What kind and how much?

Development of decision support tools for biochar amendment

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Using biochar effectively requires identifying management goals.

What kind of biochar is best?

…It depends on your goal.

How much biochar should I use?

…to do what?

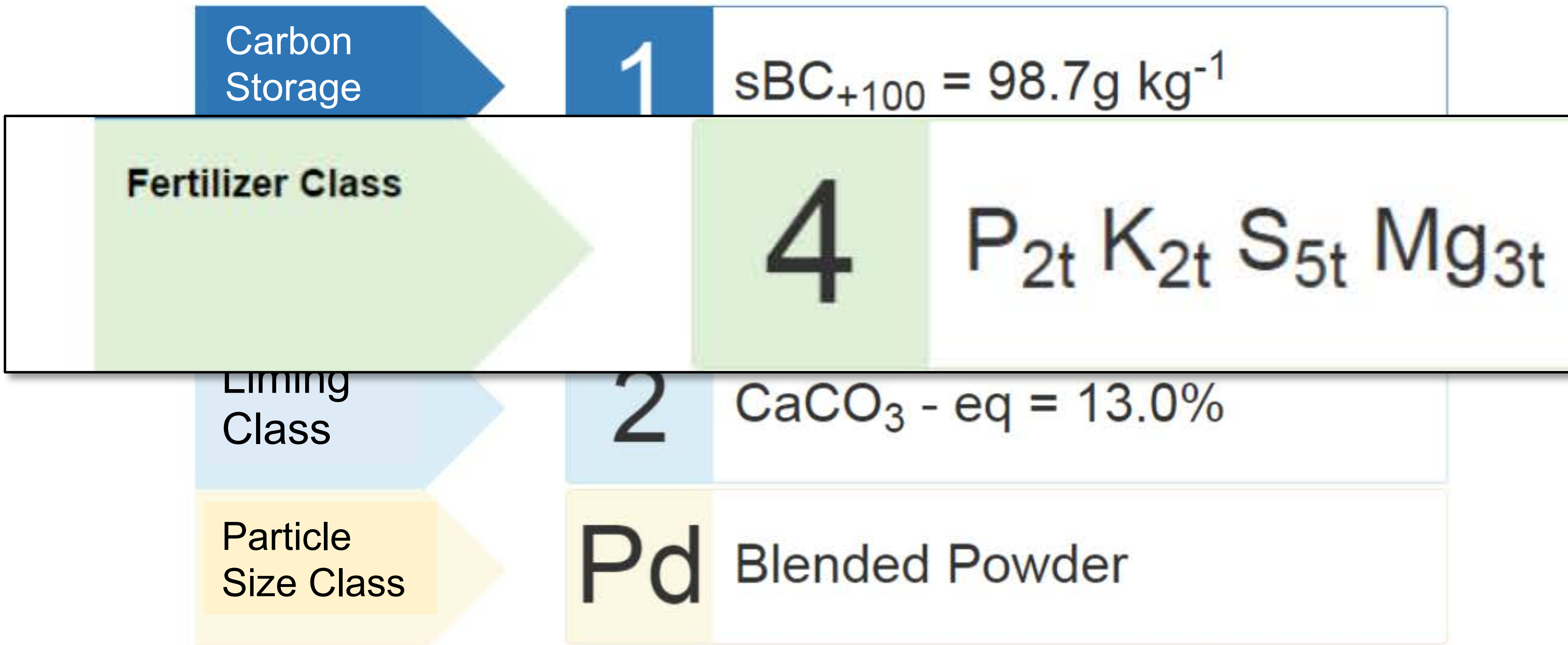
The IBI Classification System helped to answer what kind and how much

Carbon Storage Class	1	sBC_{+100} = 98.7g kg^{-1}
Fertilizer Class	4	P_{2t} K_{2t} S_{5t} Mg_{3t}
Liming Class	2	$CaCO_3$ - eq = 13.0%
Particle Size Class	Pd	Blended Powder

https://www.biochar-international.org/biochar-classification-tool/

Camps Arbestain M, J.E. Amonette, B. Singh, T. Wang, H-P. Schmidt. 2015. *A Biochar Classification System and Associated Test Methods*. In: [Biochar for Environmental Management – Science and Technology, 2nd edition](). J. Lehmann and S. Joseph (eds.). Routledge.

This system provides the basis for an accounting approach to carbon, fertility and pH management.



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We developed a tool to apply this accounting approach to crops, soils, and biochars of the Pacific Northwest

