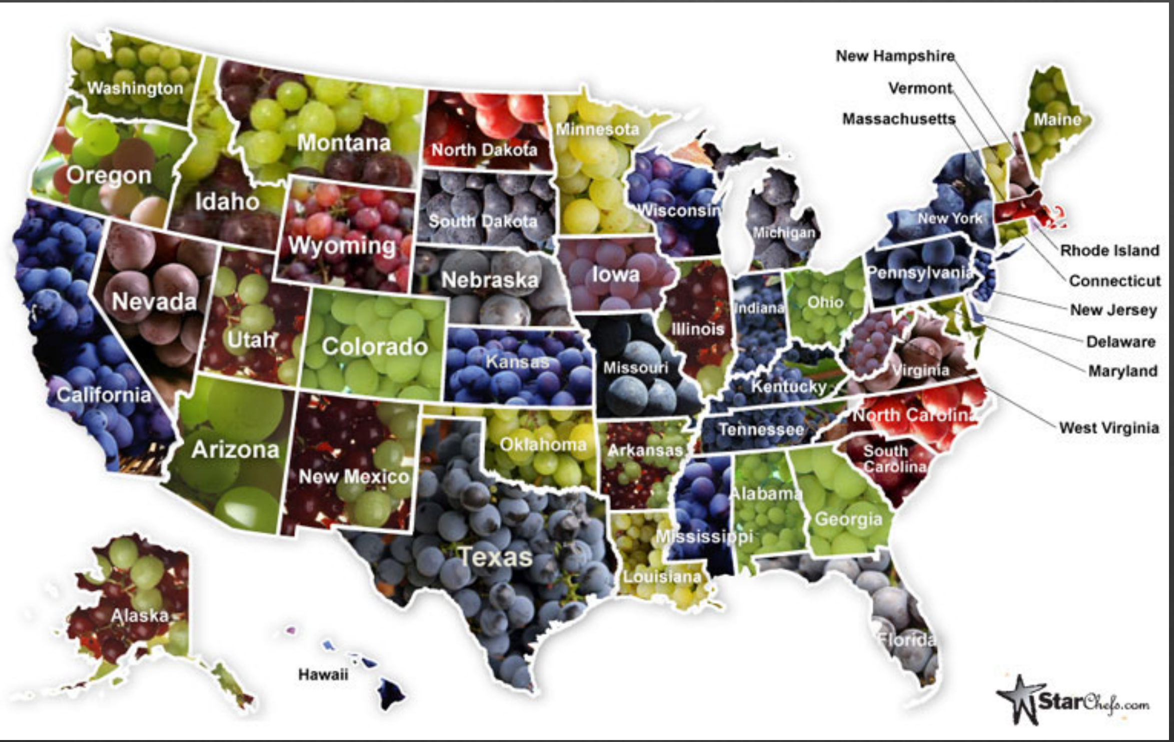
United States Department of Agriculture
Agricultural Research Service

Establishing sustainable biochar-based vineyard practices in grape production

Manuel Garcia-Jaramillo, Kristin Trippe, Alexander Levin

- March 2019 -

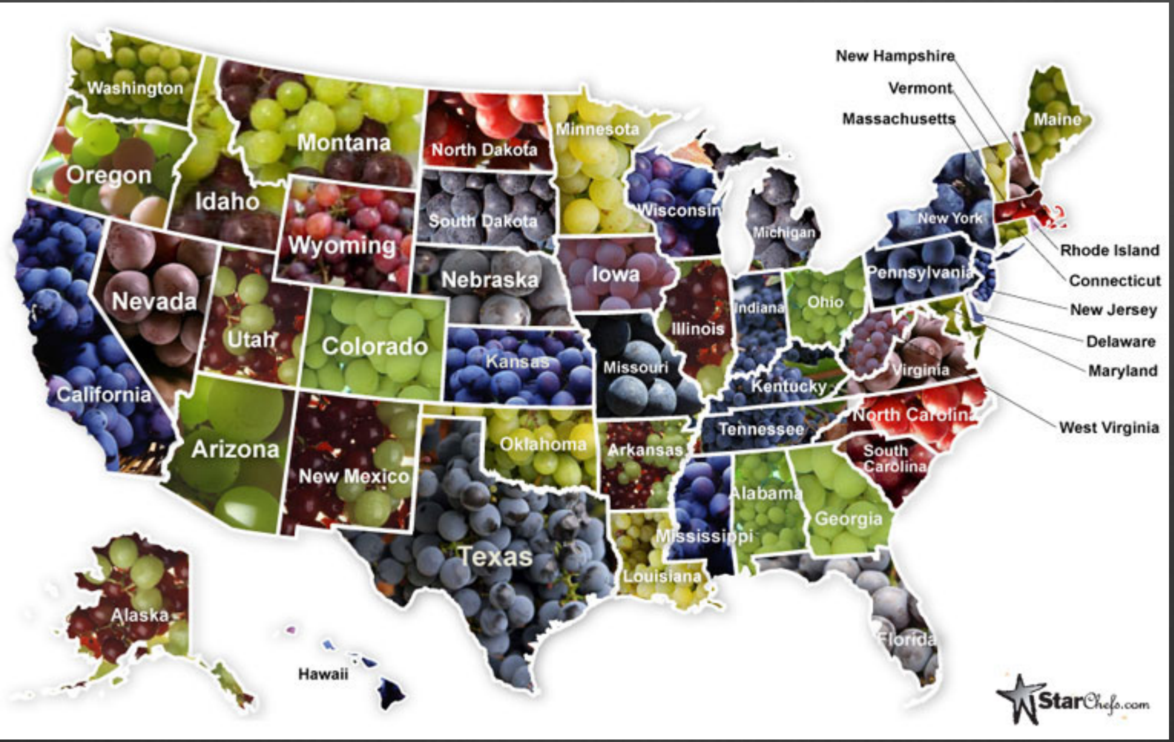
The US has more than **1 million** bearing acres of vines, producing an average of 7.57 tons of grapes/acre



