Effects of Hydromulch on Post-Fire Seed Germination

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Abstract

One of Southern California's latest fires occurred on May 8, 2007 at Griffith Park, the largest municipal park in the United States located in Los Angeles. In order to increase slope stability and protect homes, the city aerially applied hydromulch to over half of the burned area. However, the effectiveness of hydromulch as a slope stabilizer and its potential effects on post-fire vegetation are not well known. We used two experiments, one in the field and one in plant containers, to determine whether or not hydromulch had any significant negative effects on post-fire chaparral vegetation recovery. In the field experiment, there were no significant differences in plant density between our study areas with hydromulch compared to areas without hydromulch. The second seeding experiment showed growth underneath the hydromulch, from which can be concluded that enough sunlight is available underneath hydromulch to support plant growth. Thus, the insignificant differences between vegetation growth and density in hydomulched and non-hydromulched for both experiments indicated that the application of hydromulch might not be as detrimental towards vegetation germination as previously hypothesized.

Keywords

chaparral, fire, post-fire vegetation recovery, hydromulch, post-fire management

Introduction

Chaparral is a vegetation type primarily found in Mediterranean climates such as California's mountains and foothills. Composed mainly of evergreen hardy shrubs, chaparral is coadapted to drought and fire and therefore able to survive long, dry, hot summers and blazing fires. In some cases, shrub seeds require fire in order to germinate. Other fire adaptations include an underground root system, or burl, which survives after a fire and allows the plant to resprout. According to Quinn and others (2006), California fire frequency ranges from 5-40 years.

Some of California's oldest chaparral habitats consist of Toyon, Laurel Sumac and Lemonadeberry can be found in Griffith Park, Los Angeles. Griffith Park is situated in the eastern Santa Monica Mountains with an elevation ranging from 354 to 1,625 feet above sea level. Griffith's latest fire occurred on May 8, 2007 burning 817 acres northeast of the Griffith Observatory destroying Dante's Peak and the bird sanctuary. In attempt to create some slope stability to prevent landslides and debris flows, hydromulch was aerially applied to over 479 acres of burned area throughout late October 2007. As stated by the City of Los Angeles, Department of Parks and Recreation (2007), "hydromulch forms a protective topcoat that shields the topsoil from rain's erosive forces of falling rain, preventing soil erosion and damage to public and private property during heavy rainstorms that may carry the soil and other debris down into local neighborhoods and down local streets." The hydromulch consisted of wood and vegetative fibers mixed with organic gum tackifier and contained no seeds.

The use of hydromulch first began in the United States around 1950 for agricultural purposes to increase seed or fertilizer distribution efficiency. Composed mainly of vegetative fibers such as wood chips or cotton fibers mixed with water, organic glue, and coloring, hydromulch was meant to maintain the moisture level of the seed and seedlings to promote germination and prevent soil erosion. Hydromulch is typically transported in a tank on a truck or trailer and sprayed over the area with a hose. At Griffith, the hydromulch was applied aerially because of its large area, lack of roads, and steep slopes.

Today, hydromulch is still mainly used for agriculture. Unfortunately, there have been limited studies on the effectiveness of hydromulch in post-fire slope stabilization and the effects of hydromulch on natural post-fire vegetation germination and resprouting. According to Keeley and others (2006) in an article in the Journal of Forestry, hydroseeding, i.e. hydromulch that contains seeds, is ineffective since it does not prevent the erosion of dry rocks and soil immediately after a fire or the seeds are easily washed away in short and intense storms common in Southern California. Although this article refers to hydroseeds that are meant to germinate to create slope stability, the mulch itself, similar to the type applied to Griffith, is still subject to wash away during intense storms in various areas.

A study done by MacDonald and Robichaud (2007) compared the effectiveness of various treatments. They concluded that aerially applied hydromulch was effective in reducing sediment yield by creating immediate cover to decrease water drop impact. MacDonald and Robichaud also found that aerial hydromulch reduced sediment production rates by more than 90% from the time of initial application in the summer of 2002 to the summer of 2003 and 50-77% in the summer of 2004. By the summer of 2005, the hydromulch had deteriorated with no significant difference between treated and control sites.

In another study conducted by Hubbert (2004) on the 2003 Cedar Fire in San Diego, he found that in most cases, aerial hydromulch did not affect 1st or 2nd year percentage vegetation cover in both gabbro and granitic parent material. However, the lowest percentage plant recovery was found in areas with possible over application of hydromulch, one to two inches thick. Hubbert also found that the hydromulch was effective in reducing erosion during mild rains in both granitic and gabbro parent materials during the first year, but disappeared after heavy winter rains during the second year. Looking at individual species response, Hubbert's data suggested that the resprouting of Chamise might be inhibited by the mulch treatments, whereas Scrub Oak might have benefited from the moisture stored at the surface.