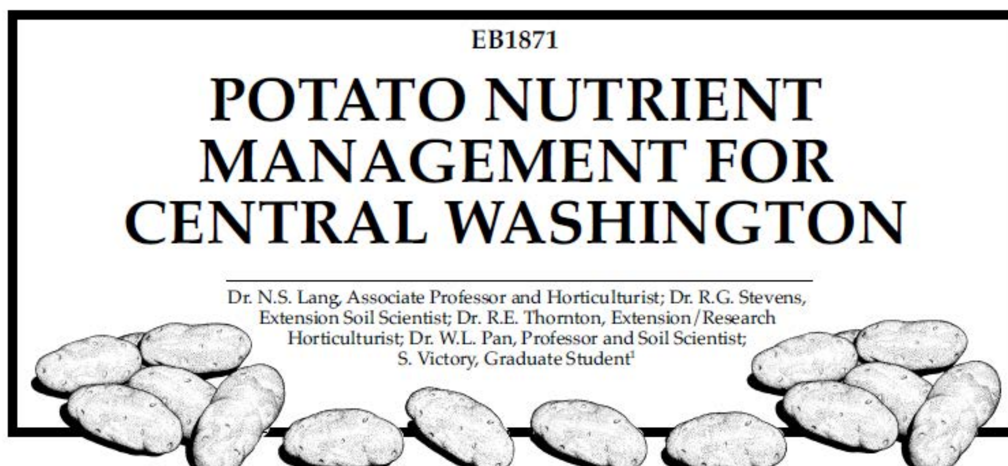
Soil test values + Crop fertilizer guides = Amount of fertilizer and lime needed

No tests? We provide representative values.

Biochar test values = Amount of fertilizer and lime provided

Goals for this talk:

