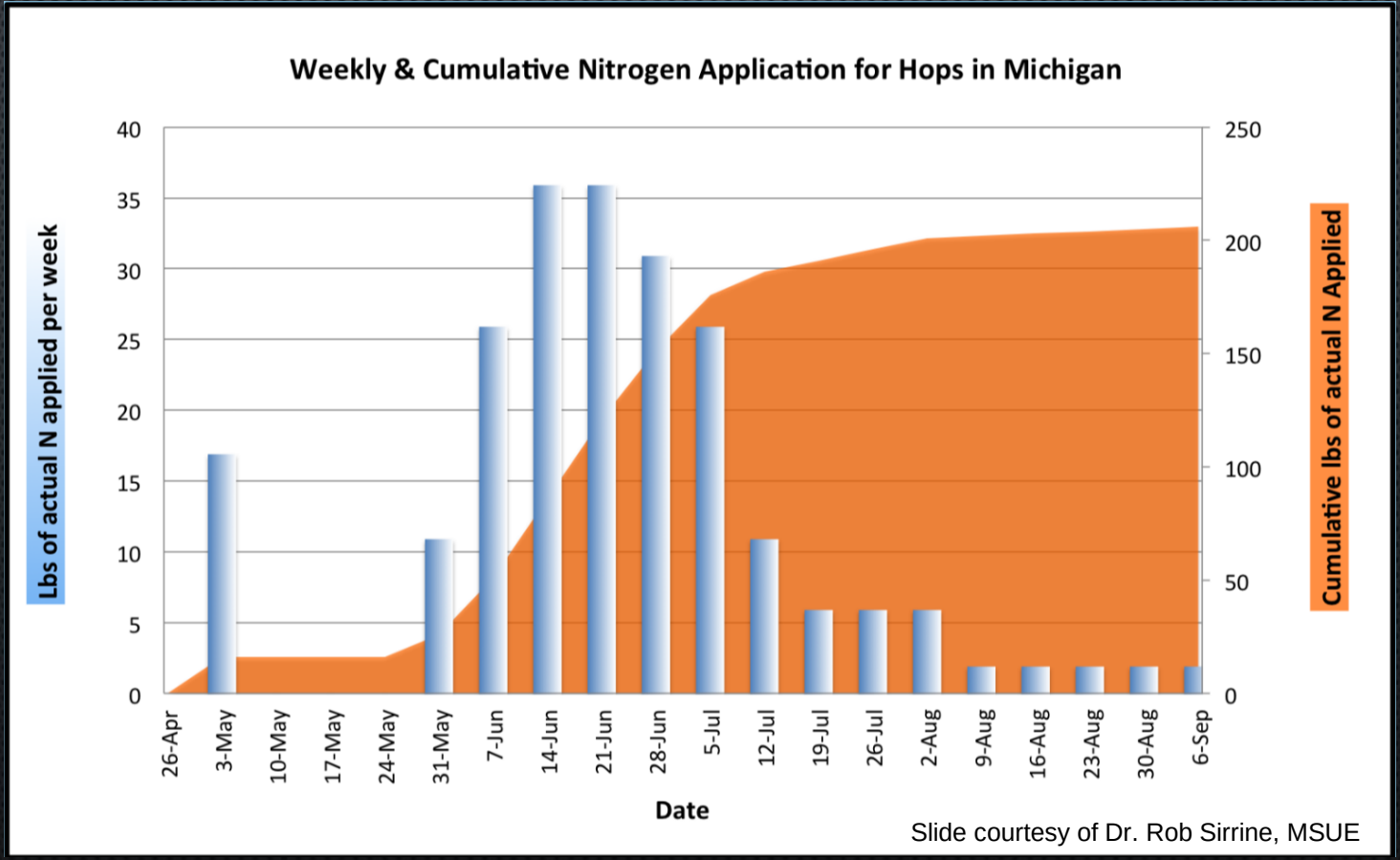
MACRONUTRIENTS

- Nitrogen (N): plant growth; photosynthesis; increases yield to a point (economic returns)
- Phosphorus (P): photosynthesis, cell division, root growth and energy transfer (usually low requirements in hops)
- Potassium (K): metabolic process, production/translocation of carbohydrates, water intake; production of lupulin and resin content

Nitrogen Guidelines for Hops

Plant Age	kg N/ha (lb N/ac)	Notes
New Yard (1-2 yrs)	65-135 (58-120)	Apply 20 kg N/ha (18 lb N/ac) at sprouting (late April beginning of May). Starting mid-May, apply every two weeks with no more than 25 kg actual N/ha (20-22 lbs N/ac) in any one application. Gradually decrease N application rate at the beginning of July through to harvest (5-10 kg N/ha (4.5-9 lbs N/ac) in July; 2-5 kg N/ha (1.5-4.5 lbs N/ac) in Aug).
Established Yard (2+ yrs)	135-165 (120-147)	

Timing is everything…



Slide courtesy of Dr. Rob Sirrine, MSUE

TYPE OF NITROGEN FERTILIZER?

