An Update on Pecan Research

TEXAS A&M UNIVERSITY
Horticultural Sciences

TEXAS A&M AGRILIFE RESEARCH | EXTENSION

College Station | Dallas| Fredericksburg
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TEXAS PECAN GROWERS ASSOCIATION

Amit Dhingra, Ph.D.
Head and Professor
Department of Horticultural Sciences
Texas A&M University

Department Head

SUSTAINABILITY I WELLNESS I FOOD
ECURITY

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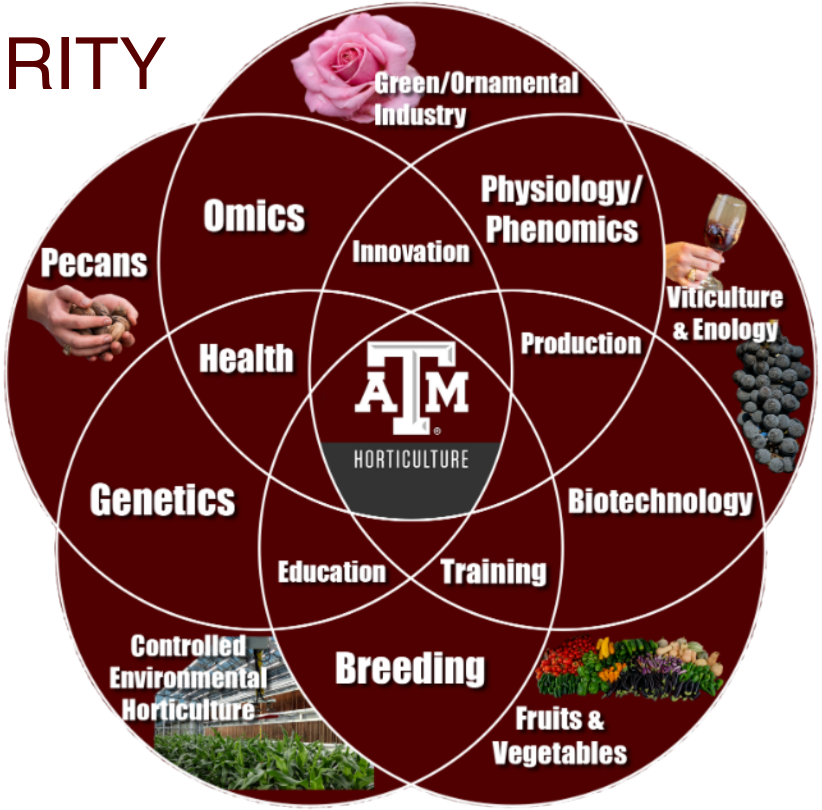

SUSTAINABILITY

PROFITABILITY

Our Research, Extension and Teaching are dedicated towards generating knowledge, tools and technologies to ensure the economic viability of our food systems.

SUSTAIN HORTICULTURE INDUSTRIES

As we work to replace ourselves, we are committed to developing the next generation of industry leaders.

ENVIRONMENT

We are committed to developing and disseminating knowledge to be the best stewards of our soils and the environment.

WELLNESS

– A sense of community.

Waldinger, the director of the Harvard Study of Adult Development, said in a viral 2015 “TED Talk” released in 2015, that “good relationships keep us happier and healthier.”

TEXAS A&M TODAY

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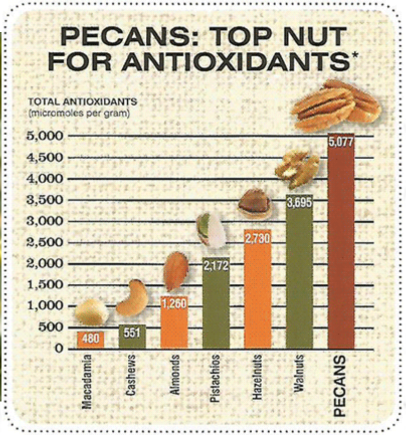
HEALTH & ENVIRONMENT

The Positive Effects Of Gardening On Mental Health

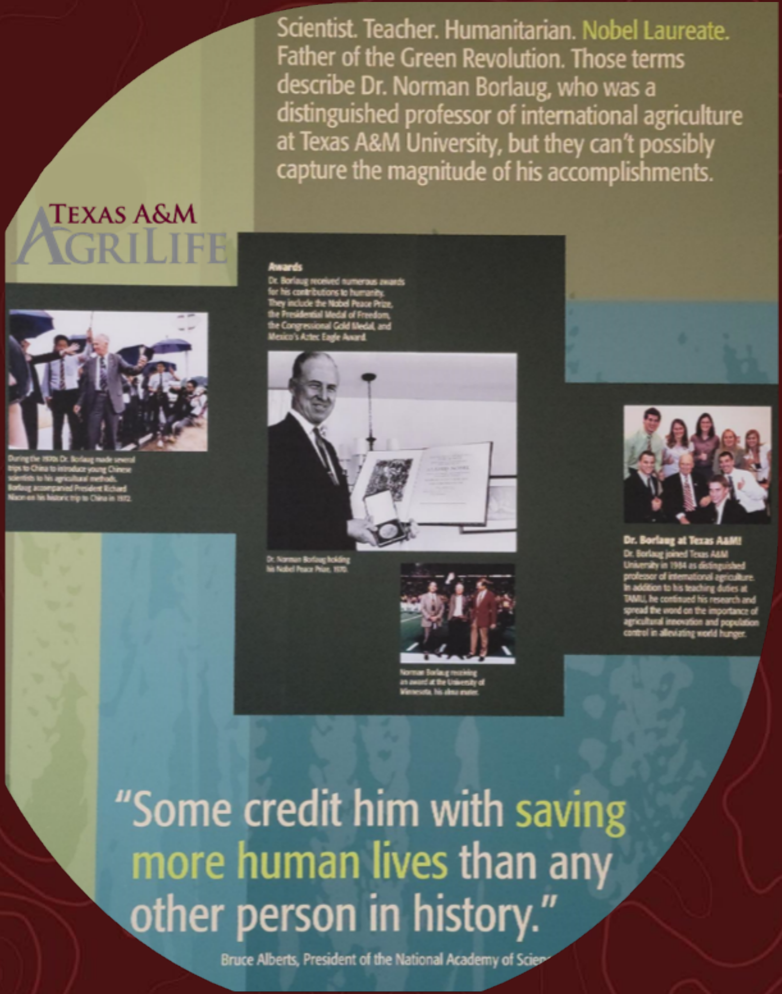
Experts say working with plants offers a host of psychological and social benefits.

By Paul Schattenberg, Texas A&M AgriLife Communications • MAY 18, 2022



FOOD SECURITY

Horticulture permanent crops require less input per calorie generated and are nutritious as well.



TEXAS A&M AGRILIFE

INSTITUTE FOR ADVANCING HEALTH THROUGH AGRICULTURE

Luis Cisneros, Ph.D.

AGRILIFE TODAY

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LIFE & HEALTH

Pecans give obesity and diabetes a slim chance

Study shows the health benefits of pecans, which can curb obesity and reduce inflammation

