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Contribution to the Study of the Health State of Holm Oak in the Chettaba Forest (Algeria)

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ABSTRACT

The oak forests in Algeria are rich in resources and services, playing an important ecological as well as socioeconomic role. The cork oak (*Quercus ilex*) is one of the most common species in the Chettaba forest, which occupies an area of 1127 hectares. This study aimed to assess the health of this species. The protocols for the crown condition indicator were placed in 13 plots of 0.09 hectares, randomly selected in the forest. The diameter and total height of each tree were measured, as well as the crown condition and stand density. A visual assessment of the crowns was performed following the ICP forests and DEPEFEU protocols. The results indicate that the overall condition of the crowns of the cork oak is a medium with significant defoliation. The crowns of the majority of trees (37.6%) are partially visible with backlighting only, codominant (36.54%), and competing with four sides (35%). More than 83.2% of the trees in the Chettaba forest have gourmets, even healthy trees, but fruiting is almost totally absent. Regarding the color of the crown, the majority of the trees examined show no discoloration. Under the current conditions of the conducted research, it can be said that the overall condition of the holm oak stands in the forest is a medium, which requires further research on the role of the many probable factors of decline. Therefore, special attention should be given to the preservation of this ecosystem.

Keywords: *Quercus ilex*, Chettaba, health status, ICP Forests, DEPEFEU

INTRODUCTION

Forests are recognized for their significant role in providing ecosystem services such as timber, recreation, water, soil regulation, air quality, and climate change mitigation [Pohjanmies, 2017; Costanza et al., 2014; Vacek et al., 2023]. These forests are subject to a series of disturbances that are themselves strongly influenced by the climate. Disturbances, such as fires, droughts, landslides, invasive species, insect outbreaks, and diseases as well as climatic phenomena such as hurricanes, windstorms, and ice storms, affect the composition, structure, functioning, dynamics, and health of forest stands [De la Cruz et al., 2014; Trumbore et al., 2015; Prăvălie, 2018]. The goal of forest health is to maintain the functions and benefits of forests by controlling the severity of these damages [Safe'i et al., 2021; Safe'i et al., 2022]. Forest health monitoring is carried out to determine the current state of the forest, which takes into account the status of each ecological indicator to evaluate it. One of the indicators used to assess forest health is vitality, with measurement parameters being tree damage and crown condition [Morin et al., 2015; Lestari et al., 2019; Safe'i et al., 2021; Cherubini et al., 2021; Safe'i et al., 2022]. Currently, many oak forests are in imbalance. Many outbreaks of decline have been reported in recent years. In the United States (USA) and Europe, defoliation, drought, and frost have been the main initiators of tree decline in oak forests [Bendixsen et al., 2015; Haavik et al., 2015]. In the Mediterranean region, oak forests in particular are no exception to the rule, but they are affected with varying intensity, depending on the country [Pasquini et al., 2023]. In general, oaks are quite resistant to drought, but under unfavorable conditions such as excessive wind, sun, and soil, they become more susceptible to water stress, stunting, and attacks by insects and fungi. These are often the causes of total defoliations that lead to serious physiological imbalances [Alderotti et Verdiani, 2023]. In the face of these situations of decline, scientists and foresters are working together to understand the mechanisms of decline and develop the tools to help managers make informed silvicultural choices [Lemaire et al., 2010; Lemaire & Maréchal, 2011].

In this regard, in the Mediterranean basin, even tree species such as the evergreen oak, which are well adapted to Mediterranean conditions, have experienced an increased decline (i.e., canopy defoliation) and mortality [Carnicer et al., 2011; Encinas-Valero et al., 2022]. A sudden death of trees or a progressive loss of foliage that affects the entire crown or only a few branches characterizes the decline of the evergreen oak. The evergreen oak is the main species in the Chettaba state forest, a subspecies of evergreen oak mainly present in the Mediterranean region of cold, semi-arid to temperate and humid bioclimates, forming dense canopies in single or mixed forests. This biome, which is relatively easy to access, has been subjected to intense perturbations of anthropogenic origin (illegal logging, fires, etc.) and climatic origin (successive and prolonged droughts) for centuries, leading to the regression of the vegetation cover [Castello et al., 2016]. Similar to other forest species, no system has been put in place to permanently monitor the health status of this species. To verify this, a number of indicators are used, such as the DEPEFEU protocol (dépérissement d'essence feuillues), developed by the DSF, and the complete evaluation protocol developed by ICP forests. These methods allow for the observation, at the individual tree scale, of a large number of parameters reflecting health status. These variables can then be correlated with other indicators of vitality, such as foliar nutritional status and circumference growth. Visual observation also highlights relatively low levels of defoliation or discoloration, allowing for the observation of the types of symptoms and the identification of responsible agents. The object of this study was to diagnose the state of health of holm oak using the above protocols.

MATERIAL AND METHODS

Presentation of the study area:

The study was carried out on a coppice stand of Quercus ilex in the Chettaba forest (Fig. 1). This forest is located in the southwest of Constantine (Algeria). It is located at the following coordinates: 36° 18', 36° 21' latitude north, and 6° 26', 6° 30' longitude east. The Chettaba Forest covers an area of 2398 hectares and is located at an altitude of between 717 m and 1300 m, with 1127 hectares occupied by cork oak. The subhumid climate with cold winters characterizes the Chettabah region. The region has two main climate types. A subhumid climate with mild winters and dry and hot summers characterizes the northeast, while a semi-arid climate with winters as well as dry and hot summers marks the southeast. The region is mainly composed of sedimentary rocks, mainly soft sediments (schists and marls) and hard sediments (limestone and sandstone). Q. ilex and Pinus halepensis are the dominant species in the forest. Local ecological conditions (altitude, topography, substrate,topography and bioclimate) determine the distribution of vegetation.

