Nitrogen Fertilization and Timing, 2 Years of Data

10th Annual Hop Production for the Wisconsin Craft Brew Industry Seminar

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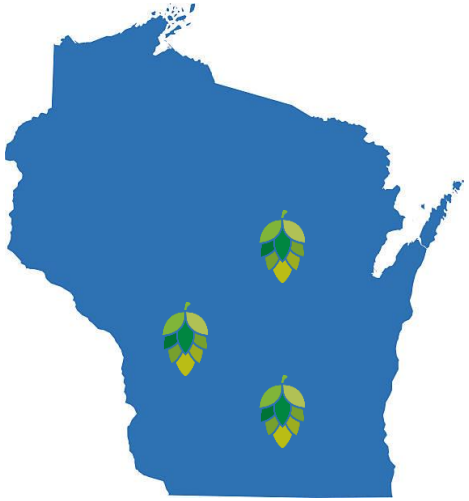
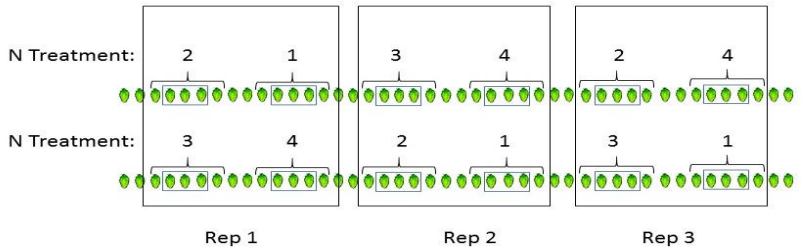
Summary of WI Hop Fertility Work to Date

- 2016 – Collected preliminary data on yield, nutrient removal and soil test levels.
- 2017&2018 – Conducted study to evaluate effect of nitrogen rate and timing on biomass and cone yield.
  - Secondary objectives:
    - collect additional nutrient composition data
    - monitor changes in soil test levels
    - compare petiole sap nitrate with tissue petiole testing

Experimental design



- 2017 (5 plots)
  - Tomah and Rosholt
  - Varieties: Cascade, Centennial and Nugget
- 2018 (4 plots)
  - Tomah, Rosholt, and Waterloo
  - Varieties: Centennial and Chinook



- 4 Nitrogen Treatments
  1. Control (No N applied)
  2. ½ recommended N rate (100 lb N/ac) applied early spring
  3. Full recommended N rate (200 lb N/ac) applied early spring
  4. Full recommended N rate, split applied between early spring and when bines reach top of the wire.

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Data Collection

- Soil samples collected and plots harvested when hops were ready, at discretion of the grower (July-Sept).
- Whole plants weighed before machine picking. Subsamples of machine-picked cones and bines collected for moisture and nutrient content determination.




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Yield Estimate Summary 2017-2018 (excluding zero N treatment)

Location-year	Harvest date	Variety	Bine DM Yield (lb/ac)	Cone DM yield (lb/ac)	Cone yield (adj. 10% moisture, lb/ac)
Rosholt-2017	8/16/2017	Centennial	1433	540	594
Rosholt-2017	9/3/2017	Nugget	3135	1072	1179
Tomah-2017	8/25/2017	Cascade	4379	736	809
Tomah-2017	8/9/2017	Centennial	3155	773	850
Tomah-2017	9/2/2017	Nugget	5142	626	688
Rosholt-2018	8/8/2018	Centennial	2828	971	1068
Tomah-2018	7/30/2018	Centennial	3679	929	1022
Tomah-2018	8/23/2018	Chinook	4775	511	562
Waterloo-2018	8/29/2018	Chinook	7133	809	890

Year, location, and variety all affected response to N treatments

Location-year	Variety	N treatment effect on Bine DM yield P-value	N treatment effect on Cone yield P-value
Rosholt-2017	Centennial	0.835	0.014
Rosholt-2017	Nugget	0.017	0.154
Tomah-2017	Cascade	0.129	0.630
Tomah-2017	Centennial	0.033	0.271
Tomah-2017	Nugget	0.001	0.740
Rosholt-2018	Centennial	0.284	0.823
Tomah-2018	Centennial	0.004	0.047
Tomah-2018	Chinook	0.015	0.683
Waterloo-2018	Chinook	0.059	0.080