Grapes are one of the highest value fruit crop in the US

The US has more than **1 million** bearing acres of vines, producing an average of 7.57 tons of grapes/acre

California used to make 85% of total U.S. wine production.



Grapes are one of the highest value fruit crop in the US

Because of the higher temperatures, water stress, and fires, California's wine industry is depleting and Oregon's wine industry is expanding

Winery sales increased in Oregon more than **50%** from 2013 to 2016

Challenges for The Future of Grape Farming

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CLIMATE CHANGE
Water stress and higher temperatures

Cabernet Sauvignon grapes shriveled by lack of water in high temperatures.

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PESTS
Intensive farming

Government of Western Australia. Garden weevil *(Phlyctinus callosus)*

Challenges for The Future of Grape Farming

Watershed contamination by runoff or leaching of pesticides

Vancouver Grape Fields.

Challenges for The Future of Grape Farming

Increasing international CONCERN about the presence of pesticide residues in food and wine

Derek Noland

Challenges for The Future of Grape Farming

Increasing international CONCERN about the presence of pesticide residues in food and wine

- The US Environmental Protection Agency (EPA) classifies glyphosate as 'practically non-toxic and not an irritant' under the acute toxicity classification system.
- However, in 2005, the Food and Agriculture Organisation (FAO) reported that glyphosate and its major metabolite, aminomethylphosphonic acid (AMPA), are of potential toxicological concern, mainly as a result of accumulation of residues in the food chain.

Bai et al., (Environ Sci Pollut Res Int.) 2016

How can we improve:

- Soil water holding capacity
- Water relations in *Vitis vinifera*
- Watershed health
- Wine quality

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The answer is BIOCHAR =

Different biochar materials. UC Davis Biochar database

What is biochar?:

Basically… charcoal used as a soil amendment, made from biomass via pyrolysis.

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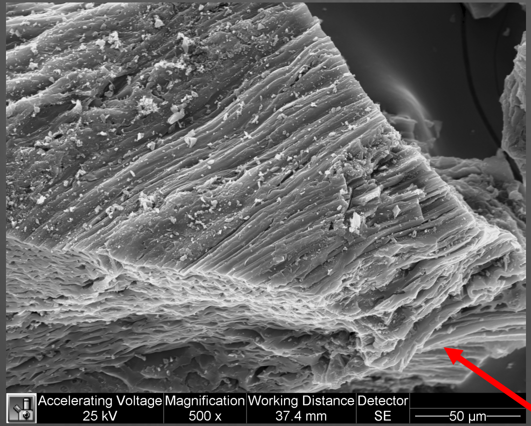
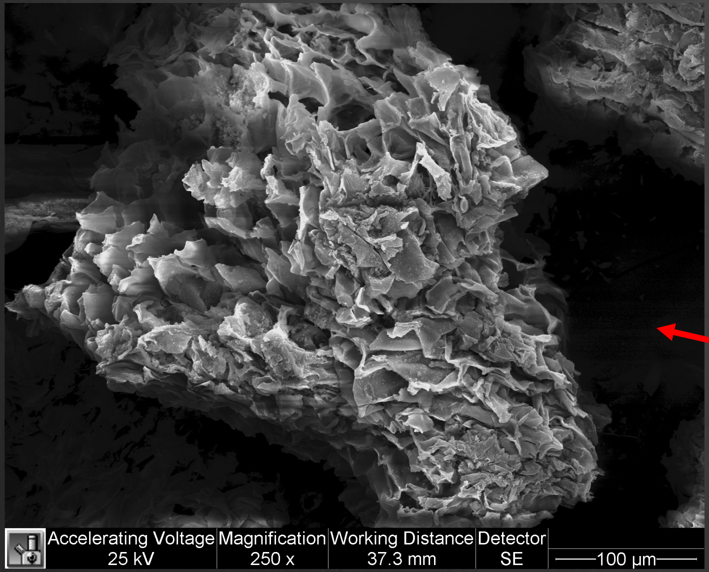
Thermal decomposition of materials at elevated temperatures in an inert atmosphere.

