

RESEARCH PAPER

Impact of Abiotic Factors on growth of *Quercus aegilops* and *Quercus infectoria* in Mergasour Natural Forest – Erbil – Iraq

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ABSTRACT:

The present study carried out in the natural forest of Mergasour. The purpose of the study to check of correlation of abiotic factors and growth of forest trees in this location for that I hypothesize that growth of trees is better in east face than west face and second I hypothesize nutrient elements are key factor for determining the growth trees. The study was including many aspects as a morphological variation of both oak species. At each face, these biometric variables measured (diameter (cm), height (m), tree branches (%)). The data analyzed as a factorial combination of the two factors; 2 faces and 2 *Quercus* spp., the analysis of variance (ANOVA) of the data computed using the Statistical package for the Social Sciences (SPSS) model (18). The multiple range test (DMRT) used to check the variations among the mean values of studied parameters. (0.05) level of possibility for the tree data. The highest mean height of autumn, winter, spring, and summer obtained were; (6.20, 6.30, 6.37 and 6.86m), of *Q. infectoria* trees in the East site. Which the largest value of diameter autumn, winter, spring and summer obtained were; (11.23, 11.52, 11.80 and 12.06cm) found in *Q. infectoria* stems at East site. And the maximum branches number obtained was; (7.0), of *Q. aegilops* branches in the East aspect. The result showed that plant growth response to topographic aspects, the rate of height, diameter and branches in east facet greater than the west face. There were differences in microclimate among the both faces Although the average soil moisture content during the four seasons of the year on the east aspect is higher than on the west face. On the other hand, soil nutrients only showed minor differences with concentrations being higher on the east face expect for potassium, which was higher on the west face.

KEY WORDS: *Quercus* sp., tree growth, abiotic factors, natural forest ecosystem.

DOI: <http://dx.doi.org/10.21271/ZJPAS.35.SpC.3>

ZJPAS (2023) , 35(SpC);23-31 .

1. INTRODUCTION

Oak a deciduous tree, belongs to Fagaceae family. Oaks (*Quercus* sp.) are dominant trees in most Asian forests, North African, European and American forests, from cool temperate environments (Douaihy *et al.*, 2020). North of Iraq in the mountains in elevations between 500 m to 2700 m distributed on many geographical areas (Tahir and Mezori, 2020). They are an important source of timber and coppice wood, but also are used to produce fuel wood, charcoal, medicinal products, animal fodder, dyes, cork and bark used in tanning (Khwarahm, 2020).

The oak tree prefers to full sun, and requires moist soil. The flowers are monoecious and are pollinated by wind (Shrestha *et al.*, 2014). Forests of Iraq are confined almost entirely to the northeast region of the country, which extends from the Zakho near the Turkey border to the Hurin Sheren in Iranian border, within the longitudes of 42° 40' - 45° 30' and two latitudes 34° 40' – 37° 08', it constitutes 4% of the total area of Iraq (Younis and Hassan, 2019). Kurdistan forests are mainly composed of broad-leaved forests mostly oak (*Quercus*) species 90 % and coniferous forests pine (*Pinus* spp.). Oak trees form the main species of the mountain forests includes *Quercus aegilops* (balut) with *Q. infectoria*, and *Q. libani* (dindar) (Shahbaz

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Article History:

Received: 21/12/2022

Accepted: 19/02 /2023

Published: 01/ 11/2023

et al., 2015). Forest ecosystem is under impact of abiotic factors; the effect of inanimate nature factors has increased (Ruba *et al.*, 2013). The main abiotic factors are classified into three broad categories such as weather (temperature, precipitation, light, and wind), soil (minerals and moisture), human activity, animals and birds (wildfire, air pollution, mechanical damage, herbicides, cutting) (Teshome *et al.* 2020). These factors have an effect on tree species in the natural forest areas surrounding Mergasour-Erbil inhabited by man from ancient times to the present.

