BLUE GRAMA GROWTH AND USE OF SURFACE LAYER AND SUBSOIL WATER

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ABSTRACT

Mechanical treatments which promote water storage in rangeland subsoils alter the depth from which plants remove water. The effects of deeper available water on water loss from the soil and growth of blue grama [(*Bouteloua gracilis* H.B.K.) Lag] were studied in the greenhouse with small weighing lysimeters. The lysimeters contained the same volumes and soil masses but dimensions were varied so depths were 0.1, 0.15, 0.2, and 0.25 m. Twelve plants were grown from seed in each lysimeter. After the plants were established, herbage was harvested and water use was determined. Water loss rate as well as herbage yield decreased from the 0.1 to the 0.25 m deep lysimeters. Deep placement of soil water in rangeland might maintain blue grama during droughts but forage production could decrease.

INTRODUCTION

Contour furrowing and ripping of rangeland increases water movement into deeper soil layers (White et al., 1981). Water stored in the subsoil in comparison to the surface layer may be used less efficiently because roots are longer. Small lysimeters with different thicknesses of soil were used to study the effect of water depth on blue grama herbage yield and water use.

METHODS

Four sizes of redwood boxes were constructed to be used as weighing lysimeters in the greenhouse. The boxes all had the same volume. Their dimensions were 0.173 x 0.173 x 0.1 m deep, 0.136 x 0.146 x 0.15 m deep, 0.136 x 0.11 x 0.20 m deep, or 0.136 x 0.088 x 0.25 m deep. An additional 0.02 m was added to the last dimension so that water would not overflow. Treatments were replicated four

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times. Each lysimeter was filled with 3.5 kg of air-dry, 1:1:1, soil:sand:peat mixture, and 6 mil polyethylene plastic was wrapped around the outside to slow evaporation. A piece of plywood with a 0.136 x 0.088 opening was placed on the soil surface of the wider lysimeters so that similar amounts of surface evaporation from all lysimeters would be likely.

A 0.136 x 0.088 m paper template with 12 evenly spaced holes was used to position 12 germinated blue grama seeds in the soil surface of each lysimeter. The soil water content was kept near field capacity until the blue grama was established and herbage had been harvested three times. Roots had time to grow throughout the lysimeter soil during this period. Water was added to each lysimeter until it flowed freely from the bottom. Excess water drained within a day or two. Each lysimeter was weighed, usually daily, until the blue grama plants began to wilt and then water was once again added. Four cycles of wetting and drying were completed. On the last drying cycle, plants were allowed to dry the soil nearly to permanent wilting or at least dormancy, and the study was terminated. The final lysimeter weight was used as a basis for calculating the plant available water content at each previous weighing.

Blue grama herbage was harvested on May 21, June 17, July 13, and September 6 in 1987. Soil water loss was measured during August 15 to 27, August 30 to September 5, September 7 to October 1, and October 11 to November 2. In the first two periods blue grama foliage was well developed, but during the third period the unharvested stubble and new growth were two cm high initially and growth was slow because day length and sunlight intensity decreased. The herbage was not harvested before the fourth period and was 6 to 8 cm high at the end of the period.

RESULTS AND DISCUSSION

Water use must be evaluated from either the amount held after free water has drained (field capacity) or the amount remaining after plant available water has been removed (wilting point). These two quantities are difficult to measure. In the first phase of this experiment field capacity was used, but water continued to drain from the 0.25 m lysimeter after the other lysimeters had ceased to drain and the plants had removed additional water from the other lysimeters. Based on lysimeter weights as free water drained and the wilting point amount, plant available water was 1.1 to 1.15 kg lysimeter^{-1} at field capacity. The curves showing water use over time (Figure 1) could be extended to this amount as a starting value but the time scale would be different for each lysimeter group, probably spanning 24 to 48 hours. Mean water contents calculated from the air-dry soil and

lysimeter weights were respectively, 35, 12, and 6 percent at field capacity, incipient wilting, and permanent wilting. Mean differences between field capacity and incipient wilting were 21, 22, 24, and 24 percent water for the 10-, 15-, 20-, and 25-cm-deep lysimeters, respectively.

