Ecology of endangered Prunus korshinskyi Hand.-Mazz. in Jabal Al-Lauz, Saudi Arabia: Plant associations, size structure, and nutritional screening

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Abstract
The wild Prunus korshinskyi has a restricted distribution in small scattered areas of Jabal Al-Lauz (2580 m above sea level), a mountain in northwestern Saudi Arabia. Major objective of current study is to provide information about P. korshinskyi by analyzing its ecology in terms of floristic diversity, plant associations, environmental features, and its size structure and nutritional value. For this purpose, 12 stands of 20 m² were selected along the Jabal Al-Lauz mountain ridge. Three plant associations and their environmental variables were identified and characterized after application of a two-way indicator species analysis (TWINSPAN), detrended correspondence analysis (DCA). And canonical correspondence analysis (CCA) as follows: VGI: P. korshinskyi-Astracantha echinosa, VGII: Artemisia siberi-P. korshinskyi, and VGIII: Retama raetam-Artemisia sieberi. The edaphic factor affecting the distribution of the associations were pH, potassium and manganese content. The size class frequency distribution of P. korshinskyi shows a J-shape in spring and fall for the whole population; there was no regeneration via seed. Nutritional evaluation showed the fruits had a higher content of total carbohydrate, fats, crude protein, phosphorus, and potassium, and lower content of ash, Fe, Ca, Mn, Mg, and Zn than that in stems and leaves. This ecological knowledge gained through this study would be beneficial for managing and conserving of P. korshinskyi in a Jabal Al-Lauz area with its distinct and unique vegetation.

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1. Introduction

Phytosociological analysis of plant community is the primary basis for the study of any vegetation, as it is a prerequisite to the understanding of community structure and organization. It provides information on the structure and dynamics, external influences, biological responses to change interaction of species/classes and interlinkages amongst species, successional status of key species and ecological restoration of degraded habitats in a community (Kent, 2012). Such studies provide information on distribution of species and also on the affinities between or within the classes results in the valuable assessment of vegetation within the study area (Frenedozo-Soave, 2003). Phytosociological as well as autecological studies are of great significance for their own sake; the progress of the study of plant communities is greatly affected by the lack of evidence regarding the life history and biotic relations of their constituent species.

Jabal Al-Lauz is the highest mountain in the northern Hijaz in northwestern Saudi Arabia. The mountain has a varied vegetation with a great degree of Mediterranean influence. There are several plant species that cannot be found anywhere else in the kingdom. Prunus korshinskyi Hand.-Mazz., is one of the dominant species found at high altitudes. In arid regions, the high-altitude areas are certainly the main hotspots with much species diversity in variable habitats (Thomas et al., 2017). The biodiversity in relation to vulnerable ecosystems in arid areas has been largely affected through many factors inconsistent of both climate change and...
human impacts (Zhang and Ma, 2008). To our knowledge, there are no previous studies of the ecology, vegetation as well as the floristic features of this area.

As per the IUCN red list of threatened species, *P. korshinskyi* has a vulnerable status (Güner, 1998). It is a small-sized tree, which is distributed in Turkey, Syria, Lebanon, Palestine, and Saudi Arabia, mostly found in northern Hijaz Mountains. Ecology of *P. korshinskyi* in Saudi Arabian habitats has not been studied before, and this is the first study of its kind. It will pave the way for improving the conservation strategies of this endangered plant not only in Saudi Arabia but in other countries as well.

The present study aims to provide information about *P. korshinskyi* by investigating its ecology: (1) floristic diversity, vegetation structure and environmental features and (2) *P. korshinskyi* size structure and nutritional value of its component parts. The characteristics of the individual plant populations along with the conditions under which they grow have great influence on the distribution of the species. This study will help understanding the floristic composition as well as the present and future status of the endangered *P. korshinskyi*.

2. Materials and methods

2.1. Study area

Jabal Al-Lauz is present in northwestern area of Saudi Arabia near Gulf of Aqaba in the Tabuk region (Fig. 1). The Jabal Al-Lauz range consumes about 464 km²; highest peak (2580 m above sea level) is located at 28°39’15”N 35°18’21”E. To the north is the Wadi Hajy, to the south is the Wadi Houi, to the west is the valley of Afal, and to the east is the Wadi Al’abyd. According to a US Geological Survey report, the peak of Jabal Al-Lauz, consists of light colored, calcium-rich, alkaline granite that is intruded by rhyolite and andesite rock sheet dikes.