The impact of abiotic factors on forest trees and shrubs is called abiotic stress. The main abiotic factors that cause stress in the ecosystem are temperature extremes, drought, wind, light, precipitation. The effects of climate factors on forests occur directly or indirectly (Teshome *et al.*, 2020). Uribe-Salas *et al.* (2008) identified a strong relationship between morphological features and environmental factors (mainly temperature and soil moisture). Temperature plays a key role in plant growth and development, because it affects metabolic rates of physiological processes like photosynthesis, respiration; provide it with energy, solar energy is the main source of heat and light by trees (Bloor *et al.*, 2010, Butler *et al.*, 2012, Melillo *et al.*, 2011, Reich *et al.*, 2018). Light is the factor that affects plant growth it use by the leaves for photosynthesis and chlorophyll synthesis (Kenzo *et al.*, 2011). Chen and Sumida, (2018) they showed that the effects of light intensity on branch growth and survival have been studied extensively. The precipitations in various forms such as rain, snow, dew and mist have a close relationship with forests because they are essential elements in nature (Goldsmith *et al.*, 2013). Soil complex natural material derived from decomposed rock and decomposed organic matter, soil provide the trees and dissolved nutrients in water as ions absorbed by the roots (Osman, 2013). Faces, influences the microclimate,

particularly air temperature, humidity, and soil moisture, as well as the daily solar radiation received at various change, months of the year. South-facing slopes, it is commonly accepted, hotter, and drier than a northeast slope (Desta *et al.*, 2004). Growth of oak species under elevation show different morphological and physiological forms (Douaihy *et al.*, 2020; Taleshi and Babarabi, 2013)

The main objective of this study:

The specific aim of this study to check the growth of natural oak trees in Mergasour districts under microclimate and aspect factor, to check effect of abiotic factors on physiological of oak trees and growth, combination between root and soil with green biomass, resource acquisition

2. MATERIAL AND METHODS

2.1 Study area

The study was conducted in the areas around Bradost Mountain, especially the eastern and western sites of the mountain in Mergasour; Mergasour is a district in northern Erbil Governorate in the Northern Iraqi Kurdistan Region. It is situated in the northern part of the Erbil Governorate, and (130kilometres) from Erbil government. The eastern front of the mountain is located (latitude 36.832 N and longitude 44.306 E), and elevation of 1171 meters above sea level (m.a.s.l). As for the western front of mountain Bradost is located (latitude 36.833 N and longitude 44.312 E), and with an elevation of 1146 meters above sea level (m.a.s.l). The topography of the area is fairly rugged and in East site the average slope inclination is 15%, and 35% to the West site. The study area's climate is characterised by cold temperatures and early winter snowfalls on the high mountains. Maximum temperature in summer is (37.2°C) and low temperature at minimum (-1.7°C) during winter season with the mean annual rainfall in the study area was more than 1000mm.

