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مقاله پژوهشی

Investigating the Influence of Pioneer Plants' Stemflow on Soil and Concomitant Plants in Arid Zones

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Abstract

This study set out to investigate the influence of stemflow of *Anabasis aphylla* L**.** and *Pteropyrum aucheri* Jaub. & Spach on soil and concomitant plants in Central Iran. To this end, the stemflow was measured on ten mature plants with five replicates per species from March 21, 2014, to May 2, 2014. Moreover, the volume of collected flows was measured after each rainfall using measuring cylinders. Then, the volume was divided by the crown area to find the flow depth for each stem. On the other hand, to investigate the influence of stemflow on nursing understory plants, the plants were treated with and without stemflow at different depths. In this regard, the *Lepidium sativum Linn* was selected as the intended species to investigate the stemflow nursing effect of *A. aphylla* and *P. aucheri*. The results of the study indicated that the average rate of stemflow in *P.aucheri* and *A.aphylla* was 18.5% and 13.4% of gross rainfall, respectively. Furthermore, the average funneling ratio was found to be 29 and 39.9 for *A.aphylla* and *P.aucheri,* respectively. The moisture, OM, and MWD obtained for the soil under *A.aphylla* and *P.aucheri* were significantly different when treated with stemflow in depths of 80 and 100 cm from the case when the underlying soil of the species was treated without streamflow. However, while the variations in soil's pH were not significant at different depths in both treatments and bare soil, the variations showed a slight increase in *A.aphylla* compared to *P.aucheri* and bare soil. On the other hand, the investigation of the two treatments in terms of EC values revealed that salinity was higher in the treatment without stemflow. It was also found that the efficiency of stemflow nursing was up to 10 cm and 7 cm in radius in *P.aucheri* and *A.aphyll,* respectively.

Keywords: Stemflow, Pioneer Plants, *Anabasis aphylla***,** *Pterpyrum aucheri,* Arid Land.

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1. Introduction

As the mere source of water in most semiarid regions, rainfall plays a crucial role in the survival of vegetation and ecosystem development (Wang et al., 2013). The classification of rainfall into interception, throughfall, and stemflow is affected by various factors such as rainfall characteristics (the amount, intensity, and duration of the rainfall and the temporal distribution of rain events), meteorological conditions (wind speed, air humidity deficit, and net radiation), and vegetation (type, canopy height, canopy area, basal area, branch angle, leaf area index, bark roughness, and leafed or leafless) (Levia and Frost 2003). Stemflow refers to the part of precipitation that flows down the stems or trunks of plants once the precipitation is intercepted (Zhang et al., 2013). As an adaptive mechanism developed by plants to survive periods of drought (Garcia-Estringana et al., 2010), stemflow is eco-hydrologically significant for plant growth in water-restricted ecosystems, being increasingly attended by scholars (Schwärzel et al., 2012). For instance, Gersper and Holowaychuk (1971) evaluated the influence of forest canopy tree stemflow on the chemical properties of soil.

In recent decades, the factors involved in the generation of stemflow have been studied in various climatic regions. For instance, Levia and Germer (2015) carried out a comprehensive review of the dynamics of stemflow generation and it-environment interactions in forests and shrublands. These reviews have greatly developed our knowledge concerning the significance of stemflow for the hydrology of the vadose zone and its biotic and abiotic contributing factors.

In this regard, Xiao and McPherson (2011) reported that plant morphology exerted a notable influence on stemflow generation in three tree species (*Ginkgo biloba*, *Liquidambar styraciflua*, and *Citrus limon*) existing in California. Swffer et al. (2014) compared stemflow generation of two co-occurring, morphologically distinct tree species in a semi-arid environment in Australia and found that *Allocasuarina verticillata* enjoyed a larger stemflow funneling ratio than *Eucalyptus diversifolia*. Zhang et al. (2015) reported a significant difference in stemflow production between xerophytic shrubs (*Caragana korshinskii* and *Artemisia ordosica*) in a rain-fed revegetated desert ecosystem in China.

Most recently, Yuan et al. (2017) found that *Caragana korshinskii* generated greater stemflow at all precipitation levels than *Salix psammophila*, and precipitation rate was the most influential meteorological factor on stemflow generation. In addition, Yang et al. (2019) investigated stemflow generation among tree and shrub species native to the Chinese Loess Plateau.

