



**ADVANCES IN
FOREST FIRE
RESEARCH**

DOMINGOS XAVIER VIEGAS

EDITOR

2014

Post fire erosion control mulch effects on soil organic matter turnover

Erin Berryman^a, Deborah Page-Dumroese^b, Martin Jurgensen^c, Peter Robichaud^d

^a *Research Ecologist, USGS Geosciences and Environmental Change Science Center, Lakewood, Colorado, USA. eberryman@usgs.gov*

^b *US Forest Service Rocky Mountain Research Station, Moscow, Idaho, USA, ddumroese@fs.fed.us*

^c *Michigan Technological University, School of Forest Resources and Environmental Sciences, Houghton, Michigan, USA, mjfurgen@mtu.edu*

^d *US Forest Service Rocky Mountain Research Station, Moscow, Idaho, USA, probichaud@fs.fed.us*

Keywords: *wheat straw, wood strands, decomposition, aerial mulching, rehabilitation*

Extended Abstract

1. Introduction

An increasingly common post fire rehabilitation practice is the aerial application of mulch or hydromulch to the soil surface, with the goal of reducing post fire erosion. Mulch has the potential to alter soil organic matter cycling compared to areas that are allowed to naturally recover following high-severity wildfire. Following wildfire, soil surfaces are exposed to higher amounts of solar radiation and have low albedo; surface mulch can increase surface albedo and may decrease soil temperature in the summertime. In addition, mulch may alter soil moisture patterns by providing to a barrier to both surface water inputs and surface moisture evaporation. These alterations in temperature and moisture may have important impacts for soil microbial activity responsible for processing soil organic matter left behind following a wildfire. In addition, mulch provides a carbon substrate for soil microorganisms with little nitrogen to support its metabolism. As a result, mulch may induce net N immobilization with potential feedbacks to soil organic matter processing. These changes to the soil physical and chemical environment can alter soil organic matter turnover rates with important implications for soil productivity during post fire recovery.

2. Methods

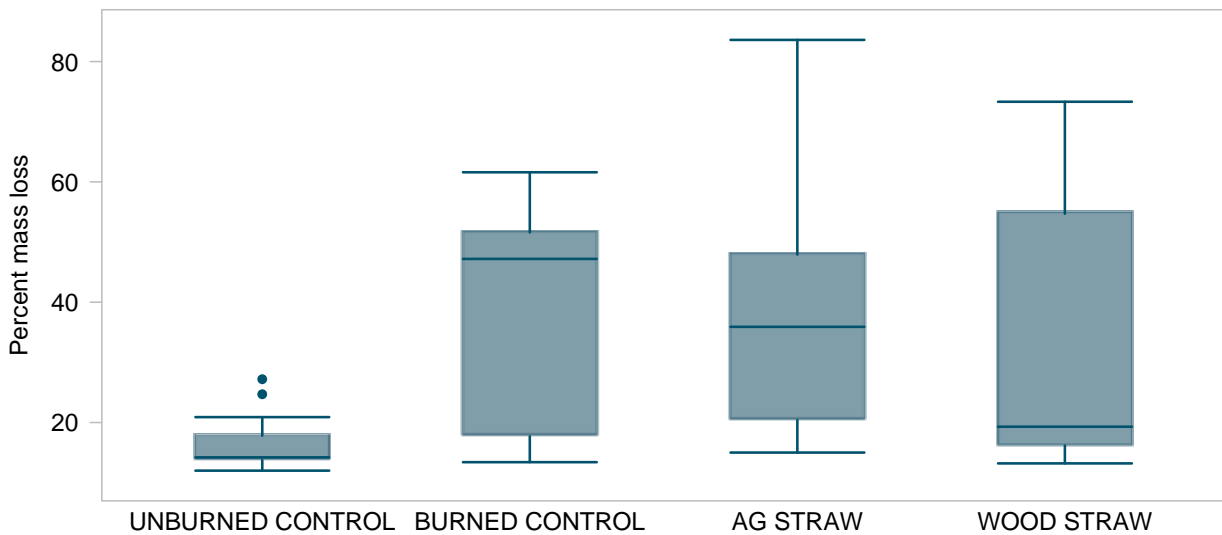
We monitored changes in soil organic matter turnover resulting from aerial mulching practices on two large fires in the western United States: the 2002 Hayman Fire in the Rocky Mountains of Colorado and the 2005 School Fire in the Blue Mountains of eastern Washington and Oregon. Plots were established within hillsides treated with agricultural straw, hydromulch, wood strands, contour felling (Hayman Fire only), and unmulched areas in both burned and unburned areas. To supplement this monitoring, a controlled experiment was established on the 2012 High Park Fire in the Rocky Mountains of Colorado to determine effects of different mulch application rates on soil organic matter turnover. Plots contained two application rates each of agricultural straw and wood strands.

