Fertilizer Management for Hop

Hop Production for the Craft Brew Industry

8th Annual Seminar, 2/25/17

Amherst, WI

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Growing the future

UW Extension
University of Wisconsin-Extension

University of Wisconsin
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Situation

- Current UW guidelines for hop based upon old (1990) UW guidelines and more recent data from Pacific North West

Goal

- Collect preliminary data on crop nutrient removal and soil test levels to determine if A2809 needs to be updated

What did we do?

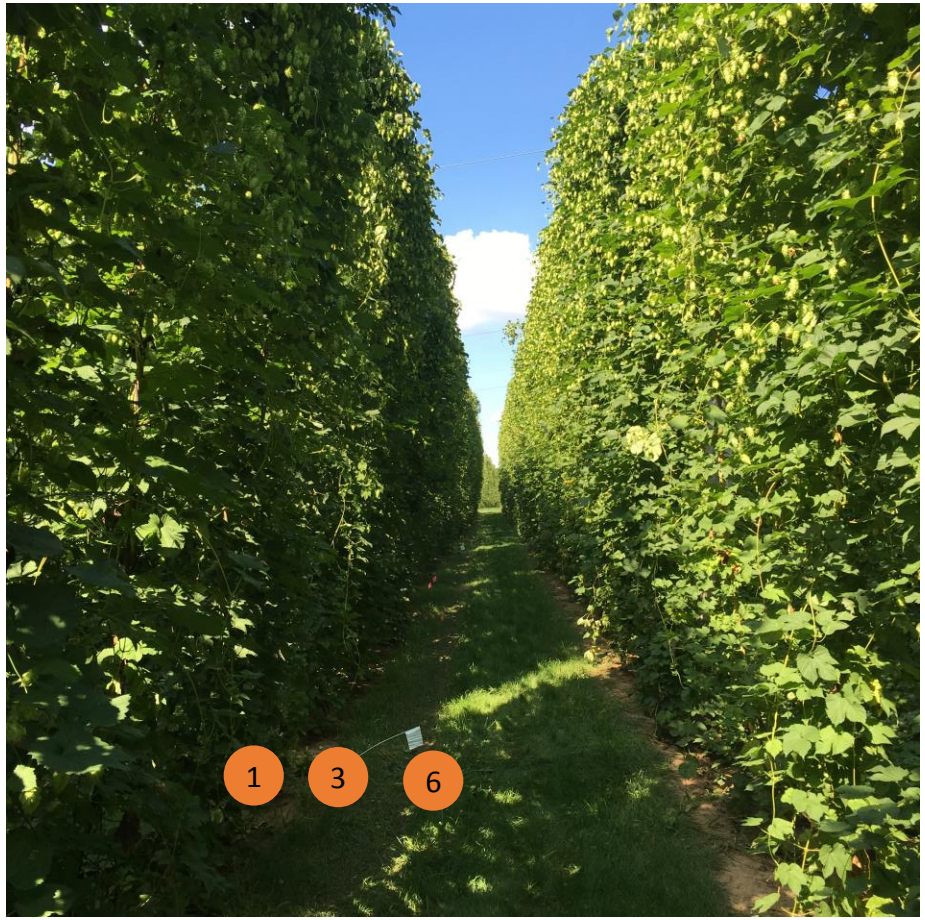
- Sampled at two locations
  - Waterloo
    - McHenry silt loam
    - pH = 6.5
    - OM = 2.6%
  - Rosholt
    - Graycalm loamy sand/Alban loam
    - pH = 5.7
    - OM = 1.5%

Plant Sampling

- Sampled above ground biomass and partitioned between cones and leaves/bines just prior to harvest
  - Collected 2 bines for each sample
  - Took 3 samples (replicates) for each variety
- Waterloo
  - Chinook
  - Sterling
- Rosholt
  - Sterling
  - Centennial
  - Willamette