Additionally, Urroz (1996) at Utah State University compared the effectiveness of hydromulch and erosion-control blankets. He stated that hydromulch has the ability to absorb water, which is effective in reducing run-off. However, hydromulched areas allowed the largest percentage of seed loss since seeds on top of the hydromulch are easily carried off by flowing water. Urroz also remarked that the organic glue or tackifier binds the mulch to create a continuous and resistant cover to protect the soil against wind and water erosion.

The purpose of the study was to test our hypothesis that the density of the hydromulch significantly impedes or interferes with post-fire seed germination by limiting sunlight penetration.

Methods

Study Site

Our study was primarily conducted in the Cadman watershed located in the Southeast corner of the park as shown in Figures 1 and 2. The experiment plots were located in the mid-to-lower portion of the hillsides on south-facing slopes. The study sites were selected in areas where the application of hydromulch appeared in highest concentrations, in accordance with our hypothesis that densely treated areas produce lower germination or resprouting results. The sites were also situated in areas isolated from normal pedestrian traffic along trails.

Procedures

Our project used two experimental approaches, one in the field and one in contained seeding pots to examine whether or not a compact layer of hydromulch interferes with natural post-fire vegetation succession. The first experiment used thirty 1m x1m square plots or windows. Ten plots were established as experimental plots, and the remaining twenty as control plots.

- Ten experimental plots were assembled using four 1x2x12" wooden stakes, and orange-colored flagging tape
- The surface layer of hydromulch was removed from each of the ten plots, creating 1m x 1m "windows" of bare soil
- Each plot was labeled using large plastic T-labels and photographed
- Two control plots for each experimental plot, were identified by applying blue spray paint onto the hydromulch surface, outlining a 1m x 1m square area
- Bi-monthly observations were made at each site, for a total of thirty individual sites
- Data was recorded based on number of plants present in plots
- Photographs were taken during each visit

The second experiment consisted of 20 eight ounce plant pots with soil and hydromulch from each of the ten sites. Ten of the pots contained a layer of hydromulch to serve as experimental pots while the uncovered pots were used as controls. The purpose of the second experiment was to investigate whether or not an adequate amount of sunlight is available under the hydromulch to support plant growth.

- Soil and hydromulch from each of the ten control plots were collected in small plastic bags
- The soil was then transferred to 20 eight ounce plant pots
- Five to seven grass seeds were planted in all 20 pots
- A layer of hydromulch was placed on top of ten pots from each field site so that every field site has one control and one experimental pot
- All pots were watered every three to four days
- Data was recorded based on the average height of the grass blades per pot

Results

No vegetation was present in any of the ten experimental field plots or windows and two plants, one Laurel Sumac and one Queen Anne's Lace, developed in control window numbers six and ten. As for the 20 container pots, six out of the ten non-hydromulched pots and five out of the ten hydromulched pots both displayed growth as shown in Table 1 and Figure 3. The growth per container was calculated based on the average height of each individual grass blade three weeks after seeding. Non-hydromulched vegetation heights experienced an average increase of 0.33 cm above hydromulched pots. The standard deviation was calculated to be 0.564 cm and 0.779 cm for hydromulched and non-hydromulched pots, respectively.

To determine whether the differences in average height were significant we used the two-sample t-test for comparing two means (one-tailed). Our calculations are as follows:

Number of pots, $N_1=N_2=10$
Degree of Freedom (DF) = $n_1 - 1$ or $n_2 - 1$ (whichever is the smaller of the two)
DF= 10-1 = 9
Probability of rejecting statistical hypothesis tested, $\alpha = .05$
Critical value = $t_{.05,9} = 1.833$

$$t = \frac{x_1 - x_2 - \Delta}{\sqrt{\frac{s^2_2}{n_1} + \frac{s^2_2}{n_2}}}$$

$$t = \frac{.8455 - .5155 - 0}{\sqrt{\frac{(.77882)^2}{10} + \frac{(.56358)^2}{10}}} = 1.0855$$

The computed t of 1.0855 is below the critical value of 1.833, so the null hypothesis cannot be rejected. The test has provided evidence that removed hydromulch was not statistically significant in benefiting plant growth.

