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SOIL AND VEGETATION PARAMETERS AFFECTING INFILTRATION UNDER SEMIARID CONDITIONS (*)

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RÉSUMÉ

Les mesures de précipitation et d'écoulement des eaux dans les versants hydrographiques secondaires du Walnut Gulch Experimental Watershed ont révélé une variation énorme dans le rapport entre la précipitation et l'écoulement. Cette variation est attribuée aux irrégularités des montant, intensité et distribution de la précipitation et aussi aux différences non mesurées parmi les versants hydrologiques secondaires.

Afin de vérifier les effets de la terre sur l'infiltration, des pluviomètres, des blocs à humidité, dits Bouyoucos (d'après le nom de l'inventeur), ont été installés sur deux terrains de drainage, l'un, herbeux, de nature volcanique et d'une superficie de 4.5 acres (approx. 1.821 hectares), l'autre, couvert d'arbustes, calcaire et d'une superficie de 3 acres (approx. 1.214 hectares). Le terrain herbeux montra de plus grandes et de plus abruptes réactions à la précipitation pluviale, aux profondeurs variant de six à dix-huit inches (approx. de 15 à 45 cm). L'épuisement d'eau à la profondeur de six inches (approx. 15 cm) était plus rapide dans l'herbage, indiquant une évaporation plus rapide ou une perméabilité plus complète des racines de la couche supérieure du sol ou encore une combinaison de ces deux facteurs. Le recul des eaux de la profondeur de dix-huit inches (approx. 45 cm) était à peu près identique dans les deux terrains. Des sondages faits à travers le profil du sol révélèrent peu de pénétration des racines en dessous d'une profondeur de vingt inches (approx. 50 cm) dans l'un comme dans l'autre terrain.

Afin de déterminer le rapport entre l'infiltration et les différents facteurs du complexe sol-végétation, des tests à infiltromètre ont été faits à l'aide d'un infiltromètre du Type-F sur des sections de six sur douze pieds (approx. 1.80 sur 3.60 mètres), choisies au hasard. L'infiltration accumulative de courte durée augmenta avec la quantité du gravier de surface. Le développement de la cime (la couronne) des arbustes sembla être en rapport plus étroit avec l'infiltration que n'importe quel autre paramètre de végétation. La combinaison de l'arbuste avec des «semi-arbustes» qui couvrent le sol de leurs cimes accompagnés du gravier de surface, formant également la couverture du sol, ainsi que la litière et l'herbage, a révélé le meilleur rapport avec l'infiltration de courte durée; et un rapport curviligne satisfaisant fut établi entre le développement de la cime des arbustes et des semi-arbustes et la capacité finale d'infiltration.

ABSTRACT

On subwatersheds of the Walnut Gulch Experimental Watershed measurements of precipitation and runoff showed extreme variation in the rainfall-runoff relation. This variation is attributed to irregularity of amount, intensity, and distribution of the precipitation and to unmeasured differences among the subwatersheds.

To ascertain effects of soil on infiltration, rain gages and Bouyoucos moisture blocks were installed on a 4.5-acre, grass-covered drainage area of igneous soil and on a 3.0-acre drainage area of calcareous soil supporting a shrub cover. Soil in the grassland area showed greater and more abrupt responses to rainfall at the 6- and 18-inch depths. Moisture depletion at the 6-inch depth was more rapid in the grassland area, indicating more rapid evaporation or more complete root permeation of the upper soil or a combination of these two conditions. Moisture withdrawal from the 18-inch depth was about the same on the two areas. Pits dug through the soil profile showed little root penetration below the 20-inch depth on either area.

To determine the relation of infiltration to different factors in the soil-vegetation complex, infiltrometer tests were made with a Type-F infiltrometer on randomly

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selected 6 × 12-foot plots. Cumulative short-time infiltration increased with surface gravel. Crown-spread of shrubs appeared to be more closely related to infiltration than any other single parameter of vegetation. The combination of the shrub and half-shrub over-story with ground cover of surface gravel, litter, and grass showed the best observed relation to cumulative short-time infiltration; and a fair curvilinear relation was demonstrated between crown-spread of shrubs and half-shrubs and final infiltration capacity.

1. Introduction

In arid and semiarid sections of Arizona and New Mexico, surface runoff results primarily from intense convective thunderstorms of limited areal extent and short duration, falling on unsaturated soils (Fletcher, 1961; Osborn and Reynolds, 1963)*. The supply for such runoff, of course, is essentially the difference between the rainfall and that portion of it that is intercepted by vegetation or absorbed by the soil. In these areas of sparse vegetation, the latter process — infiltration — is the more important of the two, and it assumes considerable importance in the hydrology of watersheds. It is generally recognized that amount and rate of infiltration are influenced by such site characteristics as slope, soil texture, and vegetational cover; but the extent to which each of the soil and vegetational parameters is effective has not been determined under conditions of low annual rainfall and sparse vegetation.

