DWR Grant Agreement 4600013458 with Sonoma Ecology Center
For a Pilot Project for Using Biochar to Save Water
In California Agriculture

Quarterly Report, Oct. 15, 2020

Current and Previous Field Research conducted by Monterey Pacific Vineyard Management, Pacific Biochar, UC Riverside, and Sonoma Ecology Center

Grape Clusters at the Oasis Vineyard 2020 Harvest

This quarter we continued our outreach on results of the final report from the original grant #4600011927, as well as on results from the 2019 harvest data at the Oasis Vineyard field trial. This included sending out notice of these results to the Sonoma Biochar Initiative mailing list of over 1000 people and organizations who have an interest in biochar (which includes many farmers and farm organizations), and we have sent the reports to our grant partners Sonoma Water and the Goldridge RCD. We have been waiting for the following report from the 2020 harvest to start the main thrust of outreach and our main push to promote the field trial results will be in the 4th quarter of 2020 and the 1st quarter of 2021. Because of Covid 19 we have not been doing any in-person events and do not anticipate doing so, but with everyone now so comfortable with the online Webinars we will be able to distribute our results to the greater farming community in California and beyond.

Oasis Vineyard Trial 2020 Harvest

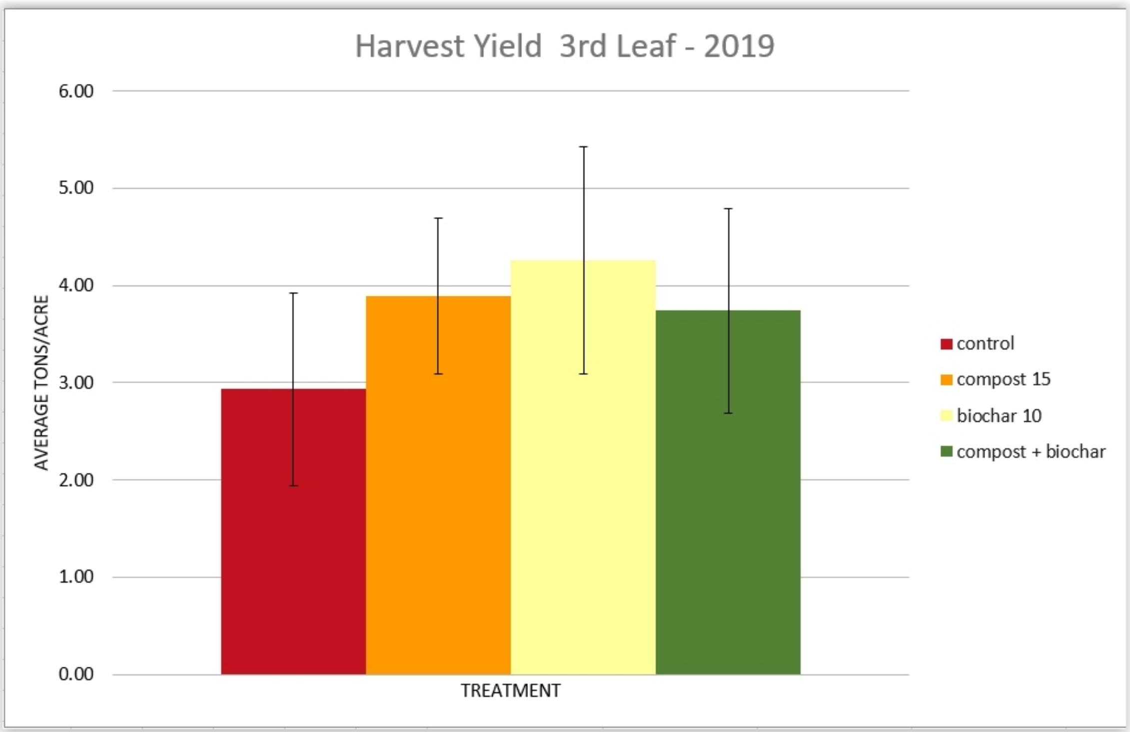
Doug Beck of Monterey Pacific Weighs Random Grape Clusters

County: Monterey
Appellation: Monterey
Vine Type: Pinot Noir

Progress Report, Oct 2020

In April 2017, grape vines were planted where biochar and compost amendments were laid down in a randomized block design in a vineyard near King City, CA under the management of Monterey Pacific. Soil amendment treatments include: control (no compost, no biochar), compost (15 tons compost, no biochar), biochar (no compost, 10 tons biochar), and biochar and compost (15 tons compost, 10 tons biochar). Each treatment was replicated four times. Each plot (replicate) is 36 (4 rows) x 605 (121 vines) ft or ½ acre. The entire experiment of 4 treatments replicated 4 times encompasses 8 acres.