However, few qualitative and quantitative studies have been carried out on the stemflow of xerophytic shrubs and its effects on soil and concomitant plants in such an ecosystem. Therefore, this study sought to measure stemflow and the factors affecting its production in two shrub and brush species and investigate the influence of stemflow on some physical and chemical properties of the soil.

Determining the significance of individual canopy structure metrics on stemflow generation is a difficult task. However, the elaboration of the role and significance of individual canopy structure metrics can advance our knowledge regarding stemflow 's ecological roles/relevance and the dynamics of stemflow generation. Therefore, the findings of this study concerning the stemflow effects of pioneer plants in semiarid and arid zones can provide valuable insights for managers involved in planning, establishing, and creating sustainable vegetation in arid areas.

In fact, the findings of the study can contribute well to the following fields: Water Resource Management, Plant Species Selection, Eco-hydrological Considerations, Soil Improvement Strategies, Salinity Management, Afforestation Planning, Drought Adaptation Strategies, and, Educational and Outreach Programs.

In summary, it can be argued that the findings of the study will provide a scientific basis for informed decision-making on vegetation management, aiding managers in implementing projects that promote sustainability and resilience in arid and semiarid ecosystems.

2. Materials and method

2.1. Study Area

Located in the bushlands of northeastern Isfahan in Central Iran, the study area possesses the coordinates 51°31´ E and 32°43´ N and an altitude of 1570 meters above sea level (fig1). Characterized by the warm and dry climate, the area enjoys an average annual precipitation of 120mm which reaches its peak in March and April. Moreover, the average annual temperature of the area is 16°C.

Figure (1): Geographical location in Google Earth software

Table (1): Soil physical and chemical characteristics

% Gravel	% $CaSo_4$	% $CaCo_3$	CEC	% OC	K g/kg	P g/kg	% N	Tex se			EC	PH
								Si	S	C		
50-65	0/08	31/5	16/5	0/17	175	8/3	0/02	61	18	21	1/8	7/5

2.2. Species Morphology

Anabasis aphylla and *Pterpyrum aucheri* are considered important rehabilitation species in dry areas (Jaafari et al., 2009), both of which are native to central Iran, being characterized by the bush and shrub growth forms, respectively. Table 2 shows the morphologic parameters of the two studied species according to Martınez-Meza and Whitford (1996).

Table (2): Mean values (± standard error) of morphologic parameters for two studied species

Morphologic parameters	*P. aucheri*	*A. aphylla*
Height (cm)	82.2±0.2	45.2±0.2
Branch angle (degree)	63.2±6	36±5
Crown area (m^2)	56.7±0.0	28.4±0.5
Basal area (cm^2)	12.5±2.1	5.3±9.1

Figure (2): A view of the case study

2.3. Rainfall Measurement

The rain gauge was located 20 meters away from the study area, where the daily precipitation was measured every morning. The depth of precipitation was also calculated after each rainfall event using a simple rain gauge located in the study area.

2.4. Stemflow Measurement

The stemflow rate was measured from 21 March 2014 to 21 May 2014 on 10 mature shrubs and bush species of *A. aphylla* (Fig. 3a) and *P. aucheri* with 5 replications for each species (Fig. 3b). The collection system included plastic funnels fixed around the stem using silicone glue. Moreover, the funnels were connected to collective bottles through plastic tubes. Volumes of collected flows were measured using measuring cylinders after each rainfall. The volume rate was then divided by the crown area to identify the flow depth for each stem.

Figure (3): a) A. *aphylla*; b) P. *aucheri*

2.5. Funneling Ratio

Following Herwitz (1986) and Levia and Germer (2015), the study calculated the stemflow funneling ratio per basal area. While this parameter does not refer to the infiltration area at the soil surface, it has the advantage of being related to easily measurable data. The ratio is expressed by Eq. (1).

$$F = \frac{Sy}{B \times P} \quad (1)$$

Where, Sy, i.e., the stemflow generation, refers to the stemflow volume per tree in L; P stands for the precipitation depth in mm, and B is the basal area of the stem at breast height in m^2.

2.6. Soil Analysis

Soil samples were collected from layers 0–100 cm to measure chemical and physical properties of the soil of the understory of *Anabasis aphylla, Pterpyrum aucheri,* and bare soil. The EC and pH were determined in the saturated extract (Slavich and Petterson, 1993). Moreover, the organic matter was measured using the Walkley and Black method (1914). In addition, the aggregate stability was determined using the Le Bissonnais method (Le Bissonnais, 1996). Finally, soil water content was measured via TDR to determine the effect of stemflow on soil water content recharge.

