Soil Moisture Response to Several Levels of Foliage Removal on Two Utah Ranges

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Highlight: *Range plant clipping studies were conducted at two elevations on Utah's Wasatch Plateau during 1966 and 1967. It was found that extreme clipping treatments (complete denudation) resulted in significantly less soil moisture withdrawal than the unclipped controls at the mid-elevation location. No significant differences were found among clipping treatments at the subalpine location, however.*

There has been considerable speculation as to the effect of foliage removal on soil moisture regime. Some investigations suggest that removal of foliage by livestock results in reduced transpiration rates, which in turn reduce soil water losses and thus create a potential for increased water yield (Dunford and Fletcher, 1947; Dennis, 1959; Baker and Hunt, 1951; Madison and Haga, 1962; Van Piper and Owen, 1964). Other studies indicate that an apparent lack of soil moisture on grazed sites may be attributed to reduced infiltration, increased surface runoff, and increased evaporation from the soil surface (Hagan and Peterson, 1953; Lassen et al., 1952; Houston, 1964).

When an area is grazed by livestock, several things may affect the amount of moisture in the soil. First, some of the plant foliage removed could affect the rate of soil moisture extraction by plants, both from the standpoint of reduced transpiration surface and reduced root development. Second, the soil and plants are subject to trampling by the livestock. Trampling often results in a compacted soil surface, which tends to restrict movement of water into the soil (Packer, 1951). When attempting to evaluate variations in soil moisture which are attributable to grazing it is most difficult to determine how much of this variation is caused by foliage removal and how much by trampling. Thus, there is a need to determine the effects of foliage removal, independent of trampling, on soil moisture regime.

As various schemes of grazing periods and intensities are currently in use on public watershed areas, it seemed desirable to study the effects of several clipping intensities and frequencies on soil moisture withdrawal patterns. The objectives of this 2-year study (1966 and 1967) were to investigate the effects of light, medium, and heavy levels of foliage removal (simulated grazing) on the soil moisture regime of two grassland locations.

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Methods and Procedures

An established stand of crested wheatgrass (*Agropyron cristatum*) and alfalfa (*Medicago sativa*) was selected for study at Major's Flat near Ephraim, Sanpete County, Utah. This mid-elevation location, a reseeding and nursery site of the Intermountain Forest and Range Experiment Station, is located at an elevation of 7,100 ft in a Gambel oak (*Quercus gambelii*) type. The site is on a gently sloping west aspect. It was selected as representative of the numerous middle elevation game-range vegetation conversions which are common throughout central and southern Utah.

Another study location was a native, subalpine grassland consisting primarily of Letterman needlegrass (*Stipa lettermani*) and yarrow (*Achillea lanulosa*) and located at the head of Ephraim Creek, on flat terrain. This area at 10,000 ft elevation on the crest of the Wasatch Plateau.

Twenty-seven circular plots (three replications of nine plots), 8 ft in diameter, were established within an area of approximately 80 ft by 100 ft at each location. A soil moisture access tube was installed in the center of each plot to a depth of 5.5 ft. The plots were fenced immediately after access tube installation to exclude grazing.

Each plot was randomly assigned a clipping treatment. These treatments were designated as follows: time or frequency of clipping, monthly (A) or seasonal (B); intensity of clipping was, extreme (E), heavy (H), medium (M), or light (L) foliage removal. Nine inch, 6", 3", and 0" stubble heights were used to obtain light, medium, heavy, and extreme foliage removal intensities at the subalpine location. Stubble heights of 12", 8", 4", and 0" were used at the mid-elevation location. The plots designated as seasonal were clipped at a time corresponding to the onset of the local grazing season. The monthly clippings were conducted throughout the growing season.

Metering to determine soil moisture beneath each treatment was accomplished with a neutron scattering device. Each plot was metered at 0.5, 1.0, 2.0, 3.0, 4.0, and 5.0 foot depths. Metering was carried out on a 2-week schedule throughout the latter portion of the 1966 and entire 1967 growing seasons. Whenever metering or clipping was performed, a 10 foot aluminum bridge was used to span the plots and thus eliminate any possibility of soil compaction.

