



Holistic Management of HLB/Citrus Greening Disease in Organic Citrus Production

Master Thesis Proposal 2

(Field experiment)

Titel	Effects of biochar application in organic orange orchards.
Abstract	<p>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 <i>et al.</i>, 2010). During pyrolysis Ca, Mg and K accumulate in biochar and are supposed to be responsible for soil pH elevation after biochar application (Laird <i>et al.</i>, 2010; Van Zwieten <i>et al.</i>, 2010). Biochar decompose very slowly in soil, with residence times of a few hundred years to millennia (Lehmann and Joseph, 2009; Zackrisson <i>et al.</i>, 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 <i>et al.</i>, 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.</p>

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Background Orange Orchards Mexico	<p>The master thesis is embedded in an on-going project at FiBL:</p> <p>Holistic Management of HLB/Citrus Greening Dis-ease in Organic Citrus Production</p> <p>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.</p>
Background Biochar	<p>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 ¹³C and ¹⁵N enriched maize in four different soils.</p>
Material & Methods	<p>Material</p> <ul style="list-style-type: none">• Selected trees in organic orange orchards, located in a long-term field experiment in Veracruz, Mexico• Local biochars (charcoal production and self-made in the field)• Compost or/and commercial organic fertilizer <p>Experimental</p> <p>Different and/or differently treated biochar is applied to the trees in trenches near the plant roots and covered with soil. After 3-4 months Plant root samples from trenches and from bare soil are analysed for AMF colonization. At the orange fruit harvest, plant orange yield is recorded. For pH, moisture and nutrient measurements samples from tranches and bare soil are taken at day 0, at root sample harvest and at orange harvest. At the experimental site, following monitoring are carried out, orange three phenology, development of natural cover, beneficials, vector of HLB and weather.</p> <p>Analysis</p> <ul style="list-style-type: none">• Soil pH, moisture content and total and available soil Nitrogen and Phosphorus• AMF root colonization (tripan blue, microscopy)• Leaf N and P content (CN – Analyzer, Spectroscopy)• Orange yield

Research questions	<ul style="list-style-type: none"> • Does biochar addition influence plant nutrient content and yield? • Does biochar influence AMF colonization? • Does biochar influence moisture content of nearby soil?
Timetable	<p>Whole work: 6 Months</p> <ul style="list-style-type: none"> • 1 Month literature and study design, organizing of materials, field work • 4 months analysis and writing • 1 month writing
Contacts	<p>Responsible Holistic Management of HLB/Citrus Greening Dis-ease in Organic Citrus Production Salvador Garibay (project leader), salvador.garibay@fibl.org</p> <p>Expertise: Michael Scheifele (Biochar expert), michael.scheifele@fibl.org</p>
Working Period	May 2016 – October 2016
Literature	<p>Ishigaki, K., Fujie, H. & Suzuki, K. (1990). The effect of the soil amendment materials with charcoal and wood vinegar on the growth of citrus, tea plant and vegetables. <i>TRA Report</i>. 107-120.</p> <p>Ishii, T. & Kadoya, K. (1994). Effects of charcoal as a soil conditioner on citrus growth and vesicular-arbuscular mycorrhizal development. <i>Journal of the Japanese Society for Horticultural Science</i>.</p> <p>Laird, D. A., Fleming, P., Davis, D. D., Horton, R., Wang, B. & Karlen, D. L. (2010). Impact of biochar amendments on the quality of a typical Midwestern agricultural soil. <i>Geoderma</i> 158(3-4): 443-449.</p> <p>Lehmann, J. & Joseph, S. (2009). <i>Biochar for environmental management: science and technology</i>. Earthscan/James & James.</p> <p>Matsubara, Y., Hasegawa, N. & Fukui, H. (2002). Incidence of Fusarium root rot in asparagus seedlings infected with arbuscular mycorrhizal fungus as affected by several soil amendments. <i>Journal of the Japanese Society for Horticultural Science</i> 71(3): 370-374.</p> <p>Rondon, M., Lehmann, J., Ramírez, J. & Hurtado, M. (2007). Biological nitrogen fixation by common beans (<i>Phaseolus vulgaris</i> L.) increases with bio-char additions. <i>Biology and Fertility of Soils</i> 43(6): 699-708.</p> <p>Saito, M. & Marumoto, T. (2002). Inoculation with arbuscular mycorrhizal fungi: the status quo in Japan and the future prospects. <i>Plant and Soil</i> 244(1): 273-279.</p> <p>Tryon, E. H. (1948). Effect of Charcoal on Certain Physical, Chemical, and Biological Properties of Forest Soils. <i>Ecological Monographs</i> 18(1): 81-115.</p> <p>Van Zwieten, L., Kimber, S., Morris, S., Chan, K., Downie, A., Rust, J., Joseph, S. & Cowie, A. (2010). Effects of biochar from slow pyrolysis of papermill waste on agronomic performance and soil fertility. <i>Plant and Soil</i> 327(1): 235-246.</p> <p>Warnock, D. D., Mummey, D. L., McBride, B., Major, J., Lehmann, J. & Rillig, M. C. (2010). Influences of non-herbaceous biochar on arbuscular mycorrhizal fungal abundances in roots and soils: Results from growth-chamber and field experiments. <i>Applied Soil Ecology</i> 46(3): 450-456.</p> <p>Zackrisson, O., Nilsson, M. C., Wardle & D, A. (1996). Key ecological function of charcoal from wildfire in the Boreal forest. <i>Oikos</i> 77(1): 10-19.</p>