The Influence of Biochar Soil Amendments on Tree Health and Vitality

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What is Biochar?

A purified form of charcoal.

- **When added to soil it:**
- Increases CEC
- Improves water retention
- Improves fertiliser effectiveness

Sequestering 'biochar' in soil, which makes soil darker in colour, is a robust way to store carbon.

Benefits are now realised.

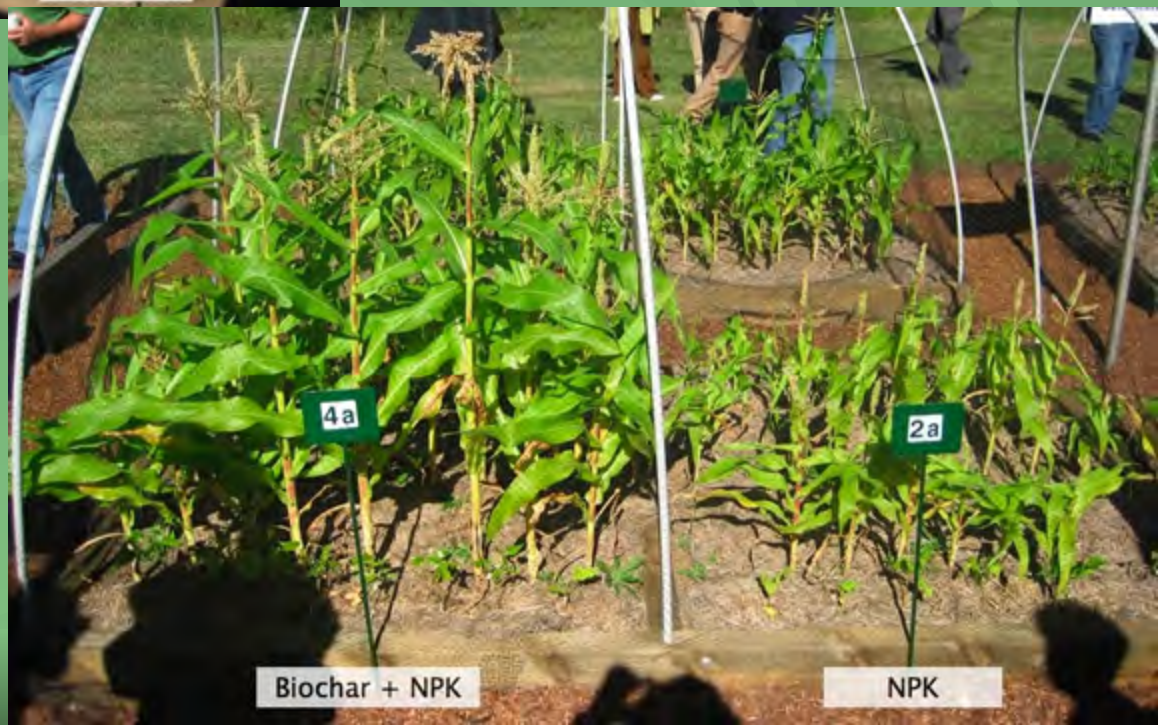
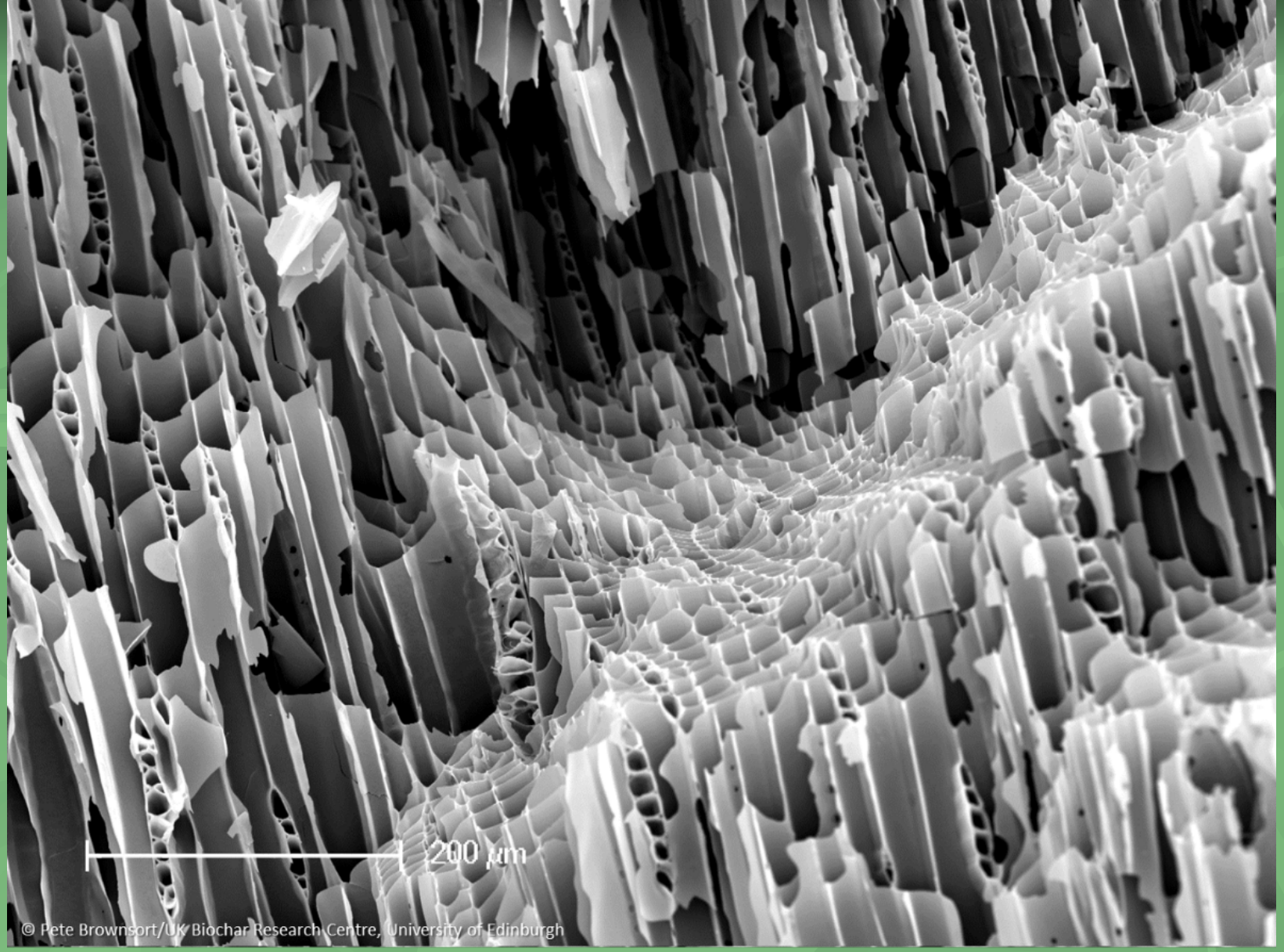


