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Closing the Knowledge Gap on Wisconsin Hop Fertility

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Summary of Recent Hop Fertility Work in Wisconsin

2016 – Collected preliminary data on yield, nutrient removal and soil test levels.

- Verified P and K removal were within UW estimates
- Indicated need for further evaluation of recommended N rates

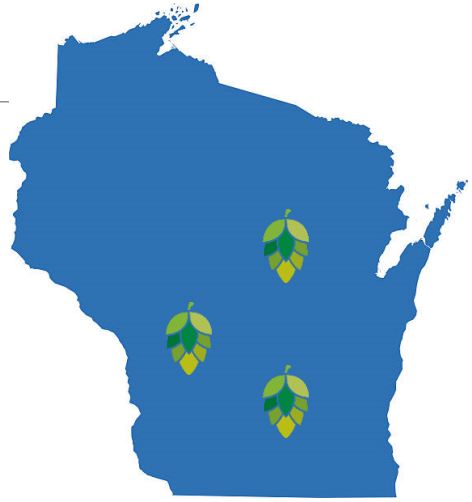
2017&2018 – Conducted study to evaluate effect of nitrogen rate and timing on hop biomass and cone yield. Incorporated petiole nitrate tissue and sap testing.

https://buffalo.extension.wisc.edu/agriculture/barley-and-hops/

2019 – Initiated a 2-year study to determine optimum N rates for Wisconsin growers.

- Included 5 N rates
- Continued petiole tissue and sap testing
- Included post harvest soil nitrate sampling
- Evaluate effect of N rate on hop quality parameters

2019 N Rate Trials



Same locations as used in 2017 and 2018

- Tomah, WI : Centennial and Cascade
- Waterloo, WI: Chinook, Tahoma
- Rosholt, WI: Magnum, Nuggett

Nitrogen Treatments

- Plots consisted of 5 “plants”
- N rates: 0, 50, 100, 150, 200 lbs N/ac
- All N rates split applied: at training and after majority of bines reached top wire.
- N source: ammonium nitrate
- Used maintenance rates of P, K, Zn, and B

Data Collection

- Soil samples collected and plots harvested at discretion of the grower (July-Sept).
- Whole plants weighed before machine picking. Subsamples of machine-picked cones and bines collected for determination of moisture and nutrient content.
- Soil samples collected from a subset of plots to investigate for determination of profile nitrate.

