Hop Seed Experiments

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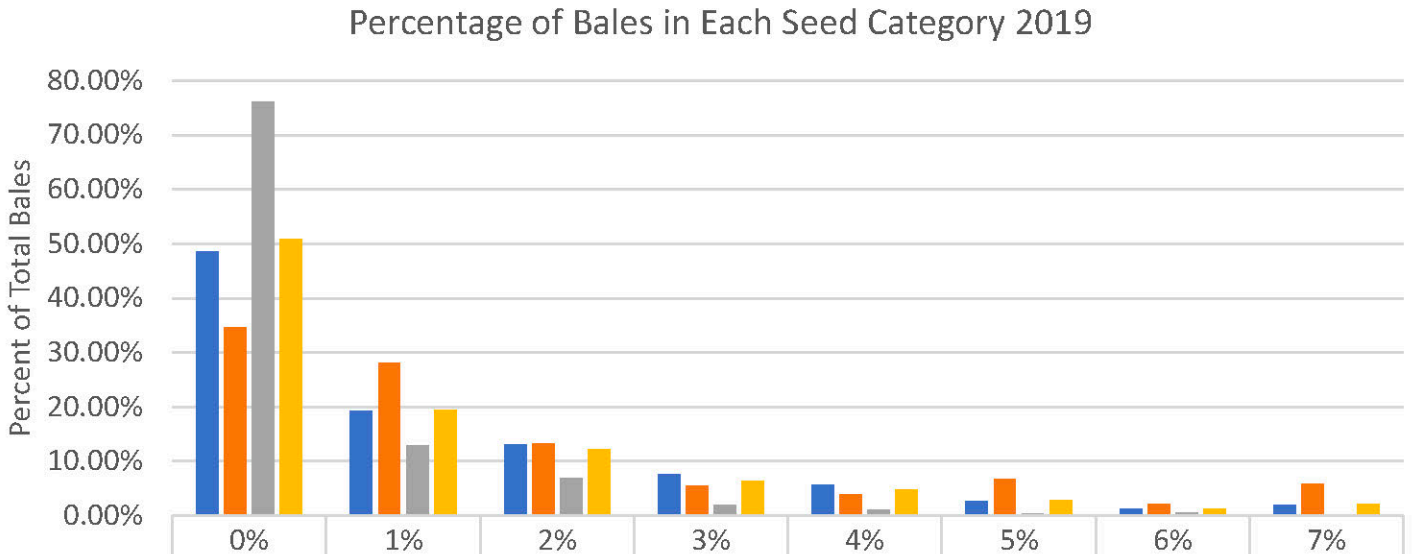
Objectves

- Does the seed count of what we receive at RRBC match that of the agricultural reports?
- Does seed count have an impact on hop creep?
- Is there varietal variability in the enzymatic potential of seeds?

Hop Growers of America 2019 Statistical Report



	0%	1%	2%	3%	4%	5%	6%	7%
WA	48.59%	19.25%	13.07%	7.53%	5.74%	2.73%	1.19%	1.90%
OR	34.68%	28.03%	13.25%	5.43%	3.93%	6.71%	2.10%	5.88%
ID	76.02%	12.98%	6.91%	1.98%	1.16%	0.46%	0.50%	0.00%
TOTAL	50.88%	19.44%	12.18%	6.44%	4.83%	2.90%	1.21%	2.12%

Percentage of Bales in Each Seed Category 2019. Seed categories are separated from 0-7% seed content by total weight. Percent of total bales was calculated by taking the percentage of the number of bales for each seed category in comparison to the total number of bales analyzed for each data set (Washington, Oregon, Idaho, and total). Data above was extrapolated from the Hop Growers of America's 2019 Statistical Report (Table 3: Number of Bales in Each Seed Category-2019).

