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Characteristics of *Viburnum lantana* L., Stands in the Lowest Limit of Its Distribution in the Arasbaran Forests, Iran

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ABSTRACT

Aims: Recognition of habitat status and ecological responses of species to environmental variables are prerequisites for better management and providing the ecological needs of each species. This research assessed the current status and distribution of *Viburnum lantana* L. It described its ecological characteristics in the lowest limit of its distribution in the Arasbaran forests.
Materials & Methods: The presence sites of *Viburnum lantana* L. (wayfaring trees) were selected based on field observations and library sources. Then, the 114 circular samples with a radius of 17.84 m were laid systematically and randomly out to collect data. Within each sampling area, the characteristics of each woody species, including species name, DBH (diameter at the breast height), and the height of all wayfaring trees and other species, were measured. The dominant species composition was calculated using the relative importance value.
Findings: Our results revealed 22 woody species with a height>130cm in our study area. *V. lantana* constitutes about 11% of the relative frequency, and its relative importance value (RIV) was 25.2, the third main species in RIV. The frequency of *V. lantana* showed a significant and positive correlation with the frequency of *Quercus macranthera*. The mean height of *V. lantana* was 2 m (±0.6 m). The highest number of *V. lantana* belonged to height class 1-2 m (47 stems per ha). Stem density per ha of *V. lantana* ranged between 24 and 403 in the lowest and highest elevation classes, respectively. There was no clear pattern of DBH and height of *V. lantana*, along with the aspect categories.
Conclusion: This species usually appears with *Quercus macranthera* as overstory species and *Lonicera iberica* as understory species in the wayfaring trees sites. Also, topographic factors such as slope, elevation, and aspect influenced the relative frequency, stem density per ha, DBH, and height of *V. Lantana.* This research is vital to inform forest managers and decision-makers about how the diversity of topographic variables differs for further planning and intervention.

Keywords: Arasbaran; Elevation; Relative Frequency; Species Richness; Wayfaring Trees.

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Introduction

Knowledge about the structure tree species and their regeneration is essential for planning management and conservation plans of them. It reflects the history of past species disturbances and their environment and can be used to predict the future development of the population of a particular species. Furthermore, the general pattern of seedling, seedling, and mature populations of plant species dynamics can indicate the regeneration profile used to determine their regenerative status and importance in forest management [1]. Collecting information on tree species and their diversity provides an essential tool for improving our ability to maximize biodiversity due to deforestation and degradation. The information in this quantitative inventory provides a valuable reference for forest assessment. It enhances our knowledge by identifying ecologically beneficial species and species of particular interest, improving our understanding of forests, and identifying conservation efforts to support biodiversity [2].

Geographic factors (altitude, latitude, aspect, and slope) play an essential role in the distribution of plant species through their effects on soil moisture and chemical properties. Physiography can be described as a given terrain relief, significantly influencing plant species diversity and distribution [3]. Topography is an influencing factor in maintaining heterogeneous forest structures. Topographical variables such as elevation and slope substantially impact local microclimate variability [4, 5]. In this way, they limit trees' growth conditions, promote environmental filtration, and control the composition of plant communities [6,7]. Of these factors, elevation changes respond to climatic and site conditions, which significantly impact plant communities [6, 8, 10]. Furthermore, interactions between undergrowth and undergrowth species play an essential role in promoting the diversity of plant species [11]. Depending on the terrain, undergrowth species show a pattern of strong spatial variation [12].