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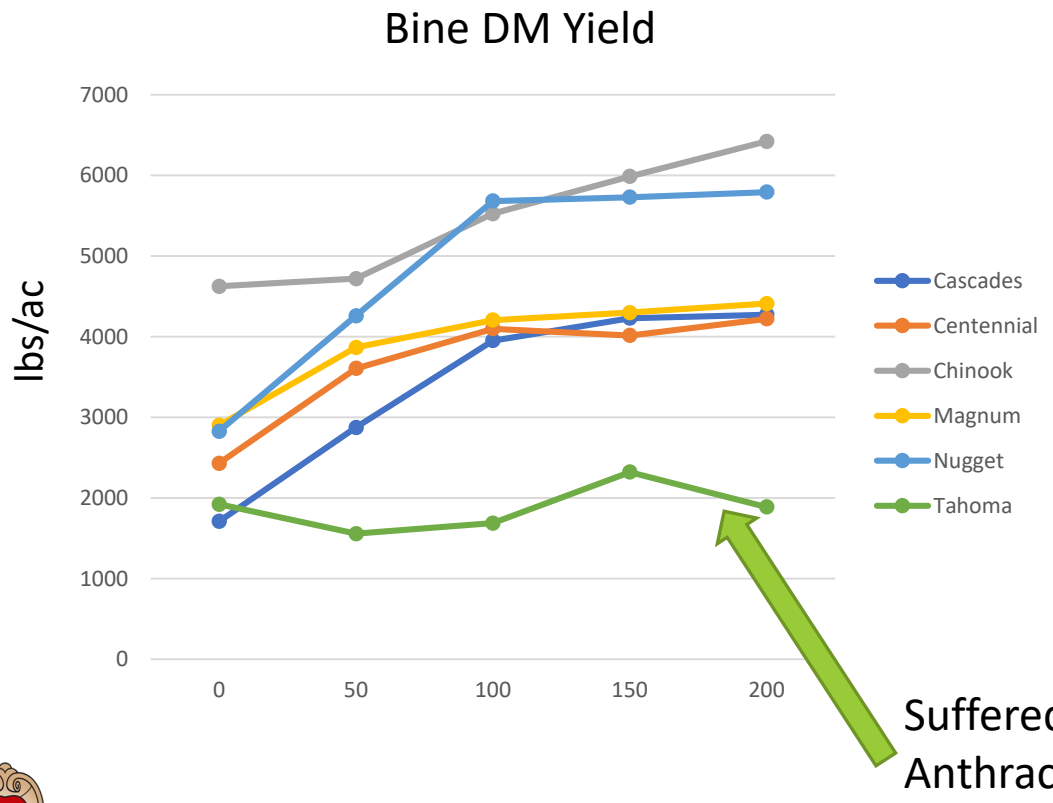
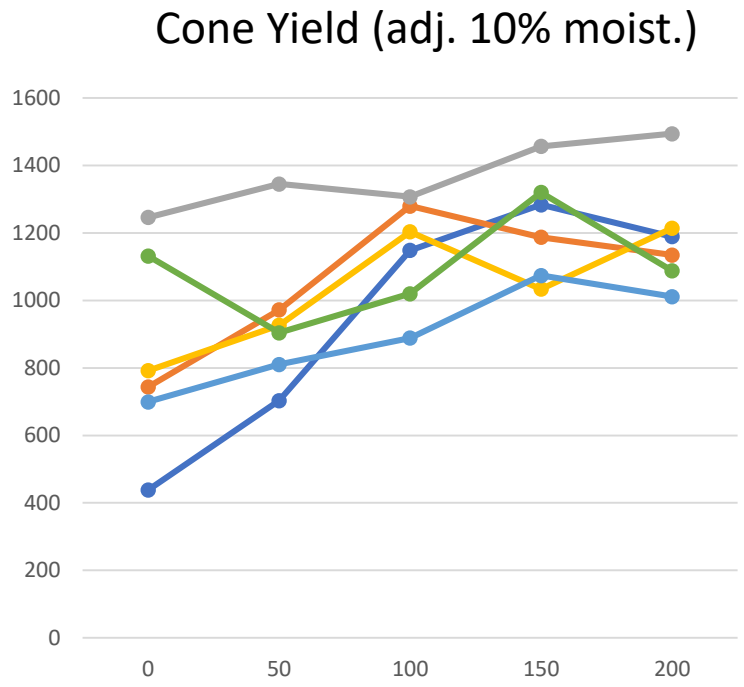
2019 Biomass and Cone Yield Results

Variety significantly affected bine and cone yield





Suffered from Anthracnose

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Significance of N rate effect on Bine and Cone Yield

Location	Variety	N treatment effect on Bine DM yield P-value	N treatment effect on Cone yield P-value
Tomah	Cascades	0.001	0.099
Tomah	Centennial	0.012	0.023
Rosholt	Magnum	0.015	0.077
Rosholt	Nugget	<0.001	0.004
Waterloo	Chinook	0.014	0.37
Waterloo	Tahoma	0.772	0.633

P values less than 0.05 generally indicate significant effect of N treatment.

