# INTERACTIONS OF *TRICHODERMA* SPP. IN SOILS WITH BIOCHARS DIFFERED BY FEEDSTOCK AND PARTICLE SIZE: CASE STUDIES WITH RYE AND CORN

**Dagnija Vecstaudza[1], Solvita Stelmahere[1], Lelde Grantina-Ievina[1], Raimonds Kasparinskis[2], Turs Selga[3], Silvija Strikauska[1,4], Vilhelmine Steinberga[1], Christoph Steiner[5,6], Olga Muter[1]**

[1]Institute of Microbiology and Biotechnology, University of Latvia; [2]Faculty of Geography and Earth Sciences, University of Latvia; [3]Faculty of Biology, University of Latvia; [4]Latvia University of Agriculture; [5]BlackCarbon A/S, Barritskovvej 36, 7150 Barrit, Denmark; [6]University of Kassel, Steintr. 19, 37213 Witzenhausen, Germany

**Biochar** has a potential to improve soil fertility and sequester carbon. The effects of biochar application to agricultural soils depend on the feedstock used for biochar production, pyrolysis temperature, application rates, particle size, soil type, etc. Being added to soil, the biochar influences soil microbiota that is dependent on environmental physico-chemical conditions and microbial species. *Trichoderma* is a ubiquitous fungal genus, representing versatile biocontrol agents and known as plant growth promoters.

This study was aimed at comparing the effect of *Trichoderma viride* alone and in the presence of 3% wood- or straw-derived biochar on the growth of rye *Secale cereale* L. (sandy soil, in pots) and corn *Zea mays* (loamy-sand soil, mini-field experiment), respectively.

## RESULTS: CORN

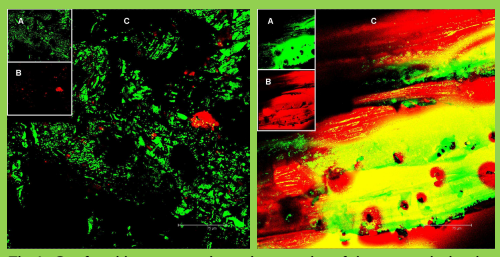


Fig.1. Confocal laser scanning micrographs of the straw-derived biochar surface

Biochar was sampled from soil after vegetation experiment with corn. As seen in Fig.1., 1 – biochar was amended to soil without *Trichoderma viride*; 2 – biochar was treated with *Trichoderma viride*. Green color corresponds to abiotic (A), while red and yellow – biotic substances (B), respectively. (C) -summary visualization of both, abiotic and biotic substances distribution.

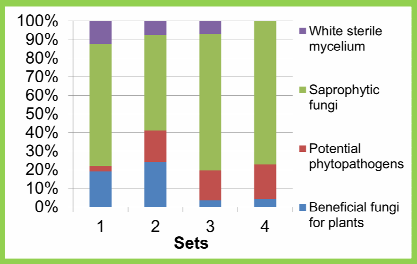


Fig.2. Abundance and diversity of microscopic fungi in soil with corn. 1- without treatment, 2-with straw biochar, 3-with straw biochar+*T.viride*, 4-with *T.viride*

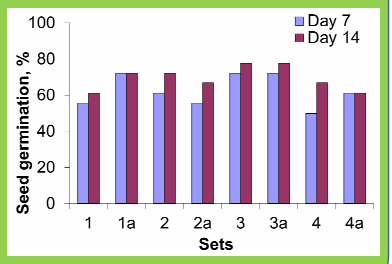


Fig.3. Corn germination in soil with different treatments. 1,1a- without treatment, 2,2a-with straw biochar, 3,3a-with straw biochar+*T.viride*, 4,4a-with *T.viride*

## MATERIALS AND METHODS

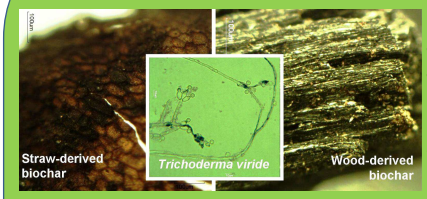


Fig.4. Close-up of wood and straw biochars and fungi *T. viride* used in experiments

**Corn**: The straw biochar was made from pelletized wheat straw. Both biochars were produced at a maximum pyrolysis temperature of 725 °C with a residence time of 1 h, at continuous flow with constant heating.

The generated producer-gas had a temperature of 460°C. The bulk density of the straw-derived biochar was 0.39 g $cm^{-3}$. Corn seeds were sown in 1x1m soil plots, with or without biochar or *T.viride* treatment (250 g biochar ± 1L *T.viride* culture liquid).

