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LARGE-PLOT INFILTRATION STUDIES IN DESERT AND SEMIARID RANGELAND AREAS OF THE SOUTHWESTERN U.S.A.

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ABSTRACT

Thirty-six large (3.05 by 10.7 m) experimental plots were established in semiarid rangeland and desert areas in Arizona and Nevada. Rainfall simulator data from these plots are used to investigate the influence of soil characteristics, vegetative cover, and surface rock and gravel cover (desert or erosion pavement) upon runoff and infiltration rates and amounts. The experimental design incorporated the influence of these factors using replicated plots and simulated rainfall during the spring and fall for four years in Arizona and two years in Nevada. Relationships between the mean final infiltration rate (a statistic representing the saturated hydraulic conductivity) and the three treatments (natural, vegetation removed, and bare soil) are established for the five sites/soils. Vegetative canopy cover and surface rock and gravel exhibited comparable, and statistically significant, influences on final infiltration rates. Final infiltration rates decreased as vegetative canopy cover and rock and gravel cover decreased. These findings have important implications for evaluation of land uses and management practices which reduce the vegetative canopy cover and/or disturb the rock and gravel cover in areas such as studied in this experiment. Such uses and practices are expected to reduce infiltration, and thus increase surface runoff which, in turn, would lead to increased erosion rates.

INTRODUCTION

Arid zones and semiarid rangelands cover extensive areas of the world (e.g., Branson et al. 1981), and form an important land resource of the United States, especially in the Southwest. Precipitation in these regions is generally less than potential evapotranspiration, so water availability is the most important environmental factor controlling survival and growth of desert and range plants (Brown 1977). Water balance calculations are necessary in soil-water-plant relationship studies, and infiltration calculations are necessary to partition precipitation into runoff and soil water recharge.

As is often the case in hydrology and agricultural science, more attention and resources have been devoted to infiltration research in humid areas subject to cultivated agriculture than to rangelands and desert areas. If we are to make better use of limited water resources in arid and semiarid areas, additional experimental data and research efforts are needed to understand and predict water infiltration on rangelands. Of the many factors controlling infiltration on rangelands, the role of desert and range vegetation and the

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role of desert or erosion pavement are not very well understood or quantified. Additional research is needed to quantify their role in determining components of the water balance, including the infiltration process. Recent advances in hydrologic modeling (e.g., Knisel 1980; Haan, Johnson, and Brakensiek 1982; and others), and extension of those models and concepts to semiarid and arid areas (e.g., Wight and Hanks 1981; Lane, Romney, and Hakonson 1984), have made hydrologic models more readily available for applications in the western United States.

The availability of these hydrologic models has important implications in current waste management studies (e.g., Hakonson et al. 1982). Recently developed rules and regulations require the ability to model hydrologic processes at shallow land burial facilities used to dispose of low-level radioactive wastes. Thus, it is important in these applications of hydrologic models to predict the amount and rates of infiltration, as they provide the source term for subsequent unsaturated flow and transport modeling. Because of the water problems associated with waste disposal, it is likely that arid and semiarid areas in the West and Southwest will receive increasing attention as possible sites for waste disposal facilities in the future. It is apparent there is a need for additional research and experimental data to quantify infiltration processes in arid and semiarid areas.

The purposes of this paper are to describe some recent rainfall simulator studies, particularly plot characteristics and summary infiltration data, in southeastern Arizona and southern Nevada, to relate this infiltration data to previously collected experimental data, and to discuss relationships among parameters expressing infiltration rates and experimental plot characteristics. Because of the large amount of data (several hundred rainfall simulator runs on several dozen plots), only summary analyses can be presented.

EXPERIMENTAL METHODS AND PROCEDURES

In the period 1981-1983, experimental plots were established in Arizona and Nevada to conduct rainfall simulator studies of erosion, runoff, and infiltration processes (Simanton and Renard 1982). These studies were conducted using a rotating boom rainfall simulator (see Swanson 1965 and Neff 1979 for details) on 3.05 by 10.7 m plots. The rainfall simulator is trailer mounted, with 10 booms 7.6 m in length supporting a total of 30 V-Jet 80100 nozzles. These nozzles apply simulated rainfall intensities of about 60 or 120 mm/hr, and produce drop-size distributions comparable with natural rainfall, but with about 80% of natural rainfall energy. The general procedure involved spring and fall rainfall applications on paired plots representing two soils in Nevada and three soils in Arizona. Location and climatic features of the plots are summarized in Table 1, and soils and vegetation are summarized in Table 2.