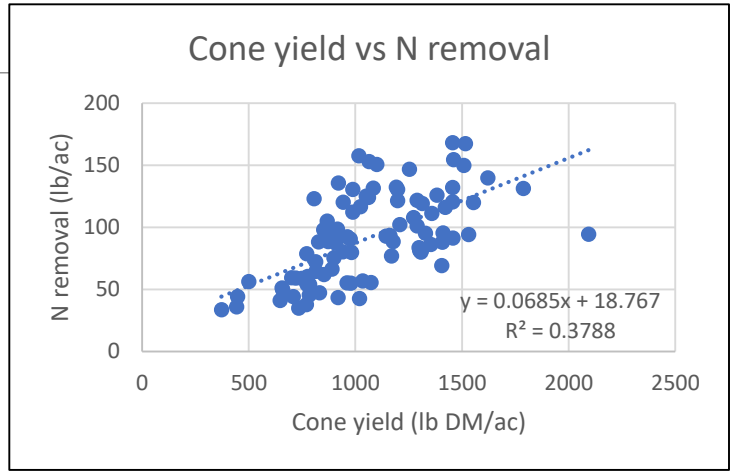
Overall Effect of N rate on Average Bine and Cone Yield

N Rate (lb N/ac)	Bine DM (lb/ac)	Cone Yield (adj. 10% moisture, lb/ac)
0	2735 C	841 C
50	3480 B	944 CB
100	4191 A	1141 BA
150	4430 A	1226 A
200	4501 A	1188 A

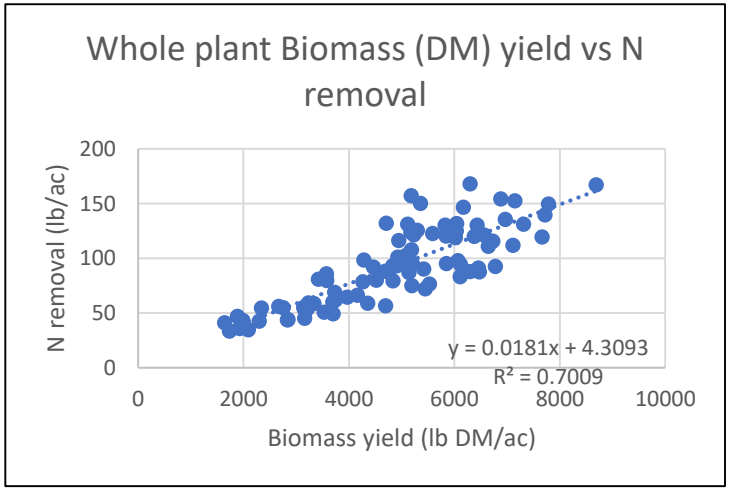
Means that do not share a letter are significantly different.

Biomass and Cone Yield affect on N Removal

- Cone yield was not a good predictor of N removal



- N removal is well correlated with biomass yield



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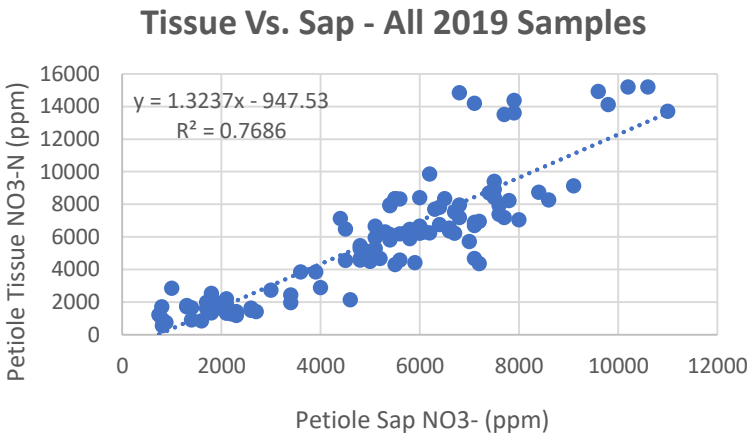
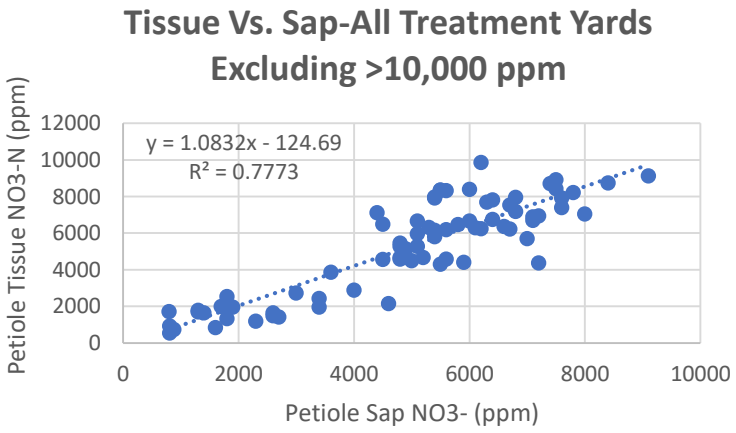
Petiole Tissue and Sap testing