Some researchers have studied different aspects of *V. Lantana* [13, 16] and other shrub species and the effect of topography on species structure [9, 12, 17, 18]. Bruun et al. (2006) focused on the relationship between the abundance of vascular plant, moss, and macromoss seeds at the northernmost Fennoscandia in the altitudes 250-1525 m a.s.l corresponding to the area between the tree line and the summit. They showed that the species richness of all woody plants is highly monomodally related. The richness of dwarf shrubs decreased monotonically with altitude [9]. Gracia et al. (2007) investigated the impact of topographical gradients and supra-soil structure on the composition and frequency of undergrowth shrub species in Massís de l'Orri (Central Pyrenees, Lleida, Spain) by organizing 329 plots in two opposing hills in the massif at altitudes from 1500 m to 2200 m [12]. They stated that species richness and variety did not vary with appearance and only slightly decreased with height. However, the composition of the undergrowth confirmed drastic changes in height and appearance. Most species exhibited variations between slopes, some exhibiting the highest canopy on south-facing plots and others on north-facing plots. Height also stimulated the percentage coverage of many undergrowth shrub species, confirming a decrease (*Arctostaphylos uva-usa*, Rosa sp.), A maximum at intermediate values (*Cytisus purgans*), or an increase (*Rhododendron ferrugineum*) with height. Yirdaw et al. (2015) investigated the influence of aspect factors on floristic composition, diversity, tree form, and line of Afromontane cloud forests at Rira in the Bale Mountains of southeastern Ethiopia using the stratified systematic sampling technique in 36 plots. Their results confirmed that the wood species richness of the forest zone was 1.7 times higher on the east side than on the west side. A significant interaction between orientation and height influenced wood species diversity [18]. Sefidi et al. (2016) studied the effects of topographical factors such as aspect, slope, and topographical index as the landform index on the predominant tree species and primary forest distribution of the *Fagus orientalis* Lipsky in northern Iran. In their study, tree density and the basal area had no significant correlation with none of the factors except for a modest relationship between basal area and LI (r = - 0.376; P = 0.029). Hosseinzadeh et al., (2016) studied the relationship between the diversity of woody plants in the central Zagros forests and their physiological factors (case studies: Perc forests, Khorramabad, Iran). They showed that the slope did not significantly affect the diversity indices. Exposure and altitude classes had a significant impact on abundance and diversity index but not on uniformity. Generally, the highest vegetation diversity was on less than 15% north slopes, with no geographical orientation, and at 2100-2200 m [19]. Ghanbari and Sheidai Karkaj (2018) studied the diversity of tree and shrub species by a random-systematic method in the woodlands of the Guijeh-bel region of Ahar, a southern part of Arasbaran forests, Iran. They showed that *V. lantana* and *Acer campestre* were common on the west and east aspects, respectively [20]. Nunes et al. (2020) studied the undergrowth of the arid Mediterranean ecosystem, which consists of savanna-like Holm oak forests along the regional climatic gradient. They have shown that geomorphological factors predominantly predict shrub invasion in arid Mediterranean lands subject to low-intensity traditional land use [21]. Woldu et al. (2020) analyzed the effects of elevation, slope, and aspect as topographical variables on woody species diversity in Dawsura exclusion in northern Ethiopia. They showed 34 woody species representing 15 families, of which 62% were trees and 38% were shrubs. The diversity of tree species at medium (1.44) and high (1.85) altitudes was significantly different from that at low (0.86) altitudes. In addition, significantly higher wood species diversity was recorded in steeply sloping areas (1.88) and moderately steeply sloping areas (1.62) compared to gently sloping areas (0.95). No significant variation in wood species diversity was observed between aspect categories. Also, Angessa et al. (2020) investigated the diversity, composition, and structure of woody plants concerning the environmental variables in the Lake Wanchi basin in the central highlands of Ethiopia. They showed an elevation effect on the composition of woody plants. Also, they stated that woody species richness declined with increasing elevation [22]. According to our knowledge, previous studies have focused on assessing the impact of topography on the species composition, diversity, and density of woody species in Iran and other parts of the world [17, 19, 20, 23]. Despite the high ecological importance of *V. Lantana*, there needs to be more scientific information on the influence of topographic factors on *V. Lantana* in the world and Iran and the composition of natural *V. lantana* stands in these forests. However, some scholars have researched other aspects of *V. Lantana*, like genetic variations and medicinal uses. [13, 15, 16, 24, 25]. In this research, we studied *V. Lantana* as an indicator species in northwest Iran. This area is the lowest limit of its distribution in the northern hemisphere. Therefore, we aimed to (i) assess the current status of *V. lantana* in the individual and stand scale and (ii) describe the relationships between topographic factors with *V. lantana* traits. We hypothesized that this species had been categorized as the main species in our study area and with a higher relative importance value rather than other woody species. Moreover, we expected that the relative frequency of *V. Lantana* would be higher than other species found in our study area. We assumed that the stem density of this species would be higher on high slopes and elevations. We expected that the stem density of *V. Lantana* would be higher in the north-facing aspect.