The climate is continental, even though influenced sporadically at the Mediterranean Sea. At winter season, the penetration of cool Mediterranean air masses brings frontal rainfall events with high intensities. During summer, 47 °C is highest temperature, and −2 °C is lowest during winter. Overall, 28 °C and 12 °C is the on an average temperatures in summer and winter (Alsharan et al., 2001). 20 mm is the average rainfall per annum (Fig. 2), 40 mm is the annual evaporation.

2.2. Vegetation samples

Totally, 12 samples relevés of 20 × 20 m were established in Jabal Al-Lauz, as two groups: relevés 1–9 were in Jabal 1 group and relevés 10–12 were in Jabal 2 group during the spring and fall seasons of 2016 (Fig. 1). Selected plant specimens were collected as per Collenette (1999) and Chaudhary (1999). The species which are life form is determined by Raunkiaer et al (1934). Based on the chrological analysis, the species which comes under category of floristic and abundance cover are also made (Wickens 1978, Zohary 1973, Kent 2012) (see Fig. 3).

2.3. Nutritional analysis of *P. korshinskyi*

In April 2016, from each stand, the plant samples were selected stand and separated into stem, leaves, and fruits. Each of these plant parts were further cleaned, dried under shade and powdered with a metal-free plastic mill. Sodium, ferrous, calcium, magnesium, potassium, manganese, zinc and phosphorus were analyzed. Ash content was assessed at 500 °C, total lipids were determined with ether extract. Crude protein (CP) and carbohydrates were calculated. Allen et al (1989) protocol was implemented in this study.

2.4. Size structure of *P. korshinskyi*

Concerned stands with area 20 m × 20 m the height as H and mean crown diameter as CD measured in different orientations based on uniformity with crown of measured tree in an individual plant of *P. korshinskyi* were measured (cm) in spring and autumn. The size index of *P. korshinskyi* is calculated as H + CD/2 (Crisp and Lange, 1976; Shaltout et al., 2003). Size index values were measured to find the distribution frequency in various size (age) cohorts. Specific size estimations are used for classifying the *P. korshinskyi* population in nine categories (first and second classes represent the juvenile stages). There were no seedlings. Overall density of plant species/hectare were measured in order to assess the characteristics of precise classes. We have also calculated the mean of height, density, size index and crown diameter of *P. korshinskyi* for separate season were also measured.

2.5. Analysis of soil samples

From the similar relevés the soil samples were adopted during the similar time along with the plant samples. As per the loss on
ignition, an organic matter was resolved at 550 °C. The texture of soil was determined using the method of hydrometer. Soil water extracts were prepared at 1:5, for estimating the pH, electrical conductivity (EC, mS cm⁻¹) and soil nutrient elements (calcium, potassium, sodium, magnesium, ferrous and phosphorus) (Allen et al. 1989).

2.6. Vegetation data analysis

Both the plant species cover the soil variable data sets which were subjected to multivariate analyses for classification using TWINSPLAN (Hill, 1979a) and confirmed by the ordination using DECORANA (Hill, 1979b) of the jabal Al-Lauz vegetation. CCA was carried out by Canoco 4.5 for windows to correlate between a derived vegetation and their environmental variable data set (Ter Braak and Smilauer, 2002).

Richness of the species for each vegetation association of *P. korshinskyi* and habitat were measured on an average species number/relevé. This species cover importance values were applied to assess the relative species evenness by index of Shannon-Weaver: \( H = \sum_{i=1}^{s} p_i \log p_i \) and the relative species concentration dominance by index of Simpson: \( C = \sum_{i=1}^{s} p_i^2 \); (s) is species no. and \( (p_i) \) is the % cover of the \( (i) \)th species. More details about these indices are available in Pielou (1975).

2.7. Statistical analysis

Pearson’s simple linear correlation coefficient \( (r) \) was used to test the relation between DCA axes and environmental variables. The variations of species diversity and soil characteristics in relation with vegetation associations are done by One-way ANOVA analysis (SAS, 1989–1996).