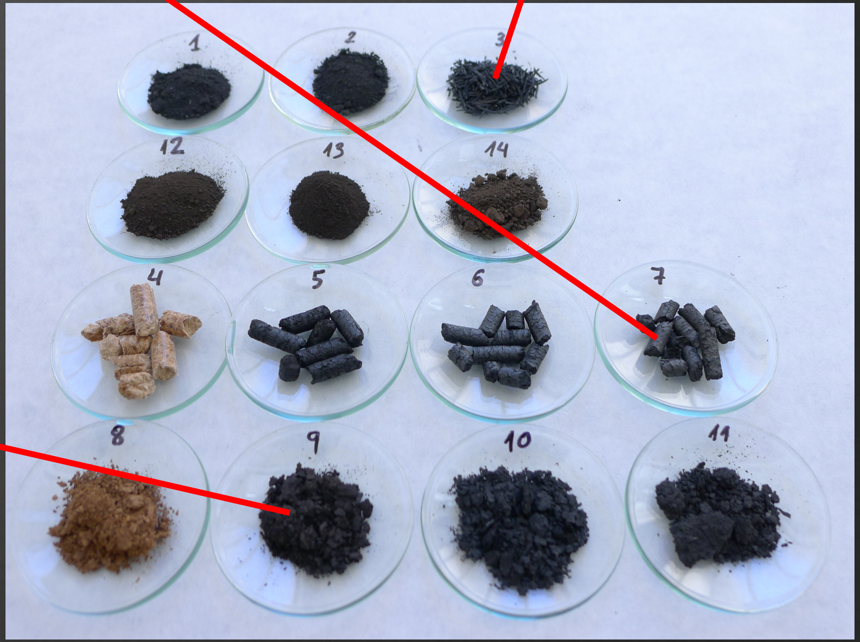
It involves the change of chemical composition and is irreversible.

The word is coined from the Greek-derived elements *pyro* "fire" and *lysis* "separating".

What is biochar?:





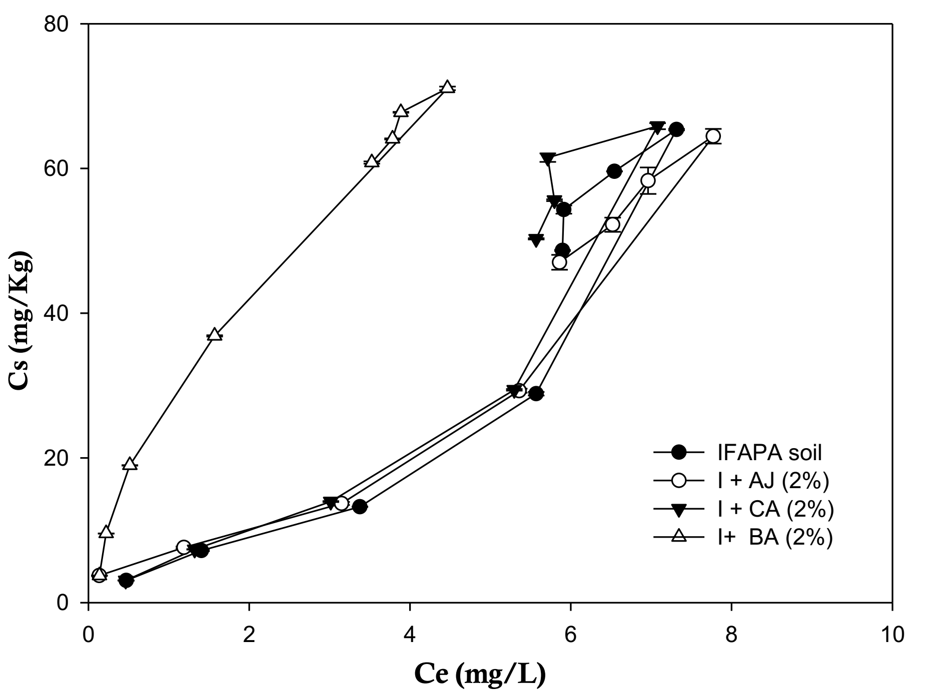


The addition of biochar to soils has been proof to be an efficient way to improve:

