OPTIMIZING HOP QUALITY

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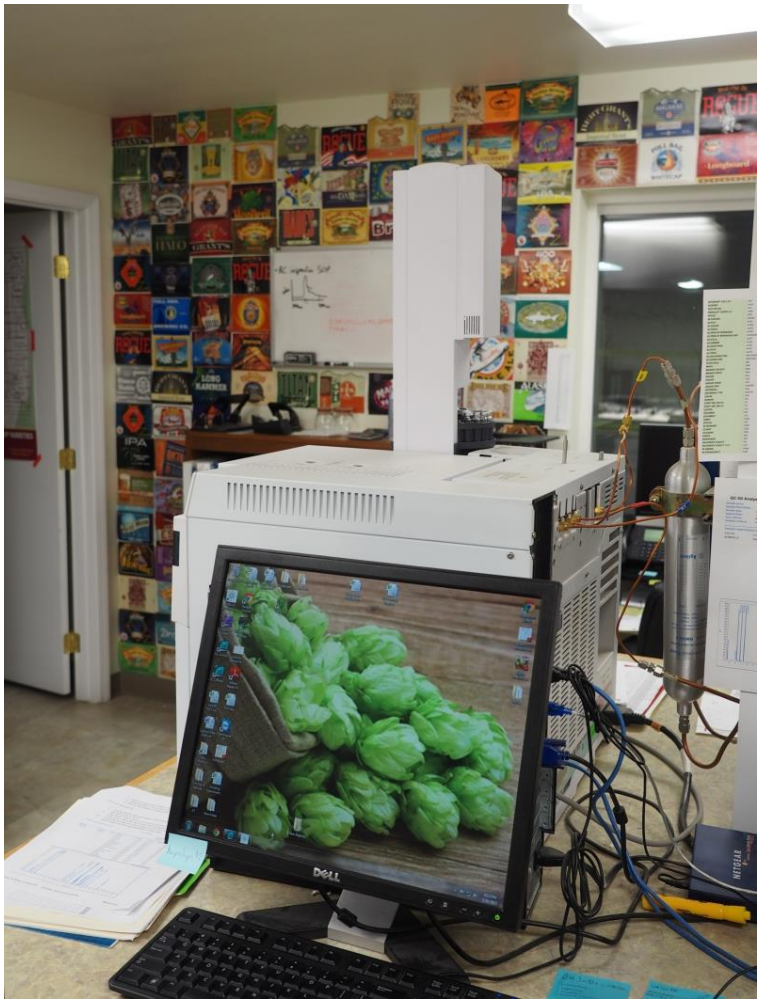
YAKIMA CHIEF HOPUNION

My Background

1. Plant population and community ecology.
2. Winemaking, production and quality systems.
3. Hops, laboratory analysis for Alpha Analytics and YCH grower-owners.
4. Hop quality initiatives
    - Grower feedback
    - Process improvement (harvest, kilning, pelleting, storage)



Outline

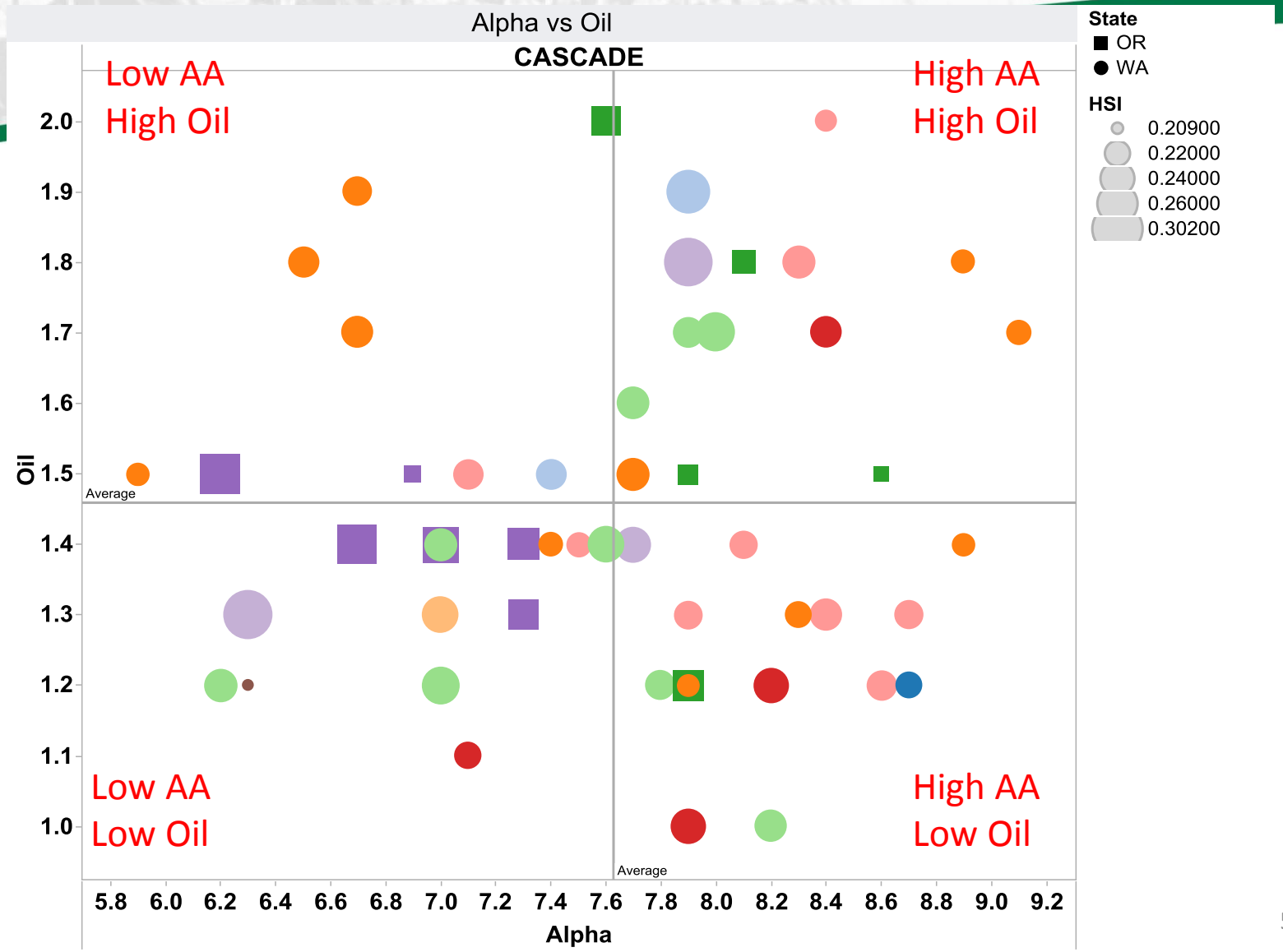
1. Quality Factors
    - Varietal Purity
    - Growing Practices
    - Approaches to handling variability
2. Growing for Oil vs Alpha
    - Bitterness vs. Aroma
    - Alpha and Oil development
    - Determining Harvest Timing
    - Analytical vs. Sensory
    - Early vs. Late Harvest
3. Post Harvest Hop Quality
    - Moisture and Kilning
    - Hop Storage Index (HSI)
    - Hop quality and storability
4. Pellet Production & Storage

I. Quality Factors

- Regional/Abiotic – latitude, climate, soil structure
- Root Stock Age, Health and Purity
- Cultural Practices
  - Burn back, training, vines/acre, cover cropping
- Harvest Timing
- Harvest Handling
  - **Pickers, kilns, farm storage, processors, merchant storage.**
- Post-Harvest Processing
  - **Raw hop packing, pelleting, storage, transport.**

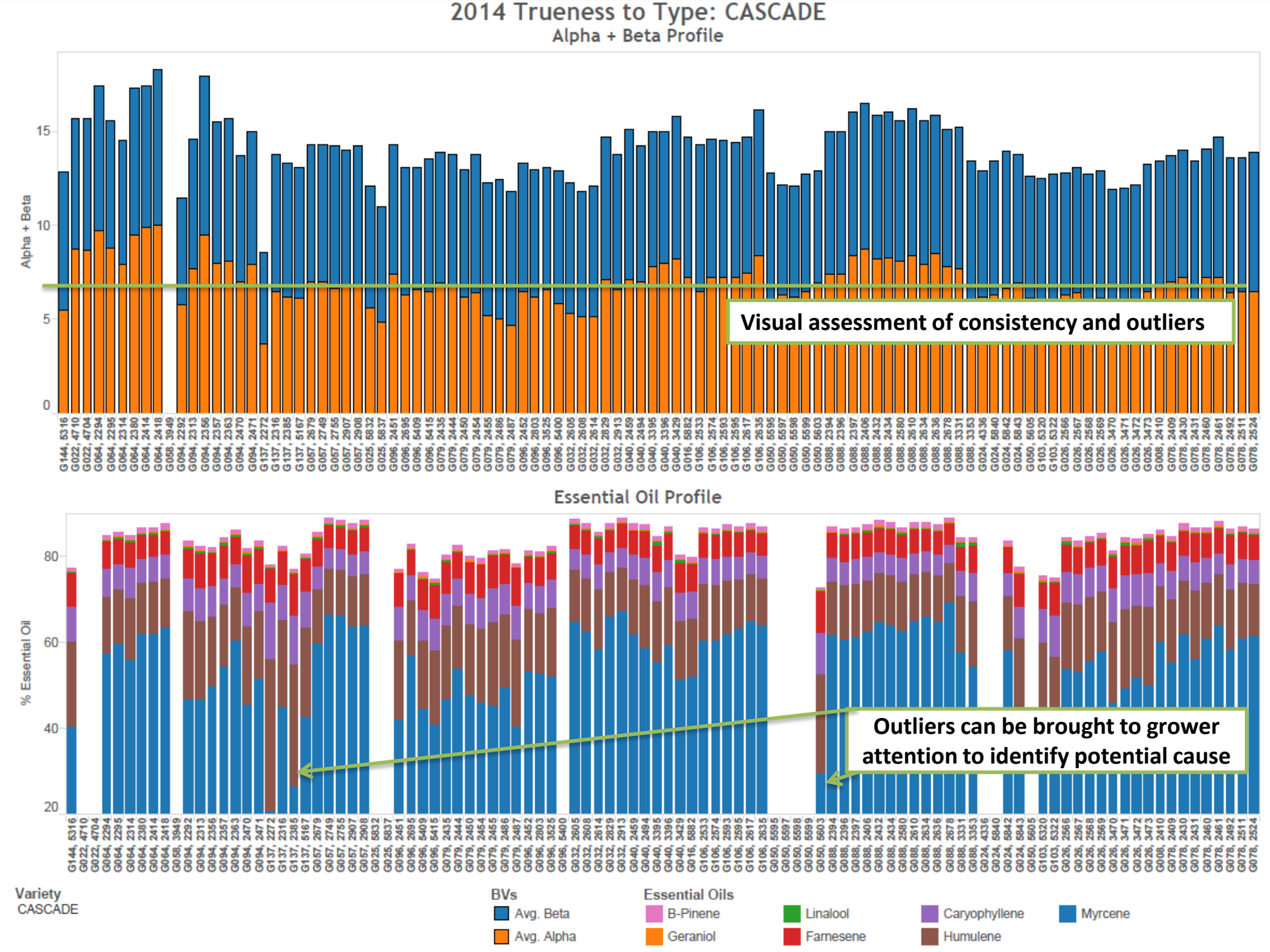
Considerable alpha and oil variability in Cascade

What are the sources?