In the study area, 13 plots for sanitary monitoring of the stands were selected on an area of 0.09 hectares (30 m × 30 m) randomly selected in the presumed natural habitat of the species, taking into account stationary and forest variables (such as the altitudinal gradient, slope classes, etc.). All trees in each plot were inventoried during the 2022 summer season (July–August). The crowns of the cork oak trees were visually assessed according to the prescriptions of the ICP Forests and DEPEFEU protocols.

The assessment of tree and stand vitality

The use of specific protocols to assess the condition of crowns allows characterizing the stages of the decline of each individual observed. A set

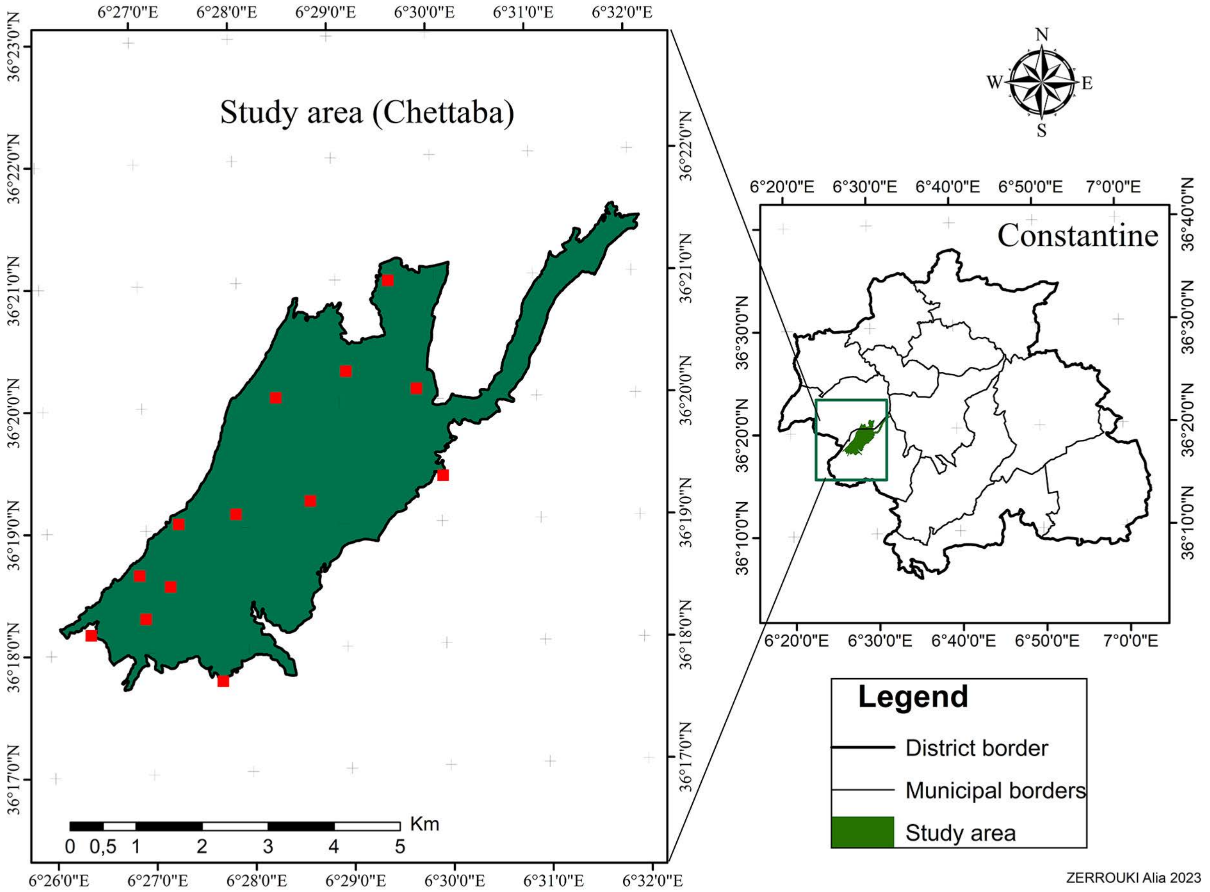

Fig. 1. The geographical location of the Chettaba forest

of symptoms, mainly visible expresses the deterioration visually. The use of different techniques commonly used, including depefeu or ICP forest standardizes the estimation of these symptoms. However, each of them uses criteria for estimating the health status of trees that are specific to them. In addition, specific application conditions must be respected for each of them.

ICP forest assessment protocol

The protocol used during the campaign was designed as part of the International Co-operative Programme on Assessment and Monitoring of Forests (ICP Forests). Three types of observations are performed for each tree: (i) description of observation circumstances; (ii) canopy condition evaluation; and (iii) description of damage [Eichhorn et al., 2010]. The protocol provides a series of evaluation criteria for each step in the form of multiple choice. Each option has a coded value. The options for each criterion are repeated in the ICP Forests Manual Part IV: Visual Assessment of Canopy Condition and Deterioration Agents (www.icp-forests.net). The codes are entered on a special field sheet. The majority of observations are made on the so-called „evaluable" crown. This evaluable crown is defined as the upper part of the crown that is visible at the time of the assessment.