3. Results

3.1. Floristic composition

A total of 44 species from 21 families were recorded; highly signified families; Asteraceae, Cruciferae and Lamiaceae. Sub-shrubs constituted the most common life form (50%), followed by annual herbs (27.3%) and shrubs (15.9%) (Table 1; Fig. 4a). Jabel Al-Louz in the northwestern region influenced with Saharo-Arabian floristic
is influenced positively by pH, K, and Mn (Table 3; Fig. 6a). The segregation of relevés along axis 1 was verified by CCA (Table 3; Fig. 6). The correlation analysis between the environmental variables and ordination axes was verified by CCA (Table 2; Fig. 5a and b). After the initial and secondary domination of elements (31.8%), followed by elements belongs to the Mediterranean region (20.5%). Mediterranean-Irano-Turanian and Tropical-African have the highest value among the biregional elements (6.8%) (Table 1; Fig. 4b).

### Plant associations

The TWINSPAN -analysis at level 2 indicated three vegetation groups (Table 2; Fig. 5a and b). After the initial and secondary dominant species, these groups were named as VGI: *P. korshinskyi*-Astracantha echinoides; VGII: *Artemisia sieberi*-Prunus korshinskyi and VGIII: Retama raetam-Artemisia sieberi. Life forms: Ah: Annual herb, PG: Perennial grass, SSH: Subshrub, SH: Shrub, TR: Tree. The chorotypes: AF: African, IT = Irano Turanian, Med = Mediterranean, SA = Saharo Arabian, SM = Somalia Masai, TR: Tropical.

#### Table 1

| Species Family | Life form | Chorotype | VG I | VG II | VG III |
|----------------|-----------|-----------|------|-------|--------|
| *Prunus korshinskyi* | Roaceous | SH | Med | 20 | 15 | 10 |
| *Artemisia sieberi* | Asteraceae | SSH | IT | 50 | 60 | 20 |
| *Tanacetum santoliioides* | Asteraceae | SSH | IT | 10 | 15 | . |
| *Alkanna orientalis* | Boraginaceae | AH | Med-IT | 1 | 5 | 1 |
| *Retama raetam* | Leguminosae | SH | SA | . | 5 | 40 |
| *Astracantha echinoides* | Leguminosae | SH | IT | 5 | 15 | . |
| *Ononis natrix* | Leguminosae | SSH | TR AF | . | 5 | 8 |
| *Nepeta abelii* | Labiatae | SSH | SA | . | 2 | 1 |
| *Parula sinica* | Umbelliferae | SSH | SA | . | 2 | 5 |
| *Echinops glaberrimus* | Asteraceae | SSH | SA | . | 2 | 5 |
| *Centareae eryngioides* | Asteraceae | SSH | IT | 1 | 4 | 1 |
| *Zilla spinosa* | Cruciferae | AH | SA | . | . | 6 |
| *Gypsophila capillaris* | Caryophyllaceae | SSH | IT | . | . | 1 |
| *Picris babylonica* | Asteraceae | AH | SA | . | . | 1 |
| *Sisymbrium erysimum* | Cruciferae | AH | Med-SA | . | 1 | 1 |
| *Asparagus sp.* | Asparagaceae | SH | Med | . | 5 | . |
| *Teucrium pollum* | Labiatae | SSH | Med-IT | . | 5 | 3 |
| *Allysum subspinosum* | Cruciferae | AH | SA | 5 | 4 | 2 |
| *Astragalum tortosalli* | Scrophulariaceae | AH | Med | 5 | 4 | . |
| *Gallium spurium* | Rubiaceae | AH | TR-IT | . | 1 | . |
| *Ballota undulata* | Labiatae | SSH | Med | 1 | 15 | . |
| *Pterocephalus sanctus* | Chenopodiaceae | SSH | IT | 5 | 3 | 2 |
| *Verbascum sinaiticum* | Scrophulariaceae | SSH | IT-SA-SH | 1 | 1 | 1 |
| *Ballota adenophora* | Labiatae | SSH | Med | 1 | 1 | . |
| *Sisymbrium septulatum* | Cruciferae | AH | TR AF | 1 | . | . |
| *Silene linearis* | Caryophyllaceae | SSH | SM | . | 5 | 3 |
| *Rosa abyssinica* | Roaceous | SSH | SM | . | 5 | 3 |
| *Salsola aegyptiaca* | Cruciferae | AH | TR AF | 1 | . | . |
| *Antirrhinum oronuntum* | Scrophulariaceae | AH | Med | 1 | . | . |
| *Diptolaxis harra* | Cruciferae | AH | SA | . | 1 | . |
| *Pagonia mollis* | Zygophyllaceae | SSH | SA | . | 5 | 3 |
| *Astraphaxia spinosa* | Polygonoaceae | SSH | Med | 5 | 1 | . |
| *Daisy thirradiata* | Umbelliferae | SSH | SA | . | 1 | . |
| *Campauna erinus* | Campanulaceae | AH | Med | 1 | . | . |
| *Origanum syriacum* | Labiatae | SSH | Med | 1 | . | . |
| *Parietaria alismifolia* | Urticaceae | AH | SA | . | 1 | . |
| *Ephedra foliata* | Ephedraceae | SSH | SA-IT | . | 1 | 1 |
| *Lavandula pubescens* | Labiatae | SSH | SA-IT | . | 1 | 1 |
| *Pistacia khinjuk* | Anacardiaceae | Tr | Med-IT | . | . | . |
| *Piptatherum millicomum* | Gramineae | Per.grass | Med-SA | . | . | . |
| *Astragalus spinosus* | Leguminosae | SSH | IT | . | . | . |
| *Platylepis palmae* | Moraceae | Tr | SM | . | . | . |
| *Scrophularia deserti* | Scrophulariaceae | SSH | SA | . | . | . |