- Potentially a valuable tool for hop growers
- Samples collected when bines are ½ - ¾ to top of trellis
- Allows for in-season adjustment of N rates
- Recommend applying 50-70% of N recommendation prior to petiole test
- General Guidelines (adapted from PNW recommendations)
  - 0-6000 ppm : Apply recommended rate plus additional 30-50lbs N
  - 6000-10000 ppm: Apply recommended N rate
  - 10000+ ppm: no additional N necessary





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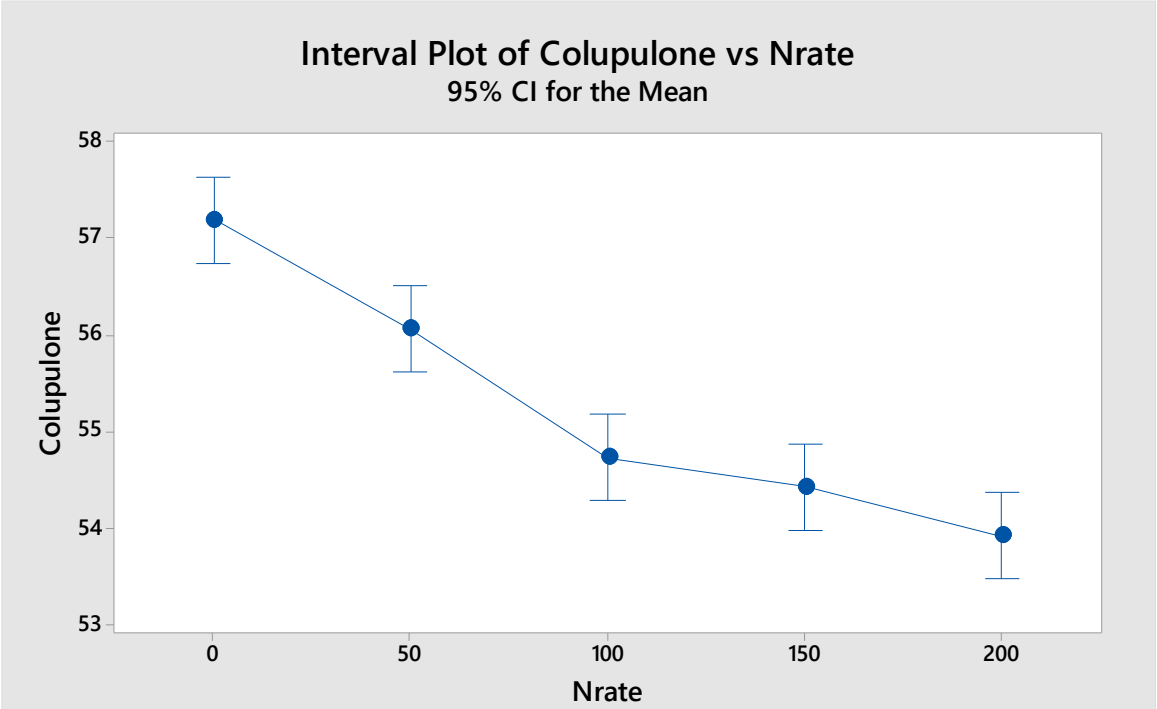
Effect on Hop Quality Parameters