Overall effect of N treatments on Biomass and Cone Yield

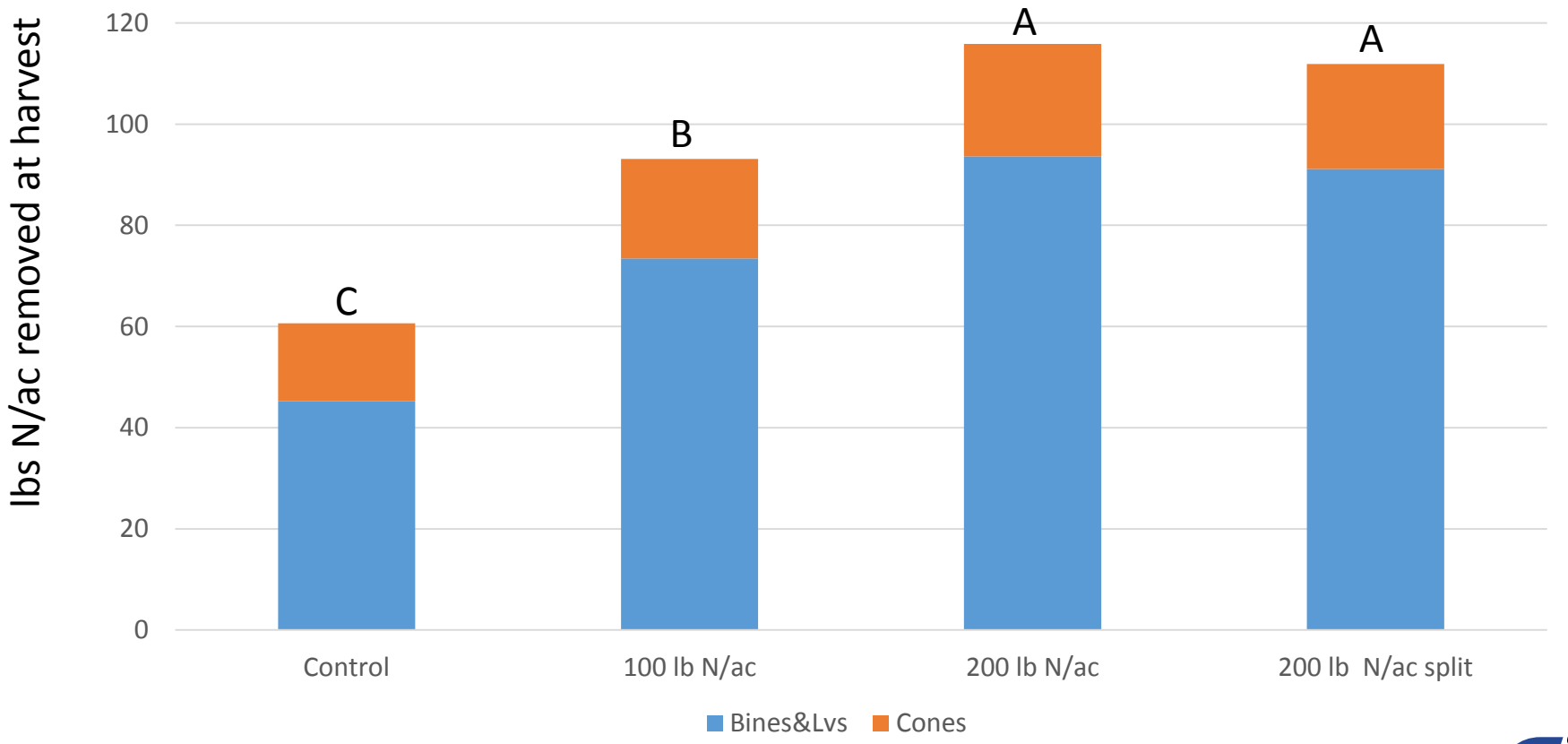
- N treatments significantly impacted biomass yield, but had variable effect on cone yield.

N treatment	Bine DM (lb/ac)	Cone Yield (adj. 10% moisture, lb/ac)
Control	3485 B	817 B
100 lbs N/ac	4678 A	943 AB
200 lbs N/ac	4973 A	989 A
200 lbs N/ac split	4574 A	937 AB

Means that do not share a letter are significantly different.

