Increased carbon dioxide in atmosphere linked to decreased soil organic matter

March 11 2008

A recent study at the University of Illinois created a bit of a mystery for soil scientist Michelle Wander – increased carbon dioxide in the atmosphere was expected to increase plant growth, increase plant biomass and ultimately beef up the organic matter in the soil -- but it didn't. What researchers found instead was that organic matter decay increased along with residue inputs when carbon dioxide levels were increased and they think the accelerated decay was due to increased moisture in the soil.

"Going into the study, the assumption was that higher levels of carbon dioxide in the atmosphere will increase crop yield and soil organic matter," said Wander. "We did see a 30 percent increase in above- and below- ground soybean biomass so we expected that to be mirrored in soil organic matter, but there wasn't an increase. In fact, organic matter levels may have even been lower than in plots not exposed to elevated carbon dioxide levels."

The study was conducted at U of I's SoyFACE facility – an open air laboratory in which rings of pipes surround corn and soybean crops and can be exposed to various levels of carbon dioxide, ozone or both pumped through the pipes. The findings from the study are published in the February issue of *Plant and Soil*.

"My student Adriane Peralta and I were looking at younger soil organic matter that would be most influenced by today's practices and we were expecting a big change -- a 30 percent increase in soil organic matter,

reflecting the changes we saw above ground.

“The source of carbon is plant biomass, so we would expect increased yield, increased biomass, increased soil organic matter in the soil. This kind of positive feedback would be good because it could offset the increases in decay that will result from rising temperature,” said Wander. She explained that the increases in carbon dioxide levels in the atmosphere insulate the earth and contribute to global warming. Average annual air and soil temperatures are increasing while winters are getting shorter. By the end of the century, maximum daily temperatures could rise by 5 to 12 degrees Fahrenheit in winter and 5 to 20 degrees Fahrenheit in summer.

“We know that microbial activity is directly influenced by an increase in temperature if other factors, like moisture aren’t limiting their growth,” she said. “Increased decomposition of organic matter is undesirable from a soil quality and climate perspective; microbial degradation of organic stocks releases carbon and nitrogen and over the long term this reduces soil’s productivity and ability to resist erosion, plus it returns the carbon dioxide to the atmosphere.” All of this talk about using agricultural lands to mitigate climate change depends upon our ability to keep the carbon in soil reserves.

Wander said that carbon dioxide is rising every year in the atmosphere because of human use of fossil fuel and deforestation. “We attribute the higher soybean yields over the past several decades to the rising carbon dioxide levels in the Earth’s atmosphere – some attribute a 10 percent increase in soybean yields already due to this carbon dioxide fertilization effect.

“Most models or projections of the future assume the carbon dioxide fertilization effect would be a good thing for agriculture and the world’s food supply and have a benefit to soil organic matter, but more and more

we are finding things are a little more complicated. What our study shows is that in this system, rising carbon dioxide levels are not contributing to soil health after all.

“So, we had a bit of a mystery to solve. Where did the organic carbon that was added by increased plant growth go" We know for certain that soil organic matter stocks result from the balance of inputs and decay so we had to look at factors influence decomposition. Nutrient levels soil pH and available N were all high in this fertile field and so we ruled these factors out.”

Wander and Peralta suspect soil moisture plays a role. Wander points out that changes in rainfall are another important aspect of climate change and notes that we are already seeing shifts in the distribution of rainfall with increases in winter and spring rains with drier summers. Dry conditions can constrain plant growth and microbial decay rates. So, what they saw in the SoyFACE plots, was evidence of an important feedback -- where crops exposed to elevated carbon dioxide became more water use efficient. “When plants take up moisture they open their stomata -- the pores through which they transport both carbon dioxide and water and when plants satisfy their need for carbon dioxide they can close those stomata and conserve water. This appears to have happened at SoyFACE in both corn and soybean crops. So, moisture feedbacks that increased microbial activity might solve the mystery”. Wander said it’s a little tricky to project the future with these findings, because they are manipulating carbon dioxide but not rainfall in the SoyFACE test plots.

Source: University of Illinois at Urbana-Champaign

March 11) retrieved 19 April 2024 from https://phys.org/news/2008-03-carbon-dioxide-atmosphere-linked-decreased.html