

Biochar from Kiwifruit Prunings: Scope and Characterization

Allister Holmes, Dr Hasinur
Rahman



PlusGroup
HORTICULTURAL SOLUTIONS



- PlusGroup Companies
 - GroPlus manages 340 ha kiwifruit (\$12M OGR)
 - PollenPlus produces 1 tonne kiwifruit pollen
 - PlusGroup is undertaking COST project in conjunction with Zespri and Plant & Food Research
 - BioSoil & Crop undertake extensive soil and leaf testing and analysis
 - RoboticsPlus developing kiwifruit harvesting robot

Potential Scope for Kiwifruit Biochar

- New Zealand has 12,000 hectares of kiwifruit
- Majority is marginally profitable
- 2,000 kg ha⁻¹ yr⁻¹ vine is pruned from mature kiwifruit, mulched *in situ* and returned to the soil
- Biochar could be made from the prunings thus returning elements to their biogeochemical cycles
- If other perennial crops (apples and grapes) are included, up to 40,000 tonnes of biochar could be produced annually in New Zealand

Objectives of Preliminary Study

1. Determine the potential scope for the production of biochar from kiwifruit prunings, and other perennial crops
2. Undertake preliminary investigation of the physico-chemical properties of biochar from kiwifruit prunings

Physico-chemical Properties Study

Materials & Methods

- Biochar was produced from three vine sources; conventional and organic *Actinidia deliciosa* (Hayward Green); and conventional *A. chinensis* (HORT 16A Gold)
- Biochar was produced at Massey University by heating at 550°C with heating rate of 40°C min⁻¹ for 15 minutes
- Physico-chemical properties of biochar were measured following standard methods
- Full details and results will be published in paper

Summary of Results

- Biochar from Gold contained and fixed more carbon than biochar from Green
- Biochar from Gold showed lower bulk density, maximum water holding capacity and field capacity; but higher hygroscopic moisture content and hydraulic conductivity than Green
- Biochar from organic Green had higher amounts of P, S, Ca, Mg, Na, Fe, Mn, Cu and B than conventional Green
- No inhibition was observed in germination tests of ryegrass seeds on different extractions of biochar

Biochar from Kiwifruit Vines

Parameter	Unit	Average
Yield	%	31.03
Vines carbon	%	46.20
Biochar carbon	%	72.40
Carbon fixed from vines	%	48.60
Bulk density	Mg m ⁻³	0.41
Maximum Water Holding Capacity	%	45.44
Field Capacity	%	36.92
Gravitational Drainage	%	8.52
Hydraulic Conductivity *0.001, cm hr ⁻¹		172.42
Hydroscopic Moisture	%	4.22
pH		8.82
Electrical Conductivity	μS cm ⁻¹	294.33

Made from 50% moisture prunings

Other 51% oil, gas and lost to atmosphere

Improve soil drainage and porosity; decrease soil bulk density and compaction

Liming affect on generally acidic kiwifruit soils

Scope for Further Work

- Investigate the effect of biochar on the physico-chemical properties of kiwifruit producing soils
- Investigate the effect that the use of biochar has on kiwifruit production
- Investigate possible retention of agrochemicals by biochar
- Determine the effect on the carbon footprint of kiwifruit production by using biochar versus current practice of mulching prunings in situ
- Calculate the cost/benefit of production of biochar and bio oil

Possible Mobile Pyrolysis Machine

- Collects and mulches prunings – mulching a cost for growers
- Injects biochar back in to soil, can also sub-soil rip at the same time
- May be able to recycle bio-oil or gases to dry prunings
- Must be low (<1.5 metres tall)

Typical Pergola



Type of Pyrolysis

Mode		Bio-oil	Char	Gas
Fast	500 °C - 1 sec	75%	12%	13%
Intermediate	500 °C – 10-20 Secs	50%	20%	30%
Slow	400 °C – long residence time	30%	35%	35%
Gasification	800 °C	5%	10%	85%

From: Pyrolysis PROJ-12011-ORI-FRI0, Per Nielsen, SCION

Mobile Pyrolysis Machines

North America



Australia



The Waikato!



Challenges

- Average orchard 4 hectares (8 T yr⁻¹ prunings)
- Collecting, carting, processing and returning biochar to kiwifruit soil
- Throughput of mobile pyrolysis machine
- Cost –
 - Capital cost of machine
 - Operational cost of machine



Kiwifruit prunings are 50% moisture – must be dried

Throughput 500 kg/hour @ 20% moisture wood chip

0.4 hectares per hour

Output 125 kg/hour Biochar

Mobile Prunings to Biochar Machine

Needs to:

- Gather and pick up prunings
- Mulch prunings
- Dry and pyrolyse chips
- Inject biochar into soil
- Be self propelled



Economics

- Mulching winter prunings costs \$150 Ha⁻¹
- What capacity would a mobile machine have?
- How much would it cost?
- How much bio oil can be produced?
- What is the value of biochar to the orchardist?
- Biochar has little nutrients (e.g. 10 kg ha⁻¹ N)
- Biochar has little potential for carbon credit value (maybe \$20 - \$30 Ha⁻¹)