

Occurrence and Distribution Characteristics of Canopy Throughfall of *Caragana intermedia* in Desert Steppe Postprint

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Abstract

To further elucidate the eco-hydrological mechanisms underlying vegetation stability maintenance in desert grassland strip plantations of *Caragana intermedia*, a comparative study of canopy throughfall between row-planted and scattered *Caragana intermedia* was conducted. The results indicate: Both exhibited significant responses to precipitation variation, yet no significant difference was observed between them. The throughfall percentage ranged from 25.6%~96.5% ($C_v=23\%$) for scattered and 25.4%~96.1% ($C_v=19\%$) for row-planted *Caragana intermedia*, with mean throughfall amounts of 7.55 mm and 7.40 mm, respectively. Throughfall amount exhibited highly significant linear regression relationships with rainfall amount, rainfall duration, and rainfall intensity, whereas throughfall percentage primarily showed power function relationships with precipitation characteristic parameters. Significant spatial heterogeneity characterized throughfall distribution beneath the canopy. Throughfall percentage generally increased linearly with distance from the shrub base. 'Dry zones' were concentrated at the base of scattered *Caragana intermedia* shrubs, with percentages gradually increasing outward; row-planted *Caragana intermedia* exhibited a mosaic distribution of multiple dry zones and rain foci.

Full Text

Occurrence and Distribution of Throughfall under *Caragana intermedia* Canopy in Desert Steppe

Abstract: The rainfall redistribution through canopy is of important eco-hydrological significance for the survival of shrubs. The *Caragana intermedia* plantation in large area in desert steppe is mostly zonal, and the growth mode and morphological characteristics of natural sporadic *C. intermedia* plants are

quite different. Whether this difference affecting the distribution of precipitation through canopy is necessary to be further verified. The eco-hydrological mechanism of vegetation stability of adult *C. intermedia* plantation in desert steppes should be further understood. The occurrence and distribution of throughfall under *C. intermedia* canopy in two different growth patterns (scattered and row distribution) were compared and analyzed by monitoring precipitation redistribution in 18 different rainfall events in 2016. The results showed that the throughfall percentage of scattered *C. intermedia* plants was 25.6%–96.5%, that of row ones was 25.4%–96.1%, and the coefficients of variation was 23% and 19% respectively. The mean values of throughfall were similar and for 7.55 mm and 7.40 mm respectively. Rainfall, rainfall duration, and rainfall intensity had a very significant linear relationship with throughfall depth, but the relationship between throughfall percentage and characteristic parameters of precipitation was complex, which was dominated by power function, and the fitting significance of scattered *C. intermedia* plants was better than that of row ones. The distribution of throughfall under canopy was spatial heterogeneity. Generally, throughfall percentage was increased linearly with the increase of distance from shrub base. The “dry area” of throughfall was concentrated at the base of scattered *C. intermedia* plants, however, the distribution of row ones was more complex. Mosaic distribution of dry areas and rainpole was found for row *C. intermedia* plants. The different growth patterns of *C. intermedia* plants did not significantly affect the throughfall depth, but the spatial distribution pattern of throughfall under canopy was significantly changed, which might further affect the process of the conversion from precipitation to soil water.

Keywords: throughfall; *Caragana intermedia*; spatial heterogeneity; rainfall; desert steppe; Yanchi county

Introduction

Rainfall redistribution through canopy interception plays a crucial eco-hydrological role in shrub survival within arid ecosystems. While large-area *Caragana intermedia* plantations in desert steppe typically exhibit zonal patterns, naturally sporadic *C. intermedia* plants show distinct growth modes and morphological characteristics. The extent to which these differences influence canopy precipitation distribution requires further investigation, as does the eco-hydrological mechanism underlying vegetation stability in mature *C. intermedia* plantations.

Methods

Data Collection and Analysis

Throughfall occurrence and distribution were monitored under *C. intermedia* canopy for two growth patterns: scattered distribution and row distribution. Precipitation redistribution was measured during 18 rainfall events in 2016. Statistical analyses were performed using SPSS 20.0 (SPSS Inc., Chicago, USA).

Regression relationships were developed to examine throughfall responses to rainfall characteristics, and spatial variability was quantified using coefficients of variation.

Results

Throughfall Characteristics

Scattered *C. intermedia* plants exhibited throughfall percentages ranging from 25.6% to 96.5% (coefficient of variation = 23%), while row-planted individuals ranged from 25.4% to 96.1% (coefficient of variation = 19%). Mean throughfall depths were similar between patterns at 7.55 mm and 7.40 mm, respectively.

Relationships with Rainfall Parameters

Rainfall amount, duration, and intensity showed highly significant linear relationships with throughfall depth. However, the relationship between throughfall percentage and precipitation characteristic parameters followed a more complex power function. The model fit was superior for scattered plants compared to row-planted ones.

Spatial Distribution Patterns

Throughfall distribution under canopy displayed marked spatial heterogeneity. Throughfall percentage generally increased linearly with distance from the shrub base. For scattered *C. intermedia* plants, throughfall “dry areas” concentrated near the stem base. In contrast, row-planted *C. intermedia* exhibited more complex distribution patterns, with mosaic arrangements of dry areas and rain poles.

Growth Pattern Effects

While growth patterns did not significantly affect throughfall depth, they substantially altered the spatial distribution of throughfall under canopy. This modification may consequently influence the transformation process from precipitation to soil water.

Discussion

The observed differences in spatial distribution patterns between scattered and row-planted *C. intermedia* have important implications for understanding water resource partitioning in desert steppe ecosystems. The mosaic distribution pattern under row plantations suggests more complex hydrological dynamics that warrant further investigation.

[**Figure 2: see original paper**] Regression relationship between throughfall, throughfall percentage and rainfall characteristic parameters

[**Figure 3: see original paper**] The change of throughfall percentage with the distance to shrub base

[**Figure 4: see original paper**] Spatial distribution of throughfall percentage under scattered Caragana intermedia plants (took B4 as an example)

[**Figure 5: see original paper**] Spatial distribution of throughfall percentage under row Caragana intermedia plants (took A2 as an example)

Note: Figure translations are in progress. See original paper for figures.

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