Studies on the Walnut Gulch Experimental Watershed were initiated to investigate effects of conservation measures on water yield and sediment production from semiarid rangelands. The limited phase of the work reported here constitutes an attempt to evaluate parameters of soil and vegetation related to infiltration and runoff. The studies involve intensive investigations on small subwatersheds having relatively homogeneous soils and vegetation, upon which rainfall, infiltration, soil moisture, and runoff are measured throughout the year. Also, artificial rainfall of known quantity is applied to randomly located 6 × 12-foot plots. The runoff and infiltration from these plots are correlated with measured characteristics of the site, soil, and vegetation.

2. Watershed investigations

In December 1961, soils and vegetation were sampled on two drainage areas above stock ponds by means of five sampling units on each area. On each sampling unit, vegetation was measured on two parallel, 100-foot line transects (Canfield, 1941) 20 steps apart, and the soil was sampled from a pit dug through the profile midway between the lines. On such transects, linear measurements are made of the vegetation intercepted by a vertical plane along the graduated edge of a steel tape. Crown spread of shrubs and half-shrubs and basal area of grasses and forbs were the parameters measured.

One of these stock ponds (Kendall's Pond No 20) receives the runoff from 128 acres of comparatively good grassland; the other (Lucky Hills Pond No 23), that from 115 acres supporting a cover of brush, among which is a sparse cover of grass (Table 1). On the Kendall area, the dominant grass is black grama (*Bouteloua eriopoda*), among which are admixtures of other grama grasses and curly mesquite grass (*Hilaria belangeri*). The most common non-graminaceous plant on the area is the low-growing, leguminous half-shrub, false-mesquite (*Calliandra eriophylla*). The soil of the area is of the Earp series, is slightly acid to slightly alkaline, and is low in lime. Mechanical analysis of the surface horizon shows that it is high in clay and relatively low in gravel (Table 2).

TABLE 1

Cover of shrubs (crown spread), half shrubs (crown spread), and grasses (basal area)

Species	Lucky Hills	Kendall
	%	%
Shrubs		
Acacia constricta	10.84	
Atriplex canescens	.52	
Condalia spathulata	.05	
Flourensia cernua	2.87	
Larrea divaricata	6.49	
Opuntia macrocentra	.02	.02
Parthenium incanum	3.20	
Rhus microphylla	.65	
Total Shrubs	*24.64*	*.02*
Half Shrubs		
Calliandra eriophylla		.39
Coldenia canescens	.12	
Haplopappus tenuisectus		.33
Krameria parvifolia	.60	
Zinnia pumila	.95	
Total Half Shrubs	*1.67*	*.72*
Grasses		
Bouteloua chondrosioides		.34
Bouteloua curtipendula		.16
Bouteloua eriopoda	.18	1.01
Bouteloua gracilis		.42
Hilaria belangeri		.48
Other species (*)	.06	.39
Total Grasses	*.24*	*2.80*

(*) Other species: Lucky Hills — *Aristida glauca, Bouteloua curtipendula, Hilaria mutica, Muhlenbergia porteri, Sporobolus cryptandrus, Tridens pulchellus.* Kendall — *Aristida arizonica, Aristida divaricata, Bouteloua filiformis, Bouteloua hirsuta, Bouteloua radicosa, Hilaria mutica, Lycurus phleoides, Muhlenbergia arenicola, Tridens muticus,* and *Tridens pulchellus.*

Vegetation on the Lucky Hills area is dominated by whitethorn (*Acacia constricta* var. *vernicosa*), creosotebush (*Larrea divaricata*), and tarbush (*Flourensia cernua*), with a considerable component of the low shrub, mariola (*Parthenium incanum*). Although there are grasses among the shrubs, they are a minor component of the cover. The soil is of the Tombstone (*) series. It is calcareous and of alkaline reaction, and is underlain by soft caliche at depths of one foot or more (Table 2).

From the available data, no correlation of runoff from these areas, as measured at the stock ponds, with either the soils or the cover of vegetation could be demonstrated. In 1961 and 1962, 15 storms produced runoff into the Kendall Pond and 16 into the Lucky Hills Pond. Percentages of the rainfall that appeared as runoff in each of these ponds were so variable, however, that no comparison of the two areas could be made. Owing, probably, to unresolved characteristics of the drainage areas, storms of

(*) These series are tentative, pending correlation.

TABLE 2

Comparison of surface soil at Lucky Hills and Kendall
(0-6" depth)

Characteristic	Lucky Hills	Kendall
	%	%
Gravel	39.4	13.7
Sand	43.8	33.8
Silt	9.1	12.2
Clay	7.7	40.3
Organic Carbon	0.36	1.31
Calcium Carbopate	1.37	0
Water in Saturated Paste	18.0	48.5

similar amounts and intensities on the same area produced differing amounts of runoff (Table 3).