- Demonstrate the tool
- Evaluate how well it works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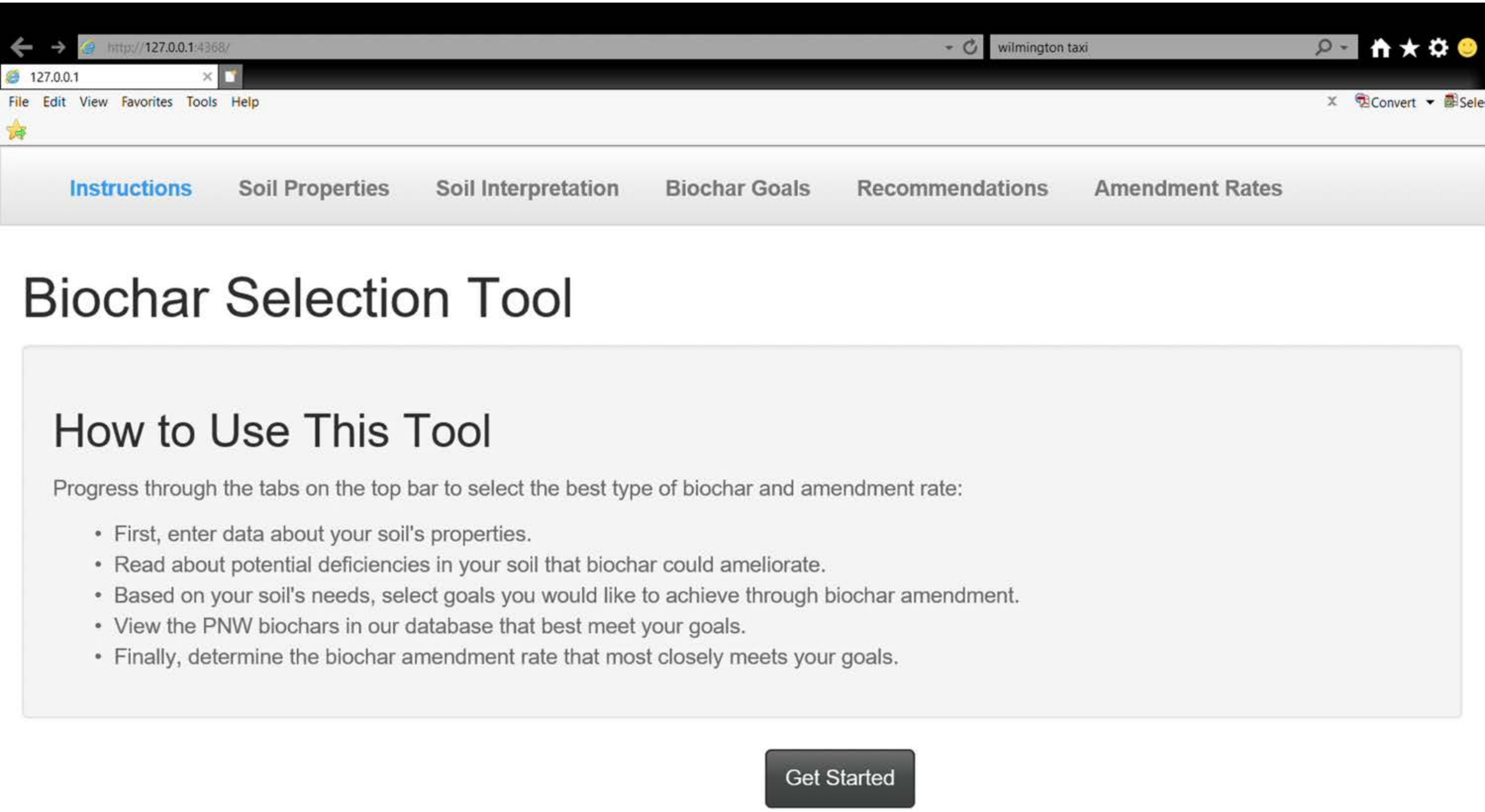
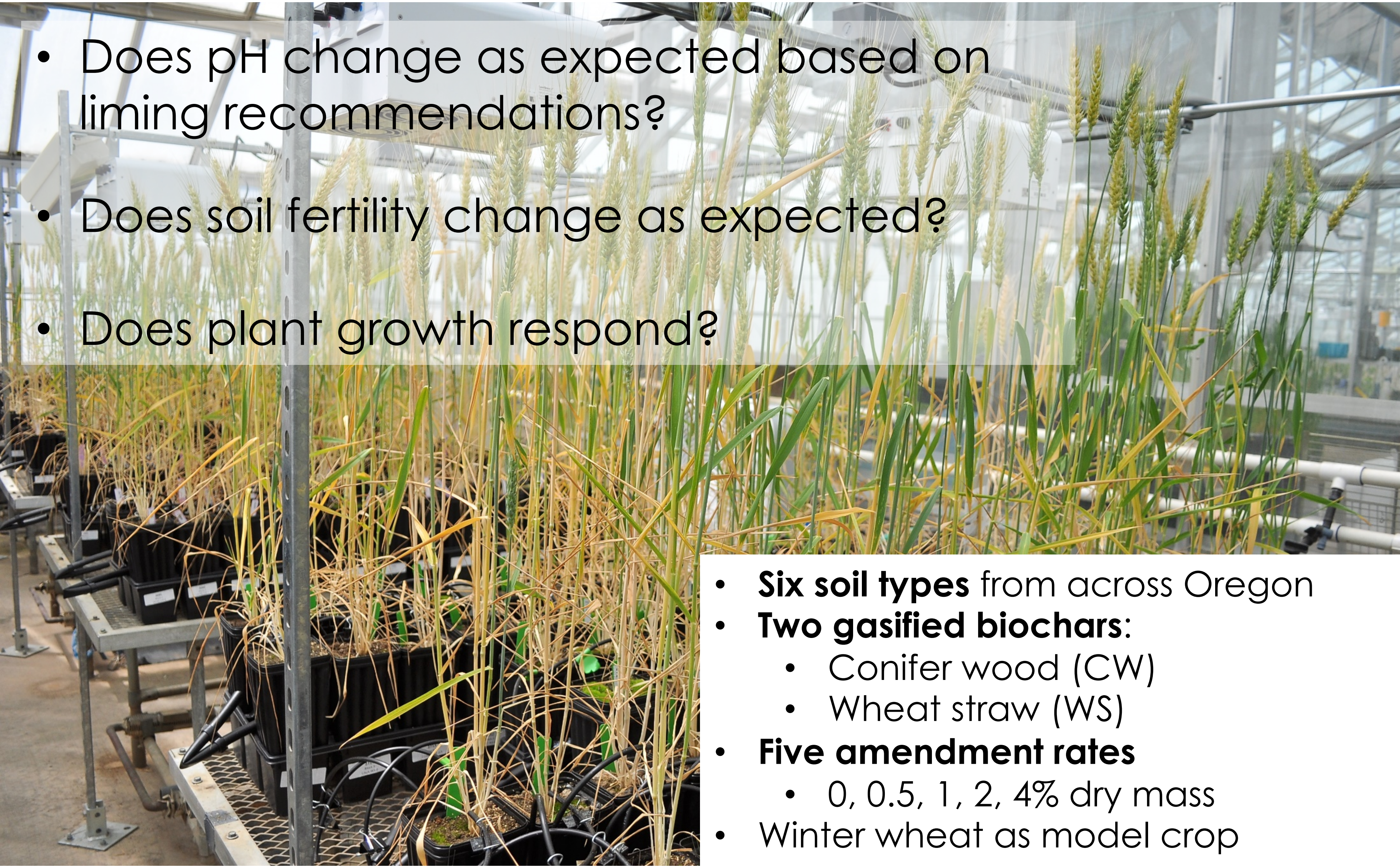
POTATO NUTRIENT MANAGEMENT FOR CENTRAL WASHINGTON