2.7. Artificial measurement of stem flow

A foggy system was used to compare the stemflow natural data with the artificial data as well as investigate some of the effective factors on stemflow rate such as height and crown area. Therefore, three bases from each species were selected and the volume of stemflow produced with three replications was measured.

2.8. Nursing Effect Experiment

Martınez-Meza and Whitford (1996) suggest that stemflow channelization by the roots of plants in semi-arid and arid areas and the subsequent infiltration of a relatively large volume of water allows the plants to uncouple themselves from short-term climate variations. The process by which stemflow is concentrated at the base of plants to enter soil moisture storage for periods of adverse climatic conditions is referred to as the 'nursing' effect (Goodall, 1965).

To investigate the role of stem flow on its nursing effect in the understory, two treatments were applied in each species of *A. aphylla* and *P. aucheri*. (One base with stem flow entry and the other base without stem flow entry). Accordingly, as *Lepidium sativum* is characterized by a rapid growth rate, it was selected as the target plant to investigate the effect of stemflow nursing of *A. aphylla* and *P. aucheri*. To this end, ten mature plants were selected for five repetitions on each species. The understory of each species was then divided into three parts, including crown projection, shading region, and open intact area.

2.9. Statistical Analysis

The normality of the data and the homogeneity of variances were controlled by Kolmogorov-Smirnov and Leven′s tests, respectively. Moreover, the significant influence of the treatments was tested by a one-way ANOVA with repeated observations during two years, followed by the Tukey test at P<0.05 and 0.01 using the SAS 9.4 software, whose results were expressed as the mean values ± SE of three observations for each treatment. Spearman correlation test with a 1% error level was also used to analyze the stem flow data generated from natural and synthetic precipitation and the funneling ratio in two species (due to data non-normality).

3. Results

3.1. Precipitation and stemflow

During the study period (April to March 2013), a total of 47 rain events with values of 0.01 mm to 45 mm and 14 snow events were recorded. The stemflow was measurable in all snow events. However, it was only measurable in 34 rain events. The minimum precipitation rate was 0.8 mm for *A. aphylla* and *P. aucheri*, indicating that the threshold of precipitation for the initiation of stemflow was one mm for both species. Furthermore, the measurements showed that the average stemflow in the *P. aucheri* was 18.5% of gross precipitation, with a range of 11-24%, while the average stemflow was 13.4% of gross precipitation in *A. aphylla*, with a range of 12-23%. As seen in Table 2, there is a strong correlation between precipitation and stemflow (α = 0.01), according to which stemflow linearly increases with an increase in precipitation intensity (Fig. 4).

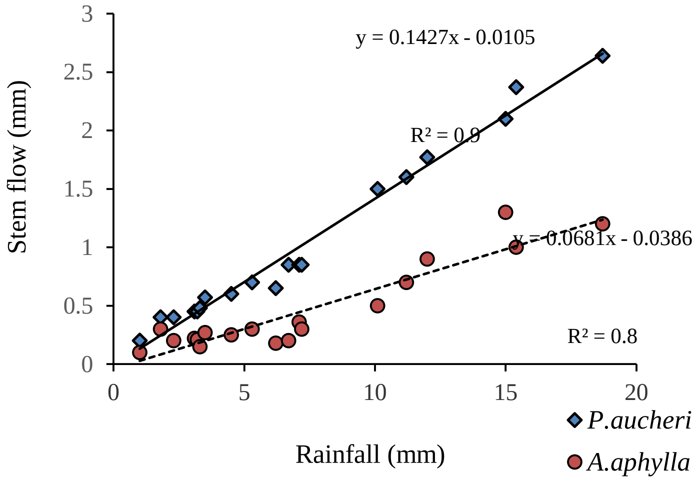

Figure (4): The relationship between stemflow and daily rainfall amount

Table (3): Correlation P. *aucheri* and A. *aphylla* with rainfall

Variable		*P. aucheri*	*A. aphylla*
	Pearson Correlation	0.98	0.99
Rainfall	Sig. (2-tailed)	0.00**	0.00**
	N	20	20

** Correlation is significant at the 0.01 level (2-tailed).

3.2. Funneling Ratio (FR)

The average funneling ratio was 29 and 39.9 for *A.aphylla* and *P.aucheri*, respectively, indicating that branches and stem fully contributed to stemflow generation and thereby provided a greater amount of water for the base of the stem. On the other hand, the average funneling ratio of *P.aucheri* was 1.37 times that of *A.aphylla* due to higher crown area, height, and basal area. Moreover, a significant correlation was found between FR and precipitation in both *P. aucheri* and *A. aphylla* (Table 4), with the FR being non-linearly increased with an increase in precipitation intensity.