DEPEFEU evaluation protocol

The DEPEFEU (Dépérissement des Feuillus) rating is used to assess the health status of a tree according to a protocol developed by the French Forest Health Department [Nageleisen, 2005; Lemaire et al., 2014; Bernard, 2017; Brunier et al., 2020]. which is based on the aspect of the tree's canopy, particularly the leaf deficit, and the mortality of perennial organs. These factors take into account both the current vitality of the tree (more or less transparent foliage, branch mortality) and the previous years (notch corresponding to a recent fall of dead branches, leaves in bundles translating the reconstitution of the crown following the mortality of small branches, etc.). According to Nageleisen and Goudet [2011], a score,

from 0 (a healthy tree) to 4 (a dead tree), is then assigned to the tree. as follows:
- healthy tree, no signs of disease;
- 1 – slightly declining tree;
- 2 – moderately declining trees;
- 3 – severely declining trees;
- 4 – dying trees.

Statistical analysis

The Minitab 16 and TANAGRA 1.4.50 software was used to perform statistical analyses, while Excel 2016 was also used for pivot tables and charts. A database was created to statistically process plot data and model variables. One of the most common multivariate data analyses is the principal component analysis (PCA) to determine which variables have an effect on tree health. It is an exploratory data analysis the objective of which is to identify tree health states by analyzing the correlations between variables and identifying distinct states**.**

RESULTS

Trees remain the most important response indicators for forest monitoring programs. The observed sample consists of 609 trees; these trees are grouped into 7 families and 8 woody species. The Fagaceae (Fagaceae) and Pinaceae (Pinaceae) families represent the highest frequency of the population, with 82.10% and 8.87%, respectively. The tree density per plot varies from 20 to 96 individuals, which gives a plantation density of 222 to 1067 trees per hectare. The diameters and heights showed very highly significant differences ($p < 0.0000$ and $\alpha = 0.05$) between the species, with the lowest values for C. spinosa and the highest for P. lentiscus (Table 1). The "ICP and DEPEFEU" sample includes 500 holm oak trees (*Q. ilex*). Evaluations were carried out on the crown, called "evaluable". This assessable crown is known as the crown, which is visible at the time of assessment. According to Fig. 2a, 37.6% of the trees in the Chettaba forest have partially visible crowns with backlighting only; 34.2% of the crowns are partially visible. Only 15.2% of the trees are fully visible. The closer a tree is to its neighbors, the more visibility decreases; the remaining holm oaks have crowns that are not visible (13%). Most of the trees in plots P1, P9, P12, and P13 are partially visible but backlit. The crowns of the trees in plots P10, P4, P2, and P6 are, on the other hand, partially visible. Plots P8, P12, and P1 have trees that are not visible.

The observation results of the social status of the stems (Fig. 2b) show that approximately 36.54% of the trees are codominant and 26.54% are dominant. The plots that present the greatest number of dominant codominant, subdominant, and dominated trees are P12 (46.81%), P4 (52%), P2 (34.21%), and P6 (20%), respectively. Depending on the area affected by neighboring trees, it appears that most holm oak trees are affected by four (35%) or three sides (29.2%), as shown in Fig. 2c. Only 7.6% of trees are dominated. The oak trees of the Chettaba forest are in contact with the neighboring crowns. Thus, 63.83% and 50% of the trees are strongly competitive (four sides) in plots P12 and P1. However, plots P3 and P2 are in competition from three sides or their tops in contact with other crowns, i.e., respectively, 50% and 44.74% of the population. The high value of trees in contact on one side is in plot P5.

Tree growth and defoliation are important indicators of tree vitality (Toïgo et al., 2020]. The defoliation percentages of *Quercus ilex*, assessed

Table 1. The mean values of measurement variables for 609 trees in the Chettaba forest

Species	N	D (cm)	H (m)
Crataegus monogyna	2	$8.75±1.12^{bc}$	$3.00±0.71^{bc}$
Quercus ilex	500	$16.48±4.88^{b}$	$4.82±0.98^{b}$
Phillyrea angustifolia	13	$5.03±1.98^{c}$	$2.01±0.28^{c}$
Juniperus oxycedrus	27	$7.43±1.98^{c}$	$2.59±0.68^{c}$
Pinus halepensis	54	$18.87±11.68^{a}$	$6.18±2.57^{a}$
Cupressus semervirens	5	$9.28±7.73^{bc}$	$2.35±0.21^{c}$
Pistacia lentiscus	3	$4.83±1.44^{bc}$	$1.85±0.07^{c}$
Calycotome spinosa	5	$4.35±0.66^{c}$	$1.89±0.14^{c}$

Note: N – number of trees; D – mean diameter; H – mean total height. abc – equal letters are not significantly different ($p < 0.000$).