Dr. N.S. Lang, Associate Professor and Horticulturist; Dr. R.G. Stevens, Extension Soil Scientist; Dr. R.E. Thornton, Extension/Research Horticulturist; Dr. W.L. Pan, Professor and Soil Scientist; S. Victory, Graduate Student[1]

pnwbiochar.org



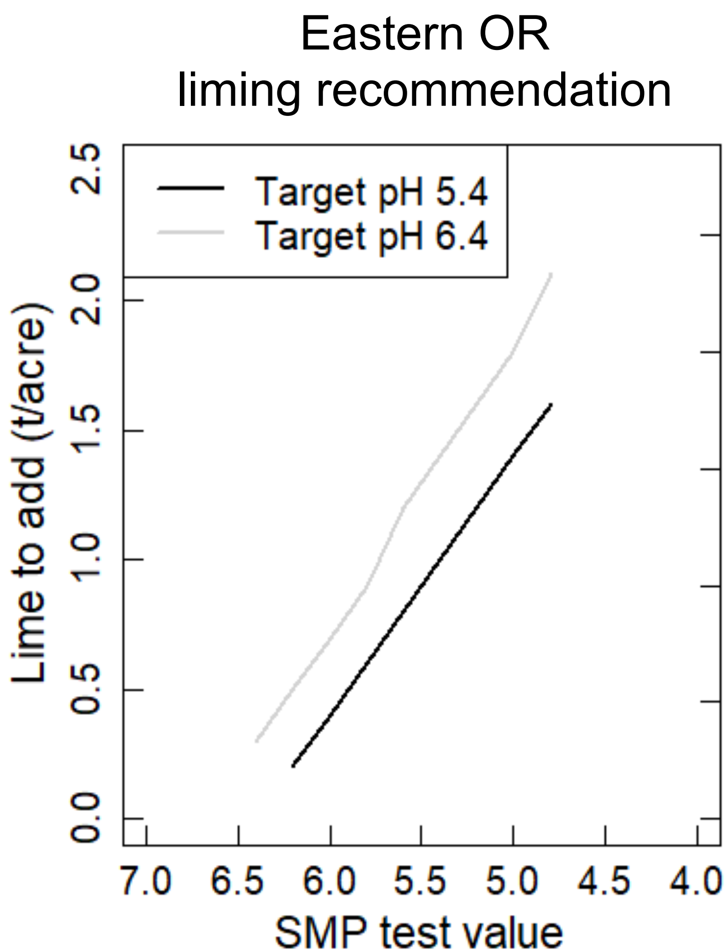
Greenhouse experiment used for validation



- Does pH change as expected based on liming recommendations?
- Does soil fertility change as expected?
- Does plant growth respond?

- **Six soil types** from across Oregon
- **Two gasified biochars**:
  - Conifer wood (CW)
  - Wheat straw (WS)
- **Five amendment rates**
  - 0, 0.5, 1, 2, 4% dry mass
- Winter wheat as model crop