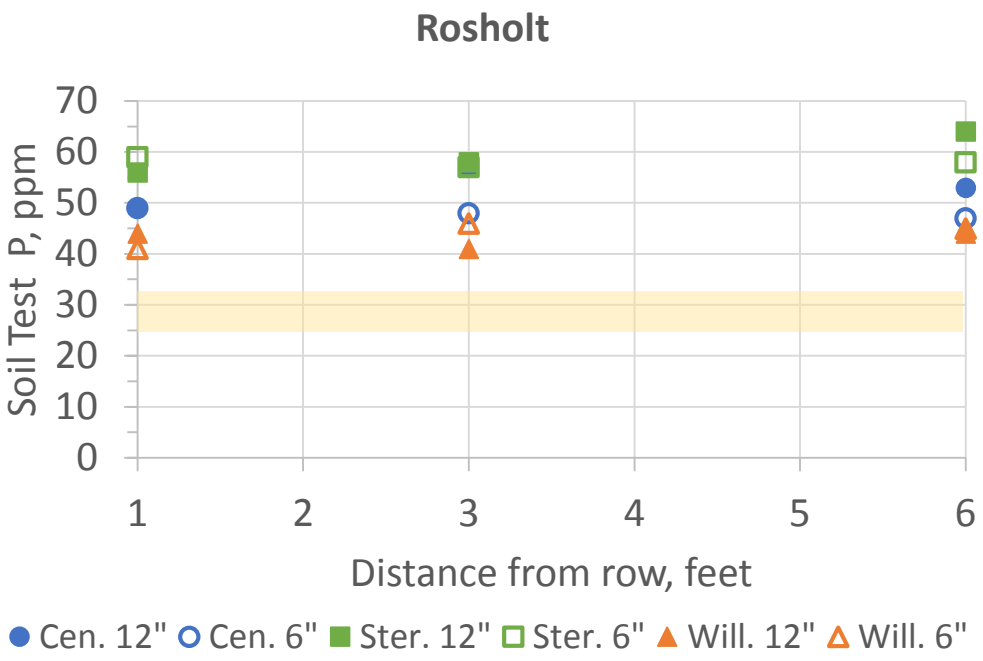
Soil sampling

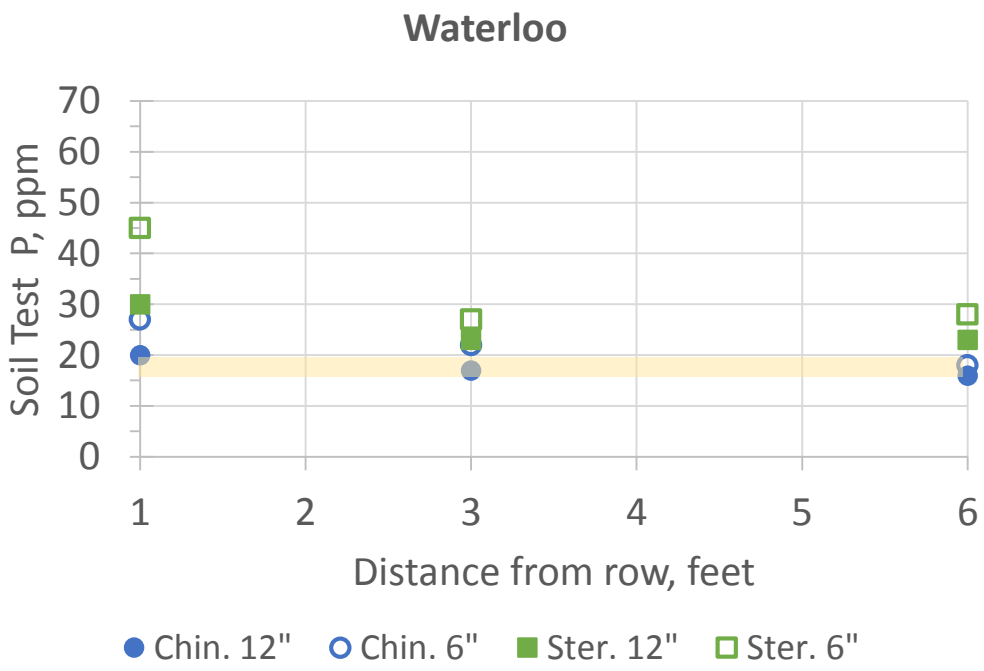
- Collected soil samples within 1’, and 3’ and 6’ from row for each variety
  - One 1 composite sample per variety per distance
  - 0-6” and 0-12” depth



Soil sampling results

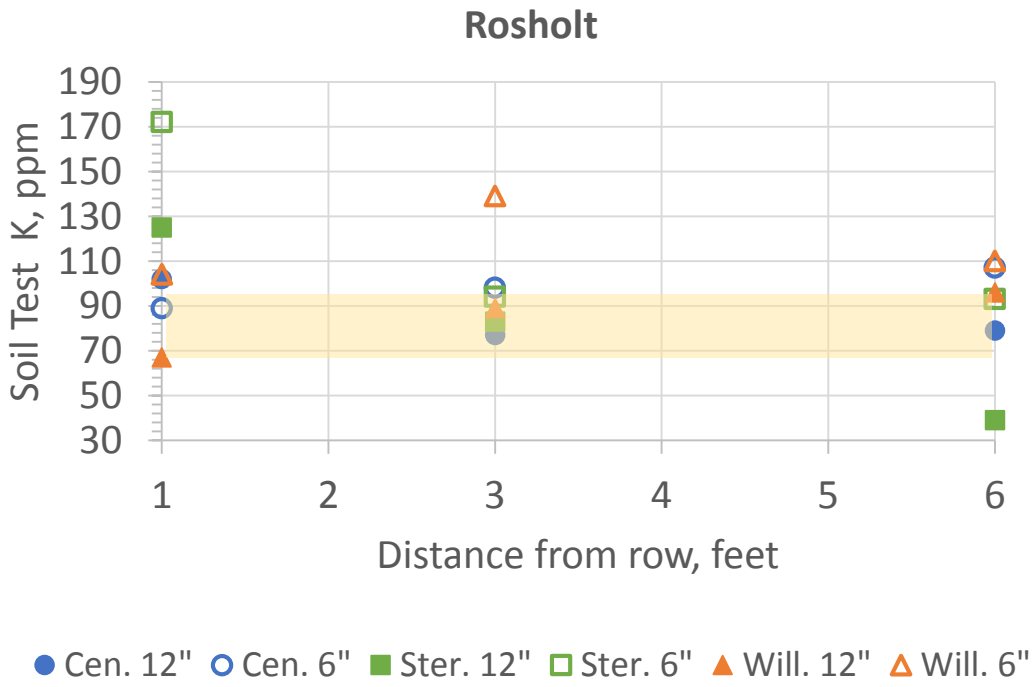
Soil test P results

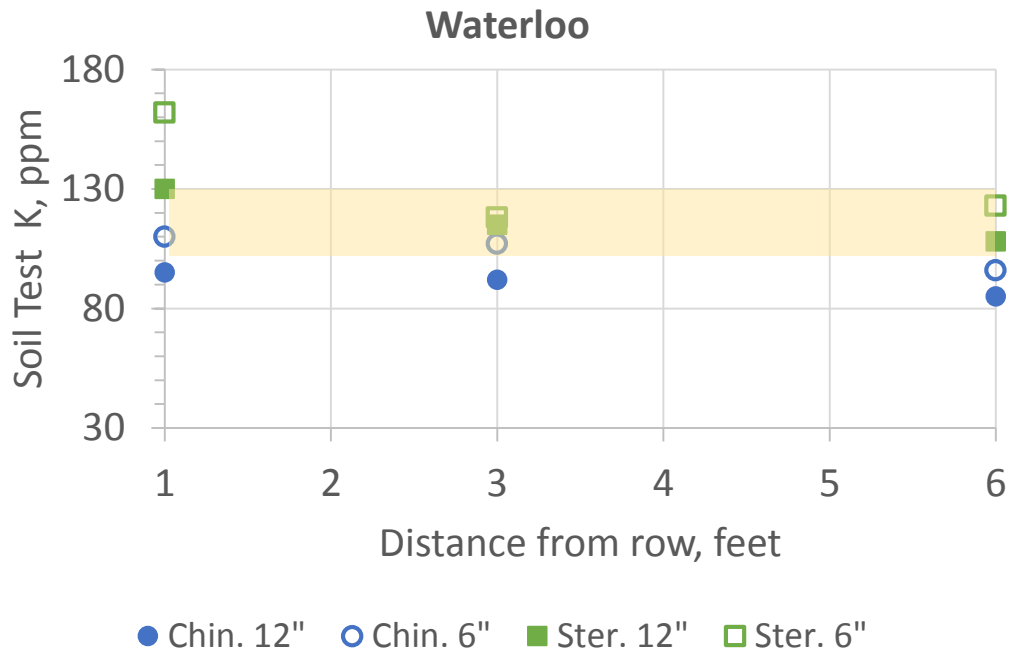




Waterloo soil test P declines as distance from row increases.