- Average seed content was 1.19%, with a range over the last nine years of 0.45-1.34%
- According to this report, ~70% of all bales are at a seed content of ≤1% BUT this leaves ~30% of bales at a seed content of 2-7%
- Oregon has a higher percentage of bales that have a very higher seed content (4-7%)

Seed Extraction at RRBC

- Seeds were manually extracted from whole cones by tearing open cones by hand and removing seeds with tweezers
- Weights were taken of seed fraction and seedless cone fraction and a percent weight was calculated
- Sample set was taken from bales currently in production at RRBC (2019 crop year) along with brewer's cuts (2019 and 2020 crop years)

Crop Year	Farm (State)	Varietal	% Seeds
2019	Crosby (OR)	Amarillo	**4.96%**
2020	Crosby (OR)	Amarillo	0.22%
2020	Crosby (OR)	Amarillo	2.98%
2020	Crosby (OR)	Amarillo	1.62%
2019	Segal (WA)	Cascade	0.54%
2019	Segal (WA)	Cascade	0.50%
2020	Segal (WA)	Cascade	0.38%
2019	Segal (WA)	Centennial	1.17%
2019	Segal (WA)	Columbus	**5.50%**
2019	Perrault (WA)	Simcoe	0.21%
2020	Loftus (WA)	Simcoe	0.05%
2020	Tributary (WA)	Simcoe	0.10%

2019 WA Simcoe

2019 OR Amarillo

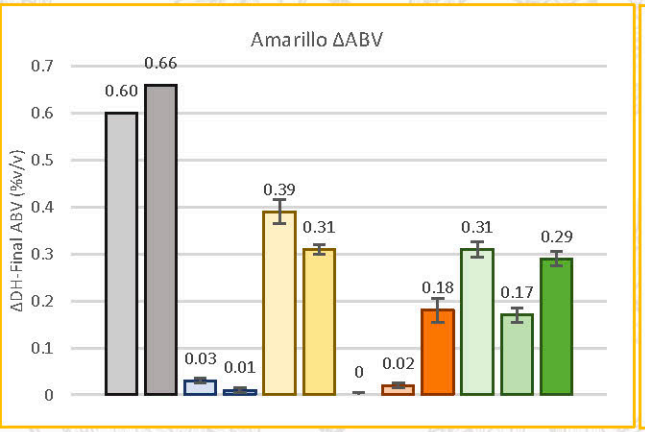
* Large variation between 3 extraction days for 2019 Crosby Amarillo ranging from 3.73-6.55% and low variation between 4 extraction days for 2020 Segal Cascade ranging from 0.41-0.64%
* Variation did not correlate with seed %
* 2019 Crosby Amarillo had high seed % but 2020 Crosby Amarillo had low-moderate seed % but 2019 and 2020 Segal Cascade were comparable