We compared observations to Oregon liming recommendations

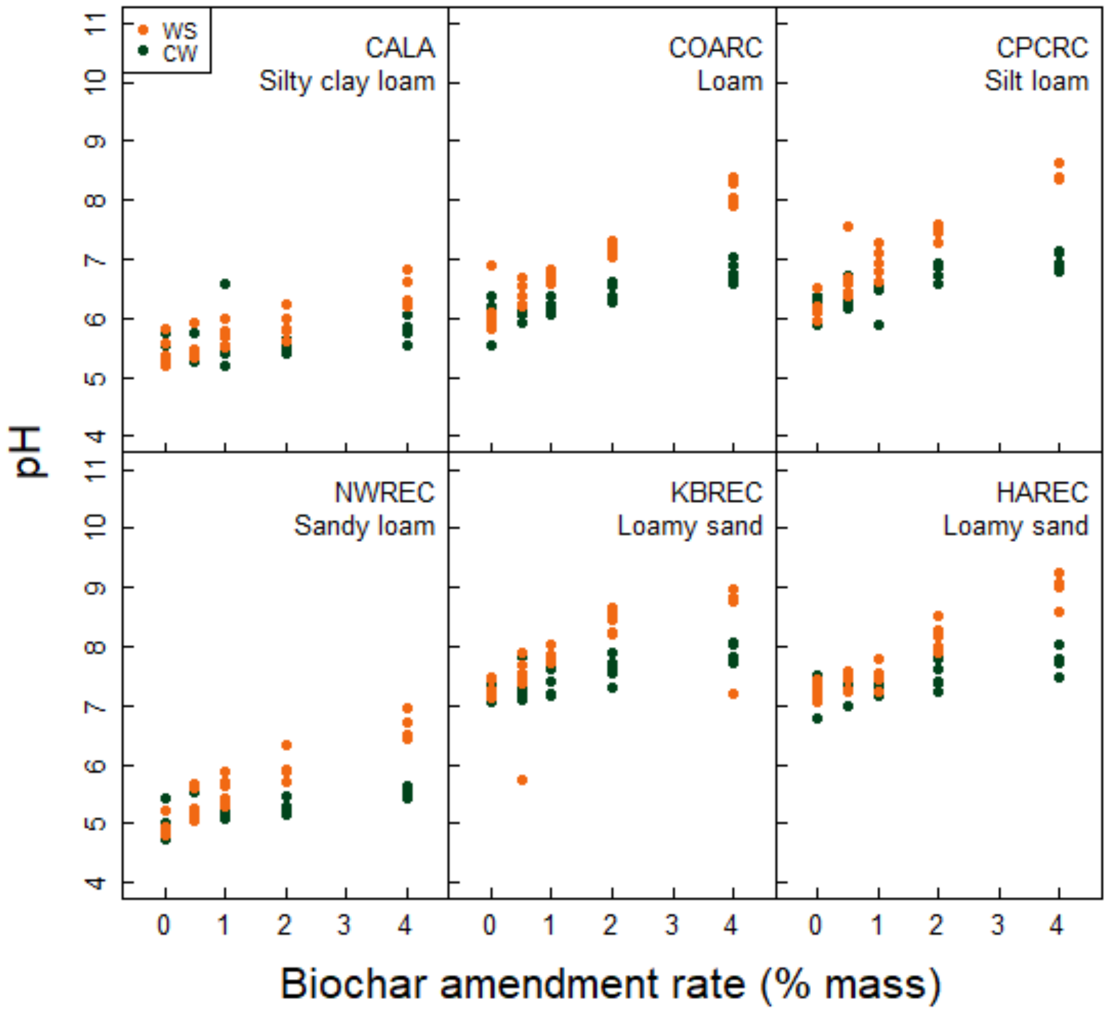


Wheat Straw (WS) =
9% $CaCO_3$-eq
1 ton lime = 11 tons WS

Conifer Wood (CW) =
6.4% $CaCO_3$-eq
1 ton lime = 9 tons CW

Anderson et al. (2013) EM 9057, OSU Extension Service

Post-harvest soil pH showed biochar liming effectiveness



Wheat Straw (WS) = 9% $CaCO_3$-eq
1 ton lime = 11 tons WS

Conifer Wood (CW) = 6.4% $CaCO_3$-eq
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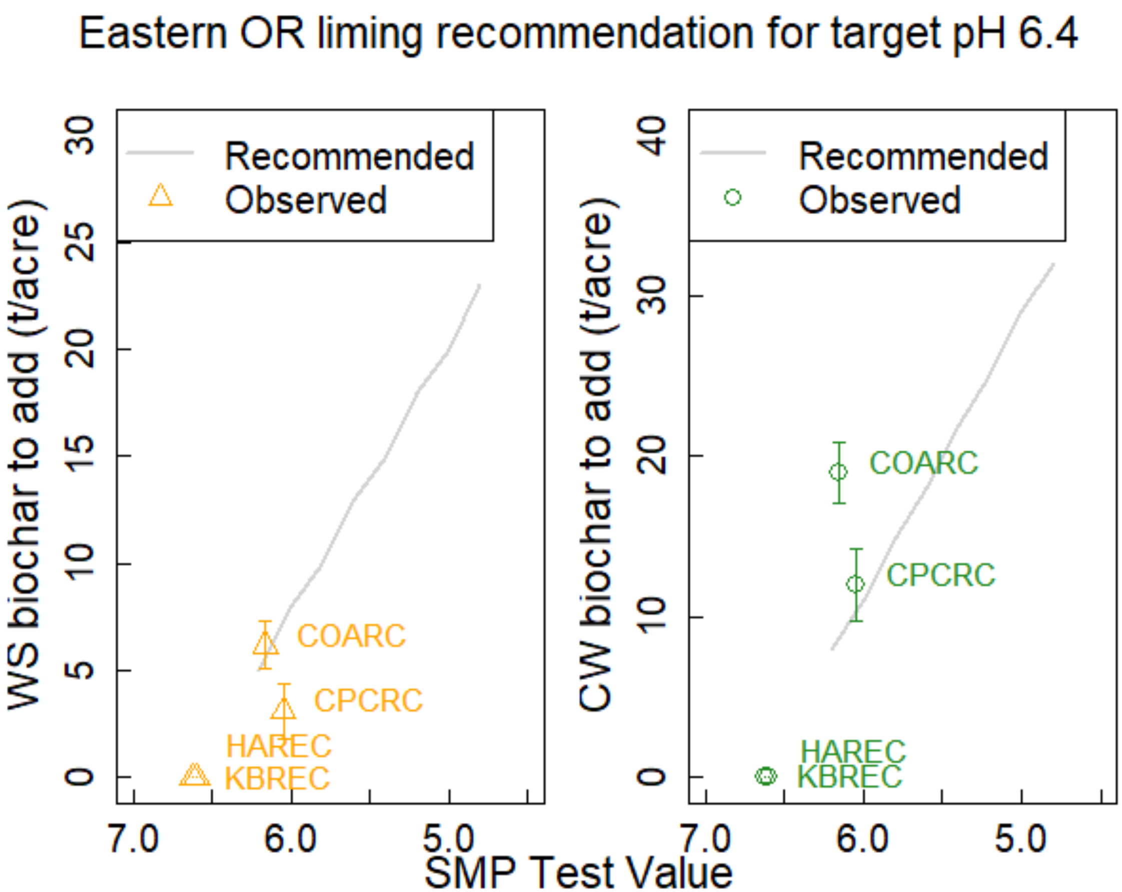
Actual rates bracketed the recommendations



Take aways:

- Some sites hit the mark. We don't expect every site to.
- The fact that there was no consistent bias is encouraging
- Uncertainty multiplies when scaling from lab mixtures to field application rates

Greenhouse experiment used for validation

- Does pH change as expected based on liming recommendations?