To reduce effects of variation in soils and vegetation, a small drainage area, relatively homogeneous in these respects, was selected on each of the two subwatersheds. Size of the one on the Kendall area was 4.5 acres; that of the one on the Lucky Hills area was 3.0 acres. In 1962, each small area was equipped with a runoff-measuring weir and a scattering of 39 Bouyoucos soil-moisture blocks. Amounts of rain falling on each area were measured with 13 non-recording gages, and intensities were measured by recording gages less than ½ mile away. Pits dug through the soil profile on the two areas revealed little root penetration below the 14- to 20-inch depth on either area.

During the 1962 runoff season, good records were obtained from the 4.5-acre Kendall area. Two storms totaling 1.78 inches were recorded on July 25, wetting the soil to a depth of 18 inches or more. Of the total rainfall, 0.45 inch was recorded as runoff at the weir, leaving 1.33 inches that was absorbed by the soil or intercepted by vegetation. Rains of slightly less than 0.5 inch on July 27 and 29 maintained the soil moisture at near field capacity until about August 10 (Fig. 1). By August 20, however, it had dropped below the wilting point at the 6-inch depth, where, despite a few light showers during the rest of August and early September, it remained until September 24, when 0.75 inch of rain fell with such intensity that 0.40 inch of runoff was recorded at the weir. At the 18-inch depth during this time, soil moisture depletion was much slower, and the wilting point was never reached.

Permeability of the soil on this area allowed penetration of the rainfall to considerable depths, even from such storms of high intensity and short duration as that of September 24, which restored the soil moisture to field capacity at depths greater than 18 inches. Because of lower temperature and evaporation rates and the cessation of growth of warm-season grasses, moisture depletion was less rapid during October and November than it was in August, despite virtually no rain until November 29. Frontal rains of 0.30 and 0.35 inch on November 29 and 30, respectively, produced no runoff and did not wet the soil to the 18-inch depth. On December 18, however, a frontal storm of 0.50 inch wet the soil to field capacity to depths greater than 18 inches, and subsequent light rainfall maintained it in that condition until January 20 (Fig. 1).

The weir below the 3.0-acre Lucky Hills area was installed too late to furnish a full runoff record for the season. On this area, intense, runoff-producing, convective rains fell on July 18, 25, 27, 29 and wet the soil to field capacity at the 6-inch level. The soil then dried out steadily until the wilting point was reached during the first

TABLE 3

Rainfall and runoff for stock pond drainage areas

Pond	Rainfall				Runoff	
	Date of Storm	Amount of Storm	Type of Storm	Highest 10-minute Intensity	Inches	Percentage of Rainfall
		in.		in./hr.		
Kendall No 20	6/19/61	.10	Convective		No runoff	
	6/24	.47	»	1.80	.021	4.3
	6/24	.10	»	.30	.003	3.0
	7/22	.25	»	1.08	No runoff	
	7/29	.30	»	0.90	.026	8.7
	7/31	.62	»	2.10	.016	2.6
	8/2	.25	»	1.20	.054	21.68
	8/17	.53	»	2.10	.072	13.62
	8/22	1.32	»	3.30	.140	10.60
	8/28	.75	Frontal	.30	.002	.27
	9/8	.12	Convective	.42	.001	.83
	9/10	1.45	»	4.62	.146	10.07
	9/11	.13	»		No runoff	
	9/14	.08	»		»	
	Total	6.47			.480	7.42
Kendall No 20	7/19/62	.12	Convective			
	7/25	.60	»	1.56	.097	16.17
	7/25	1.14	»	1.50	.142	12.46
	7/27	.32	»	.60	No runoff	
	7/28	.30	»		» »	
	7/31	.18	»		» »	
	8/16	.10	»		» »	
	8/20	.15	»		» »	
	9/4	.25	»		» »	
	9/6	.20	»		» »	
	9/11	.21	»		» »	
	9/12	.16	»		» »	
	9/22	.17	»		» »	
	9/24	.75	»	3.48	.284	37.87
	Total	4.65			.523	11.25

week in September (Fig. 2). From this time until October 10, the moisture level remained almost constant, notwithstanding several convective thundershowers, one of which produced 0.15 inch of runoff through the weir. Moisture at the 6-inch level decreased through a dry October and November, until the two frontal rains on November 29 and 30 brought it above the wilting range. Rain on December 18 further reduced the moisture tension to about 3 atmospheres.