TABLE 1. SUMMARY OF CLIMATIC FEATURES AT STATIONS NEAR THE RAINFALL SIMULATOR PLOTS IN ARIZONA AND NEVADA

	Location			Mean Annual		Period of Record (yr)
Station	Lat N	Long W	Elevation (m)	Temperature (C)	Precipitation (mm)	
Tombstone, AZ	31°42'	110°03'	1405	17.6	324	1941-1970
Rock Valley, NV	36°40'	116°05'	1020	17.0	161	1968-1976

TABLE 2. SUMMARY OF SOIL AND VEGETATION CHARACTERISTICS FOR THE RAINFALL SIMULATOR PLOTS IN ARIZONA AND NEVADA

Site	Soil	Predominant Vegetation
Arizona Plots (Walnut Gulch)		
Bernardino	Thermic, *Ustollic Haplargid*	Blackgrama (*Bouteloua eriopoda*), sideoats grama (*B. curtipendula*), snakeweed (*Gutierrezia sarothrae*)
Cave	Thermic, shallow *Typic Palerorthid*	Creosote bush (*Larrea tridentata*), white-thorn (*Acacia constricta*)
Hathaway	Thermic, *Aridic Calciustoll*	False mesquite (*Calliandra eriophylla*), creosote bush, snakeweed, blue grama (*B. gracilis*), blackgrama
Nevada Plots (Nev. Test Site)		
Mercury	Shallow, mixed thermic, *Typic Durorthid*	Spiney menodora (*Menodora spinescens*), creosote bush, shadscale (*Atriplex confertifolia*)
Area 11	Shallow, mixed thermic, *Typic Durorthid*	Boxthorn (*Lycium andersonii*), Indian ricegrass *Oryzopsis hymenoides*), shadscale

An updated soil survey underway on Walnut Gulch is changing the names of some of the soils. Bernardino will probably be called Bernardo, Cave will be called Baseal, and Hathaway will probably be called a Tombstone soil.

The Bernardino series is a deep, well-drained, fine-textured soil formed in old calcareous alluvium. The soil can have up to 50%, by volume, gravel and cobbles in the surface 10 cm, and usually less than 35% gravel in the remaining profile. Percent sand, silt, clay, and organic matter in the surface 5 cm are 84, 10, 6, and 0.8, respectively. The Cave series is a shallow, well-drained, medium-textured soil with indurated lime hardpans that have developed at less than 45 cm in old gravelly and cobbly calcareous alluvium. This soil can have up to 60%, by volume, gravel and cobbles in the surface 10 cm, and usually less than 40% gravel in the remaining profile. Sand, silt, clay, and organic matter in the surface 5 cm are 66, 26, 8, and 1.8%, respectively. The Hathaway series is a deep, well-drained, gravelly medium and moderately coarse-textured soil over very gravelly, coarse-textured materials of moderate depths. This soil was formed from gravelly or very gravelly calcareous old alluvium, and can have up to 70%, by volume, gravel and occasional cobbles in the surface 10 cm, and usually less than 50% in the remainder of the profile. Percent sand, silt, clay, and organic matter in the surface 5 cm are 74, 17, 9, and 1.5, respectively. The Bernardino, Cave, and Hathaway soils are located on the Walnut Gulch Experimental Watershed near Tombstone, Arizona (see Renard 1970 for a detailed watershed description), in an area which represents highlands in a transition zone between the Chihuahuan and Sonoran Deserts.

The Mercury plots are located on the Nevada Test Site near Mercury, Nevada in the northern Mojave Desert, and the Area 11 plots are in a transition zone between the Mojave Desert and the Great Basin. The two sites are about 35 km apart on soils that have not been officially named, but are referred to hereafter as Mercury and Area 11. The Mercury soil is loamy, underlain by silica-lime hardpan, well drained, and formed in material weathered from limestone, quartz, and tuff. Percent coarse sand, fine sand, silt, and clay in the surface 5 cm are 20.4, 58.8, 14.8, and 6.0, respectively. The Area 11 soil is coarse-loamy, underlain by silica-lime hardpan, well drained, and formed in material weathered from tuff, basalt, and limestone. Percent coarse sand, fine sand, silt, and clay in the surface 5 cm are 15.2, 69.6, 14.5, and 0.7, respectively. Additional information on soils, vegetation, and climate is given by Romney et al. (1973).