Soil test K results

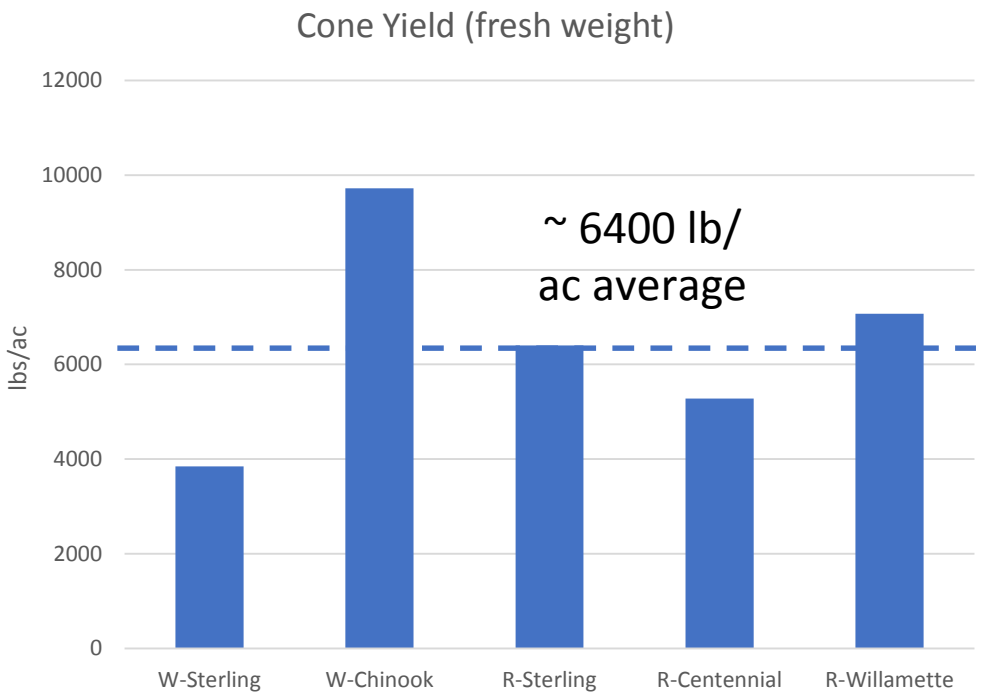


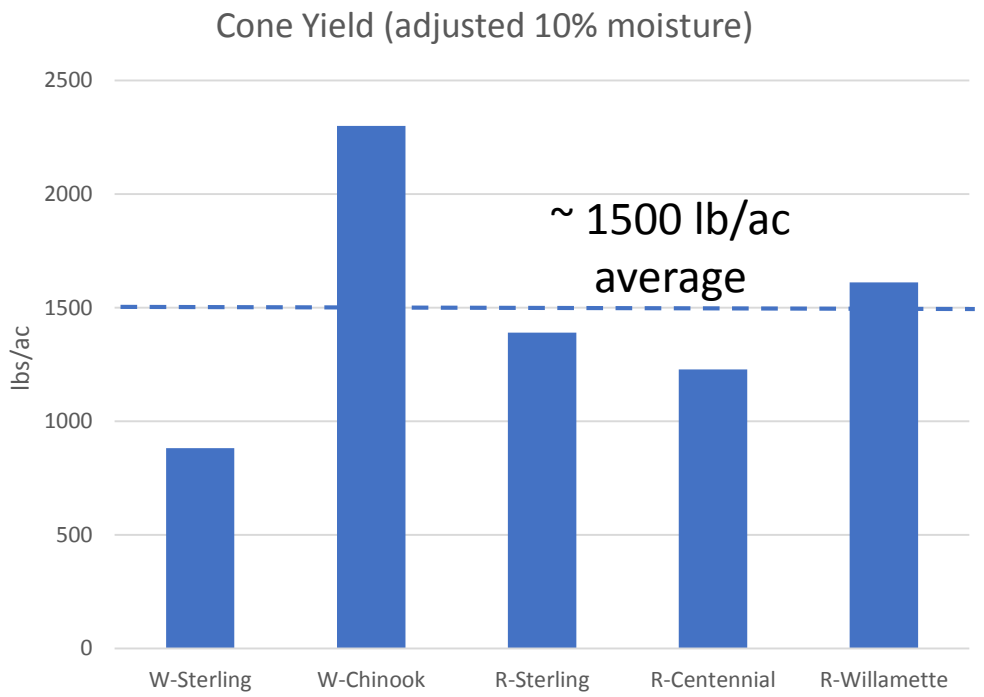


No consistent effect of distance from row on soil test K at Rosholt.
Very limited sampling. Need to sample more to determine if/how general soil sampling guidelines should be modified for hop.

Yield

Yield





- Fresh cone yield varied widely, from ~ 3859-9720 lbs/acre
- Differences are expected between our estimates and actual machine harvesting or hand-picking.
- Estimated yields are comparable to varietal yields reported in PNW.