Materials & Methods

Species Description

V. lantana L., local Azeri name is Garmasho, a shrub with a dense boom shape partially caused by accidental shoots and roots of branches in close contact with the ground [26]. *V. lantana* is widely cultivated as an ornamental plant for its flower and fruit. It has the best condition to grow on alkaline soils. Fruits are mildly toxic and can cause vomiting and diarrhea when ingested in large amounts. This species reached 1-3 m high, sometimes 5 m high [20, 27]. It extends from northern Spain to central Ukraine and northern Asia Minor. The southeastern distribution limit is in northern Iran, called the Arasbaran region. *V. lantana* also occurs in sparse oak and pine forests but rarely in mixed communities of bright-shaded beech and deciduous forests. Sometimes suppressed individuals are found in mature hardwood forests that have survived periods of the more open canopy. Fruit-eating birds spread this species, but their fruits appear much more attractive to them. This species bears fruit quickly, has a two-color display with a mixture of red and (fully ripe) black fruits, and the immature fruits are yellow-green,

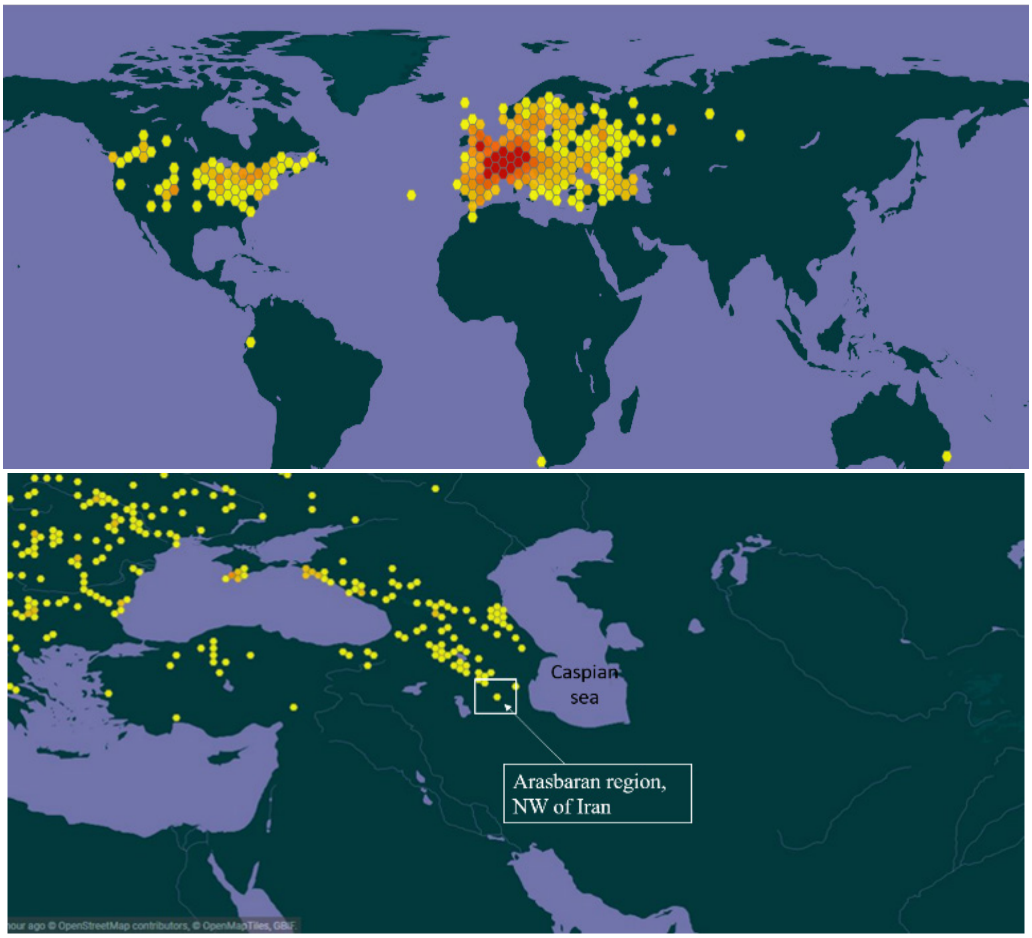

Figure 1) Location of study area and distribution area of *V. Lantana* in the world scale (upper image) and regional scale (down image) in Arasbaran, Iran (https://www.gbif.org/species/2888615).

but the main difference in attractiveness seems to be related to the chemical nature of the fruit [26]. In the Caucasus, the leaves and fruits of this species are used to treat colds, coughs, high blood pressure, inflammation, and lung and heart disease [27].