Six plots were selected on each of the five soils to receive three treatments. Two of the six plots at each site were "control" plots, and were left in their natural cover condition. Two of the six plots at each site were "clipped" plots, where all vegetation was cut at the ground surface and removed with minimal soil surface disturbance. The remaining two plots at each site were "bare" plots, where vegetation was clipped and removed, and all non-embedded rock fragments greater than 5 mm were removed. These treatments were designed to determine the influence of vegetative cover and surface rock fragment (desert or erosion pavement) cover on runoff, erosion, and infiltration. A point-frame meter with pins spaced every 60 mm of its 3.05 m length was used to determine surface and canopy measurements at 490 points on the 3.05 by 10.7 m plots. The characteristics measured at each point were: bare soil (particles < 2 mm), gravel (particles 2 to 20 mm), rock (particles > 20 mm), litter, and vegetation basal and canopy cover. Average surface characteristics for the three treatments at the five sites are summarized in Table 3. The data in Table 3 (and subsequent tables) represent averages of two replications for each treatment, and thus do not represent plot to plot variations (see Simanton and Renard 1982 for additional information).

As expected, the climatic, soil, and plot characteristics were somewhat variable among the sites. At the Arizona sites, vegetative canopy cover varied from 35% (Cave site, Table 3) to 65% (Bernardino site, Table 3). Vegetative canopy cover was about one half to one third as dense (about 20%, Table 3) at the Nevada sites. The percent rock and gravel cover on the Arizona natural plots ranged from 45 to 51%, and 49 to 58% on the Arizona clipped plots (Table 3). Rock and gravel cover was somewhat higher on the Nevada plots, and ranged from 63 to 65% on the natural plots and 66 to 75% on the clipped plots. The bare plots (after treatment) at all sites had a rock and gravel cover that averaged about 16% (range of 13 to 19%, Table 3).

The same rainfall simulation sequence was applied at all sites. Rainfall was applied in the spring and fall at each site in the following sequence. A one-hour run (DRY) was made under initially dry soil conditions followed 24 h later by a 30 minute run (WET), which was followed 30 minutes later by another 30 minute run (VERY WET). Rainfall application rates were held as constant as possible during all experimental runs, and usually varied from 55 to 60 mm/h. This experimental design allowed for comparisons among sites and at sites for varying initial soil mositure. Because rainfall rates and durations were held constant, the experimental design does not allow analyses of the influence of rainfall amount, rates, or durations. Because of the large amount of data generated by these experiments, the limited space here, and the focus of many investigations upon saturated hydraulic conductivity, subsequent discussions emphasize data from the very wet runs. In most cases, steady-state runoff rates were reached well before the very wet run ended at 30 minutes.

TABLE 3. SUMMARY OF PLOT SURFACE CHARACTERISTICS FOR THE THREE TREATMENTS AT THE FIVE SITES; DATA ARE AVERAGES OF TWO REPS, SPRING AND FALL DATA FOR 1981-1984 FOR THE ARIZONA PLOTS, AND 1983-1984 FOR THE NEVADA PLOTS

			Percent Cover							
		Slope	Surface				Canopy			
Site/plot	Trt.	(%)	Rock	Gravel	Soil	Litter	Grass	Forb	Shrub	Total
Ariz. (WG)										
Bernardino										
pl 6 & 7	Nat	11.3	22.3	28.6	42.7	6.4	39.1	20.7	5.3	65.2
pl 5 & 9	Clip	10.6	22.6	35.3	37.6	4.6	-	-	-	-
pl 4 & 8	Bare	12.0	4.5	14.6	76.4	4.5	-	-	-	-
Cave										
pl 21 & 26	Nat	10.0	18.1	26.5	42.1	13.6	9.5	23.7	1.6	34.7
pl 19 & 25	Clip	10.3	16.7	32.2	40.6	10.5	-	-	-	-
pl 20 & 23	Bare	10.0	6.6	6.8	82.0	4.7	-	-	-	-
Hathaway										
pl 12 & 15	Nat	10.3	21.7	29.3	36.1	12.9	33.1	12.4	3.2	48.7
pl 14 & 17	Clip	10.6	25.1	32.3	35.0	7.6	-	-	-	-
pl 11 & 16	Bare	9.8	6.6	8.2	78.1	7.1	-	-	-	-
Nevada (NTS)										
Mercury										
pl 7 & 11	Nat	8.8	13.1	51.6	23.5	11.8	0.6	18.6	2.8	22.0
pl 8 & 10	Clip	8.6	17.5	58.2	21.9	2.4	-	-	-	-
pl 9 & 12	Bare	8.7	5.2	10.9	83.4	1.3	-	-	-	-
Area 11										
pl 1 & 4	Nat	7.2	14.0	48.8	21.6	15.7	3.9	14.4	2.9	21.2
pl 3 & 6	Clip	6.4	14.2	51.3	29.2	5.4	-	-	-	-
pl 2 & 5	Bare	7.8	3.0	12.4	83.2	1.5	-	-	-	-