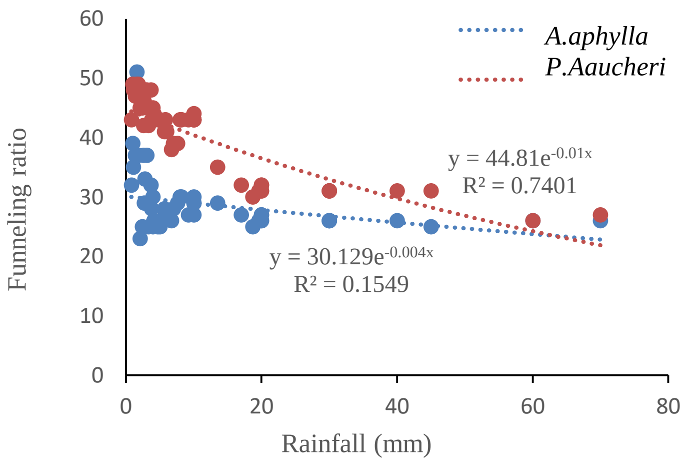

Figure (5): Funneling ration of daily rainfalls of P. *aucheri* and A. *aphylla*

Table (4): Correlation between rainfall values and funneling ration of P. *aucheri* and A. *aphylla*

		Rainfall	*P. aucheri*	*A. aphylla*
Rainfall	Pearson Correlation	1	-0.86	-0.48
	Sig. (2-tailed)		0.00**	0.00**
	N	48	48	48

** Correlation is significant at the 0.01 level (2-tailed).

3.3. Artificial stemflow

The correlation revealed that stemflow enjoyed a direct relationship with height and canopy cover (Table 5), according to which stemflow increased with an increase in depth in both species when height and canopy cover increased and vice versa (Fig. 6), indicating that the stemflow increased with an increase in precipitation intensity depending on species type (Li, 2008). Moreover, the ANOVA test showed that stemflow variations between the highest and lowest height and canopy cover differed significantly in both species (Table 6), suggesting that height and canopy cover played an important role in stemflow generation. It should be noted that the stemflow is influenced by canopy volume and area (Martinez-Meza and Whitford, 1996).

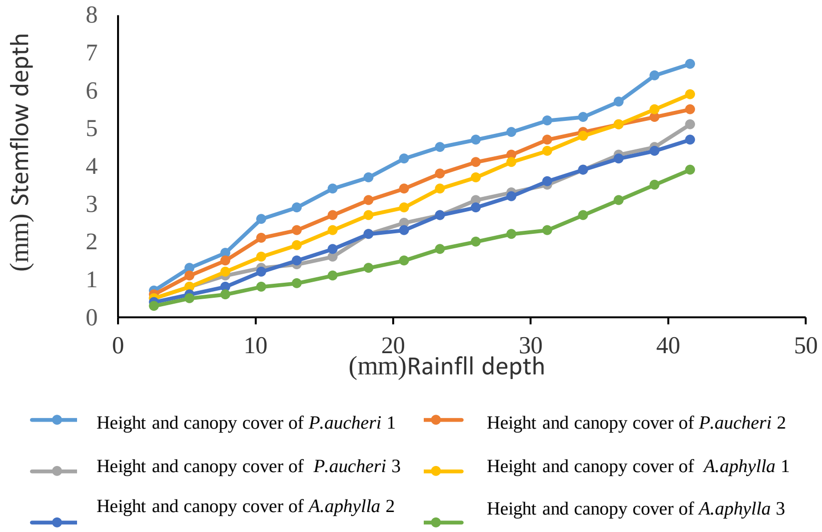

Figure (6): Stemflow in different depths of artificial rainfall in three height and canopy cover of *P. aucheri* and *A. aphylla*

