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ARE "HANEY TESTS" MEANINGFUL INDICATORS OF SOIL HEALTH AND ESTIMATORS OF NITROGEN FERTILIZER CREDITS?

By Dan M. Sullivan, Oregon State University; and David Granatstein, Washington State University-Wenatchee

"Active" soil organic matter and the mineralization of plant-available nitrogen from soil organic matter are important apects of soil health. Nitrogen mineralization from soil organic matter under typical management is already factored into existing fertilizer guides published by western U.S. land-grant universities.

Because of the current spike in interest in soil health, a special session was organized at the Western Nutrient Management Conference on March 5, 2015. The conference was attended by over 120 participants from Hawaii to Colorado. This Conference, organized by Western Region land-grant university faculty and fertilizer industry partners, strives to extend research findings on soil fertility and nutrient management to practitioners, including Certified Crop Advisors.

Dr. Rick Haney, USDA-ARS was the invited keynote speaker. Dr. Doug Smith spoke in Dr. Haney's place and presented data on the Haney methods. Also in this session, Dr. Bob Miller (Agricultural Laboratory Proficiency Program) and researchers from UC Davis (Jordon Wade, Martin Burger, & Will Horwath) presented data on soil N and C testing.

The proposed Haney tests provide an alternative method to estimate N credits from

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BIOCHAR AND MANURE EFFECTS ON NITROGEN NUTRITION IN SILAGE CORN

By Rick Lentz, corresponding author; Jim Ippolito , USDA -ARS Northwest Irrigation and Soils Laboratory, Kimberly, ID; and Kurt Spokas, USDA-ARS Soils and Water Management Unit, St. Paul, MN

Biochar, a carbon-rich charcoal derived from the pyrolysis of photosynthetically fixed carbon (C) biomass, is of interest because biochar-C is extracted from the atmosphere, can increase productivity in tropical soils, and persists in soils for >100-1000 years. Biochar could help mitigate climate change if it were applied to soils at a wide scale. However, its effects on irrigated, calcareous soils, like those in the U.S. Intermountain West are poorly understood. We evaluated the influence of one-time fall application of hardwood biochar, dairy manure, or their combination on N uptake and yield in silage corn, net N mineralization, and greenhouse gas emissions in the following three years of sprinkler-irrigated silage corn. Organic treatments were applied only once, in fall 2008, and included a (1) control (no organic amendment); (2) manure (18.7 ton ac^{-1} dry wt.); (3) biochar (10 ton ac^{-1} dry wt); and (4) manure + biochar (at single treatment rates). Annual preplant soil tests determined inorganic N fertilizer rates. In manure plots, these rates were adjusted to account for the additional N mineralized from manure,

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which was derived using a manure mineralization series estimate (determined from a previous on-farm study). We measured net N-mineralization using buried soil bags (where the net value represents the gross mineralized-N minus gross immobilized-N).

Corn Silage Yields and N Uptake

Overall , corn silage yields averaged 8.6 tons ac^{-1} (dry wt.) across the three years. The influence of biochar and manure on silage yield changed with time after application. Biochar increased corn yields slightly (5%) in 2009, decreased yields by 14% in 2010, and had no effect in 2011. Conversely, manure had no effect on yields in 2009, but increased yields substantially in 2010 (33%) and again slightly in 2011 (7%). In 2010, the effect of biochar and manure on silage N uptake followed the same pattern as that for yield, suggesting that treatment yield effects resulted from changes in N availability. Also intriguing was the fact that biochar's influence dramatically changed when combined with manure. Biochar decreased net N mineralization when added alone but increased net N mineralization when added with manure (Fig. 1). Similarly, in 2010 and 2011, biochar reduced silage N uptake without manure, but increased N uptake when combined with manure (Fig. 2).