TABLE 3 (continued)

Pond	Rainfall				Runoff	
	Date of Storm	Amount of Storm	Type of Storm	Highest 10-minute Intensity(*)	Inches	Percentage of Rainfall
		in.		in./hr.		
Lucky Hills No 23	6/19/61	.55	Convective	3.00	.033	6.00
	6/24	.08	»		No runoff	
	6/30	.25	»	1.50	.012	4.80
	7/6	.24	»	1.56	No runoff	
	7/12	.35	»	.96	» »	
	7/18	.77	»	2.88	.037	4.81
	7/25	.18	»	.60	.015	8.33
	7/28	.08	»		No runoff	
	8/17	1.33	»	4.20	.434	32.63
	8/18	.35	»	1.08	.056	16.00
	8/20	.02	»		No runoff	
	8/21	.07	»		» »	
	8/23	.25	»	1.50	.001	.40
	8/28	.95	Frontal	.90	.008	.84
	9/14	.29	Convective	1.74	No runoff	
	Total	5.76			.596	10.35
Lucky Hills No 23	7/18/62	1.10	Convective	3.42	.030	2.73
	7/21	.16	»	.90	No runoff	
	7/24	.32	»	1.08	.006	1.88
	7/25	.60	»	.84	.008	1.33
	7/27	1.00	»	1.62	.121	12.10
	7/28	.60	»	.60	.086	14.33
	7/29	.80	»	1.86	.362	45.25
	8/21	.32	»	.60	No runoff	
	9/4	.47	»	1.68	.228	48.51
	9/6	.10	»		No runoff	
	9/13	.31	»		» »	
	9/22	.27	»		» »	
	9/24	.38	»	1.14	.056	14.74
	Total	6.43			.897	13.95

(*) Intensities less than .30 inches per hour are not tabulated.

The late July rains, although they wet the soil at the 6-inch depth to field capacity on the Lucky Hills area, did not affect it at the 18-inch depth until August 2. Maximum moisture at this depth was observed on August 16, from which time it steadily decreased until the wilting point was reached about October 15. Effects of the rains of Novem-

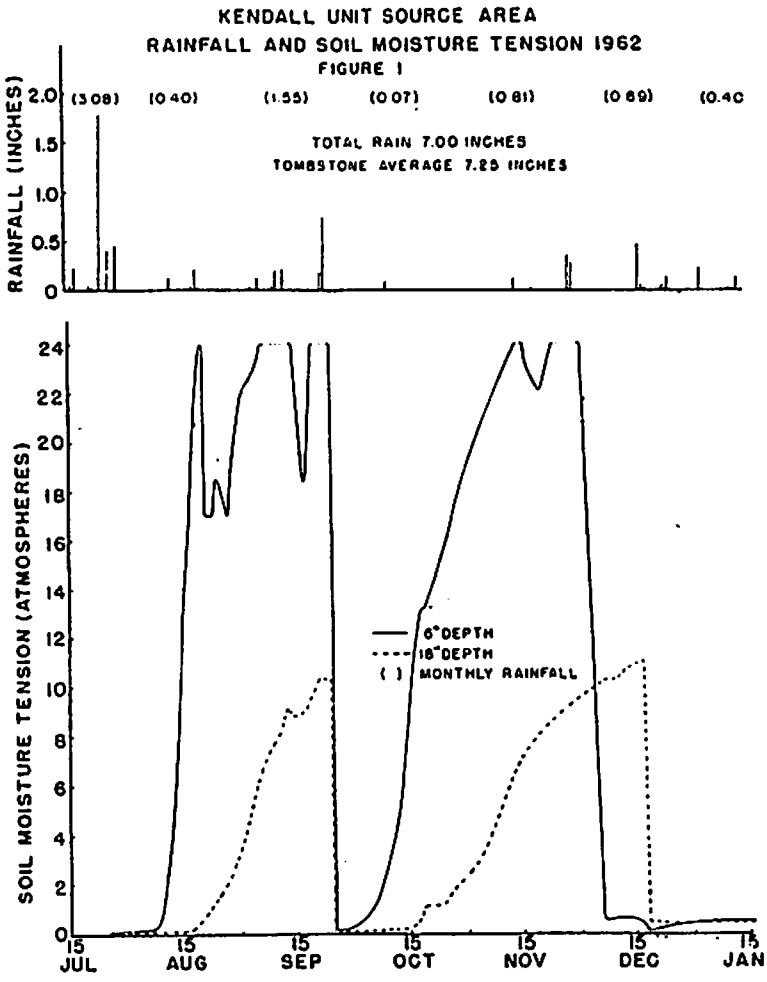

Fig. 1.

ber 29 and 30 were delayed at the 18-inch depth until December 10, but even then the moisture did not exceed the wilting percentage.

The soil moisture data furnish information for several comparisons: The greater permeability of the soil on the Kendall area allowed greater and more abrupt responses of the soil moisture to rainfall at the 6- and 18-inch depths than were observed on the Lucky Hills area (Fig. 1 and 2). Rainfall on September 24 brought to field capacity the upper 18 inches of the soil mantle on the Kendall area but produced no observable effect on that of the Lucky Hills area, even at the 6-inch depth. Following this rain, the soil on the Kendall area remained moist at 18 inches for the rest of the year, whereas that on the Lucky Hills area continued dry throughout September, October, and November. In the latter area, the moisture tension at the 18-inch depth leveled off at about 18 atmospheres during late November and early December, indicating that very little evaporation took place from this depth.