- 3 varieties sampled for hop quality parameters, analyzed by AAR Labs
- Variety significantly affected HSI, total Oils, Total A-acid, Cohumulone, Total B-acid, Colupulone, and A/B ratio. ($P<0.0001$)
- N rate did not have a effect on any quality parameter except Colupulone. ($P=0.02$).
- Colupulone (as % of BA) decreased steadily with N rate in the Chinooks, but this decrease was not observed in Cascade or Magnum varieties.

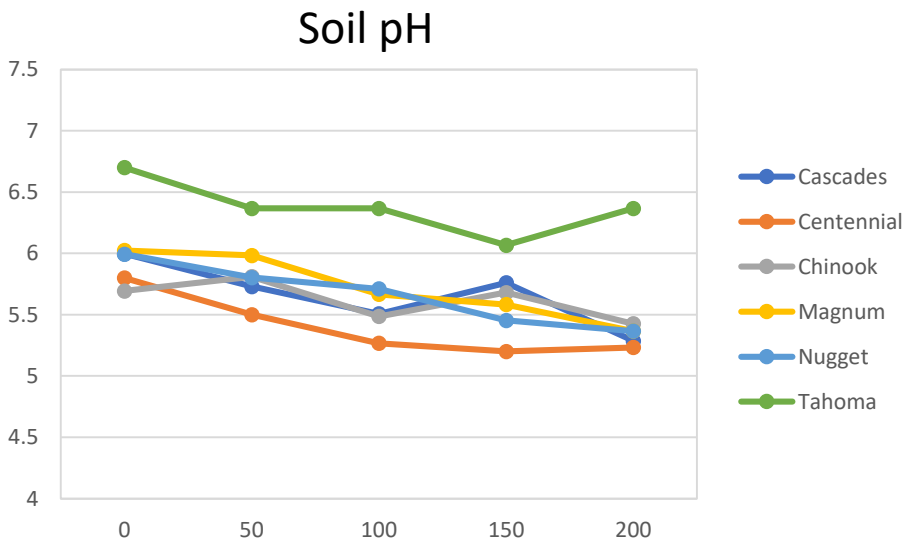
Variety	HSI	Oils (mg/100g)	Cohumulone (% of AA)	A-Acid (%)	Colupulone (% of BA)	B-acid (%)	A/B
Cascade	0.24	0.19	32.45	1.41	54.14	0.98	1.55
Chinook	0.26	0.62	30.55	2.83	55.27	0.73	3.87
Magnum	0.27	0.86	25.92	4.57	45.97	2.12	2.15

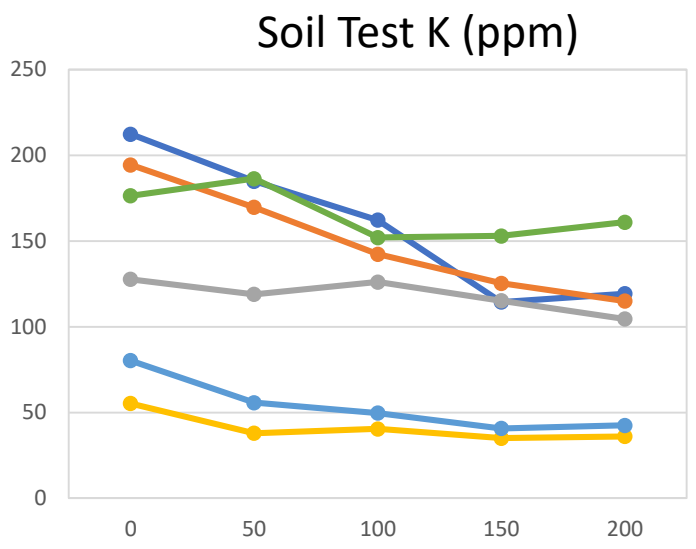
Effect of N rate on Colupulone (as % of BA) in Chinook



N treatment effect on Soil test

- N treatment had no significant effect on soil test P or organic matter, but significantly (P<0.001) affected pH and soil test potassium
- On average pH dropped 0.5 units and K dropped 45 ppm in 200lb/ac N rate plots compared to the 0 N plots.





