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Morphological Traits of *Quercus coccifera* at Different Altitudes in Al-Jabal Al-Akhdar Region, East Libya

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Abstract

Morphological traits reflect the adaptation of trees to their environment, provide an understanding of tree-environment interactions, and assess the effects of environmental changes on plant species. Essential important role in the study of tree biodiversity as they provide information on species assessment and their influence on environmental conditions. Morphological traits of (*Quercus coccifera* L.) trees were evaluated during the 2022 season at three sites different in altitude in the Al-Jabal Al-Akhdar region, eastern Libya. The results indicated significant differences in the height and diameter of the trees between the sites, where the trees were characterized by the lowest tree height and the smallest diameter, while the highest height and the largest diameter of the trees were at altitude (493m). The trees at (333m) site were characterized by the longest and widest leaf and the shortest leaf petiol, while the tree at 493m was characterized by the shortest leaf and the smallest leaf width. On the other hand, there were no significant differences in the length of masculine, feminine inflorescences, number of florets per inflorescence, and traits of Acorn between the trees in the three sites. It is important to pay attention to this a native species, preserve it, develop it, and ensure its survival and regeneration in the Al-Jabal Al-Akhdar region.

الصفات المورفولوجية للبلوط القرمزي *Quercus coccifera* على ارتفاعات مختلفة من سطح البحر بمنطقة الجبل الأخضر– شرق ليبيا

امل الطشاني صالح بوغرسة سعد بو ذهب

تعكس الصفات المورفولوجية تكيف الأشجار مع بيئتها، وتوفر فهماً للتفاعلات بين الأشجار والبيئة، وتقيّيم آثار التغيرات البيئية على الأنواع النباتية لها دور أساسي ومهم في دراسة التنوع البيولوجي للأشجار لأنها توفر معلومات عن تقييم الأنواع وتأثرها خلال موسم 2022 *Quercus coccifera* L. بالظروف البيئية. تم تقييم الصفات المورفولوجية لأشجار البلوط القرمزي في ثلاثة مواقع مختلفة في الارتفاع عن سطح البحر بمنطقة الجبل الأخضر، شرق ليبيا. أشارت النتائج إلى وجود فروق معنوية في ارتفاع وأقطار الأشجار بين المواقع، حيث تميزت الأشجار بأقل ارتفاع للأشجار وأصغر قطر لها، بينما كانت أعلى ارتفاع وأكبر قطر للأشجار على ارتفاع (493م). وتميزت الأشجار في الموقع (333م) بأطول وأعرض ورقة وأقصر أعناق الأوراق، بينما تميزت الشجرة في الموقع (493م) بأقصر ورقة وأصغر عرض ورقة. من ناحية أخرى، لم تكن هناك فروق ذات دلالة إحصائية في طول النورات المذكرة والمؤنثة، وعدد الأزهار في النورة الواحدة، وصفات البلوط بين الأشجار في المواقع الثلاثة. من المهم الاهتمام بهذا النوع المحلي والمحافظة عليه وتنميته وضمان بقائه وتجدده في منطقة الجبل الأخضر.

INTRODUCTION

The genus Quercus is an ecologically and economically essential species that is an important source of food, wildlife habitat, wood and paper products. There are about 10,400 species spread across the world's continents, and one of the most important oak tree species in the Mediterranean basin is the *Quercus coccifera* Covering more than 2 million hectares of Mediterranean forests and growing under a wide variety of soils, this species is very

important in controlling soil erosion, especially after a fire, and is an essential source of wildlife and livestock (Canellas and San 2000).

Q. coccifera L. of the Fagaceae family, a native evergreen tree that is about 10 meters high , and it may turn into a shrub as a result of animal grazing while it is small(Al-Zeni and Bayoumi, 2006).This species is found in Al-Jabal Al-Akhdar region in many sites, especially among the valleys, and it is one of the species that may prevail over other trees in red calcareous soils and under relatively high rainfall, more than 400 millimeters/year (Al-Zeni and Bayoumi, 2006). It is widespread in many site in Wadi al-Kuf, Wassita, Sousse, Ras al-Hilal and southern Al-Bayda, especially between wadis, where it is found at different altitudes starting from 33 meters from sea level (Wadi Bou al-Nidi near Nouta pools west of Sousse), as well as in the Zarda area at 664 meters from altitudes (Study and evaluation of natural vegetation in Al- jabal Al- Akhdar area,2005).