JULY 28, 2023

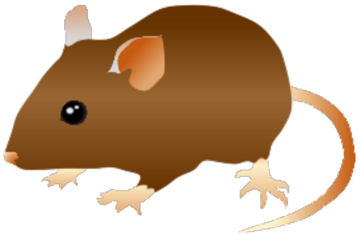
nutrients

MDPI

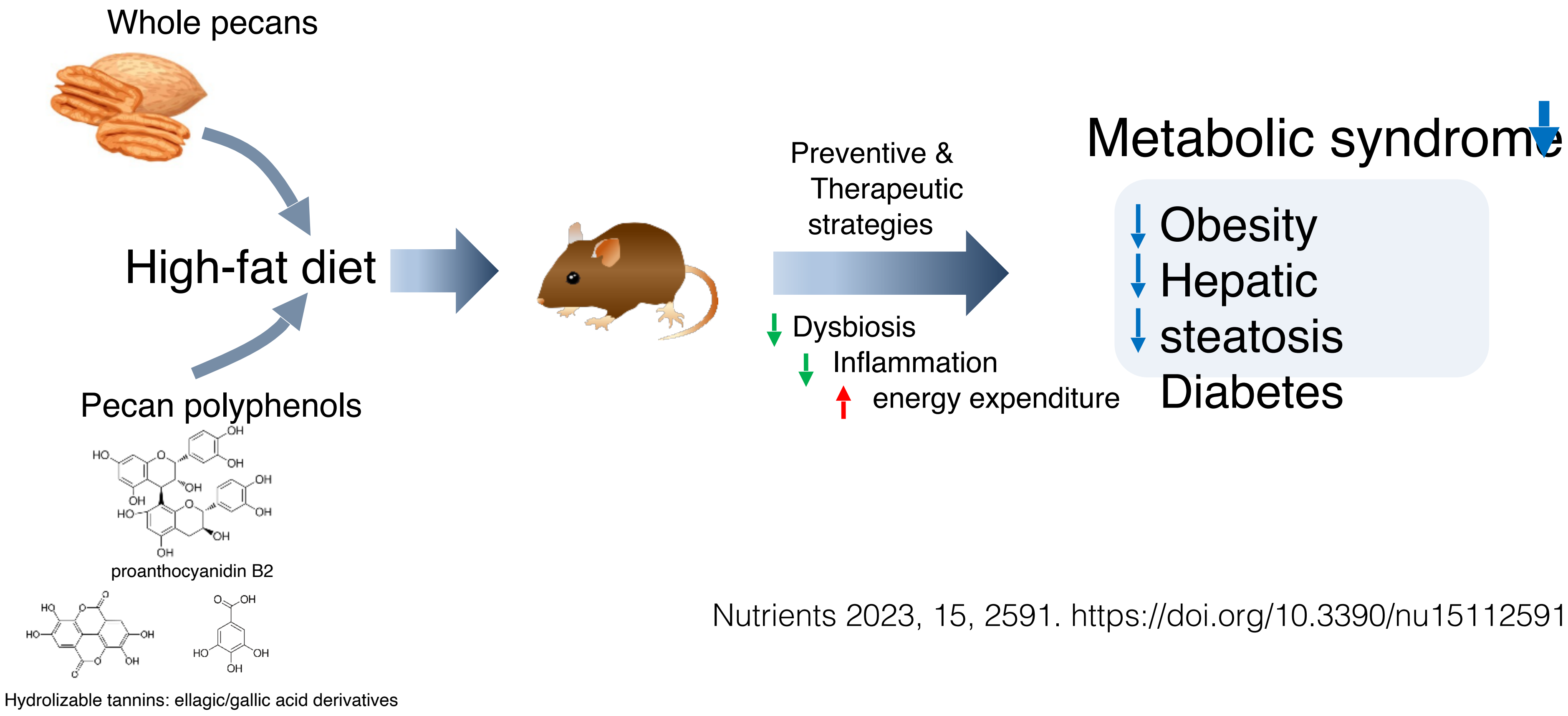
Article

Pecans and Its Polyphenols Prevent Obesity, Hepatic Steatosis and Diabetes by Reducing Dysbiosis, Inflammation, and Increasing Energy Expenditure in Mice Fed a High-Fat Diet

Claudia Delgadillo-Puga [1,*,†], Ivan Torre-Villalvazo [2,†], Lilia G. Noriega [2], Leonardo A. Rodríguez-López [2], Gabriela Alemán [2], Erik A. Torre-Anaya [2], Yonatan Y. Cariño-Cervantes [1], Berenice Palacios-Gonzalez [3], Janette Furuzawa-Carballeda [4], Armando R. Tovar [2] and Luis Cisneros-Zevallos [5,*]



Nutrients 2023, 15, 2591. https://doi.org/10.3390/nu15112591


Whole pecans
High-fat diet
Pecan polyphenols
proanthocyanidin B2
Hydrolizable tannins: ellagic/gallic acid derivatives
Preventive & Therapeutic strategies
Dysbiosis
Inflammation
energy expenditure
Metabolic syndrome
Obesity
Hepatic steatosis
Diabetes
Nutrients 2023, 15, 2591. https://doi.org/10.3390/nu15112591

Monte Nesbitt, Ph.D.

Ongoing Research Studies

Long-term, ongoing studies:

1. Comparison of low input and high input annual management in 70-year old trees.
2. Pecan variety studies. The following 17 varieties are under evaluation for disease resistance, yield, and nut quality: Pawnee, Waco, Caddo, Nacono, Oconee, Mandan, Lakota, Apalachee, Kanza, Avalon, Kalos, Fritz, Fayette, Excel, Eclipse, Ellis, Woodmen. We have plans to expand this continually—adding ARS releases and other new things that people bring to our attention. Avalon and Kalos are the latest releases from UGA.

Product testing: Small trials funded by companies seeking product efficacy data. I have two this year—one is a humic acid soil product; the other is a foliar kelp treatment.

Monte Nesbitt, Ph.D.

Ongoing Research Studies

Soil health: Last year we initiated a randomized and replicated trial investigating effects of synthetic and organic/Omri-approved post emergence herbicides and synthetic preemergence herbicides on soil health status.

Nitrogen tissue status of alternate bearing Lakota pecan trees: Comparison of leaf, stem and root nitrogen status of On-year vs Off-year cropping trees; a study aimed at identifying optimal soil N fertilizer timing and if stored N plays a role in early spring growth.

Plant Pathology Dept. trials-Dr. Young Ki Jo has fungicide trials at the Texas A&M Orchard. He has two trials—one is typical product trial; another is focused on biological or low-impact chemistries that allow for livestock grazing. He has one graduate student working on Pecan Leaf Dieback disease epidemiology in the orchard as well.

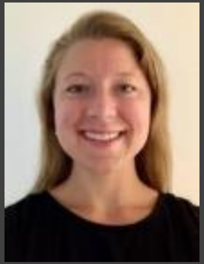
Professor and Scientist

TAMU Research Team

June Labbancz
(Ph.D.)
Plastid/Pecan
Biology

Amanda Birnbaum
(Ph.D.)
Soil amendment

Rishi Ghogare, Ph.D.
Research Scientist



Seanna Hewitt, Ph.D.
Research Scientist

Trishia Nguyen
Undergraduate
Researcher

Katie Toomey
Former
Undergraduate
Researcher

William Troxel
Former
Undergraduate
Researcher

TEXAS A&M UNIVERSITY
Horticultural Sciences

USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

Trees For the Future Grant

Primary Goals:

1. Probe the **genetic basis of climate adaptation** and cultivar-climate mismatches
2. Analyze **pecan water relations** and responses to salinity and drought stress
3. Explore **biological interactions of microbes** with pecan
4. Identify **gene networks for flowering and nut traits**
5. Determine **genetics of growth and vigor traits**

Trees For The Future
SCRI Grant #2022-51181-38332

USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

The Genetic Basis of Pecan Nut Traits

Question:

- What genes and proteins are responsible for the differences in nut size, maturity timing and nutritional quality between two pecan cultivars?

Collaborators – Chatwin and Dhingra

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USDA ars Agricultural Research Service

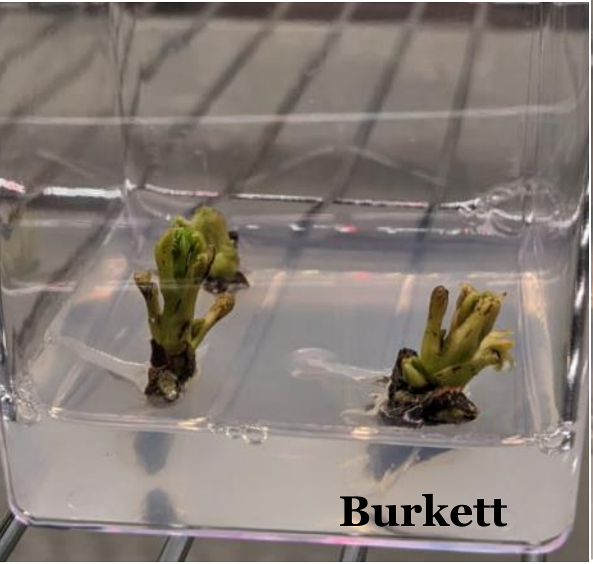
‘Mahan’

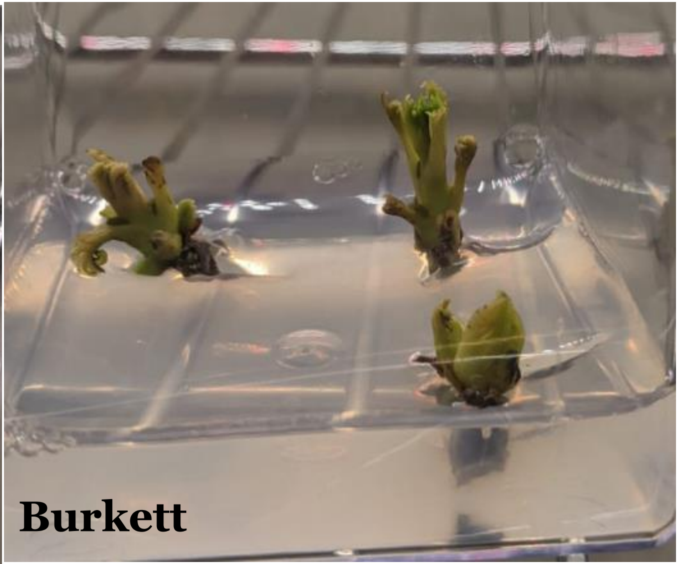
- Mississippi Seedling
- 30-60 Nuts per pound
- Large oblong nut
- Thin shell
- Late Maturity (Early Nov.)