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Deep Soil Nitrate sampling

- Collected from three varieties; Cascades (Tomah), Chinook (Waterloo), and Nugget (Rosholt).
- Used truck-mounted probe to collect samples to a depth of 7-8 ft (or refusal)
- Collected samples in row, ¼ distance between row, and ½ distance between row.
- Sampled 0, 100, and 200 lb N/acre plots.

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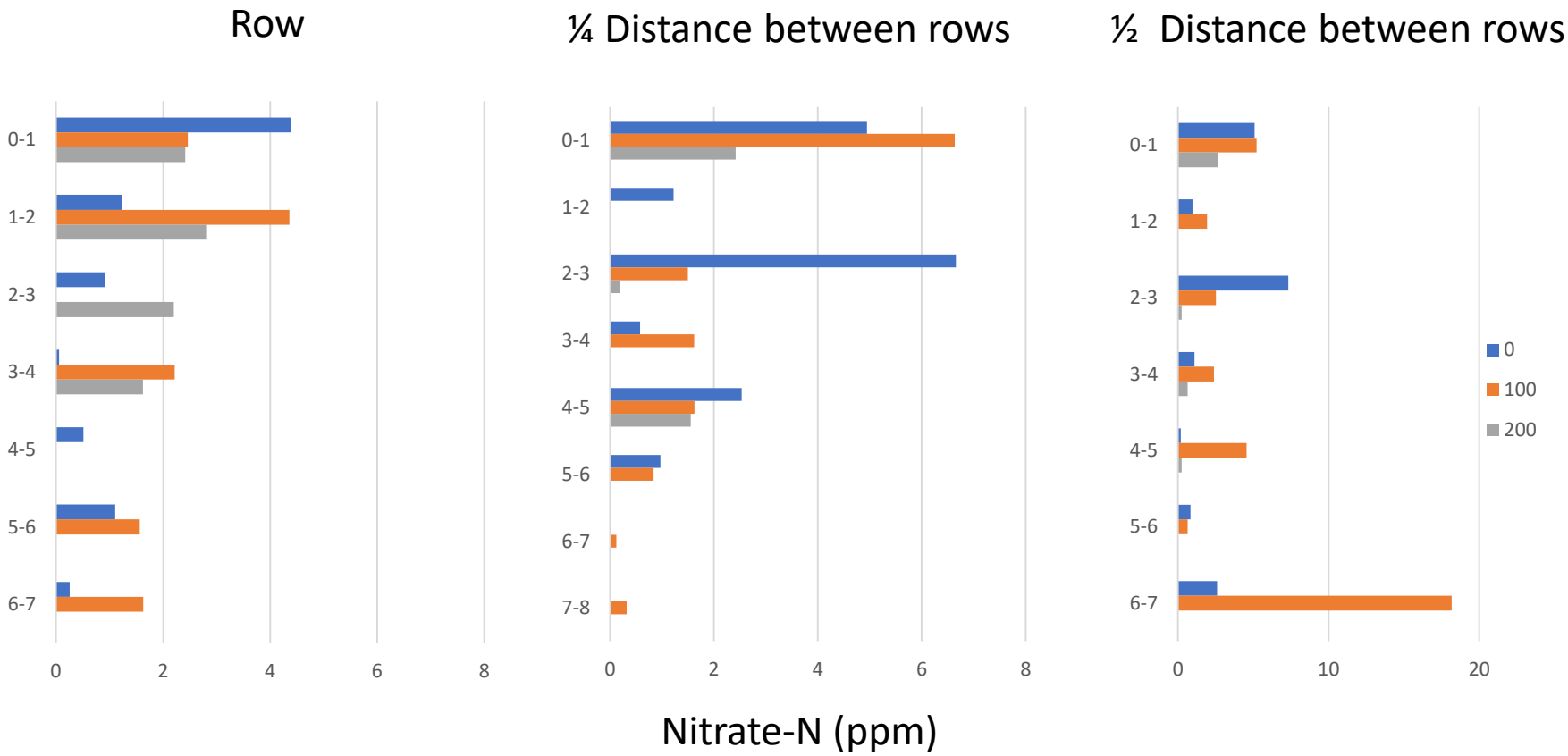
Rosholt-Nugget