Basically yes, with low precision

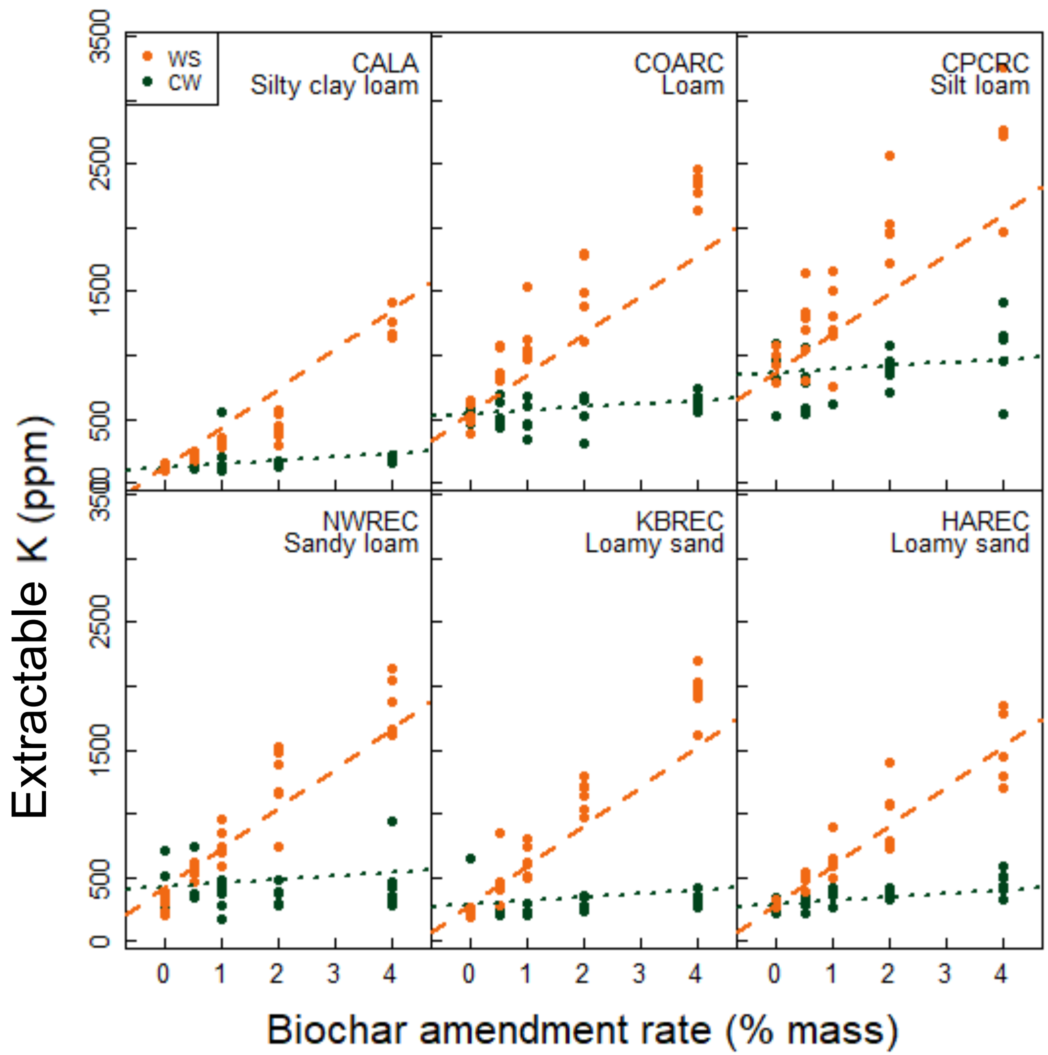
- Does soil fertility change as expected?

- Does plant growth respond?

Biochar extractable-K was a good predictor of soil extractable-K

Lines are ***expected*** K, points are observed K

Different extraction methods matched-up
  Biochar: 1 M HCl
  Soil: Mehlich III



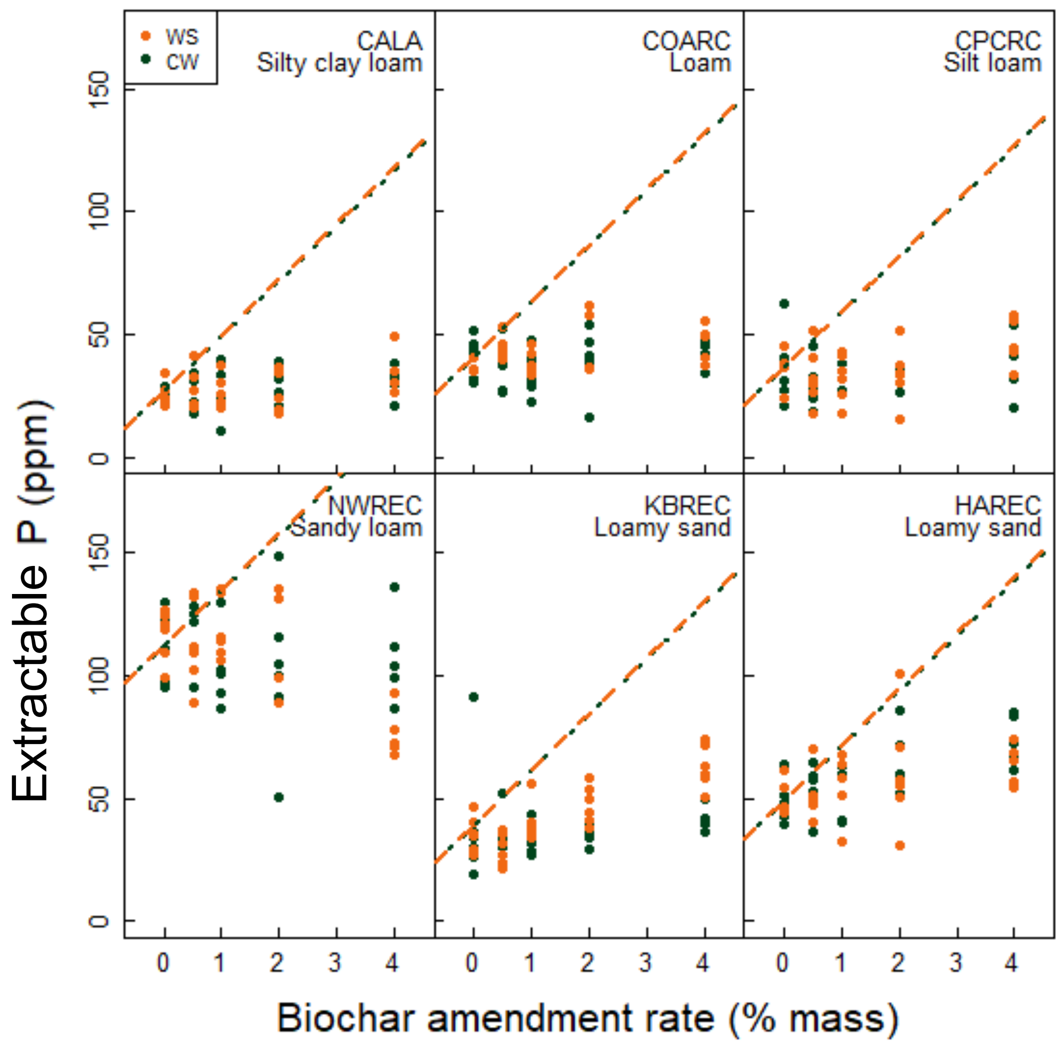
Biochar extractable-P was **not** a good predictor of soil extractable-P

