# Influence of Grass Vegetation on Water Intake of Pullman Silty Clay Loam

**RICHARD F. DEE, THADIS W. BOX AND ED ROBERTSON, JR.**[1]

*Research Assistant, Professor of Range Management, and Research Assistant, respectively Ttxas Technological College, Lubbock.*

### Highlight

**Water infiltration rates varied under different plant communities. The soil under blue grama absorbed 8.4 inches of water in a 2-hour period compared with 5.6 inches for windmill grass, 3.8 inches for annual weeds and 2.1 inches for buffalograss. High positive correlations existed between water intake and the amount of standing vegetation, litter, and litter and vegetation combined.**

Most studies show that water intake under any type of vegetation is greater than under bare ground. There is good evidence that the type of vegetation may also influence the rate and amount of water entering the soil. Box (1961) showed infiltration rates on Victoria clay were least under bare soil, increased under brush cover, and were greatest under grass sod. Thomas and Young (1954) found significant differences in infiltration rates under buffalograss (*Buchloe dactyloides* (Nutt.) Engelm.), curlymesquite grass (*Hilaria belangeri* (Steud.) Nash) and tobosa grass (*Hilaria mutica* (Buckl.) Benth.). Mazarak and Conrad (1959) working in Nebraska, found rates of water infiltration under four grass species increased from buffalograss, to blue grama (*Bouteloua gracilis* (H.B.K.) Lag. ex Steud.), to sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.), to big bluestem (*Andropogon gerardi* Vitnam.)

Total amount of vegetation, litter, and soil conditions may also influence water intake on a given soil. Duley and Domingo (1949) reported that the amount of grass cover is a greater factor in determining water intake than is soil type. The amount of standing vegetation (Johnston, 1962; Glover, Glover, and Swynne, 1962) and the dead material, or mulch, (Dyksterhuis and Schmutz 1947) may influence the rate and amount of water intake.

During the summers of 1963 and 1964 studies were conducted on the Texas Technological College Research Farm at Pantex, to determine the effect of species within a late seral stage of a mixed prairie and the effect of selected seral stages upon water intake on Pullman silty clay loam. The Research Farm is located on the old Pantex Ordnance Plant in Carson County. The original vegetation was a mixed prairie typical of the High Plains of Texas. Numerous small communities representing various stages of disturbance and successional recovery are located on the farm.

### Methods and Procedures

Several distinct stages of succession were selected adjacent to each other on Pullman silty clay loam. In

[1] *Dee is presently range conservationist, Forest Service USDA, Steamboat Springs, Colorado; and Robertson is range manager, Lincoln County Livestock Co., Roswell, New Mexico.*

**Table 1. Vegetation and soil moisture characteristics under four grasses in a mixed prairie seral stage.**[a]

| | Silver bluestem | Sand dropseed | Blue grama | Buffalo-grass |
|---|---|---|---|---|
| Herbage lb/acre | 21600 | 7930 | 3930 | 1670 |
| Litter lb/acre | 10360 | 9300 | 2800 | 2200 |
| Water intake in/hr | 2.51 | 2.08 | 2.56 | 0.84 |
| Penetration (in) | 21.0 | 19.3 | 16.0 | 11.5 |
| % soil moisture | 18.90 | 20.73 | 11.43 | 13.10 |

[a] Means connected by a single line are not significantly different from each other at the .05 level.

order to study the effects of individual species, small, uniform stands of buffalograss, blue grama, silver bluestem *(Andropogon saccharoides* Swartz), and sand dropseed *(Sporobolus cryptandrus* (Torr.) A. Gray) were staked out in a late development stage. Three replications of infiltration tests using the concentric ring method described by Leithead (1950) were established on each species stand. At each infiltration location soil samples were collected from the upper 6 inches of the soil at the time of the test. Percent soil moisture was determined by the gravimetric method. Surface soil texture at each location was checked to determine if the textural qualities were within the range of Pullman silty clay loam. The amounts of standing herbage and of litter were determined by clipping the vegetation and mulch from a 0.96 $ft^2$ plot immediately below the inner ring of the concentric ring. After the infiltration test, the depth of moisture penetration was determined by digging to dry soil.

The influence of combinations of plants was studied by establishing 12 replications of the sampling procedure outlined above on each of 4 plant communities representing successional stages in the recovery of the local mixed prairie: an early stage of annual weeds dominated by *Kochia scoparia* (L.) Schrad, an early perennial grass stage dominated by windmill grass *(Chloris verticilata* Nutt.) and sand dropseed, a late perennial stage dominated by blue grama, and a regressed perennial stage dominated by buffalograss. All communities were located within 100 yards of each other on typical Pullman silty clay loam.

Differences between community attributes were shown by analysis of variance. Relationships between water intake and community attributes were shown by correlation coefficients.

**Results and Discussion**

The amount of standing herbage was significantly different between the 4 species stands in the late developmental stage (Table 1). The amount of litter on the silver bluestem stand and the sand dropseed stand was significantly greater than on the blue grama and buffalograss stands. There was no significant difference between the water intake or depth of moisture infiltration between stands of silver bluestem, sand dropseed, and blue grama. Both water intake and depth of penetration of soil moisture were significantly less for buffalograss than for the other species.

The poor infiltration rates under buffalograss were further observed during grass interseeding in the immediate area. When the interseeder encountered a colony of buffalograss, the soil was extremely hard and dry underneath the shortgrass sod. Soil moisture precentages in the upper 6 inches of buffalograss and blue grama were significantly less than under sand dropseed and silver bluestem (Table 1).