Study area

This research was carried out in Arasbaran forests in Northwest Iran at the border of Armenia and Azerbaijan between 38° 35′ N – 39° 00′ N latitude and 45° 45′ E – 47° 05′ E longitude. The altitude from the sea level of sample plots in the study sites was between 1500 and 2300 meters. The climate is semi-humid, with an average annual temperature of 14 ° C and an average annual rainfall of 400 mm. Forest types are natural, deciduous, and mixed deciduous forests with an area of approximately 153,000 hectares [28]. The main species of these forests are Caucasus oak (*Quercus macranthera* Fisch. & C.A.Mey. ex Hohen.), common hornbeam (*Carpinus orientalis* Mill.), field maple (*Acer campestre* L.), common yew (*Taxus baccata* L.), wayfaring tree (*V. lantana* L.), reddish-black berry or rock red currant (*Ribes petraeum* Wulfen. Synonym. = *Ribes biebersteinii*), and Persian walnut (*Juglans regia* L.) [29]. The main forest types are mixed forest types of *Quercus macranthera*, *Carpinus orientalis,* and *Acer campestre* [20, 30].

Field sampling and data analysis

Based on the field observations and library sources, the present sites of wayfaring trees were selected. The 114 circular samples with a radius of 17.84 m sampling plots were laid systematically and randomly out to collect data. Within each sampling area, the characteristics of each woody species including species name, breast height (DBH) diameter, and the height of all wayfaring trees and other species were measured. The species were identified based on the Iranian flora books and the knowledge of expert botanical researchers. The DBH of all woody plants was measured in sample plots with diameter tape. The height of the wayfaring trees in each plot was measured using the clinometer. Stem density was summarized and scaled per hectare basis for all woody species. The distribution of DBH of all woody species was classified into 2 cm intervals. The height of all woody species was classified into 1 m intervals. The species' relative importance value (RIV) across all sample plots was calculated to describe the dominant species composition.

We then categorized the species based on these values and screened for the most important species. The RIV of woody species was calculated by averaging the values for relative dominance (basal area), relative density (number of stems), and relative frequency (number of plots of occurrence) [30]. Depending on the number of vegetation layers in a three-layer stand, all trees whose height was more than two-thirds of the average height of the dominant trees as dominant trees, between one-third to two-thirds of the dominant height as co-dominant, and those shorter than one-third of the dominant height were classified in the lower floor [31]. The dominant height of trees as the average height of the 100 largest trees per hectare was used in this research [32]. Based on the dominant height in the study area, the average height of the dominant trees was 7.4 m. Trees higher than 4.9 m were classified in the upper story, between 2.5 m to 4.9 m in the mid-story, and less than 2.5 m in the low story. The general characteristics of the site, such as altitude above sea level, slope percentage, and aspect, were also recorded. Sample plots were classified into three slope classes; < 30%, 31-50%, and > 50%, and four main aspect categories along three elevation ranges; < 1700 m), 1700-2000, and > 2000m.

Data followed a normal distribution (Shapiro–Wilk test, P > 0.05); therefore, significant differences in some quantitative traits of wayfaring trees, such as frequency and RIV index among slope, aspect, and elevation classes, were examined by Analysis of Variance (ANOVA) [33]. Also, correlation analysis was done between RIV and the frequency of *V. lantana*, three high-frequency species, and three dominant trees in the wayfaring tree sites.