RESULTS AND DATA

Selected data from the very wet runs at the five sites are summarized in Table 4. Again, notice that rainfall depth, P, and intensity, I, are nearly constant for the 8 experimental runs at the Arizona sites and the 4 experimental runs at the Nevada sites.

Because of water shortages, a few runs at the Nevada sites were for 25 minutes, rather than the full 30 minutes. In all cases, the runoff amount, Q,

TABLE 4. SUMMARY OF RAINFALL, RUNOFF, AND INFILTRATION DATA FOR THE VERY WET RUNS AT THE FIVE SITES; DATA ARE AVERAGES FOR THE TWO REPS, SPRING AND FALL DATA FOR 1981-1984 FOR THE ARIZONA PLOTS, AND 1983-1984 FOR THE NEVADA PLOTS.

		Simulated rainfall		Measured runoff		Infiltration		Time to runoff[2]
Site/plot	Trt.	Depth P (mm)	Intensity[1] I (mm/h)	Depth Q (mm)	Peak Q_p (mm/h)	Depth F (mm)	Final K_f (mm/h)	t_r (min)
Ariz.(WG)								
Bernardino								
pl 6 & 7	Nat	28.5	56.9	8.9	22.7	19.6	35.3	3.1
pl 5 & 9	Clip	27.6	55.2	15.1	35.1	12.4	21.0	2.2
pl 4 & 8	Bare	28.1	56.2	20.8	44.0	7.3	13.7	1.0
Cave								
pl 21 & 26	Nat	28.6	57.1	13.6	31.5	14.9	26.3	2.5
pl 19 & 25	Clip	27.4	54.8	18.7	40.8	8.8	15.0	1.9
pl 20 & 23	Bare	28.0	55.9	21.4	45.0	6.5	11.6	1.2
Hathaway								
pl 12 & 15	Nat	28.7	57.4	11.4	26.6	17.2	31.6	2.9
pl 14 & 17	Clip	28.7	57.6	18.3	40.2	10.4	19.3	1.6
pl 11 & 16	Bare	28.5	57.0	21.1	44.7	7.4	12.4	1.1
Nevada (NTS)								
Mercury								
pl 7 & 11	Nat	27.8	59.5	17.0	40.4	10.8	20.5	1.7
pl 8 & 10	Clip	25.9	54.0	20.9	47.0	5.0	7.3	1.3
pl 9 & 12	Bare	26.3	54.5	23.8	52.1	2.5	4.8	0.9
Area 11								
pl 1 & 4	Nat	26.1	54.7	7.6	21.0	18.5	33.7	4.1
pl 3 & 6	Clip	26.8	55.9	9.3	26.6	17.5	29.4	3.3
pl 2 & 5	Bare	26.5	55.4	16.7	39.0	9.8	16.3	1.2

[1] Rainfall duration is about 30 min for all very wet runs.

[2] Time from beginning of rainfall until runoff begins as measured in the flume at the lower end of the plot.

was lowest from the natural plots, intermediate from the clipped plots, and highest from the bare plots. The same (but opposite direction) relationships held for total infiltration, F, calculated as $P-Q$, and final infiltration rate K_f calculated as the difference between application and runoff rates at the end of a run. The time to runoff, t_r, is the time from the beginning of simulated rainfall until runoff is observed in the measuring flume at the lower end of the plot. The time to runoff, t_r, includes time delays due to interception, storage, and routing, and is thus always greater than the actual time to ponding. The differences between t_r and t_p are greatest on the natural plots and least on the bare plots. With these qualifications, time to ponding was largest on the natural plots, intermediate on the clipped plots, and smallest on the bare plots.