Table 1 Relation between charcoal amendments to soil and crop response

Treatment	Amendment (Mg ha^{-1})	Biomass production (%)	Plant height (%)	Root biomass (%)	Shoot biomass (%)	Plant type	Soil type
Control	–	100	100	100	–	Sugi trees	Clay loam
Wood charcoal	0.5	249	126	130	–	Sugi trees	Clay loam
Bark charcoal	0.5	324	132	115	–	Sugi trees	Clay loam
Activated charcoal	0.5	244	135	136	–	Sugi trees	Clay loam


Biochar now extensively used in horticulture

1 gram of Biochar has surface area of 2 tennis courts



Scanning electronic microscope image of biochar

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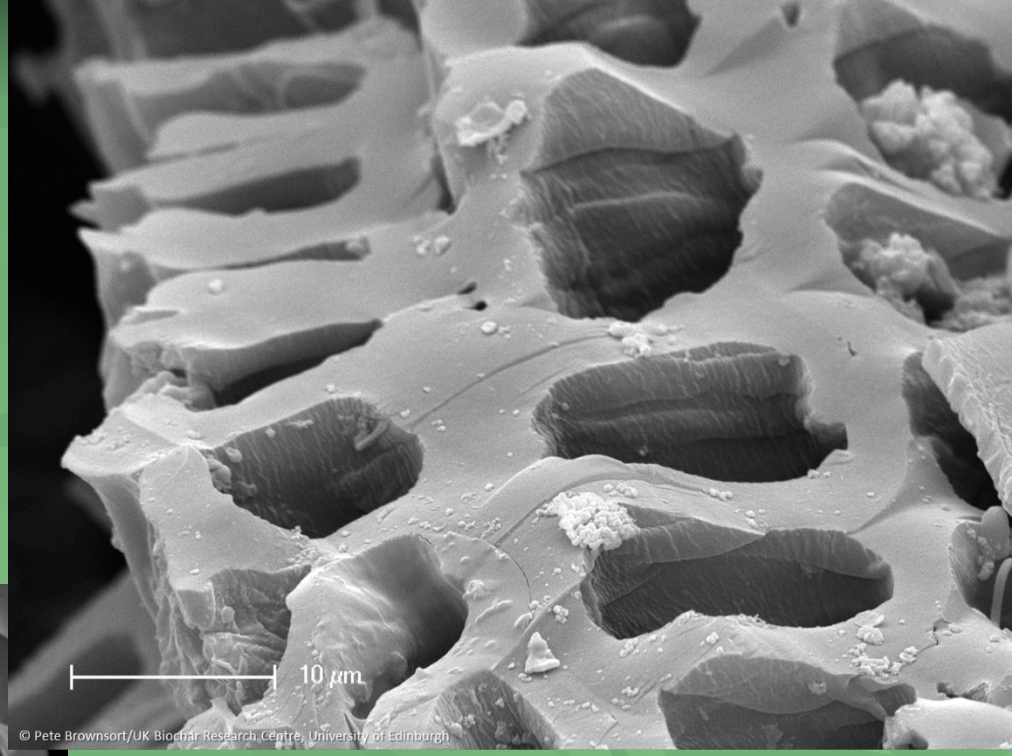