Varietal Purity

- Clonal propagation from a single parent for multiple generations
- Accumulates disease over time
- Susceptible to competition from off-types (other varieties)
- Presence of males


2014 Trueness to Type: CASCADE
Alpha + Beta Profile
Alpha + Beta
Visual assessment of consistency and outliers
Essential Oil Profile
% Essential Oil
Outliers can be brought to grower attention to identify potential cause
Variety
CASCADE
BVs
Avg. Beta
Avg. Alpha
Essential Oils
B-Pinene
Geraniol
Linalool
Farnesene
Caryophyllene
Humulene
Myrcene

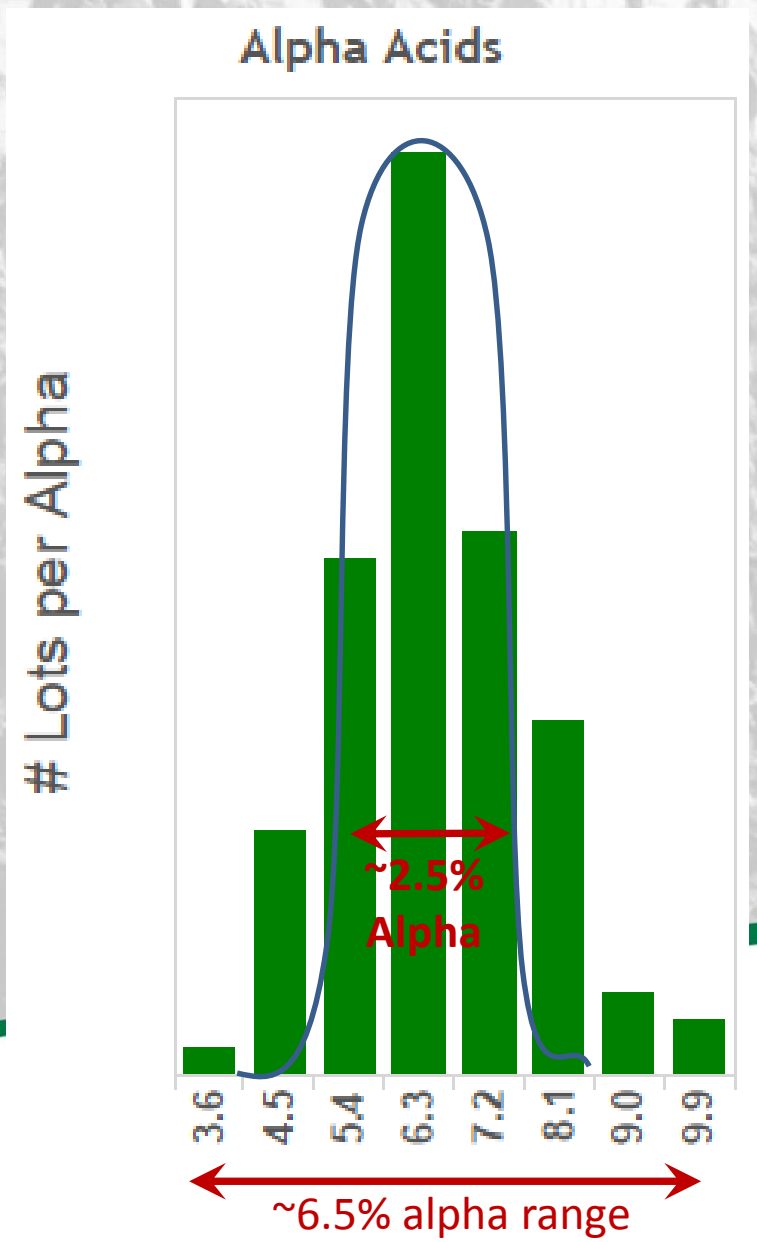
Propagation

Establishment

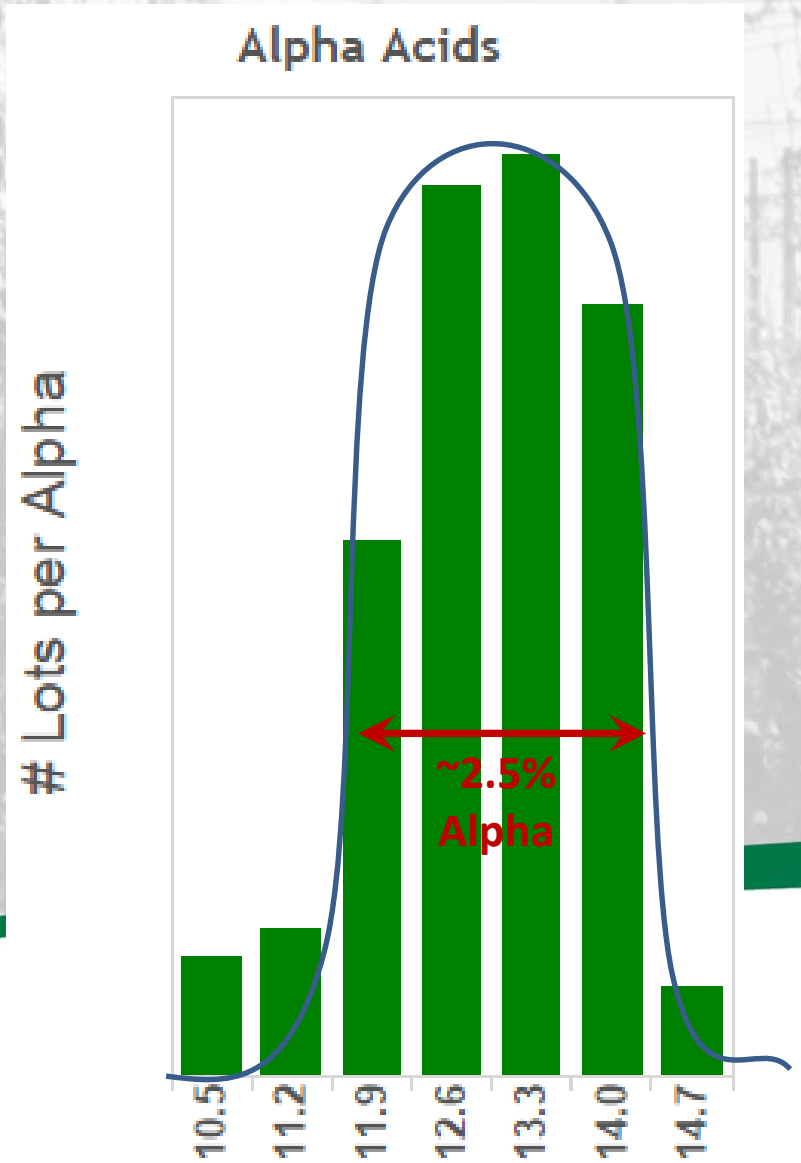
Other factors: Yard age, virus free, males, pest pressure

