

Photo by Brian Lindley



# Managing Carbon: Do You C What I C?

by Dwayne Beck

SCIENCE

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If I were to ask a class of university agronomy students, "What chemical element is taken up in the largest quantity by plants?" the response given by most of them would be: "Nitrogen." That same answer would probably also be given by most scientists and farmers. In reality the answer is carbon. Carbon, oxygen, and hydrogen constitute the vast majority of the atoms (and the mass) contained in plant dry matter. Carbon is the chemical element taken up in the largest quantity by plants.

Some of the leading books on plant nutrition (by Mengel and Kirkby; Tisdale and Nelson; or Stanley Barber) mention carbon, hydrogen, and oxygen only briefly as being essential elements. The Tisdale and Nelson book goes on to state that little or nothing can be done by man to directly impact the supply of carbon dioxide to a plant. Cook and Veseth make a similar statement in their *Wheat Health Management* publication. I believe they are wrong. I further believe that the lack of attention to carbon as a plant nutrient will be viewed as a major shortcoming of the practice of agronomy in the 20th century.



Photo by Matt Hagny

'Old land' (long history of cropping with tillage) just never produced like 'new land.' Why was that? Scientists told us it was soil organic matter supplying nutrients and storing water, so why didn't irrigation water and fertilizers fully restore the productivity? What was the mystery ingredient?

Carbon chemistry is the basis of life as we know it. The search for life on other planets begins with a search for water and carbon-containing com-

pounds. Carbon has some very unique chemical properties. In its lowest energy level it has the electron distribution of  $1s^2, 2s^2, 2p^2$ . This would lead us to believe that it would form the most stable compounds when it has a valence of +2. In fact, carbon forms its most stable compounds when it has a valence of +4 (or -4). The reason for

this lies in the promotion of one of the paired  $2s$ -level electrons to the empty  $2p$  orbital (there are two half-filled  $p$  orbitals and one that is empty). This is followed by the formation of 4 hybrid  $sp^3$  orbitals when bonding occurs. These hybrid orbitals are the basis for the tetrahedral shape that gives diamond its hardness. This property allows carbon to form rings and long chains with carbon bonded to carbon as the skeleton. Carbon forms more compounds than any other element except hydrogen. The fact that an entire field of chemistry (organic chemistry) is devoted exclusively to compounds of carbon is a testament to the importance this element holds for science.

**The introduction of European-style tillage-based farming over large expanses of formerly undisturbed lands during the late 1800s and early 1900s is a prime example of wholesale mining of stored nutrients. The "homesteaders" were searching for the stored nitrogen and other nutrients and were willing to waste organic carbon in the process.**

## Carbon in Soils

Most agronomists and farmers recognize that soils high in organic matter differ in their characteristics relative to others that have lower levels of organic matter. (That is the reason many of the grandfathers of the farmers in both the United