BIOTIC STRESS AND PHYSIOLOGICAL BEHAVIOR OF *QUERCUS SUBER* ACORNS: VARIABILITY BETWEEN PRODUCERS' INDIVIDUALS

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Abstract. In north-western Algeria (Tlemcen), we collected morphologically mature acorns separately from 17 trees, and another quantity was collected from the ground in the mountain cork oak forests: Hafir and Zariefet. The germination rate of healthy (H) and slightly damaged (S) acorns reaches 100%. The lowest emergence rates are observed in severely damaged acorns (Sd) (8%), with differences between producing individuals (the maximum recorded for Sd is 67%). The survival rate of plants varies in the same way as the emergence rate: 100% in (H) and 93% in (S). The survival score of (Sd) is 57%. These acorns can continue to produce young seedlings until the embryo is completely wiped out. However, more than 90% of the (Sd) of 64% of the trees remain metabolically inactive. In western Algeria, the 60% decrease in the germination rate of (Sd) seems to be linked to the acorns small size, which are approximately half of those in eastern Algeria. Depredation of acorns by insects hardly affects the growth of young seedlings in the first days of their development, but occurs much later, depending on the physiological integrity of the almond, cotyledonary mass and quality, and the infestation intensity.
Keywords: *cork oak, acorns' quality, acorns' depredation, germination, stress response*

Introduction

The Algerian Forest is so diverse in terms of trees, that it is difficult to give a simple overview of this region. The landscapes that we see are very different and contradictory with high forest richness. The national forest heritage (Northern Algeria) covers approximately 41 000 square kilometers (km^2) (i.e. 16.4% for northern Algeria and only 1.7% if the arid Saharan regions are also taken into consideration), distributed as follows:

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43% in the East; 29% in the West; 27% in the Center and 1% at the level of the Saharan Atlas (subsistence of relics subjected to a strong endemic drought) (DGF, 2018).This is deemed insufficient by the Algerian FOSA report (the prospective study of the forestry sector in Africa), which estimated the area required for a good level of protection at 70 000km^2, i.e. an afforestation rate of 28% for northern Algeria, while the existing area of forest and scrub corresponds to around 57% of the desired level (FAO, 2002).

Constituting one of the most important riches of Algeria, cork oak (*Quercus suber*L.) in its spontaneous state is observed only in the western Mediterranean basin and on the Atlantic coast. It occupies about 20 000 km^2, including 11 000 km^2 in Europe: Portugal, Spain, Italy, France, and the rest in North Africa: Algeria, Morocco and Tunisia. It grows in the plains as well as in the mountains and requires a mild and humid climate. It is a species that has always been sought after for its bark (cork), used in several industries, for its wood of good calorific value and for its acorns very appreciated by humans, wild and domestic animals. It’s very important socio-economic, ecological and landscape roles have earned it a particular attraction throughout the Mediterranean region (Bouchaour-Djabeur et al., 2011).

The Algerian cork oak forest which covered an original area varying, according to the authors, between 4290 and 4800 km^2 (third place after Portugal and Spain), are currently estimated at 3572,31 km^2, including 68% are old standing timber. The large mass of the best and most extensive woodlands is found in the eastern part of the country, mainly in wetlands and subwetlands. Outside this region, cork oak grows in a rather discontinuous way in the form of isolated and smaller massifs. In the West, it is less frequent; it occurs in Relizane (Ami Moussa), south of Mascara (Nesmoth), near Tiaret (Tagdempt), in the vicinity of Oran (M’sila and Terziza) and especially in Tlemcen (Hafir and Zariefet State Forests).

The alarming drop in subericultural production confirms the difficulties encountered by the species in guaranteeing permanent production and in regenerating and conserving itself. This reality is a consequence of various catastrophic historical events in addition to climate change, which has already produced new, more intense and unpredictable disturbance regimes (Bouchaour-Djabeur, 2016).

These are in general the same problems posed on the scale of the Mediterranean cork oak forest. Prolonged droughts, repeated fires, regeneration difficulties, inadequate development and restoration programs, the wrong systems of exploitation, the actions of man including his domestic animals, dieback, etc., weakens cork oak. Becoming sensitive, it is also the victim of spectacular damage from several insect groups that jeopardize its production and regeneration. These depredators, depending on their diet, can be classified as defoliators, xylophages, cork depreciators and acorn pests (Bouchaour-Djabeur, 2016; Bouchaour-Djabeur et al., 2021).

Work on the phytosanitary evaluation of acorns and its impact on germination and/or seedling growth is limited and fragmented at international level (Weckerly et al., 1989; Stiti, 1999; Branco et al., 2002; Xiao et al., 2003, 2007; Leiva and Fernandez-Ales, 2005; Abidi and Abidi, 2009), as well as nationally (Algeria) (Saouli, 2009; Chaabna, 2012; Saadi, 2013; Ghanem, 2014 in the northeast and Bouchaour-Djabeur et al., 2011) in the west.

For large-seeded plants such as oaks, damage by predatory insects is often complete before dispersal (Crawley, 2000; Hulme and Benkman, 2002). The probability that a given seed can survive and become a seedling is largely dependent on its ability to defend itself or to tolerate damage caused by predators or even to escape this damage.

