Enhancement of Nutrient and Water Uptake in Vineyard Using Soil Amendments/Biochar

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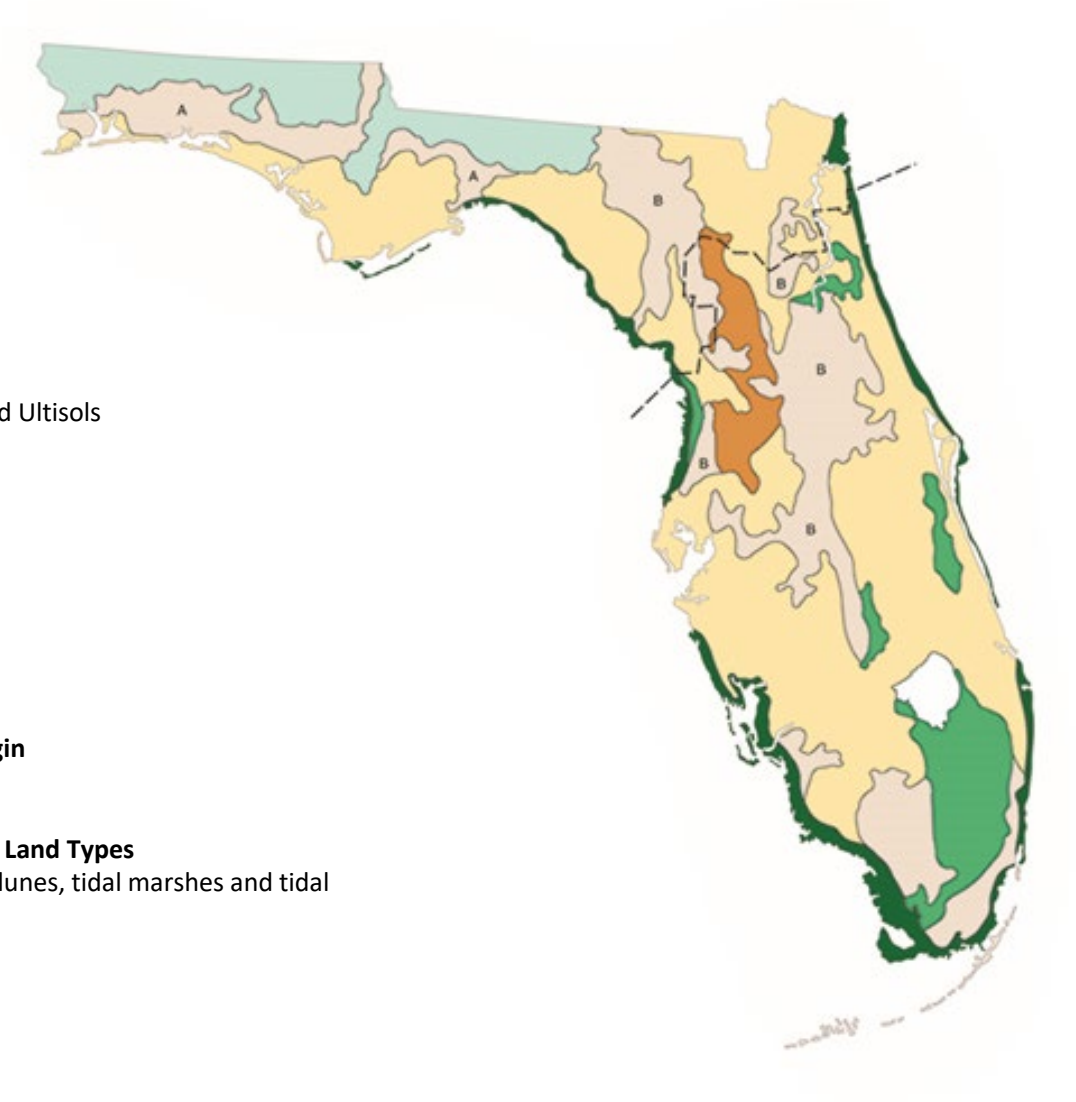
Soil Health

-Function as vital living system
-Sustain biological productivity
-Maintain environmental quality
-Promote plant health

-Part of key vineyard management
- *Water retention*
- *Soil structure: compaction and erosion*
- *Nutrient recycling and plant uptake*
- *Organic matter*

Photo credits: Proffitt, T. and Campbell-Clause, J. (2012).