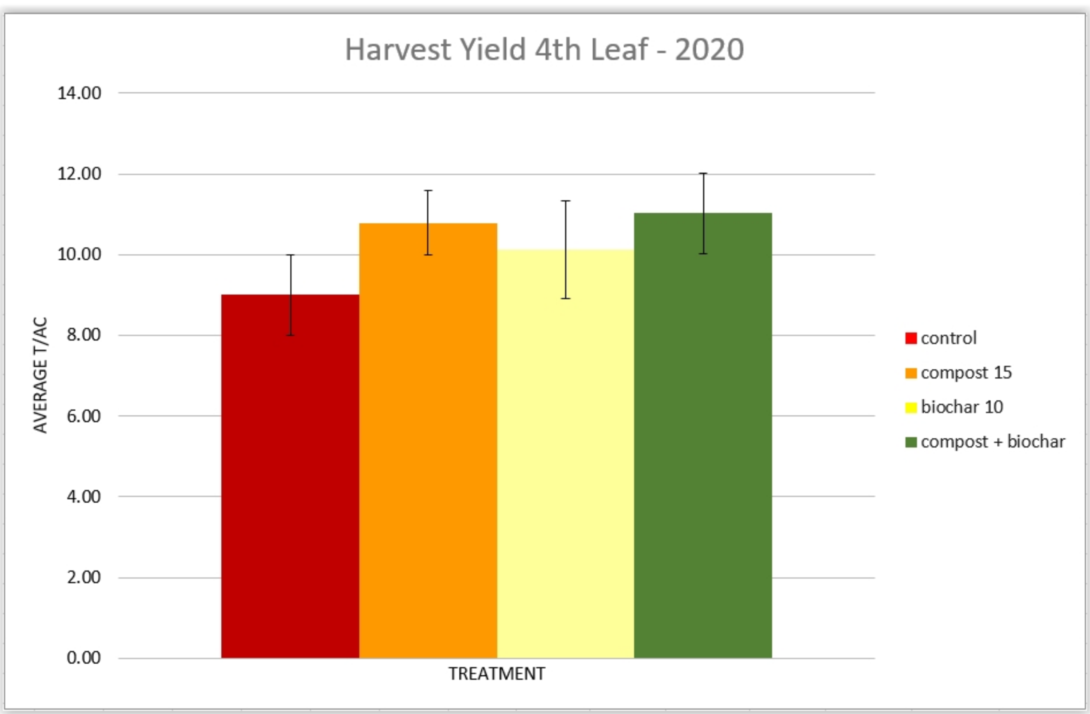
Yields obtained in the third year of growth showed that the biochar treatment had higher yields than the other treatments, and significantly exceeded the yield of the control plots by more than a ton per acre.



Pruning weights obtained in the winter of 2019-2020, showing vine growth over the previous (2019) season, gave results similar to the aerial vine vigor imagery. Compost+Biochar > Compost > Biochar > Control, though differences were not significant.

Aerial imagery of the combined subblocks of each treatment (VineView) showed the same hierarchy of vigor.

Fourth leaf harvest in September 2020 gave even more encouraging yield results, with all amendments significantly beating the control. The biochar only treatment increased yield as it did in 2019 by a little over a ton/ac, while compost only at 15 ton/ac increased grape yield by 1.8 tons per acre. And the compost + biochar treatment increased yields significantly by 2 tons/ac.



Our conclusion is that compost effected greater vine growth, whether alone or in combination with biochar, because of the increased nutrient availability as compost decomposed and released NPK into the soil solution.   Clearly, soil organic matter is limiting in this system and both compost and biochar improved vine growth and productivity significantly.