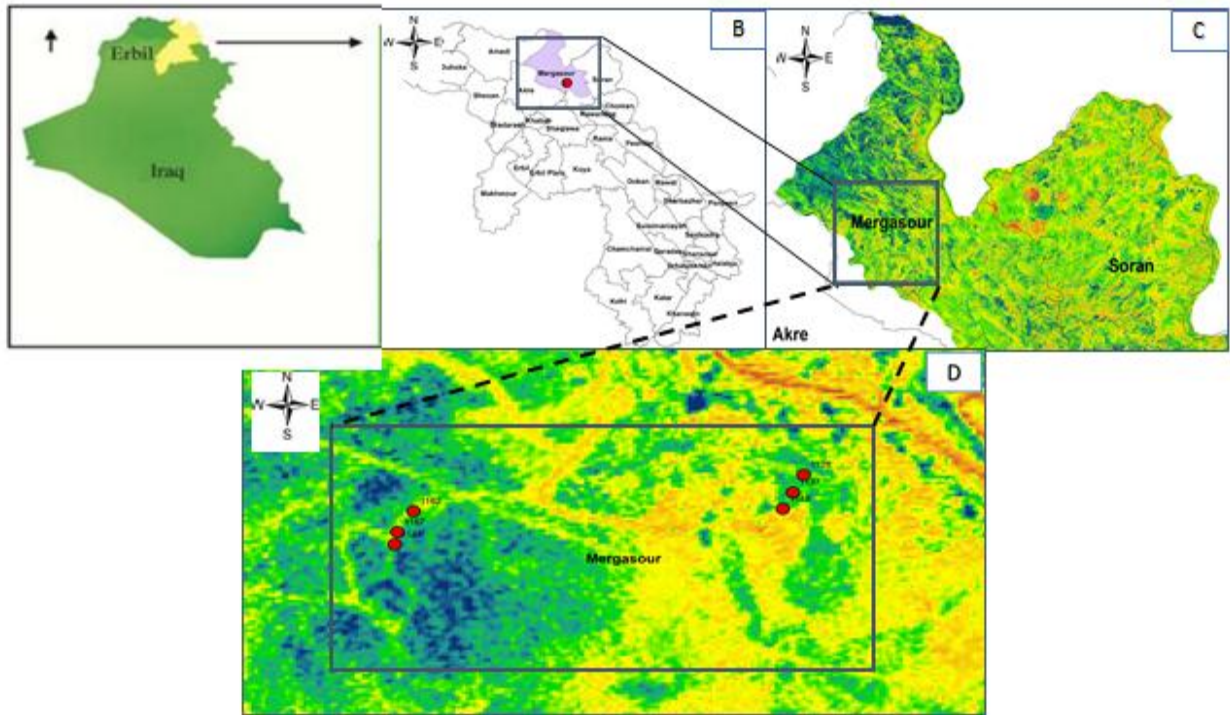


Figure1. (A) the map of Iraq; (B) the map of Kurdistan region (C) the map of Mergasour; (D) location of study area.

Table (1) Metrological data in Mergasor region (October 2021) to (September 2022)

Months	Temperature (C)			Relative Humidity (%)	Precipitation (mm)	Sunshine Dura. hours	Wind speed
	Min.	Max.	Av.				
Oct	15.5	24.6	19.8	234.1	30.2	18.4	2.0
Nov	8.8	17.6	13.2	49.1	18.4	15.4	1.8
Dec	3.0	9.7	6.3	70.8	351.2	10	1.9
Jan	-1.7	5.1	1.6	82.6	168	7.9	1.6
Feb	2.9	11.0	7.0	65.0	261.4	14.1	1.9
Mar	2.5	8.8	5.6	72.9	229.0	7.3	2.2
Apr	10.0	20.5	15.2	68.8	46.0	15	2.3
May	12.5	23.2	17.8	73.8	30.0	20	2.5
Jun	20.0	30.1	25.0	57.6	0.0	22.6	2.4
Jul	25.6	37.2	31.4	20.6	0.0	25.1	2.6
Aug	25.0	36.2	30.6	18.6	0.0	26.5	2.4
Sep	20.3	30.7	25.5	23.5	0.0	24.6	2.4

2.2 The experimental design and Statistical analyses

The study was organized with complementary randomized design (factorial CRD); we worked on two faces (east and west) in Mergasour region, in each face measured fifteen trees randomly, in three replication. The analyzed as a factorial combination of a two factors (AS); two Aspects (A) East (A1), West (A2) of Oak forest Mergasour in Kurdistan region, with the two abundant oak species (S) in these aspects; *Quercus aegilops* (S1) and *Quercus infectoria* (S2). Analysis of variance (ANOVA) of the data computed using

the Statistical package for the Social Sciences (SPSS) model 18. The Duncan’s multiple range test (DMRT) used to check the variations among the mean values of studied parameters 5 % level of possibility for the height, diameter, number of trees and branches growth characters.

2.3 Biometric measurements

At each face, these biometric variables measured (height (m), diameter (cm), branches number (%) and tree number) were measured from the study area for all trees larger than 4m height and 6 cm diameter at breast height (dbh) because homologous we used to selected trees in each

replication. In order to compare species dominance across the two faces, it was assumed that the dominating species for each had the highest value.

2.3.1 Measuring the height of trees

Tree height was measured using Haga altimeter. The height was measured by taking two types of *Quercus* tree in each repeater of each aspect randomly and then taking the rate of height of this tree to express the height of both species in each replication, and so on for both types of *Quercus* tree and for both aspects (Larjavaara and Muller-Landau, 2013).