Other factors: Salmon Safe, Global GAP, Organic, IPM, Fertility…

Cascade



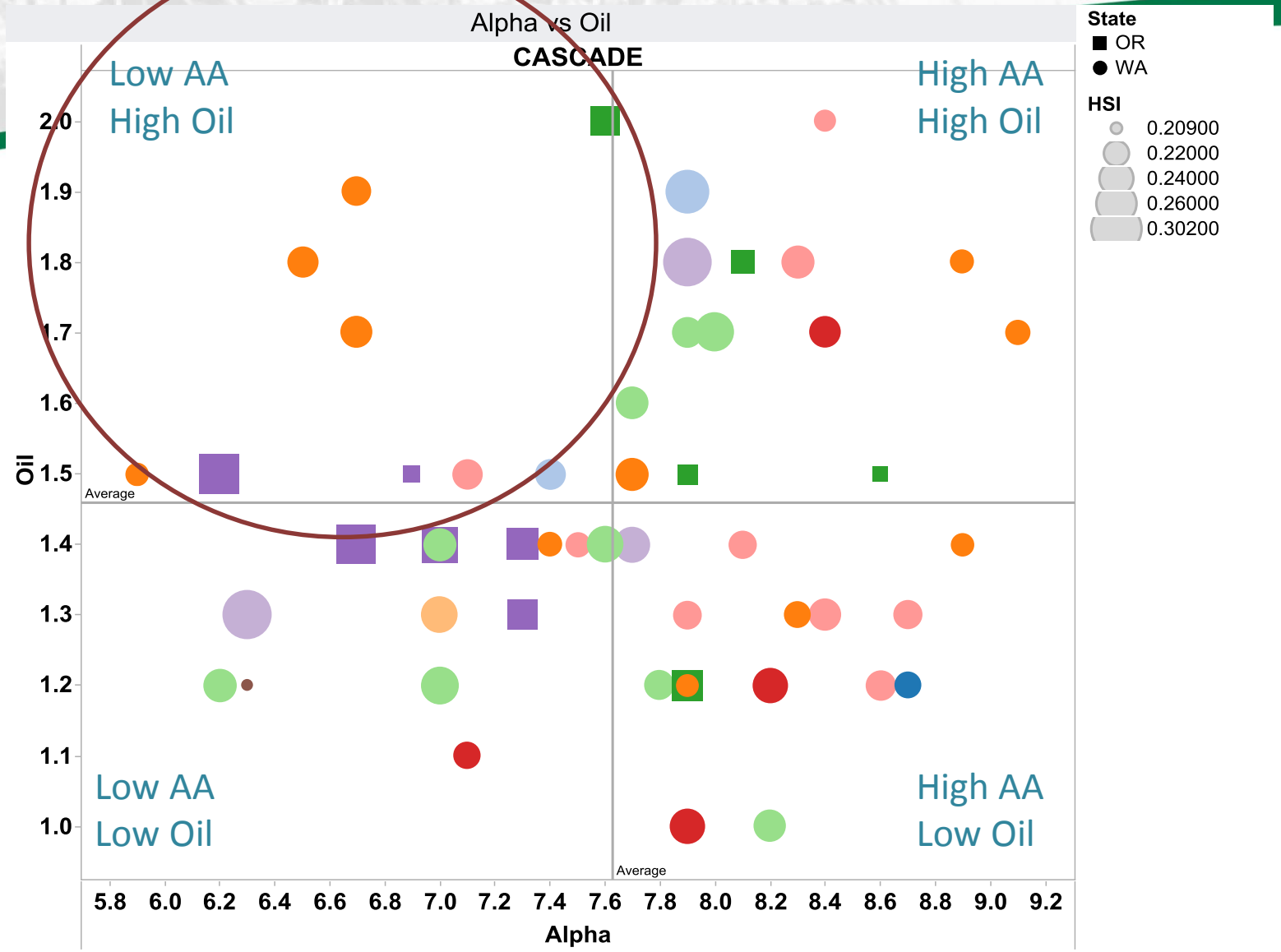
Simcoe® YCR 14 cv.



What's a Supplier to Do?

A. Collaboratively develop Best Farming practices to improve crop consistency
B. Embrace Variation and work with growers and brewers to make the most of it.
C. Blend lots for consistency of the varietal

Do you embrace the variability or try to homogenize the crop?



II. Growing for Alpha vs Oil

(Bittering) (Aroma)

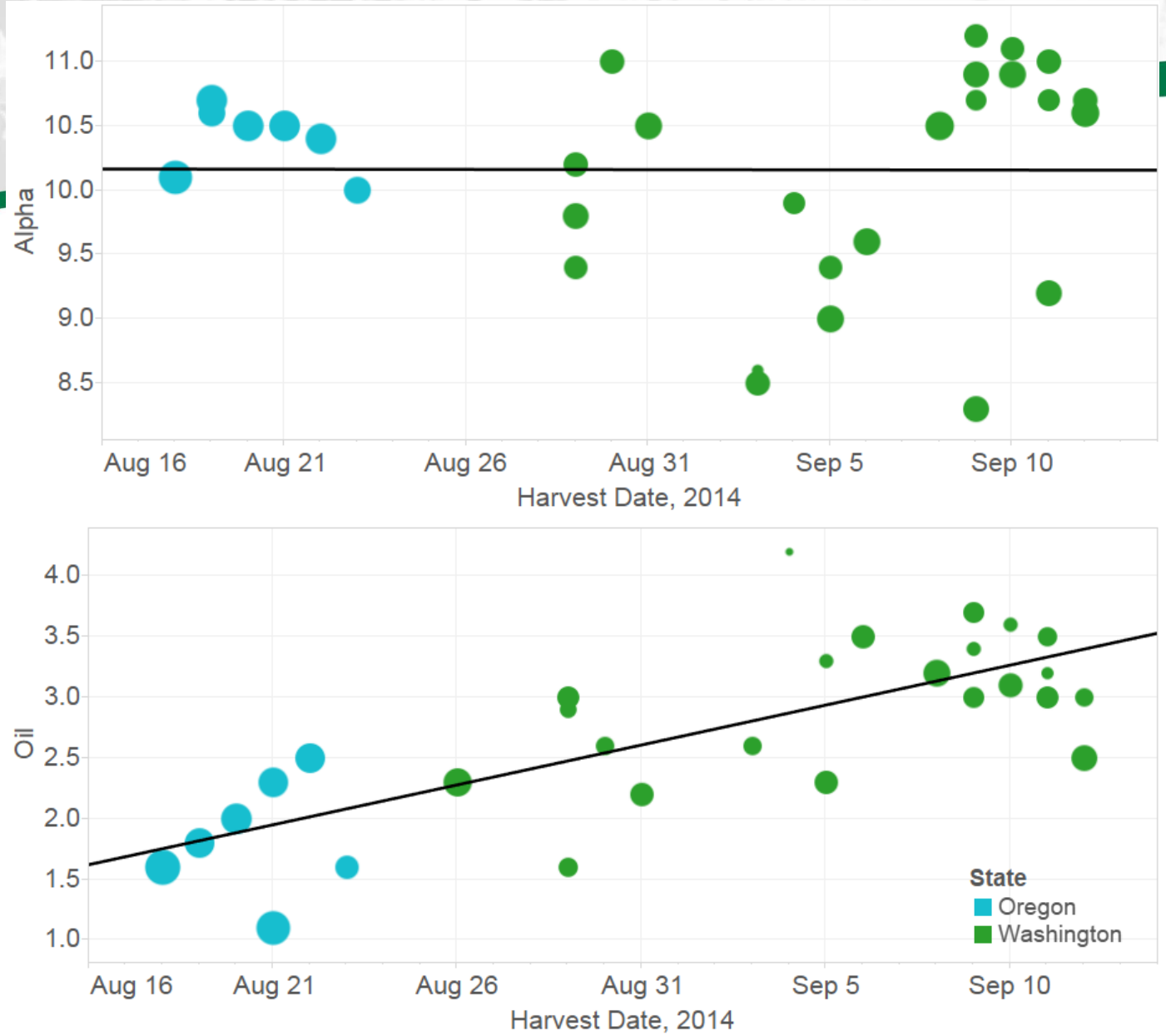
Bittering Hops

- Hops boiled for a long time to stabilize bitterness.
- Typically, most aroma character is lost when hops are used for bittering.
- Brewers have many choices for adding bitterness.
- Super-alpha varieties: CTZ, Apollo, Bravo, Warrior, etc.
- Advanced products: CO_2 extract, Isomerized extracts, etc.

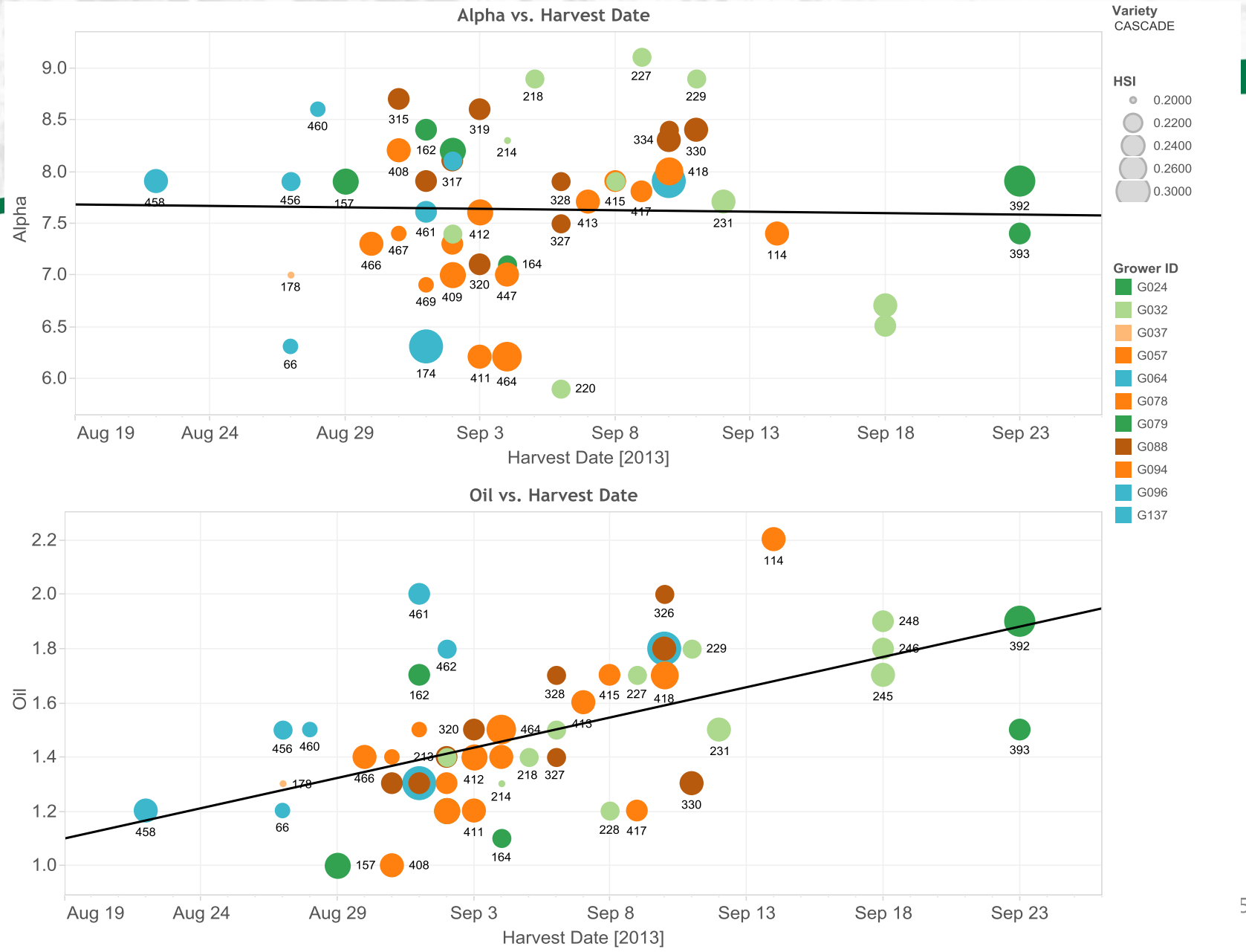
Aroma Hops

- Boiled for short time or not at all.
- Delicate aroma compounds are retained, some bitterness is produced at high hopping rates.
- Majority of hops in craft breweries are used for aroma.
- Highlights uniqueness of hop, making the beer unique!