Table (5): Correlation between rainfall depth and stemflow at three height and canopy cover of *P. aucheri* and *A. aphylla*

	A. aphylla						*P. aucheri*					
	Canopy cover (m^2)	Height (cm)	Canopy cover (m^2)	Height (cm)	Canopy cover (m^2)	Height (cm)	Canopy cover (m^2)	Height (cm)	Canopy cover (m^2)	Height (cm)	Canopy cover (m^2)	Height (cm)
	0.34	52	0.22	38	0.12	27	0.64	92	0.68	74	0.33	48
Correlation coefficient	99.0 **		99.0 **		99.0 **		99.0 **		99.0 **		99.0 **	

Table (6): ANOVA Test for average values of artificial stemflow in different height and canopy cover of *P. aucheri* and *A. aphylla*

	A. aphylla						*P. aucheri*					
	Canopy (m^2) cover	Height (cm)	Canopy (m^2) cover	Height (cm)	Canopy (m^2) cover	Height (cm)	Canopy (m^2) cover	Height (cm)	Canopy (m^2) cover	Height (cm)	Canopy (m^2) cover	Height (cm)
	0.34	52	0.22	38	0.12	27	0.64	92	0.68	74	0.33	48
Mean stemflow depth	3.2^{a}		2.5^{ab}		1.8^{b}		4^{a}		3.4^{ab}		2.6^{b}	

Non-identical letters are significant at 5% level.

3.4. Soil Water Content

Table 7 shows the results of the ANOVA test carried out in soil water content in different soil depths in three treatments of *P. aucheri* and *A.aphylla*. It was also found that the soil water content of the understory of *P. aucheri* and *A.aphylla* differed significantly when the species were treated with and without 80-100 depths.

Table (7): ANOVA test of soil water content at different depths of soil in three treatments of *A. aphylla* and *P. aucheri*

Treatment / Depth of soil	Species	0-20	20-40	40-60	60-80	80-100
With stemflow	*A. aphylla*	13.97^{a}	10.7^{a}	8.7^{a}	6.4^{a}	5.3^{a}
	P. aucheri	13.9^{a}	11^{a}	9.2^{a}	7^{a}	6.7^{a}
Without stemflow	*A. aphylla*	10.3^{b}	7^{b}	6.8^{b}	5.4^{b}	5.3^{a}
	P. aucheri	10^{b}	8.2^{b}	6.8^{b}	5.9^{b}	6.2^{b}
Bare soil	*A. aphylla*	13.2^{a}	7.8^{b}	6.4^{b}	5.5^{b}	5.3^{a}
	P. aucheri	13.2^{a}	7.8^{b}	6.4^{b}	5.5^{b}	5.3^{c}

3.5. Organic Matter (OM)

By comparing bare soil in different depths, this study identified the role of roots in transferring organic matter. The organic matter of the underlying soil of *A.aphylla* and *P.aucheri* in treatments with and without stemflow showed a significant difference of up to 100 cm depth in *A.aphylla* and up to 80 cm depth in *P.aucheri* (Table 8). A significant difference was also observed between each species with bare soil up to 100 cm and 80 cm depths, respectively.

Table (8): ANOVA test of OM at different depths of the soil in three treatments of *A. aphylla* and *P.aucheri*

Depth of soil / Treatment	Species	0-20	20-40	40-60	60-80	80-100
With stemflow	*A. aphylla*	0.99^{a}	0.66^{a}	0.52^{a}	0.31^{a}	0.17^{a}
	P.aucheri	1.63^{a}	1.07^{a}	0.73^{a}	0.6^{a}	0.24^{a}
Without stemflow	*A. aphylla*	0.72^{b}	0.4^{b}	0.33^{b}	0.25^{b}	0.15^{b}
	P.aucheri	0.84^{b}	0.62^{b}	$0{,}53^{b}$	0.45^{b}	0.18^{b}
Bare soil	*A. aphylla*	0.19^{c}	0.18^{c}	0.15^{c}	0.13^{c}	0.13^{c}

3.6. Soil EC

EC values in treatments with and without stemflow suggested that EC was higher in the treatment without stemflow, indicating the leaching role of stemflow in the soil (Table 9). On the other hand, the salinity significantly increased in bare soil at a depth of 40-60 cm, indicating that in bare soil, only the leaching up to the 40 cm boundary was carried out and solutes accumulated at lower depths.