Discussions

Summary and Discussion of Results

One of the most important and surprising findings from our study was that there were no statistically significant differences between hydromulched and non-hydromulched areas for both field and seeding experiments. We expected at least some growth, especially in the plots where we had removed hydromulch. However, as the vegetation recovered in the hydromulched burned areas, many plants sprouted near or around our plot window, but never inside. Additionally, some germination occurred in our control plots, which were outlined by spray paint. These results were highly unusual to us since we expected minimal growth in heavy hydromulched areas and increased growth in our exposed plots.

As for our seeding experiment, the results were less surprising and followed our basic expectations. There was initial growth in pots with and without hydromulch. The results after 3 weeks showed the average growth in non-hydromulched pots was 0.33cm above hydromulch covered pots. However, the statistic test rendered there results insignificant.

Therefore, we cannot say with confidence that the hydromulch significantly impeded growth. Furthermore, we realize that the grass seed germination in a controlled environment cannot be directly compared to post-fire chaparral vegetation. In spite of this, growth underneath the hydromulch demonstrates that there is an adequate amount of sunlight available on the underside of the hydromulch to support the growth of grass blades.

Limitations

Our project faced various limitation including location accessibility and time constraints. For instance, locating experimental areas for our plots with slope and vegetation diversity proved difficult, due to the steepness of the slopes. We also struggled to not disturb the area around us, but there was no alternative if we wanted to set up our plots. Our shoes and equipment could have tracked seeds from other areas to the surrounding hydromulched areas. Furthermore, seeds might have been attached to the underside of the hydromulch we removed. Unfortunately, there was no way for us to know or to test this theory. However, with the assumption that seeds were present and attached to the underside of the hydromulch, we might have also been removing seeds for the plot areas, which can help explain why there were no results in our plots.

Plots were also not completely randomly selected. We chose areas that seemed to have the highest concentration of hydromulch. However, since vegetation was presented in densely hydromulched areas near or around our plots, this rejects the notion that densely treated areas impeded growth. In our opinions, densely treated areas might have impeded the growth of certain species such as Black Mustard or Castor Bean. However, these are annual plants that perish after flowering. Thus, the hydromulch may have not significantly affected permanent, woody, chaparral vegetation such as Laurel Sumac, Toyon, or Lemonadeberry.

Management Implications

Based on our results and additional findings from other research such as Hubbert (2004 and 2005), MacDonald and Robichaud (2007), Robichaud and others (2006) and Urroz (1996), hydromulch has no significant detrimental affects on post-fire vegetation recovery, especially one to three years after initial application when most if not all of the hydromulch has naturally degraded. Although our experiment did not test for the effectiveness of hydromulch as a slope stabilizer, past research has supported this claim that the application of hydromulch does help increase slope stability one year after initial application. Combined with our results that hydromulch does not significantly impede vegetation development and allows adequate amounts of sunlight penetration for seed germination, we consider that hydromulch is a good approach for post-fire slope stabilization.

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Figures

Figure 1 Aerial view of Griffith Park after the fire. Our plots are primarily located on the southeast corner of the park, known as the Cadman watershed.
Image obtained from GoogleEarth on June 1, 2008

Figure 2 Zoomed in image of the location of our field sites. Image obtained on GoogleEarth on June 1, 2008