Effect of N treatment on N Uptake

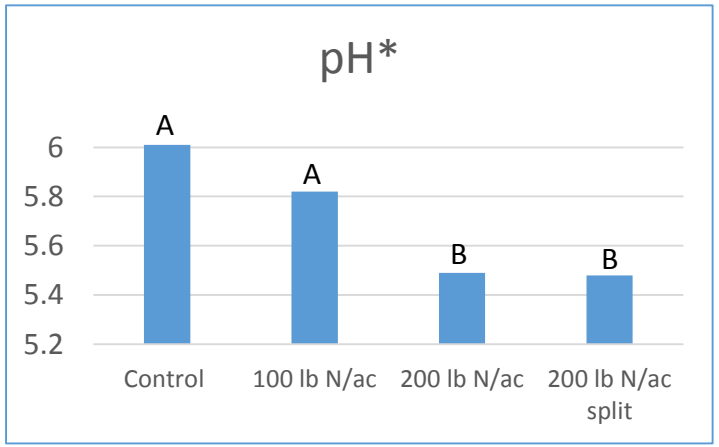
- Averaged over years, locations and variety, N uptake increased with increasing N rate and was similar for both full-rate treatments.

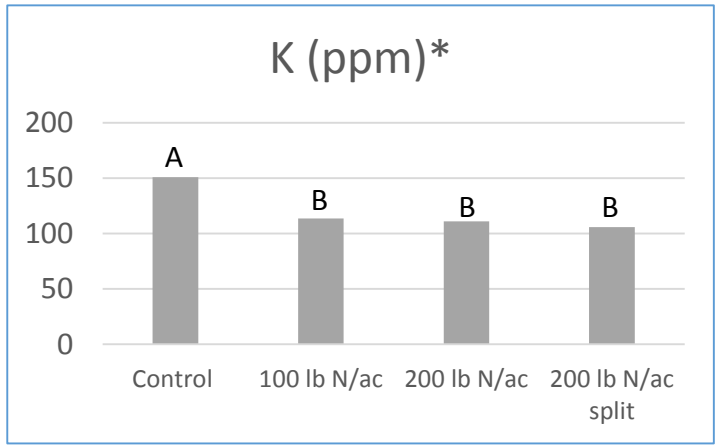


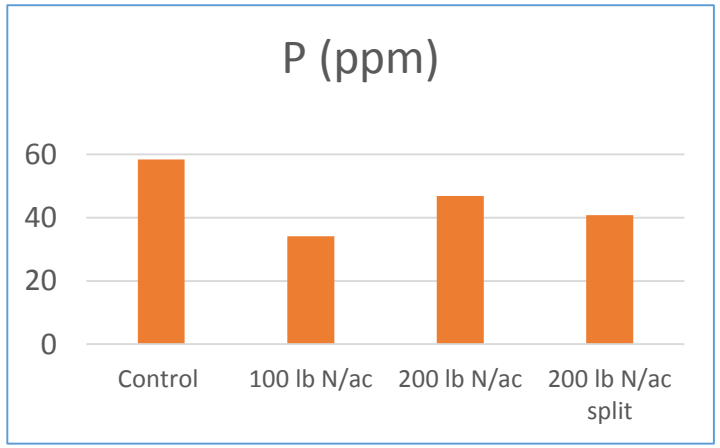
Nutrient Removal at Harvest (excluding 0 N treatment)

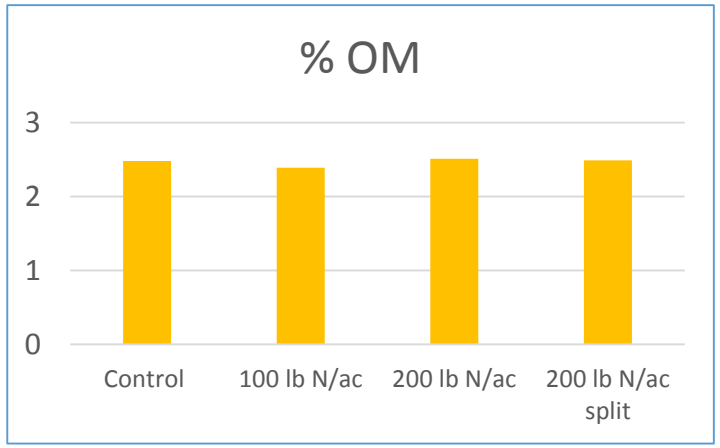
Nutrient	Bines	Cones	Total
	---------- lb/ac ----------		
Phosphorus (as P_2O_5)	21.6	7.3	28.9
Potassium (as K_2O)	76.8	20.6	97.4
Calcium	52.3	3.8	56.6
Magnesium	18.3	2.4	20.7
Sulfur	6.4	1.5	7.9
Zinc	0.07	0.02	0.10
Manganese	1.02	0.07	1.09
Boron	0.15	0.03	0.18
Iron	0.30	0.05	0.35
Copper	0.19	0.01	0.20