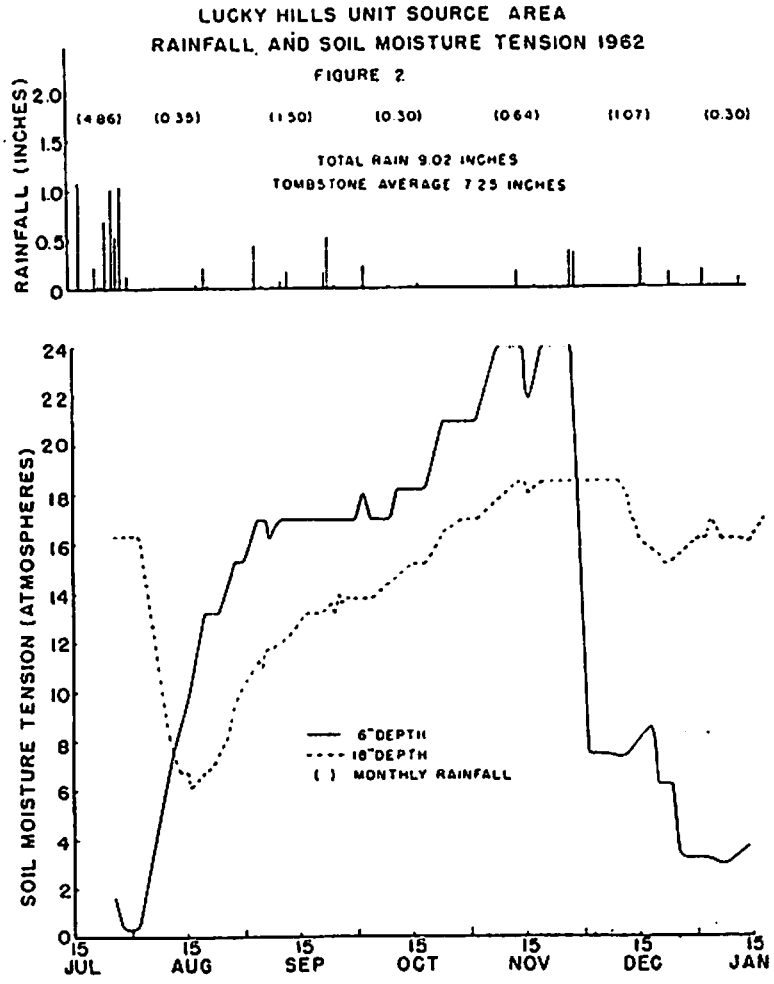

Fig. 2.

(*) Electrical resistance in the soil moisture blocks was converted to moisture tension for expression in figures 1 and 2. A rising line in the figures is indicative of increasing moisture tension and decreasing moisture content. The dotted lines at 24 atmospheres tension correspond to 1×10^6 ohms resistance, which was the upper limit of the equipment used.

At the 6-inch level, moisture depletion on the Kendall area was more rapid than on the Lucky Hills area, probably because of greater evaporation and heavier root development in the upper soil of the Kendall area. Rate of moisture loss on the two areas at the 18-inch depth differed little, suggesting similar degrees of root occupancy.

3. Infiltrometer investigations

Evaluation of effects of varying parameters of soil and vegetation on runoff, even from areas of the size of those just discussed, would require measuring a large

number of runoff events and very intensive surveys of the cover and the soils. In an effort to evaluate effects of the more obvious of these parameters on on-site runoff and to relate this runoff to that measured at the outlet of the watersheds, infiltrometer studies are being conducted on 6 × 12-foot plots. Preliminary results are reported here.

Artificial rainfall at the rate of 4 inches per hour is applied to these plots by means of a type-F infiltrometer (Musgrave, 1941). The water is applied through 12 specially designed nozzles inclined toward the plot at 7° from the vertical. The spray arches upward about 8 feet before falling. An adjacent 2-foot-wide strip receives the same application as the plot. Canvas curtains shield the sprinkled area and the appa-

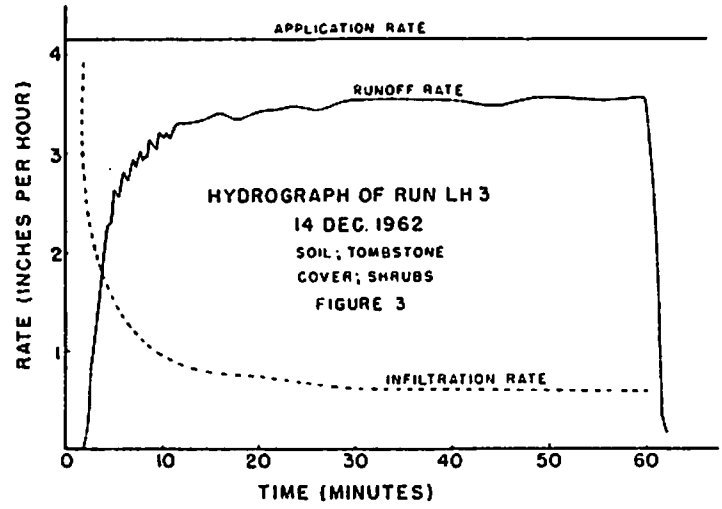

Fig. 3.