Both total amount of water absorbed and infiltration rate increased with an increase in stage of succession (Fig. 1). Almost 3 times as much water infiltrated the late perennial grass stage as entered the soil under annual weeds. The infiltration rate for buffalograss was less than for any stage in the secondary successional pattern. Extremely low infiltration rates for buffalograss have been reported by Thomas and Young (1954) on the Edwards' Plateau of Texas, Box (1959) on the Texas Coastal Prairie, and Mazarak and Conrad (1959) in Nebraska. In all cases, buffalograss represented a regressed stage. Apparently,

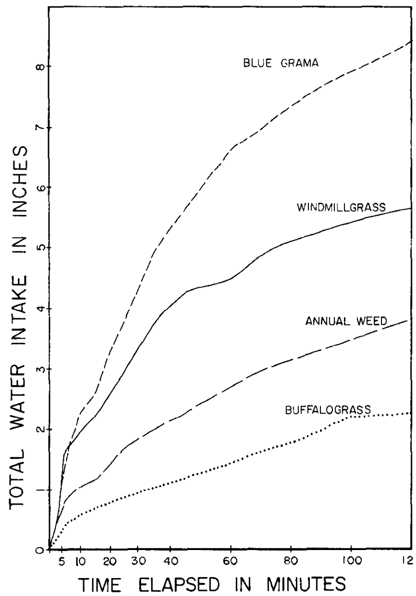


FIG. 1. Water intake curves under four successional stages on Pullman silty clay loam near Amarillo, Texas.

water relationships in the regressed stage are poorer than in the developmental stages.

There was no significant difference in water intake under blue grama and windmill grass for the first 35 minutes of the 2-hour test. After 35 minutes, the rate of intake for windmill grass sod declined while the rate under blue grama remained relatively constant. Total intake was significantly greater under blue grama than under windmill grass.

After the first 5 minutes, there was no significant difference in the rate of infiltration between annual weeds and buffalograss. However, the total amount of water entering the soil during a

2-hour period was slightly higher under annual weeds than under buffalograss.

Blue grama was superior to the other species studied in promoting water intake into Pullman silty clay loam. Windmill grass was equally effective during the first half hour, but was not equal to blue grama for the entire period. Annual weeds and buffalograss were inferior to blue grama and windmill grass in aiding infiltration on rangelands.

Poor condition ranges on Pullman silty clay loam evidenced either by a low successional stage of annual weeds or a regressed stand of buffalograss, were inferior to fair or good ranges in aiding infiltration. Ranches with poor condition ranges or low successional stages may be forced to ranch on less effective moisture than their neighbors under the same rainfall condition.

The amount of water entering the soil was positively correlated ($p < .01$) with the amount of standing vegetation and litter on the soil (Table 2). With each additional unit of standing vegetation or mulch, infiltration was directly increased in all successional stages. Johnston (1962) in Alberta and Glover, et al. in Africa (1962) reported similar results.

Infiltration rates in the Pullman silty clay loam are determined, in part, by the species of vegetation, the stage of succession, the amount of current vegetation growth, and the amount of litter from past years. In general, infiltration is increased under plants that occupy a higher level in the successional pattern. Within a species stand, infiltration increases with the amount of standing vegetation and mulch. Therefore, management for increased water efficiency should include consideration of type of vegetation and the amount remaining on the soil.

**Table 2. Correlation coefficients between water intake of Pullman silty clay loam and vegetative attributes of four plant communities.**

| Attribute correlated to water intake | Blue grama | Windmill grass | Annual forbs | Buffalo-grass |
|---|---|---|---|---|
| First 5 minutes | | | | |
| Standing herbage | .964** | .983** | .979** | .917** |
| Litter | .822** | .987** | .865** | .799** |
| Litter & herbage | .705* | .995** | .929** | .904** |
| After 2 hours | | | | |
| Standing herbage | .979** | .928** | .972** | .943** |

* r values significant at .05 level.
** r values significant at the .01 level.

## Summary

During the summers of 1963 and 1964, infiltration tests were made with concentric rings on Pullman silty clay loam near Amarillo, Texas. The soil under blue grama absorbed 8.4 inches of water in a 2-hour period compared with 5.6 inches for windmill grass. In general, infiltration rates increased with the increasing position of a plant in the successional scale, the stage of succession of the community, the amount of standing vegetation, and litter from previous years. Infiltration rates in soil under different successional stages were significantly different from each other. Highly significant positive correlations were shown between the amount of water intake and the amount of standing vegetation, litter, and litter and vegetation combined.

## LITERATURE CITED

Box, T. W. 1959. Relationships between soils and vegetation on four range plant communities on the Welder Wildlife Refuge. Ph.D. Dissertation, Agr. and Mech. College of Texas. 100 p.

Box, T. W. 1961. Relationships between plants and soils of four range plant communities in South Texas. Ecology 42:794-810.

Duley, F. L., and C. R. Domingo. 1949. Effects of grass on intake of water. Neb. Agr. Exp. Sta. Res. Bull. 159. 15 p.

Dyksterhuis, E. J., and E. M. Schmutz. 1947. Natural mulches or "litter" of grasslands: with kinds and amounts on a southern prairie. Ecology 28:163-197.

Glover, P. E., J. Glover, and M. D. Gwynne. 1962. Light rainfall and plant survival in E. Africa. Ecology 50:199-206.

Johnston, A. 1962. Effects of grazing intensity and cover on water-intake rate of fescue grassland. J. Range Manage. 15:79-82.

Leithead, H. L. 1950. Field methods used to demonstrate range conservation. J. Range Manage. 3: 95-99.

Mazarak, A. P., and E. C. Conrad. 1959. Rates of water entry in three great soil groups after seven years in grasses and small grains. Agron. J. 51:264-267.

Thomas, G. W., and V. A. Young. 1954. Relation of soils, rainfall, and grazing management to vegetation, Western Edwards Plateau of Texas. Tex. Agr. Exp. Sta. Bull. 786. 22 p.