What drought and fire do to your dirt

by Meryl Rygg McKenna
with Certified Crop Advisers

Farmers and ranchers sometimes call themselves “next-year” people, always hoping for better results next season. For many, the severe conditions of 2017 beg a better sequel.

A December 2017 drought monitor map showed much of Montana in moderate to severe drought, although Montana’s northwestern corner improved since early November. According to the National Interagency Fire Center, Montana’s 2017 wildfire season resulted in more than 1.25 million acres of forest, rangeland and cropland burned. Drought or fire can have significant impacts on soil health, affecting soil’s ability to receive, soak up and retain moisture, among other things.

Soil nutrient testing to make better management decisions is essential after a fire or during a drought, said Mike Choriki, Certified Crop Adviser (CCA) from Billings. While the main concerns after a bad range-fire or forest-fire season are erosion and weed control, fertility management comes first on cropland and is the main focus of this article.

Nutrients: Up in smoke?

The impact of fire depends on its intensity, duration and the proportion of plant material that is burned. In general, fast-moving grass fires have little effect on soil health and nutrients, due to the lower temperature of the soil surface compared to slow, smoldering hotter fires in moderate to heavy fuels.

Most nutrients stay behind after a fast-moving fire because they are not converted to gasses until they reach temperatures hotter than the soil’s surface, said Clain Jones, chair of the Rocky Mountain Certified Crop Adviser program and Montana State University’s Soil Fertility Extension Specialist.

“Fast-moving fires convert nutrients in branches, bark, stubble, grass, etc., into more usable forms because they’re hot enough to burn the carbon in these materials but not hot enough to combust most plant nutrients. This leaves phosphorus (P), potassium (K) and sulfur (S) more available,” Jones explained.

Nutrients such as magnesium, zinc and manganese are also quite stable. They are not lost directly through combustion, but rather through blowing ash and post-fire soil erosion.

Forest and shrubland fires, however, will likely reduce the organic matter at the soil surface because temperatures there will combust soil organic matter. While these intensely hot fires can send some surface nutrients into the air, nutrients more than an inch down in the soil are not as likely to be lost.

Organic nitrogen (N) may or may not go up in smoke, depending on the temperatures involved. The effect of nitrogen being released from plant material burned quickly (with lower surface temperatures) shows clearly in the vibrant green of the first grass following a fast-moving fire.

Nitrogen is extremely mobile and can be lost through leaching or surface runoff when few living plant roots are present to use it. Little surface residue means N can be lost through erosion, as well. Loss of N can have a long-term impact on productivity of forest and rangeland, but is more easily managed on cropland.

Jones strongly recommends soil sampling to determine nitrogen levels after a burn, since fire's effect on nitrogen levels is so unpredictable.

Fire effects on soil properties

While cropland or grassland fires rarely burn hot enough to affect organic matter down in the soil, the loss of surface plant residue is of significant concern. Plant residue reduces erosion and protects the soil's surface from being physically damaged by the impact of raindrops.

Ash particles also plug soil pores, preventing water from soaking in and increasing the risk of water runoff or soil erosion. Soil aeration, the infiltration and retention of water, and the soil's ability to hold nutrients coming from ash or fertilizer are reduced.

Fire can create a water repellent layer in the top 2 inches of forest and shrubland soil, due to waxy compounds in the burned litter that coat soil aggregates and minerals. Soil aggregates are groups of soil particles that bind strongly to each other. The water repellent layer varies in depth and thickness and can affect the soil's ability to take in water for months or years. Stubble fires should not cause a repellent layer unless surface residues were heavy.

Fire kills bacteria and fungi at the soil surface, but healthy microbes will recolonize from deeper soil layers. With deeper sterilization, the microbes require more recovery time. They also need new plant material to help sustain their population.

After a fire, it is best to establish ground cover where possible to reduce weeds and erosion from wind and water, spread manure if available, and soil test for N, P and K. For soil samples, avoid areas that had high amounts of plant residue, such as from bales or windrows.

Managing effects of drought

"During drought periods, our level of management and use of technology and knowledge is more important than in wet years," Choriki said. "Many producers cut back fertilizer rates during dry years, resulting in decreased yield and quality. The crop's quality, however, is what determines its value."

Specific nutrient guidelines include:

Phosphorus: Use the same amount of P in dry years as in normal years. It increases root growth and the rate of photosynthesis, and helps roots take up water efficiently.

Potassium: Fertilize with the same amount of K in wet and dry years; it can prevent wilting.

Nitrogen: Add less N during dry years, based on yield potential and soil testing.

After a dry year with low harvest, like much of eastern Montana experienced, the soil likely holds more residual nutrients not used by plants this year. Again, test N, P and K in the spring.

Prolonged drought calls for long-term management plans on rangeland. Grazing duration, frequency and timing are important factors. Choriki also recommended considering annual forages for temporary pasture.

For more information specific to your conditions, contact a Certified Crop Adviser near you, http://www.certifiedcropadviser.org.