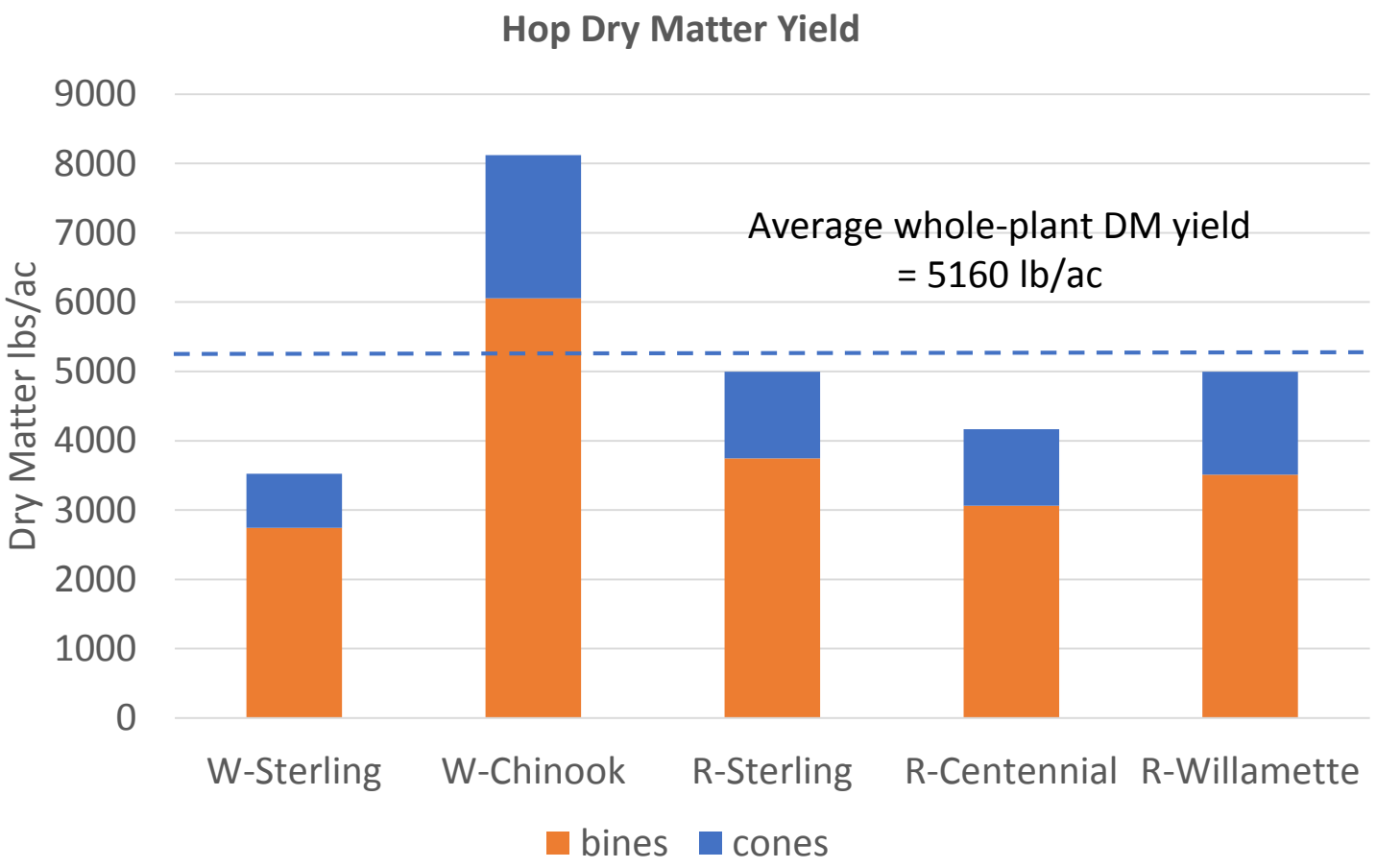
Yield Estimates and PNW Yields

Variety	WI[1]	Idaho[2]	Oregon[2]	Washington[2]
Sterling	1135 (2)	NA	1626	NA
Chinook	2299 (1)	1712/418	1675/107	1420/1415
Centennial	1229 (1)	NA	1235/723	1355/4359
Willamette	1611 (1)	NA	1573/883	1277/728

[1] Estimated cone yield per acre adjusted to 10% moisture. Number of measurements shown in parentheses.

[2] Cone yield per acre and acres reported, 2016 National Hop Report, USDA, NASS.

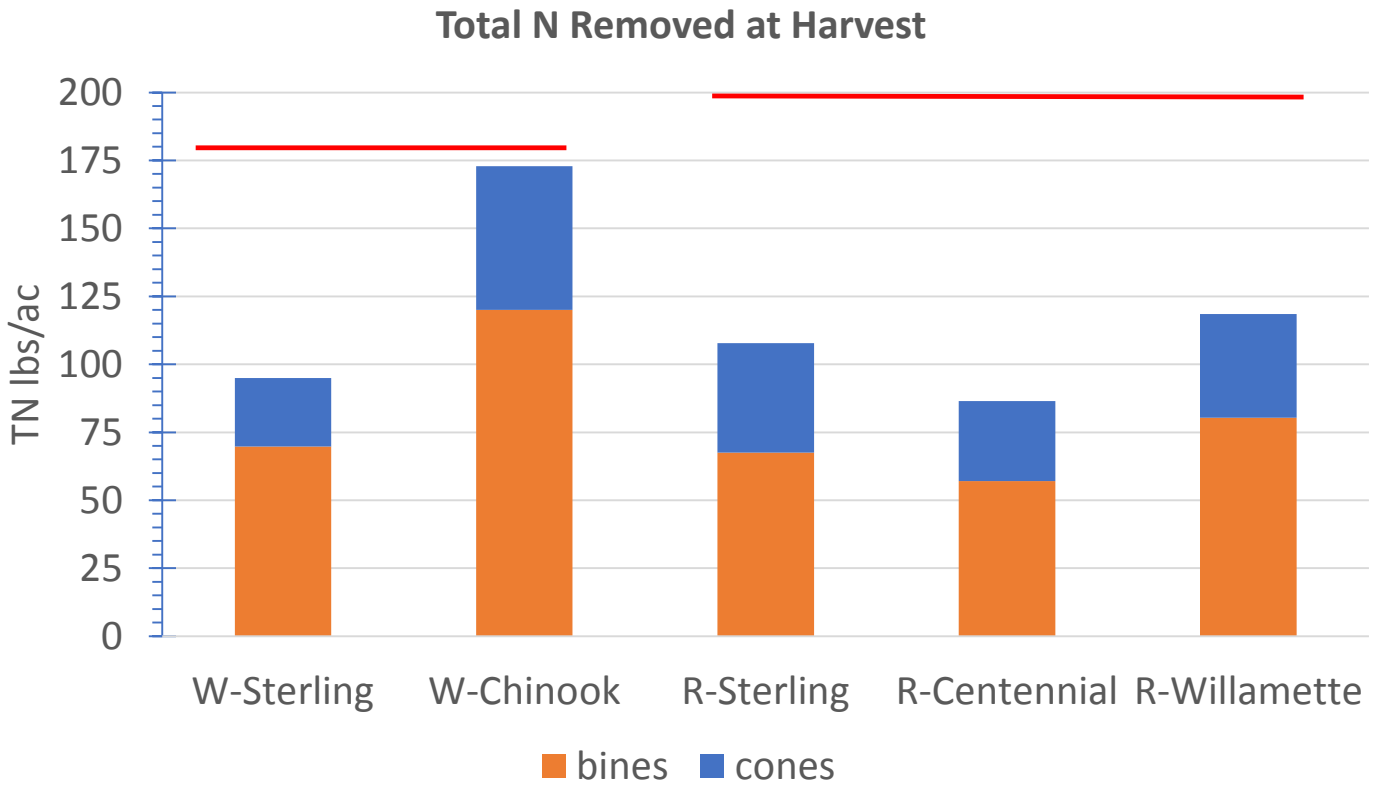
Biomass Yield



- Cones averaged 31% of total DM removed.