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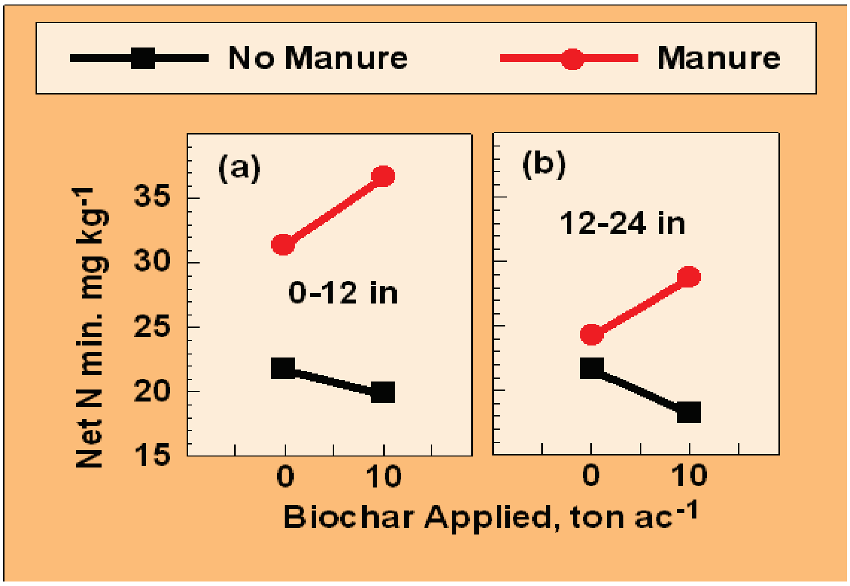

Figure 1. Biochar decreased mean season-long, net-N-mineralization at both 0-to-12 (a) and 12-to-24 in (b) depths when added alone, but increased net N mineralization when added with manure, in three years after a one-time, fall 2008 manure/biochar application.

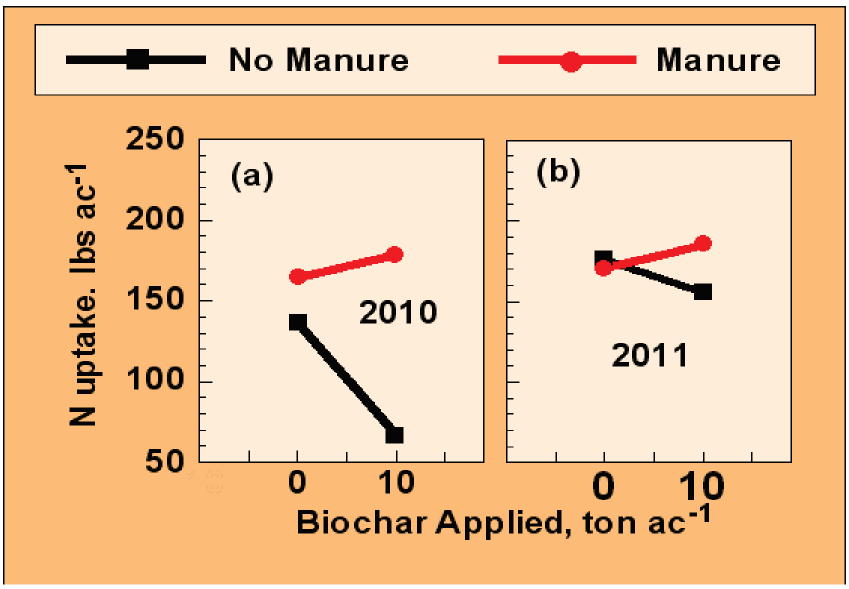

Figure 2. Biochar decreased corn N-uptake when added alone, but increased N-uptake when added with manure in 2010 (a) and 2011 (b), the 2nd and 3rd growing seasons after a one-time, fall 2008 manure/biochar application.

Why did biochar reduce silage yields only in 2010?

Results suggest that biochar's physiochemical characteristics may have changed with time and contributed to reduced 2010 yields by decreasing N availability. It is known that soil aging increases the number of negative charged sites on biochar, which increases its capacity to bind and act as a sink for NH_4-N. Furthermore, the 2010 season was unique because 1) crop residue was from corn (relatively low C:N ratio) and not a previous barley crop (relatively high C:N ratio) as in 2009, and 2) soil temperatures in 2010 were substantially less than those of other years (Fig. 3a). These two factors combined to inhibit nitrification in soils, which caused an increase soil NH_4-N concentrations relative to NO_3-N in late summer 2010 compared to earlier times (Fig. 3b and 3c). We hypothesize that this predominance of NH_4-N in soil, combined with biochar's increased capacity to sequester NH_4-N in 2010, led to a shortage of available inorganic N for crop uptake.