The morphological diversity of oak species has received considerable attention in taxonomic studies (Valencia, 2004; Rodrguez-Rivera and Romero-Rangel, 2007; Martinez-Cabrera *et al*., 2011). A plethora of ecological studies have been conducted in order to analyse morphological variation in environmental factors (see Gonzalez-Rodriguez & Oyama, 2005; Uribe-Salas *et al*., 2008). It has been established through previous studies that geographic and environmental factors play a significant role in influencing plant morphology and species stability across diverse habitats (Bruschi *et al*., 2003). Furthermore, distinct leaf traits of various oak species have been correlated with environmental factors, including temperature and precipitation, within distinct geographical regions. This suggests that such correlations may serve as indicators of environmental resilience responses or adaptive genetic diversity among individuals and across populations. (Balaguer *et al*., 2001; Uribe-Sales *et al*., 2008; Rodriguez-Gomez *et al*., 2018; Albarran-Lara *et al.*, 2019).

Leaf morphology shows the methods by which plants adapt to different habitats and environments (Siso *et al*., 2001; Xu F *et al*., 2009), especially climatic conditions and different soil types (Booth et al., 2005; Lin,S *et al*., 2018). Some studies have also shown that increased altitude and decreased rainfall and nutrients in the soil have resulted in a decrease in leaf size (McDonald *et al*, 2003; Liu, W., 2020). Moreover, elevated temperatures, concomitant with declining solar radiation, have been observed to result in increased leaf thickness and diminished leaf area. This phenomenon has been shown to mitigate the damage to leaf tissue caused by sunlight. (Leigh *et al*., 2012; McLean *et al*., 2014). The change in leaf phenotype can also be attributed to degrees of inclination and slope in latitude and altitude (Tang and Ohsawa, 1999).

Some sources reported that the variation of leaf morphology with altitude gradient has been associated with environmental factors, as (Velazquez-Rosas *et al*.,2002; Uribe-Salas *et al*.,2008) reported a strong relationship between leaf morphology and environmental factors, specifically (temperature). Leaf morphology may be affected by microclimate conditions such as temperature, solar radiation fall and humidity. In some cases, sun-exposed leaves have been found to have smaller, thicker and more lobed leaf cover than tolerant leaves (Mitchell *et al*. 1999; Bruschi *et al*. 2003; Valladres *et al*. 2014). Leaves in different layers of the tree absorb, receive and reflect light differently, which has an impact on physiological processes within the leaf (Ellsworth and Reich 1993). Also, taller leaves with larger leaf area are not necessarily found in areas with high rainfall (Gouveia and Freitas, 2009; Ramirez-Valiente *et al*., 2015).

Q.coccifera L. face many challenges in semi-arid regions as climate change leads to more severe droughts and higher temperatures, unregulated grazing can damage trees and prevent their regeneration, and the removal of oak forests for various reasons such as agriculture and construction leads to the loss of ecosystems (Perez-Luque *et al*., 2021), so we found it important to pay attention to this local plant species in order to preserve, develop and ensure its survival and regeneration in the Al-Jabal Al-Akhdar region.

The objective of this research is to study the growth of the *Q. coccifera* L. tree distributed in some sites of different altitudes in the Al-Jabal Al-Akhdar region by studying the difference in the morphological traits of the trees.

MATERIALS AND METHODS

Three sites in the Al-Jabal Al-Akhdar region with different altitudes of *Q. coccifera* L. (Table1).

Morphological traits

For each site, tree height was measured with a Haga Altimeter, and stem diameter at breast height (d.b.h.). Also, were measured morphological traits of leaves, flowers, acorns and seeds (Table 2).

Table1: **Description of the sites of study.**

Sites	Altitude (M)	Longitude	Latitude
Lamloda	608	22° 09' 48.12"	32° 49' 09.36"
Arqoub Al-Abiad	493	22° 09' 47.40"	32° 51' 11.94"
Sidi Khaled	333	22° 28' 22.92"	32° 46' 40.44"

Table 2: Morphology traits of *Q. coccifera*

Trait	Measurement
leaf length	cm
leaf width	cm
Petioles length	mm
Acorn length	cm
Acorn thickness	cm
Acorn	num. Acorn/Kg
Seed thickness	cm
Seed length	cm

Statistical analysis

The results obtained were analyzed using the Completely Randomized Design (CRD) and the means were compared using Tukey at the 0.05 significance level (IBM SPSS Statics,v.25).

RESULTS AND DISCUSSION

Q. coccifera L. is a native evergreen tree that reaches a height of 2 m to 8 m in the study sites, and may turn into a shrub as a result of animal grazing when young. The leaves are simple, alternate, oval or slightly elongated, circular or cordate at the base, with a length of 3.5-4.6 cm and a width of 2.1-2.5 cm, dentate where the average number of dentate is between 6-12, and have short petioles with an average at the three sites of about 0.31-0.42 mm.

The flowers are greenish-yellow and are unisexual and the plant is monoecious, the male flowers are pendulous, slender inflorescences 4.33 cm long with an average of about 16 flowers per inflorescence and the female flowers in spikey inflorescences about 4 cm long with an average of about 16 flowers per inflorescence. The buds are scaly, but towards the apex they form irregular clusters. Acorns have an average length of 3.9 cm and an average thickness of 1.3 cm, but part of the base of the Acorns is covered with a cup-like or funnel-like structure consisting of scales superimposed on each other.