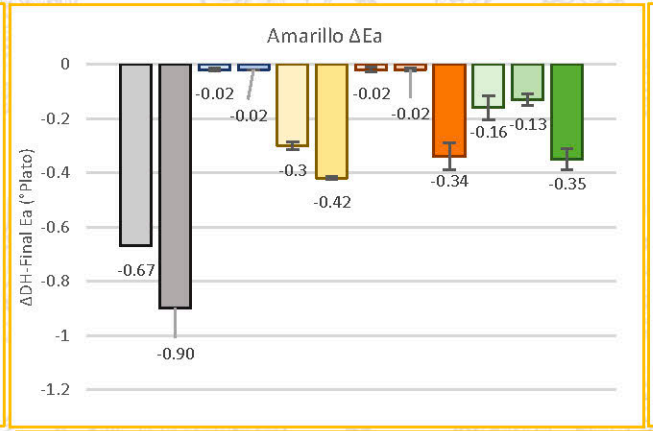
Benchtop Dry Hop Method

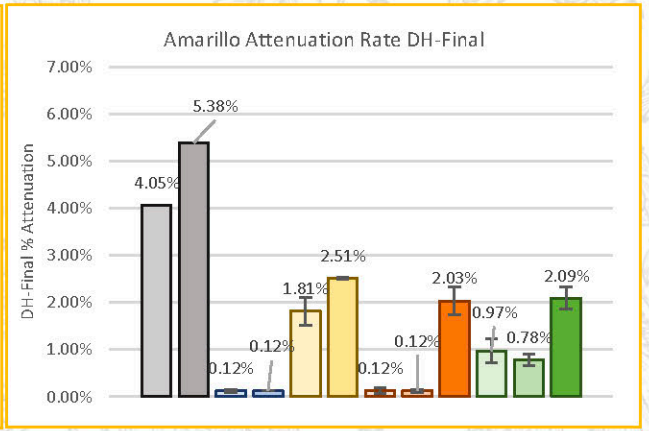
- Pliny the Elder was collected post-fermentation, post-harvest, pre-dry hop into sterile 1L jars
- Jars were set with airlocks and dry hopped at a rate of 2.0lb/bbl using sanitized mesh bags with stainless steel weights in order to fully immerse bags
- Samples- duplicate and triplicate
  - Control- empty bags
  - Seedless cones- whole cones that had seeds removed by hand
  - Seeds- the seeds from the removed whole cones
  - Crushed seeds- seeds from the same extraction method but crushed
  - Unmodified- unmodified whole cones
  - Unmodified open- unmodified whole cones that were shredded by hand to replicate the seed removal process

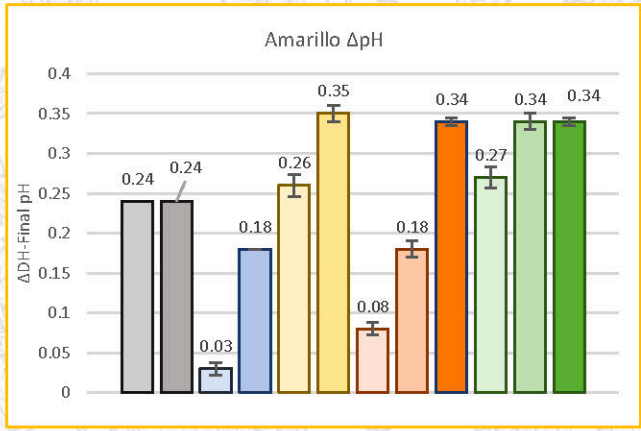
*Seeds were dosed at the relative percent by weight they were found in the whole cone hops they were extracted from (4.5-5.0% for 2019 OR Amarillo and 0.5% for 2019 WA Simcoe) and remaining whole cones were dosed at a rate proportionate to the quantity of seeds removed (95.5-95.0% for 2019 OR Amarillo and 99.50% for 2019 WA Simcoe)

