Sediment Production and Infiltration Rates as Affected by Grazing and Debris Burning on Chained and Seeded Pinyon-Juniper

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Highlight: *Sediment production and infiltration rates were measured in conjunction with an analysis of burning and grazing treatments in a chained pinyon-juniper study in southeastern Utah. While high natural variability was present among sites, no significant changes in sediment production were detected following our prescribed burning or grazing treatments. Following treatment, however, both the burned and grazed sites exhibited significantly depressed infiltration rates during certain time intervals in comparison to the "undisturbed, natural" woodland control location.*

Sediment production and infiltration rates in a chained watershed in southeastern Utah have been followed by Gifford and his associates for several years. During 1973 and 1974, secondary treatments of debris burning and grazing were superimposed over the initial chaining treatments of double chaining with debris-in-place and chaining-with-debris-windrowed, respectively. The initial chaining treatments were conducted in 1967. The chained areas were seeded to crested wheatgrass (*Agropyron cristatum*) during the fall of 1967. The areas were subsequently given complete protection for the next 6 years.

Prior to 1970, Gifford et al. (1970) noticed that significant decreases in infiltration rates were still occurring in the areas which received the chained-with-debris-windrowed treatment in 1967. Loope and Gifford (1972) noted that mechanical surface disturbance was very detrimental to soil microflora and destruction of this cryptogamic crust decreased the amount of moisture infiltrating the soil surface. They found less mechanical disturbance in an area receiving a double chaining with debris-left-in-place than one in which the trees were chained and then bulldozed into windrows. Wright et al. (1974) have observed in their ongoing research in Texas that level, dozed-then-burned ash juniper sites allow very little sediment production. They found that sediment losses (2.75 tons/ha on 15% slopes and 22 tons/ha on 53% slopes) stabilized in 9 to 15 months on moderate slopes and in 15 to 18 months on steep slopes.

Gifford (1973) found that sediment production was greatly reduced during runoff events under double chaining with debris-left-in-place treatments as compared to undisturbed woodland and chained-with-debris-windrowed treatments. He observed that, while 1.6 to 6 times more sediment can be expected from windrowed sites than from adjacent woodland, sediment yields from debris-in-place sites were similar to those from adjacent unchained natural woodland sites. Gifford theorizes that the differences between runoff and sediment rates from windrowed treatments and debris-in-place treatments are due to several factors:

(1) It appears that infiltration rates at given points on the debris-in-place treatment are only slightly affected by chaining activities.

(2) Apparently the debris which remains scattered over the soil surface following a debris-in-place chaining is sufficient to detain and retain water to the point that runoff is minimized or eliminated. He notes that "the soil under the debris-in-place treatment is not able to absorb water any faster than is the soil under the woodland—it's just held on the landscape until the soil has the time to absorb it."

Methods

Secondary treatment was applied to the chained sites during the fall of 1973 and spring of 1974. Baseline information was collected during 1973 and represented a full season of field collections prior to initiation of the secondary treatment.

A Rocky Mountain infiltrometer (Dortignac, 1951) was

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used to generate runoff from small plots, each plot being 0.23 m^2 in size.

All plots were pre-wet prior to application of simulated rainfall in order to eliminate confounding effects of antecedent moisture. Artificial rainfall was thus applied to the plots at a rate of approximately 7 cm per hour for 28 minutes. Both runoff and "rainfall" were collected initially, after 3 minutes, and subsequently at 5-minute intervals during the rainfall period.

Infiltration rates were determined from the relationship between "rainfall" and runoff during the 28-minute simulated storm.

Sediment production was obtained by collecting and analyzing an integrated sample (0.95 liters) of runoff water generated from each plot. The sediment was allowed to settle, the water evaporated off, and the oven-dried sediment production was then determined and converted to kilograms per hectare.

Results and Discussion

Figure 1 is a graphic representation of the potential sediment production values which were measured. Potential sediment production varied considerably, but generally was less than 5,000 kg/ha and frequently was less than 2,000 kg/ha. No significant treatment differences were observed. Immediately following the fire in September, 1973, however, a large 19,500 kg/ha, increase was noted on the debris-left-in-place area. This increase in potential sediment and ash production apparently declined rapidly. By early June, 1974, the debris-in-place site had the potential for contributing about the same amount of sediment as the other sites.