**Rye**: The feedstock for wood biochar consisted of shattered wooden boxes (10%) and disposable wooden pallets (90%). Biochar was didvided into two fractions (LPB – large particle bioochar, SPB – small particle biochar) by sieving with a pore size diameter 2 mm. Portion of both fractions was treated with *T.viride* culture liquid. Vegetation experiment was performed in 7 L boxes containing 5 kg sandy soil, the upper layer of soil (2.5 kg) was mixed with biochar. Boxes were placed outdoors under the tent, 20 seeds of rye were sown. Seed germination and plant growth was monitored for 60 days.

## CONCLUSIONS

- Experiments with corn demonstrated a stimulating effect of treatments to the plant growth in comparison with untreated soil, in the following order: **[*Trichoderma viride*] > [*Trichoderma viride*+straw biochar] > [Straw biochar].** Biochar addition resulted in a considerable decrease of the percentage of saprophytic fungi.
- Corn and rye seed germination was faster in the presence of both biochar types tested in this study, irrespectively of different soil types and other experimental conditions.
- Wood biochar (especially its finest fraction with ∅<2mm) positively influenced the rye growth, abundance of cellulolytics, fungi and actinomycetes in a pot experiment.
- The presence of *Trichoderma* was markedly elevated by the presence of biochar in sandy soil with rye

## RESULTS: RYE

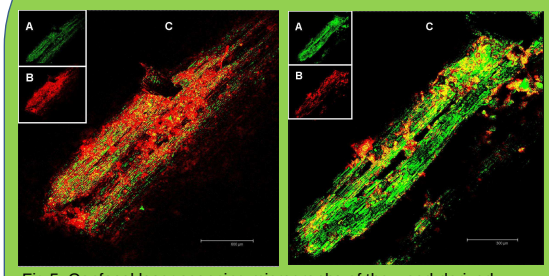


Fig.5. Confocal laser scanning micrographs of the wood-derived biochar surface.

Biochar was sampled from soil after vegetation experiments with rye. As seen in Fig.5., 1 – large particle biochar, treated with *Trichoderma viride*, was applied; 2 – small particle biochar, treated with *Trichoderma viride,* was applied. Green color corresponds to abiotic (A), while red and yellow – biotic substances (B), respectively. (C) -summary visualization of both, abiotic and biotic substances distribution.

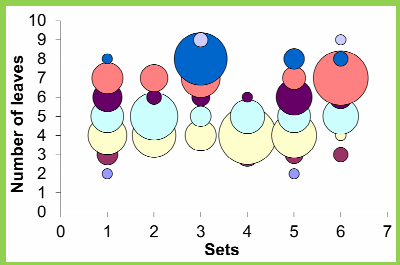


Fig.6. Number of leaves for rye plants grown in soil with different amendments. 1-without biochar, 2-LPB, 3-SPB, 4-LPB+*T.viride*, 5-SPB+*T.viride*, 6-*T.viride*

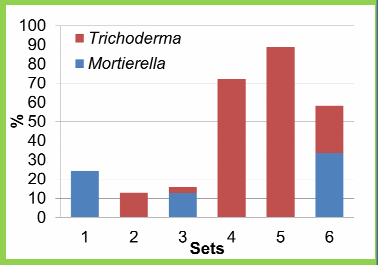


Fig.7. Abundance of *Trichoderma* and *Mortierella* genus fungi in soil with rye. 1-without biochar, 2-LPB, 3-SPB, 4-LPB+*T.viride*, 5-SPB+*T.viride*, 6-*T.viride*

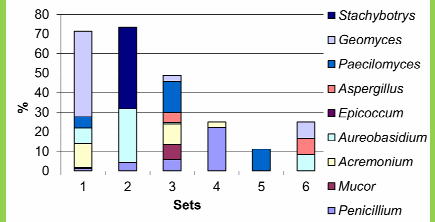


Fig.8. Abundance and diversity of microbial fungi in soil with rye. 1-without biochar, 2-LPB, 3-SPB, 4-LPB+*T.viride*, 5-SPB+*T.viride*, *6-T.viride*

## REFERENCES

Muter O., Berzins A., Strikauska S., Pugajeva I., Bartkevics V., Truu J., Truu M., Steiner C. (2014) The effects of woodchip- and straw-derived biochars on the persistence of the herbicide 4-chloro-2-methylphenoxyacetic acid (MCPA) in soils. Ecotoxicology and Environmental Safety 109, 93-100.

## ACKNOWLEDGMENTS

Research was financially supported by the Latvian National Program 2014.10-4/VPP-6/6 ResProd.