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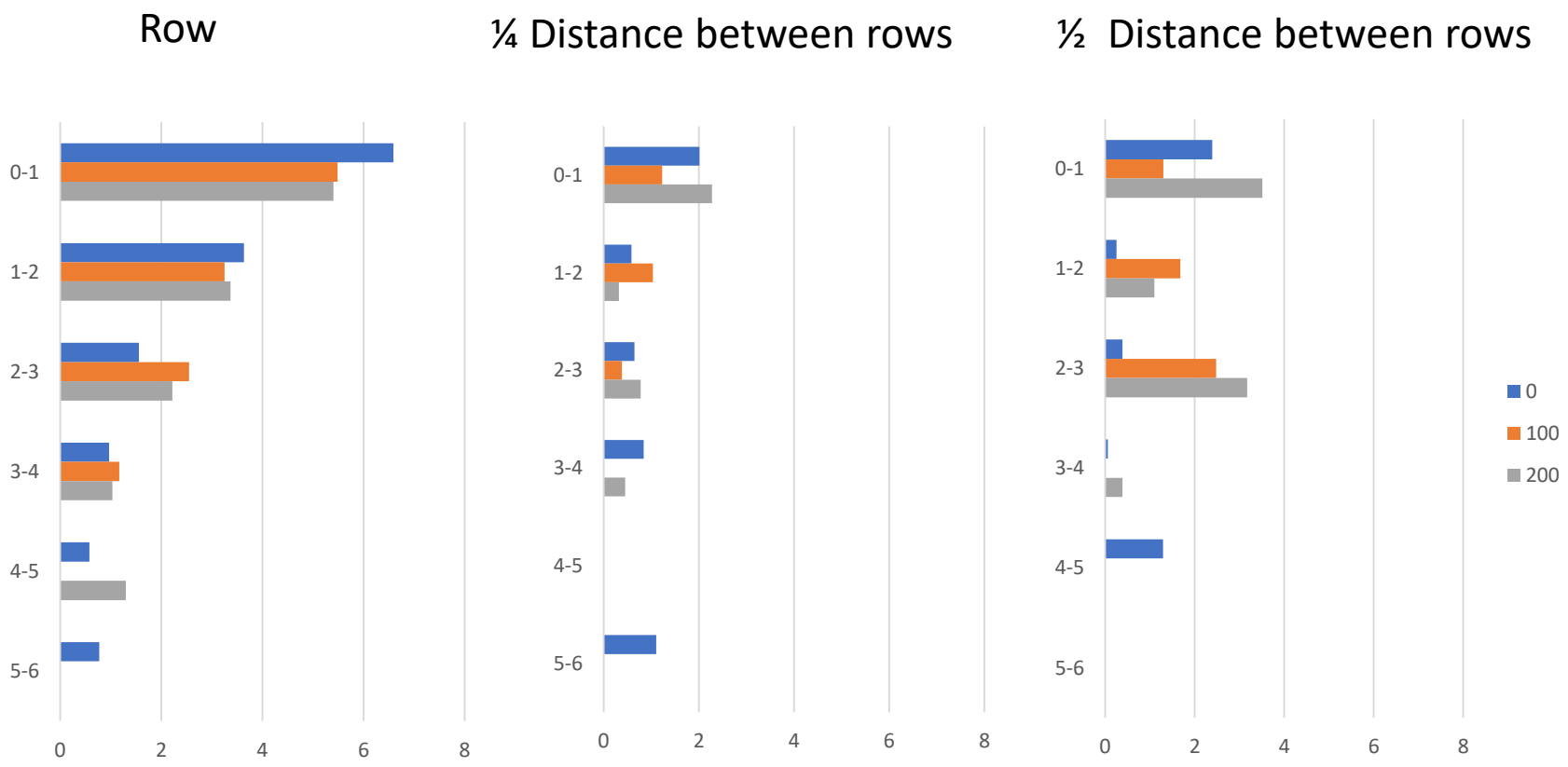
Waterloo-Chinook



