Infiltration Rate and Sediment Production Trends on a Plowed Big Sagebrush Site¹

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Highlight

The trend was toward lowered infiltration rates following plowing and seeding of a big sagebrush site. The greatest decline occurred during the fall period of the second year following treatment. Sediment production rates increased following plowing, but yields were variable. The ability to predict infiltration rates using cover characteristics alone in multiple regression equations varied with time, both within a given storm event and also on a seasonal basis. Ability to predict infiltration rates was not particularly affected by the plowing treatment.

Considering the vast number of acres of big sagebrush (*Artemisia tridentata*) which have been plowed, sprayed, burned, railed, ripped, or contour furrowed in the last 20 years, one can only wonder at the lack of quantitative information regarding influence of such cultural practices on both biotic and abiotic segments of rangeland environments. Information regarding hydrologic aspects of vegetation manipulation in the big sagebrush type is particularly lacking.

Surface runoff from big sagebrush sites within the Sevier Lake Watershed in Utah has been studied by Woodward (1943). Using an F-type infiltrometer (plots 6 ft. × 12 ft.), he found that infiltration capacities increased directly with increases in plant-cover density. The magnitude of increase varied with soil type. Through use of regression equations infiltration rates as a function of time and parent material were calculated for varying cover densities and a series of curves were developed.

Rosa and Tigerman (1951) have summarized the sediment data from the Sevier Lake Watershed study, as well as some sediment data collected along the Wasatch Front during the years 1941–47. Sediment production rate from sagebrush sites with good vegetal cover was about one-third of the rate for sagebrush sites in fair condition. Sites in poor condition produced sediment at a rate about three times greater and the bare condition sediment production was from five to twelve times greater than for sites in fair condition.

A study by Tigerman (1952), utilizing a limited number of plots, indicated that disturbance of sagebrush range by overgrazing, reseeding practices, or burning will reduce the infiltration capacity of the site.

More recently, Gifford and Skau (1967) have studied the influence of various cultural treatments on runoff and sediment production the first year following treatment from two big sagebrush sites in Nevada. Treatments evaluated with a large 14 nozzle sprinkling apparatus equipped with type "F" nozzles included rip and drill, plow and drill,

plow and contour deep furrow drill, spray and drill, and spray and contour deep furrow drill. Results indicated that the influences of site and condition of plots (dry or wet) were significant during all aspects of infiltrometer runs from start of incipient ponding through infiltration rates after 30 minutes. The alluvium site and dry plot conditions had greater infiltration rates than the site with sedentary soils and wet plots, respectively. Treatment influenced only certain aspects of the infiltrometer runs; time from start of infiltrometer run to when runoff exceeded 0.1 inches/hr and infiltration rates after 10, 15, and 20 minutes. Plowing significantly reduced infiltration rates as compared with other treatments, including controls. Major factors important in controlling infiltration included percent cover, soil texture, condition of plot (dry or wet), and rock (% by wt) in the 0–1 inch or 1–4 inch layer of soil. Sediment yields were variable, with no distinct pattern emerging.

This study was designed to provide additional information regarding the influence of plowing sagebrush on surface runoff and sediment production.

Methods and Study Area

The study site is located in southern Idaho, about 5 miles west of Holbrook. Topography of the treated area is gently rolling, with a south aspect. Soils are derived from basaltic materials and are silty loam in texture. Some limited erosion pavement is present under the natural sagebrush, but surface soils generally have less than 5% by weight rock. Before plowing, principal plant species included big sagebrush, Sandberg bluegrass (*Poa secunda*), squirreltail (*Sitanion his-*

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Table 1. Influence of sampling date on infiltration rates (inches/hr) and sediment production (tons/acre).

Sampling date	Avg. cover ¹ (%)	Infiltration rates at given time intervals (min) ²					Sediment ² yield
		3-8	8-13	13-18	18-23	23-28	
8/ 6/68 ³	57	3.23 ^{cd}	2.64 ^{bc}	2.40 ^c	2.30 ^c	2.24 ^d	0.26 ^a
4/12/69	26	3.65 ^d	3.02 ^c	2.49 ^c	1.93 ^{bc}	1.66 ^b	0.35 ^a
6/18/69	41	3.89 ^d	2.83 ^{bc}	2.52 ^c	2.31 ^c	2.22 ^{cd}	2.13 ^{bc}
8/11/69	37	2.53 ^{ab}	1.64 ^a	1.60 ^{ab}	1.56 ^{ab}	1.57 ^b	3.24 ^c
6/20/70	67	3.42 ^{cd}	2.80 ^{bc}	2.12 ^{bc}	1.99 ^{bc}	1.74 ^{bc}	0.68 ^{ab}
8/27/70	73	2.93 ^{bc}	2.16 ^{ab}	1.51 ^a	1.50 ^{ab}	1.38 ^{ab}	1.83 ^b
10/ 3/70 ⁴	65	2.22 ^a	1.56 ^a	1.20 ^a	1.15 ^a	1.03 ^a	1.45 ^{ab}

¹ Includes litter, brush, grasses, and forbs.² Any two means in same column with same letter are not significantly different at .05 level of probability.³ Sampling date prior to plowing.⁴ Cattle were grazing treated area during this sampling period.

trix), Idaho fescue (*Festuca idahoensis*), broom snakeweed (*Gutierrezia sarothrae*), small rabbitbrush (*Chrysothamnus viscidiflorus*), bluebunch wheatgrass (*Agropyron spicatum*), *Eriogonum* spp., arrowleaf balsamroot (*Balsamorhiza sagittata*), and *Phlox* spp. After plowing, principal plant species included crested wheatgrass (*Agropyron cristatum*), cheatgrass (*Bromus tectorum*), alfalfa (*Medicago sativa*), intermediate wheatgrass (*Agropyron intermedium*), *Lupine* spp., *Cirsium* spp., broom snakeweed, and small rabbitbrush. The area was grazed by cattle during the fall period of the second growing season following seeding.