- Ammonium nitrate slightly more available at low temperatures than urea.
- No practical difference between the two.
- The cheapest form of nitrogen probably your best option for profitability.

PHOSPHORUS AND POTASSIUM GUIDELINES

Test your soil first!

Table 3: Phosphate Guidelines for Hops Based on OMAFRA Accredited Soil Tests for Similar Vegetative Perennials (based on OMAFRA Publication 360, Guide to Fruit Production, 2016-2017)

Soil Phosphorus (ppm)*	Rating[1]	Phosphate (P_2O_5)[2] required (kg/ha)	
		New Plantings	Established Plantings
0-3	HR	140	100
4-5		130	90
6-7		120	80
8-9		110	70
10-12	MR	100	70
13-15		90	60
16-20	LR	70	50
21-25		60	40
26-30		50	30
31-40	RR	40	20
41-50		0	0
51-60		0	0
61-80	NR	0	0
80+		0	0

*0.5M sodium bicarbonate extract test method.

[1]HR, MR, LR, RR, and NR denote, respectively, high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

[2] Where manure is applied, reduce fertilizer applications according to the amount and quality of manure.

Table 4: Potassium Guidelines for Hops Based on OMAFRA Accredited Soil Tests for Similar Vegetative Perennials (based on OMAFRA Publication 360, Guide to Fruit Production, 2016-2017)

Potassium Soil Test (ppm)*	Rating	Potassium (K_2O)[2] required (kg/ha)
0-15	HR	130
16-30		120
31-45		110
46-60		100
61-80	MR	90
81-100		80
101-120	LR	70
121-150	RR	60
151-180		40
181-210		0
211-250		0
251+	NR	0

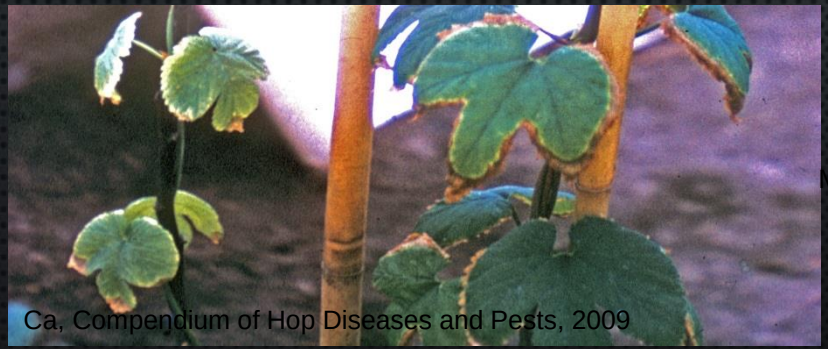
*1 M ammonium acetate extract test method.

[1]HR, MR, LR, RR, and NR denote, respectively, high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

[2] Where manure is applied, reduce fertilizer applications according to the amount and quality of manure.

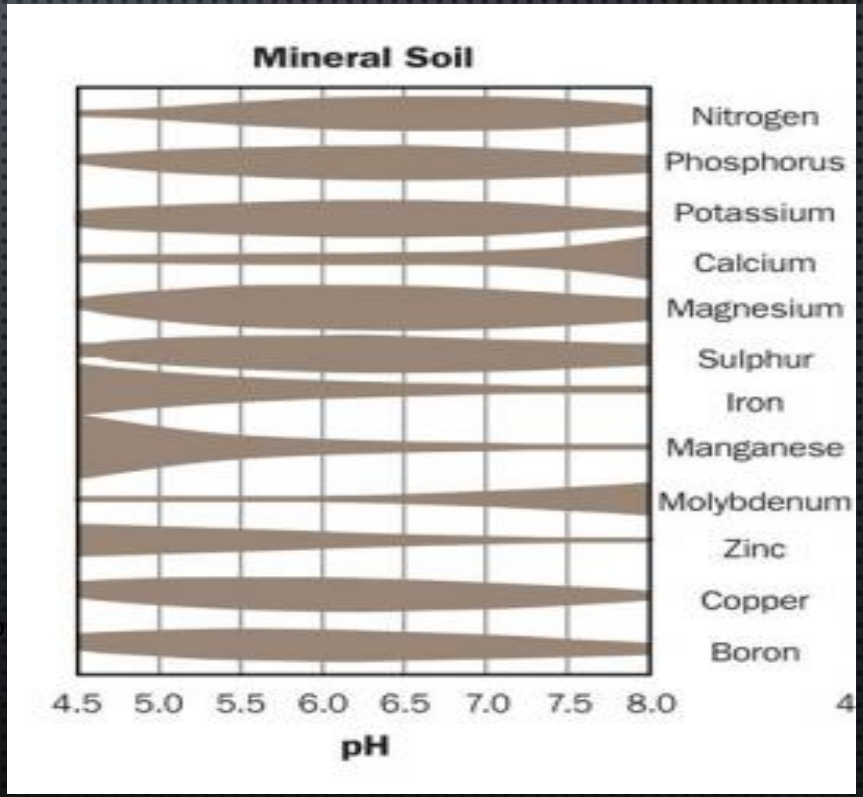
MICRONUTRIENTS

Fe, Field Guide for Integrated Pest Management in Hops, 2009



Ca, Compendium of Hop Diseases and Pests, 2009

Mg, Co



BORON

- Deficiency: seen at growing tips (shoots new leaves); stunting, cupping/crinkling of leaves upward, leading to necrosis; delayed shoots; leaves lacking nodes