FL Soil Map



Western Highlands
- Mostly Ultisols
- Mostly Entisols

Central Ridge
- Mostly Alfisols and Ultisols
- Mostly Entisols

Flatwoods
- Mostly Spodosols

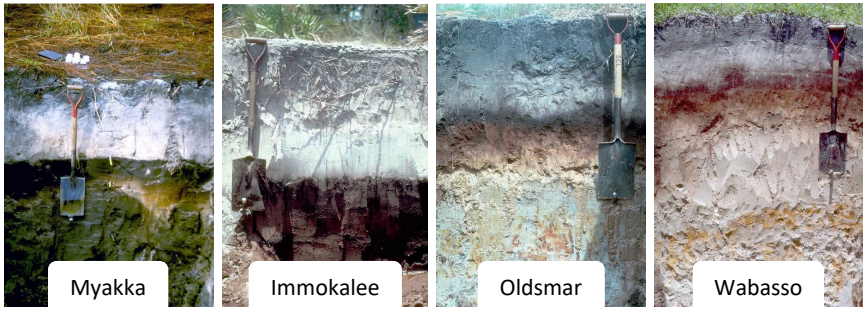
Organic Origin
- Mostly Histosols

Recent Limestone Origin
- Mostly Entisols

Miscellaneous Coastal Land Types
- Mostly beaches, dunes, tidal marshes and tidal swamps

https://soils.ifas.ufl.edu/extension/soil-and-water-resources/general-soils-map-of-florida/

FL Soil Map



Central Ridge Soils (Entisols), characteristics:

- Sandy texture (~98%) in all layers
- Well to excessively drained
- High hydraulic conductivity (6-8.5 inch/hr)
- Nearly level to sloping (up to 8% slope)
- Little or no evidence of development of pedogenic horizons
- ~0.7% Organic Matter
- Yellow, orange, or brown colored sand is more likely to be coated
- Bright white sand is not coated. May not hold soil P, and then leaching occurs

Flatwoods (Spodosols), characteristics:

- Sandy texture (~97%) in top layer
- Poorly to very poorly drained
- Low hydraulic conductivity ($\leq$0.2 inch/hr)
- Nearly level (<2% slope)
- Spodic horizon, an acidic subsurface hardpan composed of Al and Fe “cemented” together with OM
- ~1.5% Organic Matter
- High water table during wet season
- In most undisturbed soils, an albic horizon overlies the B horizon

Soil series profiles from Central Ridge and Flatwoods, (Obreza and Collins, 2008)

FL Vineyard Soils

-Low soil fertility
-Highly susceptible to erosion
-Low in organic matter contents
-Low water and nutrient holding capacity

Biochar

-Biochar is a pyrolysis product of organic materials (Lehmann and Joseph, 2009).
-Organic materials could be any agricultural, forest, or animal waste.

Properties and Benefits of Biochar

Chemical properties

High carbon sequestration (Lehmann et al., 2006; Glaser et al., 2007)

High cation exchange capacity (Liang et al., 2006)

Physical properties

High water holding capacity (Mukherjee et al., 2013)

High porosity (Lehmann et al., 2011)

Low bulk density (Zhang et al., 2012)

Soil amelioration

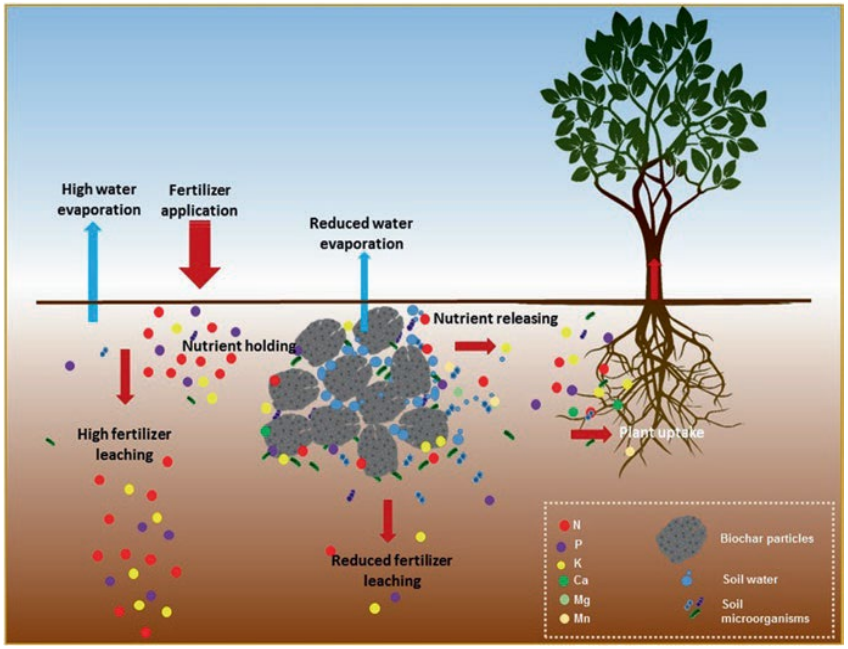
Slow nutrient release (Bourke et al., 2007; Major et al., 2010)