- Soil water holding capacity
- Water infiltration
- Soil water availability
- Nutrient retention
- Hydraulic conductivity
- Soil aeration
- Soil microbial activity
- Immobilization of heavy metals and pesticides

Some examples of the immobilization of pesticides:

Adsorption isotherms of TRICYCLAZOLE (hydrophobic fungicide)



Cs = amount of pesticide adsorbed per mass of amended or unamended soil (mg/Kg)

Ce=amount of pesticide in solution after equilibration (mg/L)

M. Garcia-Jaramillo et al. Science of the Total Environment 466–467 (2014) 906–913

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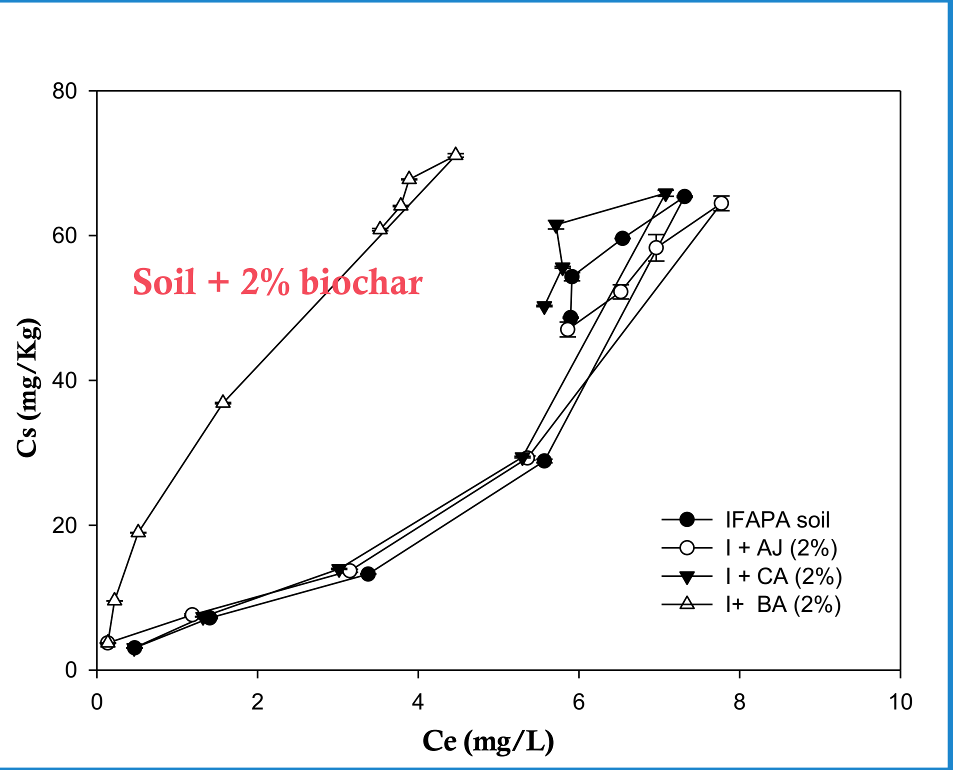

Take home:

The addition of biochar, at a rate of 2%, increased **8 times** the adsorption/retention of this fungicide into the soil

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Some examples of the immobilization of pesticides:

GLYPHOSATE (polar herbicide)
sorption on biochars and raw feedstock materials

Data from Hall et al., Pest Manag. Sci. 2018; 74: 1206–1212

Sorbent	% Sorbed (mean ± SE)
Pecan (raw)	<0.5
PC-350	<0.5
PC-500[b]	3.0 ± 0.5
PC-700	56.4 ± 3.0
PC-900	68.3 ± 1.6
Cherry (raw)	<0.5
CH-350	<0.5
CH-500	5.8 ± 0.4
CH-700	2.0 ± 0.6
CH-900	18.3 ± 1.8
Apple (raw)	<0.5
AP-350	<0.5
AP-500	8.8 ± 2.1
AP-700	35.0 ± 7.4
AP-900	66.6 ± 5.8
Wood pellet (raw)	<0.5
WP-350	<0.5
WP-500	1.5 ± 0.3
WP-700	25.8 ± 1.3

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Take home:

The adsorption of glyphosate to biochar increases with higher pyrolysis temperatures and depends on the feedstock used for its production

Long-term goals:

Establish and advance sustainable biochar-based vineyard practices that simultaneously improve soil, watershed, grapes and wine quality!