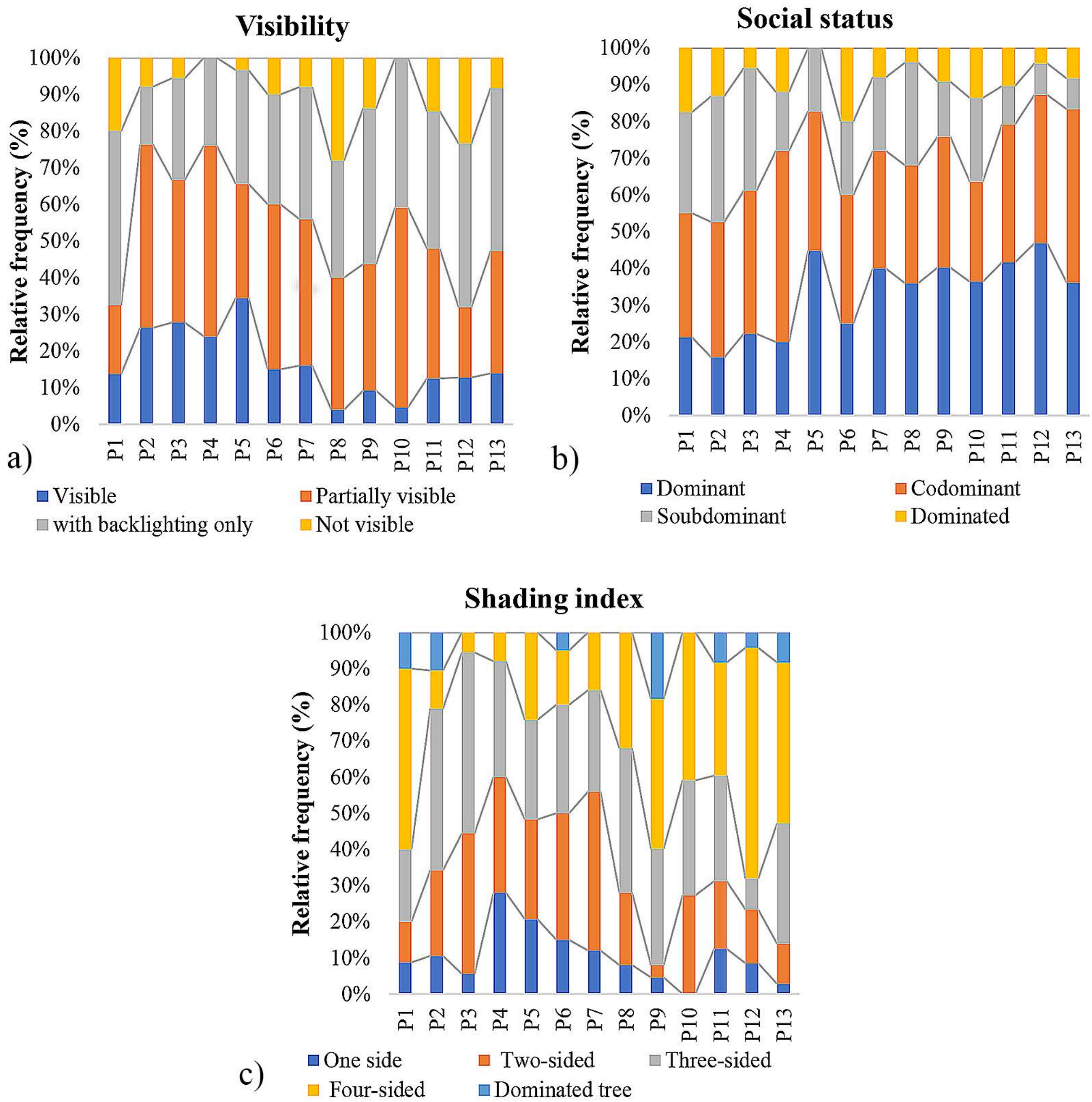

Figure 2. Distribution of holm oak trees according to the description of observation conditions

on plots, were divided into defoliation classes, as indicated in Fig. 5a. The majority of trees have a defoliation rate of 44.2% over a range of 30–60%. According to the results, 31.4% have damaged leaves, 21% are healthy and show no signs of defoliation, and 3.4% of trees are dead. For the heavy defoliation class, where trees lose their leaves from 26% to 60%, the highest values are recorded in plots P6, P8, and P10 with 65%, 60%, and 59.09%. Healthy holm oak trees that showed no signs of defoliation are important in plots P7 (44%) and P5 (34.48%). However, 13.16% of the crowns in plot P2 are dead crowns.

Regarding the coloring of the crowns, most of the trees analyzed do not show any notable discoloration (Fig. 5b); 77.2% of the trees have foliage with normal coloring. The majority of trees with light discoloration are in plot 3 (33.33%), followed by plot 11 (25%). All types of discoloration were observed in plots 2, 11, and 12 (none, light, moderate, severe, and dead tree). The plots containing trees without any discoloration are P8 (92%), P1 (91.25%), and P10 (78.26%), and trees with slight discoloration are P10 (21.78%), P1 (8.75%), and P8 (8%). Oaks are generally slightly discolored. Some Holm oak individuals appear to have moderate to severe levels of discoloration. Tree discoloration is strongly correlated with defoliation (Fig. 3). As shown in Fig. 5c, more than 83.2% of the trees in the Chettaba forest have gourmets; even healthy trees are never completely free of gourmets, especially oak. For plot 11, more than 93.8% of its trees contain gourmets, followed by P12 (91.5%) and P10 (90.9%). The

Figure 3. Discoloration of holm oak leaves

lowest percentage of gourmands (57.9%) characterizes plot 2. These gourmands are either abundant or visible. Plot 11 contains the highest percentage of gourmets, of which 90% are abundant and 20% are visible. The trees that do not have gourmets are either senescent or severely degraded (irreversible degradation).

The fruiting of oaks varies greatly from one individual to another (Fig. 4); according to this study, 14.8% of the trees analyzed have abundant bearing and 32.8% have visible fruits, while 52.4% show no fruit in the upper crown (rare) (Fig. 5d). It should be noted that fruiting in the analyzed holm oak trees is almost completely absent for P9, P10, P11, P12, and P13. Initially, the analysis of the data concerns the appearance of the crowns and the different parameters in which, according to the DEPEFEU rating protocol set up by the Forest Health Department (DSF), all the oaks are inventoried (Fig. 6). According to the results, the individuals observed are mainly in low decline (Table 2). The problems in the health of the trees explain why they belong to classes DEPEFEU 2 and DEPEFEU 3, with percentages of 45.6% and 24.6%, respectively. The percentage of trees in DEPEFEU class 1 is lower than the previous ones, with a rate of 22%, while the lowest percentage is in classes 0 and 4, not exceeding 8%.