2.3.2 Measuring the diameter of trees

The caliper is used to measure the diameter of trees at DBH height and has three sizes 50cm, 100cm, 130cm. The diameter of the five random trees was calculated in each replication and for each face (West, 2015).

2.3.3 Measuring the branches of the stem trees

The number of branches in tree and each replication were measuring by taking five trees.

2.3.4 Measuring the number of trees

Measuring the number of trees for both aspects in each of the three replications of the both studied areas by making rep (20*20) m, calculating the number of trees and then calculates the rate of each tree species for each aspect.

2.4 Soil sampling

Soil tacked at the base of trees by using augers and shovels, from the organic layer to a depth of 50cm and putted polyethylene bags and labeled, then closed tightly to prevent moisture leakage, in labs the samples dried and then sieve with texture, physical and chemical measured table (3). Soil texture was measured based on the triangle of strengths USDA texture triangle according to the book (Ryan *et al.*, 2001). The pH measured on a 1:1 ratio soil: distilled water suspension. Using the EC-meter (Model Conductivity meter in a lab, the soil samples EC value was calculated according to (Rhoades, 1996). Total nitrogen % was determined by the Kjeldahl digestion-distillation method. Measuring of organic matter ratio (OM) according to Walkley – Black method (wet oxidation method) as described in (Estefan *et al.*, 2013). Phosphorous (ppm) was determined by using Olsen procedure. Potassium (ppm) extracted by using flame photometer (Ryan *et al.*, 2001).

2.4.1 Soil moisture content (SMC %)

Soil samples were taken in the field from a depth of 50cm and placed in nylon bags and closed

tightly in order to prevent the loss of moisture. In the lab 10g of soil weighed dried metal box (at 105°C temperature) and previously balanced (soil weight with can before drying), after that dried the samples in the oven at 105°C, and the next day, removed the samples from the oven, closed the box directly, then cooled the samples with the dryer for at least 30 minutes in desiccator, and then weighed the samples again (weigh the soil with the can after drying) as described in (Estefan *et al.*, 2013).

3. RESULT AND DISCUSSIONS

3.1 Height of trees

Height is an important parameter in the morphological state of the tree. In forestry, tree height is a crucial factor since it is necessary for estimating tree volume and biomass (Younis and Hassan, 2019). The analysis of variance the effect of different aspects on the height of *Quercus aegilops* and *Quercus infectoria* demonstrated that height of sampled tree were significantly impacted by different aspects of four year seasons as shown in table (2). The highest average height of autumn, winter, spring, and summer obtained were; (6.20 ± 0.15 , 6.30 ± 0.09 , 6.37 ± 0.06 and 6.86 ± 0.11), of *Q. infectoria* trees in the East (S2A1). However, the lowest values of tree heights were found during the same period (S1A2) by *Q. aegilops*; (4.83 ± 0.14 , 5.07 ± 0.32 , 5.00 ± 0.15 , and 5.33 ± 0.20) in west face. The results of the tree growth analysis of the studied areas showed that the height of trees in East face was better in west face due to the difference in the percentage of moisture available to the tree in the soil, due to the difference in the amounts of precipitation eastern and western aspects of Mergasour mountain, Temperature has a greater impact on growth in height, as well as temperatures that affect the amount of evaporation due to the fall of sunlight for longer hours on the western face and the lack of fall on the eastern face and this is identical to what them said (Rentch *et al.*, 2002 ;Way and Oren, 2010).

3.2 Diameter of trees

One of the indications of the state of oaks is the degree of branches transparency (Jurc *et al.*, 2009). The result of the statistical analysis showed that there were significant differences for tree diameter changes of both species at each season in the studied areas at the level of change in the aspect factor. In all seasons the largest value of stem diameter were recorded in (S2A1), ($11.23 \pm$

0.69, 11.52 ± 0.65 , 11.80 ± 0.45 , 12.06 ± 0.63), while a significant decreases in this measurement were observed in (S1A2), (8.77 ± 0.28 , 9.02 ± 0.20 , 9.09 ± 0.25 , 9.58 ± 0.12). The trees in the studied area are generally of small diameter not more than 12 cm table (2). This is due to the high temperatures in the summer, which lead to frequent evaporation and plant consumption of

stored water in the process of respiration and frequent evaporation from the soil surface, as trees benefit from rain water during the rainy seasons only, but in the summer they depend on the amounts of moisture in the soil during the root system of each type of tree, these are identical to what them stated (Shiran *et al.*, (2011).