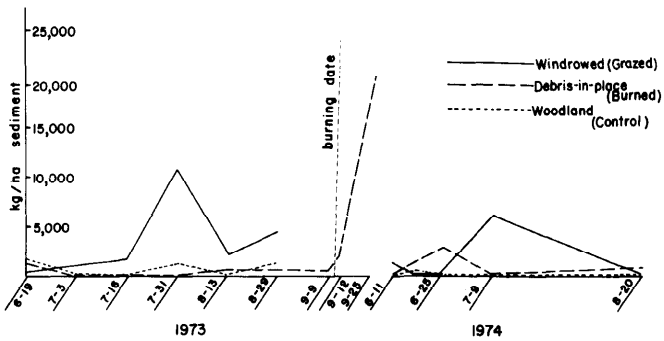
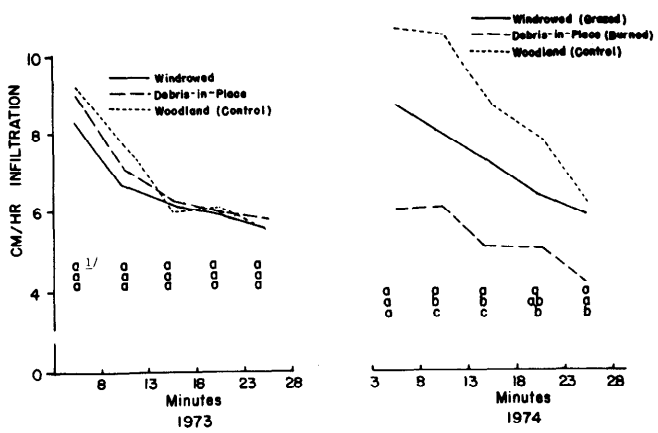


Fig. 1. *Potential sediment production under several treatment conditions.*

Natural variability among sites seems to be the theme for sediment production within the debris-windrowed site also. The area was grazed by cattle during mid-late June, 1974, and no predictable increase in potential sediment production was observed at this particular level of grazing (2 ha/AUM). Apparently, any increase in potential sediment production caused by a single instance of grazing or fire disturbance had been masked by the high natural variability which seems to exist within these locations.

Several interesting patterns emerged when infiltration rates were examined. Figure 2 is a graphic representation of the average infiltration rates observed prior to secondary treatment (1973) and following secondary treatment (1974).

During 1973, no statistical differences were observed among the primary treatment means. Apparently the significantly depressed infiltration rates in the chained with-debris-windrowed location, observed following chaining by Gifford et al. (1970) and Gifford and Busby (unpublished



1/ Infiltration means not matched to the same letter are statistically different (.05 level).

Fig. 2. *Mean infiltration rates per treatment for each of several time intervals during a 28-minute simulated rainstorm.*

data), had been restored to a pre-treatment condition in terms of infiltration rates. Six years of complete protection from livestock grazing had been provided on these sites following the initial chaining treatment; therefore, it is reasonable to expect a restoration of hydrologic conditions on the area.

Secondary treatment was in effect during 1974, however. The chained with debris-left-in-place location was burned and the windrowed location was grazed. At certain time intervals within the 28-minute simulated rainstorm, significantly decreased infiltration rates were noted when compared to the control location, apparently due to the trampling effect of the grazing animals.

The burning treatment resulted in a further depression of the infiltration rates. It may be that hydrophobic soils were a problem following burning. These particular desert soils seem to be rather susceptible to this hydrophobic phenomenon, even under "undisturbed" conditions.

Summary and Conclusions

No significant changes were recorded in terms of potential sediment production during the study. Any changes in potential sediment production due to grazing or burning were masked by the high natural variability which exists in these locations.

Significant interactions involving years, particularly years/treatment, were noted at certain infiltration time intervals within a simulated rainstorm. Earlier investigations in the same location indicated that mechanical disturbance following chaining could have a significant impact on infiltration rates. During 1973, however, no statistical differences among treatments were noted for any of the initial land treatments. The area had been afforded complete protection from livestock grazing during the 6 years since original treatments had been implemented.

Statistical infiltration differences became apparent only after secondary treatments in 1974. The impact of the grazing animal was apparently sufficient at the stocking rate used to significantly depress the infiltration process. A further decline in infiltration rates was observed on the burned watershed. Soil wettability is frequently a problem on coarse, textured soils. Burning may have increased the problem by contributing to this hydrophobic soil phenomenon.

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