Again, different extractions
Biochar: 2% Formic acid
Soil: Mehlich III

Why the mismatch?

Working hypothesis: 2% formic acid is a more aggressive extraction than Mehlich III

- Requires further testing



Greenhouse experiment used for validation

- Does pH change as expected based on liming recommendations?

Basically yes, with low precision

- Does soil fertility change as expected?

Yes for K, no for P

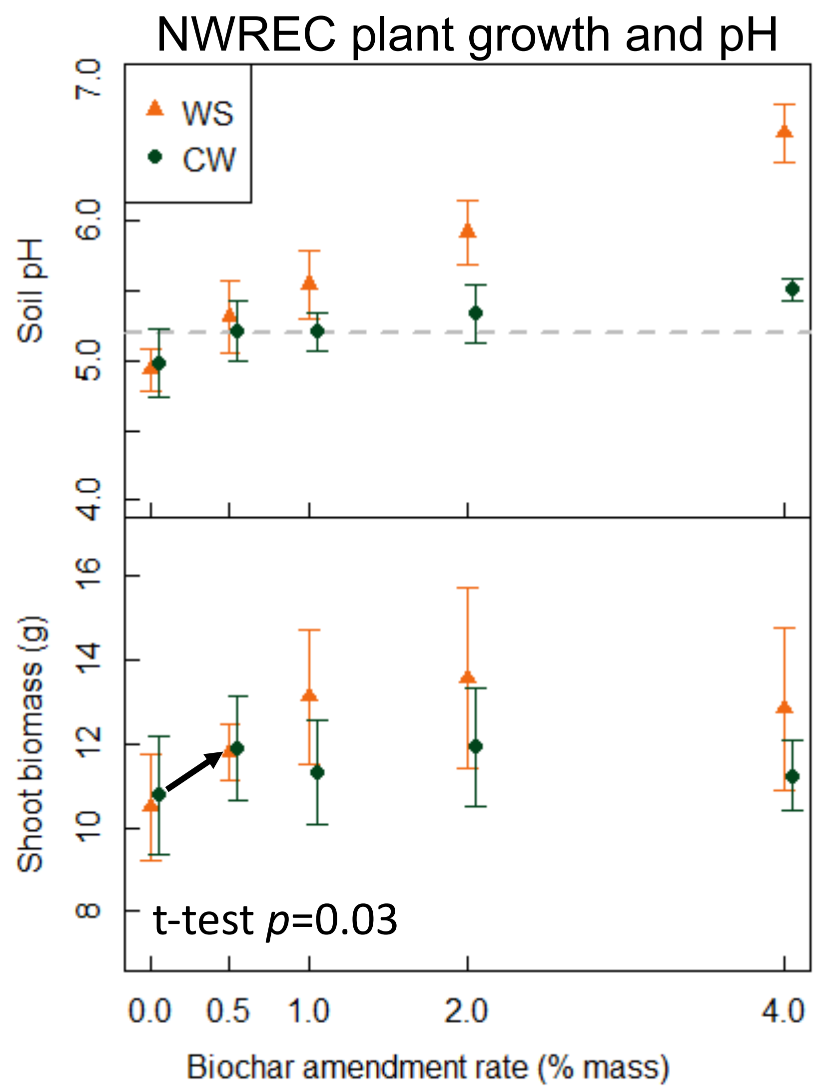
- Does plant growth respond?

Did plant growth respond?

Biochar increased growth where pH was deficient.