Better O_2 and moisture level (Tang et al., 2013)

Increases microbial abundance (Liang et al., 2010)

Enhances enzyme activities (Vanessa et al., 2011)

High complexation (Uchimiy et al., 2010)

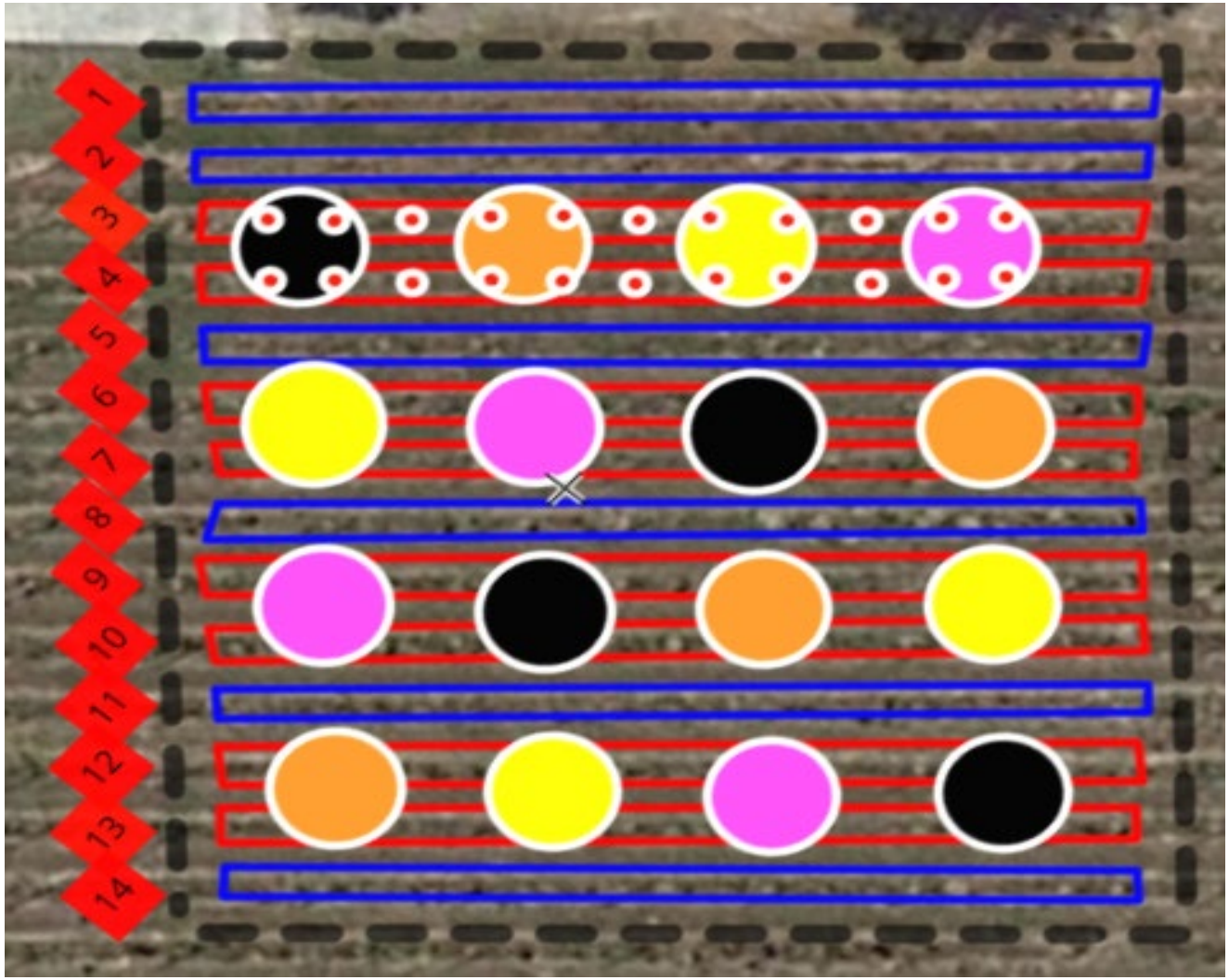


Gunarathne et al., 2017

Biochar Trial

-Location: Lakeridge Winery and Vineyards, in Clermont, FL
-Soil type: Central Ridge Soils (Entisols)
-Four treatments: Control, Biochar, 50% compost + 50% Biochar mix, and compost (Mirimichi Green)
-Application rate: 20t/ha
-Established vines of 3-year-old ‘Noble’ muscadine