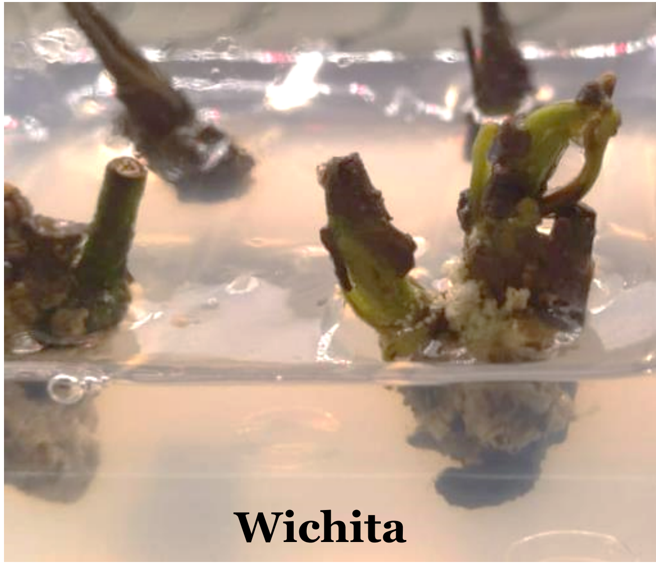
‘Tiny Tim’

- Missouri Native
- 180-200 Nuts per pound
- Small round nut
- Thick shell
- Early Maturity (Early Sept.)

Establishment of *in vitro* cultures







Thank you, Larry Don Womack

Understanding the impact of crop-residue-derived biochar on root associated-microbiome function and plant health

Elvir Tenic
M.S. Horticulture

Daylen Isaac
M.S. student

Seanna Hewitt, Ph.D.
Post-doctoral Scientist

David Drinkard,
VP Biomass Processing
Qualterra

WASHINGTON STATE UNIVERSITY

TEXAS A&M UNIVERSITY
Horticultural Sciences

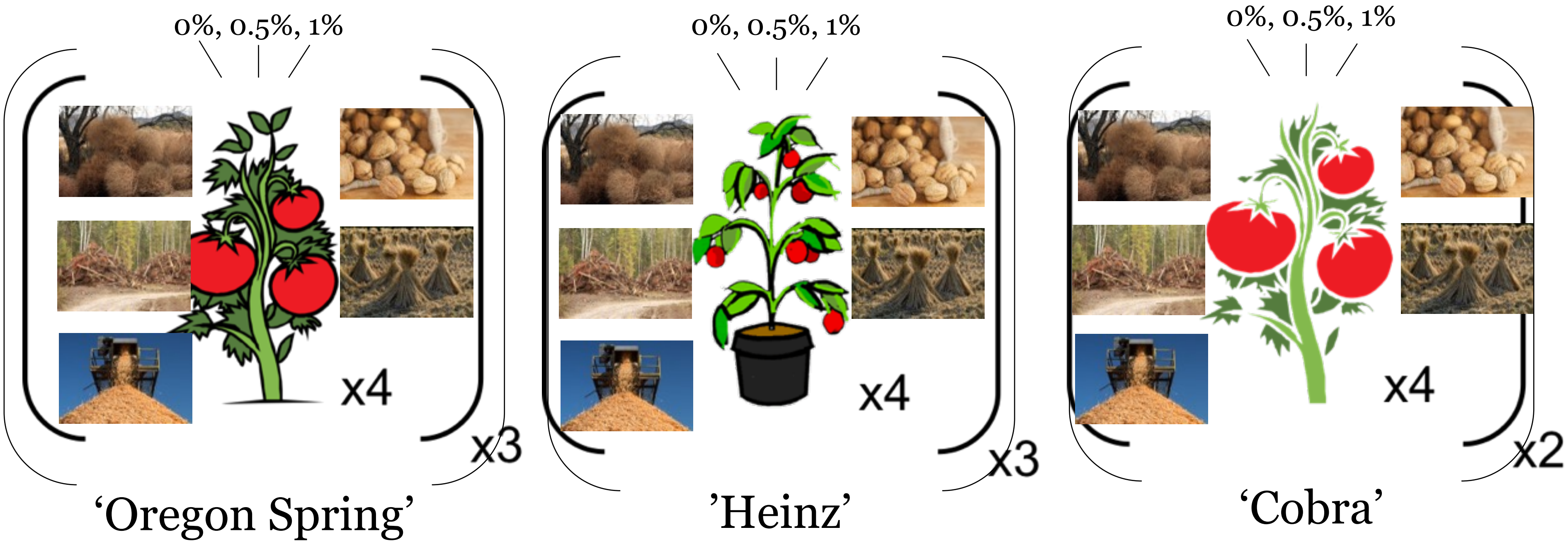
Funding

Western Sustainable Ag Research and Education
Department of Horticulture, WSU

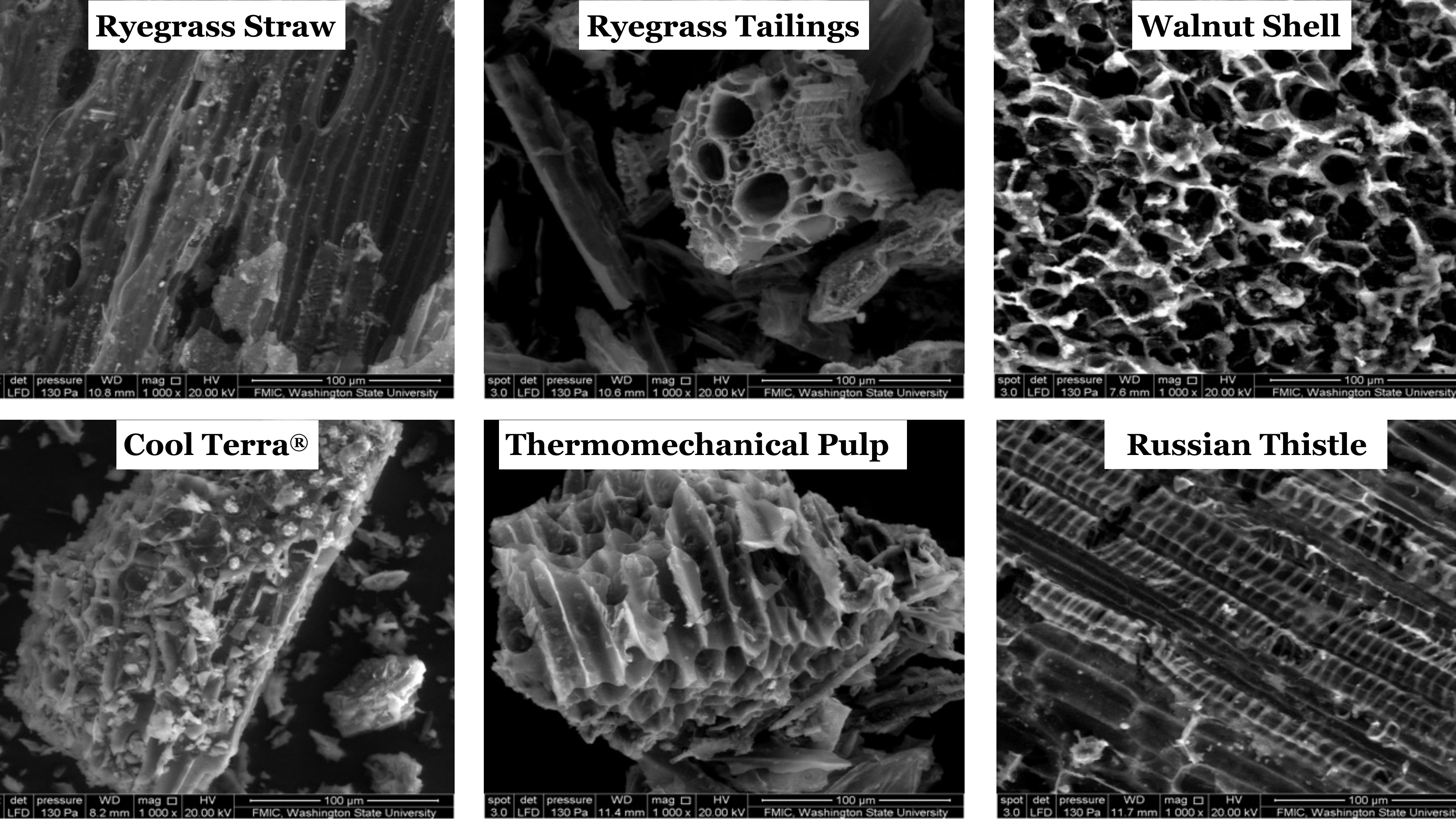
QUALTERRA
Innovations for Agriculture and Sustainability

Does the source of biomass or the genetic background impact plant performance?