#### 3.2. Plant associations

3.2.1. Vegetation group characteristics

3.2.2. Species diversity

3.2.3. Soil characteristics

#### 3.3. Interaction with species diversity and soil

Total number of species and richness is absolutely associated with pH, sand and Mn content. However, it is negatively associated with clay and silt content (Table 3). Species is positive associated with sand content and negatively associated with clay, silt and phosphorous content. Evenness shows a positive correlation with sand. The Shannon index is significantly associated with pH and sand content and negatively correlated with clay content. The Simpson index is significantly associated with clay and potassium and phosphorus content; negatively correlated with sand content.

#### 3.4. Soil characteristics of vegetation group(s)

*P. korshinskyi*-Astracantha echinoides (VG I) had -high values in species evenness, Shannon index, organic matter, clay, magnesium, phosphorus and ferrous content, and the lowest values in total species number, total plant cover, Simpson, pH and manganese...
content (Table 4). The *P. korshinskyi*-*Artemisia sieberi* community (VG II) had higher content of the total species number, total plant cover, richness, Simpson index, sand and lower values of species evenness, Shannon, salinity, clay, silt, potassium, calcium, magnesium, sodium, phosphorus, and ferrous. The *Retama raetam*-*Artemisia sieberi* community (VG III) had the higher values of species richness, salinity, pH, silt, manganese, potassium, sodium, calcium and lower values of organic matter and sand content.

### 3.5. Nutritional analysis

Nutritional analysis on the plant parts of *P. korshinskyi* revealed that the stems showed the highest content of ferrous, manganese, magnesium, and zinc and lowest content of fats, crude protein, and sodium. Leaves had the highest content of ash, sodium, and calcium and lowest content of carbohydrate, phosphorus, and potassium. Whereas, the fruits had the highest content of carbohydrate, fats, crude protein, phosphorus, and potassium, and lowest content of ash, ferrous, calcium, manganese, magnesium, and zinc (Table 5).

### 3.6. Size structure

Population structure studies of *P. korshinskyi* revealed that during the spring and autumn seasons the values of density, diameter and size index are higher in Jabal 1 while height values are higher...
in Jabal 2 (Table 6). The ratio of height to diameter of P. korshinskyi is more than unity, with the trees having a cylindrical habit. The size class frequency distribution of P. korshinskyi shows J-shape in both spring and fall for the whole population (Fig. 7a, b).

### 4. Discussion

In Saudi Arabia limited distribution of P. korshinskyi were available from north-western side with few escarpments and slopes of Jabal Al-Lauz. It occurs due to inability of regeneration via seeds of flowers of P. korshinskyi is infected through the fruit wasp Eurytoma amygdali, which consumes the ovary during the flowering stage itself. This shows that P. korshinskyi might be propagated only by vegetative means in Jabal Al-Lauz since we have observed only small juvenile individuals.