The results showed that the highest tree height of 5.7 m and the largest diameter of 20.7 cm was at Al-Arqoub Al-Abiad site while the lowest height and smallest diameter at the Lamlouda site was 3 m and 8.4 cm, respectively, (Figure 1). There were also significant differences in leaf length among the three sites, where Sidi Khaled site was characterised by the longest leaf length of 4.652 cm, while the leaf length was not significantly different in Al-Arqoub Al-Abiad and Lamlouda sites, 3.582 cm and 4.137 cm, respectively. (Figure 2).

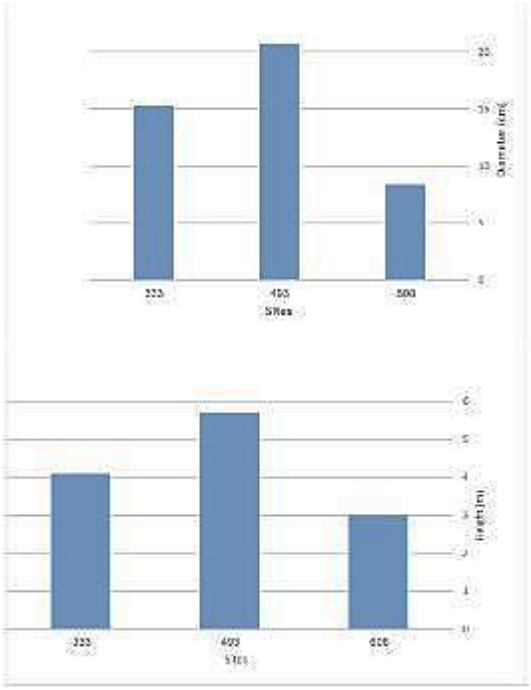

Figure 2: Tree height and diameter at breast height

Also, figure (2) shows There were a significant difference in leaf width, Al-Arqoub Al-Abiad site was lowest leaf width of 2.146 cm. While Lamlouda site was characterised by the longest leaf petiole of 0.422 mm. As well as, There was a difference in the number of dentate among the three sites, Sidi Khaled was highest number of dentate (12) and Lamluda the lowest (6).

The results indicate that there are no significant differences in the length and thickness of the acorn and seed, where the highest length and thickness of the acorn in the Al-Arqoub Al-Abiad site were 3.95 cm and 1.37 cm, respectively, while the longest seed in Sidi Khaled site was 3.51 cm also, the highest seed thickness was in the Al-Arqoub Al-Abiad site 3.246 cm (Tabel,3). On the other hand, the results of the number of acorn per kilogram indicate, the largest number was 363 acorn/kg at Lamlouda site, while the fewest number was 270 Acorn/kg at Al-Arqoub Al-Abiad site.

Table 3: Morphological traits of acorn and seed

Site	Acorn length	Acorn thickness	Acorn/kg Num.	Seed length	Seed thickness
Lamlouda	3.909	1.227	363	3.246	1.043
Al-Arqoub Al-Abiad	3.950	1.367	270	3.336	1.183
Sidi Khaled	3.849	1.216	290	3.507	1.093

