FIELD WATER REGIMES OF SANDY LOAM SOILS ON ARID RANGELANDS OF SOUTHERN NEW MEXICO

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SUMMARY

There is little information on field measurement of soil water on arid rangelands. Forage production is largely dependent upon adequate water. The soil water potential is characterized for three sandy loam soils during 1957–76 on arid rangelands of southwestern United States. Gypsum-impregnated resistance blocks were placed at soil depths of 10, 25, 41, 61, and 91 cm. The average annual precipitation during the study periods was 244, 265, and 233 mm. At the 10–cm soil depth, the probability of soil water ≥ —1.5 megapascals during December–March was 66, 70, and 68% at the three sites; during July–September, it was 40, 50, and 49%, respectively. Factors affecting soil water were: 1) precipitation amount, 2) surface soil characteristics, 3) topography, 4) soil texture, and 5) vegetation type. This information is useful for modeling the range ecosystem.

KEY WORDS: soil water potential, probabilities, precipitation, soil structure, vegetation.

INTRODUCTION

The level of forage production is dependent upon adequate water and other factors. The effects of precipitation on soil water depends on such factors as 1) soil characteristics (e,g., texture and structure), 2) position on the landscape (runoff, runin), 3) amount and intensity of precipitation event, 4) plant cover, and 5) soil water status at time of precipitation event (Herbel and Gile, 1973). This paper characterizes the soil water potential on three sandy loam sites on rangelands in southern New Mexico.

MATERIALS AND METHODS

This study was conducted on the Jornada Experimental Range near Las Cruces, New Mexico. Most of the Experimental Range lies in a closed intermountain basin where topography is level to gently undulating. The average annual precipitation is 230 mm; an average of 120 mm occurs July through September. The precipitation is highly variable temporally and spatially. Soil parent materials in the basin floor are sandy sediments. A generalized soil survey of the area was reported by Bulloch and Neher (1980).

Site A belongs to the Canutio soil series and is classified as a coarse-loamy, mixed, thermic Typic Torriorthentic. It is on a 2% fan–piedmont slope dominated by creosotebush (*Larrea tridentata*). The surface at this site has considerable fine gravel and a vesicular structure in interspaces between shrubs that is 3 mm thick.

Site B is a fine-loamy, mixed thermic Typic Haplargid of the Headquarters series. Site C is a coarse-loamy, mixed, thermic Typic Calciorthid of the Wink series. Sites B and C are located on nearly level alluvial fans dominated by mesa dropseed (*Sporobolus flexuosus*).

Electrical resistance blocks impregnated with gypsum were placed at the three locations at depths of 10, 25, 41, 61, and 91 cm. Matric potential measurements were recorded with an ohmmeter 1–3 times per week when there was soil water during the summer. They were recorded monthly during the remainder of the year when there were fewer changes in water status. The blocks were calibrated in light– and medium–textured soils. The calibration and use of gypsum blocks has been discussed by Taylor et al. (1961). Soil temperatures were also recorded at several depths at several nearby locations about the same time as soil water was recorded.

All of the resistance readings were corrected to 15.6°C. Precipitation was recorded at each study site in a standard U.S. Weather Bureau rain gauge modified to reduce evaporation loss. The precipitation is discussed in terms of a crop-year, or October 1 of the preceding year to September 30 of the year identified, e.g., crop-year 1961 is October 1, 1960 through September 30, 1961.

The resistance was determined for each reading and translated to megapascals (MPa). For days when the resistance was not determined, MPa was determined by 1) previous determinations of soil water at that depth, 2) precipitation, 3) soil water at other depths at that location, and 4) previous precipitation events at that location. All the daily determinations were grouped into water potentials of 0 to −0.1 MPa, −0.1 to −1.5 MPa, and ≥—1.5 MPa. The blocks were installed at the 10–, 25–, and 41–cm depths at sites B and C in July 1957; and at site A in July 1958. They were installed at the 61– and 91–cm depths at the three locations in July 1959. Readings were terminated December 31, 1973, at site C and December 31, 1976, at sites A and B. No readings were obtained August 1 through December 31, 1972.

RESULTS

During the study periods, the average crop-year precipitation was 244, 265, and 233 mm for sites A, B, and C, respectively (Fig. 1). The average July–September precipitation for sites A, B, and C for the study periods was 149, 155, and 139 mm, respectively.

SITE A

At the 10–cm soil depth, the probability of soil water > —1.5 MPa during December–March during 1958–76 was 66% (Fig. 1). At the 25–cm depth, it was 59%. The probability of soil water ≥ —1.5 MPa during December–March was 30, 27, and 12% for the 41–, 61–, and 91–cm depths, respectively. During July–September, the probability of soil water ≥—1.5 MPa at the five depths was 40, 21, 14, 16, and 6%, respectively.

Daily precipitation of < 13 mm did not contribute to soil water ≥—1.5 MPa unless the surface soil had water from a recent storm, a situation that was rate. If daily precipitation < 13 mm was omitted, crop-year precipitation during the study period averaged 163 mm and July–September precipitation averaged 93 mm. There was an average of 3.7 days July–September and 6.4 days per year with > 13 mm of precipitation.