S. Baronti et al. Europ. J. Agronomy 53 (2014) 38–44

Project AIMS

Research & Extension

OBJECTIVE 1 (research): **improve plant productivity, soil and watershed health, while reducing the concentration of residual pesticides in grapes and wine.**

OBJECTIVE 2 (extension): **develop outreach and education materials for dissemination to winegrowers and producers.**

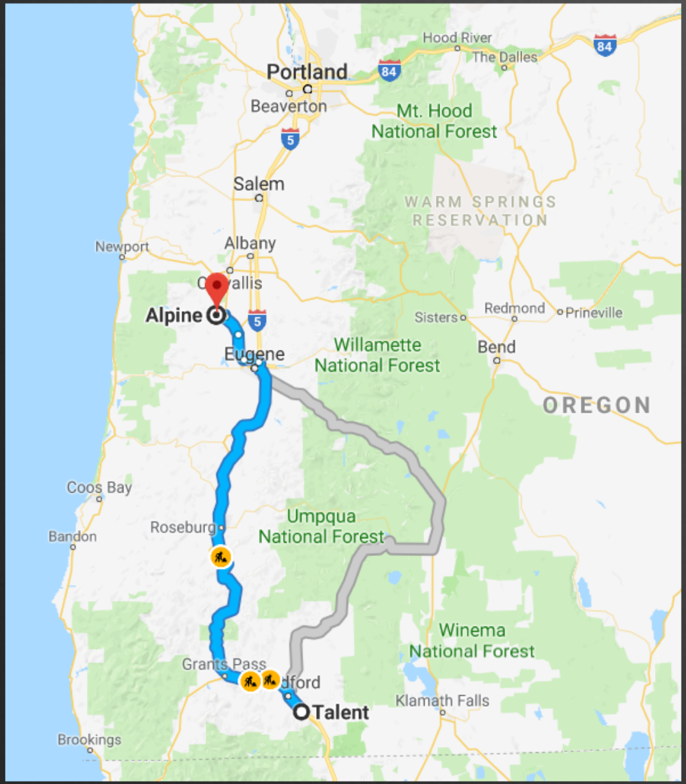
- **Workshops and outreach activities**
- **Informational videos**
- **Stakeholder presentations**
- **Website development**
- **Biochar recommendations**
- **Viticulture recommendations**

→ Published on social media outlets and biochar centric websites, including www.PNWBiocharAtlas.org (Claire Phillips, Adam Lindsley & Kristin Trippe)

How biochar can reduce the amount of residual pesticides in grapes and wine?

Field Studies

Field plots:

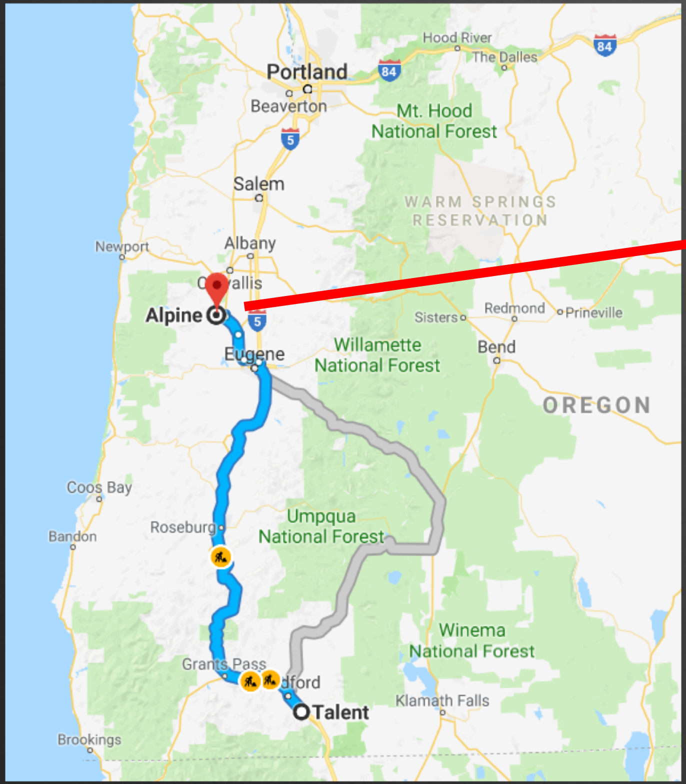


- Trials have been established in two different locations, with a similar soil and design (pruning, spacing), and the same scion/rootstock combination (Pommard/101-1).

- Together, these regions encompass nearly 90% of the wine grape acreage in the state of Oregon.

