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# Interception of Rainfall by Tarbush

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## Abstract

**The objective of this study was to determine the interception by tarbush of artificially applied rainfall. Twelve tarbush shrubs were collected near Las Cruces in southern New Mexico to obtain a representative sample of shrub size classes. Simulated rainfall was applied at the rate of 6 cm/hr for 30 min. Canopy cover of the tarbush community was determined from 10 line intercept transects 30.48 m long. A stepwise regression analysis using the minimum $R^2$ improvement technique was used to examine the effects of plant parameters on interception. The "best" one variable model was shrub green weight, which accounted for 75% of the variability of the intercepted rainfall. Extrapolating the calculated interception of artifically applied rainfall to the native stand of tarbush with 15.2% canopy cover indicated that 0.5 mm of rainfall would be intercepted from a 30 mm rainfall event. Disregarding rainfall events of less than 3.0 mm, an average of 8.5 mm of rainfall would be intercepted by the tarbush community or 6.7% of the average rainfall from May through October.**

The hydrologic cycle has been the subject of much research because of its importance in arid land ecosystems and is probably the best known of the abiotic cycles. Interception, a process affecting the disposition of water in the hydrologic cycle, can be defined as the process of aerial redistribution of precipitation by vegetation (Collins 1970). Although some information is available (Zinke 1966, Helvey 1967, Helvey and Patric 1965) concerning interception by trees, there is a general paucity of information on interception by arid and semiarid rangeland shrubs. Some reasons for this lack of information may be the small, inconspicious stature of shrubs when compared to trees and also, the vegetation cover is often less than 50%, giving the appearance of individual plants rather than a solid block as would a dense stand of trees.

The few studies available on interception by shrubs indicated that saltbush (*Atriplex argentea* Nutt.) 46 cm high and in full bloom occurring in dense stands intercepted 50% of a 150 mm rain applied in 30 minutes; burning bush (*Kochia scoparia* [L] Schad.) 76 cm high intercepted 44% (Collins 1970). Hull (1972) and Hull and Klomp (1974) using 10-cm diameter gages determined interception for dense stands of big sagebrush (*Artemisia tridentata* Nutt.) for 2 locations in Idaho. Rainfall amounts from gages placed in heavy brush and brush-free areas were compared. The heavy brush intercepted about 30% of the rainfall between April 1 and October 30. The potential interception per rainfall event was determined to be 1.0 mm by spraying 10 individual plants with water. Rowe (1948) and Hamilton and Rowe (1949) reported that interception amounted to about 8% of the annual rainfall for the chaparral type in central and southern California.

West and Gifford (1976) determined mean interception rates of individual plants of big sagebrush and shadscale (*Atriplex confertifolia* [Torr. and Frem.] Watts) to be 1.5 mm for both species when averaged over 3 sampling dates and 2 intensities. Utilizing this information and the average rainfall for April 1 to November 30 for northern Utah, but ignoring storm events less than 1.5 mm, they determined an average of 5.9 mm of rainfall to be intercepted by big sagebrush and shadscale communities. This amounted to approximately 4% of the total precipitation which fell as rain.

The objective of this study was to examine interception of artificially applied rainfall by tarbush (*Flourensia cernua* DC) for elucidating and improving the understanding of this phenomenon in hydrologic processes. Tarbush occurs on 13.25 million acres of rangeland in the United States. (Platt 1959).

## Methods

The interception studies were performed near Las Cruces in southern New Mexico. Twelve individual plants were subjected to simulated rainfall from a sprinkling type rainfall simulator. Rainfall intensity was 6 cm/hr for 30 min. This high intensity was selected to insure that water loss by evaporation would be minimized since we were interested in actual rainfall interception and storage on the canopy. Parameters determined for each shrub included: (1) crown cover, (2) shrub height, (3) shrub green weight, (4) green weight of stems, (5) oven-dry weight of stems, (6) green weight of leaves, (7) oven-dry weight of leaves, (8) number of stems, (9) leaf area, and (10) shrub volume. The shrub crowns were elliptical rather than circular in shape thus both maximum and minimum diameters were measured for determining crown area. After the measurements of crown area were made the shrub was severed at the soil surface, transported to the laboratory, weighed on a beam balance, and subjected to simulated rainfall. After 30 minutes the shrub was reweighed and the difference in weight recorded as intercepted rainfall. Leaves were stripped from the stems and the leaf area determined using a leaf area meter. Green weight of leaves and stems was measured and the leaves and stems oven-dried at 60° C for 24 and 48 hours respectively, and then reweighed to determine oven-dry weight. Crown cover was determined using the equation for an ellipse. Shrub volume was calculated by multiplying crown area by shrub height.