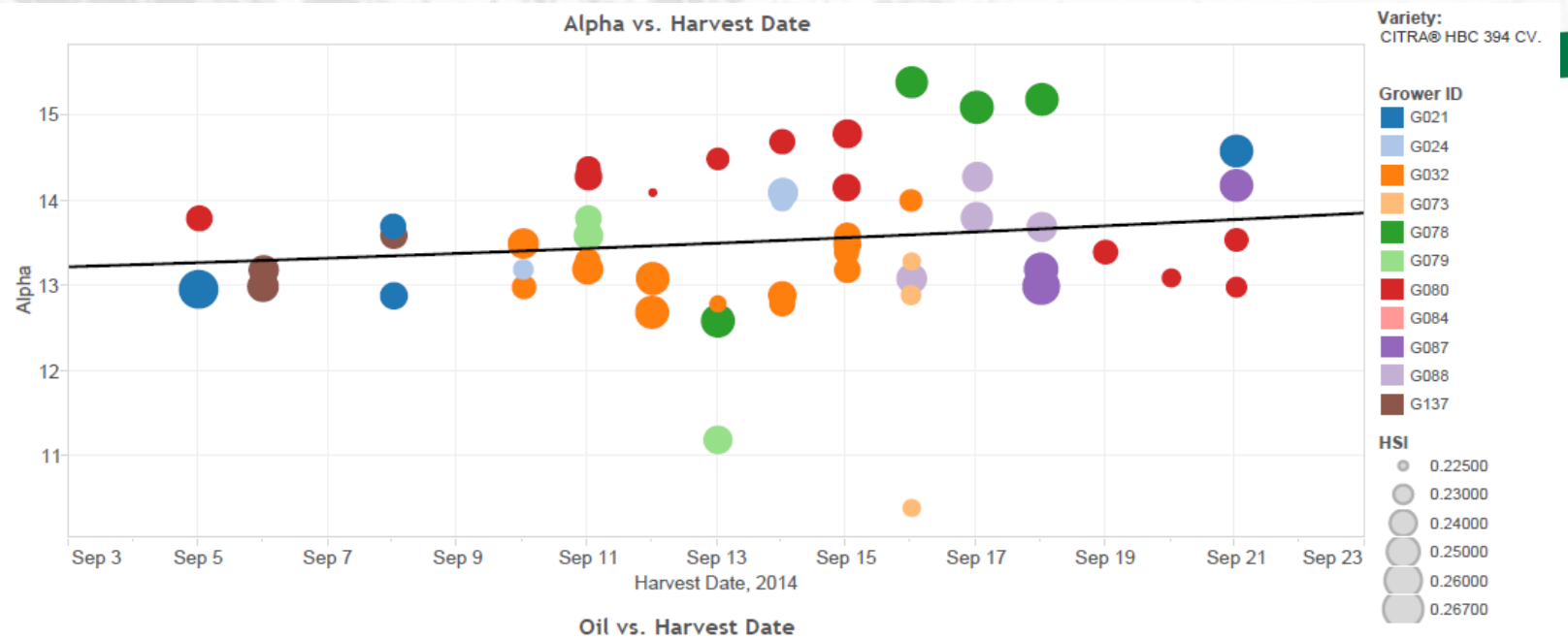
Growing for Alpha vs Oil (Centennial)

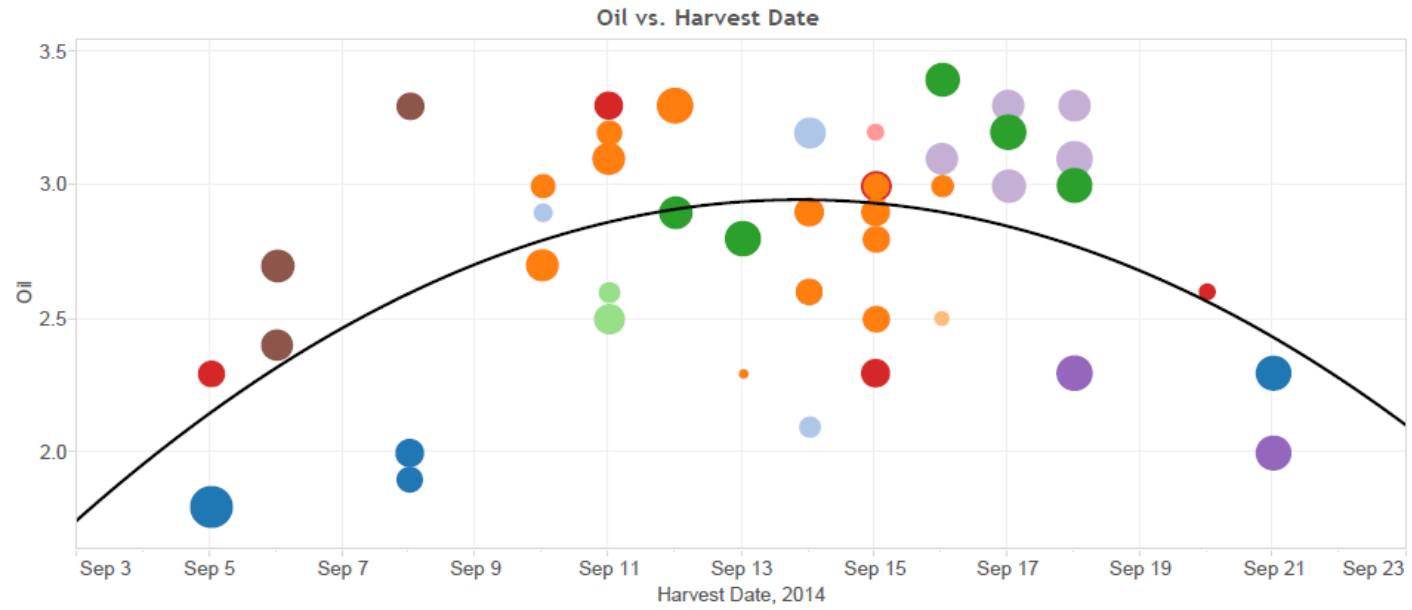


Growing for Alpha vs Oil (Cascade)



Growing for Alpha vs Oil (Citra®)





Determining Harvest Timing

Harvest too Early

- Low Alpha
- Low Oil
- Reduced yield *next year*

Harvest too Late

- Poor aroma (onion, garlic)
- Oxidation (cheese, storability)
- Disease & Pests

Determining Harvest Timing

Dry Matter – Easy to test at home

- "Classic" method
- Hop cones dry naturally as they mature
- Mature cones have ~22-23% dry matter (77-78% moisture)

Alpha vs Oil development – requires lab equipment

- Harvest when target alpha is reached
  - ✓ What if target is never reached?
- Harvest when oil stops increasing
  - ✓ What if oil doesn't stop increasing?

Know your crop, use your senses

- Onion / Garlic
- Pests
- Browning cones
- Grassy / Vegetal / Green aroma
- Dankness!

http://www.uvm.edu/extension/cropsoil/wp-content/uploads/Hop_harvest_fact_sheet.pdf

III. Factors that affect post-harvest hop quality

- Light
  - Never good, but especially bad if the cones and glands are broken, easy to control
- Heat
  - Accelerates chemical breakdown (oil and alpha)
  - Hops at 75° degrade 4x faster than frozen
- Oxygen
  - Loss of bitterness
  - Cheesy aroma
- Moisture

Hops should be dried to 8.5-10.5% moisture

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Pitfalls when drying

- Outer bracts dry quickly.
- Inner strig retains moisture longer.
- Hops feel dry, but moisture remains inside.
- Moisture equalizes in bag, causing hops to feel soggy.

Simple method for drying samples of hops

- Standard household food dehydrator.
- Insert thermometer in top vents.
- Target 135°F (57°C)
- Maximum airflow.
- 3-4 hours on our dehydrator…

Drying and measuring moisture:
http://msue.anr.msu.edu/news/drying_hops_on_a_small_scale
http://www.uvm.edu/extension/agriculture/engineering/?Page=hopscalc.html

Processing and Kilning Practices

24 – 36 hours harvest to bale

Delmhorst G-34 Baled Hop Moisture Meter

1. No birds, no sticks, no poop!
2. Gentle handling at all stages is critical.
3. Kilning
   - Target 125 - 140°F
   - Can start with higher temps, decreasing as hops dry
   - Maximize airflow to carry away moisture
   - Measure moisture to achieve 8.5-10.5%
   - Adjust bed depth to minimize stratification
4. Cooling
   - Gently move to cooling floor or circulate cool air
   - Allows moisture to equalize
5. Baling
   - Protects hops from shatter
   - Reduces oxygen contact in storage

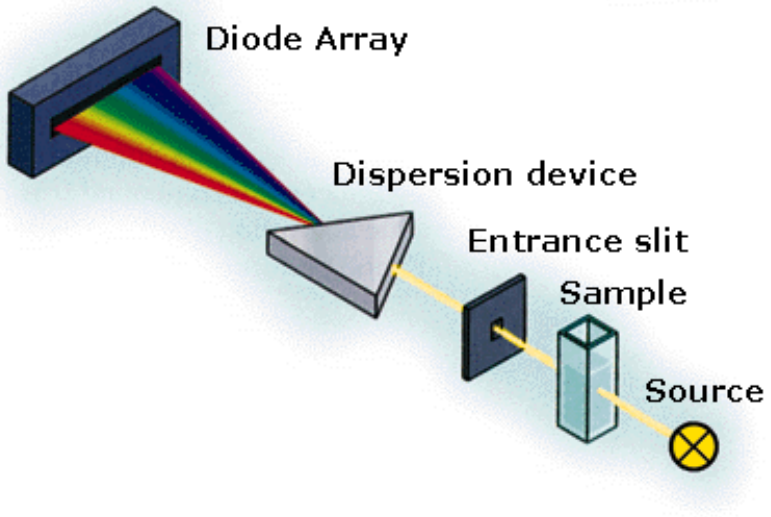
Metrics of hop quality

- Dankness
- Onion / Garlic / Cheese
- Alpha, Oil
- Hop Storage Index (HSI)

  Alpha Acid potential lost in 6 months, at 68°, in bales

  Please don't store bales at room temperature!!!