The comparison of the state of health between the plots shows that the highest rate of healthy trees characterizes plot P8. The latter represent 52% of all the trees in the plot where symptoms

Figure 4. Green oak fruiting

are approximately absent. They nevertheless present withered, dead branches in the upper half of the crown, but represent less than 50% of the poorly developed secondary branches. In turn, the crowns of the trees in plot P10 are dying and represent 45.45% of the trees. Healthy holm oak trees that do not have symptoms are absent in

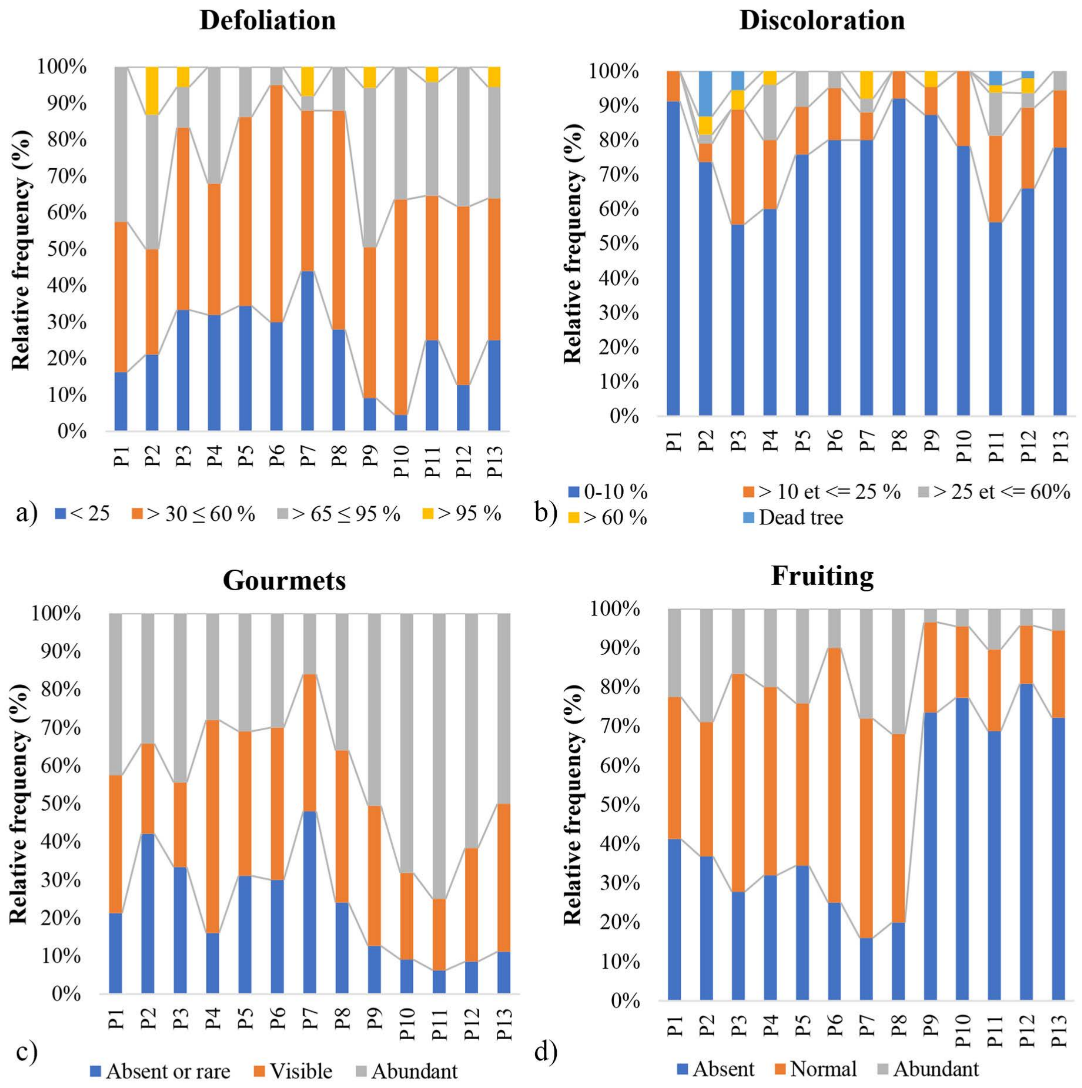

Figure 5. Distribution of trees on plots according to assessment of the state of the crown

plots P4, P6, P9, and P10. The trees with a dead crown (DEPEFEU 4) present in half of the plots with the largest percentage of trees are in P2. The trees in this class suffer from some serious health problems that must be taken into account to prevent their condition from deteriorating. The correlations between dieback and numerous criteria were studied statistically in an attempt to discover certain explanatory elements of dieback. The relationships between variables are examined to increase confidence in the interpretation of results (Fig. 7). There is a positive correlation between DEPEFEU 0 and fully visible trees (r=0.55); consequently, the more visible trees are in good health. Visibility is linked to crown competition, so visibility is reduced due to the presence of neighboring crowns. The degree of crown competition has little effect on defoliation and dieback. The crowns subject to the strongest competition have the greatest dieback; a positive correlation (r=0.56) is observed between the DEPEFEU4 class of all plots and the three-sided competition class. No significant correlation is recorded between discoloration and fruiting classes. The numbers for high coloring classes are, however, very small. Fruiting is also associated with defoliation. Due to the death of fruiting branches after fruit production, fruiting could contribute to this degradation, but the fruiting of this stand is few.

