MASTER THESIS

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Holistic Management of HLB/Citrus Greening Disease in Organic Citrus Production
Master Thesis Proposal 1
(Lab experiment)

Titel	Influence of biochar and role of AMF on growth and nutrient supply of organic orange seedlings.
Abstract	To retain a productive and healthy horticulture orchard fertilizing is essential. Organic Orange Orchards in Mexico receive much less fertilizer input than conventionally managed ones as mineral fertilizers are forbidden and organic fertilizers are hardly available. A healthy, well-managed soil exhibits a better nutrient cycling what results in a better plant residue mineralization as well as plant nutrient uptake. This supports plant health and increases it resistance against diseases. To maintain plant productivity in low input soils soil water household, pH and soil microbiology are crucial. Biochar application could be a simple and possibly effective solution to improve soil health locally at plant roots. The application of biochar effectively changes the physical and chemical properties of soil. The high porosity of biochar reduces the soil bulk density and increases its water holding capacity and aeration (Tryon, 1948; Laird *et al.*, 2010). During pyrolysis Ca, Mg and K accumulate in biochar and are supposed to be responsible for soil pH elevation after biochar application (Laird *et al.*, 2010; Van Zwieten *et al.*, 2010). Biochar decompose very slowly in soil, with residence times of a few hundred years to millennia (Lehmann and Joseph, 2009; Zackrisson *et al.*, 1996). The micropores of biochar may serve as niches that protect plant beneficial microorganisms as arbuscular mycorrhiza (AMF) (Saito and Marumoto, 2002). Positive effects of rice husk charcoal on the formation of arbuscular mycorrhiza of citrus seedlings were reported by Ishii and Kadoya (1994). The effects of biochar on soil microbiology may depend on biochar nutrient content as wood charcoal was indeed found to improve soil properties, but mixtures with chemical or organic fertilisers gave better results than charcoal alone on tea and citrus plants (Ishigaki *et al.*, 1990). The results mentioned above suggest a significant role of biochar for beneficially altering soil properties in citrus orchards. Biochar especially may improve symbioses with AMF. However, effects seem to depend on the biochar used, biochar from lighter nutrient rich material (e.g. straw, rice husk) or nutrient enriched hard wood biochar seem to have better effects than hard wood biochar alone. In the proposed master thesis, we want to assess the application possibilities of biochar in organic orange orchards in Mexico to improve plant health. We want to test locally available biochars on their effect on soil pH, AMF root colonization, plant nutrient status and yield.

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Background Orange Orchards Mexico	The master thesis is embedded in an on-going project at FiBL: Holistic Management of HLB/Citrus Greening Disease in Organic Citrus Production HLB is a highly contagious bacterial disease and affecting the quality of the juices, reducing its ratio, as well as the amount of yield and the general health of the citrus trees. HLB stroke Brazil since in the last couple of years with the effect, those organic producers changed back to conventional in order to control this disease and its vector with chemical methods. That is why several governments mandate to control the vector chemically, which means that organic producers would have to restart from 0 after such interventions. HLB is a big challenge to control with the methods of organic farming. However, further research and dissemination of solutions is necessary in order to offer practical alternatives for organic citrus producers. The project will further, develop, test and disseminate organic management measurements tools for HLB disease in Mexico and possible transfer to further potential providers of organic citrus juices.
Background Biochar	During the SNF funded project "**Effects of biochar amendment on plant growth, microbial communities and biochar decomposition in agricultural soils**" FiBL elaborated the effects of microbial community changes induced by biochars in arable soils. The study evaluated the short and long- term effects of pyrogenic and hydrothermal derived biochar from wood and ^{13}C and ^{15}N enriched maize in four different soils.
Material & Methods	Material • Soil from organic orange orchards in Mexico Experimental at FiBL's lab Two chambered pots are set up with different soil from orange orchards (chamber 1) and differed or differently treated biochars (chamber 2). In half of the pots the two chambers are separated by a mesh allowing AMF to pass but not the plant roots. Orange seedlings are grown in the soil chamber and harvested after 8 weeks. It is supposed that the soil carries enough native AMF to guarantee colonization. Otherwise, AMF are inoculated to the soil before planting. Analysis at FiBL's lab • Soil pH and total and available soil Nitrogen and Phosphorus • AMF root colonization (tripan blue, microscopy) • Plant biomass, C, N and P content (CN – Analyser, Spectroscopy) • Optional: (Microbial biomass (Cm, Nm, Pm) (CFE, Resin-P)
Research questions	• Does biochar addition influence plant nutrient content? • Does biochar addition influence AMF colonization? • Are AMF responsible for the nutrient transfer between biochar and plants?

Timetable

Whole work: 6 Months

- 2-3 weeks literature and study design, pot experiment set up
- 3.5 months experimentation and analysis
- 2 months writing

Contacts

Responsible Holistic Management of HLB/Citrus Greening Dis-ease in Organic Citrus Production

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Working Period

April 2016 to September 2016 (or as soon as possible)

Literature

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