Hop Storage Index (HSI)



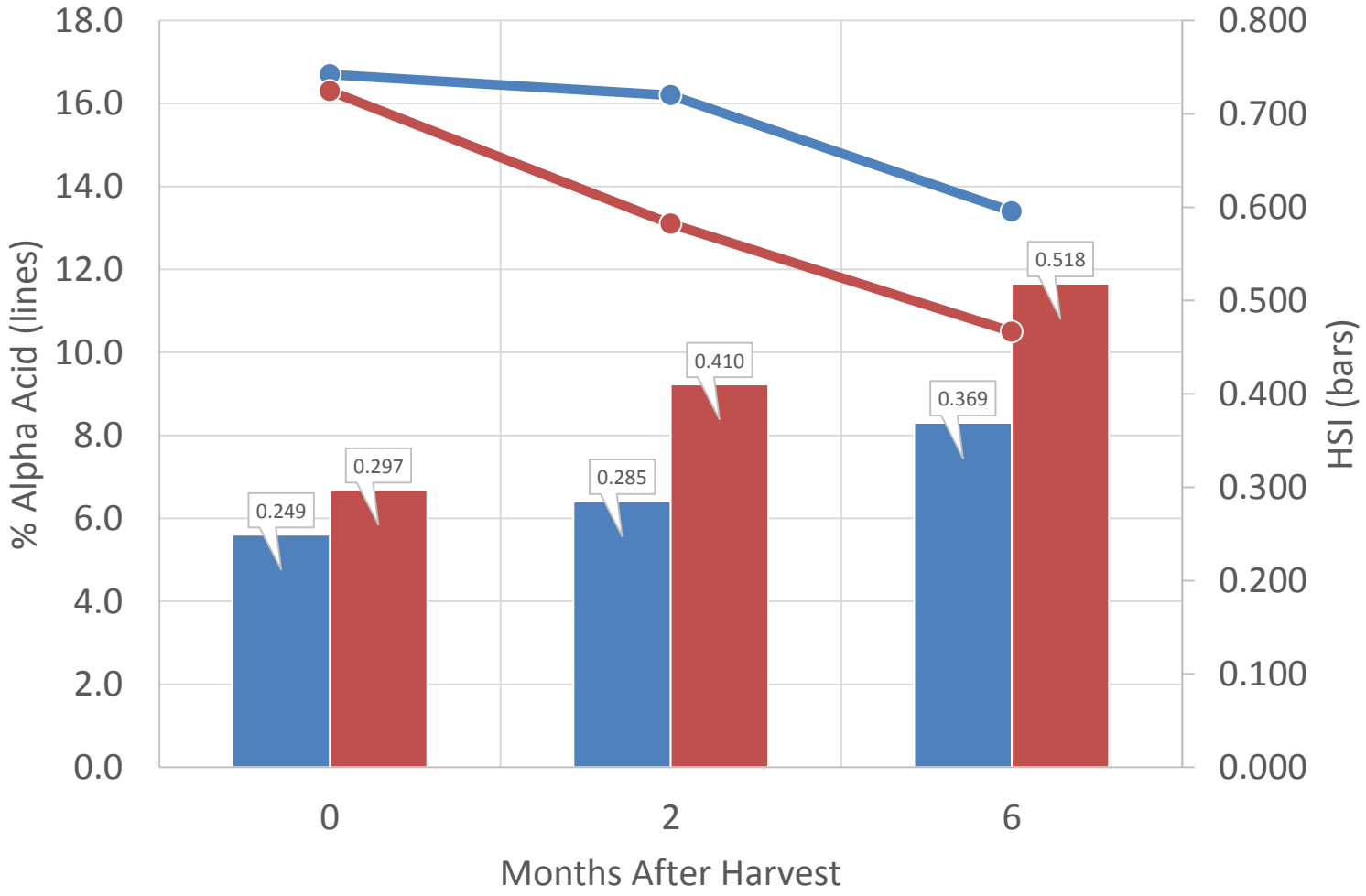
- Hop compounds absorb specific wavelengths of light.
- Oxidation compounds absorb light near 275 nm, Alpha Acids absorb near 325 nm*.

$$\frac{Oxidation\ Compounds}{Alpha\ Acids} = \frac{Absorbance@275}{Absorbance@325}$$

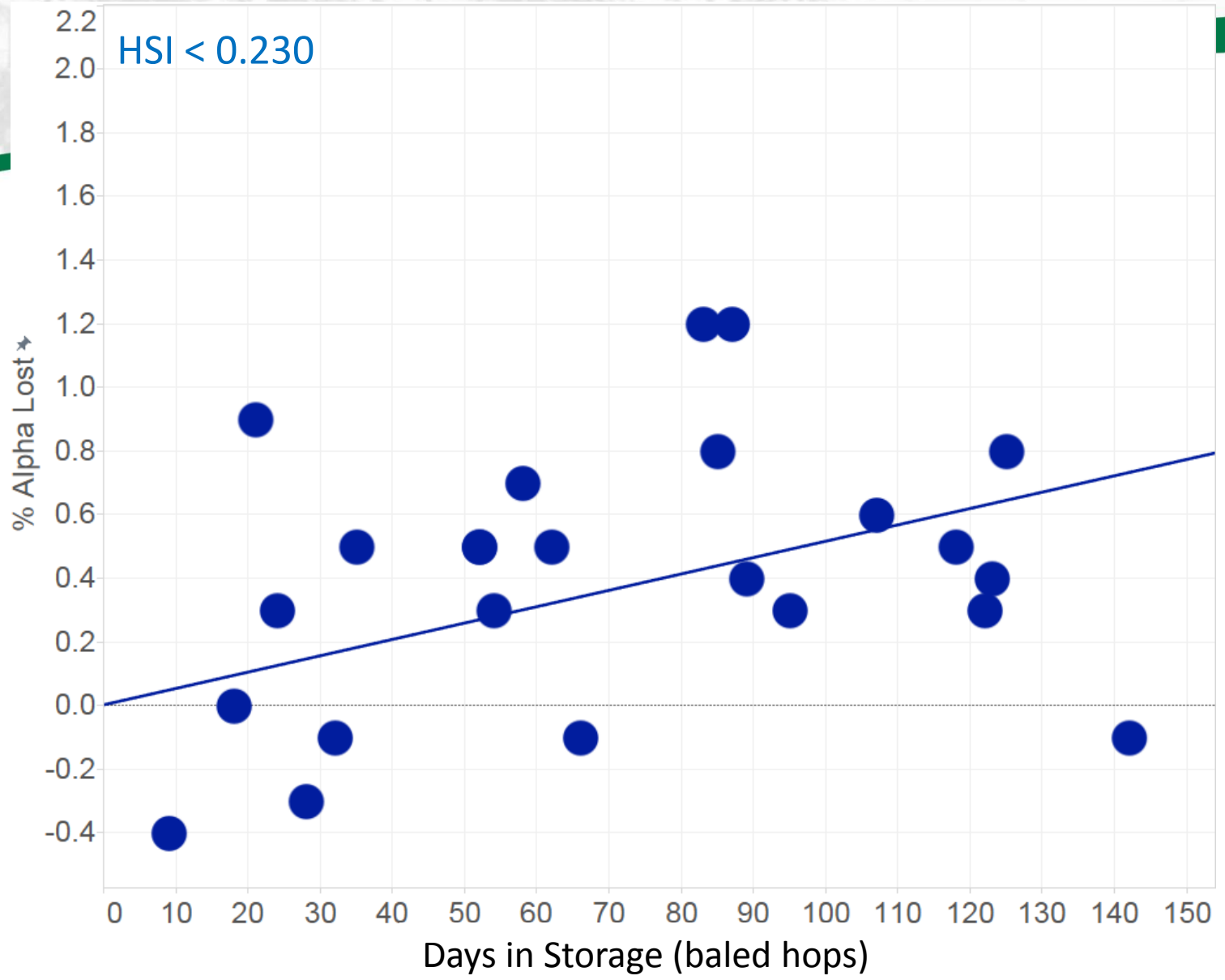
- As hops age, alpha decreases, oxidation products increase, and HSI goes up.
- HSI is an indicator of hop degradation, but DOES NOT enable calculation of future alpha loss (e.g. “after 6 months…”)