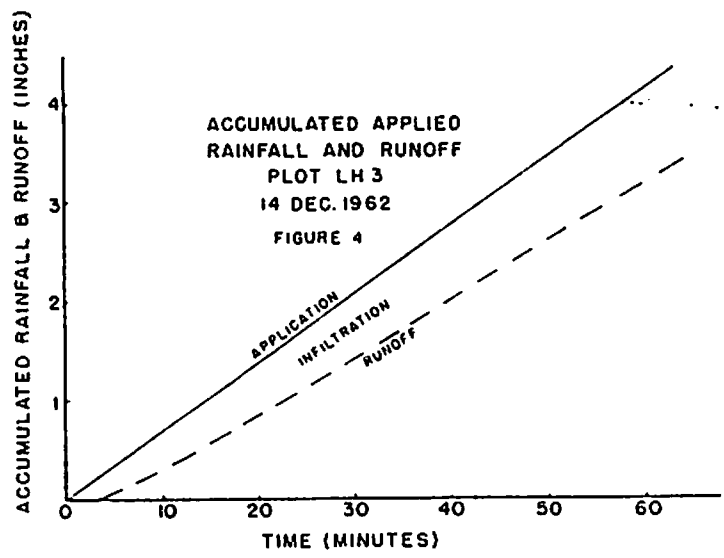

Fig. 4.

ratus from wind. An electric pump is used to maintain a steady pressure of 35 pounds at the nozzles. The plot is enclosed on three sides by metal boundary plates partially buried in the soil. On the fourth side — the lower end — is a combined end-plate and collecting trough which concentrates the runoff into a spout from which are collected volumetric samples of the runoff. Because, under natural conditions in this area, runoff nearly always results from rain falling on dry or partially wet soil, runoff is measured from initial applications rather than from those applied to soil that has been raised to its water-holding capacity.

On each plot, characteristics of the soil, the vegetation, and the general site are noted. Vegetation measurements, by species, are basal area, crown spread, dry weight of tops, and density — number of plants per unit area. Except for the weight of tops, these measurements are made before sprinkling. Plant litter is measured without regard to species. Soil characteristics measured are erosion pavement; texture, depth, and lime content of each stratum; antecedent moisture; and depth of root penetration. Notes are made of the slope, previous erosion, direction of exposure, and altitude above sea level.

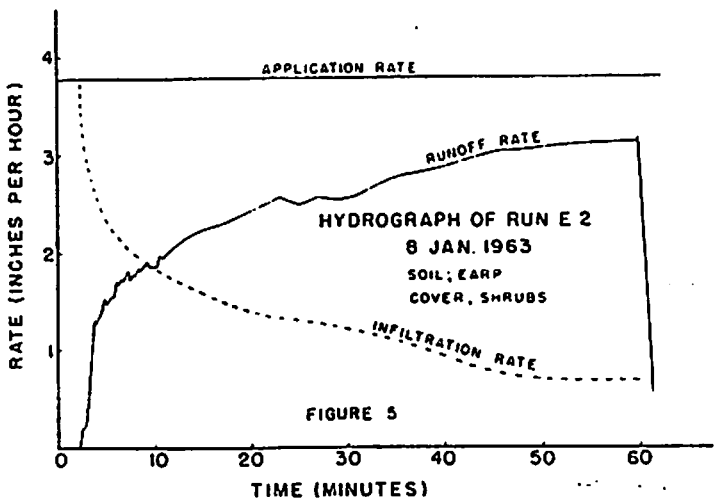

Fig. 5.

For an interval after the beginning of application, there is no runoff. Rate of intake soon decreases below that of application, however, and water accumulates in surface depressions. When these depressions fill — usually from two to five minutes after start of application — runoff begins. Runoff generally becomes constant before 30 minutes have elapsed. That portion of the applied water referred to here as infiltration is actually applied water minus runoff. Besides the water absorbed by the soil, it includes that intercepted by vegetation, that held in depressions, and that in transit across the surface at the moment runoff is sampled.

As application is begun, a stopwatch is started. Fom the beginning of runoff, 15-second samples are taken continuously until 11 minutes after the beginning of application. Following this, 1-minute samples are taken every 2 minutes until the end of the first half-hour. During the second half-hour, 1-minute samples are taken every 5 minutes. From these samples are calculated rates and amounts of infiltration and runoff (Fig. 3, 4, 5, 6).