2.1. Soil organic matter turnover and soil environment

In two subplots per treatment, soil organic matter turnover was measured by monitoring changes in mass loss of buried wooden stakes over time. Control over organic matter quality was achieved by using the same organic material among sites and treatments, which assures comparison of decomposition as a function of treatment-induced abiotic and biotic soil conditions. Wood is a major component for surface and mineral forest soil, and has a slow decomposition rate that integrates changes in soil conditions over a long period of time. Wood is also an important factor after burning since wood is often left within the soil profile or on the surface. Aspen (*Populus tremuloides*) and pine

(*Pinus taeda*) stakes (dim: 2.5 x 2.5 x 30 cm) were buried vertically to a depth of 30 cm in the mineral soil, buried between the mulch and soil interface, and secured on top of the mulch surface. Each year, five replicate stakes from each fire, treatment and position were retrieved, dried, weighed for mass loss determination, and measured for loss in tensile strength. Soil temperature was monitored at all three sites. At the High Park Fire controlled experiment, soil moisture at two depths (5 cm and 20 cm) was also continuously monitored.

School Fire - 4 years post fire



Hayman Fire - 4 years post fire

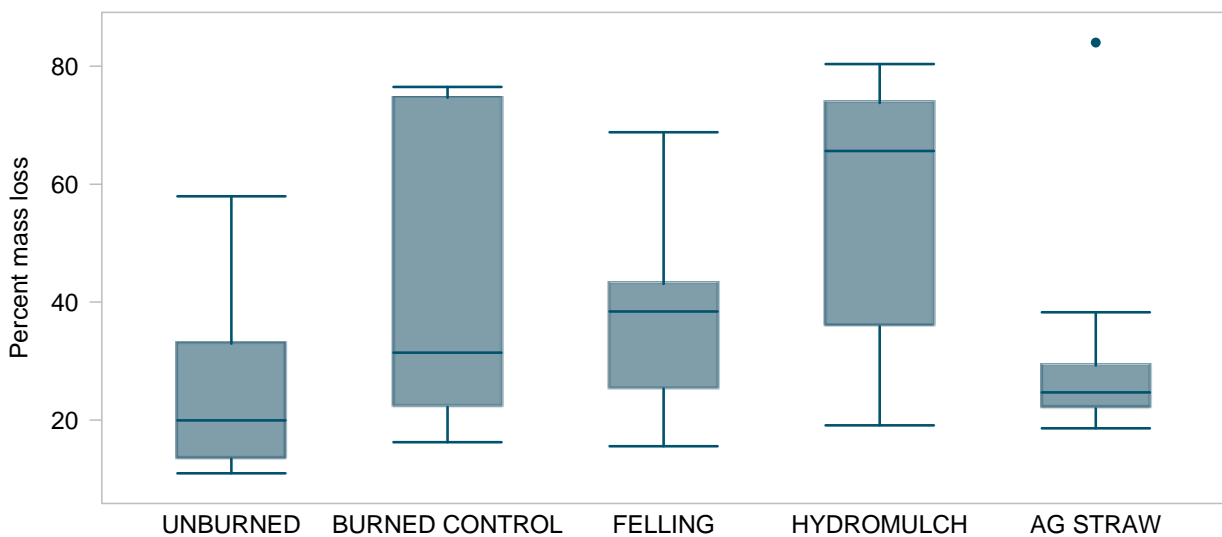


Figure 1. Mass loss from wood stakes four years following fire and mulch application at the School Fire (top) and Hayman Fire (bottom).

3. Results

Four years following fire, stake decomposition was increased in burned soil compared to unburned soil at both the Hayman and the School Fire (Figure 1). Following wildfire, char on the soil surface

decreases albedo and increases solar radiation absorption, which leads to temperature increases. Temperature is a key control over biological and chemical reactions involved in soil organic matter processing. In addition, wildfire often leads to an increase in soluble nitrogen to the soil; such nitrogen may allow for increased metabolism of carbon in the decomposition stages by soil microorganisms.

Four years following application, mulch had little effect on stake decomposition at both the School Fire and the Hayman Fire (Figure 1). Initial differences in treatment, such as increased stake decomposition underneath hydromulch in the first year, disappeared later in the trajectory, leading to no differences among treatment seven years after mulch applications.

On the School Fire, wheat straw led to increased stake decomposition compared to the Hayman Fire. This may have been due to differences in climate, vegetation or soil texture between the two sites. The controlled experiment at the High Park Fire provided insight to mulch effects on soil organic matter turnover. Mulch increased summer time soil moisture, with the greatest effects seen at the 20 cm depth.

4. Conclusions

These findings support the idea that fire enhances soil organic matter turnover, at least in the first several years post burn. In addition, we have demonstrated that mulch applications may alter the initial stages of soil organic matter turnover, but with little long-term effects beyond the first few years. The Hayman Fire and the School Fire data have important limitations, however, due to the unreplicated nature of the hillside-scale mulch applications. The controlled experiments at the High Park Fire allowed a more robust test of mulch application on soil processes, suggesting that these initial effects on stake decomposition are derived from an altered soil environment. It remains unknown whether these initial mulch effects on soil organic matter turnover establish a unique plant response trajectory compared to unmulched areas. More replicated mulching studies are needed, covering a range of soil textures and climates, that explicitly monitor soil processes important for organic matter turnover and soil productivity and tie these to plant responses.