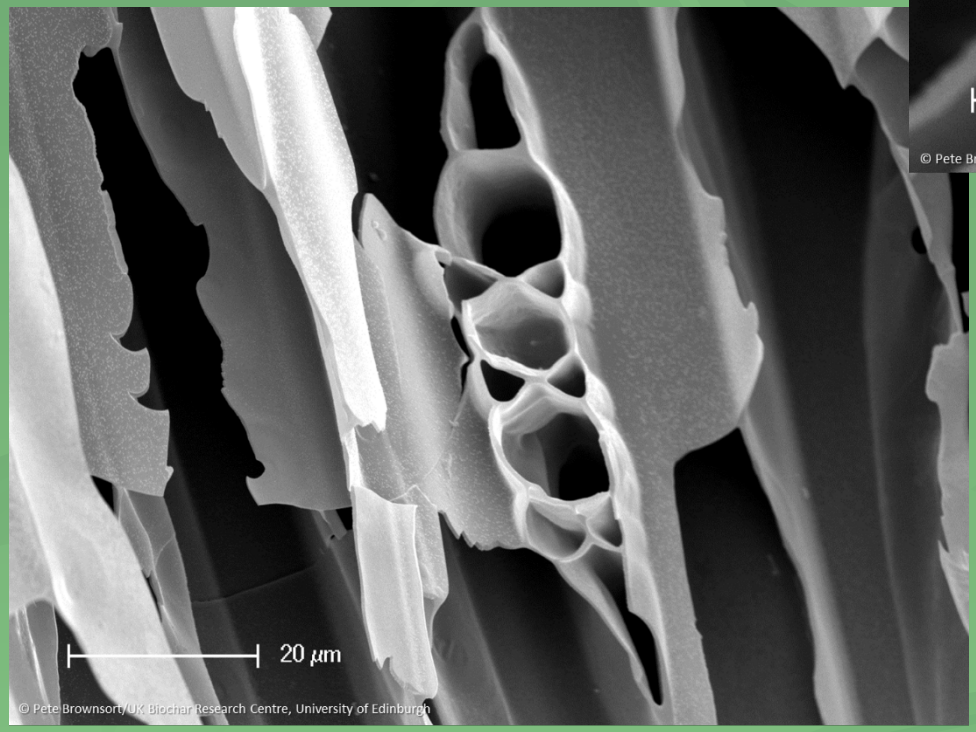

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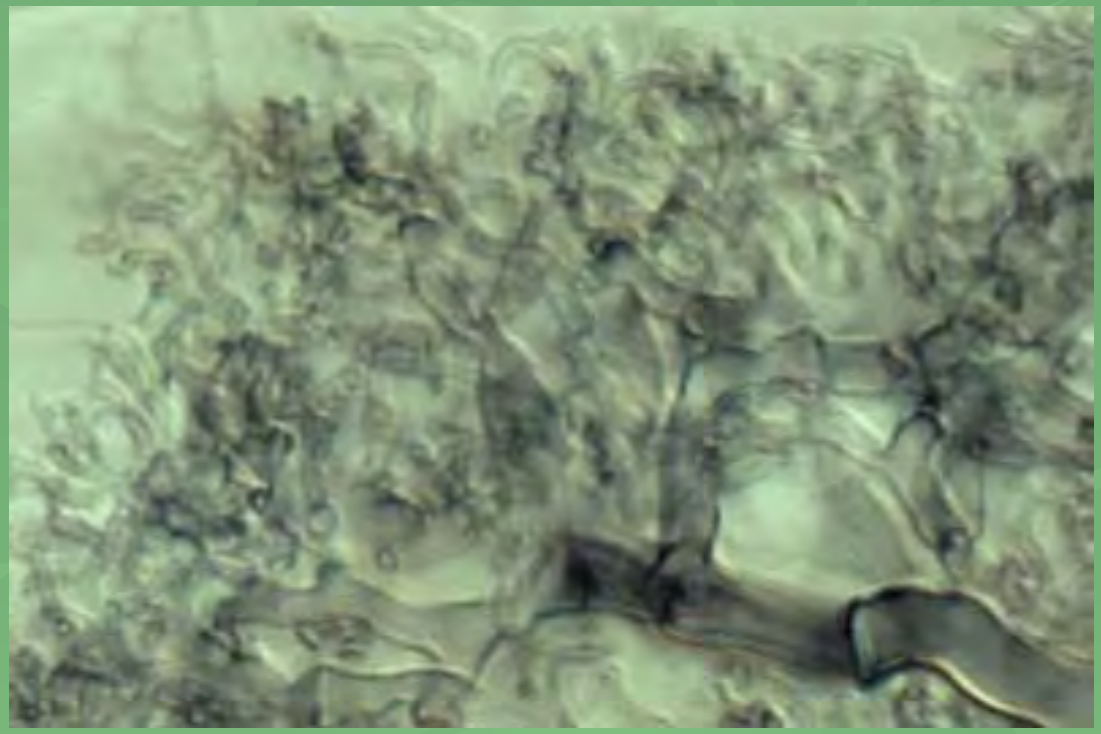