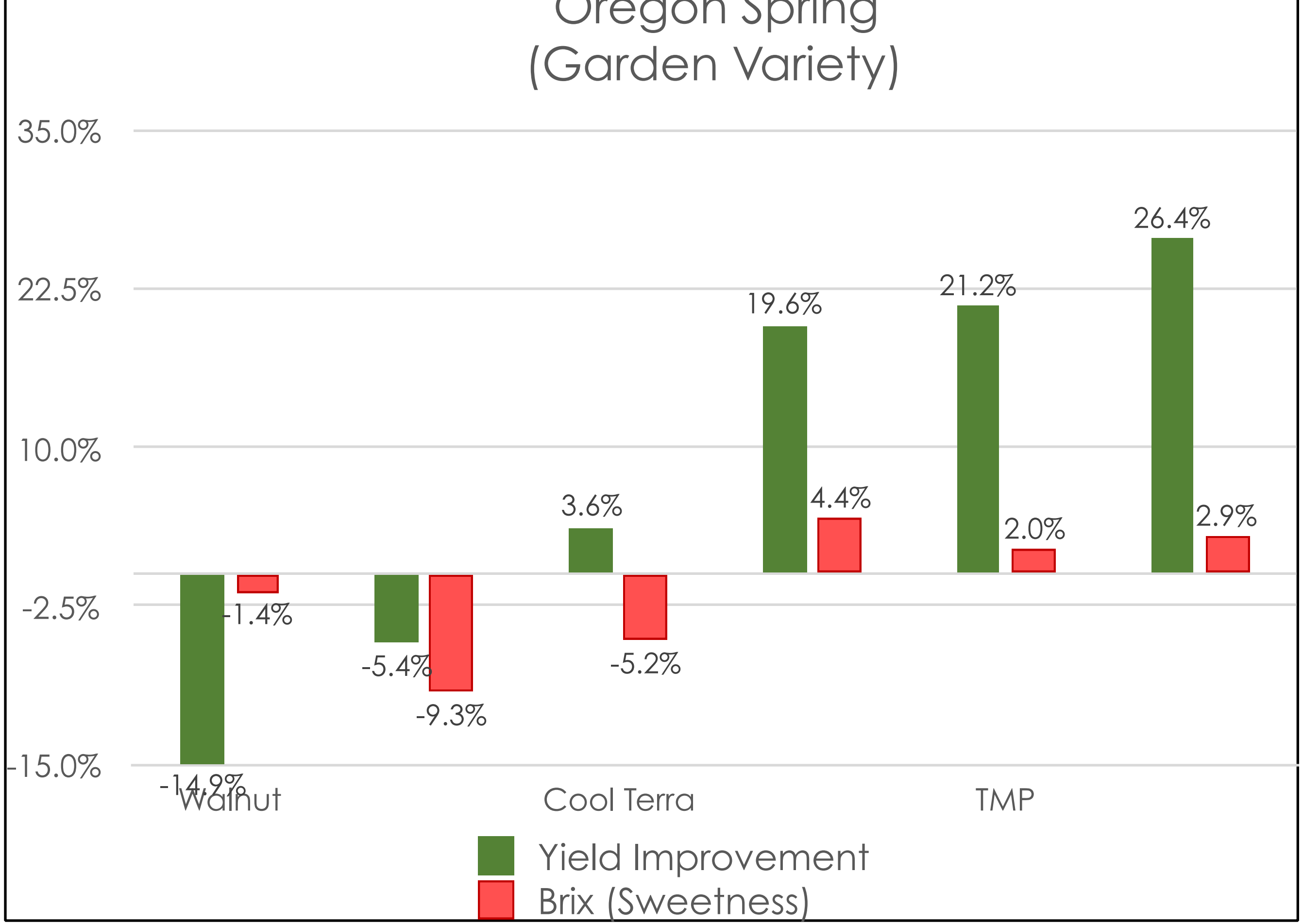
Experimental Design



Elvir T, Daylen I, Rishikesh G, Amit D: Variability in Fruit Yield and Quality of Genetically Diverse Tomato Cultivars in Response to Different Biochars. *bioRxiv 2020:2020.2006.2028.176487.*


Ryegrass Straw
det pressure WD mag HV 100 µm
LFD 130 Pa 10.8 mm 1 000 x 20.00 kV FMIC, Washington State University
Ryegrass Tailings
spot det pressure WD mag HV 100 µm
3.0 LFD 130 Pa 10.6 mm 1 000 x 20.00 kV FMIC, Washington State University
Walnut Shell
spot det pressure WD mag HV 100 µm
3.0 LFD 130 Pa 7.6 mm 1 000 x 20.00 kV FMIC, Washington State University
Cool Terra®
det pressure WD mag HV 100 µm
LFD 130 Pa 8.2 mm 1 000 x 20.00 kV FMIC, Washington State University
Thermomechanical Pulp
spot det pressure WD mag HV 100 µm
3.0 LFD 130 Pa 11.4 mm 1 000 x 20.00 kV FMIC, Washington State University
Russian Thistle
spot det pressure WD mag HV 100 µm
3.0 LFD 130 Pa 11.7 mm 1 000 x 20.00 kV FMIC, Washington State Universit

Yield and Brix



Elvir T, Daylen I, Rishikesh G, Amit D: Variability in Fruit Yield and Quality of Genetically Diverse Tomato Cultivars in Response to Different Biochars. *bioRxiv 2020:2020.2006.2028.176487.*

Sources of variation and levels of significance (P-values) for the 3-way ANOVA of the effects of three cultivars and six biochar soil amendments (3 rates) on plant dry weight, fruit yield per plant (YPP), fruit organic acid, and fruit sugar concentrations of tomato cultivars grown in the greenhouse.

There is a significant interaction between the cultivar (genetic background) or biochar type or rate.

Sources of Variation	Plant Wt	YPP[1]	Citrate	Malate	Glc	Fru
Cultivar (C)	0.001	0.001	0.001	0.001	0.001	0.001
Biochar (B)	ns[2]	ns	0.001	0.001	0.001	0.001
Rate (R)	0.05	0.001	0.002	ns	0.04	0.003
C x B	ns	ns	0.001	0.001	0.001	0.002
C x R	ns	0.005	0.001	0.001	0.001	0.001
B x R	ns	ns	0.02	0.001	ns	ns
C x B x R	ns	ns	0.002	0.001	0.04	0.04
Cultivar (C)	0.001	0.001	0.001	0.001	0.001	0.001
Biochar (B)	ns	ns	0.02	0.001	0.001	0.001
Rate (R)	ns	0.03	0.03	0.002	ns	ns
C x B	ns	ns	ns	0.001	0.03	0.001
C x R	ns	0.008	0.001	0.005	0.003	ns
B x R	ns	ns	0.001	0.001	0.001	0.001
C x B x R	ns	ns	ns	0.001	0.001	0.001

Elvir T, Daylen I, Rishikesh G, Amit D: Variability in Fruit Yield and Quality of Genetically Diverse Tomato Cultivars in Response to Different Biochars. *bioRxiv 2020:2020.2006.2028.176487.*

Feedstock Source

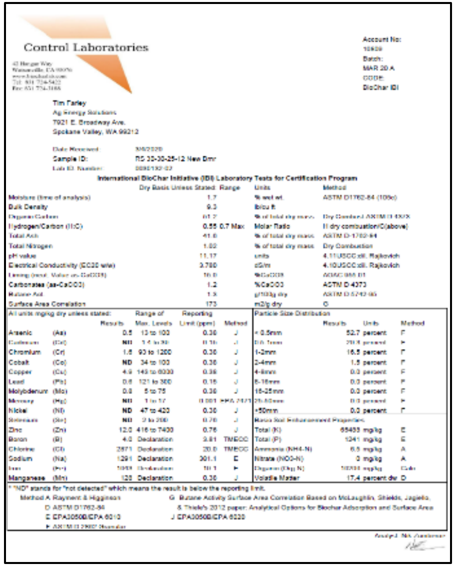
Crop Residue

Soft Wood - pruned

Hard Wood

Biochar – Things to Remember

- Not all biochar is created equal
- Check the chemical composition of the biochar
- Ensure you can get the same quality of biochar – consistency across multiple batches



