Water Repellency of Soils under Burned Sagebrush

MOHAMED S. A. SALIH, FAISAL KH. TAHA, AND GENE F. PAYNE

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 repellency[1] of soils heated with and without sagebrush mulch in the laboratory.

Treatment	With Mulch[2]	Without mulch
600°F (316°C)	0.0 d	0
900°F (482°C)	0.0 d	0
1200°F (649°C)	4.3 c	0
1300°F (704°C)	5.0 c	0
1400°F (760°C)	10.0 b	0
1500°F (816°C)	25.0 a	0
1800°F (982°C)	6.0 bc	0
2100°F (1149°C)	0.0 d	0

[1] Time in seconds required for a drop of distilled water to be absorbed by the soil sample.

[2] Means with one or more letters in common are not significantly different, according to Duncan's Multiple Range Test, at 0.05 level.

Test II

This was a field test of the effect of burning on water repellency. One set of three sagebrush plants having a natural residual mulch approximately 2 inches deep underneath and one set of three plants with the natural residual mulch completely removed were burned. Diesel oil was used on all plants to start the fires. The soil was a gravelly sandy loam.

The burned spots were left to cool for 1 hour. Soil samples were then taken at depths of 0-1, 1-2, and 2-3 inches. Water repellency was tested with distilled water drops. The results of the trial are shown in Table 2.

Table 2. Water repellency[1] of soils under sagebrush plants burned with and without natural residual sagebrush mulch.

Soil depths (inches	With mulch[2]	Without mulch
0-1	40.0 a	0
1-2	18.0 b	0
2-3	1.3 c	0

[1] Time in seconds required for a drop of distilled water to be absorbed by the soil sample.

[2] Means with one or more letters in common are not significantly different, according to Duncan's Multiple Range Test, at 0.05 level.

The nonmulched soils were nonrepellent at all three profile levels. In the soils covered with natural residual mulch during burning, water repellency was highest in the 0-1 inch layer. The 1-2 inch samples averaged about half the repellency of the 0-1 inch level. The 2-3 inch samples of the mulched soils were nonrepellent.

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

The authors are graduate research assistants and professor of range science at Montana State University, Bozeman.

The study is a contribution from the Montana Agricultural Experiment Station, Bozeman (Journal Series No. 380).

Manuscript received September 28, 1971.

mulch are cool and damp is not likely to cause water repellency. The drier the soil and mulch, and hence the hotter the fire, the more likely it is that water repellent spots of soil will be formed.

Literature Cited

DeBano, L. F. 1969. Observations on water-repellent soils in the Western United States. Proc. Symp. on Water-Repellent Soil, Univ. Calif., Riverside, p 17-29.

Foggin, G. T. and L. F. DeBano. 1971. Some geographic implications of water-repellent soils. Prof. Geogr. 23:347-350.