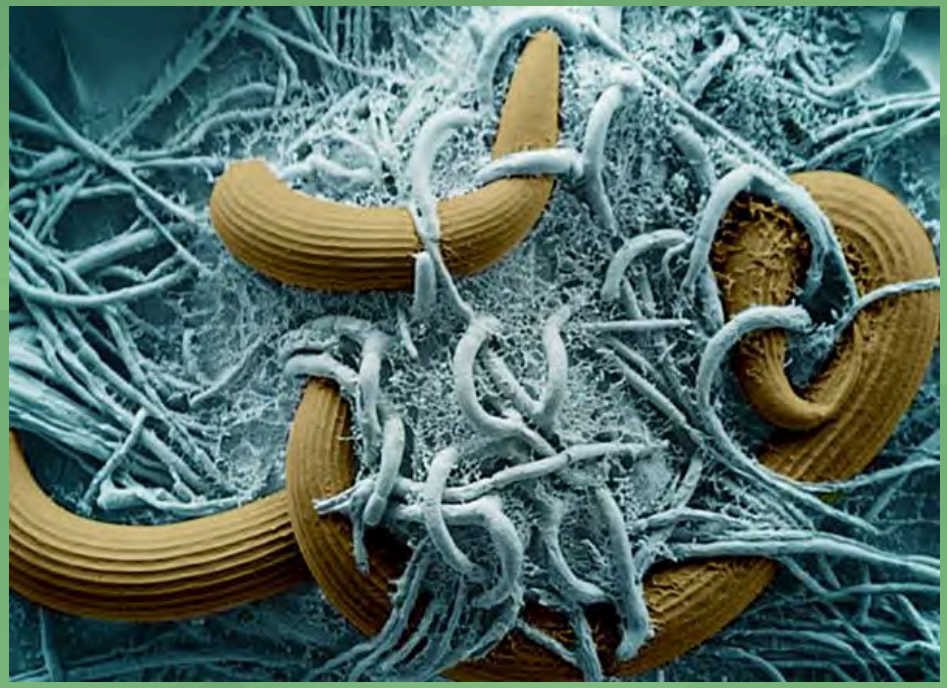
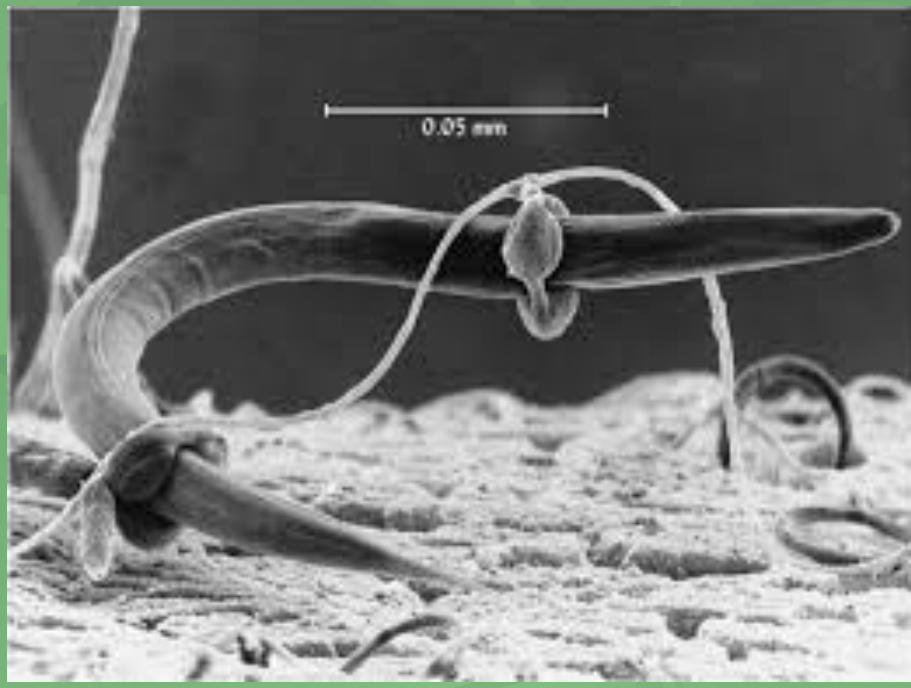
Acts as a haven for mycorrhiza