N treatment effect on soil test









What we've learned so far…

- Averaged over years, location, and variety, N treatment significantly impacted bine yield and above-ground biomass N uptake.
- Cone yield response to N treatment varied by year, location, and variety.
- Cone yield was significantly greater in the 200 lb N/acre (full rate applied in spring) treatment compared to the control.
- No significant differences observed in bine or cone yield, or in N uptake among full rate or split-applied N.
- N rate impacted soil pH and K soil test emphasizing importance of regular soil testing.
- Small plot/sample size contributed to a relatively wide variation in data.

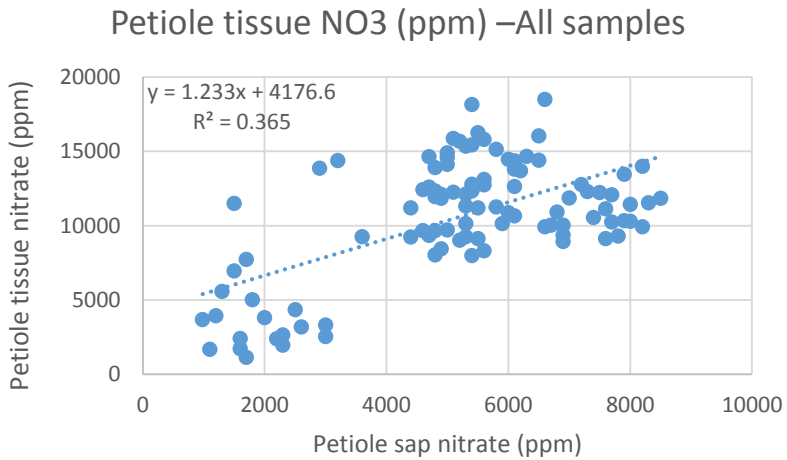
Petiole Sap Analysis – a tool for real-time monitoring of nutrient status?

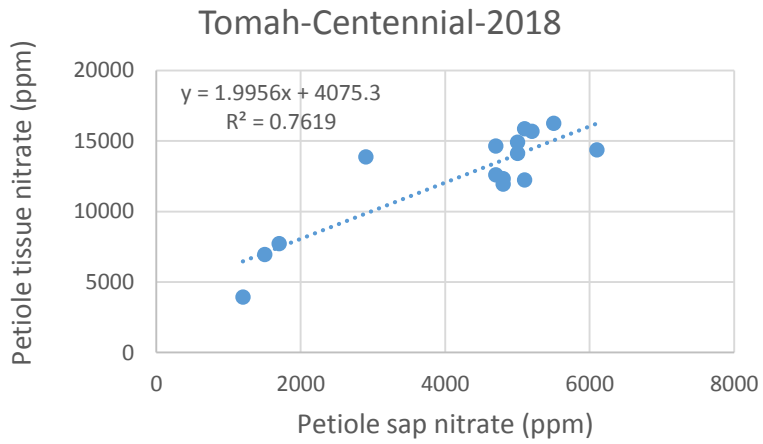
- Sap testing using handheld nutrient meters have been used for years in evaluation of nutrient status of greenhouse plants.
- Provide instant value for comparing nutrient status of normal vs. abnormal plants.

- If calibrated with tissue data, may be able to develop recommendations based on sap analysis.

Results of Petiole Sap & Tissue Testing

- Correlation between sap and tissue analysis vary by location and variety, and may be dependent on tissue sample handling prior to laboratory analysis.
- Continuing work to develop proper techniques for sap analysis and petiole sampling protocols.





Future Work

- Continue research aimed at improving nutrient use efficiency of hop (form, rate, timing of applications), with emphasis on N.
- Investigate effects of fertilization practices on hop quality.

Acknowledgements

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Award Winners!

- Taylor Haney (2017) and Alyssa Carpenter (2018) presented results of the study at the state Junior Science and Humanities Symposium and earned a trip to the National symposium.
- Taylor also placed 1st in her division at the state FFA Agriscience Fair, and received Silver placing at nationals!