* Note that this is an oversimplification

Degradation of Tomahawk® baled hops



Alpha loss is greater with high harvest HSI



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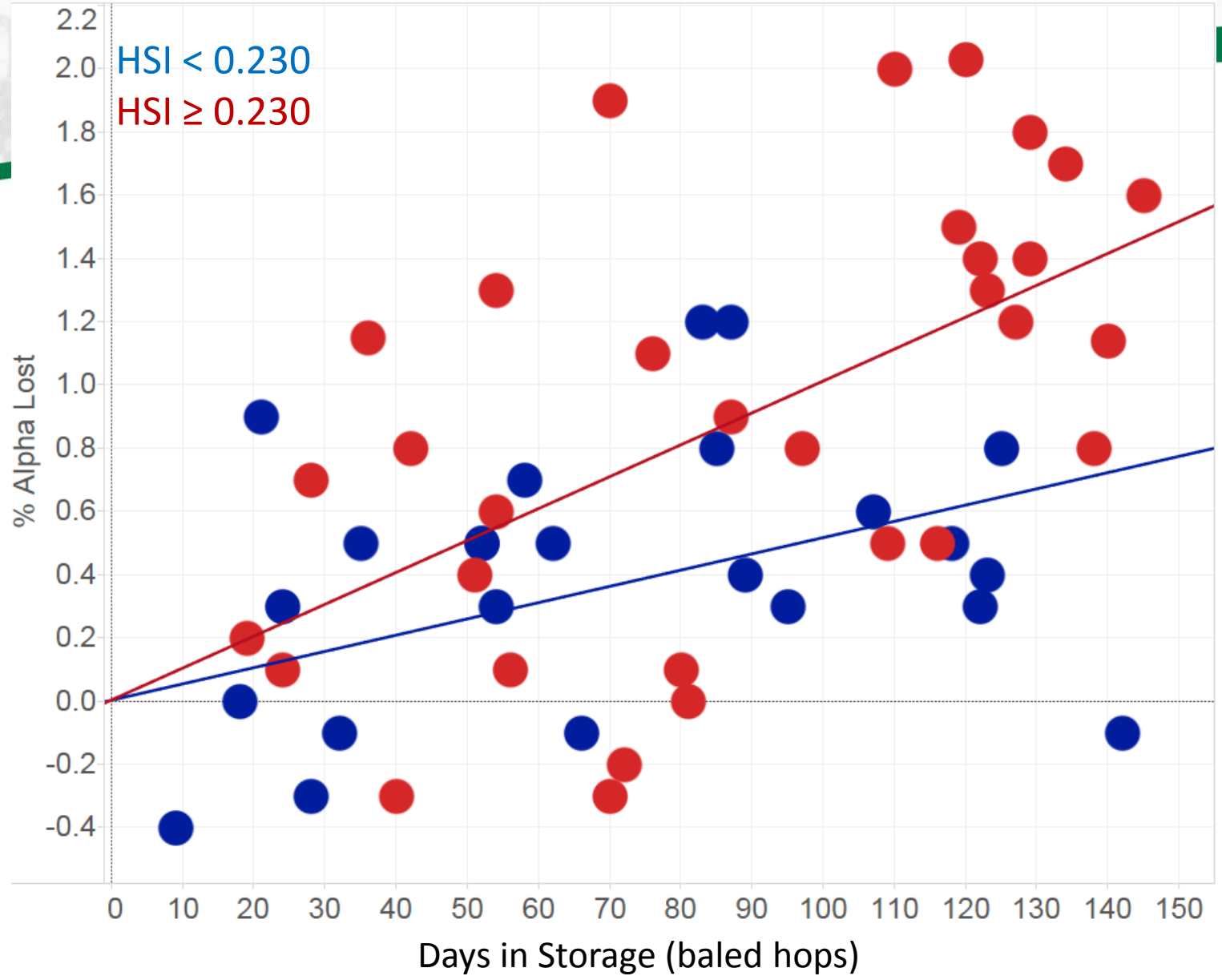
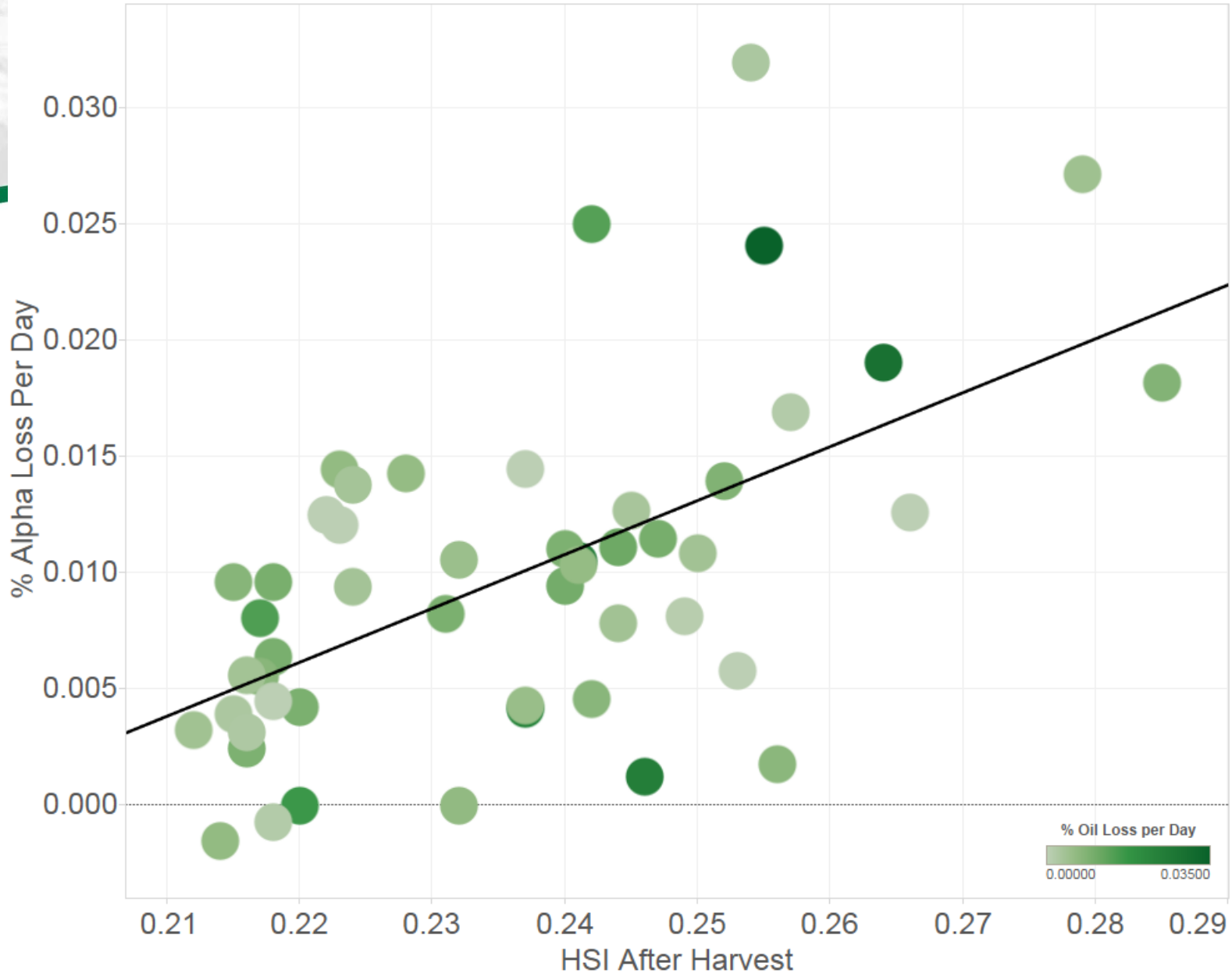
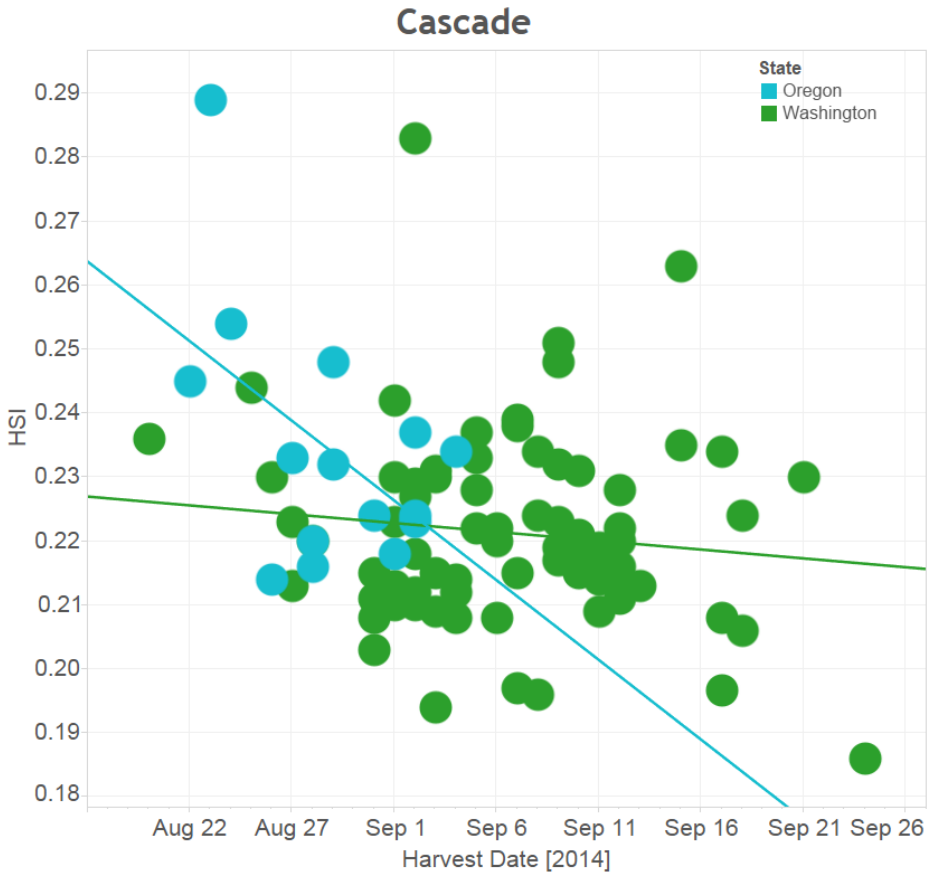
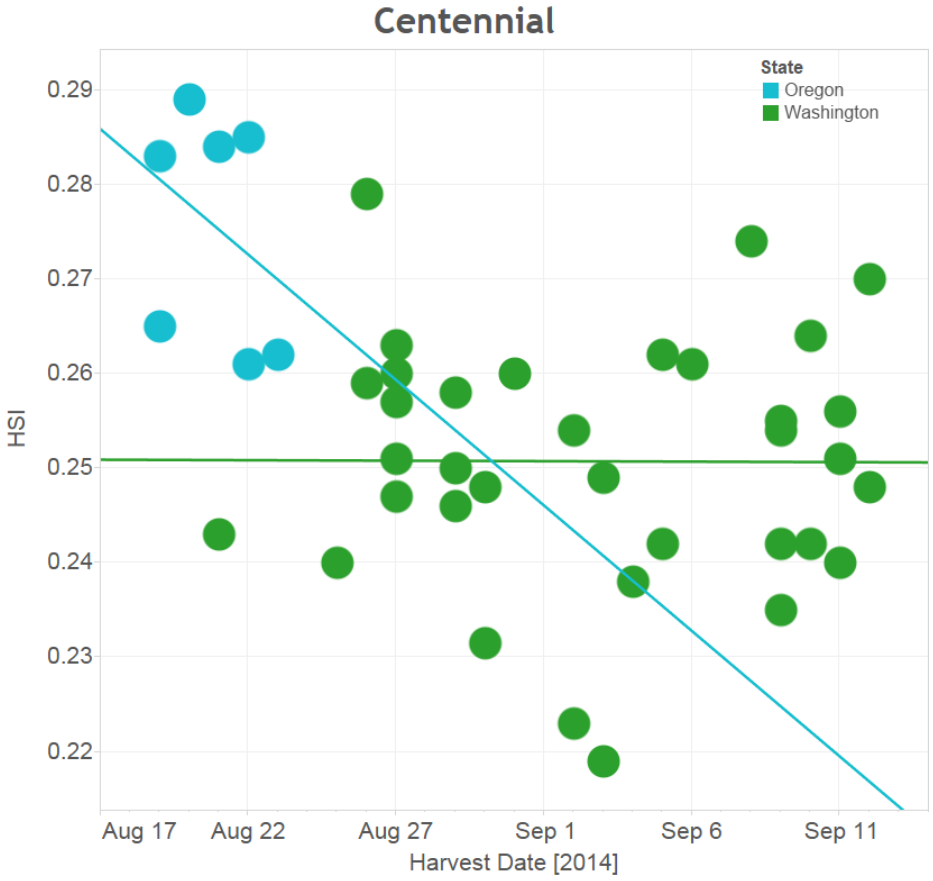