Biochar increased pH above critical threshold for plant growth (5.3)

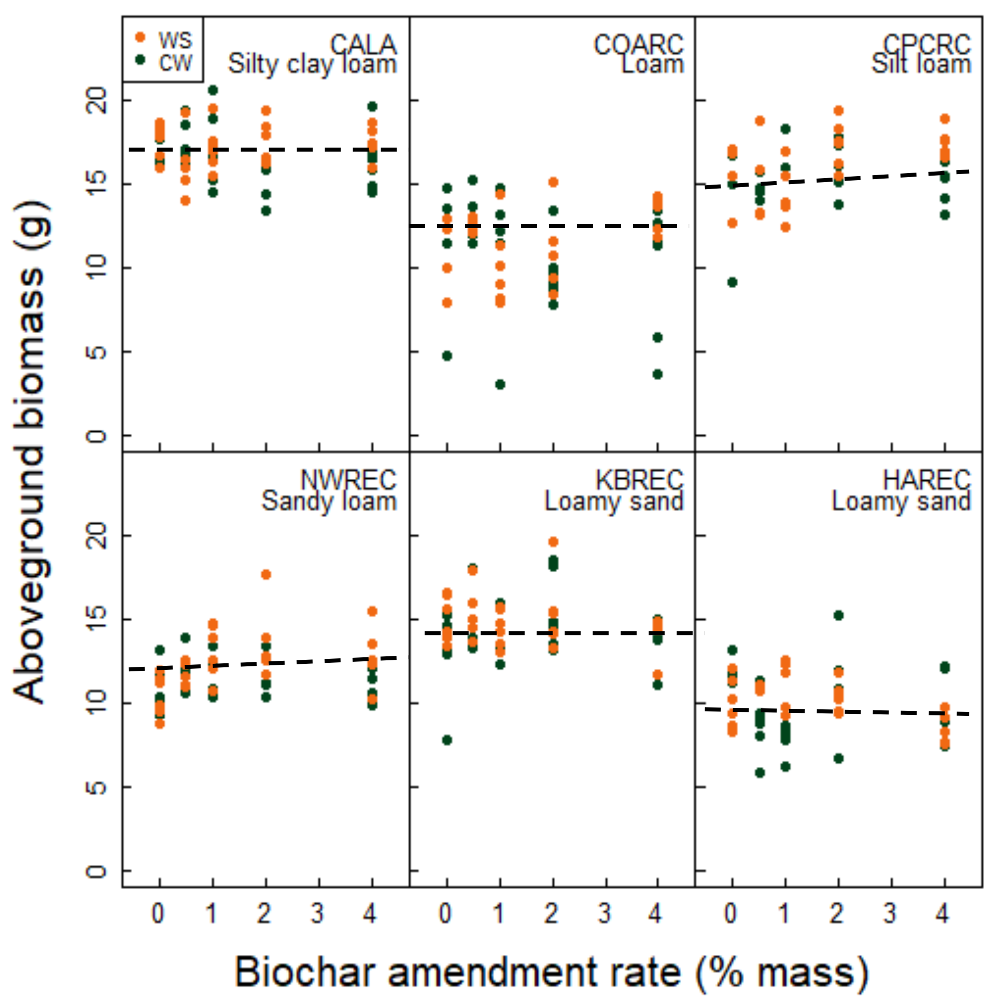
Plant growth increased significantly crossing the pH threshold



Plant growth did not change where pH and soil fertility were well managed

No significant correlations between biomass and amendment rate.

Biochar impact on shoot biomass



Greenhouse study provided validation dataset for amendment rates

- Does pH change as expected based on liming recommendations?

Basically yes, with low precision

- Does soil fertility change as expected?

Yes for K, no for P

- Does plant growth respond?

Yes—plants grew more when there was a deficiency, and did not when there was no deficiency

Conclusions

- The tool did a good job of predicting soil pH, plant growth, and available-K, and illuminated some potential problems with the IBI biochar P test.
- We expect this chemical accounting approach to have limitations in soils with a strong biological response to biochar, e.g. plant ethylene response, or microbial priming
- This decision-support tool is an important step forward in establishing a process to use biochar effectively.

Acknowledgements

Agricultural Research Service
Northwest Climate Hub

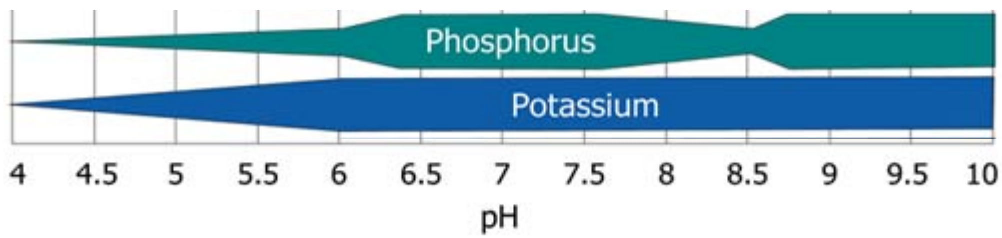
Northwest Climate Science Center

This work was supported by the USDA Agricultural Research Service project in the laboratory of K.T (2072-1410-1004) and the U.S. Department of the Interior under JVA #16-JV-11261944-089 to C.P. and K.T

Questions? Comments?

Photo by D. Morrison

Extras



Did plant growth respond?

Biochar only increased growth where pH was deficient.

No significant correlations between biomass and amendment rate.

pH was below critical threshold at one site

Biochar impact on shoot biomass