

# INITIAL IMPACTS OF BIOCHAR AND COMPOST ON SOIL HEALTH AND GRAPEVINE PERFORMANCE IN A NAPA CABERNET SAUVIGNON VINEYARD

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## BIOCHAR AND COMPOST APPLICATIONS

The objective of this trial was to determine the effects of compost and/or biochar applications on soil health and vine performance in a recently planted Cabernet Sauvignon vineyard in Napa.

- Compost (Jepson Prairie Organics) was applied at rate of 20 tons per acre in December 2021
- Biochar (Pacific Biochar) was applied at a rate of 10 tons per acre in December 2021 (Photos 1 and 2).
- Treatments included biochar, biochar + compost, compost, and control.
- Both compost and biochar were broadcast with Whatcom Mulch spreader and later incorporated into soil.
- The trial was set up in randomized complete block design with Biochar as main effect and Compost as sub-plot.
- There were 3 field replications (each field rep consisted of 4 row with 60 vines per row (Figure 1).
- An estimate of 2.83 tons per acre of carbon were added to soil by applying biochar, 3.36 tons per acre with compost application, and 6.19 tons per acre of carbon with combined biochar + compost (Table 1).

	Units	Biochar Application	Compost Application	Compost + Biochar
Bulk Density	lbs/cu ft	19.1	37	
Wt. Amend (lbs per yd)	lbs/cu yd	516	999	
Application Rates	cu yd/ row	5.5	5.5	
App Rate (cu yd./acre)	cu yd./acre	39.61	39.61	
App Rate (#/acre)	lbs / acre	20,428	39,573	60,002
App Rate (tons/acre)	tons / acre	10.21	19.79	30.00
Carbon applied	%	27.7	17.0	
tons per acre	tons / acre	2.83	3.36	6.19
lbs per acre	lbs/acre	5,659	6,727	12,386
Acre-swath	lbs/acre	2,000,000	2,000,000	2,000,000
Expected C increase per acre		0.28%	0.34%	0.62%
C:N Ratio		139	15	26
Nutrients Applied				
N	lbs/acre	41	435	476
P	lbs/acre	2	79	81
P205	lbs/acre	5	178	183
K	lbs/acre	9	257	266
K2O	lbs/acre	11	309	320

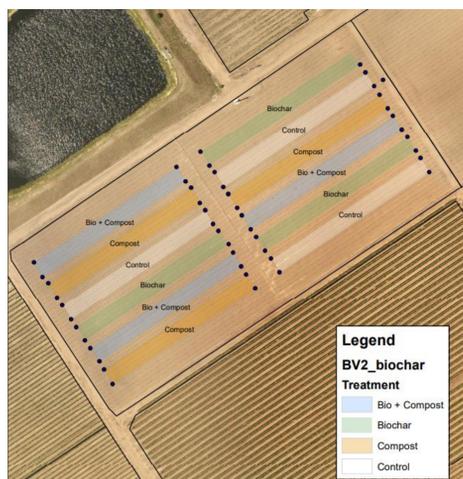


Figure 1. Layout of biochar and compost treatments in Cabernet Sauvignon vineyard.



Photo 1. Applying biochar with mulch spreader.



Photo 2. Aspect of vineyard after application of biochar (green), compost (orange), biochar + compost (blue) compared to control plot (white).

## SOIL HEALTH ASSESSMENT METHODOLOGY

- SAMPLING.** Composite samples (3-5 per plot) were collected in May of 2022 and sent to the Soil Health Laboratory at Oregon State University of analysis.
- METHODOLOGY.** The samples were analyzed following the adopted methodologies for assessing soil health at the Soil Health Lab.

Method Descriptions	
Moisture	Gravimetric moisture as sample is received. All other data reported on a dry matter basis
Texture	Determined with Hydrometer method after cementing and flocculating agents removed
Water Stable Aggregates	Percentage of 0.25 - 2.00 mm aggregates that stay on a sieve after a simulated 5 minute rain using the Cornell Sprinkle Infiltrometer
CN	Dry combustion and direct measurement of total nutrients with Elemental Macro Cube
OM	Organic matter calculated using total organic carbon * 2 as per review by Pribyl, 2010 in Giesderma
Active Carbon	Readily oxidizable carbon measured by potassium permanganate reduction.
CO2 Respiration	CO2 evolution measured after 24 hour and 96 hour incubation with soil wetted to 50% water filled pore space incubated at 23C
Potentially Mineralizable Nitrogen	NO3-N measured at time 0 using 2M KCl extraction followed by a 28 day incubation at 50% water filled pore space at 23C. NO3-N measured again with 2M KCl extraction at day 28 to calculate the rate of nitrogen mineralization.
pH	Measured in 1:1 soil:water ratio on Hanna HI5522 benchtop meter
P, K, Ca, Mg	Extracted with Mehlich 3 solution, measured on Agilent 5110 ICP-OES
CEC	Sum of bases estimation of CEC
BQL	Below quantifiable limits

Table 2. Impact of Biochar and Compost applications on Soil Health Assessment parameters in Cabernet Sauvignon vineyard six months after applications.