DISCUSSION

Tree vitality is a crucial indicator of forest condition, indicating a tree's overall appearance and its health, which also reflect its disease state [Cherubini et al., 2021]. Vitality cannot be directly measured, but various indicators can be

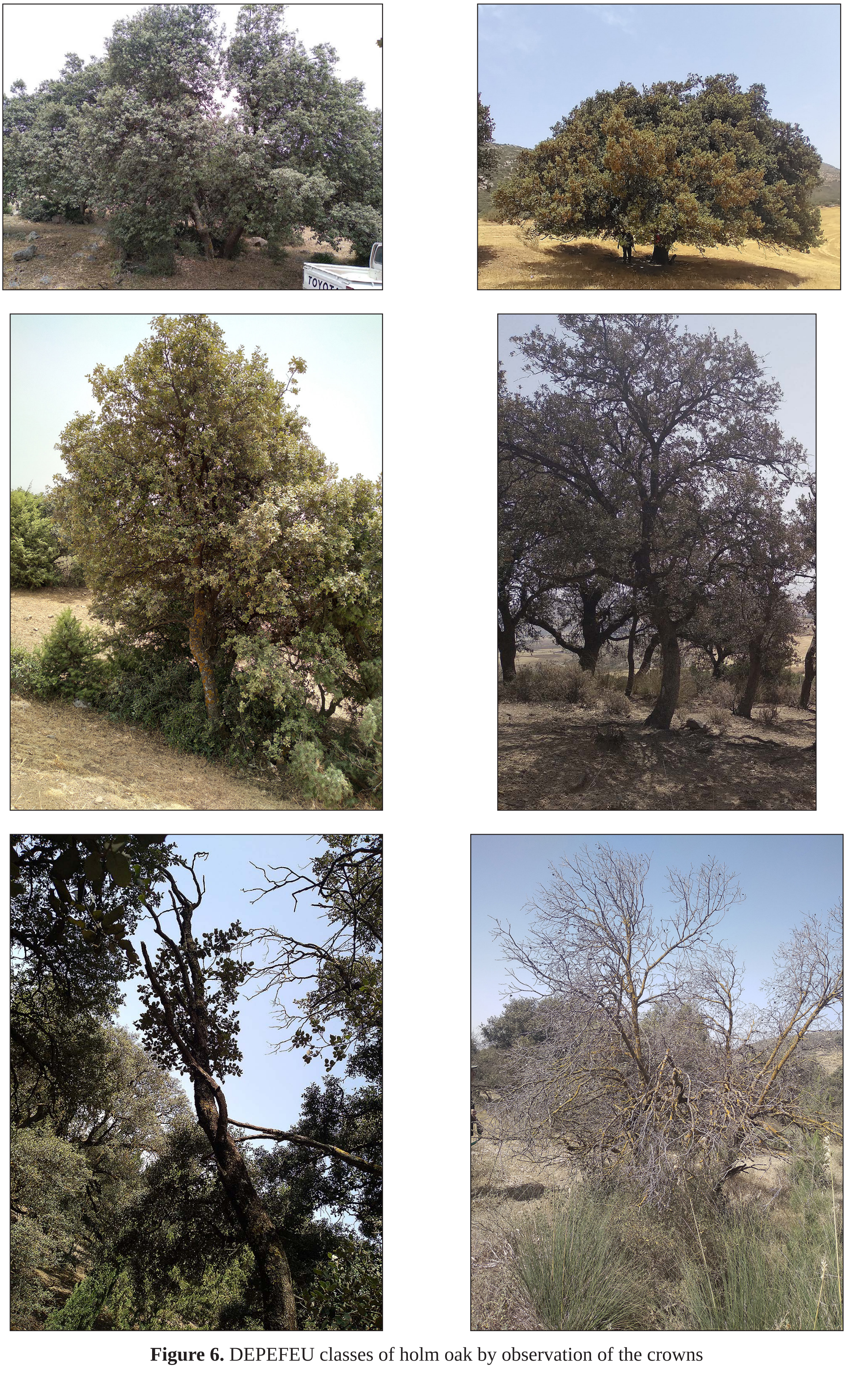

Figure 6. DEPEFEU classes of holm oak by observation of the crowns

Table 2. Distribution of holm oak trees by DEPEFEU classes in the study area

Plots	DEPEFEU 0	DEPEFEU 1	DEPEFEU 2	DEPEFEU 3	DEPEFEU 4
P1	44	344	389	111	-
P2	22	89	178	78	56
P3	22	44	111	11	11
P4	-	89	78	111	-
P5	44	56	189	33	-
P6	-	56	100	67	-
P7	22	78	122	33	22
P8	22	144	100	-	11
P9	-	100	544	267	56
P10	-	11	122	111	-
P11	22	100	200	189	22
P12	11	44	244	222	-
P13	11	67	156	133	33
Sum	222	1222	2533	1367	211

used to describe it, and assessing the condition of the crown is crucial for determining its vitality [Safe'i et al., 2022]. The crown is where the leaves are gathered, which play an important role in the process of photosynthesis to support the growth of the tree. The results of the crown condition assessment made it possible to obtain the crown visibility value, which corresponds to the circumstances under which the assessable crown is apparent from the ground [Braem, 2009; Eichhorn et al., 2016]. Only 15.2% of holm oak trees are fully visible and can be viewed from