Nutrient Removal

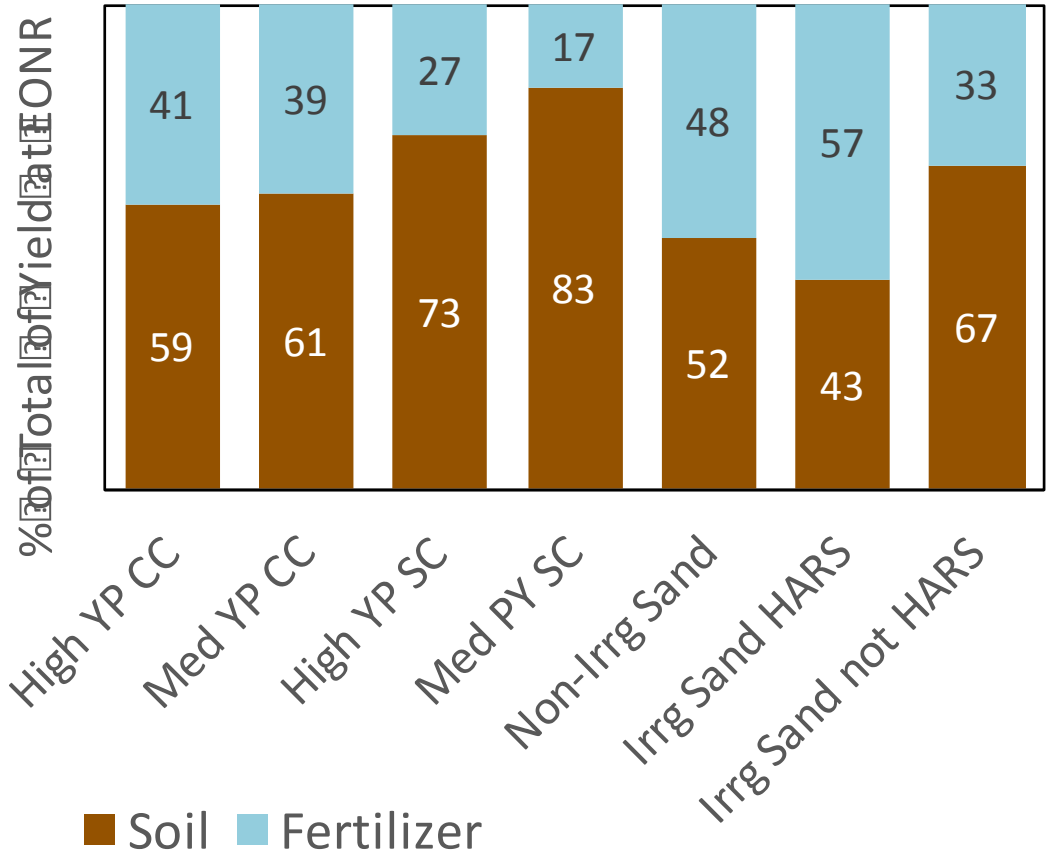
Nitrogen



Redline indicates N recommendation, based on soil organic matter level.

Total N removed in corn silage can vary from 130 to 240 lb N/a.

Soil N's contribution to corn grain yield in WI



Amount of N applied should NOT equal crop removal.

Soil supplies a lot of N on most of our soils!

This principal applies to all WI crops.

Nitrogen application guidelines

- Oregon State University research:
- 10% of total N uptake by early June
- N uptake increases rapidly in mid June & total N uptake is almost complete by early July
- Split apply N on sandy soils
- Initial N application should be made in April or May
- 2nd application approx. when vines meet wire

