Water Repellency of Soils under Burned Sagebrush

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Highlight: Burning of sagebrush produces water repellency in soils. Maximum repellency occurs at soil temperatures between 1400 and 1800°F. The field test indicated that repellency is produced as a result of the burning of the sagebrush leaf mulch under the shrub rather than the burning of the live plant material.

DeBano (1969) defined water repellency in terms of the time required for a drop of water to be absorbed by the soil. If a water droplet fails to penetrate within 5 seconds, the soil is classified as being water repellent.

Foggin & DeBano (1971) have discussed the nature of water repellency in some detail. According to these authors, water repellency is caused by an organic coating on the soil particles. The chemical nature of this organic coating is still unidentified. These authors go on to state that factors affecting water repellency include "...the composition of the micro-organic community, the nature of the vegetation, physical characteristics of the soil, and the fire history of the area."

During the course of studies by the Montana Agricultural Experiment Station on sagebrush control, it was noted that the soils immediately under burned sagebrush plants remained bare for 3 years or more. This phenomenon has been observed in several other sagebrush burns. Water repellency was suspected. Two limited studies to test water repellency following burning were conducted.

Test I

This test was conducted in the laboratory. One set of soil samples was collected from under large, mature sagebrush plants. The mulch overlying these soil samples was discarded. A second set of soil samples was collected from immediately adjacent areas not having a sagebrush mulch. All samples were from the 0-3 inch layer of the soil profile. The texture was sandy loam. All soil samples were tested for water repellency by applying a drop of distilled water on the soil surface and timing absorption. No water repellency was exhibited by any of the samples.

The samples were divided into eight groups, each group with three samples to be heated without a mulch cover and three samples to be heated with a mulch cover of about 1 inch of leaves and small twigs taken from live sagebrush plants. Each group was heated for 15 minutes in a muffle furnace at one of the following temperatures: 600, 900, 1200, 1300, 1400, 1500, 1800, and 2100°F.

The heated samples were cooled for 15 minutes. Those with mulch were then thoroughly mixed. Repellencies again were tested with distilled water drops. Results are shown in Table 1.

No water repellency was exhibited in soils heated without sagebrush mulch. Heat alone, then, apparently is not a factor in developing water repellent soils. Adequate organic matter also must be present.

Temperatures of 600 and 900°F did not produce repellency in soils with sagebrush mulch. The mulched soils heated at 1200 and 1300°F exhibited repellency averaging about 5 seconds or borderline repellency based on DeBano's (1969) classification. Mulched soils heated at 1400 and 1500°F showed increasing repellency, with samples heated at 1500°F having about five times the repellency of those heated at 1200°F.

The soils heated at 1800°F had reduced repellency; at 2100°F there was no repellency at all.

Table 1. Water repellency1 of soils heated with and without sagebrush mulch in the laboratory.

<table>
<thead>
<tr>
<th>Temperature (°F)</th>
<th>With Mulch2</th>
<th>Without mulch</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 (316°C)</td>
<td>0.0 d</td>
<td>0</td>
</tr>
<tr>
<td>900 (428°C)</td>
<td>0.0 d</td>
<td>0</td>
</tr>
<tr>
<td>1200 (649°C)</td>
<td>4.3 c</td>
<td>0</td>
</tr>
<tr>
<td>1300 (704°C)</td>
<td>5.0 c</td>
<td>0</td>
</tr>
<tr>
<td>1400 (760°C)</td>
<td>10.0 b</td>
<td>0</td>
</tr>
<tr>
<td>1500 (816°C)</td>
<td>25.0 a</td>
<td>0</td>
</tr>
<tr>
<td>1800 (982°C)</td>
<td>6.0 bc</td>
<td>0</td>
</tr>
<tr>
<td>2100 (1149°C)</td>
<td>0.0 d</td>
<td>0</td>
</tr>
</tbody>
</table>

1Time in seconds required for a drop of distilled water to be absorbed by the soil sample.
2Means with one or more letters in common are not significantly different, according to Duncan's Multiple Range Test, at 0.05 level.

Table 2. Water repellency1 of soils under sagebrush plants burned with and without natural residual sagebrush mulch.