- Confused with: leaf hopper (cupping/crinkling of leaves downward), herbicide damage (eg 2,4-D, clopyralid leaf cupping upwards/crinkle), virus

- Apply based on soil test
  - < 1.5 ppm apply 1.1-1.6 kg B/ha (1.0-1.5 lb/ac)
  - > 1.5 ppm no need to apply

Field Guide for Integrated Pest Management in Hops, 2009.

FOLIAR APPLICATION

- Roots take up nutrients, not leaves
- Success of foliar application is complex, depends on:
  - Crop species
  - Nutrient, nutrient form, and mobility
  - Application
  - Absorption
  - Environmental conditions (e.g. %RH)
  - Nutrient status/demand of the plant

- Problem elements: Ca, Mn, B (no benefit from foliar application)
- Potential candidates: Fe, Zn, Cu, Mo (deficiencies are rare)
- Soil apply: N, P, K, Mg, Ca, B, Mn, S, Cl, Na

COMING SOON???
NUTRIENT DEFICIENCY GUIDE FOR HOPS

- KTT Funding Program
- “Development of nutrient deficiency pictorial guides for hops and industrial hemp”
- If funded, preliminary results posted by mid-2020
- Full guide published by 2021
  - Hard copy and e-copy

RESOURCES

ONSpecialtyCrops Blog:
www.onspecialtycrops.wordpress.com

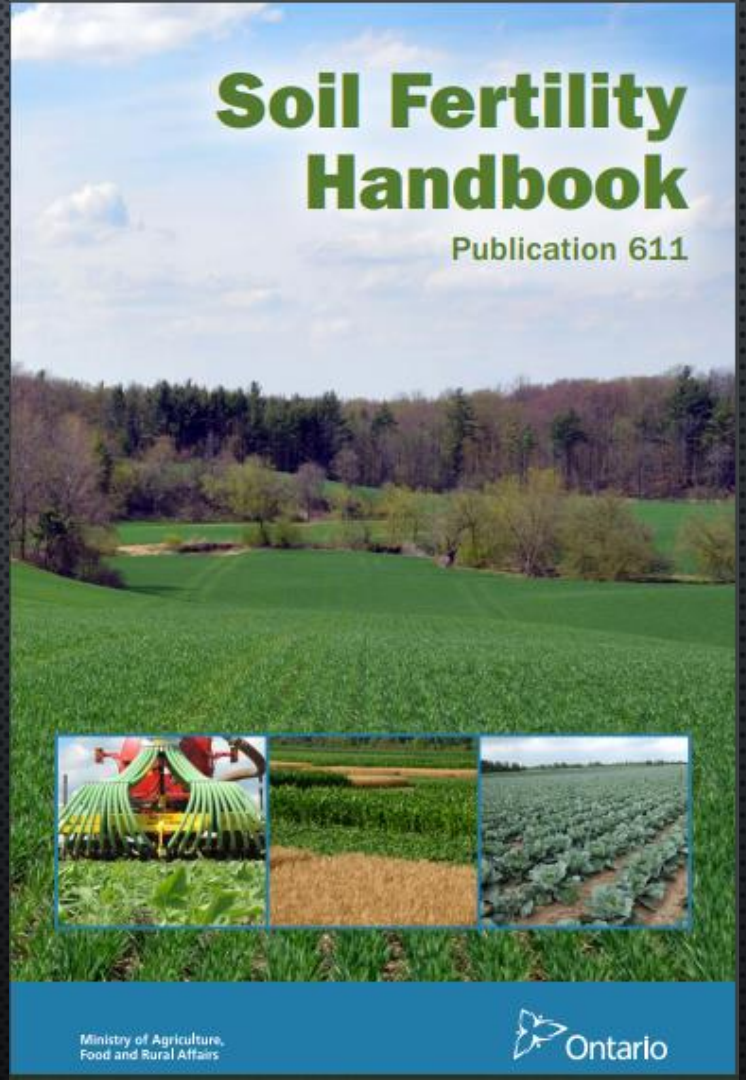
- Hop Fertility Guidelines
- Hop Nutrient Deficiency Photo Guide (if funded)

Hop Production in Midwest and Eastern North America (online course):
www.canr.msu.edu/hops/uploads/files/Registration%20instructions%20for%20hop%20d2l%20course.pdf

Free Download!

Soil Fertility Handbook Pub 611

www.omafra.gov.on.ca/english/crops/pub611/pub611.pdf



Thank You!

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