Findings

The 22 woody species were recorded in *V. lantana* presence areas. *C. orientalis* (25%), *Q. macranthera* (23%), and *V. lantana* (11%) were the three main species in terms of relative frequency (Figure 2). Other species were *Acer campestre, Acer monspessulanum, Berberis densiflora, Cerasus avium, Cornus sanguinea, Cotoneaster horizontalis, Crataegus orientalis, Euonymus verrucosa, Fraxinus excelsior, Juniperus excelsa, Lonicera iberica, Malus orientalis, Mespilus germanica. Prunus spinosa, Pyrus glabra, Ribes biberestentii, Rosa canina, Sorbus aucuparia, and Sorbus graeca.*

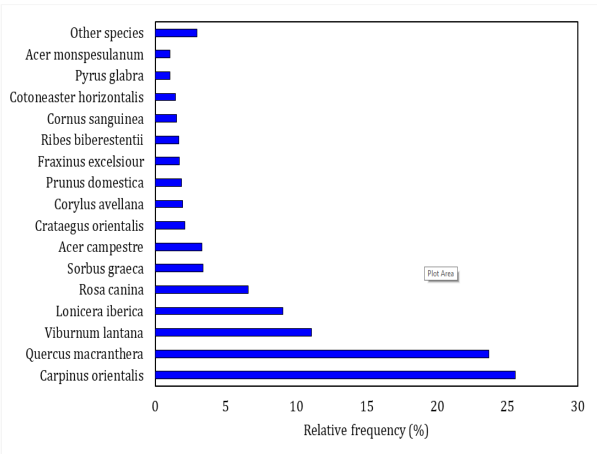

Figure 2) The relative frequency percent of woody species in the wayfaring trees sites, Iran.

Similar to the relative frequency, the relative importance value index (RIV) showed that *Q. macranthera, C. orientalis,* and *V. lantana* had the highest value among species. Other three important tree species were *Sorbus graeca*, *Sorbus aucuparia*, and *Acer campestre*. In verses, *Juniperus excelsa*, *Malus orientalis*, and *Mespilus germanica* were the least essential species in RIV (Figure 3).

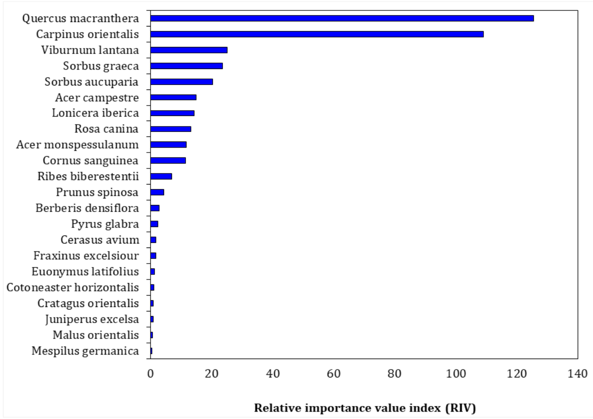

Figure 3) The relative importance value index of *V. Lantana* and other species in the wayfaring tree sites, Iran.

Trees distribution in diameter classes showed L-shaped distribution, usually observed in uneven-aged stands. The mean (±sd) DBH of all trees was 11.3 cm (±7.6 cm), and the maximum DBH observed in this area was 51 cm for the Caucasian oak. The mean DBH of *V. lantana* was 2.8 cm (±0.9 cm). The largest DBH of the wayfaring tree was 10 cm. The majority of individuals of all species (157 stems per ha) belonged to the DBH class <2 cm, that is followed by the class 2-4 cm (113 stems per ha) and 8-10 cm (106 stems per ha) (Figure 4).

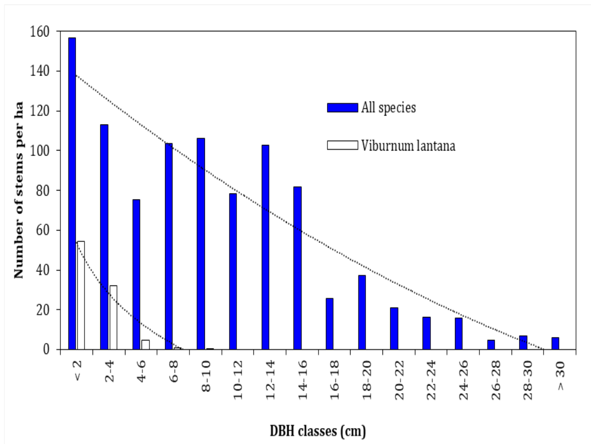

Figure 4) DBH classes' distribution of all species and *V. Lantana* in the wayfaring tree sites, Iran.

