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Environmental risks of biochar in soils: ecotoxicological effects on plants and microarthropos

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Keywords: Biochar, Environmental Risk, Ecotoxicity, Soil microarthropods, *Folsomia candida*

Biochar is the solid residue produced by the pyrolysis bio-wastes (biomasses, sludges, agricultural wastes) for energetic purposes. Its application to soil is considered a promising tool to improve soil fertility and to mitigate climate change. Several benefits are been described using biochar in agriculture or in remediation. However high salinity, high alkalinity and the presence of contaminants (heavy metals and polycuclic aromatic hydrocarbons deriving from the originating feedstocks or enhanced by the production methods) might induce detrimental effects on soil habitat and soil biota. These potential risks can't be ignored and it is necessary ensure the safety of biochar before to add it to soils.

We present some ecotoxicological results of four biochars, deriving from different biomass feedstocks from a gasification plant (©AGT s.r.l., Cremona, Italy), on plants and soil microarthropods.

The biochars, deriving from conifer -CO-, Grape Marc -GM-, Poplar -PO- and Wheat Straw -WS-, were pulverized and mixed to standard soil at increasing w/w concentrations (0.5- 1- 2- 5- 10- 20- 50 %). Phytotoxicity was assessed using 5 L. (cucumber), 5 L. (watercress) and *Sorghum saccharatum* (L.) Moench (sorghum) performing the UNICHIM (2003) procedures. The seeds were placed in Petri dishes containing 15 g of biochar mixes and incubated at 25±2 °C for 72h. Then thee germination rate and the root length were determined. Ecotoxicity was evaluated by using the collembolan *Folsomia candida* in a inhibition of reproduction test (ISO 11267:1999) and in an avoidance test (ISO 17512-2:2011). For the first test, synchronized juveniles (10-12 days old) were placed in Petri dishes with biochar mixes, kept at 20±2 °C for 28 days, then adults and juveniles were counted after flotation. For the second one, 10 synchronized juveniles were disposed on Petri dishes in the conjunction between biochar mixes and standard soil. The test lasted 48h, then the substrates were separated with a plastic bar and counted after flotation.

The results showed that both plants and animals were affected by biochar, especially at higher concentrations. The origin of biomasses seemed to impact in different way the germination and the elongation of seeds and the survival and reproduction of collembolans, outlining differences between wood derived biochar (CO and PO) and herbaceous biochar (GM and WS).

Among the biochars, the GM revealed the worse effects on root length of seeds and on survival and reproduction of springtails. This point unveils the necessity of test biochars before the application on agricultural fields in order to avoid detrimental effects.

Environmental risks of biochar in soils: ecotoxicological effects on plants and microarthropods

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Introduction

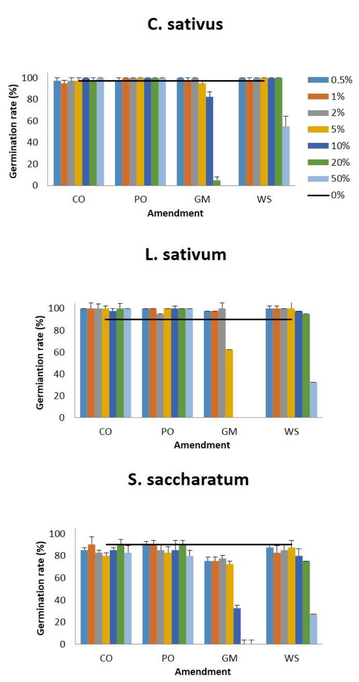
Biochar is a solid residue produced by the pyrolysis or gasification of bio-wastes (biomasses, sludges, agricultural wastes) for energetic purposes. Its application to soil is regarded currently as a novel approach to improve soil fertility and soil functions (Jeffery et al., 2011) and to mitigate climate change due to high stability of carbon (Lehmann et al, 2006; 2011). Despite many benefits have been described after biochar application in agriculture and remediation, biochar has some peculiar physical-chemical characteristics that could be dangerous for the maintenance of soil health. High salinity, high alkalinity and the presence of contaminants (heavy metals and PAHs deriving from originating feedstocks or enhanced by the production methods) might induce detrimental effects on soil habitats and soil biota. These potential risks can't be ignored and it is necessary ensure the safety of biochar before adding it to soils.

Story

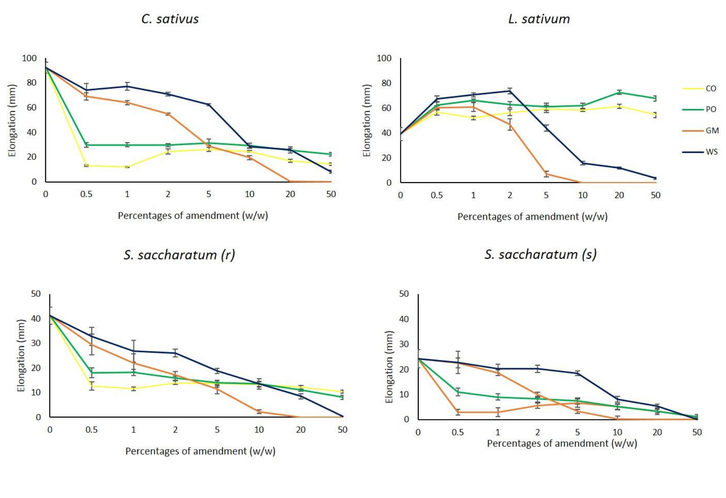
Phytotoxicity test

Three species have been used to evaluate direct effects on plants: *Cucumis sativus* L. (cucumber), *Lepidium sativum* L. (cress) and *Sorghum saccharatum* Moench (sorghum). These species are routinely used in bioassays and they are known for their sensitivity to chemical compounds and heavy metals, even for residual doses or traces.

Seven increasing percentages were considered: 0.5%, 1%, 2%, 5%, 10%, 20%, 50%. For each percentage and each plant species, four replicates were carried out: 15 g of mixture were put in 90 mm disposable Petri dish, covered by a Whatman #1 filter paper and wetted with 5 ml of deionised water. 10 undamaged and plump seeds were then added. Closed in polyethylene bags, the dishes were incubated at 25±1° C for 72 hours.



The germination showed different responses depending on plant species. While *L. sativum* seemed to be favoured by the presence of some biochars (CO and PO), S. saccharatum revealed a severe inhibition, in particular within the shoot. GM biochar affected all the plant species teste at medium-high percentages, while WS biochar showed negative effects at the highest dose.



An inhibition of root elongation was observed with GM and WS biochars for all species (from 5% and at 50% respectively. *L. sativum* seemed, on the contrary, to be favoured by CO and PO biochars. *S. saccharatum* showed a strong root inhibition and shot elongation in all biochars.

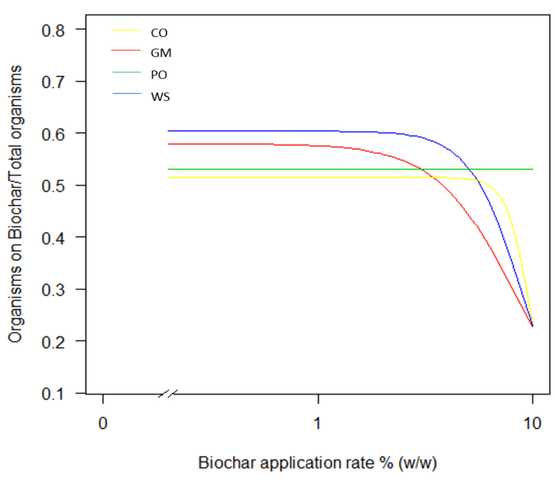
Ecotoxicological experiments with the springtail *Folsomia candida*

Two types of test were performed to determined a) the animals' tendency to avoid a potential source of contamination, and b) the effect on animal's survival and reproduction when they came in touch with the amendment.

a) Avoidance test (ISO 17512-2: 2011)
The pulverized biochars were mixed to soil standard at 5 rates (w/w: 0.5, 1, 2, 5, 10). 10-12 days-old synchronized juveniles were put in the conjunction between biochar mix and soil standard. The test lasted for 48 h, then the substrates were separated using a plastic bar and the organisms were counted after flotation.

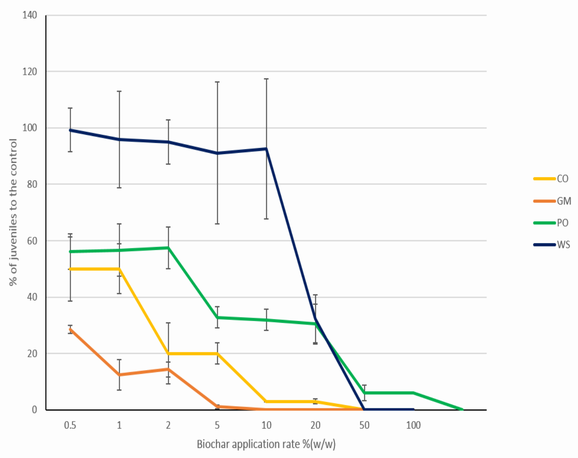
b) Inhibition of reproduction (ISO 11267:1999)
The pulverized biochars were mixed to standard soil at 8 rates (w/w: 0.5, 1, 2, 5, 10, 20, 50, 100%). Synchronized juveniles (10-12 days old) were placed randomly in each Petri dish. After 28 days the juveniles were counted after flotation.

Five replicates were performed for each condition and for control. The experiments were carried out at 20±2 °C with 55-65% humidity.



Avoidance graph (obtained with *drc* package in R) as the interpolation of data with an extended logistic regression model.

The avoidance test showed that the springtails didn't avoid biochar substrates up to the ratn't b of 2-5% and in the highest concentration the animals kept away from them, preferring soil standard.



The results of reproduction test with the four biochars tested referred to the control

The results obtained in the second test suggested that the reproduction rate of *F. candida* was seriously affected by the highest concentration of biochars, associated in the case of GM to a high adults mortality. But even at low percentages the numbers of juveniles has been reduced compared to the control (that counted an average number of 284 young springtails).

References and/or Acknowledgments

References

Jeffery S., VerHeijen F.G.A., van der Velde M., Bastos A.C., 2011. A quantitative review of the effects of biochar application to soils on crop productivity using meta-analysis. Agriculture, Ecosystem and Environment 144: 175-187

Lehmann J., Gaunt J., Rondon M., 2006. Bio-char sequestration in terrestrial ecosystem- a review. Mitigation and Adaptation Strategies for Global Change 11: 403-427

Lehmann J., Rilling M.C., Thies J., Masiello C.A., Hockaday W.C., Crowley D., 2011. Biochar effects on soil biota – a review. Soil Biology and Biochemistry 43: 1812-1836

Biochars

All of the biochars were produced from different biomass feedstocks at 1200 °C in a gasification plant (© A.G.T.- Advanced Gasification Technology s.r.l., Cremona, Italy).

Four biochars were analysed: Conifer (CO), Grape Marc (GM), Poplar (PO) and Wheat Straw (WS).

All the biochars have been pulverized and mixed to soil standard (70% of quartz sand, 20% of kaolinite clay, 10% finely ground *Sphagnum* peat) at different percentages (w/w).

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