How Drought Affects Soil Health

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Abstract
Drought conditions during most of the growing season in Iowa can have a profound impact on soil health, just as when we have extreme wet conditions. The effect of drought can be noticed very clearly on crop performance when the lack of water availability is severe. This water stress can affect soil chemical, physical, and biological activities that are essential for plant and soil health.

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Drought conditions during most of the growing season in Iowa can have a profound impact on soil health, just as when we have extreme wet conditions. The effect of drought can be noticed very clearly on crop performance when the lack of water availability is severe. This water stress can affect soil chemical, physical, and biological activities that are essential for plant and soil health.

One of the obvious effects of drought on soil health is the lack of nutrient uptake by crops, as water is the major medium for moving nutrients into plants as a result of water uptake. The increase in soil temperature associated with lack of soil moisture has an impact on microbial activities and nutrient processing, both of which are important for plant use for biomass and grain production. Microbial activities in soil generally are controlled by soil moisture and temperature. The departure from the optimum ranges of soil moisture (water field capacity) and soil temperature (approximately 76-86°F), which varies for different microbial communities in soil, can alter microbial activity. Changes in soil temperature during drought conditions can affect soil organic matter (SOM) decomposition and increase the release of carbon dioxide. Also, during this process additional mineral N, mostly in the form of nitrate, will be released in the soil system. This change in soil environment affects the stability of SOM and subsequently, affects the soil biological system.

The most profound effect that can be experienced in cropland is the excess release of nitrate which may not be utilized by crops due to the lack of moisture available for the plant to uptake nutrients. This shift in biological and chemical processes during the growing season influences many other relationships that are essential for crop performance, quantitatively and qualitatively, by changing activities that are important to nutrient cycling such as, enzymatic activities, change in soil chemicals concentrations, etc.
Management practices to reduce drought effects
In order to moderate future drought event’s effect on soil health, several practices can be valuable to enhance soil health by improving soil physical, chemical, and biological properties:

1. Crop residue: crop residue can provide important benefits like improving soil moisture with an increase in soil water infiltration during and off-season as well as increase recharge of the sub-soil profile. The other benefit of residue is the moderation of soil temperature, where crop residue acts as an insulation layer by increasing soil surface reflectance to sun radiation (i.e., change in Albedo, the ratio of the light reflected by surface to that received by it, where residue color is lighter than soil surface). These benefits of crop residue have direct impacts on soil biological and chemical properties by reducing soil temperature and the slowdown of organic matter mineralization. The increase in soil organic matter can increase soil water storage capacity (Fig. 1). The other benefit of moisture conservation and its availability to crops during drought periods is the increase of utilization of nutrients and reduction of nutrient concentration in soil and loss during off-season rain events.

2. Cover crops: cover crops have many benefits that are critical, especially during drought conditions. The way that cover crops provide such benefits during drought conditions is based on the cumulative effects of cover crops during previous seasons, where they promote better soil biological and physical conditions. It is well documented that cover crops increased soil water infiltration and recharge of the soil profile by improving soil aggregate stability and soil porosity. Furthermore, cover crops contribute to the increase of the soil organic matter pool, which is essential for building soil health.

3. Balanced crop rotation: crop rotation and diversity of crops within one year or over several years is one of the most important practices that enhance soil health and mitigate drought conditions during the growing season. The diversity of crops on the land can provide a rich soil environment for a healthy and diverse biological system. The inclusion of different crops such corn, soybean, alfalfa, small grain, etc., provides diversity of root systems that promote a wide range of microbial community, therefore enhancing soil nutrient and organic matter pools as compared to a mono-cropping system (i.e., continuous corn).

These practices, in addition to organic amendments, are important in mitigating unexpected drought conditions in the long-term. These practices, along with minimum or no-tillage, can reduce the prolonged impact of drought events by increasing soil resiliency. The degree at which soils in Iowa and the Midwest have absorbed the dramatic impact of drought events was due to the rich soil organic matter content. Factors which contributed to that are the temperate climate and vegetation base (i.e., prairie), which encourage greater organic matter accumulation. This unique soil quality provides high water storage
capacity that sustains crop production. So, to sustain such soil quality, we need to maintain it through the implementation of soil health principles by adopting conservation systems.

![Graph showing the increase in soil moisture storage capacity with increase in soil organic carbon in 10 years tillage and crop rotation study (Al-Kaisi et al., 2014).](image)

**Figure 1.** Increase in soil moisture storage capacity with increase in soil organic carbon in 10 years tillage and crop rotation study (Al-Kaisi et al., 2014).

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**Category:** Soils
Mahdi Al-Kaisi is a professor of agronomy and extension soil and water specialist at Iowa State University. His current research and extension in soil management and environment focuses on the effects of crop rotation, tillage systems, residue management, and nitrogen input on soil carbon dynamic...