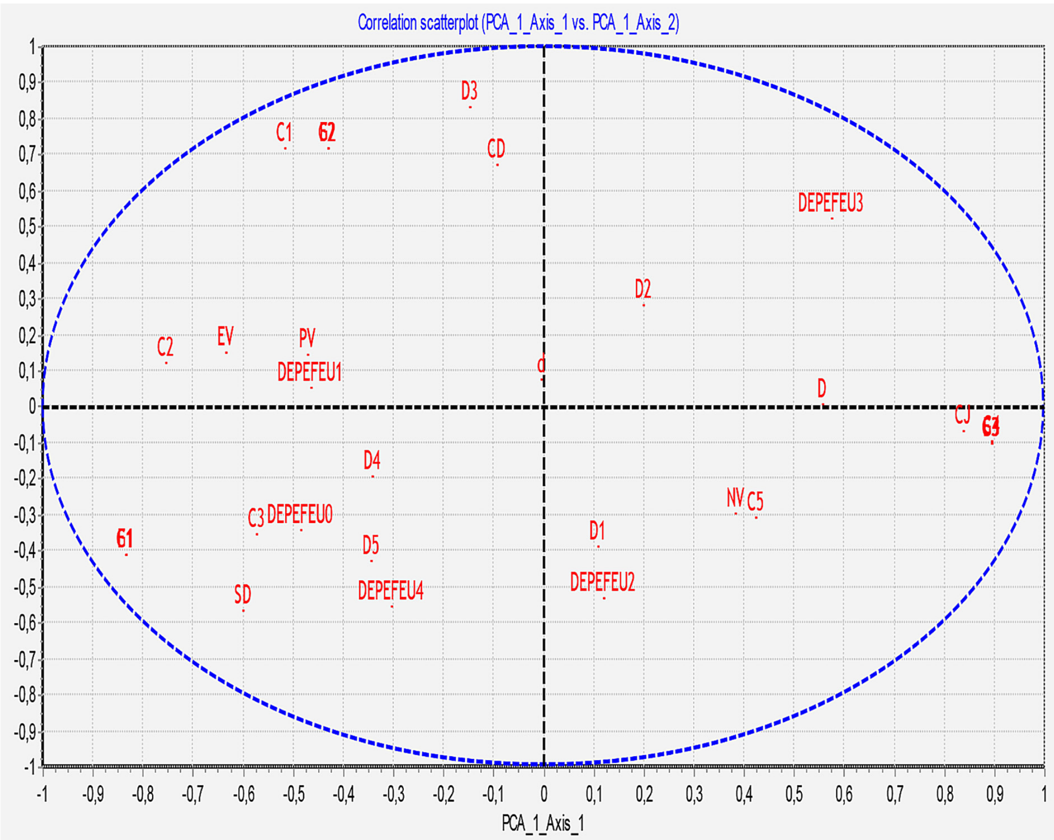

Figure 7. PCA of variables studied with TANAGRA

different viewing angles. The crown is not visible laterally, which means that these trees were observed from below. Most of these trees are generally located in the youngest stands. Their exclusion therefore leads to an underrepresentation of young and therefore less degraded trees [Ponette, 2022]. The crowns of Sidi R'Ghies are more visible than those of the Chettaba forest, where 55.20% of holm oaks have a fully visible crown [Rached-Kanouni et al., 2020]. The distance from the tree generally improves the visibility of the tree, though competing vegetation might reduce visibility [Ostry et al., 2011, Rached-Kanouni et al., 2020]. The low visibility crowns are not removed from the sample because the objective sampling design means that excluding them could skew the results. Certain parameters, such as stem and branch damage, can be assessed on these trees [Lakatos, 2014; Eichhorn et al., 2016].

Each individual tree's social class corresponds to its ability to mobilize resources in its specific environment [Henry et al., 2010; Varo-Martínez et al., 2021]. In the Chettaba forest, codominant and dominant trees are best represented. These results are entirely consistent with those of Rached-Kanouni et al. [2020] for the Sidi R'Ghies forest. Dominant trees spread out more to take advantage of the light as much as possible compared to co-dominant and subdominant trees [Braem, 2009]. The latter have reduced crowns and try to stay at the height of the upper floor to benefit somewhat from the sun. This struggle for light pushes the trees towards the higher level and gives the stands a certain leveling of the structure, even if the ages are very different [Balandier et al., 2010]. In some cases, defining a tree's social status can be difficult. Classification of steep slopes can be difficult because even relatively short trees can receive direct light from above. In this situation, categorization must be based on the trees' relative heights [Lakatos et al., 2014; Manual et al., 2016]. More than two thirds of the oaks analyzed are affected on all four and three sides of their crown; that is to say, they are found in dense stands. Competition indicates the amount of room available for crown growth. The shade index observed in the field therefore reflects the local closure of the canopy owing to the evaluation of the number of sides of the crown in contact with other crowns [Ponette, 2017] and is used to describe the social status of an individual tree and quantify the surrounding environment [Weiskittel et al., 2011]. The greater the index, the closer and larger the competing tree is to the subject tree [Pedersen et al., 2013]. The degree of shade can have a significant effect on crown condition, stand structure, and forest health. Dominant trees growing in closed, competing stands are less sensitive to water stress than free-growing trees. This could be explained by the fact that free-growing trees have a wider crown, which increases their water demand at the tree level and therefore their sensitivity to water stress [D'Amato et al., 2013; Trouvé, 2015]. The trees with favorable crown positions exhibit higher vigor, survivability, reproductive potential, and growth than the trees with an unfavorable crown position [MacFarlane et al., 2017].