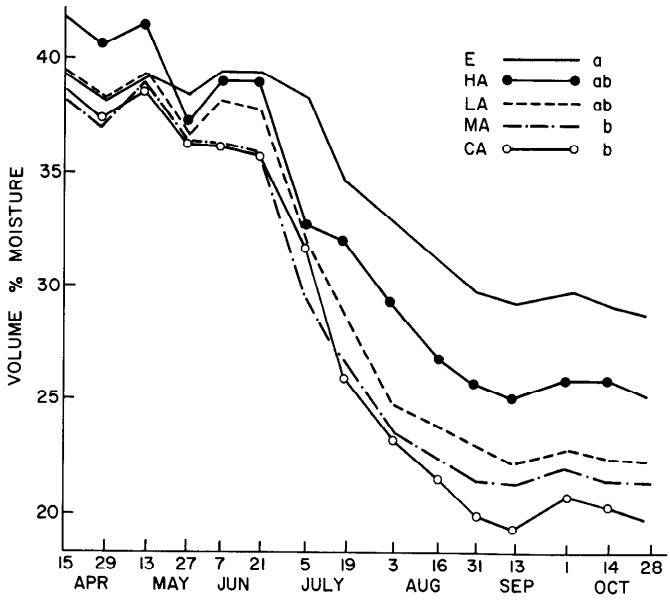

Fig. 1. *Soil moisture regime, clipped monthly, 5-foot averages, pooled over depth and time. Mid-elevation location. E = extreme, H = heavy, M = medium, L = light, and C = control levels of foliage removal. Soil moisture means not matched to the same letter are statistically different (.05 level).*

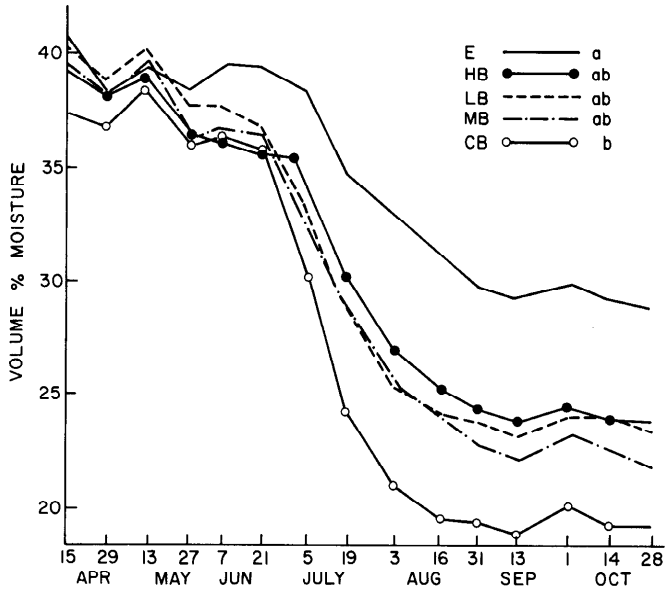

Fig. 2. *Soil moisture regime, clipped seasonally, 5-foot averages, pooled over depth and time. Mid-elevation location. E = extreme, H = heavy, M = medium, L = light, and C = control levels of foliage removal. Soil moisture means not matched to the same letter are statistically different (.05 level).*

Results and Discussion

Mid-elevation (7,100 ft) Locations

Figures 1 and 2 graphically show the integrated 5-ft profile soil moisture values. It is apparent that the extremes of complete foliage removal and no foliage removal are significant in altering the amount of water present in the soil profile. The relative positions of each of the other treatments can be observed from the graphs. In general, the relative order of decreasing soil moisture is from extreme to control (no foliage removal), with the intermediate levels of foliage removal falling in between. The intermediate levels of treatment were not, in all cases, significantly different from the preceding treatment.

Seasonal foliage removal, under these clipping intensities, showed significant differences only between the extreme clipping and control (no clipping) treatments.

In terms of inches of moisture used under each treatment one observes the same general patterns of moisture use (Table 1). By September 14 the control plots had depleted an average of 20.3 inches of water from their 5-ft soil profile.The bare plots (extreme clipping) on the other hand indicated a soil moisture loss of only 14.9 inches over the entire soil profile. The difference apparently is due to vegetative transpirational losses.