Table (9): ANOVA test of EC at different depths in three treatments of *A.aphylla* and *P. aucheri*

Depth of soil / Treatment	Species	0-20	20-40	40-60	60-80	80-100
With stemflow	*A.aphylla*	2.4	3.2	3	3.6	4.1
	P. aucheri	1.1	1.3	1.9	1.9	1.7
Without stemflow	*A.aphylla*	3.3	3.6	4.4	4.7	4.1
	P. aucheri	1.6	1.5	2.4	2.9	3.1
Bare soil	*A.aphylla*	2	2.5	4.3	3.8	3.9
	P. aucheri	2	2.5	4.3	3.8	3.9

3.7. Soil pH

PH variations found in two treatments and bare soil at different depths showed no significant difference. However, a slight increase was observed in *A.aphylla* compared to *P.aucheri* and bare soil (Table 10).

Table (10): ANOVA test of pH at different depths in three treatments of *A.aphylla* and *P. aucheri*

Depth of soil / Treatment	Species	0-20	20-40	40-60	60-80	80-100
With stemflow	*A.aphylla*	7.9	7.8	7.9	7.9	7.8
	P. aucheri	7.6	7.6	7.5	7.5	7.5
Without stemflow	*A.aphylla*	7.9	7.9	7.9	7.9	8
	P. aucheri	7.7	7.8	7.7	7.7	7.8
Bare soil	*A.aphylla*	7.7	7.8	7.6	7.5	7.6
	P. aucheri	7.7	7.8	7.6	7.5	7.6

3.8. Soil MWD

The MWD of the undelaying soil of *P.aucheri* and *A.aphylla* in two treatments revealed a significant difference up to 100 and 80 cm. Moreover, the MWD of bare soil at different depths showed a significant difference up to 100 and 80 cm (Table 11).

Table (11): ANOVA test of MWD at different depths of the soil in three treatments of *A.aphylla,* and *P. aucheri*

Depth of soil / Treatment	Species	0-20	20-40	40-60	60-80	80-100
With stemflow	*A.aphylla*	1.77^a	1.17^a	0.92^a	0.82^a	0.38^a
	P. aucheri	1.14^a	0.91^a	0.5^a	0.38^a	0.19^a
Without stemflow	*A.aphylla*	1^b	0.6^b	0.61^b	0.52^b	0.28^b
	P. aucheri	0.65^b	0.53^b	0.31^b	0.23^b	0.18^a
Bare soil	*A.aphylla*	0.2^c	0.34^c	0.35^c	0.23^c	0.2^c
	P. aucheri	0.2^c	0.34^c	0.35^b	0.23^b	0.2^a

3.9. Nursing Effect

According to Table 12, the results suggested that the buds in the canopy projection of both species emerged faster in both treatments than in the other parts of the species. Accordingly, the *Lepidium sativum* seeds grew on the fourth day in the canopy projection in treatment with streamflow, while the seeds sprouted in two parts on the sixth day. On the other hand, in the treatment carried out without stemflow, the seeds germinated in the crown projection on the fifth day, and the other two on the sixth day. The seeds grown in the canopy projection showed a significant difference in the number of germinated seeds in the other two parts. Furthermore, the number of shoots of crown projection in two species in both treatments revealed no significant difference. However, no seed sprouted in treatment without stemflow within a 10 cm radius of *P.aucheri* and 7 cm of *A.aphylla* stem, indicating that the stemflow did not spread more than 10 cm in radius in *P.aucheri* and more than 7 cm in *A.aphylla*. It was also found that the average number of survival days of the buds in the crown projection was higher than the other two treatments and without the stemflow treatment.

Table (12): Survival duration of *Lepidium sativum* in the understory of *A. aphylla* and *P. aucheri*

Variable	Species	No. of days to start germination	No. of germinated seeds	No. of germinated seeds after 5 days	No. of germinated seeds after 10 days	No. of germinated seeds after 15 days	Survival duration (days)
Crown projection	*A. aphylla*	4	53	23	1	0	11
	P. aucheri	4	163	126	31	2	17
Shading area	*A. aphylla*	4	6	3	0	0	6
	P. aucheri	4	15	6	0	0	7
Open intact area	*A. aphylla*	6	0	0	0	0	0
	P. aucheri	7	2	0	0	0	2

4. Discussion

The higher stemflow rate of *P. aucheri* than the *A. aphylla* can be attributed to *P. aucheri's* shrub form and its larger crown area. It can be argued that the bush form of *A. aphylla* and nodular stems could have probably kept it from generating higher stemflow. On the contrary, *P. aucheri* possesses relatively large branches and crown areas which makes it more suitable for rainwater harvesting. In this regard, in a study carried out by Zhang et al. (2013), they reported that stemflow linearly increased with an increase in precipitation intensity for two xerophytic shrubs of *Caragana korshinskii* and *Artemisia ordosica*.