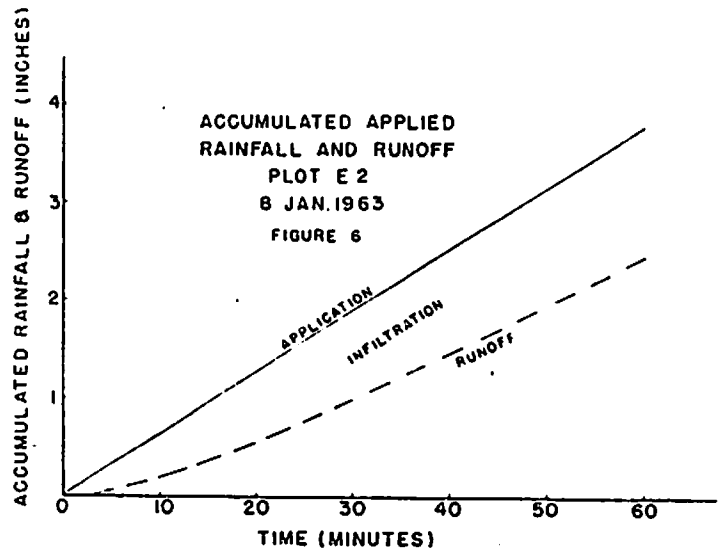

Fig. 6.

The total amount of water absorbed by the soil during the period of precipitation is dependent not only on the constant infiltration rate eventually reached but also on the length of time necessary to reach this constant rate. As an example, on Plots *LH*-3 and *E*-2, although the constant infiltration rates were nearly equal, that of Plot *LH*-3 was reached in 20 minutes, whereas that of *E*-2 was not reached until about 50 minutes had elapsed (Fig. 3, 5; Table 4); therefore, the total amount of water absorbed by *E*-2 was more than one-third greater than that absorbed by *LH*-3 (Fig. 4, 6). Where runoff-producing rains are usually of short duration, this phenomenon may be of

TABLE 4

Total water absorbed and rate of infiltration for representative infiltrometer runs

Run No	Water Absorbed During (minutes)						Infiltration Rate at End of (minutes)					
	5	10	20	30	45	60	5	10	20	30	45	60
	in.						in./hr.					
E-3	.33	.61	1.06	1.43	1.87	2.30	3.73	2 88	2.42	2.16	1.87	1.67 *
E-2	.27	.44	.70	.90	1.13	1.32	2.33	1.93	1.35	1.22	.76	.68
E-4	.27	.42	.55	.70	.92	1.12	1.58	1.25	1.00	.86	.84	.80
LH-3	.29	.38	.53	.65	.81	.96	1.51	.96	.73	.60	.60	.58
E-1	.25	.32	.46	.60	.82	1.00	1.39	1.10	.78	.78	.69	.67
K-10	.24	.31	.42	.53	.65	.78	1.21	.97	.64	.59	.50	.52

* Constant infiltration rate had not yet been reached.

TABLE 5

Infiltration and associated site characteristics of six representative infiltrometer runs

Site	Time for .5" Intake	Water Absorbed at 60 min.	Infil. Rate at 60 min.	Gravel in Crust	Gravel in Surface Soil	Soil Reaction
	min.	in.	in./hr.	%	%	pH
E-3	8.0	2.30	1.68 (*)	72.1	48.3	6.72
E-2	12.0	1.32	.68	68.1	39.0	7.57
E-4	17.0	1.12	.80	59.5	41.0	7.72
LH-3	17.5	.96	.58	39.4	33.5	7.96
E-1	23.5	1.00	.67	48.9	51.4	7.75
K-10	26.5	.78	.52	43.2	32.5	7.70

Site	Cover of Erosion Pavement	Cover of Litter	Basal Area Grass	Grass Plants on Plot	Crown Spread Shrubs	Shrubs on Plot
	%	%	%	No	%	No
E-3	23.57	1.65	1.45	56	37.34	4
E-2	23.12	1.58	2.48	69	25.84	9
E-4	8.37	1.73	.44	21	25.34	13
LH-3	14.77	1.72	1.15	49	13.34	9
E-1	11.72	1.02	1.97	51	23.50	13
K-10	12.37	2.07	3.28	95	0.00	0

Site	Crown Spread Half-shrubs	Half-Shrubs on plot	Crown Spread Shrubs and Half-Shrubs	Shrubs and Half-Shrubs on Plot	Forbs on Plot	Total Plants on Plot
	%	No	%	No	No	No
E-3	5.58	38	42.92	42	23	121
E-2	6.83	6	32.67	15	30	114
E-4	6.33	16	31.67	29	26	76
LH-3	5.83	9	19.17	18	3	70
E-1	.50	2	24.00	15	0	66
K-10	5.68	28	5.68	28	10	133

(*) Constant infiltration rate had not yet been reached.

considerable importance, since infiltration during the first few minutes of rainfall may account for much of the water absorbed by the soil. Also, such differences in infiltration may help account for differences in the rising stages and floodpeaks of hydrographs of runoff from small watersheds.