During crop-year 1971, a year with 172 mm precipita-

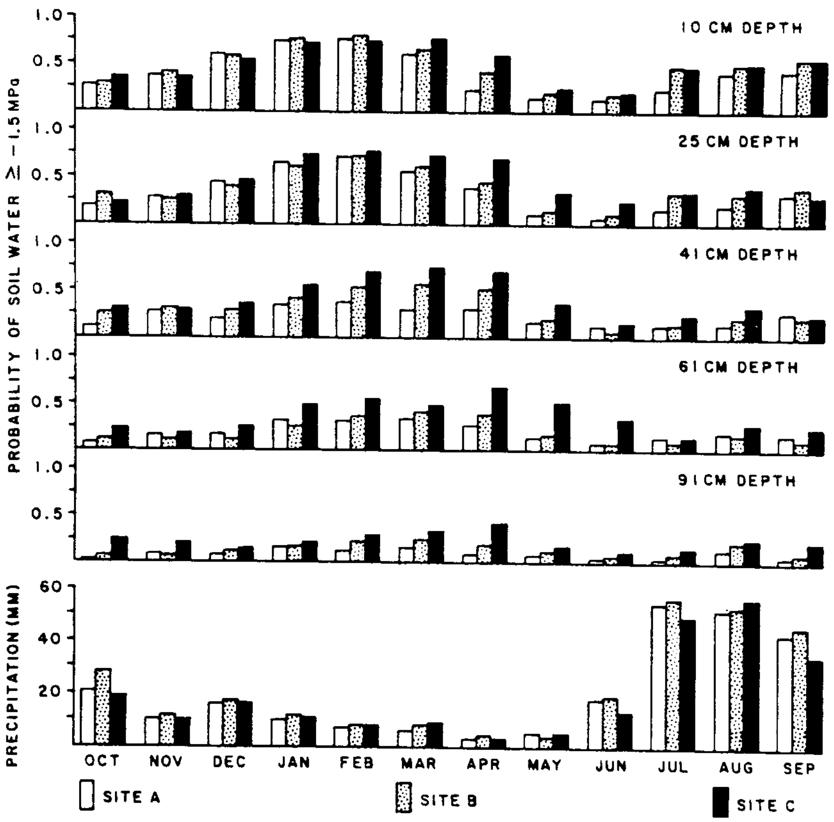

Fig. 1. Average monthly soil water probabilities and precipitation for site A (1958-76), site B (1957-76), and site C (1957-73) for the crop-year (Oct. 1 to Sept. 30) on the Jornada Experimental Range.

tion, soil water ≥ —0.1 Mpa occurred at the 10–cm depth October 4–12, 1970; July 24–31, 1971; and August 29–September 4, 1971. There was a low amount of precipitation in most years in May and June (Fig. 1).

SITE B

The probability of soil water ≥ —1.5 MPa in December–March during the study period was 70, 58, 46, 28, and 18% for the 10–, 25–, 41–, 61–, and 91–cm depths, respectively (Fig. 1). During July–September, the probability of soil water ≥ —1.5 MPa at the five depths was 50, 34, 19, 10, and 8%, respectively. Crop–year precipitation during the study period averaged 182 mm and July–September preciptation averaged 118 mm if daily precipitation of < 13 mm was omitted. There was average of 4.3 days July–September and 7.3 days per year with > 13 mm of precipitation during the study period. During a crop–year with 453 mm precipitation, 1958, there was soil water ≥ —0.1 MPa at the 10–cm depth October 5–May 2 and September 13–30.

SITE C

The probability of soil water ≥ —1.5 MPa during December–March was 68, 68, 58, 46, and 24% for the 10–, 25–, 41–, 61–, and 91–cm soil depths, respectively (Fig. 1). During July–September, the probability of soil water > —1.5 MPa at the five depths was 49, 33, 25, 24, and 23%, respectively. There was also considerable soil water during April at this location. July–September and crop–year precipitation during the study period averaged 74 and 102 mm, respectively, if daily amounts < 13 mm are omitted. During the study period, there was an average of 5.1 days/year with > 13 mm precipitation and 3.4 days during July–September. During crop–year 1962, with 367 mm precipitation, soil water ≥ —0.1 cm MPa occurred at the 10–cm depth Ovtober 1–6, 1961; November 8–May 4, July 3–August 11, August 15–18, and September 25–30, 1962.

DISCUSSION AND CONCLUSIONS

At all study sites, the probability of soil water ≥ —1.5 MPa was greater in winter than in other seasons of the year. This winter moisture lasted until April in most years, particularly at depths below 10 cm. The dry winds of spring remove some of the soil water by evaporation and plant transpiration removes the remainder. Thus plant growth is largely dependent on soil water supplied by summer rainfall. This study showed that daily precipitation < 13 mm was ineffective in contributing to soil water at depths ≥ 10 cm. Therefore, precipitation values alone do not give a reliable estimate of soil water.

The eroded soil at site A had a lower probability for soil water ≥ —1.5 MPa during December–March at the 41– and 91–cm depths, and during July–September at 10–, 25–, 41–, and 91–cm depths. Conversely, site C had a higher probability for soil water ≥ —1.5 MPa than site A, although site C had fewer precipitation events > 13 mm. Soil water probabilities at site B were intermediate between sites A and C, although it had daily precipitation > 13 mm. The lower probabilities of soil water at site A are believed to be due to: 1) a sloping surface leading to more runoff in high-intensity rainfalls; 2) the presence of a platy, vesicular layer in the top 3 mm of the surface soil which reduces infiltration; 3) shallower depth to the Clca horizon, 20 cm, versus the 50–cm depth to the Clca horizon at sites B and C; and 4) differences in vegetative cover, i.e., brush versus grass.

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