Table (2) Variation in trees height (m) and stem diameter (cm) during the four year seasons of 2021-2022 growing period

Treatment combination	Season	Tree height (m)	Stem diameter (cm)
S1A1	Autumn	5.53 ± 0.11 b	10.94 ± 0.57 a
S1A2		4.83 ± 0.14 c	8.77 ± 0.28 b
S2A1		6.20 ± 0.15 a	11.23 ± 0.69 a
S2A2		5.43 ± 0.14 b	10.30 ± 0.51 ab
S1A1	Winter	5.60 ± 0.09 b	11.33 ± 0.68 a
S1A2		5.07 ± 0.32 c	9.02 ± 0.20 b
S2A1		6.30 ± 0.09 a	11.52 ± 0.65 a
S2A2		5.47 ± 0.17 bc	10.48 ± 0.53 ab
S1A1	Spring	5.66 ± 0.08 b	11.50 ± 0.51 a
S1A2		5.00 ± 0.15 c	9.09 ± 0.25 b
S2A1		6.37 ± 0.06 a	11.80 ± 0.45 a
S2A2		5.65 ± 0.15 b	10.67 ± 0.43 a
S1A1	Summer	5.96 ± 0.18 b	11.92 ± 0.63 a
S1A2		5.33 ± 0.20 c	9.58 ± 0.12 b
S2A1		6.86 ± 0.11 a	12.06 ± 0.63 a
S2A2		5.91 ± 0.12 b	10.8 ± 0.5 ab

- Different litters showed a significant differences across two studied species under the same aspects according to DMRT test ($P < 0.05$)

3.3 The number of branches

One of the indications of the state of oaks is the degree of branches transparency (Jurc *et al.*, 2009). Of both species were significantly variable at the study area as shown in figure (2). A higher value of branches number per stem were obtained for *Q. aegilops* (7.0 ± 0.28), in East aspect (S1A1). Similarity, in west *Q. infectoria* had the

minimum number of branches; (5.3 ± 0.40) (S2A2). The results of the tree growth analysis of the studied areas showed that the number of branches in East face was better in west face due to the difference in the percentage of moisture and nutrients plays a prominent role in re-forming tree branches.