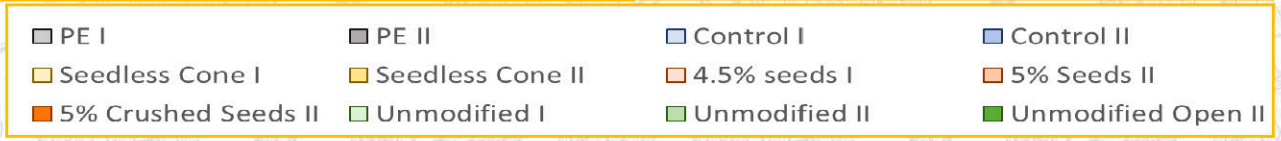
Benchtop Dry Hop Results

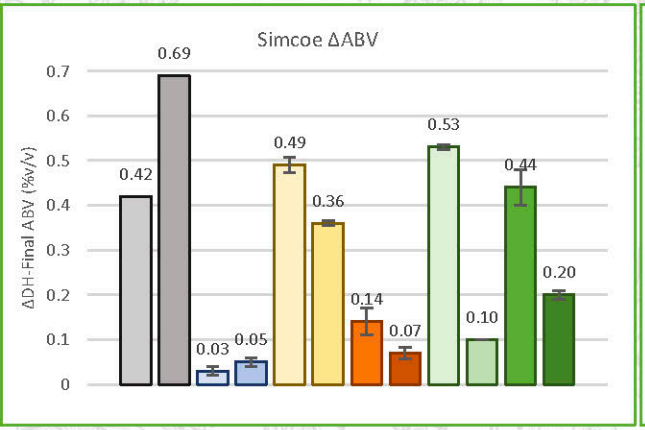


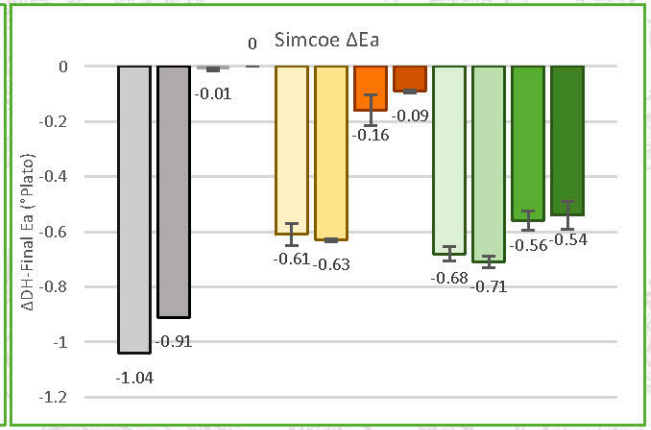


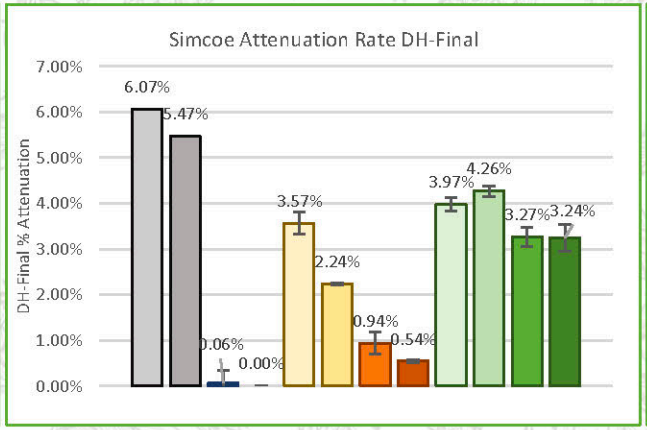


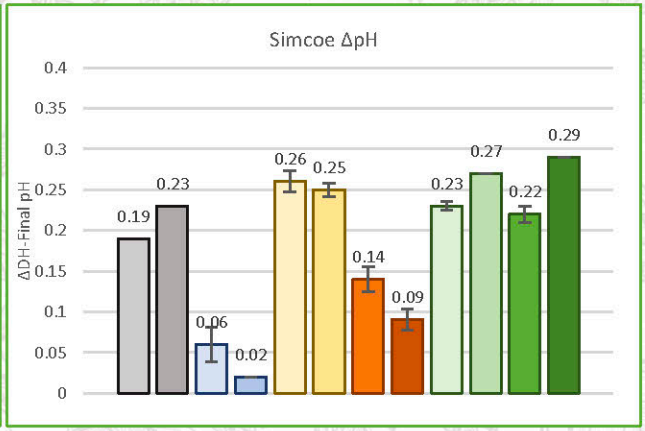












Conclusions

- Benchtop results mimicked variation seen in PE
  - Benchtop attenuation rates were lesser than what is seen in PE
  - Impact of benchtop samples in regards to pH was comparable
- Crushed seeds have a drastic increase in hop creep and pH
- Despite Simcoe having 10-fold fewer seeds per liter than Amarillo, the Simcoe only had a 2.7-fold lower attenuation rate for the crushed seed sample
  - Could be variation in hop creep potential of seeds in each varietal
- Unmodified open was to determine if the manual opening of cones would increase hop creep potential (dry hopping with whole cones vs. pellets)
  - Seedless and unmodified open had slightly higher levels of attenuation than the unmodified for Amarillo
  - Seedless, unmodified, and unmodified open had comparable levels of attenuation for Simcoe
- **A higher seed count could influence hop creep potential in pelletized hops**

Next Steps

- More seed extractions!
- Put together a more cohesive project
  - 2019 vs 2020
  - OR vs WA
  - Amarillo vs Simcoe
- Vary seed dosage in benchtop
- Tearing open manually vs mechanical pulverization