Figure 5 illustrates the number of stems with height classes for all species and *V. lantana*. The majority of individuals of all species (149 stems per ha) belonged to the height class 1-2 m, which is followed by the class 3-4 m (147 stems per ha), and 2-3 m (142 stems per ha). Higher height class > 12 m consists of 9 stems per ha. The mean height of all species was 5.4 m (± 3 m), while for *V. Lantana* was 2 m (±0.6 m). The highest number of *V. lantana* belonged to the height class 1-2 m (47 stems per ha), followed by the 2-3 m class (28 stems per ha). The maximum height of the wayfaring tree was 4.5 m.

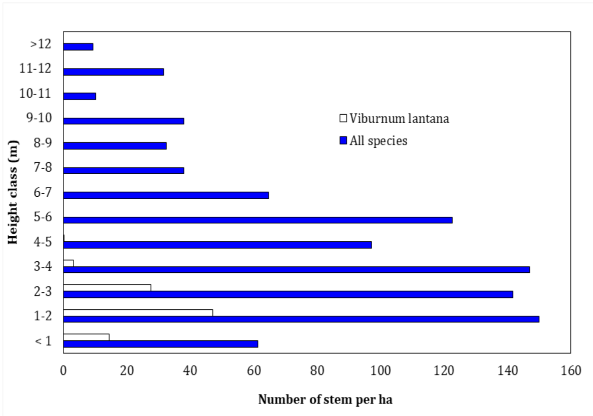

Figure 5) Height classes' distribution of all species and *V. Lantana* in the wayfaring tree sites, Iran.

Q. macranthera, C. betulus, and *Lonicera iberica* were three high-frequency species, and *Q. macranthera, C. betulus*, and *A. campestre* were classified as three dominant trees in the upper layer of the forest stand. The correlation analysis of the RIV of *V. lantana* and three high-frequency species had a positive and significant correlation between the RIV of *V. lantana* and *Q. macranthera* (r=0.505, p<0.01) and *L. iberica* (r=0.704, p<0.01). At the same time, the RIV of *V. lantana* had a negative and significant correlation (r=-0.860, p<0.01) with the RIV of *C. betulus* (Table 1). The correlation analysis of the frequency of *V. lantana* with dominant trees in the stands had a significant and positive correlation with the frequency of *Q. macranthera* (r=0.421, p<0.01).

Woody species richness had a significantly higher value at the higher slope (7.7), followed by a moderately steep slope (7.1) and lower slope (6.9). The same trend was observed in the stem per ha of *V. lantana*. DBH of *V. lantana* did not vary significantly among slope classes, although we found a decrease in DBH with an increasing slope. Species richness was significantly greater at high altitudes than at moderate and low altitudes. Stem density per ha of *V. lantana* ranged between 24 and 403, with the significantly highest value recorded in high elevation and the lowest in low elevation (Table 2). Although there was a differentiation in DBH and height of *V. lantana*, it was not significant. Species richness varied from 5 to 8.5, with the highest and lowest value in the west and south aspect, respectively. There was a significant (p >0.05) difference in species richness among the aspect categories. Similarly, there was a significant difference in stem per ha among the aspect categories. However, the highest and lowest stem per ha was recorded in the west and south aspect, respectively. There was no clear pattern of DBH and height of *V. lantana* along the aspect categories. Links between aspect, DBH, and height were insignificant (p > 0.05).

Discussion

The forest sites investigated in this study are characterized by a high abundance of relatively small trees with DBH smaller than 2 cm (59% of all wayfaring trees). The distribution of wayfaring trees in different DBH classes followed the curve of an uneven-aged forest, but its order was somewhat different in the Arasbaran forest. The frequency distribution of height classes in both wayfaring trees and other species was almost right-skewed except in height class < 1m. Regarding the stem density of wayfaring

Table 1) Correlation analysis of RIV and frequency of *V. Lantana*, three high-frequency species, and three dominant trees in the wayfaring tree sites, Iran.

Correlation	RIV* of *Q. macranthera*	RIV of *C. betulus*	RIV of *L. iberica*
RIV of *V. lantana*	0.505**	-0.860**	0.704**
Correlation	Freq. of *Q. macranthera*	Freq. of *C. betulus*	Freq. of *A. campestre*
Freq.*** of *V. lantana*	0.421**	-0.132	-0.096

** Correlation is significant at the 0.01 level (2-tailed). RIV*: relative importance value, Freq.***: Frequency

Table 2) Mean some quantitative traits of wayfaring trees in different topographic factors in the wayfaring tree sites, Iran.