Field plots:

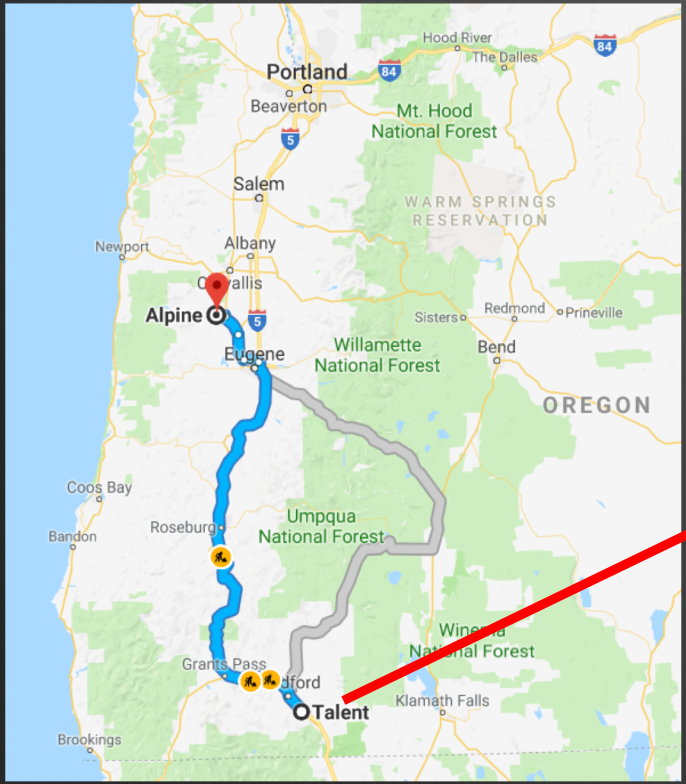
Woodhall III Vineyard, OSU, Alpine, OR



Rogue Biochar™ - Oregon Biochar Solutions

Field plots:

Cedars Ranch, Quail Run Vineyards, Talent, OR



Making biochar from vineyard waste

And at the lab…

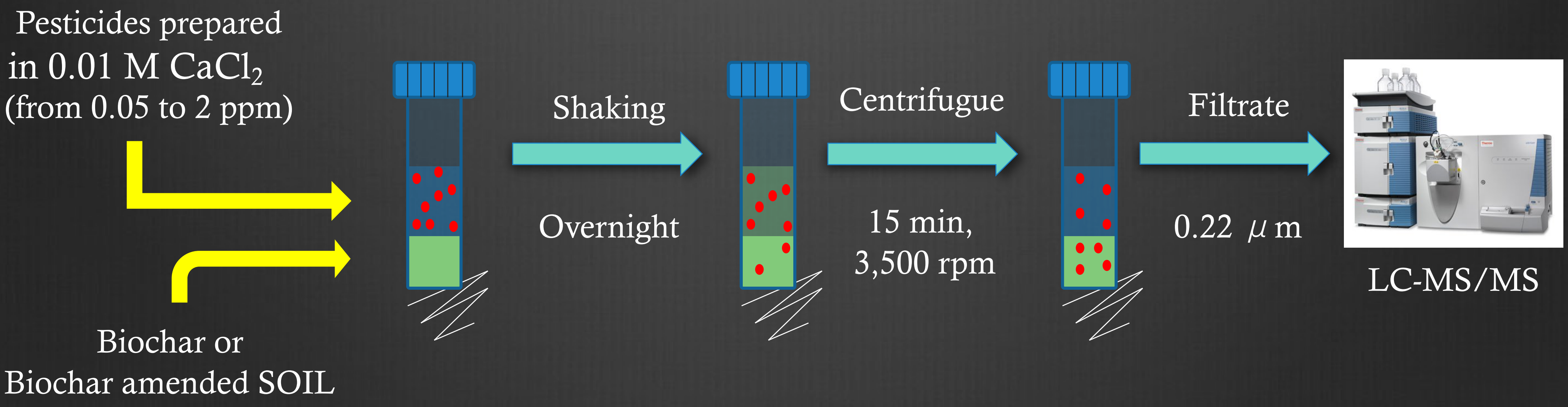
Testing the adsorption of herbicides to different biochars