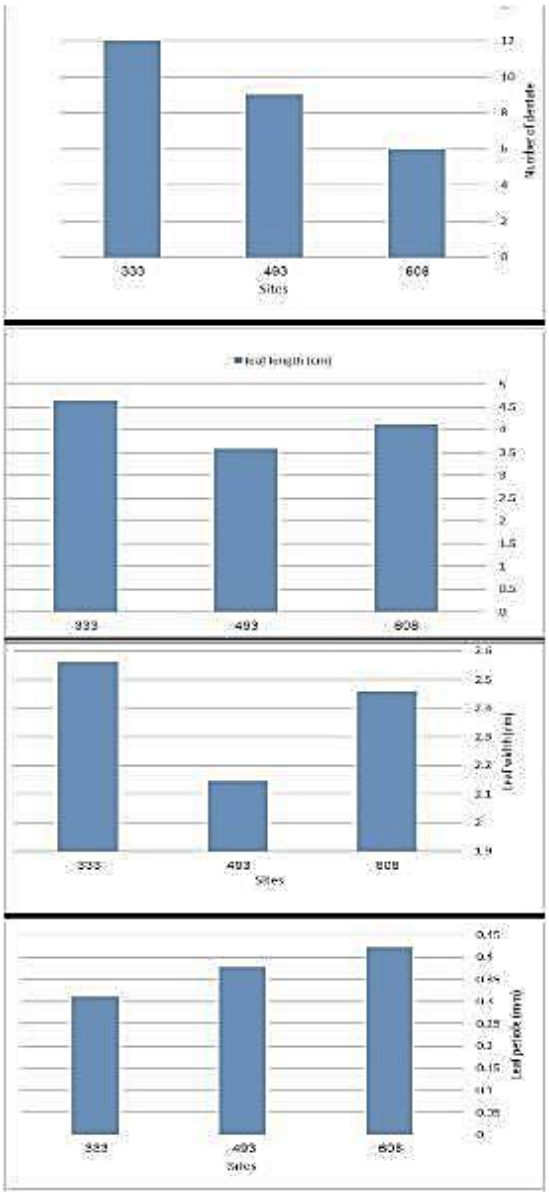

Figure 2: Morphological traits of leaves

DISCUSSION

The morphological traits of the oak trees were different between the sites, where there was a difference in the height of the trees, where the highest height was in , Al-Arqoub Al-Abiad site, this may be due to the fertility of the soil in this site, which was higher than the other sites where the percentage of organic matter reached 7.73%, as well as the high percentage of phosphorus and nitrogen elements compared to the other two sites, which is well reflected in the height and diameter of trees in this site. It can be said that the height and diameter of the tree were influenced by soil factors in terms of nutrient content more than climate factors. This is consistent with Souad & Amraoui (2020). In his study on the effect of soil properties on oak growth, he stated that soil properties have an impact on competition and that the difference in soil texture and nitrogen ratio affects root production and thus reflects on the biomass of trees. The increased leaf length and width at the Sidi Khaled site can also be attributed to the increased amount of incident radiation and thus the optimal use of light through photosynthesis. Also, leaf morphology may be affected by microclimate conditions such as temperature, solar radiation fall and humidity, as in some cases sun-exposed leaves were found to have a smaller, thicker than those growing in the shade. (Mitchell *et al*., 1999; Bruschi *et al*., 2003; Valladres *et al*.,2014).

On the other hand, the reason for the small leaf size at the Lamluda site as well as the low height and diameter of the trees at this site may be due to grazing, which may affect the decrease in the amount of carbohydrates and thus affect the size of the leaf, this is consistent with the study of(Papatheodorou *et al*.,1998) On the effect of grazing on the biomass of *Q. coccifera* shrubs, he reported that grazing significantly affected leaf properties, as the mean leaf area and weight were lower in grazed shrubs compared to non-grazed shrubs. The reason for the variation in leaf size between the study sites was also due to the difference in environmental factors, in Lamluda site the annual temperatures were low during the 2022 season and this result agrees with (McDonald *et al*. 2003; Ordonez *et al*., 2009; Liu *et al*., 2020) who stated that increasing altitude and decreasing the amount of nutrients in the soil leads to a decrease in leaf size. Also, the variation in leaf morphological traits is related to the degree of slope, slope, temperature and humidity differences. Also, longer leaves with larger leaf area are not necessarily found in areas with high rainfall (Gouvei & Freitas 2009), and our results contradict Maya-Gaecia *et al*. (2020), who also emphasised that trees at higher altitudes have wider and thinner leaves than those growing at lower altitudes, which have narrower and thicker leaves (Maya-Gaecia *et al*.2020), which also emphasised that trees at high altitudes have wider and thinner leaves compared to those growing at lower altitudes, which have narrower and thicker leaves. Also, the difference in leaf morphological characteristics is related to the degree of slope and gradient as well as the difference in temperature and humidity. On the other hand, the number of Acorn per kilogram was different between the sites, with 363 Acorn in Lamlouda site,

probably due to the effect of grazing on tree biomass and this is consistent with the study of Papatheodorou *et al*., (1998) on the effect of grazing on the biomass of oak. Acorn production is also influenced by several factors such as tree density, rainfall in the spring season, water status within the plant (Carevic *et al*., 2009), soil properties, site characteristics or the availability of a certain level of light (Gea-Izquierdo *et al.*, 2006).

CONCLUSION

This study was conducted to estimate the morphological traits of scarlet *Q.coccifera* L. growing at different altitudes in the Al-Jabal Al-Akhdar region, eastern Libya. The soils of the three sites are alkaline loamy soils. The soils differed in the percentage of organic matter, the height and diameter of the trees differed between the sites, as well as the length and width of the leaves and the number of acorn per kilogram, and there were no differences in the characteristics of flowers and Acorn. Planting *Q.coccifera* L. trees in deforested regions and applying organised grazing plans to preserve the oak trees is recommended. It is also important to pay attention to the conservation, preservation, development, survival and regeneration of this local species in the Al-Jabal Al-Akhdar region and to focus on increasing studies on the nutritional importance of *Q.coccifera* L. acorn. It is also conduct studies on genetic diversity using anatomical, chemical and molecular markers.

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