Table 1. Soil moisture depletion (inches) by treatment during the 1967 growing season as of September 14, 1967. Mid-elevation location.

Treatments		
Intensity of foliage removal	Time of clipping	Soil moisture depletion
Control (no clipping)	–	20.29
Light	Monthly	19.27
"	Onset of grazing season	19.15
Medium	Monthly	19.21
"	Onset of grazing season	19.81
Heavy	Monthly	19.15
"	Onset of grazing season	19.15
Extreme	–	14.89

Subalpine (10,000 ft) Location

The 1966 and 1967 field seasons began in July. No significant interactions were noted during those field seasons. Apparently, the lack of treatment significance during the study period is due to a combination of natural soil moisture variability and insignificant retardation of root growth, compounded by slight soil moisture stress and a short growing season at this elevation.

Ellison (1954) reported a 16-year study conducted in this area, at similar elevations, in which soil moisture remained above wilting point at the surface 6 inches throughout the entire summer in 6 of the 16 years. Thus, with high residual soil moisture conditions, clipping treatments did not significantly alter the soil moisture throughout the profile. However, examination of the treatment mean comparisons showed that the extreme treatment of complete foliage removal tended

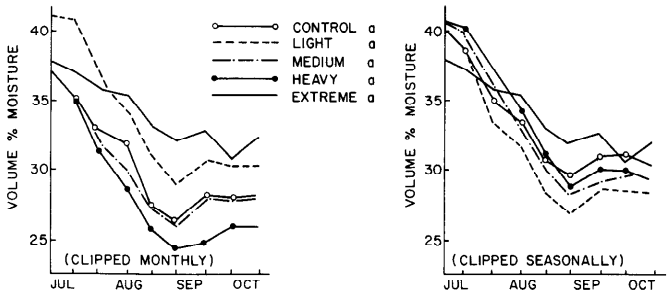

Fig. 3. *Soil moisture regime, 5-foot averages, pooled over depth and time. Subalpine location. Soil moisture means not matched to the same letter are statistically different (.05 level).*

toward higher soil moisture values at the end of the growing season than did any of the other levels of foliage removal (Fig. 3).

One notes that inches of water use throughout the profile at the subalpine study area reflects the on-site conditions (Table 2). The control plots depleted an average of 10.6 inches of soil moisture during the 1967 growing season as of September 14, while the bare plots depleted only 7.0 inches. Since the clipping treatments were not significant, these values represent only the natural variability of the site and possibly an apparent trend.

Table 2. Soil moisture depletion (inches) by treatment during the 1967 growing season as of September 14, 1967. Subalpine location.

Treatments		Soil moisture depletion
Intensity of foliage removal	Time of clipping	
Control (no clipping)	–	10.6
Light	Monthly	10.7
"	Onset of grazing season	11.4
Medium	Monthly	9.9
"	Onset of grazing season	10.9
Heavy	Monthly	9.8
"	Onset of grazing season	9.6
Extreme	–	7.0

Summary and Conclusions

During 1966 and 1967, a range plant clipping study was conducted at a mid-elevation location of 7,100 ft, near Ephraim, Utah. It was found that extreme clipping treatments, i.e., complete denudation, resulted in significantly less soil moisture withdrawal than the control condition. Other clipping intensities also showed reductions in soil moisture withdrawal as compared to the control plots, although in some cases the differences were not statistically significant.

During the same time period a similar study was conducted further up the Wasatch Plateau at a subalpine elevation of 10,000 ft. At this location it was found that clipping treatments did not result in statistically significant changes in soil moisture withdrawal patterns.

It would appear from these studies that extreme grazing may promote increased soil moisture in some instances; however, no watershed manager would advocate complete denudation of the watershed, because of vivid past experiences with floods, mudrock flows, decreased water quality, and poor seasonal control of the water. It would seem from these studies that moderate or light levels of foliage removal will allow livestock use while not significantly changing soil moisture patterns observed under control (no clipping) conditions. It must be remembered that this study was conducted in terms of foliage removal, independent of trampling. Therefore, until the additional effects of compaction are fully explored, direct implications between this study and the absolute response of soil moisture to livestock grazing cannot be drawn.

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