TREATMENT	Organic Matter (%)	Total C (%)	Total N (%)	Active C (ppm)	Soil Respiration CO <sub>2</sub> , 24H (µg/g/day)	Microbial Active Carbon (%)	Potentially Mineralizable Nitrogen (mg N/kg /Day)	C:N Ratio	Water Stable Aggregate (%)	Soil pH	EC (ds/m)	CEC (meq/100g)
Biochar + Compost	2.69	1.34	0.11	213	37	17	0.37	12	37	7.30	0.20	22
Biochar	2.31	1.15	0.10	196	35	18	0.27	11	43	7.26	0.20	22
Compost	2.29	1.14	0.11	217	46	21	0.37	10	30	7.31	0.21	23
Control	2.13	1.07	0.10	211	47	23	0.19	10	29	7.14	0.19	21
<i>Biochar</i>	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
<i>Compost</i>	ns	ns	ns	ns	ns	ns	0.05	ns	ns	ns	ns	ns
<i>Biochar x Compost</i>	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
<i>Rep</i>	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

## SOIL HEALTH ASSESSMENT RESULTS

- Organic Matter.** The average level of soil organic matter (SOM) for control treatment was 2.13%. There was a tendency for SOM to increase with both biochar (2.29%) or compost application (2.31%). SOM was 2.69% for combined biochar and compost application.
- Total Carbon.** Total Carbon was not significantly increased with either biochar or compost application.
- Active Carbon.** The levels of active carbon (readily oxidizable C) in the soil were not different between treatments.
- Soil respiration.** Soil respiration rates were not significantly impacted by either biochar or compost application, although there was an indication that biochar depressed soil respiration rates.
- Nitrogen;** Total nitrogen (%) was not significantly increased by either compost or biochar addition. Potentially mineralizable nitrogen was significantly increased by compost application, but not by biochar application.
- Water Stable Aggregates.** There was no significant response in percent stable aggregated due to biochar or compost application.
- Soil pH, EC, and CEC.** There were no significant impacts of either compost or biochar application on soil pH, CEC, or EC.

## Vineyard Performance

- The application of biochar did not impact **bloom leaf blade** macronutrient (N, P, K, Mg, Ca) concentrations, while there were significantly lower concentrations of Na, S, Al, and Zn in petioles from plots with biochar applied (Table 3).
- There was no significant **yield response** to either a biochar or compost this first year after application: yield, clusters per vine, average cluster weight and crop load were similar for all treatments (Table 4).
- There was also no significant impact of biochar or compost of vine **pruning weights** in 2022 (Table 4).
- There was a significantly **lower Brix** near harvest in plots with compost application (Table 5).
- The **average Brix** of fruit from plots with biochar (25.6), compost (25.2), or biochar + compost (24.5) was 1 to 2 Brix lower than fruit from control plots (26.7) on September 14, 2022 (Table 5).
- A significant 6-day heat wave event, with temperatures reaching 115F, occurred during the week prior to maturity sample date and the results indicate that vines that received compost and biochar were more resilient to negative effects of heat on fruit becoming overripe.

## ACKNOWLEDGMENTS

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Table 3. Effect of biochar and compost applications on bloom leaf blade macro and micronutrient levels in Cabernet Sauvignon vineyard the first season after application.

TREATMENT	% dry weight						ppm dry weight						
	N	P	K	Mg	Ca	S	Na	Zn	Cu	B	Al	Fe	Mn
Biochar + Compost	3.62	0.26	1.22	0.48	2.50	0.21	0.01	90	9	58	108	109	83
Biochar	3.68	0.27	1.16	0.50	2.70	0.22	0.01	86	9	57	114	112	87
Compost	3.62	0.26	1.19	0.45	2.32	0.25	0.02	133	9	70	131	109	79
Control	3.67	0.27	1.16	0.47	2.50	0.24	0.02	128	9	72	125	105	75
<i>Biochar</i>	ns	ns	ns	ns	ns	0.05	0.05	0.05	ns	ns	0.05	ns	ns
<i>Compost</i>	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
<i>Biochar x Compost</i>	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
<i>Rep</i>	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 4. Effect of biochar and compost applications on yield parameters and pruning weights for Cabernet Sauvignon the first season after application.

TREATMENT	Shoots per vine	Pruning Wt (kg/vine)	Yield (kg/vine)	Average Cluster Wt (g)	Clusters per vine	Cluster per shoot	Crop Load (kg/kg)
Biochar + Compost	20.0	0.58	4.98	126.2	39.4	1.97	8.6
Biochar	20.9	0.70	5.44	124.6	43.8	2.10	7.9
Compost	21.6	0.71	5.45	132.2	41.0	1.90	7.7
Control	20.0	0.66	5.25	130.8	40.6	2.02	8.0
<i>Biochar</i>	ns	ns	ns	ns	ns	ns	ns
<i>Compost</i>	ns	ns	ns	ns	ns	ns	ns
<i>Biochar x Compost</i>	ns	ns	ns	ns	ns	ns	ns
<i>Rep</i>	ns	ns	ns	ns	ns	ns	ns

Table 5. Effect of biochar and compost applications on fruit maturity of Cabernet Sauvignon on September 14, 2022

TREATMENT	Brix	pH	Titrateable Acidity (g/L)
Biochar + Compost	24.5	3.33	5.90
Biochar	25.6	3.36	5.90
Compost	25.2	3.38	5.93
Control	26.7	3.40	5.57
<i>Biochar</i>	ns	ns	ns
<i>Compost</i>	0.05	ns	ns
<i>Biochar x Compost</i>	ns	ns	ns
<i>Rep</i>	ns	ns	ns