

COPPER-ACCUMULATION IN VINEYARD SOILS AS CONSEQUENCE OF FUNGICIDE APPLICATIONS – BIOCHAR AS RESCUE?

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Introduction

Fungicide applications in vineyards have caused elevated soil concentrations of copper. Especially in traditional wine-growing regions without interruption of vineyard cultivation since centuries, the necessity to combat downy mildew (*Plasmopara viticola*) has caused the side-effect of Cu enrichment in the soil. As Cu is predominantly bound in the upper soil layers, migration to the vine roots and plant uptake of Cu is usually no problem. However, the observed concentrations of Cu in the top soil (in certain wine-growing regions 25 % of all areas show concentrations of >90 mg EDTA-Cu kg⁻¹ with maximum values >300 mg total Cu kg⁻¹; Berger et al., 2011) may inhibit microbial activity and root growth of green cover plants.

Organic amendments like biochar and compost frequently exert positive effects on physico-chemical soil properties. So this study had the aim to analyse the interactions of these amendments with Cu and to test the hypothesis that Cu could be immobilized and ecotoxic effects reduced.

Methods

The effects of different soil amendments on Cu mobility was tested with 2 different soils in a greenhouse experiment and in a field experiment.

In the pot experiment, soil columns were installed as microlysimeters with glass ceramic suction plates at the base. Leachate water was produced by applying a negative pressure of 200 mbar. The pots (height: 0,5 m; volume: 15 L) were grown with one vine each (cv. Grüner Veltliner) and the soil surface was sown with green cover plants (*Lathyrus sativus*, *Avena sativus*, *Medicago lupulina*). Soil treatments consisted of different combinations of wood chips biochar and compost (4 kg additive d.m. m⁻²). In some treatments, citric-acid modified biochar was used.

In the field experiment, the plots of 90 m² were supplied with pure biochar, pure compost (4 kg d.m. m⁻²) or mixtures of both (1:1 w/w; 4 or 10 kg d.m. m⁻²).

Results

In the greenhouse pot experiment the soil additives showed a higher potential to decrease Cu²⁺ in the seepage water of a slightly acidic soil than of a calcareous soil. In the first measurements of seepage water

all additives could reduce the Cu^{2+} concentration in the acidic soil whereas the effect of the additives in the calcareous soil seemed to depend on the stage of vegetation development. This might be caused by an effect of the root exudates on Cu speciation. Biochar modified with citric acid showed in both seepage water measurements a significant reduction of the biotoxic Cu^{2+} speciation. Exchangeable copper, however, was rather mobilized, depending on the proportion of compost in the additive.

In the field experiment soil cover crops were analysed for their Cu concentrations in the roots (the above-ground plant parts were impacted by fungicide applications). Pure biochar reduced Cu uptake into the roots by about 50 % whereas compost slightly increased the Cu concentrations (but not in the highest application rates; Figure 1).

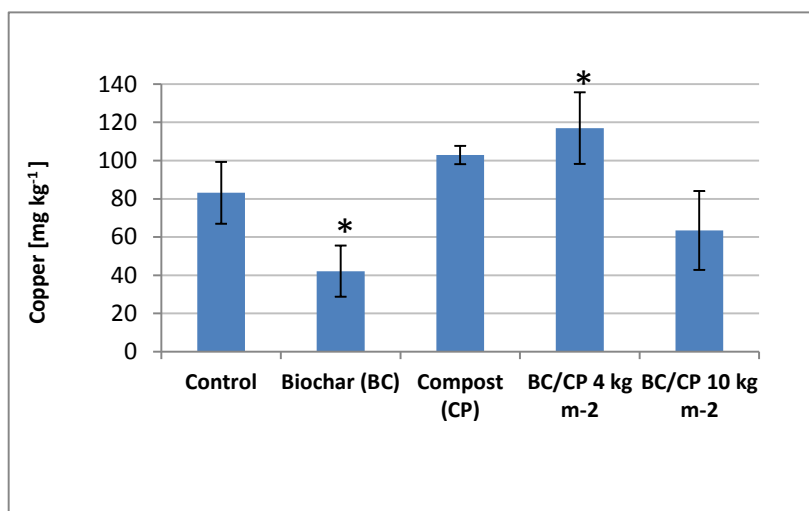


Figure 1. Copper concentrations in roots of white clover (*Trifolium repens*), grown as cover crop in the plots of a vineyard treated with different organic amendments. Total copper concentrations in the soil were 250 mg kg⁻¹, pH=7.3, lime: 11 %. The asterisk indicates statistically significant differences from the untreated control.

Conclusion

This study underlines the difficult situation for organic vine farmers: on the one hand they need high organic carbon levels in the soil. On the other hand this enhances mobilization of Cu. On the one hand they need Cu-based fungicides to combat downy mildew, on the other hand this further increases the Cu-levels in the soils. It might be a potential solution for the future to keep at least the Cu^{2+} - levels low with the help of moderate to high levels of biochar. This way the ecotoxic effects of Cu should be reduced low even when total Cu mobility is barely changed.

References

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