Asteraceae, Cruciferae, and Lamiaceae were the most represented families in Jabal Al-Lauz. Similar results have been reported in Migahid (1990), Thomas et al. (2016), and Thomas et al. (2017) in diverse regions especially in northern side of KSA, whereas the vegetation has a typical Saharo-Arabian floristic structure as reported by Quézel (1978) and Al-Hassan (2006). The sub-shrubs (Chamaephytes), followed by therophytes and shrubs were the most common life forms in Jabal Al-Lauz. The high number of Chamaephytes is typical of dry desert vegetation (Deil, 2014). In addition, also therophytes with short life spans are adapted to dry habitats (Kassas and Imam, 1954; Asri, 2003; Shaltout et al., 2010; El-Sheikh, 2013). Our results are in line with other studies in different parts of KSA (Thomas et al., 2017; El-Sheikh et al., 2019).

There is a high share of Saharo-Arabian plants in this study site, as a result of the more convenient environmental factors which provide suitable shelter for Saharo-Arabian species (Chazanfar and Fisher, 1998). The presence of numerous biregional elements species in Jabal Al-Lauz may be a result of the area being considered to be in a transition region between some floristic zones (e.g., Mediterranean, Irano-Turanian, Tropical and African). Alatar et al. (2012) documented the phytogeographical areas have much influence on flora at north side of KSA.

P. korshinskyi is a three plant associations, two of them (VG I and VG II) are characterized by the presence P. korshinskyi. It is interesting to notify that P. korshinskyi was one of the main plant community components in Jabal Al-Lauz. Talhouk et al. (2000) reported similar results of endangered P. korshinskyi in the mountains of Lebanon. P. korshinskyi and associated species are found on many sites such as cliffs and between cracks on slopes of the mountain, which have an alkaline silty soil with more minerals composition.

The segregation of the relevés laterally for the axis one is powerfully associated with pH, potassium, manganese, organic matter and sand content. Plant distribution and compositions are well known to be determined by the micro environmental features (Keenan and Kimmins, 1993). Annual herbs like Picris babylonica, Sisymbrium erisyminoides, Diplotaxis harra, Parieraria alsinformia were situated at upper positive region at both the axis connected with sand content. Plant distribution and compositions are well known to be determined by the micro environmental features (Keenan and Kimmins, 1993). Annual herbs like Picris babylonica, Sisymbrium erisyminoides, Diplotaxis harra, Parieraria alsinformia were situated at upper positive region at both the axis connected with soil factors: organic matter, EC, Mg and sand content. Plant distribution and compositions are well known to be determined by the micro environmental features (Keenan and Kimmins, 1993). Annual herbs like Picris babylonica, Sisymbrium erisyminoides, Diplotaxis harra, Parieraria alsinformia were situated at upper positive region at both the axis connected with soil factors: organic matter, EC, Mg and sand content. There is an increasing amount of human activities (e.g., firing, trampling,}

**Table 3** Correlation analysis of species diversity indices and soil features.

| Variable          | Species number | Species richness | Species cover | Evenness | Shannon (H) | Simpson (C) |
|-------------------|----------------|------------------|--------------|----------|-------------|-------------|
| Soil variables    |                |                  |              |          |             |             |
| pH 0.4112*        | 0.4310*        | –0.0308          | 0.1875       | 0.4625*  | –0.3796     |             |
| EC mS/cm 0.0094   | 0.0025         | 0.3723           | –0.1806      | –0.0256  | 0.1731      |             |
| Bulk soil %       |                |                  |              |          |             |             |
| Organic matter    | 0.1833         | 0.1511           | 0.2932       | 0.0833   | 0.2535      | –0.1917     |
| Sand              | 0.5958**       | 0.5120*          | 0.3577*      | 0.0472   | 0.5030**    | –0.4000     |
| Clay              | –0.5218        | –0.5041          | –0.3315      | –0.2238  | –0.5920     | 0.5262      |
| Silt              | –0.5442        | –0.4148          | –0.6233*     | 0.1296   | –0.3159     | –0.0827     |
| Macro-elements ppm|                |                  |              |          |             |             |
| Sodium            | –0.1984        | –0.2658          | 0.2049       | 0.3021   | 0.0215      | –0.1917     |
| Calcium           | 0.1074         | 0.0675           | 0.3056       | 0.0111   | 0.1556      | –0.0379     |
| Manganese         | 0.4712*        | 0.4227           | 0.06630      | –0.3676  | 0.0453      | 0.1256      |
| Magnesium         | 0.1746         | 0.1271           | 0.3705       | –0.0853  | 0.1273      | 0.0134      |
| Potassium         | –0.1190        | –0.1300          | –0.3834      | 0.3131   | –0.2897     | 0.4821      |
| Ferrous           | 0.2951         | 0.2115           | 0.1146       | –0.1528  | 0.1346      | 0.0194      |
| Phosphorus        | 0.0336         | –0.0203          | –0.5825*     | –0.056   | –0.3667     | 0.5671*     |