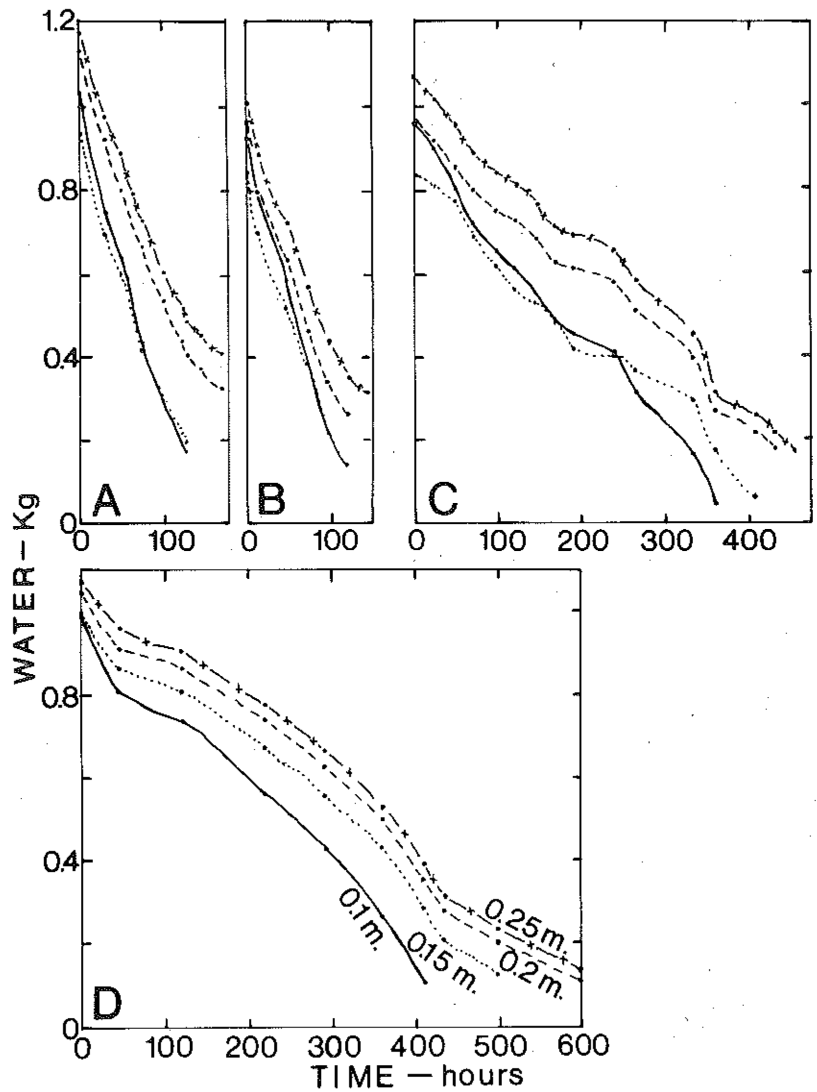

Figure 1. Water evapotranspiration from 0.1, 0.15, 0.2, and 0.25 m deep lysimeters planted to blue grama when the greenhouse was hot--A and B, warm--C, or cool--D.

Water loss was most rapid from the 0.10 m lysimeter and decreased with increasing soil thickness (Figure 1). Weaver (1954, p 163) reported 87.7 percent of blue grama roots were in the upper 0.5 foot (0.15 m) of the soil and 6.7 percent in the next 0.15 m layer. In comparison, western wheatgrass (*Agropyron smithii*) had 51 percent of the roots in the upper 0.15 m. Differences in water loss rate in the different lysimeters may be related to root density differences with depth. These differences were also reflected in the herbage mass which tended to decrease with increasing soil thickness (Table 1). Photosynthetic energy used to extend roots to a greater depth would decrease herbage growth, but after the first four harvests the roots should have extended throughout the soil. Weaver (1954, p 161) indicated that 45% of blue grama roots near the crown were still alive after three growing seasons, so die back of major roots is probably not a factor. Regeneration of secondary roots may have used some photosynthetic energy which otherwise would have increased top growth.

Table 1. Blue grama herbage mass on four harvest dates from plants grown on soil that was 0.10, 0.15, 0.20, or 0.25 m deep.

Harvest	Herbage mass (gm) Soil rooting depth (m)				Orthogonal Comparison* Columns		
	0.10	0.15	0.20	0.25	1vs2,3,4	2vs3,4	3vs4
1 (5/21/87)	6.1	6.5	6.4	4.6	NS	0.10	0.01
2 (6/17/87)	6.0	4.9	4.3	3.8	0.01	0.05	NS
3 (7/13/87)	6.3	5.2	4.4	4.7	0.05	NS	NS
4 (9/6/87)	11.3	10.5	8.4	9.1	0.10	0.10	NS

*Orthogonal comparison significantly different at 0.10, 0.05, or 0.01 probability level or NS, not significantly different.

CONCLUSION

Storage of water in lower soil layers rather than in upper layers would cause blue grama herbage production to decrease. However in extreme droughts, deeper water storage should extend the period before permanent wilt or dormancy occurs so that a precipitation event could replenish surface layer water. Contour furrowing or ripping of rangeland would not benefit blue grama as much as species such as western wheatgrass, which has more roots distributed in the subsoil.

LITERATURE CITED

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