Vine waste biochar traditionally made

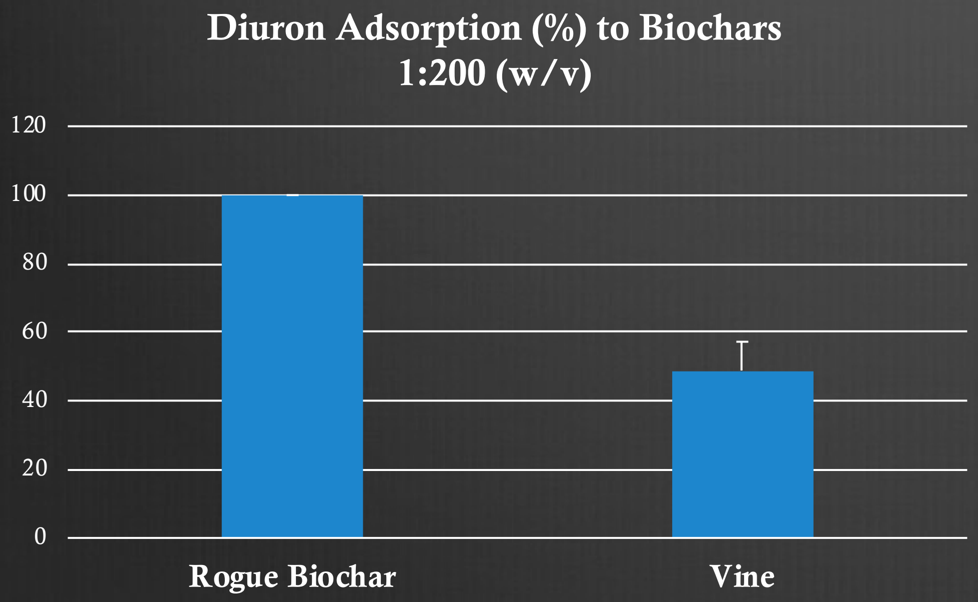
VS

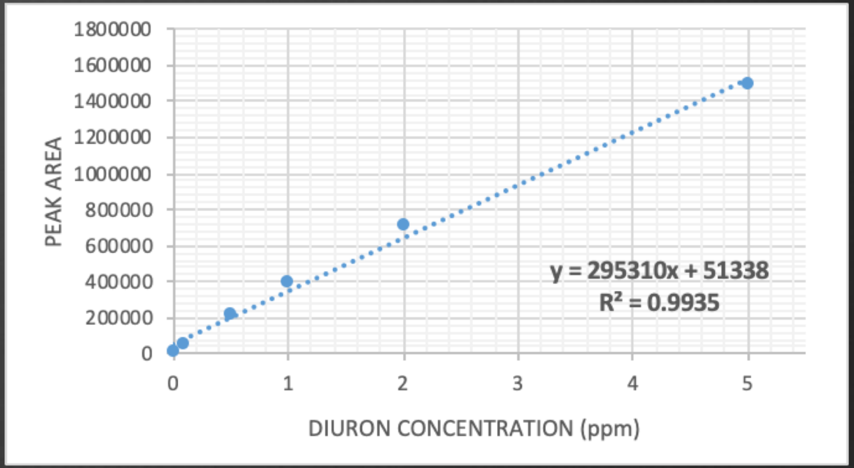
High carbon, ultra-pure biochar

Testing the adsorption of herbicides to different biochars



Testing the adsorption of herbicides to different biochars





Implementing analytical methods

- Extraction and analysis of pesticides in grapes and wine-

Pest Management Science SCI

Review

Analysis of glyphosate and aminomethylphosphonic acid in water, plant materials and soil

William C Koskinen, LeEtta J Marek, Kathleen E Hall

First published: 10 October 2015 | https://doi.org/10.1002/ps.4172 | Cited by: 10

Pest Management Science SCI

Research Article

Glyphosate sorption/desorption on biochars – interactions of physical and chemical processes

Kathleen E Hall, Kurt A Spokas, Beatriz Gamiz, Lucia Cox, Sharon K Papiernik, William C Koskinen