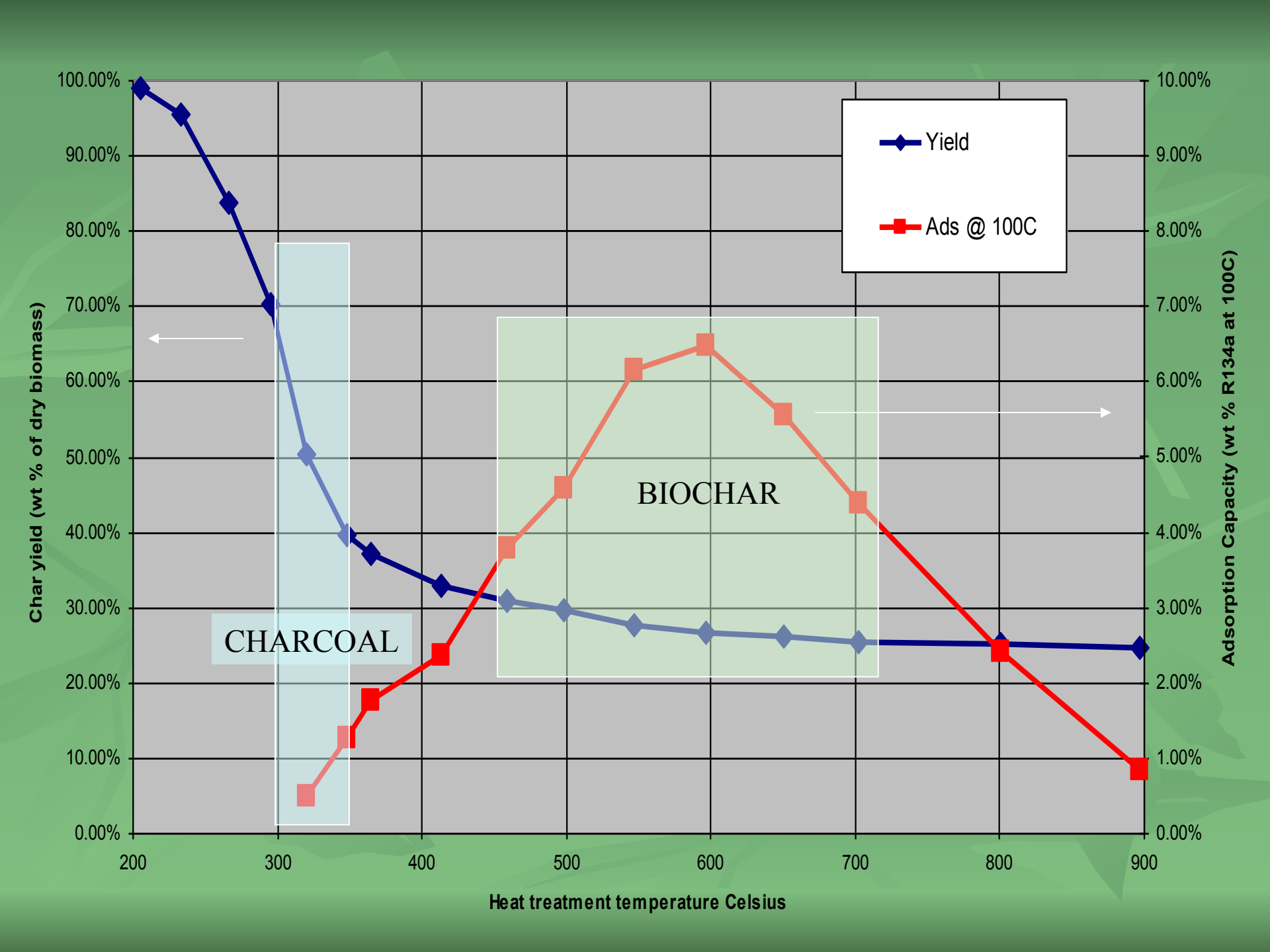
Slides courtesy of J MacPhail





Mycorrhizae trapping nematodes with their filamentous hyphae

Slides courtesy of J MacPhail


Yield
Ads @ 100C
CHARCOAL
BIOCHAR
Char yield (wt % of dry biomass)
Adsorption Capacity (wt % R134a at 100C)
Heat treatment temperature Celsius
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
10.00%
9.00%
8.00%
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
200
300
400
500
600
700
800
900

Uses of Biochar – Transplant Survival

Horse chestnut (*Aesculus hippocastanum*): partial removal of root systems

Aesculus hippocastanum trial plot after biochar application

Horse chestnut *Aesculus hippocastanum* Planting

After planting

Year 1 results

Treatment	Crown coverage	SPAD	PI	Mortality (%)
Control (No Amendment)	3.5a	31.6a	4.3c	0
GroChar* (0.25kg m^2)	4.5cd	29.5a	4.2c	0
GroChar (0.5kg m^2)	4.3bc	32.7a	4.6c	0
GroChar (1.0kg m^2)	4.0b	30.1a	4.0bc	0
Bamboo Biochar (0.25kg m^2)	4.7d	31.3a	4.5c	0
Bamboo Biochar (0.5kg m^2)	3.3a	29.3a	3.1a	0
Bamboo Biochar (1.0kg m^2)	3.3a	31.7a	3.5ab	0

*** Commercial enriched Biochar containing mycorrhiza, wormcasts and sea weed extracts**

GroChar

Control

Unexpected side effect on leaf blotch and leaf miner severity

GroChar
0.25kg m^2

Control

GroChar 0.50kg m^2

Pear (*Pyrus communis* ‘Conference’) Trial

Bare rooted stock used and root pruned to create a root:shoot ratio of 0:33; a ratio associated with transplant stress

Pear (*Pyrus communis* 'Conference') Trial

20L HOLE DUG AND AMENDED WITH:
BACKFILL – CONTROL
MOLASSES PELLETS
PURE BIOCHAR
MOLASSES PELLETS + BIOCHAR (2.5%:2.5%)
ALL PRODUCTS APPLIED AT 5% BY VOLUME

Pure Biochar + Organic BOOST 5% by vol

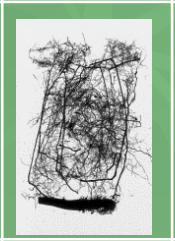
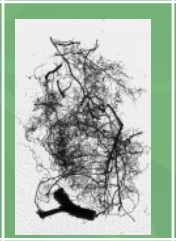
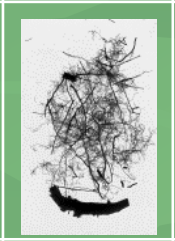
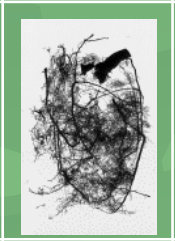
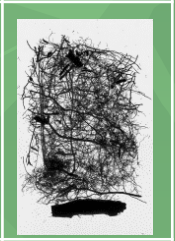
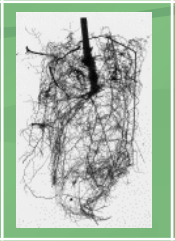
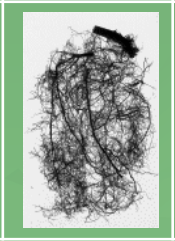
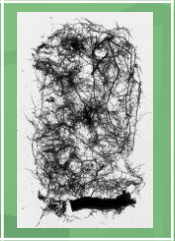
Pure Biochar 5% by vol

Control

TREATMENT	Leaf Chlorophyll Content	Leaf Photosynthetic Efficiency	Mortality
Control (No Amendment)	38.7	6.2	20
Molasses Pellets	42.3	7.1	0
Biochar	44.5	8.2*	0
Molasses Pellets + Biochar	49.9*	7.2	0
Organic BOOST	50.3*	11.1*	0
Organic BOOST + Biochar	50.1*	10.0*	0

Recent Research from the USA

[Scharenbroch, B.C., E. Meza, M. Catania, and K. Fite. 2013. Biochar and biosolids increase tree growth and improve soil quality for urban landscapes. Journal of Environmental Quality. doi:10.2134/jeq2013.04.0124]

Genus species (soil)	Water	Com-post tea	Wood chips	Com-post	NK fert	Bio-char	Bio-solids
Acer saccharum (silt loam)							
Acer saccharum (compact clay)							
Acer saccharum (sand)							

Root scans from *Acer saccharum* in sand, silt loam, and compact clay

Tree growth

Greenhouse experiment after 18 month

Treatment effects:

Total (P=0.0048)