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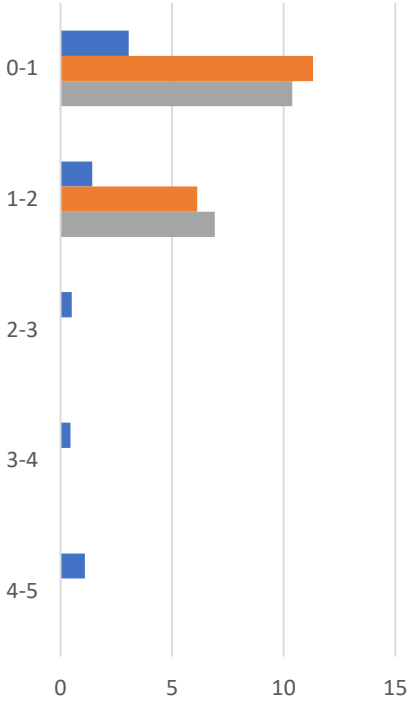
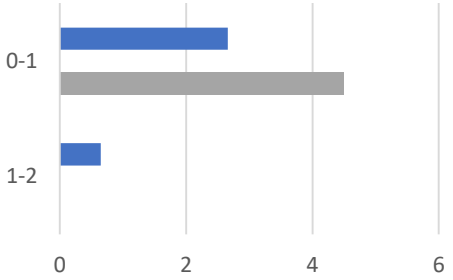
Tomah-Cascade

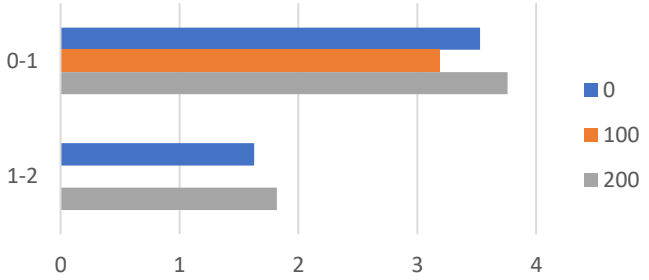
Row



¼ Distance between rows



½ Distance between rows



Rocky subsoil prevented coring at most locations.

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SUMMARY

- 2019 growing season data suggest, on average, N rate above 150 lb/ac did not increase cone yield.
- Cone yield doesn't appear to be a good predictor of optimum N rate.
- Fine-tuning N rate for hop will likely involve variety-specific adjustments for biomass production.
- Petiole testing has promise for in-season adjustments of N rate – proper sampling time is important.
- Most quality parameters don't seem to be affected by N rate, but data suggest that N fertility decreases colupulone in at least one variety
- Managing lime and K inputs are important considerations for hop growers
- End-of season soil nitrate-N concentrations were generally low, and didn't appear to reflect N rate.

Acknowledgements

- Hannah McWhirter - UW Platteville, Class of 2019.
- Fine Bine Farms – Randy and Peggy Urness
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