A Rocky Mountain infiltrometer (Dortignac, 1951) was utilized to simulate high intensity (three inches/hr or greater) rainfall on plots approximately 2.5 ft² in size. The area to be treated was sampled during August 1968, prior to plowing; during April, June, and August of 1969, the first summer following plowing; and during June, August, and October of 1970, the second summer following plowing. One hundred fifty eight plots were studied during the 7 sampling dates (20 to 24 plots per date).

All plots were pre-wet a minimum of 3 hours before infiltrometer runs began. Runoff was measured at selected time intervals

during each infiltrometer run. Infiltration, as used here, includes water absorbed into the soil, that intercepted by vegetation, that held in depressions, and that in transit across the surface at the moment runoff was sampled. Simulated rainfall was applied to each plot until a constant runoff rate was reached (generally 25 minutes were sufficient).

Sediment was measured by collecting total runoff plus sediment from each plot, mixing thoroughly, and finally obtaining a 1-quart sample. The water was then evaporated off, sediment oven-dried, and sample weights converted to tons per acre.

Results and Conclusions

Values given in Table 1 indicate that distinct changes in infiltration rates occurred on the treated area. The differences probably represent both normal seasonal fluctuations (high in spring, lower in fall) and influence of the land management practices. Higher infiltration rates in the spring result from increased porosity (less compaction) caused by freezing and thawing over winter. As the summer progresses, drying of the soil, soil microorganism activity, and convectional rainfall (which disturbs and/or seals the soil surface) all contribute to lower infiltration rates. As grazing is im-

FIG. 1. Infiltration curves for seven sampling dates. Infiltration rates for the sampling period prior to plowing (August 6, 1968) are denoted by circles. The dashed lines emphasize the decrease in infiltration rates late in the second year following treatment.

posed on the area, the additional compaction and removal of plant materials also contributes to lowered infiltration rates. Of particular note are the decreased infiltration rates apparent in the fall of 1969 and 1970 (Fig. 1), especially after approximately 13 minutes of simulated rainfall. The decrease was greatest in the fall of the second year, even though percent cover had nearly doubled over that present the first year, and even exceeded that present prior to plowing (Column 2, Table 1).

Sediment yields were greatest the first year following plowing, probably the result of reduced plant cover. A review of data in Table 1 indicates however, that sediment yields were variable regardless of sampling date.

Factors Influencing Infiltration and Sediment Production

The possibility of predicting infiltration rates and sediment production based on cover characteristics was tested by multiple regression techniques. Independent variables included percent bare soil, percent litter, percent brush, percent grass (all species), percent crested wheatgrass, percent cheatgrass and percent forb cover. Table 2 shows R² values for predicting infiltration rates during specified time intervals and also sediment production on the 7 sampling dates, plus a composite (data from all dates combined).

Table 2. R^2 values for predicting infiltration rates (inches/hr) during specified time intervals (min) and also sediment production (tons/acre) on 7 sampling dates, plus a composite.

Sampling date	Avg. cover ¹ (%)	Infiltration rates at given time intervals					Sediment yield
		3-8	8-13	13-18	18-22	23-28	
8/ 6/68 ²	57	.32	.53	.46	.48	.44	.52
4/12/69	26	.24	.25	.47	.47	.60	.67
6/18/69	41	.16	.46	.53	.55	.56	.40
8/11/69	37	.14	.07	.15	.28	.37	.07
6/20/70	67	.23	.27	.45	.61	.62	.45
8/27/70	73	.46	.32	.29	.27	.47	.42
10/ 3/70 ³	65	.68	.38	.35	.45	.25	.38
Composite	52	.08	.10	.16	.15	.16	.06

¹ Includes litter, brush, grasses, and forbs.

² Sampling date prior to plowing.

³ Cattle were grazing treated area during this sampling period.

It is obvious that the ability to predict infiltration varies considerably both within a given sampling date and also between sampling dates. It is also obvious that little meaningful information is derived through pooling of data collected during several sampling dates over a two-year period. This brings out some important points.

1. The ability to predict infiltration rates using cover characteristics alone varies with time, both

within a given storm event and also on a seasonal basis,

2. The relation of measured cover characteristics may help explain hydrologic behavior of a site at one time, yet be of little value at another time,

3. Considering the variation, the ability to predict infiltration rates was not particularly affected by the plowing treatment.

Predictive abilities might be improved through addition of soil

characteristics to the prediction equations, as in the Nevada study (Gifford and Skau, 1967). However, in many hydrologic analyses time and equipment are too limited for detailed examination of soils.

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