Control Laboratories

Account No: [illegible]
Batch: MAR 20 A
CODE: BioChar IBI

Tim Farley
Ag Energy Solutions
7921 E. Broadway Ave.
Spokane Valley, WA 99212

Date Received: [illegible]
Sample ID: RS 30-30-25-12 New Dmr
Lab ID Number: [illegible]

International BioChar Initiative (IBI) Laboratory Tests for Certification Program

	Dry Basis Unless Stated	Range	Units	Method
Moisture (time of analysis)	1.7		% wet wt.	ASTM D1762-84 (105c)
Bulk Density	9.3		lb/cu ft	
[illegible]	[illegible]		[illegible]	[illegible]
Hydrogen/Carbon (H:C)	0.55	0.7 Max	Molar Ratio	H dry combustion/C(above)
Total Ash	[illegible]		% of total dry mass	ASTM D-1762-84
Total Nitrogen	1.00		% of total dry mass	Dry Combustion
pH value	11.17		units	4.11USCC:dil. Rajkovich
Electrical Conductivity (EC20 w/w)	3.780		dS/m	4.10USCC:dil. Rajkovich
[illegible]	[illegible]		[illegible]	[illegible]
Carbonates (as-CaCO3)	1.2		%CaCO3	ASTM D 4373
[illegible]	[illegible]		g/100g dry	[illegible]
Surface Area Correlation	173		m2/g dry	G

All units mg/kg dry unless stated:		Results	Range of Max. Levels	Reporting Limit (ppm)	Method
Arsenic	(As)	0.5	13 to 100	0.36	J
[illegible]	[illegible]	ND	[illegible]	[illegible]	J
Chromium	(Cr)	1.6	93 to 1200	0.36	J
Cobalt	(Co)	ND	34 to 100	0.36	J
Copper	(Cu)	4.9	143 to 6000	0.36	J
Lead	(Pb)	0.6	121 to 300	0.16	J
Molybdenum	(Mo)	0.8	5 to 75	0.36	J
[illegible]	[illegible]	ND	1 to 17	[illegible]	[illegible]
Nickel	(Ni)	ND	47 to 420	0.36	J
[illegible]	[illegible]	ND	[illegible]	[illegible]	J
Zinc	(Zn)	12.0	416 to 7400	0.76	J
Boron	(B)	4.0	Declaration	3.81	TMECC
Chlorine	(Cl)	2871	Declaration	20.0	TMECC
Sodium	(Na)	1291	Declaration	301.1	E
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Manganese	(Mn)	128	Declaration	0.36	J

Particle Size Distribution	Results	Units	Method
< 0.5mm	52.7	percent	F
[illegible]	[illegible]	percent	F
1-2mm	16.5	percent	F
2-4mm	1.5	percent	F
4-8mm	0.0	percent	F
8-16mm	0.0	percent	F
16-25mm	0.0	percent	F
[illegible]	[illegible]	percent	F
>50mm	0.0	percent	F
Basic Soil Enhancement Properties			
Total (K)	65433	mg/kg	E
Total (P)	1241	mg/kg	E
Ammonia (NH4-N)	6.5	mg/kg	A
Nitrate (NO3-N)	0	mg/kg	A
[illegible]	[illegible]	mg/kg	[illegible]
Volatile Matter	17.4	percent dw	D

* "ND" stands for "not detected" which means the result is below the reporting limit.
Method A Rayment & Higginson
D ASTM D1762-84
E EPA3050B/EPA 6010
F [illegible]
G Butane Activity Surface Area Correlation Based on McLaughlin, Shields, Jagiello, & Thiele's 2012 paper: Analytical Options for Biochar Adsorption and Surface Area
J EPA3050B/EPA 6020

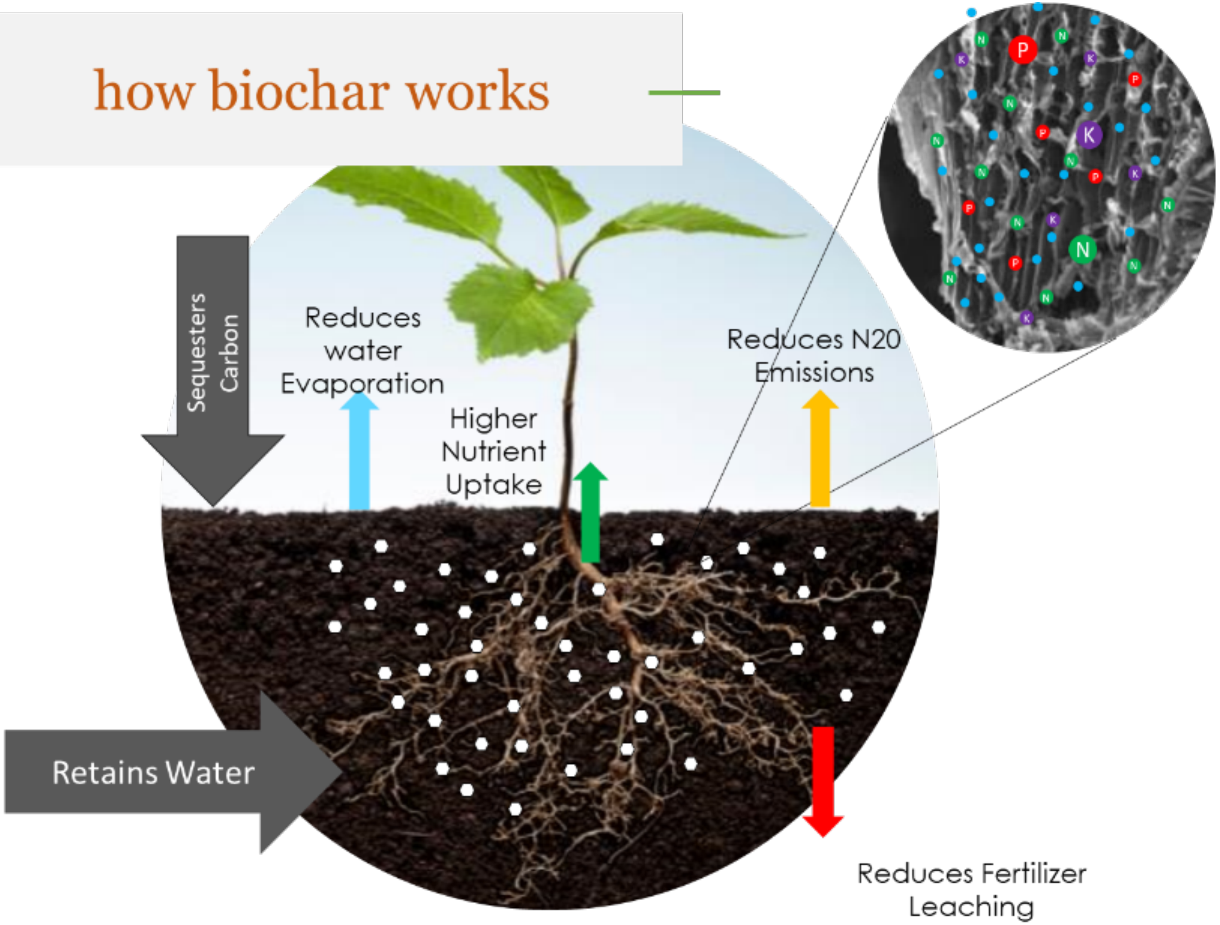

Control
Biochar treatment

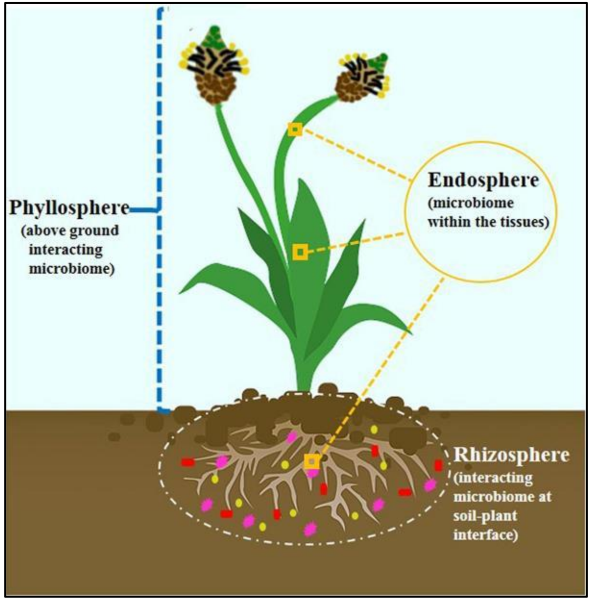
What is the underlying reason for the increased above-ground biomass across different plant species?