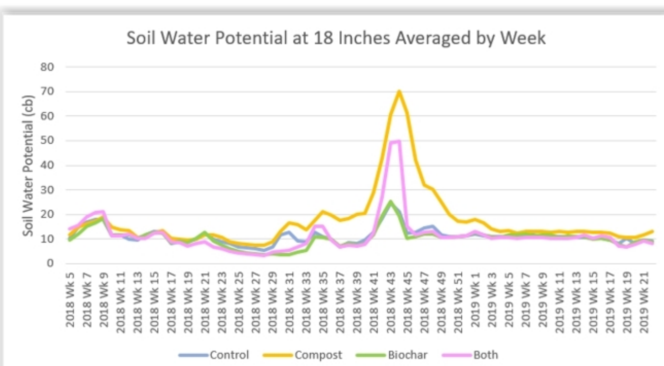
There were no differences in cluster size/weight for either harvest, but cluster numbers did differ and accounted for the yield differences. The biochar treatment had the highest number of clusters in 2019, and the compost-biochar mix had the most clusters in 2020.   More clusters appear to be mostly the result of larger more vigorous vines.

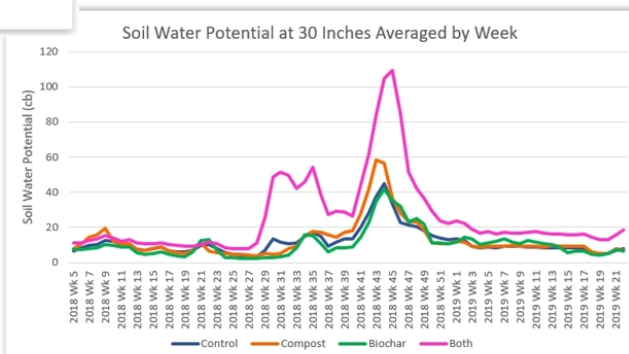
Harvest 2019 3rd Leaf	Yield	Cluster #	Cluster lb
R1	2.78	26.40	0.31
R2 Control	3.73	28.70	0.27
R3	2.82	23.10	0.25
R4	3.92	26.30	0.31
Control Average	**3.31**	**26.13**	**0.29**
R1	4.04	30.60	0.27
R2 Compost	3.30	27.10	0.25
R3	4.20	33.20	0.26
R4	4.02	27.60	0.30
Compost Average	**3.89**	**29.63**	**0.27**
R1	3.94	28.50	0.29
R2 Biochar	4.90	39.60	0.26
R3	3.63	27.30	0.28
R4	4.55	33.30	0.28
Biochar Average	**4.26**	**32.18**	**0.28**
R1	3.78	26.80	0.29
R2 Compost + Biochar	3.58	24.40	0.30
R3	3.83	36.90	0.21
R4	4.08	31.50	0.27
Compost-Bio Average	**3.82**	**29.90**	**0.27**

Harvest 2020 4th Leaf	Yield	Cluster #	Cluster lb
R1	9.22	54.60	0.31
R2 Control	10.12	53.95	0.34
R3	8.66	46.60	0.34
R4	8.00	41.85	0.35
Control Average	**9.00**	**49.25**	**0.34**
R1	10.37	55.25	0.34
R2 Compost	10.72	54.30	0.36
R3	11.39	62.60	0.33
R4	10.68	54.45	0.36
Compost Average	**10.79**	**56.65**	**0.35**
R1	10.71	57.00	0.34
R2 Biochar	10.79	57.40	0.35
R3	10.72	58.50	0.34
R4	8.27	45.55	0.33
Biochar Average	**10.12**	**54.61**	**0.34**
R1	11.21	58.80	0.35
R2 Compost + Biochar	10.23	55.15	0.34
R3	13.09	65.10	0.37
R4	9.57	49.85	0.35
Compost-Bio Average	**11.02**	**57.23**	**0.35**

The original aim of this DWR project was to demonstrate improved water use in biochar amended soils. Biochar and compost in fact increased water use because it produced bigger vines with more leaves and greater transpiration. The compost and compost+biochar treatments both dried the soil more than control, which was little different than the control.

These soil moisture graphs show drier soil in the compost+biochar and compost treatments, which also showed the most vine vigor, pruning weights, and yields.





Josiah Hunt of Pacific Biochar pulls random cluster samples for lab testing.

Doug Beck and staff pull individual berries for quality testing.

Given the promising results of the first season of production (2019), DWR awarded an extension of the project to gather more relevant data during 2020. One of the possibilities most concerning was the potentially negative effect of biochar on wine grape quality. We therefore analyzed 300 berries at harvest Sept 14, 2020 from every sub block, for sugar and acidity but also for total phenolics (color and flavor components) at a professional laboratory (ETS).