High harvest HSI loses more alpha per day

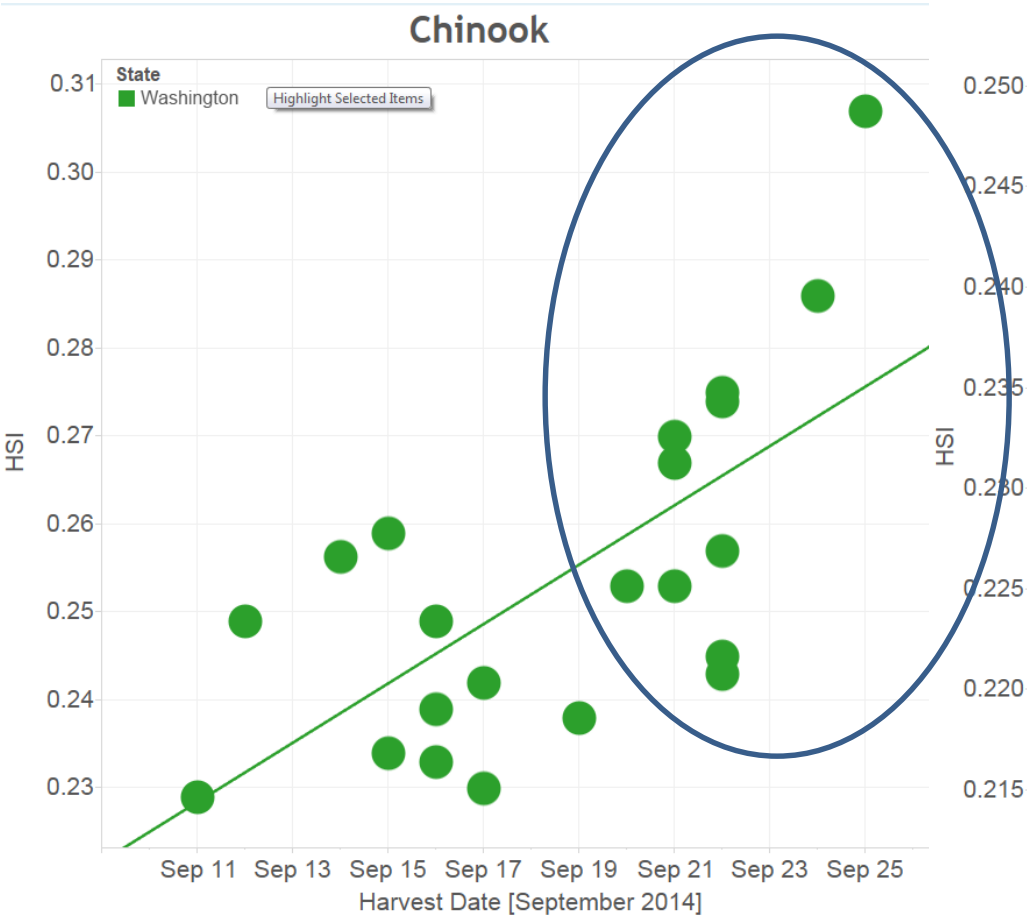


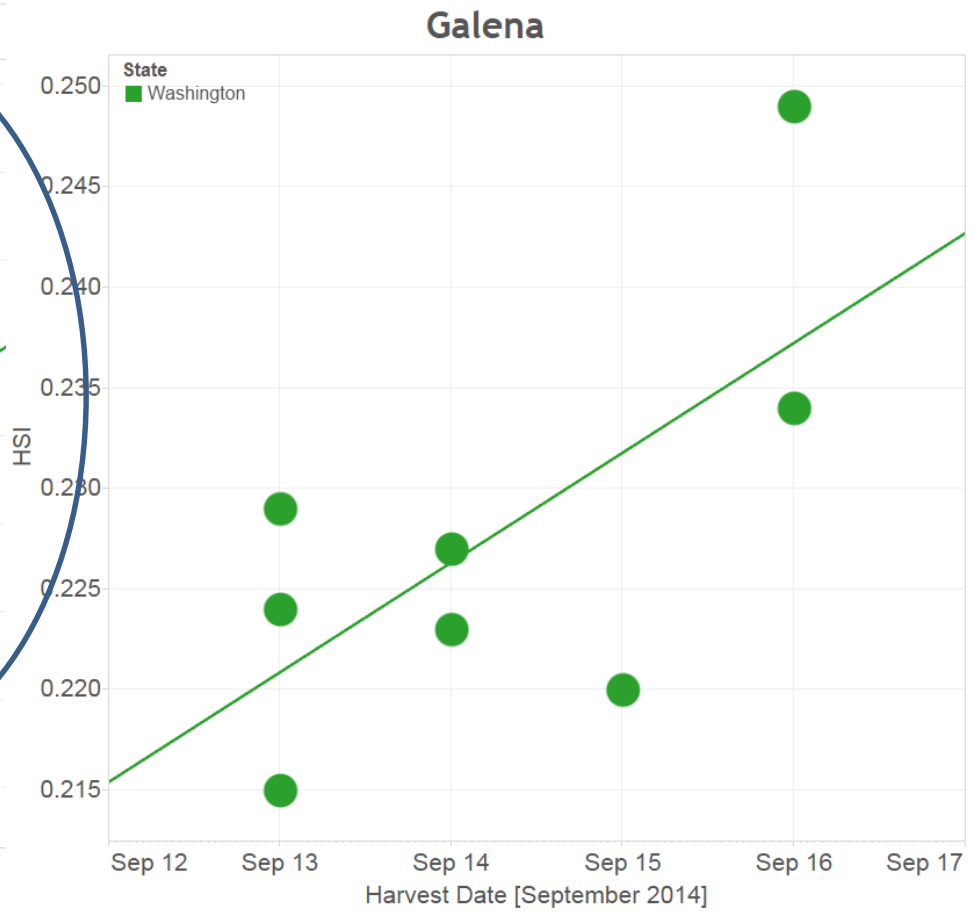
HSI generally does not increase through the “normal” harvest window



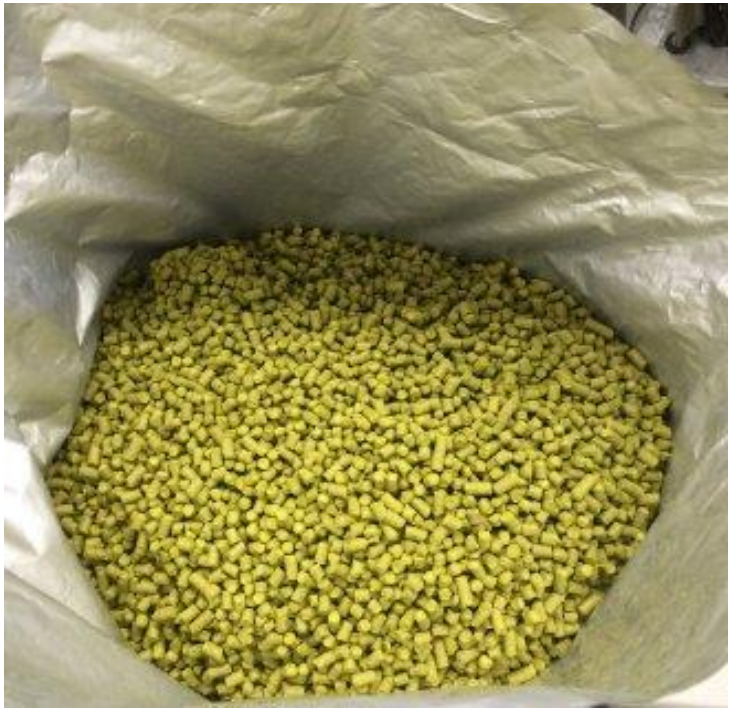


Two exceptions in our data





IV. Pelleting and Storage



Pelleting significantly slows degradation

- Pellet HSI = Harvest -> Pelleting
- Does not accurately predict Alpha Acid breakdown once pelleted.