A simple correlation matrix, for the data shown in Table 4 and for selected plot characteristics, is shown in Table 5.

TABLE 5. CORRELATION MATRIX FOR PLOT CHARACTERISTICS, RUNOFF, AND INFILTRATION VARIABLES; DATA ARE AVERAGES OF TWO REPLICATIONS FOR VERY WET RUNS ON EXPERIMENTAL PLOTS IN ARIZONA (1981-1984) AND NEVADA (1983-1984)

	Q[1] (mm)	Q_p (mm/h)	t_r (min)	F (mm)	K_f (mm/h)	PC[2] (%)	PRG (%)	CC (%)
Q	1.00[3]	0.99*	-0.96*	-0.98*	-0.97*	0.45	-0.54*	-0.65*
Q_p		1.00	-0.95*	-0.99*	-0.98*	0.37	-0.48	-0.68*
t_r			1.00	0.93*	0.92*	-0.39	0.60*	0.59*
F				1.00	0.99*	-0.31	0.49	0.71*
K_f					1.00	-0.27	0.48	0.74*
PC						1.00	-0.15	0.13
PRG							1.00	0.26
CC								1.00

[1] See Table 4 for definition of variables.

[2] PC = % clay in soil 0-5 cm; PRG = % rock and gravel on plot surface, and CC = % canopy cover.

[3] Correlation coefficients for d.f. = N-2 = 13 are significant at the 5% level if r > = 0.514. Significant values are shown with *.

Notice that the runoff and infiltration variables are highly intercorrelated, as they should be when rainfall application rates and amounts are held nearly constant and uniform. This suggests that analyses with a single variable such as K_f would indicate the expected relationships and trends with the other intercorrelated variables. The data in Table 5 are suggested as qualitative measures of the influence of the treatments upon infiltration rates and amounts. For example, final infiltration rate, and thus saturated hydraulic conductivity, should decrease with increasing percent clay in the soil, and increase with rock and gravel cover (desert or erosion pavement) and vegetative canopy cover. The data shown in Tables 3, 4, and 5 suggest relationships among plot characteristics, treatments, soils/sites, and runoff and infiltration variables. Again, they do not suggest anything about variations in runoff and infiltration with precipitation amount or rate or antecedent moisture.

Means and 95% confidence limits on the mean final infiltration rates for the three treatments at each of the five sites, and for all sites together, are shown in Figure 1. This graph emphasizes the influence of treatments at each site. At the Bernardino site, there are significant differences between the natural and bare plots, with the clipped plots intermediate. However, there appear to be greater differences between the natural and clipped plots than between the clipped and bare plots. Similar relationships and patterns are evident for the Hathaway and Cave sites. At the three Arizona sites, there is a statistically significant difference between final infiltration