Factor	Class	Species richness*	Relative frequency (%)	Stem per ha	DBH (cm)	Height (m)
Slope (%)	< 30%	6.9 (±2.7)	7 (±9.2)	70 (±116)	**3.1 (±1.2)**	**2.2 (±1.1)**
	30-50%	7.1 (±3.1)	9.9 (±11.6)	145 (±239)	2.7 (±0.9)	1.9 (±0.5)
	> 50%	**7.7 (±2.8)**	**16.6 (±13)**	**200 (±210)**	2.6 (±0.8)	2.1 (±0.3)
	F-value	3.528*	0.946	3.599*	0.039	1.176
Elevation (m)	< 1700m	6.9 (±3.6)	7.4 (±10.2)	24 (±37)	1.8 (±0)	1.7 (±0)
	1700-2000m	6.7 (±2.5)	**11.4 (±11.7)**	106 (±163)	**2.9 (±1)**	2 (±0.8)
	>2000 m	**10.2 (±2.6)**	9.6 (±13.6)	**403 (±300)**	2.7(±0.8)	**2 (±0.4)**
	F-value	11.412**	0.734	21.232**	0.613	0.13
Aspect	North	7.5 (±2.6)	8.5 (±10.8)	128 (±187)	2.7 (±0.9)	1.9 (±0.6)
	East	7 (±2.3)	6.2 (±6)	101 (±181)	**3 (±0.7)**	2.2 (±0.9)
	South	5 (±3.8)	**22 (±12.4)**	9 (±33)	1.8 (±0)	1.7 (±0)
	West	**8.5 (±2.8)**	13.3 (±13.4)	**326 (±284)**	2.8 (±1.2)	**2.3 (±0.4)**
	F-value	4.122**	0.951	7.916**	0.439	1.122

*This index is for all species in plots, and other indices are for just *V. Lantana*. **Bold** values show the highest value in that category.

trees in DBH and height classes, it should be noted that in the wayfaring tree sites, about 59% of the wayfaring trees belong to the DBH classes less than 2 cm. Although in other research, it has been stated that this species has low DBH and can be categorized as a shade-tolerant species [26, 27]. Regarding height classes, about 51% of the wayfaring trees belong to the 1-2 m class. The distribution of DBH classes showed that the wayfaring trees belong to an uneven-aged forest with high frequency in smaller classes. The diameter distribution of tree species revealed that the forest structure was not equal in age throughout, as indicated by the inverted J-shaped distribution of all species. The frequency of stems in the smaller classes is the result of the forest's enclosure and conservation and good regeneration in recent decades. *V. lantana's* ability to invade the rabbit enclosure depends partly on its unpalatableness and partly on its ability to re-grow after consumption [26]. Comparison of wayfaring trees with other species is not the right path because this species can reach up to 5 m in height. In contrast, this height for other species found in our study sites is medium. The highest wayfaring trees found had a 4.5 m height, close to this species' maximum height in other sites [26, 27]. According to the height structure of trees (Figure 5), wayfaring trees have appeared in the understory layer.

Interspecific correlations as understory-understory interactions have been studied by other scholars [34,36]. Our results showed that overstorey broadleaf abundance positively influences understory species in the wayfaring trees sites. In some cases, the composition of the overstory can help predict the composition understory structure [35]. Overstory broadleaved trees increased understory cover, while shrub layer richness did not. It reflects the low number of shrub layer species [34].