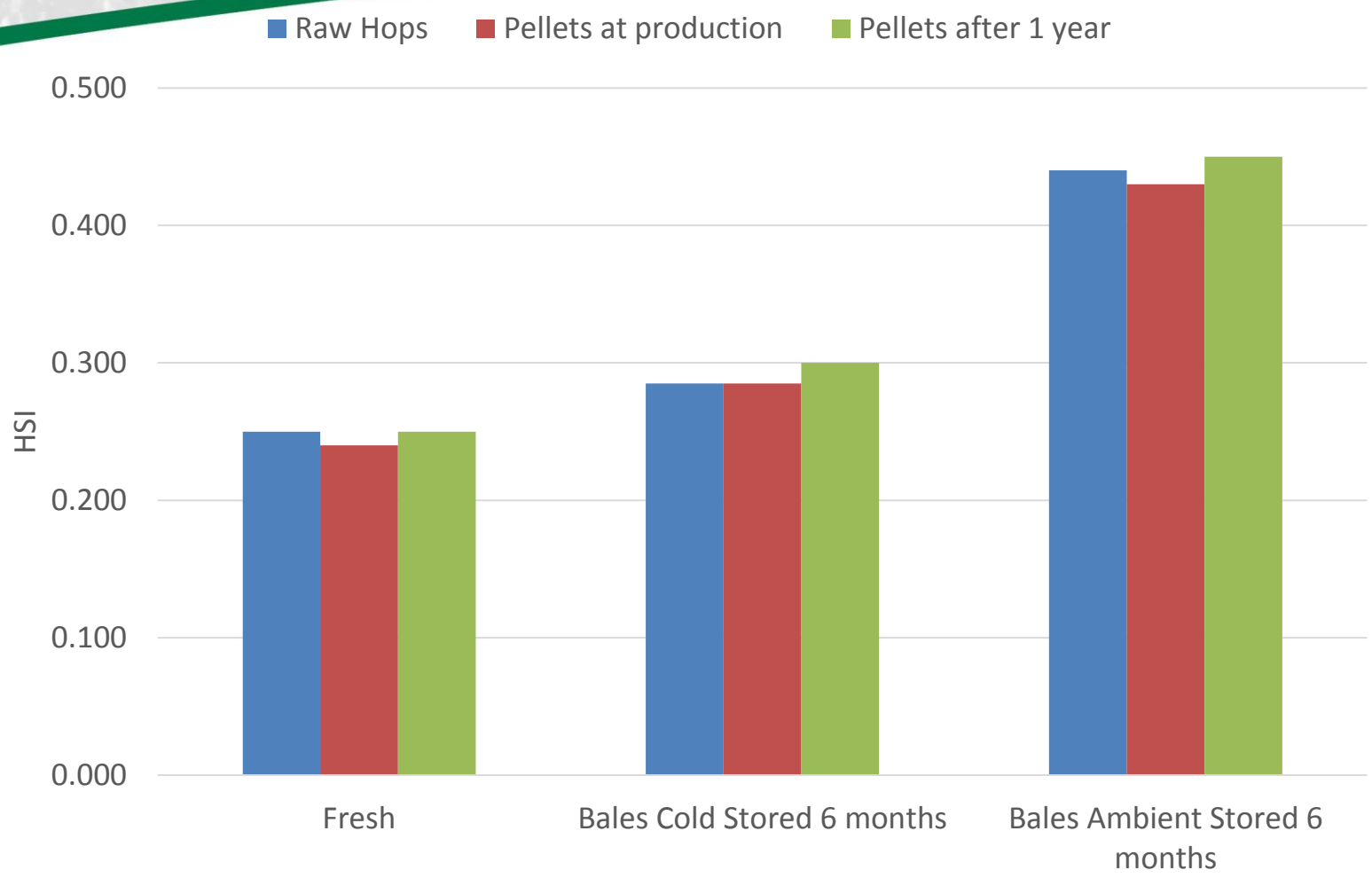
Best practices

- Consistent, fine, grind.
- Die cooling (liquid N).
- Inert gas packaging (N and/or CO_2).

Why?

- Grind size = pellet consistency (manufacturing) and extraction efficiency (brewing).
- Milling ruptures lupulin glands, exposing resins and oils to oxygen.
- Heat and oxygen can cause rapid degradation.

Pelleting slows the aging process



Forster, A. 2001. The importance of crop year for evaluating hop products. *Brauwelt International.* 1:32-37.

Recognizing Pellet Quality


Observations
• Inconsistent coarse grind
• Off color bits
• Density too low = oxygen

Observations

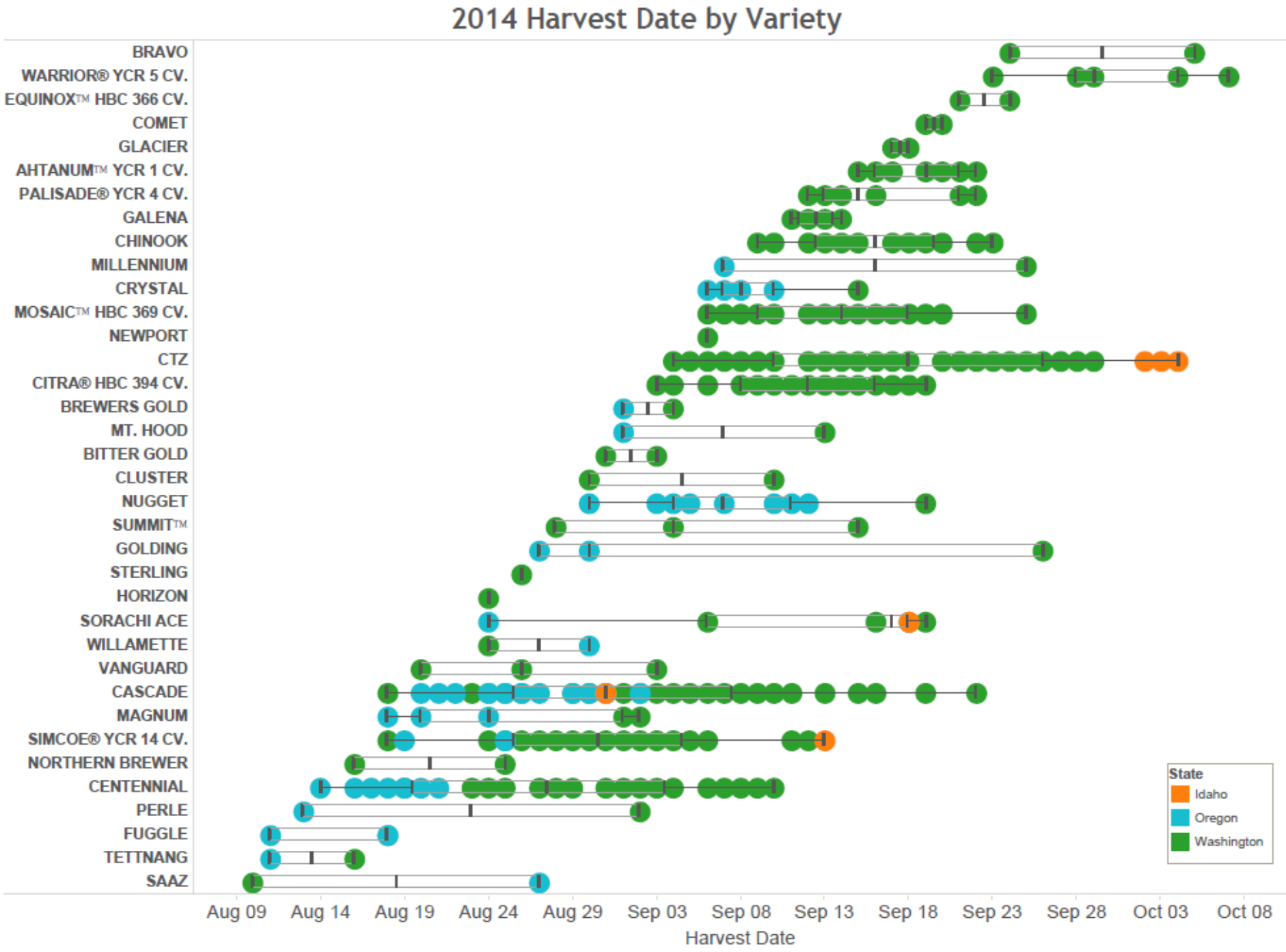
- Nice dull surface
- Consistent color
- Firm

High Quality Pellets

1. Dull, but smooth surface.
   - NOT glossy (density, temp, feed rate issue)
   - No gaps, cracks, large pores.
2. Consistent color.
   - Hops naturally vary in color, pale or dark OK if consistent.
   - No individual dark pellets (inconsistent feed).
3. Intermediate density.
   - Crushable between fingers.
   - Too hard = poor dispersion in fermenter.
   - Too soft = oxidation, dust in bag.
4. Hard vs. Soft Pack
   - Resinous hops tend to form solid bricks when vacuum (hard) packed.
   - Brewers generally prefer soft pack.

Summary

- ✓ Alpha is generally stable within the harvest window
- ✓ Oil generally increases throughout harvest window
- ✓ Brewers generally shopping for aroma hops
- ✓ Trend would suggest harvesting as late as possible to maximize oil / aroma.
- ✓ *Post-harvest processing and pelleting critical to preserving alpha, oil, and aroma, can negatively impact HSI*


2014 Harvest Date by Variety
BRAVO
WARRIOR® YCR 5 CV.
EQUINOX™ HBC 366 CV.
COMET
GLACIER
AHTANUM™ YCR 1 CV.
PALISADE® YCR 4 CV.
GALENA
CHINOOK
MILLENNIUM
CRYSTAL
MOSAIC™ HBC 369 CV.
NEWPORT
CTZ
CITRA® HBC 394 CV.
BREWERS GOLD
MT. HOOD
BITTER GOLD
CLUSTER
NUGGET
SUMMIT™
GOLDING
STERLING
HORIZON
SORACHI ACE
WILLAMETTE
VANGUARD
CASCADE
MAGNUM
SIMCOE® YCR 14 CV.
NORTHERN BREWER
CENTENNIAL
PERLE
FUGGLE
TETTNANG
SAAZ
Aug 09
Aug 14
Aug 19
Aug 24
Aug 29
Sep 03
Sep 08
Sep 13
Sep 18
Sep 23
Sep 28
Oct 03
Oct 08
Harvest Date
State
Idaho
Oregon
Washington

Thank you!

Ashley Trenkenschuh
Brad Titus
Amanda Smalling
Alex Jensen
Joe Catron
Zach Turner
Missy Raver
Steve Carpenter