The average crown cover of the tarbush community was determined from 10 line intercept transects 30.48 m long. Utilizing the interception storage data determined from individual shrubs and data from the line transects, rainfall interception was calculated for the tarbush community.

## Results and Discussion

Measured interception of simulated rainfall by tarbush was 3.0 mm. This amounted to 10% of the applied rainfall. A stepwise regression analysis using the minimum $R^2$ improvement procedure (1979) was used to examine the effects of plant parameters on interception. This method determines the "best" one-variable model, the "best" two-variable model, and so forth for describing the influences of the measured plant variables on the water intercepted. The best one variable model ($R^2$=.75) was shrub green weight, which accounted for 75% of the variability of the intercepted rainfall (Fig. 1). A further example is the three variable model ($R^2$=.89) which accounted for 89% of the variability. This model includes shrub green weight, crown area, and stem dry weight.

Aston (1979) reported the canopy storage capacity to be the most important plant parameter in the interception process. Leonard (1965) reported that storage capacity is a function of leaf area, leaf area index, storm intensity, and surface tension forces resulting from leaf surface configuration, liquid viscosity, and mechanical activity. Canopy storage can be expressed either as depth (mm)

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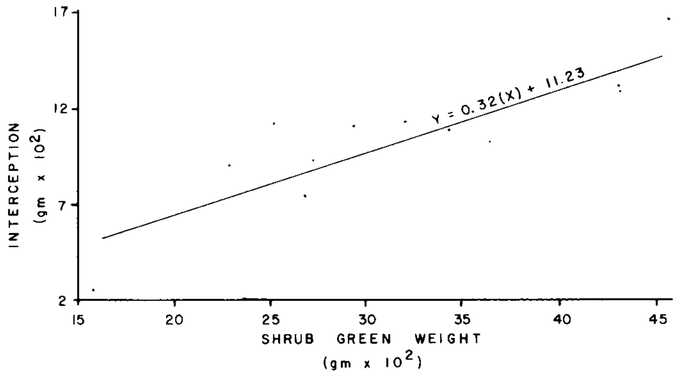

**Fig. 1.** *Intercpetion versus shrub green weight for tarbush subjected to simulated rainfall.*

of water per crown projection area on the soil surface or as depth of water per unit area of the representative plant community.

The change in water detained on the plant canopy, assuming zero evaporation, has been described by Aston (1979) as:

$$\frac{\Delta C}{\Delta T} = (1 - p) R - \exp (a + bC)$$

where:

a = empirically determined constant
b = empirically determined constant
C = quantity of water detained on the canopy
R = rainfall intensity
p = proportion of rainfall passing through the canopy
T = time.

It was considered that the leaves were the major plant tissues intercepting water and it would be the depth of water on the leaf surface which determines the rate of water loss. Interception storage capacity is a function of the amount and configuration of the intercepting leaf surfaces and the storage is linearly related to the leaf area. Under field conditions and natural rainfall the amounts of intercepted water would be influenced by wind and this would need to be assessed. The impact of raindrops may influence water flow across the leaf surface and also the leaf angle. These factors, plus others which may influence the balance of leaf surface tension forces with gravitational forces, will all effect water storage on the leaves.

Total interception loss is far from an insignificant quantity of water (Helvey and Patric 1965). Losses are proportionally smaller in regions of lower rainfall when compared to regions of higher rainfall, but losses may be more important in arid regions simply because less water is available. The amount of precipitation received from individual rainfall events is characteristically small in arid regions. Interception would unquestionably subtract a relatively large proportion of the total amount of rainfall received from these events.

The crown cover of a native tarbush community was calculated to be 15.2% from 10 line transects 30.48 m long at the site from which the shrubs were selected for this study. Thus, given a storm of sufficient volume and intensity to completely wet these shrubs, they would intercept 3.0 mm of rainfall. Extrapolating the calculated interception of artificially applied rainfall to the native stand of tarbush with 15.2% crown cover indicated that approximately 0.5 mm of rainfall would be intercepted from a 30 mm rainfall event. The annual average precipitation for the experimental site is 230 mm. Approximately 55% or 126 mm of this amount is received from rainfall events of varying amounts and intensities during the summer when the tarbush is in full leaf and has maximum interception potential.

The intercepted precipitation would be held above the soil surface in proportion to the amount of canopy cover and would be subjected to evaporative losses at a rate exceeding that of the soil surface. There was an average of 17 events greater than 3.0 mm that occurred each year from May 1 to October 31 from 1970 to 1980 based on National Oceanic and Atmospheric Administration records. Disregarding rainfall events of less than 3.0 mm an average of 8.5 mm of rainfall was intercepted by the tarbush community. This amounts to 6.7% of the average rainfall from May through October.

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