The fact that stemflow plays a crucial role in rainwater distribution has well been confirmed by previous studies (Ma et al., 2016). For instance, Yang et al. (2019) suggested that the generation of stemflow varied significantly among the tree and shrub species, with the shrub species enjoying greater values in terms of stemflow volume, stemflow depth, and stemflow percentage of gross precipitation. They also reported that this could be eco-hydrologically significant for the species' survival in drought environments.

As a quantitative index for evaluating the effect of stemflow funneling of rainwater to plant bases which may have significant implications for plant survival in drought conditions, FR merits more attention (Garcia-Estringana et al., 2010; Siegert and Levia, 2014). The ratio describes the efficiency of each plant in capturing rainfall and generating stemflow, allowing the comparison of stemflow rates for different plants (Siegert and Levia, 2014; Levia and Germer, 2015). Accordingly, the higher rates of FR found in the shrub species (i.e. *S.psammophila* and *C.korshinskii*) than the tree species (i.e. *P. Tabuliformis* and *A. Vulgaris*) revealed that shrubs were morphologically more effective in funneling rainwater to the soil at the basal area, which can be eco-hydrologically crucial for survival and growth in drought conditions (Carlyle-Moses, 2004).

It can be concluded that bushes are less able to transfer stemflow to lower depths than shrubs. Therefore, the delivered rainwater would preferentially infiltrate into deep soil layers through root channels and soil microspores, thereby creating islands of soil moisture, which can be an important potential source of soil moisture allowing plants to remain physiologically active during dry periods (Navar, 2011).

A clear linkage between aboveground ecohydrology and belowground hydropedology in desert shrubs is worth noticing, whereby an increase in stemflow will increase soil hydrologic heterogeneity (Li et al., 2009). Stemflow always results in spatial heterogeneity in soil-water fluxes due to stemflow and root channelization processes (Li et al., 2009). In this regard, Zheng et al. (2019) investigated throughfall and stemflow heterogeneity under the maize canopy and its influence on soil water distribution at the row scale, suggesting that the presence of maize canopy altered the soil water flux and thus caused heterogeneous infiltration of water to the soil.

As found by the current study, the rates of soil water content, organic matter, and MWD were significant in *P.aucheri* and *A.aphylla* up to 100 cm depth, indicating that soil stability was directly related to soil moisture and organic matter content. The results prove that to the extent that stemflow permeates, soil moisture, organic matter, and soil stability also change, affecting the soil's physical and chemical properties (De Schrijver et al., 2008). Moreover, the comparison of the aggregate stability values of *P.aucheri* and *A.aphylla* (treatment with streamflow) at different depths of the soil under two species with bare soil revealed the significance of plant existence in soil conservation and stability, even at lower depths.

5. Conclusion

This study compared the stemflow generation of two species (*P. aucheri* and *A. aphylla*) in Central Iran during the rainy seasons of 2013 and 2014. Accordingly, the nursing experiment suggested that the buds in *P. aucheri* understory enjoyed more viability and freshness than *A. aphylla's* understory. Moreover, it was found that *P. aucheri* provided better nursing conditions than *A. aphylla* for understory plants due to better shading and higher stemflow production rate.

The higher stemflow production along with the wider canopy cover allow the surface soil to remain moist, thus preventing the soil from being hardened. In this regard, the evaluation of the stemflow rate of *P. aucheri* and *A. aphylla* showed that higher stemflow production and soil moisture nutrition led to more growth in understory plants, where the canopy form played a significant role. It appears that large plants with large canopy cover provide better habitat conditions for their understory plants.

This study sought to show a direct relationship between the stemflow rate generated by the species and their nursing effect on their understory plants, proposing such a relationship to be considered in the management of arid areas. Finally, the knowledge gained by combining an understanding of stemflow generation and the chemical properties of stemflow may prove crucially important.

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Declaration of interests
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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