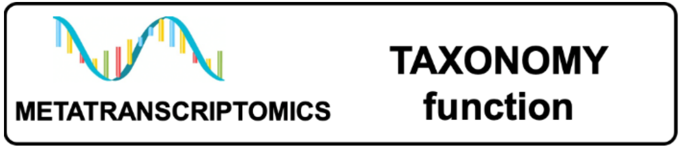
how biochar works

Biochar Value

- Improves soil structure
- **Enhanced microbial activity**
- Reduces water utilization
- Optimizes Nutrients
- Bigger, better crops







How is the plant responding?

Impact of Biochar on Plant-Soil Microbiome Interaction
Metatranscriptome study

Juvenile

25 days

TP 1

Pre-Flowering

40 days

TP 2

Fruiting

50 days

TP 3

Mature

70 days

TP 4

WASHINGTON STATE UNIVERSITY

WESTERN SARE Sustainable Agriculture Research & Education

Seanna Hewitt, Rishikesh Ghogare, William Troxel, Elvir Tenic, Daylen Isaac, Amit Dhingra
Metatranscriptomic analysis of tomato rhizospheres reveals insight into plant-microbiome molecular response to biochar-amended organic soil. Frontiers in Omics – Under review

Biochar Application

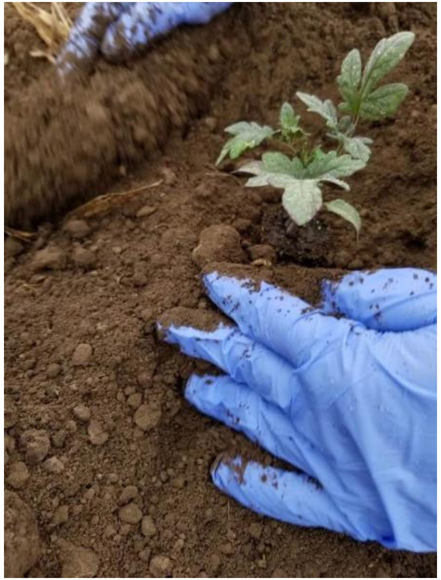
Soil before BC incorporation

Soil after BC incorporation

Planting tomato plants

Seanna Hewitt, Rishikesh Ghogare, William Troxel, Elvir Tenic, Daylen Isaac, Amit Dhingra
Metatranscriptomic analysis of tomato rhizospheres reveals insight into plant-microbiome molecular response to biochar-amended organic soil. Frontiers in Omics – Under review

Experimental Procedures



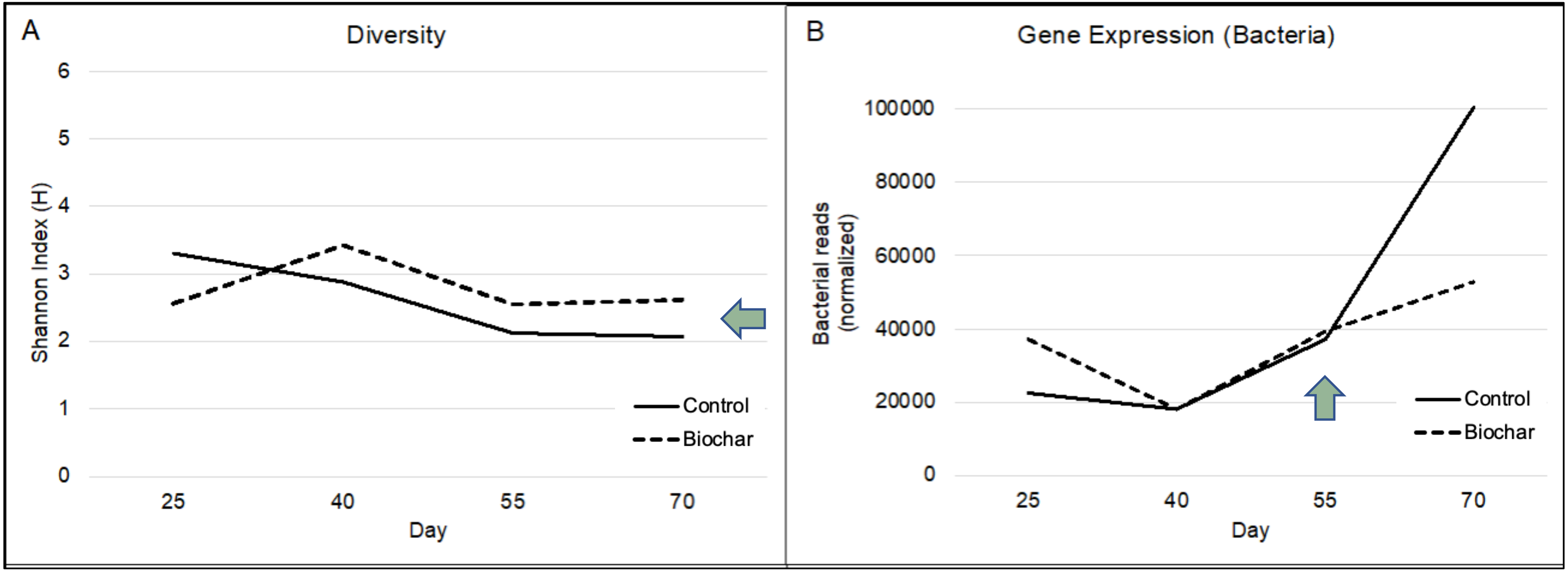
Planting tomato plants

TP1 - 40 days old

Tomato root for sampling

Seanna Hewitt, Rishikesh Ghogare, William Troxel, Elvir Tenic, Daylen Isaac, Amit Dhingra
Metatranscriptomic analysis of tomato rhizospheres reveals insight into plant-microbiome molecular response to biochar-amended organic soil. Frontiers in Omics – Under review

Functional Diversity
(Metatranscriptomics)



Rhizosphere microbial diversity (A); bacterial functional diversity (B);

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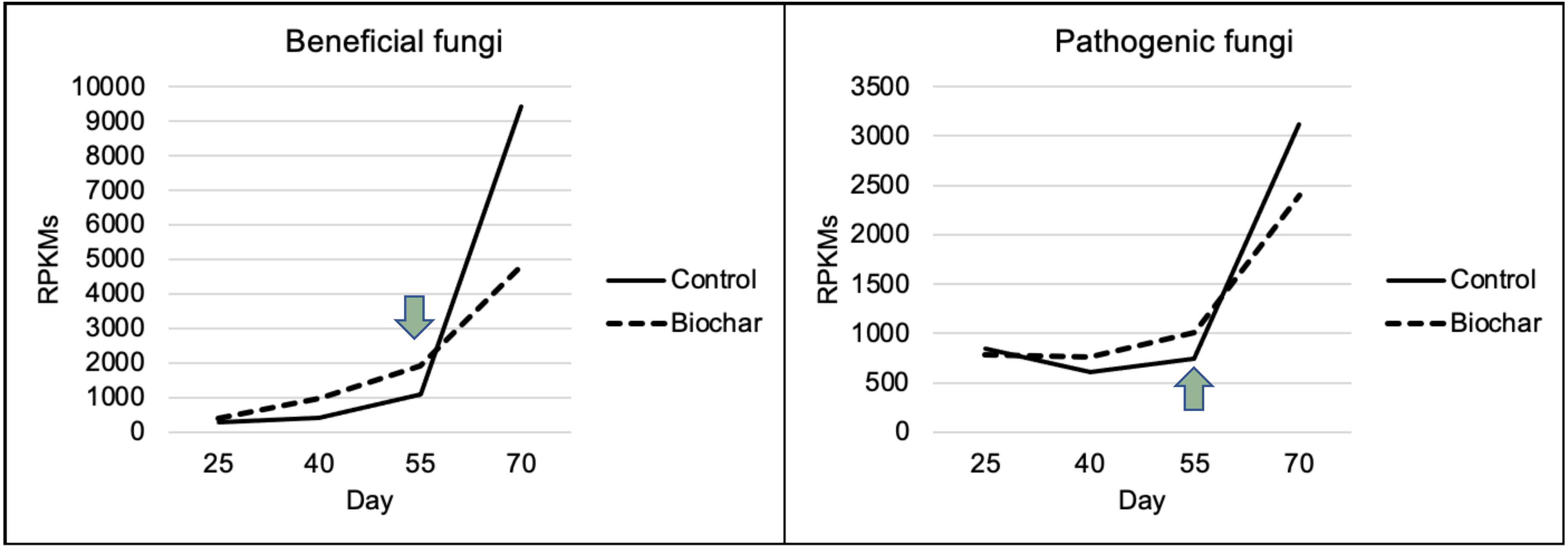
Metatranscriptomic analysis of tomato rhizospheres reveals insight into plant-microbiome molecular response to biochar-amended organic soil. Frontiers in Omics – Under review

Fungal Metatranscriptome



Expression of beneficial (A) and pathogenic (B) soil fungi.