Concerning defoliation, the values obtained are clearly significant in the forest; opposite results were obtained by Camarero [2015] for holm oak stands in the Arascués forest, Aragón, in northeastern Spain. Defoliation is a crude visual indicator of the relative amount of foliage on the tree crown [Ferretti et al., 2014]. This criterion is often used to establish the health assessment of forest stands, also called the crown transparency index [Sarmoum et al., 2019]. A closer inspection of the data reveals that defoliation was significantly significant within the forest and evenly distributed across plots, i.e., the cause of defoliation likely affected the entire study site. The defoliation observed on the crown could also be due to the death of twigs or entire branches or the sparse development of new twigs [Wang et al., 2007]. Plants use defoliation as one of their methods of reducing the risk of mortality under unfavorable conditions [Pollastrini et al., 2019]. Defoliation is not an indicator of mortality but rather a physiological strategy, which is a specific protective mechanism used under stressful conditions. Defoliation is considered a symptom of decline when plants are defoliated for an extended period of time, suffer permanent damage, and reach the point of no return [Bussotti et al., 2021]. For discoloration, the majority of trees in the plots have foliage with a normal coloring of 77.2%; even the crowns show an alteration of the normal color of the foliage. The presence of gourmets and epicormic shoots is more generally observed in oaks. Most trees in Chettaba Forest contain gourmets. They play an important role during periods of heatwaves because, being in the shade, they continue to photosynthesize while in the sun, leaf activity is stopped. Food feeders have a role in restoring the balanced leaf surface area of a tree in relation to available resources (light, nutrients, etc.) and in rejuvenating the crown [Drénou et al., 2016]. When a healthy tree undergoes dieback, it deviates from the norm and expresses symptoms that can be observed at different levels (morphological, anatomical, physiological, biochemical, etc.). Among these symptoms, how should the appearance of gourmets retreating from dead branches be interpreted. The appearance of gourmets can have several origins: drought, lack of light, or, on the contrary, high-light exposure (sudden thinnings), broken branches, pathogens, etc. If the tree emits orthotropic gourmands, a return to normal radial growth but also to a satisfactory level of reserves is possible. This has been demonstrated in several ornamental species, pollarded oaks, and beech [Chanson et al., 2001]. This resilience involves the restoration of efficient water circulation, and from this point of view, gourmands play many roles [Drénou et al., 2012]. This resilience involves the restoration of efficient water circulation, and from this point of view, gourmands have many roles to play.

Among forest oaks, a little more than half of the trees do not contain fruiting bodies. Fruit production is a crucial stage in the life cycle of trees to ensure the natural regeneration of forests [Lebourgeois et al., 2019]. Many factors [photoperiod, humidity, temperature, pollination, etc.) control it. Fruiting is also an important concern for foresters in the context of questioning the natural or assisted migration of species to respond to environmental changes [Lebourgeois et al., 2019]. Global warming also has a negative effect on fruiting in oaks in the Mediterranean region; summer water stress at the time of fruit ripening is well known to impact fruiting success [Pérez-Ramos et al., 2010], and the properties of the Mediterranean climate (interannual fluctuations] lead to particularly chaotic fruiting from one year to the next [Jdaidi et Hasnoui, 2016]. The current state of dieback of stands with the DEPEFEU protocol shows that the general condition of the crowns of holm oak trees is average in the Chettaba forest, despite the significant presence of dead standing trees and dying trees. The obtained results are entirely consistent with those of Rached et al. [2020] in the Sidi R'Ghies forest of eastern Algeria and Bec et al. [2020] for the holm oak stands in France. The holm oak forest in Algeria has suffered from decline in recent years. This dieback is due to a number of factors, including grazing and wildlife, insects, fungi, anthropogenic injuries, weather damage (abiotic), fire, acute pollution, etc., which are assessed simply based on their presence or absence. Thus, other biotic and abiotic factors can affect forest health. The age of the tree, its size, and the history of its deterioration are all essential information for understanding changes in the structure of the forest [Hamidi, 2014].

Dieback following storms, droughts, or other disturbances affects the habitat conditions in forest ecosystems. Resulting from the progressive decline in the average health status of trees, they result in different environmental effects at the spatial scales of the tree, the stand, and the landscape [Bouget, 2023].

CONCLUSIONS

This study is a contribution to the analysis of the ecological mechanisms involved in the dieback of the holm oak in the Chettaba forest and to the characterization of its health status. This type of intervention can be considered a first step in evaluating the classes of dieback and the complexity of the causes leading to the degradation of a forest stand. and finding the necessary means to manage this forest stand before it deteriorates. If dieback continues later in the rest of the stand, one can move on to crisis-type management. The percentages of trees showing premature decline and dieback are identified using the DEPEFEU and ICP Forest protocols. To determine appropriate courses of action, plots must be assessed at the local level. According to the results, most of the individuals observed showed low dieback, which can be attributed to tree health problems. The current state of health of holm oak stands is average because the percentage of healthy trees is lower than the dying ones. It is recommended to consider management methods in order to reduce the sources of population weakness. Other factors can also play a role in the appearance of this phenomenon, such as climate, pathogens, and edaphic properties of soils, which underlines the importance of carrying out parallel studies on this subject. In this regard, the establishment of a monitoring and observation system for the health of holm oaks is necessary for good management of the stands.

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