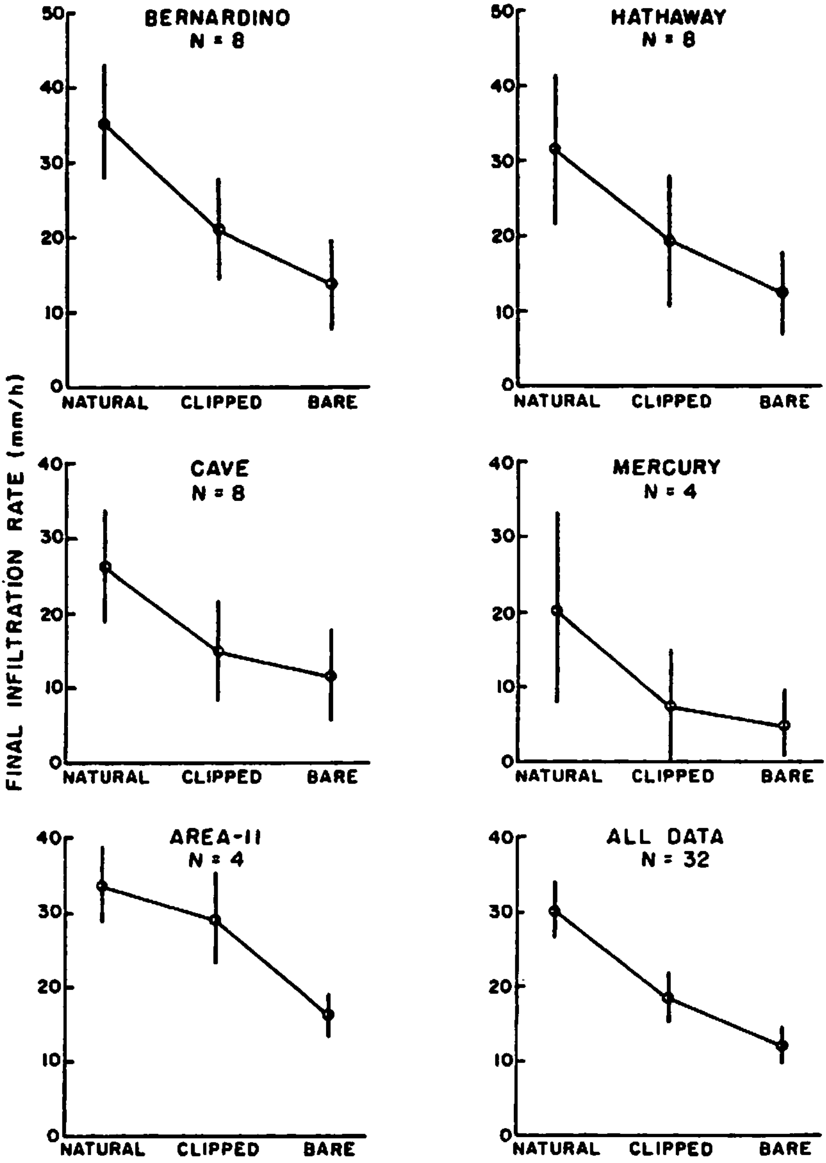

Figure 1. Final infiltration rates shown as the mean and 95% confidence intervals for the very wet runs on the five sites/soils in Arizona and Nevada.

rates on the natural and bare plots. Bare soil plots always had significantly lower infiltration rates than the corresponding natural plots. While not statistically significant at the 95% level, the final infiltration rates were lower on the clipped plots than on the natural plots, and higher than on the bare plots. This same pattern was observed at all five sites, suggesting statistical significance at the 3% level, since this outcome would be expected only once in 32 times by chance. The results shown for the Mercury and Area 11 sites are based on only 4 observations, so they should be given qualitative interpretation only. However, the Nevada results shown in Figure 1 do seem to match the results observed at the Arizona sites. When all data are pooled (lower right hand corner of Figure 1), the results are significant at the 95% level. Final infiltration rates are lower on the clipped plots than on the natural plots, and lower on the bare plots than on the clipped. With respect to the pooled data, removing the vegetative canopy cover resulted in a 39% decrease in mean final infiltration rate, and also removing the rock and gravel cover resulted in an additional 34% decrease in final infiltration rate.

RELATION TO PREVIOUS STUDIES

Previous studies of infiltration on the Walnut Gulch Experimental Watershed in Arizona include early Type F infiltrometer studies on 1.8 by 3.7 m plots as reported by Kincaid, Gardner, and Schreiber (1964). These plots represented two soil types with predominately brush on one site and grass vegetative cover on the other. The soil characteristics and vegetation cover were similar, but not identical to, those used in the present study. Kincaid, Gardner, and Schreiber (1964) found that total infiltration amount increased with surface gravel cover, that shrub canopy cover together with surface cover of grass, litter, and gravel was most strongly related to infiltration amount, and that final infiltration rate increased as the crown spread of shrubs and half-shrubs increased.

Kincaid and Williams (1966) used similar 1.8 by 3.7 m plots to evaluate the influence of range improvement practices upon runoff (and thus infiltration) over a summer runoff season. Their most significant finding of interest here was that runoff volume showed a significant negative correlation with vegetation canopy cover. A subsequent study reported by Schreiber and Kincaid (1967) developed regression equations relating precipitation quanity, vegetation canopy cover, and antecedent soil moisture to runoff volume for 34 natural storms on 1.8 by 3.7 m plots. Their study indicated that total precipitation or rainfall intensity was most significant, that total runoff volume had a significant negative correlation with vegetation canopy cover, and that antecedent soil mositure was not significantly correlated with runoff volume. Smith and Chery (1973) reported on the results of application of a parametric infiltration model to a subset of data (events with a recorded hydrograph rather than just total runoff for the storms) from the 1.8 by 3.7 m plots. Their results reported potential advantages of their infiltration model over another empirical infiltration model. Smith and Chery (1973) concluded that instruments used to measure rainfall and runoff on the 1.8 by 3.7 m plots lacked adequate sensitivity.