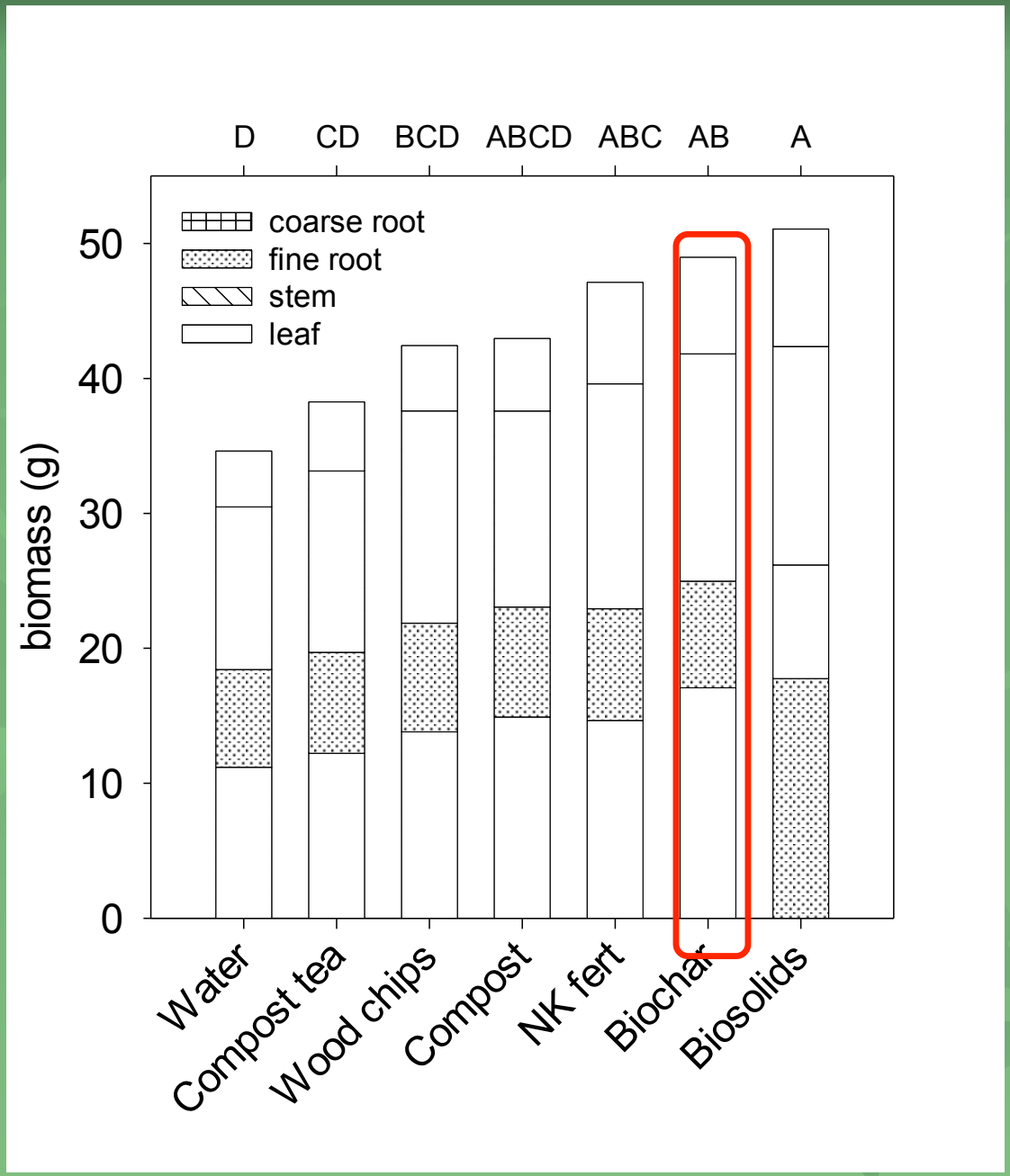
C. Root (P=0.0010)

F. Root (P=0.0835)

Stem (P=0.0036)

Leaf (P<0.0001)

[Scharenbroch et al. 2013]