* P ≤ 0.05.  
** P ≤ 0.01.
grazing, and cultivation) occurring in Jabal Al-Lauz. Such activities may increase the organic matter and salinity, which alters the community structure and increase the proportion of therophytes (Shaltout and El-Sheikh, 2003).

Species number, cover, and richness were strongly associated with pH, sand and Mn content; negatively connected with clay and silt content. Whereas, the dominance of species “Simpson index” is significantly associated with clay, phosphorous and potassium content; negatively correlated with sand content. Similar relations were stated by El-Sheikh et al. (2013). These correlation findings clearly illustrate the richness of the association VG II and why P. korshinskyi inhabits on sandy soil substrates which are

Fig. 6. CCA biplot and environmental variables (arrows), the stands (a) and the species (b). (For complete names of species, see Table 1).
the result of erosion of granite rocks. Certain species of grass have been reported as the main pioneering species of these sandy soil environments; the grasses stabilize the sandy substrate by fixing the sand in place, and also retain nutrients and moisture in the soils, thereby changing the environment and converting it into a more viable ecosystem due to climate change and increasing of anthropogenic factors (Zhang and Ma, 2008).

Our findings on the soil characteristics of *Prunus korshinskyi* show that this species exhibits considerable tolerance to limestone/calcareous soils as well as drought, and it can tolerate cold conditions, and diseases. Therefore, it can be used as a rootstock for peach, plum, apricot and almond. These results are consistent with the results presented by Nicotra and Pellegrini (1989), Vito et al (2001), Gradziel (2008) and Reighard and Loreti (2008).

Many economically important species of *Prunus* as peach, nectarine, European plum apricot, mume, cherry (sweet/sour) and almond have high nutritional value and are cultivated for their fruit and nut production. The nutritional quality of *P. korshinskyi* remains unexplored. Nutritional analysis of the stems, leaves, and fruits of *P. korshinskyi* revealed that the fruits had the highest content of carbohydrate, fats, P, Ca, and K. More studies should be done for enhancing the nutritional value of wild plant varieties. The main reason that limits such research is the lack of awareness about plant metabolism as well as the complex associations and interlinkage of many metabolic pathways. Both traditional plant breeding and advanced recombinant DNA techniques can be used to metabolically engineer underutilized wild plants to obtain desired quality traits.
P. korshinskyi had attained high productivity in the spring season during which water and minerals are more readily available after the rainy winter season on the Tabuk region with a maximum rainfall of 64 mm (Galal and Fahmy, 2012). After that, the plant succeeds a long dry season during summer and autumn with temperature reaching a maximum of 38.1°C (Asri, 2003). The height:diameter ratio of P. korshinskyi is more than unity; therefore, the habit of the P. korshinskyi appears as cylindrical rather than the cushion shrubby desert habit. Therefore, this habit of the P. korshinskyi indicates the habitat of study area as following the Mediterranean region, which is relatively wetter than the desert habitat of the Saharo-Arabian region (Shaltout et al., 2003; El-Sheikh, 2013).

The size class frequency distribution of P. korshinskyi are in the whole population shows J-shape, where the plant populations consisted of very few individuals (one or two scattered individuals of an old shrub) which were growing in the grooves between stones that are protected from animal grazing. The chances of successful regeneration by seed of these populations are further reduced as the seeds are attacked and destroyed by the larvae of different pests. Alkassis and Sookar (2006) reported similar observations for almond, where regeneration by seed was reduced by larvae of the fruit wasp Eurytoma amygdali. There were no P. korshinskyi seedlings in the Jabal Al-Lauz populations. The only regeneration that has been reported has been by vegetative means through the dissemination of fragmented plant organs by grazing animals (Al-Rowaily et al., 2015).

**Declaration of Competing Interest**

The authors declared that there is no conflict of interest.
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