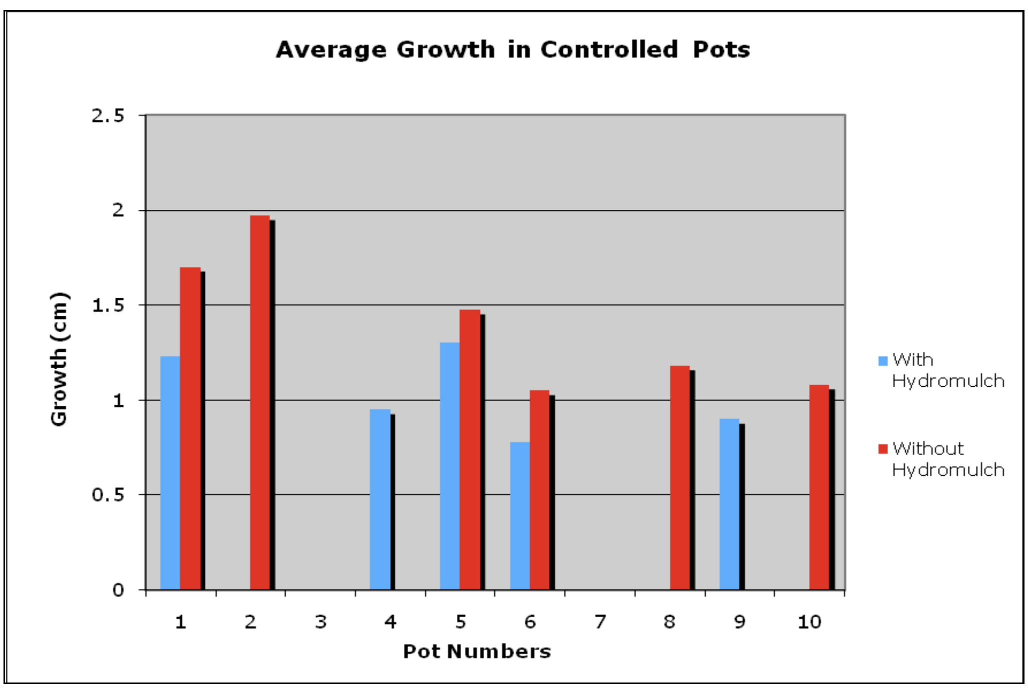

Figure 3 Average growth in centimenters per pot, three weeks after seeding

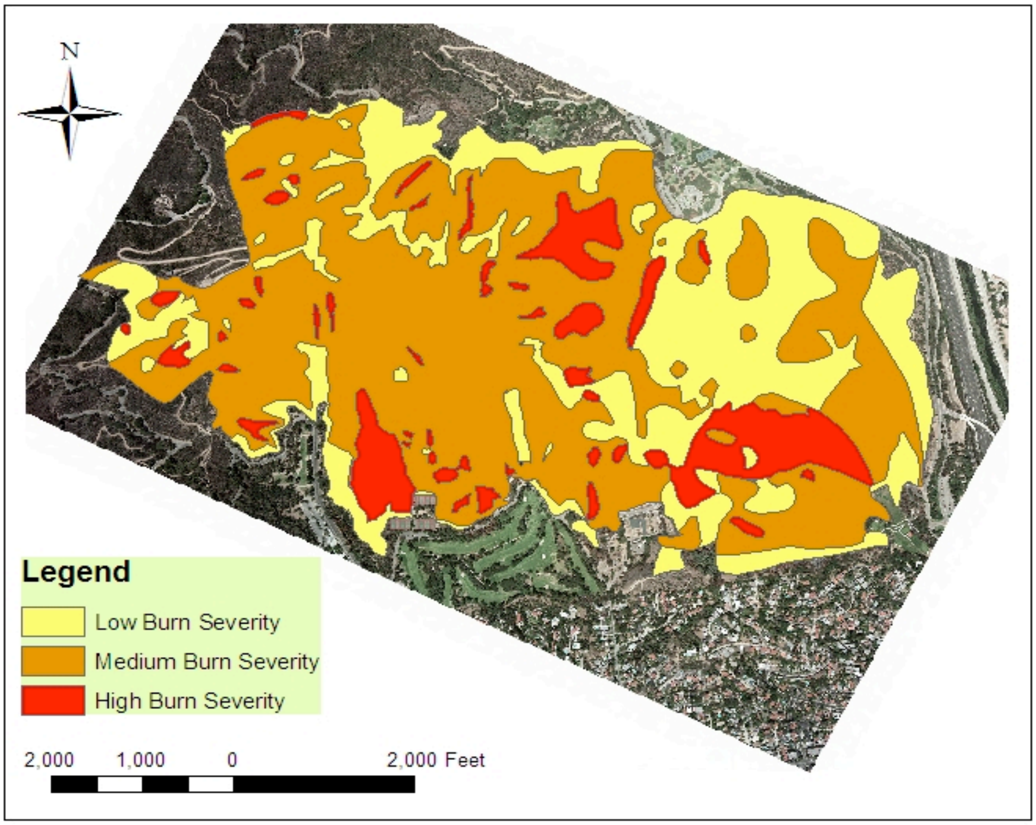

Figure 4 Griffith fire burn severity
Data obtained from eroom access website on May 21, 2008

Tables

Pot Number	W/Hydromulch (centimeters)	W/O Hydromulch (centimeters)
1	1.23	1.7
2	0	1.97
3	0	0
4	0.95	0
5	1.3	1.475
6	0.775	1.05
7	0	0
8	0	1.18
9	0.9	0
10	0	1.08
Average	0.5155	0.8455
Std Dev	0.56358	0.77882

Table 1 Chart of average growth in centimeters per seeding pot.