First published: 23 January 2017 | https://doi.org/10.1002/ps.4530

JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY

Article

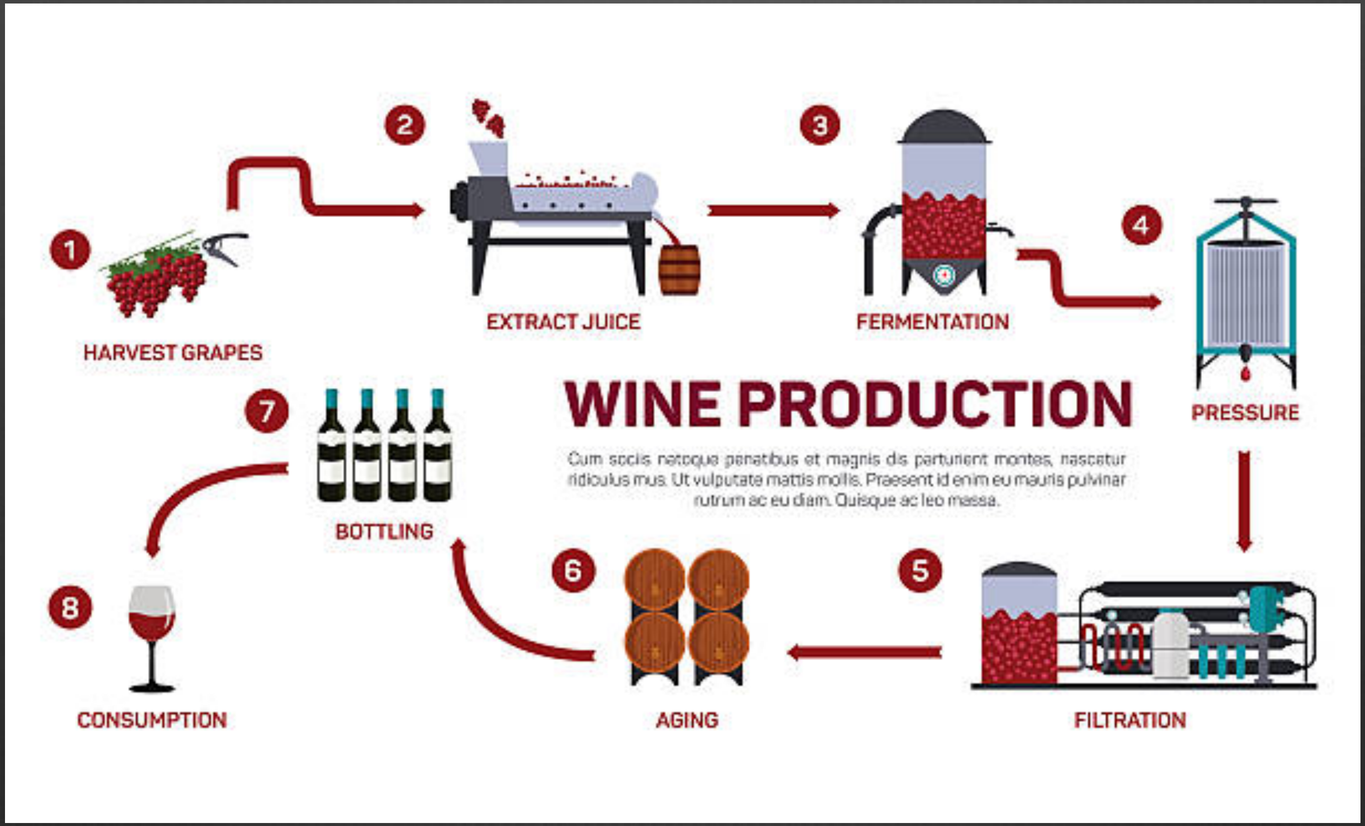
pubs.acs.org/JAFC

Determination of Glyphosate, Maleic Hydrazide, Fosetyl Aluminum, and Ethephon in Grapes by Liquid Chromatography/Tandem Mass Spectrometry

Narong Chamkasem*

Southeast Food and Feed Laboratory (SFFL), U.S. Food and Drug Administration, 60 Eighth Street, N.E., Atlanta, Georgia 30309, United States

Learning about the vinification process



Getty Images

What is next?

Soil sampling

(at the beginning and end of the season)

- To measure:
  - Extractable macronutrients
  - pH
  - Soil respiration
  - C/N

Plant sampling (May to September)

Monthly during the season:

- Midday leaf water potential (with a pressure chamber)
- Stomatal conductance/Photosynthesis (with an IRGA)

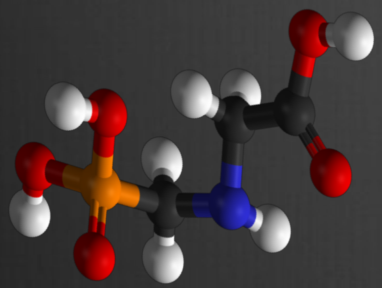
At harvest:

- Yield and yield components (clusters per vine, cluster weight, berries per cluster, and berry weight)
- Primary juice chemistry (Brix/pH/titratable acidity)
- Berry secondary metabolites (skin anthocyanins + skin/seed tannins and total phenolics)

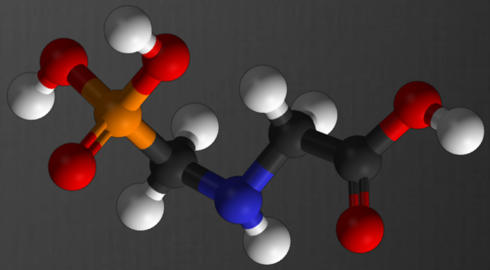
At dormancy:

- Pruning weights

Monitoring Glyphosate residues in:



- Destemmed crushed grapes
- Macerated must
- Pressed must
- Filtered wine



We will get an idea about the residues transferred from grapes into the must and through the vinification process into the wine.

Acknowledgments

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Kelpie Wilson (WBA)
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Cedars Ranch, Quail Run Vineyards

Stakeholders

Rogue Biochar (OBS)
Rogue Valley (winegrowers association)
LIVE (Certification board)

Thank you very much for your attention!

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