180 lb N/a if 2.0 to 9.9% OM

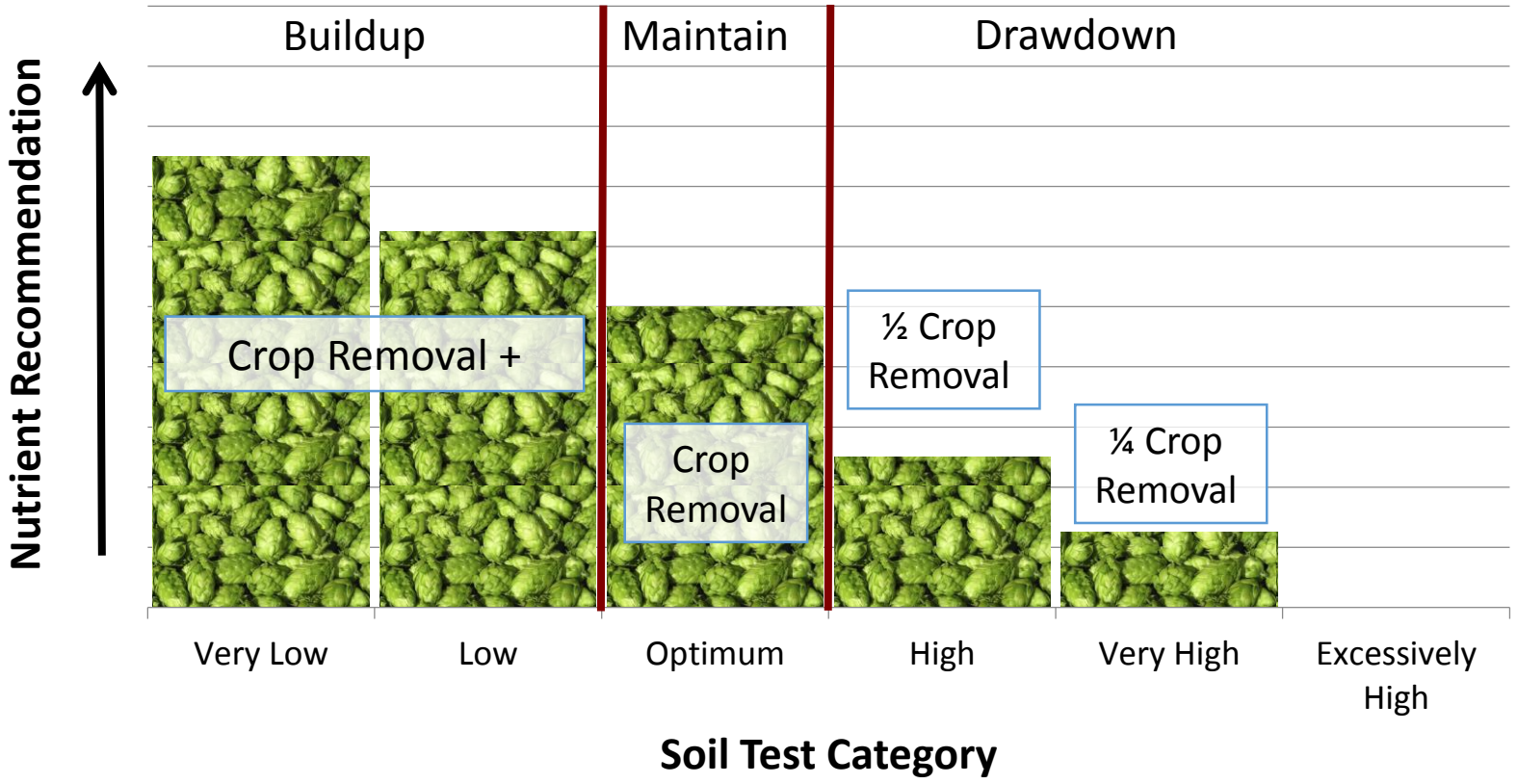
200 lb N/a if <2.0% OM

✓Reduce rates by 50 lb N/a if residues are returned

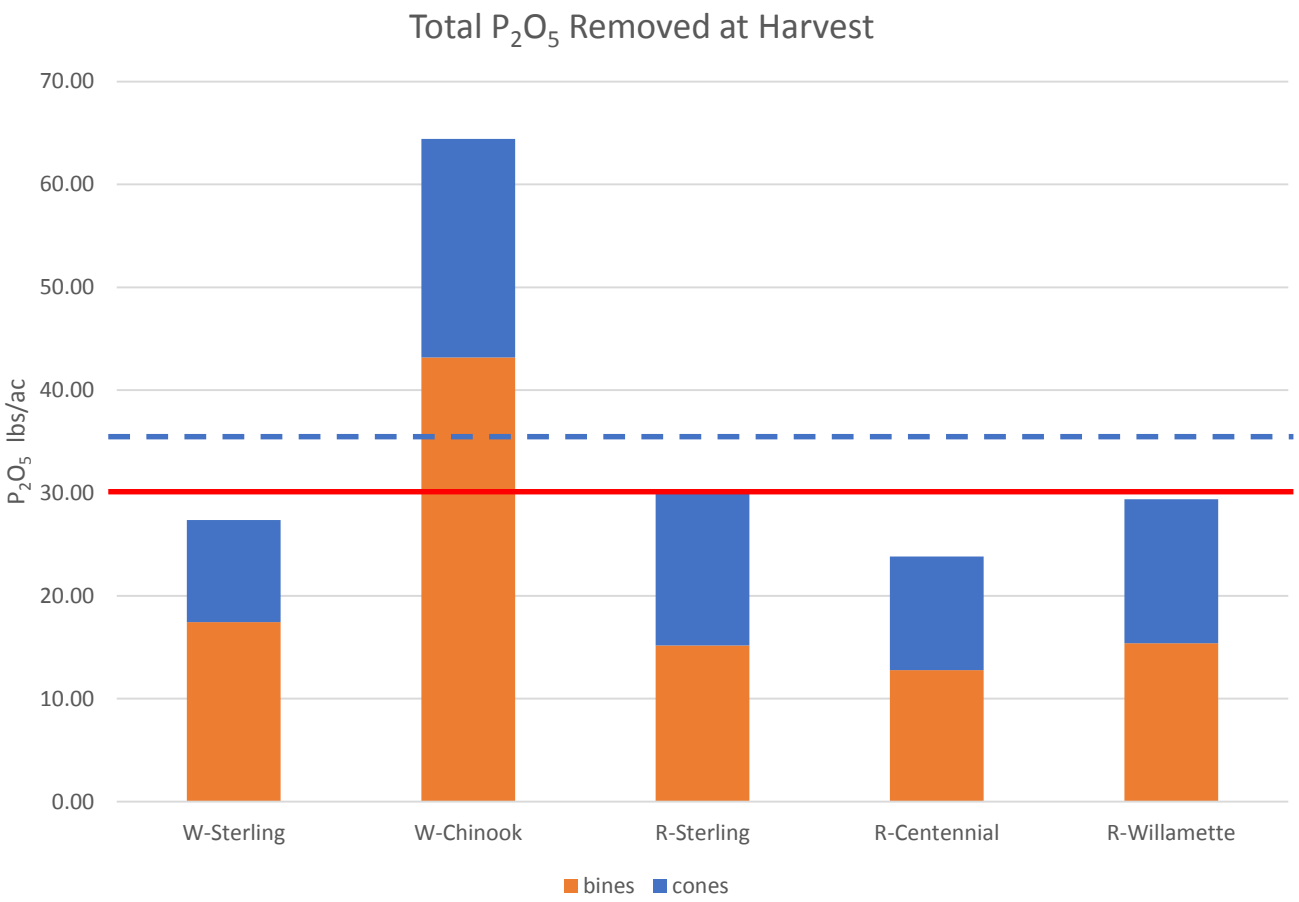
Petiole nitrate test

- Oregon State Univ. guidelines to determine if additional N is needed in June.
  - Collect 40 petioles from recent fully developed leaves at eye level and composite into one sample
  - 5,000 to 9,000 ppm is adequate
    - No yield gain from additional N if petiole nitrate was in this range
- When using petiole nitrate test, apply about 70% of recommended N in April/May
  - If test indicated additional N is needed, apply remainder of recommended rate in June prior to increased demand