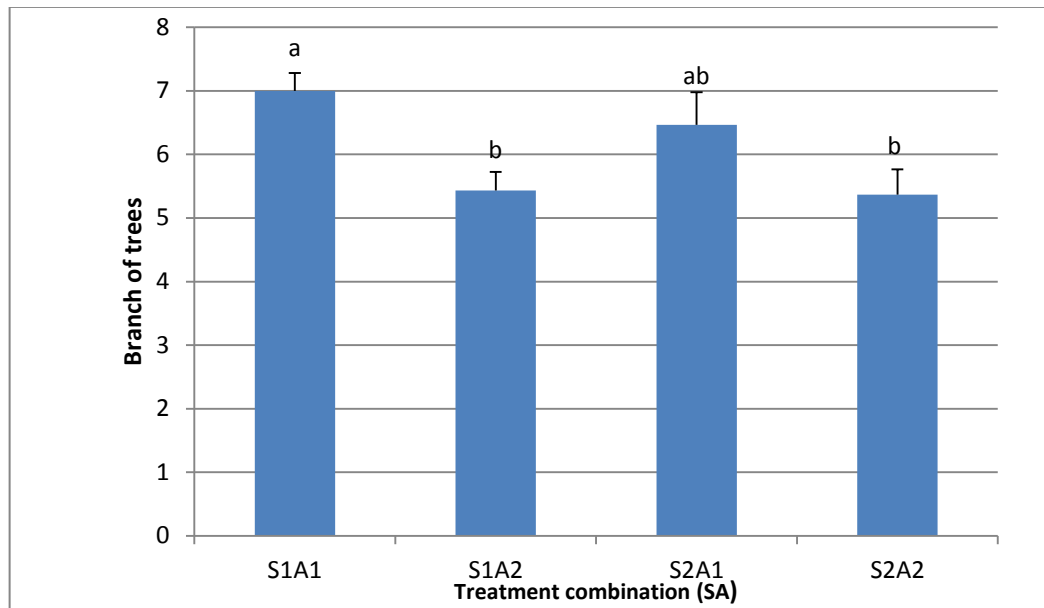


Figure2. Effect of aspects on the number of branches of the studied species

- Different litters showed a significant differences across two studied species under the same aspects according to DMRT test ($P < 0.05$)

3.4 Number of trees in the area

There were significant differences between mean effects of tree number of both tree species (*Quercus aegilops* L., *Quercus infectoria* Oliv), as exhibited in figure (3). The maximum tree number was (32.67 ± 6.73) recorded by *Q. aegilops* in west (S1L2). However, the minimum tree number was; (12.00 ± 1.73) recorded by *Q. infectoria* in west (S2L2). The rate of tree growth is an integrated response to both past and current

stresses (Kozłowski *et al.*, 1991). For oak trees, while temperature rise starting between the ends of April and the middle of May as this conditions are very necessary for the oak trees that make up the forests of the region mainly, because it mainly affects the growth, as oak trees have their growth limited to only two seasons, such as summer and spring.

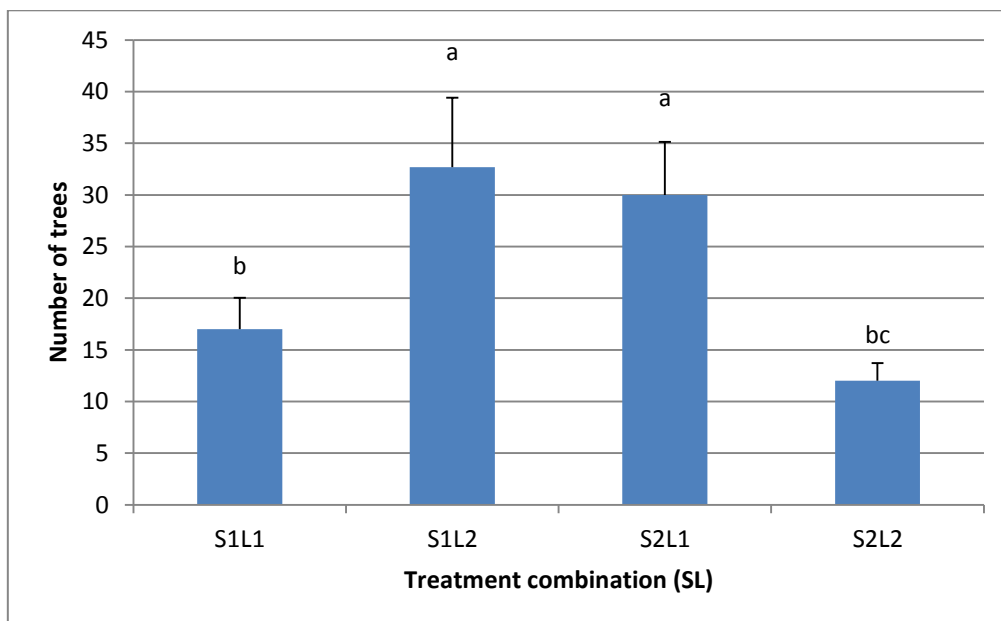


Figure3. Effect of aspects on the number of tree per area of the studied species

- Different litters showed a significant differences across two studied species under the same aspects according to DMRT test ($P < 0.05$)