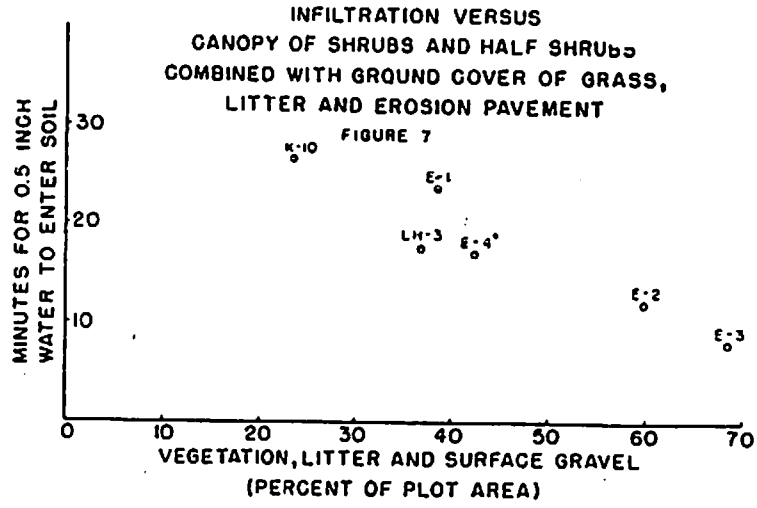

Fig. 7.

Six randomly selected plots of the 20 thus far tested are used in this paper to illustrate relation of infiltration to characteristics of the soil and the vegetational cover (Table 5). The time required for infiltration of 0.5 inch of water is considered as an index to the expected on-site retention of rainfall from short-duration storms. With one exception, length of time required for infiltration of the first 0.5 inch of water decreased linearly with an increase in the percentage of gravel in the soil crust — the

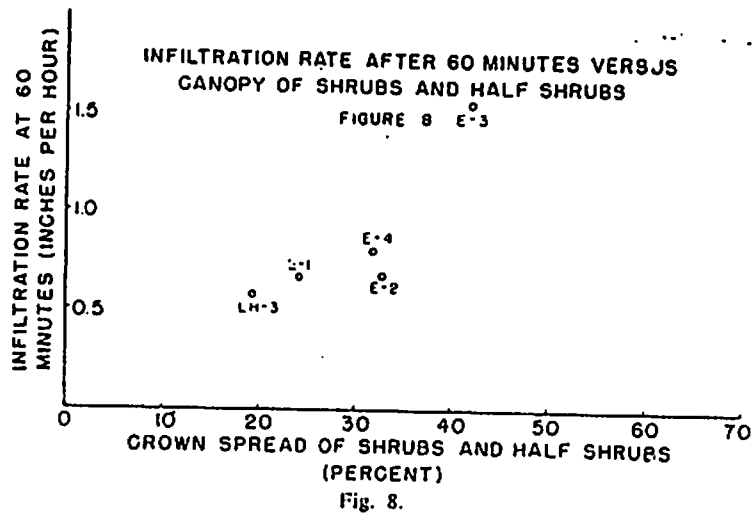

Fig. 8.

upper 0.25 inch. This relationship was less marked, but still somewhat apparent, when the percentage of gravel in the crust was combined with that of the underlying surface horizon. Time of infiltration of the initial 0.5 inch of water decreased, also, as the percentage of area occupied by erosion pavement (gravel stones) increased (Table 5). Although there appeared to be an ill-defined relation of initial infiltration time to lime content and to pH of the surface horizon, the relationships were vague and must await further work for resolution.

In general, infiltration time of the initial 0.5 inch decreased with an increase of combined cover of shrubs and half-shrubs and with total number of plants on the plot, but no correlation was observed with basal area of grasses or with cover of litter, which was very low. Best correlation was observed, however, when this infiltration was compared with a combination of cover of litter and erosion pavement, basal area of grasses, and over-story of shrubs and half-shrubs (Fig. 7).

Woodward (1943) observed a general increase of both initial and final infiltration capacity with increase of plant cover. Experiments reported by Harold (1951) indicated that, in areas where much of the ground is covered, cover of plants and litter is the main site characteristic affecting infiltration and runoff. Harold also reported that in tests on sparsely-covered desert grassland range, effects of soil texture overshadowed those of cover.

In our tests, crown cover of shrubs and half-shrubs exhibited a curvilinear relationship with infiltration rate after 60 minutes of applied rainfall (Fig. 8); but below a certain minimum cover, vegetation appeared to have no effect on this value. Influence of surface particle-size distribution — particularly of erosion pavement — appears to be related to amount of vegetational cover. Under very sparse vegetation, if the crust contains more than 60 percent of gravel, perhaps no other soil or vegetation parameter need be considered for prediction of cumulative short-time infiltration. As amount of vegetation increases, however, importance of surface gravel as an effective parameter may decrease. The present infiltrometer tests are directed toward defining the range of influence and the relative importance of these and other parameters.

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