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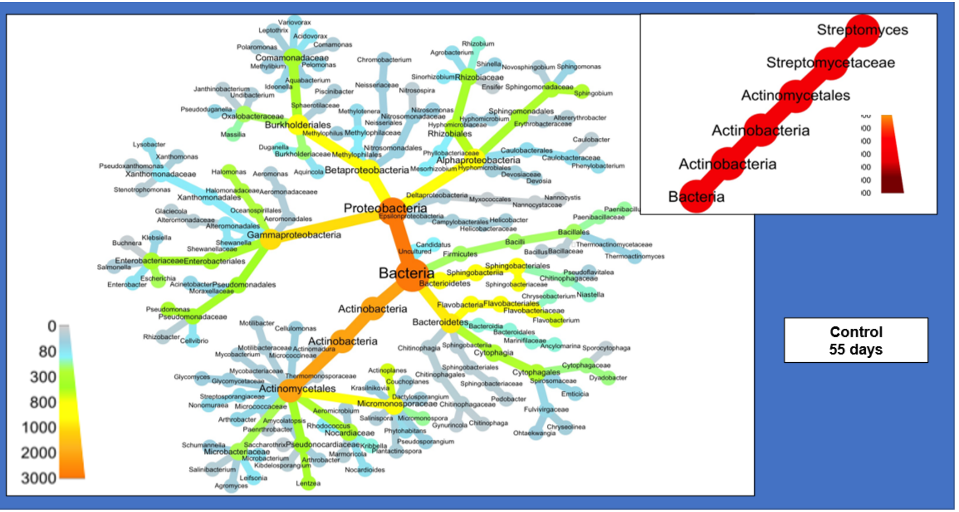
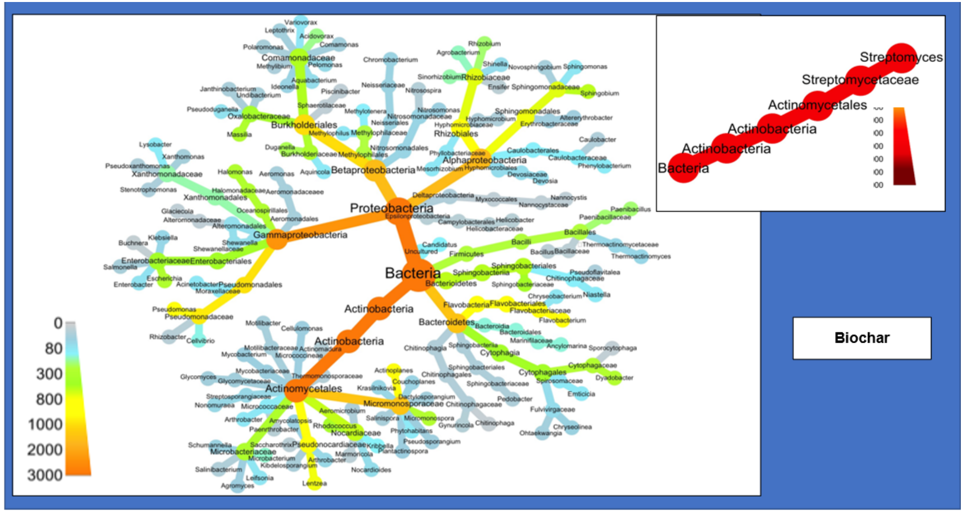
Metatranscriptomic analysis of tomato rhizospheres reveals insight into plant-microbiome molecular response to biochar-amended organic soil. Frontiers in Omics – Under review

Metatranscriptomics: Time Point 3 – Day 55
Transition to Fruiting
(Heat Tree Map)





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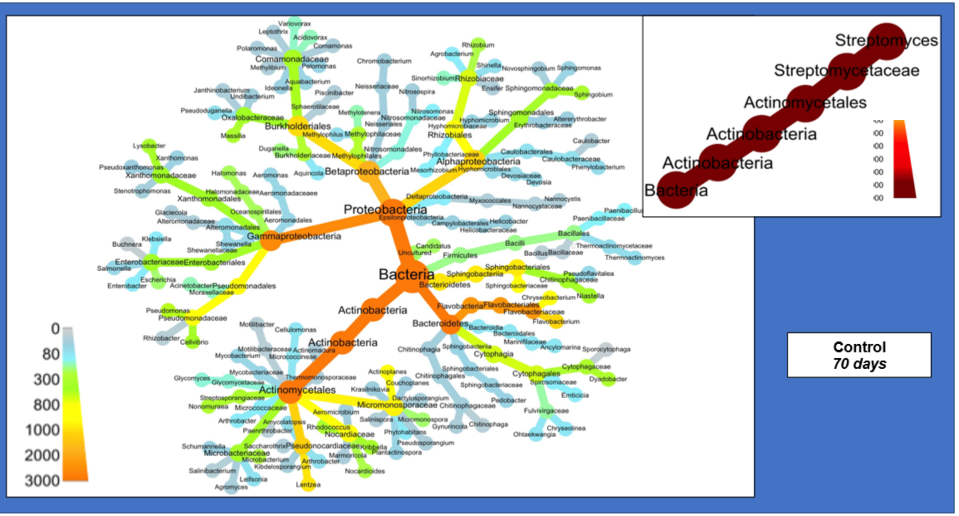
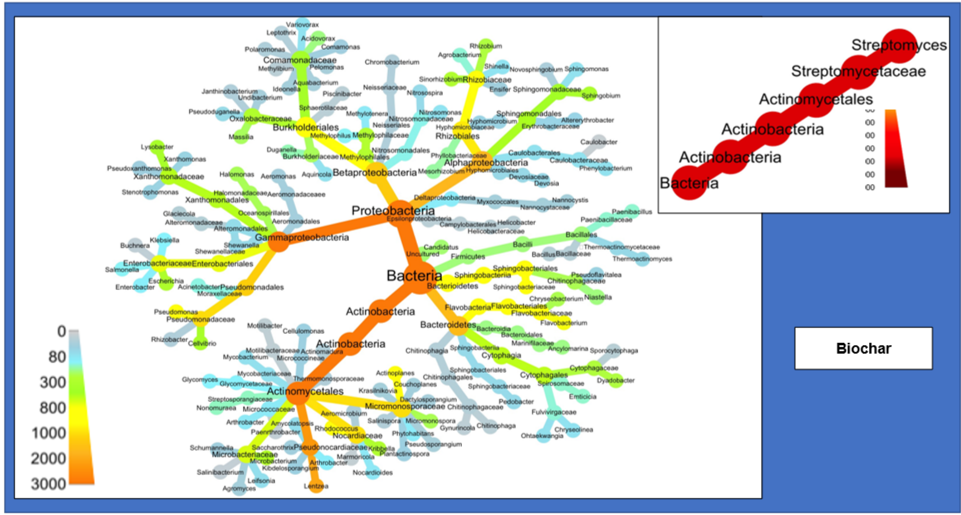
Metatranscriptomic analysis of tomato rhizospheres reveals insight into plant-microbiome molecular response to biochar-amended organic soil. Frontiers in Omics – Under review

Metatranscriptomics: Time Point 4 – Day 70
Full Maturity
(Heat Tree Map)