<table>
<thead>
<tr>
<th>Soil depths (inches)</th>
<th>With mulch2</th>
<th>Without mulch</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>40.0 a</td>
<td>0</td>
</tr>
<tr>
<td>1-2</td>
<td>18.0 b</td>
<td>0</td>
</tr>
<tr>
<td>2-3</td>
<td>1.3 c</td>
<td>0</td>
</tr>
</tbody>
</table>

1Time in seconds required for a drop of distilled water to be absorbed by the soil sample.
2Means with one or more letters in common are not significantly different, according to Duncan's Multiple Range Test, at 0.05 level.

Discussion

Clear evidence is presented that the burning of sagebrush produces water repellency in soils. Maximum repellency occurs at soil temperatures between 1400 and 1800°F. The field test indicated that repellency is produced as a result of the burning of the sagebrush leaf mulch under the shrub rather than the burning of the live plant material.

From a practical standpoint, it appears that burning sagebrush while the soil and

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Fire in Medium Fuels of West Texas

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Highlight: Chained and unchained mesquite in medium fuels were burned to measure the effect of prescribed burning on noxious brush species and on the production and utilization of major forage species. The fire did not kill any living mesquite trees. Very few standing dead mesquite stems burned down. Chained mesquite stems were easily consumed by fire with 2,000 lb/acre of fine fuel. Pricklypear and cholla mortality exceeded 50% by the end of the second growing season. Burning greatly increased production and utilization of tobosa grass; production of buffalograss was unaffected. Most annual forbs were harmed by burning.

Fire has the potential to burn down and kill honey mesquite (Prosopis glandulosa var. glandulosa) in heavy fuel types (4,000 to 7,000 lb/acre) in west Texas (Britton and Wright, 1971), but knowledge concerning the effects of fire in light to moderate fuels (1,000 to 4,000 lb/acre of fine fuel) is lacking. This study was designed to measure: 1) the effect of planned burning on the mortality of mesquite, cholla (Opuntia imbricata), and pricklypear (Opuntia phaeacantha); 2) the burndown of standing mesquite trees previously top-killed by aerial spraying; 3) the percent consumption by fire of mesquite logs previously chained; 4) the effects of burning on the composition and production of a High Plains grass community; and 5) the utilization of tobosa (Hilaria mutica) and buffalograss (Buchloe dactyloides) in burned and unburned plant communities.

Mesquite trees are relatively tolerant of fires, although some usually die after fires, especially if they are young (Glendening and Paulsen, 1955; Cable, 1961). Glendening and Paulsen (1955) reported that summer fires killed 52% of the young velvet mesquite (Prosopis velutina) that were 0.5 inches or less in basal stem diameter. However, after mesquite trees develop beyond the "young" stage, they are very difficult to kill. Only 8 to 15% of the velvet mesquite trees larger than 0.5 inches are killed by summer fires, although the percentage of those top-killed varies from 62 to 99% (Glendening and Paulsen, 1955). If the trees have been top-killed before burning, mortality of honey mesquite has varied from 0 to 32% after the first growing season (Stinson and Wright, 1969; Britton and Wright, 1971).

Cleaning up dead brush is another asset from prescribed burning. Britton and Wright (1971) found that weather, fine fuel, diameter of trees, surface characteristics, and borer activity influenced percent of dead mesquite stems that burned down. Relative humidity, wind, and fine fuel accounted for 86% of the variation. Burndown increased from 38% for 2-inch trees to 67% for 3-inch or larger trees.

Cactus plants in mesquite communities have shown considerable variability in their response to fire. In Arizona the mortality for pricklypear the first year after burning varies up to 32% (Cable, 1967). Cane cholla (Opuntia spinosior) mortality, however, is usually higher—about 45% (Cable, 1967). Cane cholla less than 1-ft tall is much more susceptible to mortality than cholla over 1-ft tall (Dwyer and Piper, 1967).

The effect of burning on grassland production varies from one area to another. Cable (1967) stated that, "fire may kill or damage individual perennial grass plants, or may indirectly increase grass growth by reducing the density of competing shrubs." Other researchers have found that burning reduced grass production for the first few years (Reynolds and Bohning, 1956; Trilica and Schuster, 1969).

Aldous (1934) studied the effects of burning on bluestem pastures in eastern

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