Trial Map



Color key: Black (Biochar), Orange (Compost), Yellow (Control), Pink (Biochar+Compost)

Plot Marking & Raking

Applying Treatments

Applying Treatments

Incorporating Products Evenly into Soil

Measuring Soil Moisture

Oct 2018 Dec 18 Mar 19 Apr 2019

Soil Sampling

0-11.8 inch (0-30cm) 11.8-23.6 (30-60cm) 23.6-35.4 (60-90cm)

Leaf Sampling

Macronutrients: N, P, K, Mg, Ca, S, and Micronutrients: Mn, Fe, Cu, Zn, M, B.

Results: Soil Moisture

	October 2018	December 18	March 19	April 2019
Treatment	VWC%**	VWC%	VWC%	VWC%
Biochar	3.94a*	8.31a	3.34a	13.79a
Biochar+compost	3.89a	6.82b	2.94a	11.95ab
Compost	3.72a	6.73b	2.64a	10.06b
Control	3.54a	6.34b	2.12b	9.95b

*Rows with same letter indicate no statistically significant difference between values. Values expressed in percent volumetric water content. **plots were irrigated in the morning prior to measurements

Results: Soil Properties

Treatment	OM%	pH	P lb/a	K lb/a	Mg lb/a	Fe lb/a	Cu lb/a	Zn lb/a
Biochar	0.78a*	7.88a	197.58cb	71.83a	115.58b	19.33c	13.04b	36.35a
Biochar+compost	0.78a	7.86a	415.42a	74.92a	181.67a	28.67a	16.58ab	35.37a
Compost	0.67a	7.83a	280b	58.42b	137.08b	23.25b	17.93a	28.13a
Control	0.75a	7.82a	157.83c	50.17b	105.50b	19.83bc	17.78a	19.13b

*Rows with same letter indicate no statistically significant difference between values.

Results: Leaf Nutrient

Treatment	N%	P%	K%	Ca%	Mg%	S%	Mn ppm	Fe ppm	Zn ppm	Cu ppm	B ppm
Biochar	3.22a*	0.25a	1.07a	1.62a	0.25a	0.47a	1054.27b	70.39a	150.10b	8.13b	38.55ab
Biochar+compost	3.33a	0.25a	1.00a	1.56a	0.22a	0.49a	1135.52ab	73.72a	177.28a	9.33a	35.66b
Compost	3.18a	0.25a	1.13a	1.65a	0.26a	0.47a	1095.23ab	69.76a	154.21ab	8.67ab	42.87a
Control	3.32a	0.25a	1.1a	1.60a	0.22a	0.50a	1176.75a	70.41a	162.49ab	9.14a	39.28ab

*Rows with same letter indicate no statistically significant difference between values.

Conclusion and Future Study

-Biochar increased percent of volumetric water content.

-Different kind (from different feedstock) and rate of Biochar need to be considered for FL sandy soil.

-Incorporation methods of Biochar into the soil might effect the efficiency of Biochar.

-Economical application of Biochar into the soil needs to be considered.

-Long-term data in relation to specific soil parameters and specific plants is critical to promote Biochar use in plant productivity.

-Studies on Biochar impacts on soil microbial populations, and their activities that may determine plant nutrient uptake are limited.

Greenhouse Study of Biochar

Label	A	B	C	D	E
Biochar rate (w/w)	0%	5%	10%	15%	20%

0% 5% 10% 15% 20%

More Field Study

Biochar	Biochar+Compost	Compost	Black Kow	Winey Waste Compost	Control
20t/ha 40t/ha	20t/ha 40 t/ha	20t/ha 40t/ha	20t/ha 40t/ha	-	-

Thank You

Thank You

Florida Department of Agriculture and Consumer Services
Division of Marketing and Development

Lakeridge Winery & Vineyard

Horticultural Sciences Department
UF/IFAS

PSREU Team
Staci Sanders, Jim Boyer, Buck Nelson, ….

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“I cannot do all the good that the world needs. But the world needs all the good that I can do.”-Jana Stanfield