Tromble, Renard, and Thatcher (1974) used a rotating disk rainfall simulator (Morin 1967) to study infiltration at selected rangeland sites on the

Walnut Gulch Experimental Watershed. Their results were for 1 m square plots on Bernardino, Cave, and Hathaway soil with 3 replications at seven sites. The Bernardino soil was represented by 3 natural plots in grass cover. The Cave soil was represented by 3 natural brush plots, 3 natural grass plots, and 3 bare soil plots. The Hathaway soil was represented by 9 plots with 3 grazed grass plots, 3 ungrazed grass plots, and 3 natural brush plots. Their results showed higher infiltration on the brush plots than on ungrazed grass plots which had higher infiltration rates than the grazed grass plots. In agreement with the present study and the previously cited studies, Tromble, Renard, and Thatcher (1974) found significant increases in infiltration with increases in vegetative canopy cover and significant decrease in infiltration on bare soil plots.

Dixon, Simanton, and Lane (1978) evaluated several algebraic infiltration equations on a variety of data including some from the Santa Rita Experimental Range located approximately 80 km W,NW of the Walnut Gulch Experimental Watershed. Their most significant finding relative to the present study was a listing of the most important soil surface conditions affecting infiltration as microroughness, macroporosity, plant litter, and effective surface head. Lane et al. (1978) used similar infiltrometer data from the Santa Rita Experimental Range to evaluate the capillary and saturated hydraulic conductivity term in the Philip (1957) equation. They found (on 1 m square plots) that plots including a dense cover of grass plants had significantly higher final infiltration rates than adjacent bare soil plots.

Simanton and Renard (1982) developed the experimental design upon which the present study is based, and reported on the first full year of data (spring and fall, 1981) from Walnut Gulch. They found runoff, infiltration, and soil loss to vary with treatments (following the patterns described in the previous sections of this paper), and with season as well. The initial experimental design developed by Simanton and Renard (1982) was intended to develop Universal Soil Loss Equation (Wischmeier and Smith 1978) parameters for rangeland conditions. Since that time, however, the data have been utilized in infiltration and erosion modeling studies.

Previous studies of infiltration on the Walnut Gulch Experimental Watershed, and similar semiarid rangeland areas, have produced quantitative and qualitative relationships among vegetative canopy cover, rock and gravel surface cover, and infiltration rates and amounts. Data presented in Tables 1-5 and Figure 1 support the previous studies. The large-plot infiltration data reported herein for the Nevada sites in the Mojave desert appear to be unique in that no comparable results in Nevada were found in the literature surveyed.

SUMMARY AND DISCUSSION

Rainfall simulator data on 3.05 by 10.7 m plots, at three semiarid sites in Arizona and two arid sites in Nevada, were used to investigate the influence of soil surface characteristics and surface treatments (natural vegetation and rock and gravel cover, clipped or vegetation removed, and bare soil plots) upon runoff and infiltration rates and amounts. Site characteristics are summarized in Tables 1 and 2, plot surface characteristics are summarized in Table 3, rainfall, runoff, and infiltration data are summarized in Table 4, and Table 5 presents a correlation matrix for plots characteristics with runoff and infiltration variables. Because rainfall application rates were held constant and uniform (except for the dry runs as noted earlier), runoff and infiltration variables exhibited strong intercorrelation. Final infiltration rate at the end of the very wet runs was selected as the infiltration variable for further analyses and for investigation of the influence of the treatment upon infiltration.

Relationships between the mean final infiltration rates and treatments for the five sites/soils are summarized in Figure 1. Vegetative canopy cover and surface cover of rock and gravel exhibited comparable influences on final infiltration rates. Final infiltration rates decreased significantly as vegetative canopy cover and soil surface rock and gravel cover decreased. These findings are in agreement with previous studies at the same or similar locations.

These findings (particularly the relationships shown in Figure 1) have important implications for management of semiarid and arid rangelands. Land uses and management practices which reduce the vegetative canopy cover and/or disturb the rock and gravel (desert or erosion pavement) in areas such as studied in this experiment are expected to significantly decrease infiltration with resulting increases in runoff and erosion.

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