Microbial improvement of compost and biochar products by combination with arbuscular and ericoid mycorrhizal fungi

Areg Poghosyan, Henning von Alten
Section Phytomedicine, Institute of Horticultural Production Systems,
Leibniz University of Hannover
Herrenhaeuser Str. 2, D-30419 Hannover, Germany
e-mail: von-alten@ipp.uni-hannover.de

Introduction: The high amounts of bio-waste produced in the EU have an enormous beneficial potential if the material could be led back into agri- or horticulture. The "end of waste" (EoW) concept opens the possibility that waste, after a recovery treatment, can cease to be waste, if it fulfils certain quality criteria regarding human health and environment.
The significance of treated bio-waste for agri- and horticulture lies in its nutrient content but as well in the possibility of a combination with beneficial micro-organisms.

The REFERTIL project (Oct 2011 – Sept 2015) has the mission to contribute to the transformation of bio-waste into new resources. This includes standardization of bio-waste treatments and nutrient recovery processes. The output products will be safe, economical and standardized compost and biochar (BC) products containing phosphorous and nitrogen that can be beneficially used by farmers. The REFERTIL consortium consists of 13 partners from 9 EU member states (research institutions, SME, public authorities).
Composts are commonly known for their nutritional and disease suppressive effects on plants. However, its quality and beneficial potential depend on the input material used for compostation. Biochar originates from different types of plant and/or animal waste biomass carboniferous materials. Properly produced biochar from bone material contains high amounts of P and Ca, whereas the contamination with heavy metals and organic pollutants is minimal. The P-fraction in the BC is not easy available to plant roots. This makes BC interesting as a P-fertilizer for organic vegetable production or low input agriculture.

Objectives of the work shown here:
Selection of arbuscular (AMF) and ericoid (ERMF) isolates of mycorrhizal fungi, suitable for combination with biochar and compost products.
Evaluation of biochar and compost products for their technical suitability to be used in a combined product together with mycorrhizal fungi.
Investigation of the role of AMF in nutrient transfer from biochar and compost to plants and antibiotic activity of ERMF against *Phytophthora cinnamomi*.
Investigation of the possible role of compost organisms.

Materials:
Biochar (from bone material) was produced under low temperature carbonization conditions at an average 500°C in the absence of oxygen. Composts were produced by members of the REFERTIL consortium, part of composts was sterilized by X-ray (10 kGy).

Results: AMF and ERMF combined with bio-waste products
1. Possible negative effects on mycorrhizal development were tested with different AMF and ERMF isolates by mixing 10% biochar (from bone particles) or compost ("green compost" made 100% from plant material) into the substrate. Regarding compost 10% is a realistic mix, regarding biochar 10% is about 10 times overdose. Fig. 1 and Fig. 2 show that these amendments do not hinder a good mycorrhizal development.
2. Mycorrhizal functioning was investigated regarding P-transfer from biochar to the host plant (Tagetes) via AMF and suppression of P. cinnamomi development by ERMF in sterile and non-sterile compost substrate. Fig. 3 shows the growth of the plants, without AMF they have no access to the P bound in the biochar particles (row B). Fig. 4 shows that after sterilisation (compost organisms killed) COES3 compost has lost its suppressiveness against P. cinnamomi, but when inoculated with ERMF, it significantly reduced the pathogen development.

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REFERTIL-Coordinator contact: Edward Someus, Terra Humana Ltd,
e-mail: biochar@3ragrocarbon.com, for more information: http://refertil.info

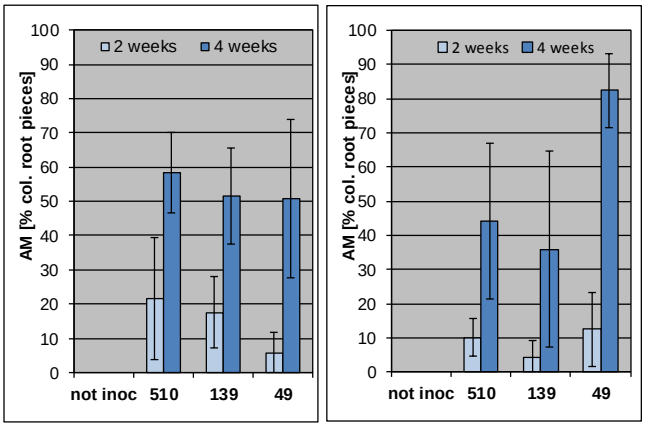

Fig. 1: AM colonization (± SD) of *Tagetes erecta* cv. Luna Lemon grown in quartz sand, inoculated with *G. intraradices* (510; 49) or *G. etunicatum* (139). All plants fertilized without P.
left = substrate + 10% BC; right = substrate + 10% compost.

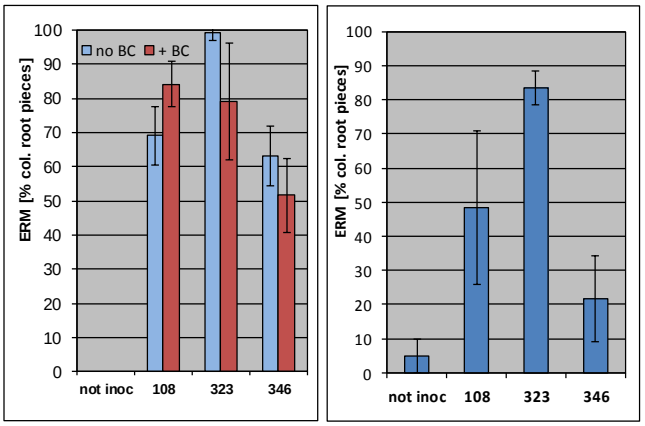

Fig. 2: ERM colonization (± SD) of Rhododendron cv. Cunningham´s White grown in rhodo-substrate, inoculated with ERMF isolates 108 (not identified), 323 (*Rhizoscyphus ericae*) or 346 (*Oidiodendron maius*).
left = substrate + 10% BC; right = substrate + 10% compost.

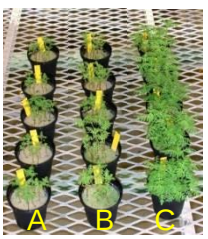

Fig. 3 (up): *Tagetes erecta* cv. Luna Lemon grown in quartz sand, 34 days after sowing. All plants fertilized without P. A = inoculated with AMF; B = with 2% (v/v) BC; C = AMF + 2% (v/v) BC.

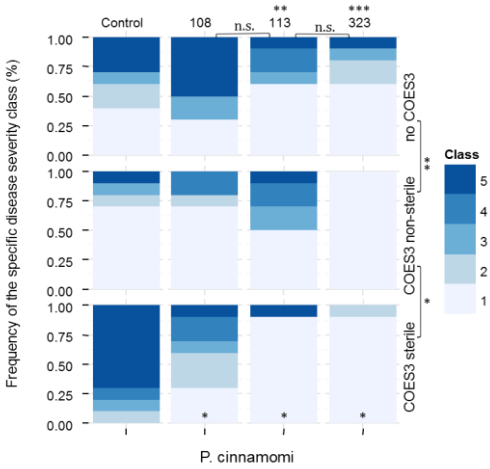

Fig. 4 (right): Disease severity rate (class 1-5) of *Phytophthora cinnamomi* on rhododendron plants, affected by ERMF isolates 108, 113 and 232. Substrate amended with sterile or non-sterile compost COES3. Significance codes: 0 '*'; 0.001 '**'; 0.01 '*'; not significant 'n.s.').**