While the biochar-only treatment demonstrated a potential to minimize CO_2-C and N_2O-N gas emissions in these calcareous soils, biochar also caused decreased corn yields under certain soil nutrient conditions. If farmers wish to apply biochar to these soils, combining it with manure appears to be an effective method of utilizing these soil amendments as it eliminated potential yield reductions from biochar and maximized net N mineralization potential of the added manure.

REFERENCES

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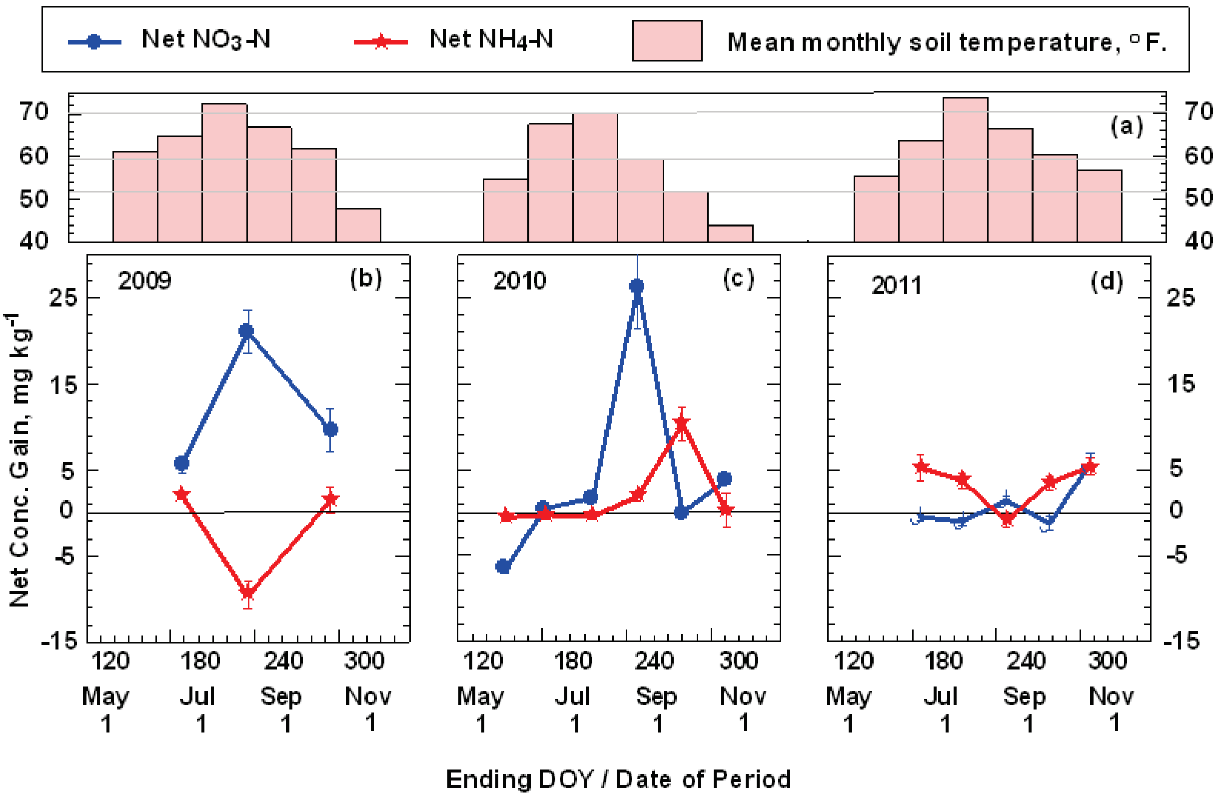

Figure 3. Shown are the overall average gains in soil NO_3-N and NH_4-N in 0-to-12-in buried bags for 2009 (b), 2010 (c), and 2011 (d) measurement periods, following a one-time manure/biochar application in fall 2008. Relatively cool mean monthly soil temperatures at 3-in depth in the late-2010 and early-2011 growing seasons (a) coincided with a rise in the dominance of soil NH_4-N (c, d).