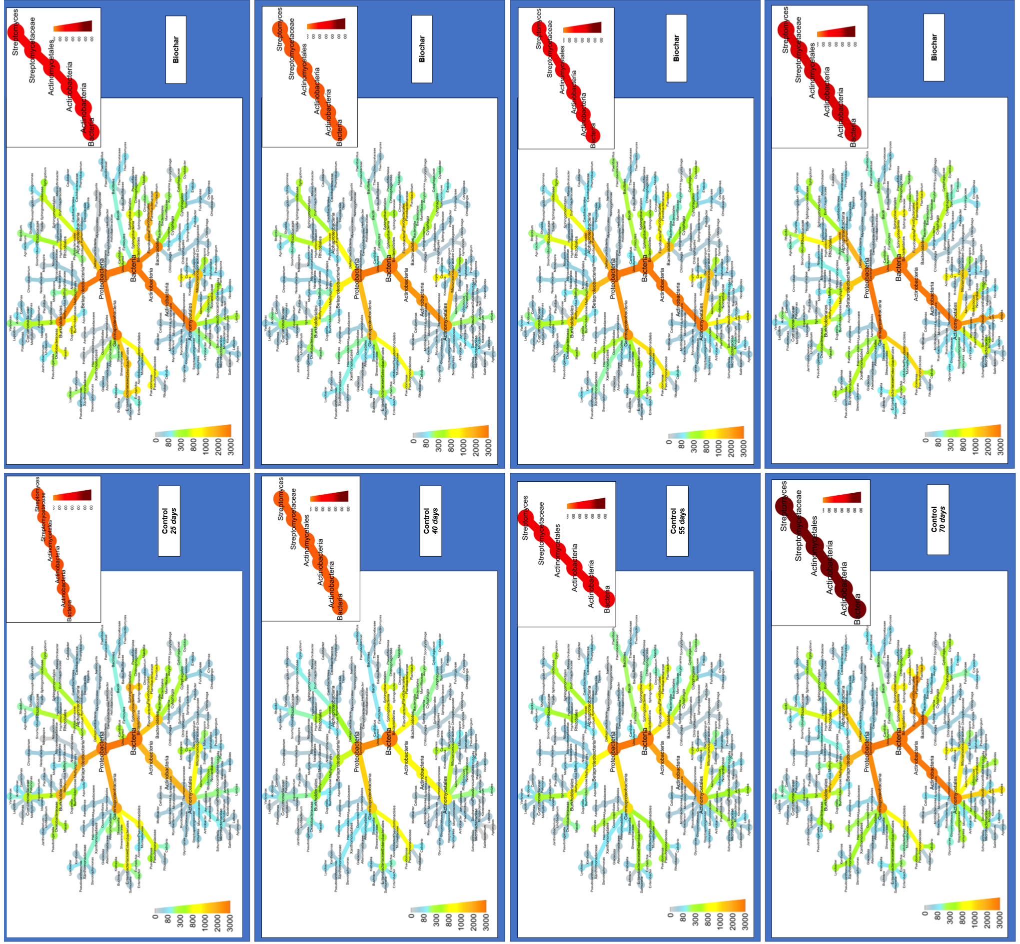




Seanna Hewitt, Rishikesh Ghogare, William Troxel, Elvir Tenic, Daylen Isaac, Amit Dhingra
Metatranscriptomic analysis of tomato rhizospheres reveals insight into plant-microbiome molecular response to biochar-amended organic soil. Frontiers in Omics – Under review

Biochar

Control



- Enrichment of beneficial microbial function
- Reduction of microbial competition for Carbon at full maturity – more Carbon for the plant
- Improved communication between the plant and the rhizosphere microbial community

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Metatranscriptomic analysis of tomato rhizospheres reveals insight into plant-microbiome molecular response to biochar-amended organic soil. Frontiers in Omics – Under review

Microbial – Functional Enrichments

			Control				Biochar				Control				Biochar			
GO Term	GO Name	GO Category	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
GO:0005488	**binding**	MOLECULAR																
GO:0043167	**ion binding**	MOLECULAR																
GO:0003824	catalytic activity	MOLECULAR																
GO:0008152	metabolic process	BIOLOGICAL_																
GO:0006807	nitrogen compound metabolic process	BIOLOGICAL_																
GO:0016491	**oxidoreductase activity**	MOLECULAR																
GO:0043169	**cation binding**	MOLECULAR																
GO:0046872	metal ion binding	MOLECULAR																
GO:0009058	biosynthetic process	BIOLOGICAL_																
GO:0043170	macromolecule metabolic process	BIOLOGICAL_																
GO:0071704	organic substance metabolic process	BIOLOGICAL_																
GO:0044238	primary metabolic process	BIOLOGICAL_																
GO:1901576	**organic substance biosynthetic process**	BIOLOGICAL_																
GO:1901566	**organonitrogen compound biosynthetic process**	BIOLOGICAL_																
GO:1901564	**organonitrogen compound metabolic process**	BIOLOGICAL_																
GO:0043604	**amide biosynthetic process**	BIOLOGICAL_																
GO:0043603	**amide metabolic process**	BIOLOGICAL_																
GO:0044237	cellular metabolic process	BIOLOGICAL_																
GO:0034641	**cellular nitrogen compound metabolic process**	BIOLOGICAL_																
GO:0044271	**cellular nitrogen compound biosynthetic process**	BIOLOGICAL_																
GO:0009987	cellular process	BIOLOGICAL_																
GO:0043043	**peptide biosynthetic process**	BIOLOGICAL_																
GO:0006518	**peptide metabolic process**	BIOLOGICAL_																
GO:0044249	**cellular biosynthetic process**	BIOLOGICAL_																
GO:0010467	**gene expression**	BIOLOGICAL_																
GO:0009059	**macromolecule biosynthetic process**	BIOLOGICAL_																
GO:1901363	**heterocyclic compound binding**	MOLECULAR																
GO:0097159	**organic cyclic compound binding**	MOLECULAR																
GO:0006412	**translation**	BIOLOGICAL_																
GO:0019538	protein metabolic process	BIOLOGICAL_																
GO:0003676	**nucleic acid binding**	MOLECULAR																
GO:0051234	establishment of localization	BIOLOGICAL_																
GO:0051179	localization	BIOLOGICAL_																
GO:0006810	transport	BIOLOGICAL_																
GO:0003735	**structural constituent of ribosome**	MOLECULAR																
GO:0005198	**structural molecule activity**	MOLECULAR																
GO:0016787	hydrolase activity	MOLECULAR																
GO:0016740	transferase activity	MOLECULAR																
GO:0036094	small molecule binding	MOLECULAR																

Plant roots – Functional Enrichments

			Contro l				Biocha r			
GO Term	GO Name	GO Category	1	2	3	4	1	2	3	4
GO:0010467	**gene expression**	BIOLOGICAL_I								
GO:0006412	**translation**	BIOLOGICAL_I								
GO:0006518	**peptide metabolic process**	BIOLOGICAL_I								
GO:0009059	**macromolecule biosynthetic process**	BIOLOGICAL_I								
GO:0043043	**peptide biosynthetic process**	BIOLOGICAL_I								
GO:0043603	**amide metabolic process**	BIOLOGICAL_I								
GO:0043604	**amide biosynthetic process**	BIOLOGICAL_I								
GO:0044249	**cellular biosynthetic process**	BIOLOGICAL_I								
GO:0044271	**cellular nitrogen compound biosynthetic proces**	BIOLOGICAL_I								
GO:1901566	**organonitrogen compound biosynthetic process**	BIOLOGICAL_I								
GO:1901576	**organic substance biosynthetic process**	BIOLOGICAL_I								
GO:0005198	structural molecule activity	MOLECULAR								
GO:0043170	**macromolecule metabolic process**	BIOLOGICAL_I								
GO:0008152	metabolic process	BIOLOGICAL_I								
GO:0019538	**protein metabolic process**	BIOLOGICAL_I								
GO:1901564	**organonitrogen compound metabolic process**	BIOLOGICAL_I								
GO:0009058	**biosynthetic process**	BIOLOGICAL_I								
GO:0009987	cellular process	BIOLOGICAL_I								
GO:0044237	cellular metabolic process	BIOLOGICAL_I								
GO:0005488	binding	MOLECULAR								
GO:0003723	**RNA binding**	MOLECULAR								
GO:0006807	**nitrogen compound metabolic process**	BIOLOGICAL_I								
GO:0071704	**organic substance metabolic process**	BIOLOGICAL_I								
GO:0034641	**cellular nitrogen compound metabolic process**	BIOLOGICAL_I								
GO:0065009	**regulation of molecular function**	BIOLOGICAL_I								
GO:0030234	**enzyme regulator activity**	MOLECULAR								
GO:0098772	**molecular function regulator activity**	MOLECULAR								
GO:0009607	response to biotic stimulus	BIOLOGICAL_I								
GO:0065007	biological regulation	BIOLOGICAL_I								
GO:0050896	response to stimulus	BIOLOGICAL_I								
GO:0009605	response to external stimulus	BIOLOGICAL_I								
GO:0006950	response to stress	BIOLOGICAL_I								


thank you
gracias
merci
danke
謝謝
ngiyabonga
teşekkür ederim
obrigado
bedankt
dziękuję
go raibh maith agat
sukriya
kop khun krap
terima kasih
спасибо
mochchakkeram
arigatô
dakujem
grazie
takk
tapadh leat
dank je
감사합니다
ありがとう
ευχαριστώ
мерси
рахмат
Баярлалаа
faafetai lava
kiitos
dankie
dhanyavad
hvala
mauruuru
köszönöm
enkosi
sagolun
chnorakaloutioun
gratias ago
gràcies
sulpáy
taiku
tanemirt
rahmet
diolch
dhanyavadagalu
shukriya
trugarez
xièxie
kam sah hamnida
najis tuke
didi madloba
mèsi
sobodi
děkuji
rahmat
blagodaram
vinaka
спасибі
mersi
kia ora
barka
welalin
tack
spas
misaotra
matondo
paldies
grazzi
mahalo
хвала
asante
manana
obrigada
tenki
murakoze
chokrane
mamnun
дякую
djiere dieuf
tau
akun
dankon
ačiū
bayarlalaa
gràçie
nandri
nanni
mercé