3.5 Effect of Soil and Aspects on tree growth

Table (3) shows the results of the chemical and physical properties for the soil properties for both faces. The pH of soil is considered to be one of the most important properties of soil. In this study the pH value 7.86 for east face compared to 7.53 for west face. Even electrical conductivity (Ec) in east face was 0.2 ds/m, compared to 0.3 ds/m for the west face. The total nitrogen (N) for the east face was 0.10% and for the west face was 0.12%. The concentration of phosphorus (P) element in the east aspect with a concentration of 23ppm was found greater than the west aspect with a concentration of 19.5ppm. While the potassium (K) element in the west face were 202ppm, compared to 86ppm in east face. Organic matter content (OM) for east face 2.13%, compared to 2.86% for the west face. From finding of the present study there were differences in the proportion of nutrients in the soils of both aspects as in the table (3). While, the main factor influencing the process of forest tree growth is the

element nitrogen (Wallace *et al.*, 2007). The lack of nitrogen percentage in the soil of studied area due to the high temperature during the collection of soil samples had a role in the decrease in the amount of nitrogen in the soil, as there is a direct relationship between the high temperatures and the lack of nitrogen due to the fly. Through the chemical analysis of the soil of the studied area, we found that the soil of the forest of this area suffers from a lake of organic matter content, because the both of the aspects have small percentages of organic matter.

Physical analysis of the soil of both aspects was carried out to find out the type of soil, that it's found the soil of both the studied area is similar in terms of texture, namely clay soils due to the increase in the percentage of clay on sand and silt, tree growth is usually greater in fine-textured soils, resulting in larger return residues to the soil, these are identical to what them stated (Jackson and Meetei, 2018).

Table (3) Analysis some chemical and physical properties for the soil samples of the studied location

Physical properties						
Location	Particle Size Distribution (PSD) %			Soil texture class		
	Sand	Silt	Clay			
East	18.3	17.5	64.2	Clay		
West	23.3	22.5	54.2	Clay		
Chemical properties						
Location	Nitrogen%	Phosphor (ppm)	Potassium (ppm)	pH	Ec ds/m	OM %
East	0.10	23	86	7.86	0.2	2.13
West	0.12	19.5	202	7.53	0.3	2.86

3.6 Effect of Aspects on Soil moisture content (SMC %)

From October to June, there was obvious variability in the readings obtained at the 50 cm depths on both sites of the mountain. In all four seasons of the year autumn, winter, spring and summer the rate of soil moisture in the east was higher than in the west. In the autumn seasons the percentage of soil moisture of east face was 18.76%, compared to 11.35% for west face. In winter season, the soil moisture for east face was 47.05%, compared to 35.13% for west face. In the spring, the percentage of soil moisture east face

were 32.10%, compared to 25.31% for west aspect and in the summer season 14.67% in east, compared to 12.35% in west face. In general, that amount of soil moisture of the east aspect was more than of the west aspect in different seasons of the year because the amount of drops is more proportional in the east aspect as well as the western aspect is exposed to the sun for longer hours than the west aspect so evaporation increases in it as well as the processes of transpiration and breathing of plants due to heat and thus increase water consumption by the roots of trees. Topography one of the factors affected on

soil moisture content such as slope and elevation of the study area, because slope in study area of the west-facing more than of the east-facing, so with decrease of slope, increases the retention of soil water and increased the rate of growth. Soil

moisture is one of the most important abiotic factors determining vegetation growth, variability and regeneration (Legates *et al.*, 2011).

Table (4) Soil moisture content in Mergasour during (15.10.2021 – 15.7.2022) is measured on the basis of aspects in studied area

Location	Soil moisture content %			
	Autumn % 15.10.2021	Winter % 15.1.2022	Spring % 15.4.2022	Summer % 15.7.2022
East	18.76	47.05	32.10	14.67
West	11.35	35.13	25.31	12.35

4.CONCLUSION

Concerning the relationship between topographic factors and microclimate response, the study comes to the conclusion that while the difference between the more exploitative species' microclimate response in the East and West sites was moderate or negligible for the more dominate species, it was significant. The severity, site environments, essential characters (abiotic tolerance and competitive strategy) of the species, as well as other factors, can all have an impact on the outcome of such investigations. Although this study evidently indicates the high sensitivity of *Quercus sp.*, to both the changes in climate and topographic aspect, for climate reconstruction studies. Should be considered so, that the species has a high potential for such studies.

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