BTRL trial: simulated planting pits of approx. 4.0 cu metre. – oak, maple


CAT
320C L

MGB ‘Regal Prince’ oak
‘Pattern Perfect’ maple

Gravel Biochar Mulch

Gravel Biochar Mulch

Month 12 after treatment

MGB ‘Regal Prince’ oak
‘Pattern Perfect’ maple

Biochar Gravel Mulch Biochar Gravel Mulch

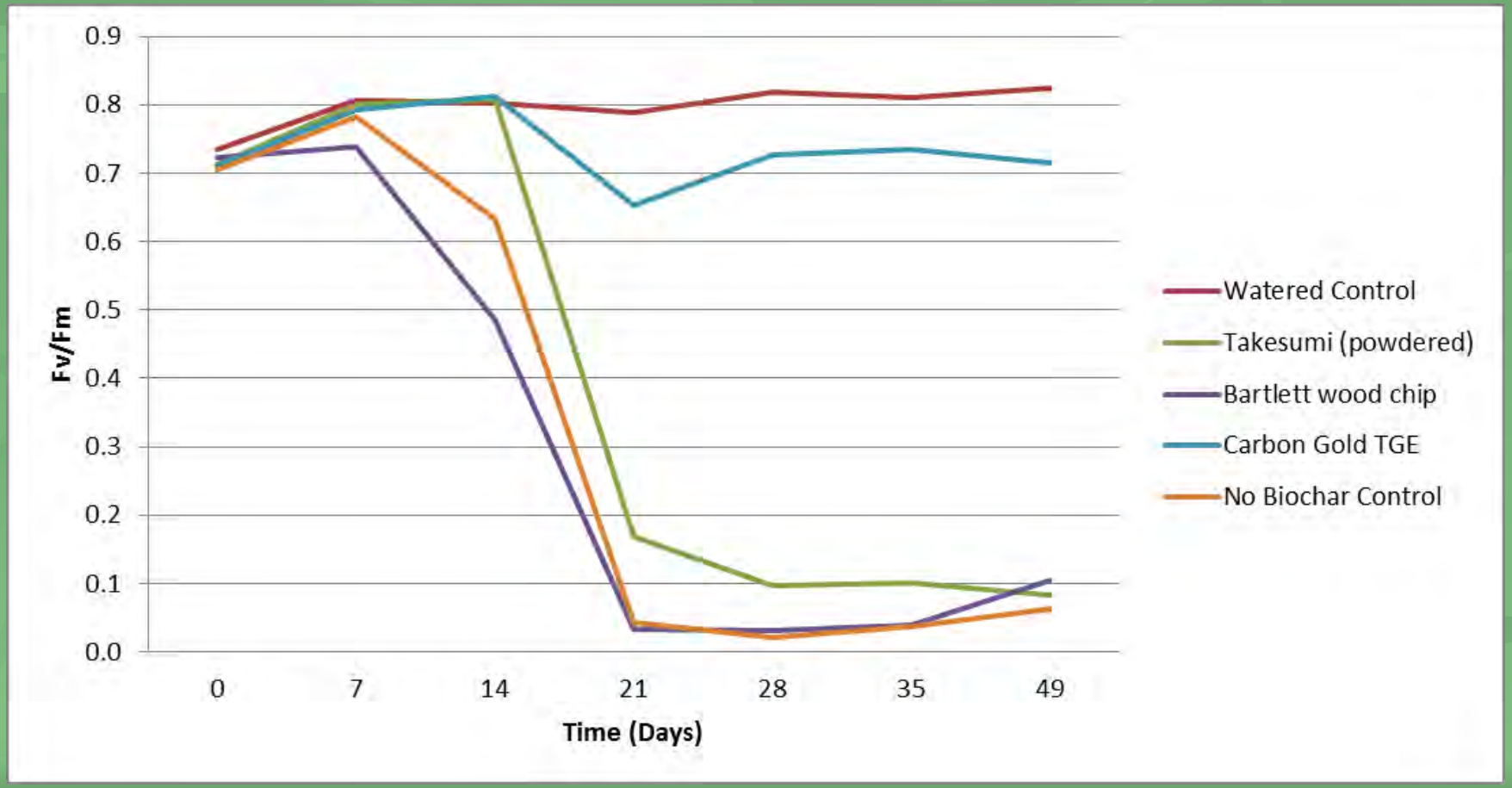
Month 18 after treatment

Control (first growing season) Biochar

Cherry Drought Trial

- Irrigation was removed from *Prunus avium* to monitor their drought response
- Above: Control with no soil amendment
- Below: Treated with enriched biochar

Leaf photosynthetic efficiency across time of drought-stressed Cherry saplings in different biochars



2015 repeat

- Trees droughted for approximately 14 days
- Currently in recovery period – data collection continues