Titratable Acidity			
AVERAGES	mg/L	% difference	ST DEV
Control	6.425	0.00%	0.26
Compost	6.375	-0.78%	0.29
Biochar	6.375	-0.78%	0.33
Com+Biochar	6.25	-2.72%	0.24

pH			
AVERAGES	pH	% difference	ST DEV
Control	3.3925	0.00%	0.08
Compost	3.4125	0.59%	0.09
Biochar	3.4275	1.03%	0.12
Com+Biochar	3.4575	1.92%	0.09

Brix			
AVERAGES	brix	% difference	ST DEV
Control	23.875	0.00%	1.01
Compost	23.35	-2.20%	0.47
Biochar	24.25	1.57%	0.99
Com+Biochar	23.75	-0.52%	0.87

Biochar alone increased the grape sugar content over control, but differences were not significant. Differences in acidity were small and insignificant.

Interestingly, color and flavor components of the biochar treatment were higher than in all other treatments though again the differences were not significant due to the large degree of variability in the trial. We don’t really have an explanation for this, but it is clear that biochar is not adversely affecting quality!

Polymeric Anthocyanins			
AVERAGES	mg/L	% difference	ST DEV
Control	6.25	0.00%	0.9574
Compost	6.00	-4.00%	0.0000
Biochar	6.50	4.00%	0.5774
Com+Biochar	5.75	-8.00%	0.5000

Tannin			
AVERAGES	mg/L	% difference	ST DEV
Control	207.50	0.00%	18.9473
Compost	200.25	-3.49%	18.9978
Biochar	211.75	2.05%	22.3961
Com+Biochar	201.00	-3.13%	20.4124

Total Anthocyanins			
AVERAGES	mg/L	% difference	ST DEV
Control	627.50	0.00%	63.1057
Compost	628.50	0.16%	15.3514
Biochar	659.75	5.14%	49.5202
Com+Biochar	642.50	2.39%	60.7317

Another interesting side effect of the biochar was berry size, which was significantly larger in the biochar only treatment than the control. Better internal water availability may be the cause, but it is not clear why the biochar produced bigger berries with better quality.

Raw Biochar

Berry Weight

AVERAGES	g/berry	% difference	ST DEV
Control	1.3675	0.00%	0.02
Compost	1.33	-2.74%	0.05
Biochar	1.3925	1.83%	0.05
Com+Biochar	1.3575	-0.73%	0.02

Berry Volume

AVERAGES	ml/berry	% difference	ST DEV
Control	1.1475	0.00%	0.04
Compost	1.185	3.27%	0.07
Biochar	1.24	8.06%	0.08
Com+Biochar	1.15	0.22%	0.03

Sugar per Berry

AVERAGES	mg/berry	% difference	ST DEV
Control	271.5	0.00%	12.48
Compost	273	0.55%	16.15
Biochar	298.5	9.94%	12.79
Com+Biochar	270.5	-0.37%	16.82

Obtaining yield results over 2 years gave us a much clearer picture of the impact of the treatments on this perennial crop trial. The results in the second year of production were larger vines and higher yields, which translates to economic return.

Yield Increases

2019 +biochar = 1.3 ton/acre increase

- Grape price $2000/ton
- Additional revenue/acre = **$2,600**

2020 +biochar = 1.1 ton/acre increase

- Grape price $2000/ton
- Additional revenue/acre = **$2,200**
- No further amendments cost

Biochar cost

Rate 10 ton/acre
Biochar cost $200/ton
Cost/Ac = $2000

Return on Investment

- Additional revenue **$2600**/ac first 2 producing years
- Assume additional per year of 0.5 t/ac over no amendments, $8000 extra over 8 years
- Potentially added $**10,400** income/ac over 10 yrs by adding 10 t/ac at planting. That is equal to $1,040,000 for 100 acres of vineyard over 10 years.

- Add in the value of the sequestration of carbon contained in the biochar for hundreds and even thousands of years, and biochar's additional benefit as a natural climate change solution significantly increases its value as a tool for regenerative, carbon farming.

While more research is needed in future harvests to get a better sense of biochar's ability to affect increases in production over the long term, and soil and biochar type likely play an important role in these findings, the results achieved thus far should be of great interest to vineyard managers and other farmers as well.

Many thanks to the organizations that contributed to this report: