IBI Research Summary:

Biochar Impact on Soil Carbon Losses

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Author: Julie Major, PhD

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Question: Is there any evidence that adding biochar to soil could stimulate losses of soil organic carbon?

There is no evidence or research indicating that biochar could trigger additional mineralization of "resident" soil carbon. A study by Wardle et al., (2008) placed mesh bags of charcoal in the humus layer of a forest and observed a subsequent loss of carbon. They did not measure the physical transport of carbon to areas outside the mesh bags they used in the experiment. Carbon that is leached into deeper layers of soil has repeatedly been shown to become stabilized by interactions with minerals, and thus to remain within the soil system.

Further, the study was not designed to determine whether the carbon loss observed came from "resident" soil carbon or actual biochar-carbon. The source of the observed carbon loss was most likely a combination of both resident soil carbon and biochar-carbon, but the Wardle study did not account for either, and so the effects of biochar on other forms of soil carbon cannot be determined from that single study.

Moreover, the Wardle study did not characterize the biochar in terms of its pH. Fresh biochar typically is quite alkaline, and the effect seen by Wardle could have simply been a liming effect, which is well known to stimulate microbial activity and organic matter decomposition. Finally, the effect of biochar on plant growth was not captured in the studied system and this can make a significant difference in total carbon accounting in the field (Major *et al.*, 2010). Thus, the Wardle study does not reach any conclusive results. While it shows enhanced carbon dioxide emissions from a forest humus layer when amended with fresh, presumably alkaline, biochar, it is certainly not evidence that biochar could cause large losses of soil organic carbon from agricultural soils where it is most likely to be applied. We recommend characterizing biochar before using it as a soil amendment (some soils need liming, others do not) and, if need be, aging it or treating it

with steam or heated air to bring the pH close to that desired (e.g., neutral or slightly acidic).

Subsequent laboratory studies using agricultural soils (e.g. Kuzyakov et al. 2009 , Bruun et al., 2009; Spokas et al., 2009), as opposed to a forest humus layer, have shown no evidence for the large release of carbon dioxide reported by the Wardle study. Rather, their results suggest that adding biochar to soil reduces the decomposition of non-biochar soil organic matter (SOM).

In a field study, Kimetu and Lehmann (2010) assessed carbon dynamics after the addition of biochar and green manure, both applied at the same carbon-based rate. They found that biochar became stabilized in soil to a greater extent than did green manure, and also resulted in less non-biochar SOM being respired from soil.

More recently, Novak et al. (2010) also showed that biochar addition to soil in the laboratory did not stimulate the loss of "resident" soil C, however when biochar was added along with powdered Switchgrass, more of this Switchgrass was mineralized than when added without biochar. These authors suggest that biochar may have shifted the preference of soil microbes from "resident" soil C to newly added C (in this case, Switchgrass). This must be investigated further, since the decomposition of newly added organic matter provides nutrients for crop growth.

REFERENCES ON THE SOIL CARBON LOSS QUESTION

Bruun, S., El-Zahery, T., Jensen, L., 2009. Carbon sequestration with biochar - stability and effect on decomposition of soil organic matter. IOP Conference Series: Earth and Environmental Science 6, doi:10.1088/1755-1307/1086/1084/242010.

Kimetu, J.M., Lehmann, J., 2010. Stability and stabilisation of biochar and green manure in soil with different organic carbon contents. Australian Journal of Soil Research 48, 577-585.

Kuzyakov,Y., Subbotina,I., Chen,H., Bogomolova,I., Xu,X. (2009) Black carbon decomposition and incorporation into soil microbial biomass estimated by C-14 labeling. Soil Biology & Biochemistry, 41 (2) 210-219.

Lehmann, J, Sohi, S. (2008) Comment on "fire-derived charcoal causes loss of forest humus". Science 321, 5894

Major, J., Lehmann, J., Rondon, M., Goodale, C., 2010. Fate of soil-applied black carbon: downward migration, leaching and soil respiration. Global Change Biol. 16, 1366-1379.

Novak, J.M., Busscher, W.J., Watts, D.W., Laird, D.A., Ahmedna, M.A., Niandou, M.A.S., 2010. Short-term CO2 mineralization after additions of biochar and switchgrass to a Typic Kandiudult. Geoderma 154, 281-288.

Spokas, K.A., Koskinen, W.C., Baker, J.M., Reicosky, D.C., 2009. Impacts of woodchip biochar additions on greenhouse gas production and sorption/degradation of two herbicides in a Minnesota soil. Chemosphere 77, 574-581.

Wardle, D.A., Nilsson, M. C., Zackrisson, O. (2008) Fire-derived charcoal causes loss of forest humus. Science 320, 629.