Pest and Disease Management

Vinca and Gardenia inoculated with *Phytophthora*

Control

Compost

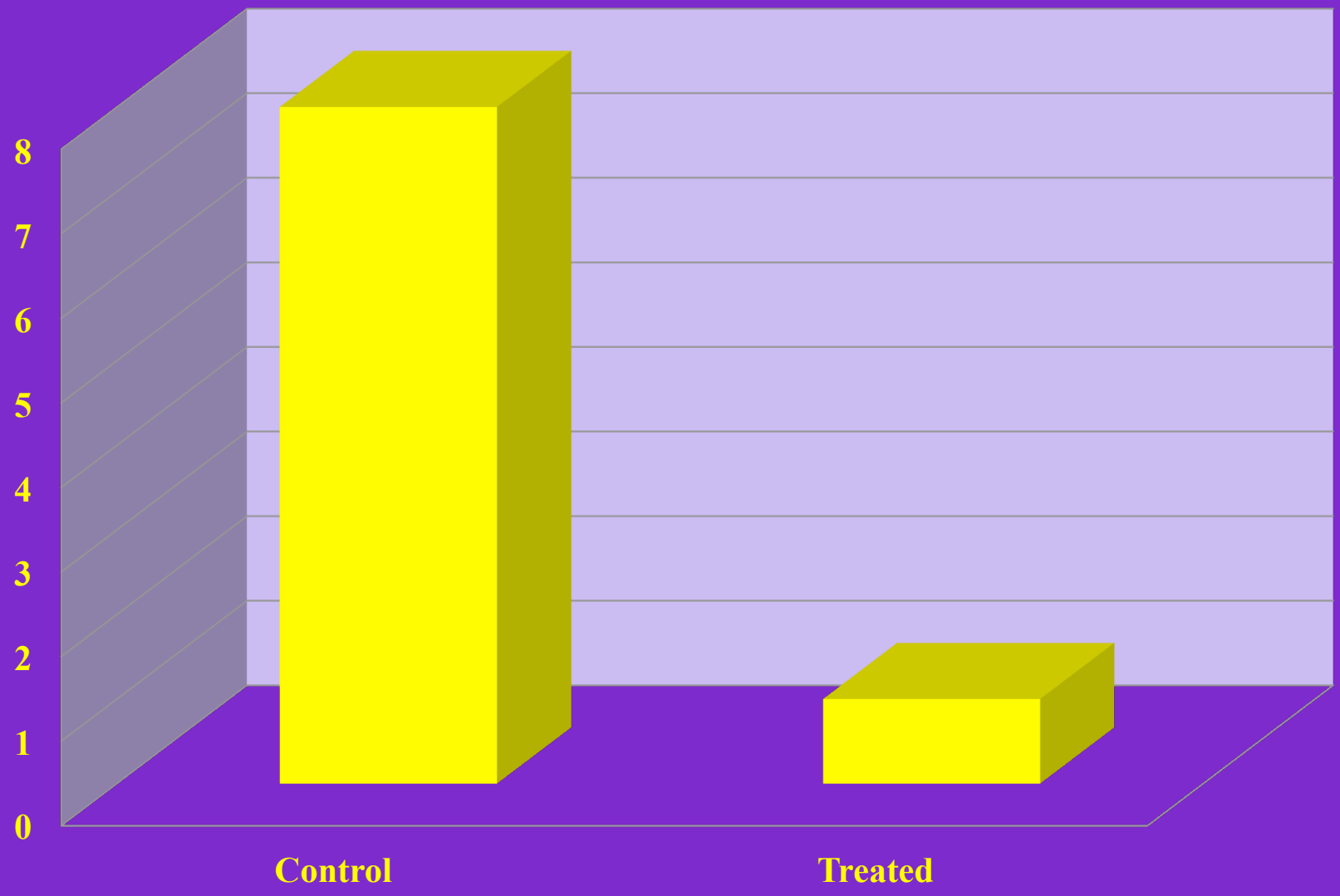
Biochar

Case Scenerio

Honey Fungus

Air-spade + Grochar

Number Trees Infected Over 2 Years



Ash Die-back

Ash Die-back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12kg

Ash Die-back Site Year 1

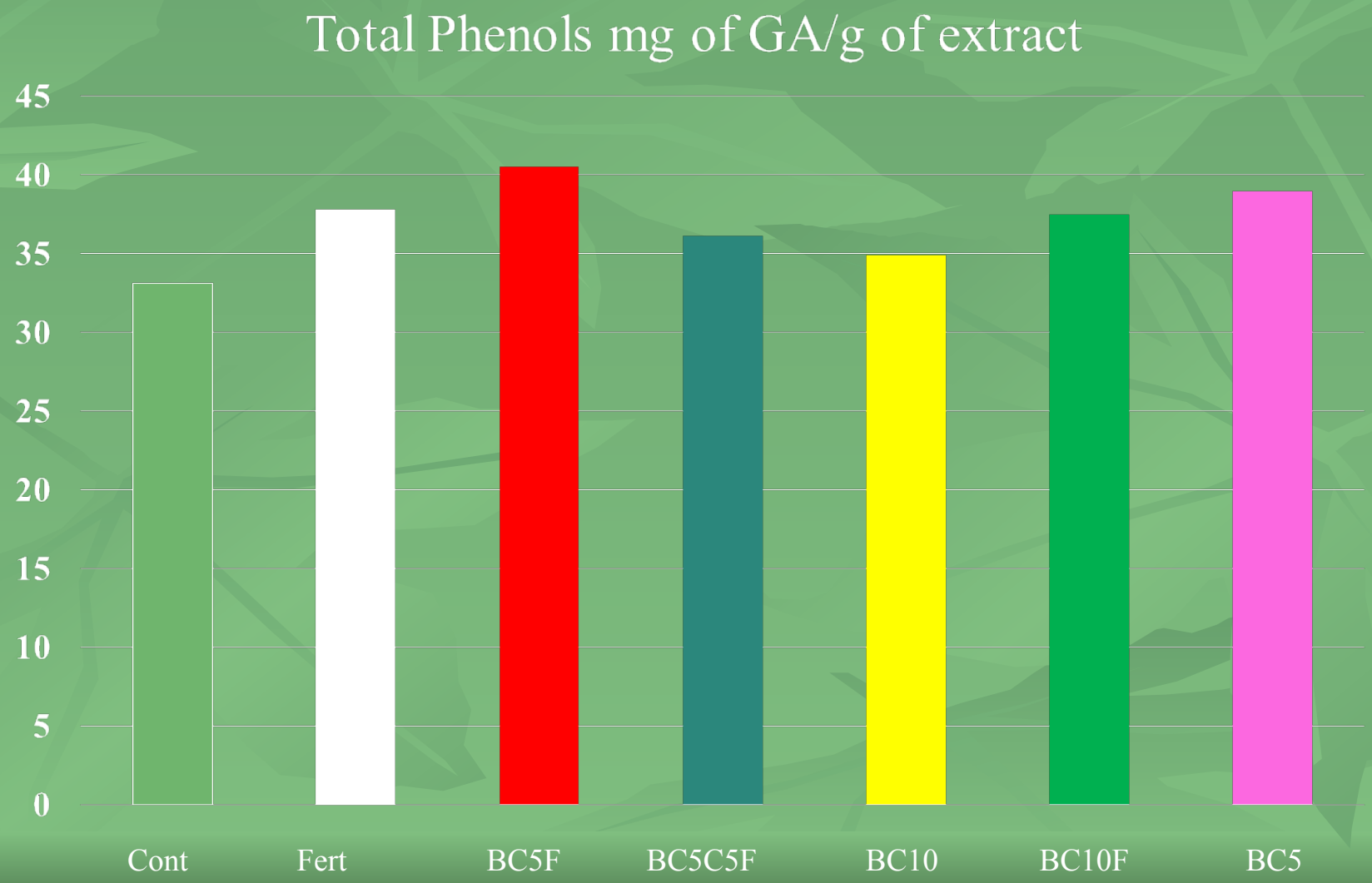
Ash Die-back site (Year 3)

Ash Die-back site

Treatment	Mortality		
	Year 1	Year 2	Year 3
Control	2	3	6
Air-spading	1	3	4
Mulch	0	0	3
GroChar	0	0	0
Air-spading + Mulch + GroChar	0	0	0

Ash Die-back – To date none of the Grochar, Grochar + Mulch treated trees have been infected.

Understanding how Biochar works: Induced resistance or improved tree vitality?



Conclusions.

Use of enriched Biochar has consistently shown to:

Enhance transplant survival
Improve drought tolerance (other stressors under evaluation)
Improve pest and disease resilience (Research ongoing in conjunction with CRD)
Not all biochars created equal i.e. source material is important
Nutrient drawdown although not recorded has been shown elsewhere
5% by soil volume has been shown to be optimal
Combing Biochar with fertiliser can improve efficacy (research on going).
Initial cost can be expensive, however, Biochar remains in soil for 5000 to 2000 years.

Bartlett Lab Staff At Work