Relationship between soil test P & K and nutrient recommendations



Phosphorus



Average whole plant removal (both sites) = 35.0 lb P2O5/ac

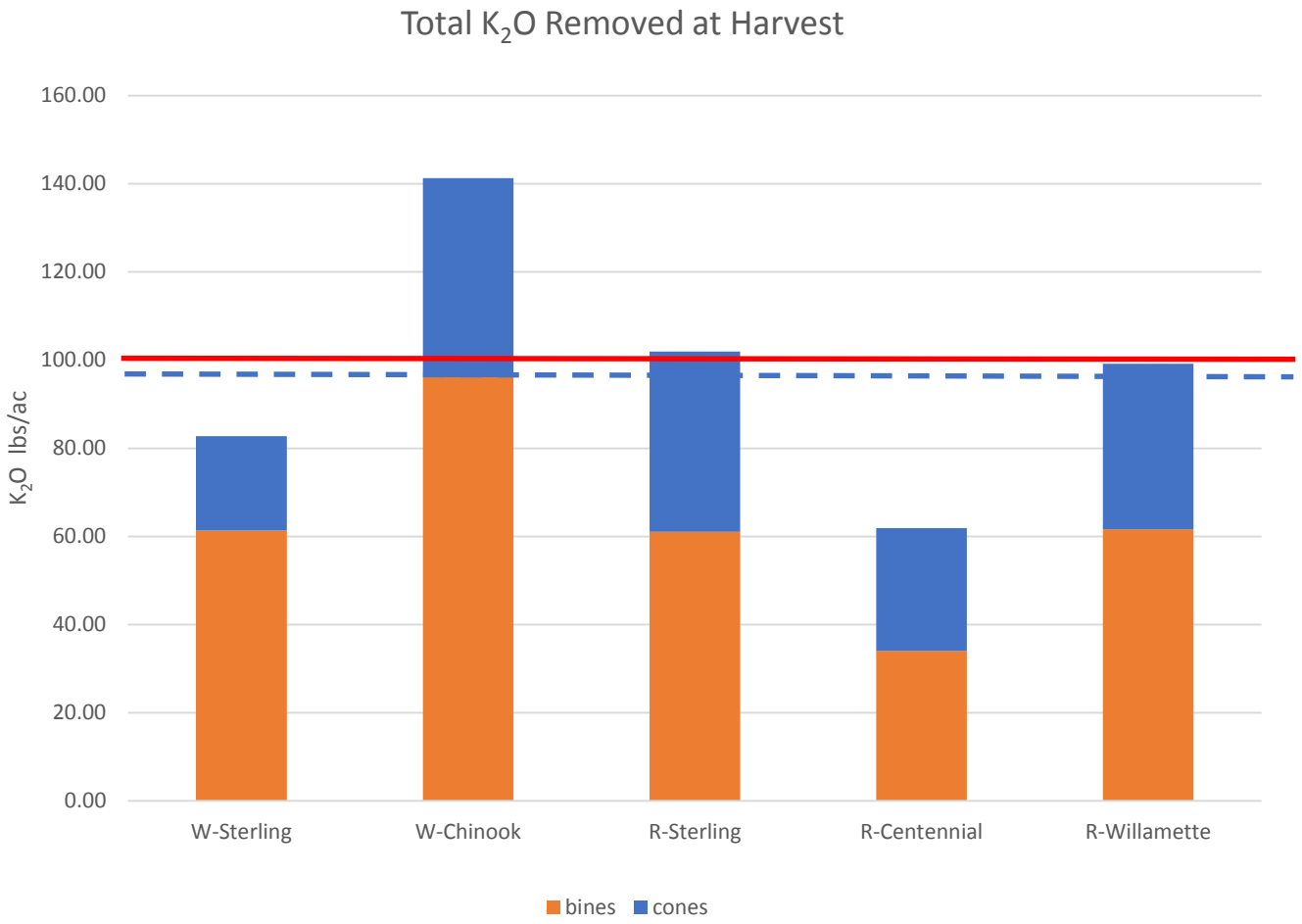
Red line indicates recommendation at optimum soil test level.

- Bine removal averaged 21 lbs P_2O_5 per acre.
- Current A2809 recommendation at optimum soil test level approximated P removal.
- More samples needed to verify relationship between soil test level and P_2O_5 recommendation.

Phosphorus

Soil Group	Soil Test Category				
	Very Low	Low	Optimum	High	Excessively High
	---------- Soil test P ppm ----------				
Loamy	<10	10-15	16-20	21-30	>30
Sandy, Organic	<12	12-22	23-32	33-42	>42
	---------- lb P_2O_5/a to apply ----------				
	70	60	30	15	0

Potassium



Red line indicates recommendation at optimum soil test level.

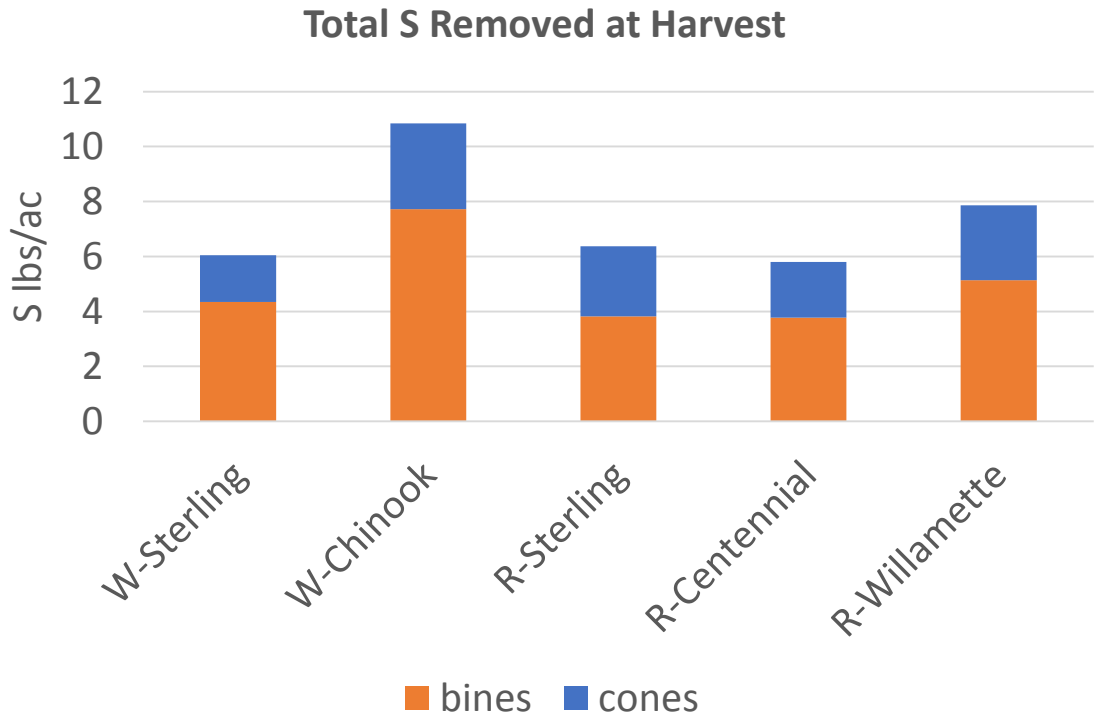
Average whole plant removal (both sites)= 97.4 lb K2O/ac