The present study revealed that topographic factors affected relative frequency, stem per ha, DBH, and height of wayfaring trees. The slope has been known as an influential factor for forest ecosystems [7, 8, 37]. The slope had a significant effect on species richness of all species and also stemmed density per ha. Contrary to our results, Hosseinzadeh et al. (2016) indicated that slope had no significant effect on the diversity indices. The highest plant diversity was in slope classes less than 15 % in their research area, while we found the highest species richness in the slopes higher than 50% in the wayfaring trees sites. As Ahmadi et al. (2020) analyzed the effect of slope on yew trees, they showed that it was primarily found in the higher slopes (> 65%). The yew stands are located on very steep slopes with superficial soils in poor condition, but when slope and soil roughness decrease, their status will also be improved due to better soil moisture and the plant's water supply. The results of Bussmann et al. (2020) also indicated that wayfaring trees are mainly growing on upper forested mountain slopes, which is consistent with the results of our study. The elevation is another critical environmental variable affecting species traits in forest ecosystems, as observed in numerous studies [8, 9, 12, 18, 38]. Similarly, a study by Ahmadi et al. (2020) reported that elevation variation influenced forest structure and quantitative traits of species. Our research also confirmed the results given by Angessa et al. (2020), who revealed that elevation was among the main factors influencing species diversity and forest structure in the Lake Wanchi watershed, central highlands of Ethiopia. In this study, woody species richness increased as altitude increased. Higher altitudes had a higher value of woody species richness. In agreement with this study, Cui and Zheng (2016) and Woldu et al. (2020) also reported a direct relationship between woody species richness and altitude, with the highest diversity being recorded at the highest altitude in evergreen broadleaf forests in southern China and Northern Ethiopia. Zhang et al. (2013) found that the highest species richness appeared in the middle elevation and under medium disturbance intensity in the Baihua Mountain Reserve, Beijing, China [39]. Also, other studies have emphasized that maximum diversity is commonly observed in the intermediate elevation [40, 41], highlighting the role of suitable temperature in these areas. In comparison, Heydari and Mahdavi (2009) showed versus results from our study. Adel et al. (2018) stated that the elevation range of *V. Lantana* was between 1950-2400 m in the riparian forests of Iran. Changes in species composition and spatial distribution patterns with elevation changes are associated with microclimate differences that influence necessary regeneration and competition processes [42]. The different elevation range has been reported for *V. lantana* from different parts of Europe. For example, the limit is 1450 m in the northern Alps, 1600–1700 m in the central Alps (Engadin), and 1450–1800 m in Morocco. In northern Greece, it is found most often from 800 to 1700–1850 m, but its highest locality in the Gramos mountains is at about 2100–

2150 m [26].

The results showed that aspect significantly affected species richness and stem density per ha, with no significant effect on relative frequency, DBH, and height of *V. Lantana* in the wayfaring trees sites. Other results also confirmed that species richness is affected by aspects [7, 8, 12, 18]. Our results showed a significant interaction between aspect and species richness which is in line with Yirdaw et al. (2015) in the Bale Mountains, southeast Ethiopia. At the same time, Woldu et al. (2020) stated that there was no significant relationship between woody species diversity and the aspect classes. Another trait influenced by aspect is stem density per ha. The highest stem density per ha for wayfaring trees (326 (±284) stem per ha) was in the west-facing aspect. The west-facing aspect of the site of the wayfaring tree is affected by the Caspian front, which is usually foggy and moist. Ghanbari and Sheidai Karkaj (2018) also confirmed that *V. lantana* was often found on the west-facing aspects. The lowest stem density per ha was observed in the south-facing aspect. In the Northern Hemisphere, south-facing aspects receive about six times more solar radiation than north-facing aspects. In other words, south-facing aspects have a drier environment than north-facing ones, that is, warmer, drier, and more variable microclimates. They are only a few hundred meters apart and share the same macroclimate zone, but the microclimate conditions on the aspects and slopes change and can affect the biology of the organism at all levels [7].

Conclusions

The present study highlights the *V. Lantana* sites and the relationship between the quantitative traits of *V. Lantana* and topographic variables. Our findings revealed that this species appeared as an understory species with a mean DBH of 2.8 cm and a height of 2m. *V. Lantana* was ranked as the third species in relative frequency and RIV. This species usually appears with *Q. macranthera* as overstory species and *L. iberica* as understory species in the wayfaring trees sites. Also, topographic factors such as slope, elevation, and aspect influenced the relative frequency, stem density per ha, DBH, and height of *V. Lantana.* This research is important to inform forest managers and policymakers on how diversity varies along topographic variables for further planning and intervention. Moreover, the present study attempted to evaluate the effect of topographic variables on species richness and *V. Lantana.* Further studies should be done on the effect of other physical and anthropogenic factors on *V. Lantana*.

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