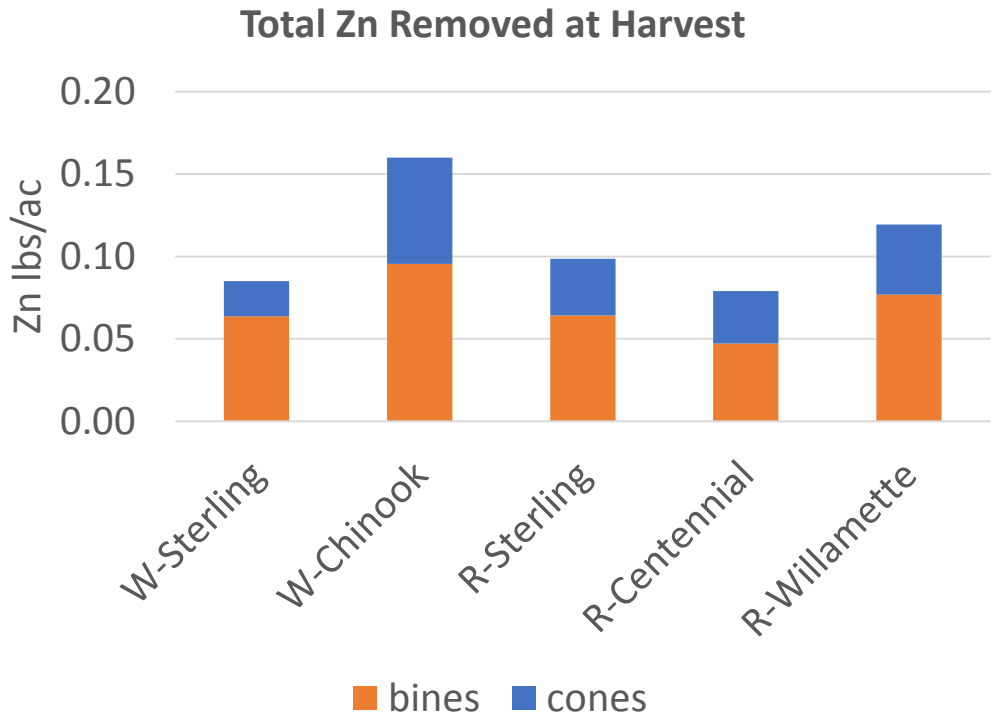
- Bine removal averaged 63 lbs K_2O per acre.
- Current A2809 recommendation at optimum soil test level approximated K removal.
- More samples needed to verify relationship between soil test level and K_2O recommendation.

Potassium

Soil Group	Soil Test Category				
	Very Low	Low	Optimum	High	Excessively High
	---------- Soil test K ppm ----------				
Loamy	70-100	101-130	131-160	161-190	>190
Sandy, Organic	45-65	66-90	91-130	--	>130
	---------- lb K_2O/a to apply ----------				
	130	100	50	25	0

Sulfur & Zinc





Soil OM supplies S

Very small quantities of Zn are removed

Plant analysis for sulfur & micronutrients

- Soil tests for S and micros are not as reliable as soil tests for P, K, pH
- Plant analysis can be used to evaluate crop. Exercise caution.
  - Best used as a comparison – good vs. poor
  - Will vary with variety in a field
  - Will vary between fields within a variety
  - Adequate ranges vary between growing regions
- Collect samples from 30+ newest mature leaves

Plant Analysis Interpretation

Nutrient	Sufficiency Range
N, %	2.5 - 3.5
P, %	0.35 - 0.6
K, %	2.8 - 3.5
Ca, %	1 - 2.5
Mg, %	0.3 - 0.6
S, %	0.18 - 0.3
Zn, ppm	35 - 80
B, ppm	25 - 70
Mn, ppm	30 - 100
Fe, ppm	35.4 - 151
Cu, ppm	6 - 12

Summary of Preliminary Data

- WI Hop yield estimates varied widely, but averages were comparable to yields in the PNW.
- Average P and K removal at harvest approximated recommendations at optimum soil test levels published in A2809.
- Current N recommendations may be a little high.
- Further data is needed to verify relationship between soil and/or plant tissue testing and current nutrient recommendations for Hop.
- Studying spatial variability of soil test levels could suggest a better soil sampling scheme.

Questions?

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NPKetc

A good nutrient management program starts with soil sampling

- Collect a sample of soil that represents your field
  - Take soil samples to 6-inch depth
  - Composite 10 to 20 cores from a 5-acre (or less) area to make one sample
    - Smaller sampling areas may be more appropriate depending on your operation
  - Sample once every 4 years at a minimum (every other year OK)
  - Ideally, collect samples at the same time of year

- Get the sample tested at a WI DATCP certified lab
  - http://uwlab.soils.wisc.edu
- Estimate the nutrients needed for crop production using test results

Nutrient crediting

- Credit nutrients from organic sources (manure, compost, etc) or if vines/leaves are returned to hop yard
  - Preliminary data indicate ~20 lbs P_2O_5 and 60 lbs K_2O/acre are potentially recyclable with bines.
  - Recommendations are for total amount of nutrients applied, not just commercial fertilizer
- Failure to credit organic sources can result in excess N and P and negative impacts on surface and groundwater quality

pH and liming

- *Proper soil pH is the cornerstone to a good fertility program*
- Minimum pH is 6.0
- Apply lime & incorporate before planting
- Pelletized lime must be applied at the same rates as ag lime to be effective!

Lime Recommendation

Soil pH	Buffer pH					
	6.3	6.4	6.5	6.6	6.7	6.8
	Tons/a of 60-69 grade lime to apply					
5.4	4.5	3.7	3.0	2.2	2.0	2.0
5.5	4.1	3.3	2.6	2.0	2.0	2.0
5.6	3.7	3.0	2.2	2.0	2.0	2.0
5.7	3.3	2.6	2.0	2.0	2.0	2.0
5.8	3.0	2.2	2.0	2.0	2.0	2.0