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Currently, investigating the evolution of plant defenses requires a characterization of existing traits and a reconciliation of these traits with the forces of natural selection that are (and arguably were) operating in the system (Xiao et al., 2007). However, studies that address how seed predators influence the defensive traits of that seed or plant are rare, in contrast to the abundant literature examining plant-herbivore interactions (Stowe et al., 2000; Strauss and Zangerl, 2002).

Seed depredation must be exceptionally considered, as almost all future value of planting will depend on the health and genetic quality of the seed used (Bouchaour-Djabeur et al., 2011). The present study focuses on two cork production forests in northwestern Algeria, the Hafir and Zariefet forests (Tlemcen).

Materials and methods

Study area

To the southwest of the town of Tlemcen on Sequanian sandstones at the northern level of the mountains is a grouping comprising the two interesting cork oak massifs of Zariefet (9.62 km^2) and Hafir (98.72 km^2) (Tlemcen National Park, 2000) (*Fig. 1*). The choice of this portion of cork oak forest was guided by the fact:

- that it is representative of the development conditions of the cork oak despite their low capacity and their geographical isolation from other cork groves, better equipped from a climatic point of view (Eastern Algeria),
- that it is also suffering from decline, its cork production is gradually falling, its area is declining more and more and the shape of the forest that it constitutes is constantly changing (Bouchaour-Djabeur, 2001),
- it is highly irregular, heterogeneous and fragmented, with the risk of rapidly losing its resources(Bouchaour-Djabeur et al., 2020, 2021).

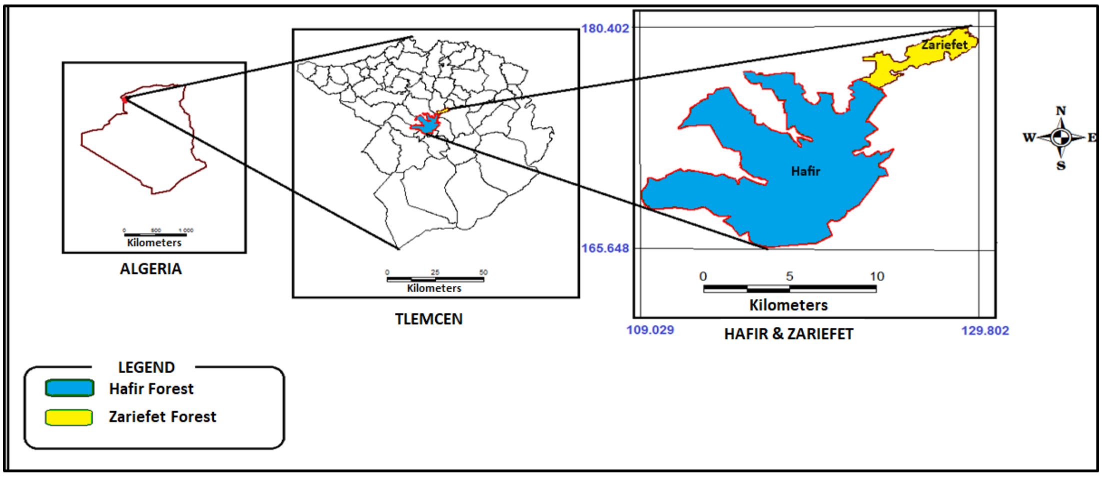

Figure 1. *Geographical location of the Hafir-Zariefet forest*

This massif enjoys a subhumid bioclimate, from 500 to 650 millimeters per year (mm/year). The very rugged landscape where all the exhibits are present. The dominant slopes vary from 12 to 50%. Bare and rocky terrain, occupying a small area, is found on summits and ridge lines. The altitude of the massif varies from 700 to 1418 meters (m).

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The maximum annual average temperature is 18.9°C, the minimum annual average temperature is 8.2°C. The sandstones gave rise to brown forest soils with a sandy-loamy texture, often evolving into fersiallitic soils (Gaouar, 1998).

It is composed mainly of hardwood trees such as oaks (*Quercus suber*, *Quercus rotundifolia* and *Quercus faginea ssp. tlemceniensis*), *Olea europea ssp. oleaster* and a few feet of *Fraxinus oxyphylla*, but also softwood trees such as *Tetraclinis articulata*, *Juniperus oxycedrus*, *Pinus halepensis*, *Pinus pinaster*, *Cupresus communis* and the Eucalyptus trees in some degraded cantons (they were introduced there). In good resorts, cork oak is mixed with zeen oak (*Quercus faginea*) and holm oak (*Quercus rotundifolia*). The cork oak forest is aging with subjects' more than bicentennial and undergoing significant anthropogenic pressure.

Most of the cork oak forest is today transformed into a degraded landscape (density < 100 stems/ha) with the extension of the maquis, very dense with plants (cistus, heather, calicotome, etc.) which sometimes cover the entire ground.

Plant material

Ten circular plots (P) from 7 to 20 ares (depending on the density of the stand) were set up, 5 in the forest of Hafir (H) and 5 others in that Zariefet (Z) (*Fig. 2*). At the level of each plot, 5 trees (T) were chosen and numbered by the method of Mueller-Dembois and Ellenberg (1974). However, when the stem is composed of several strands of coppice, we have retained only the largest strand, and if they are of the same size, one strand is selected randomly.

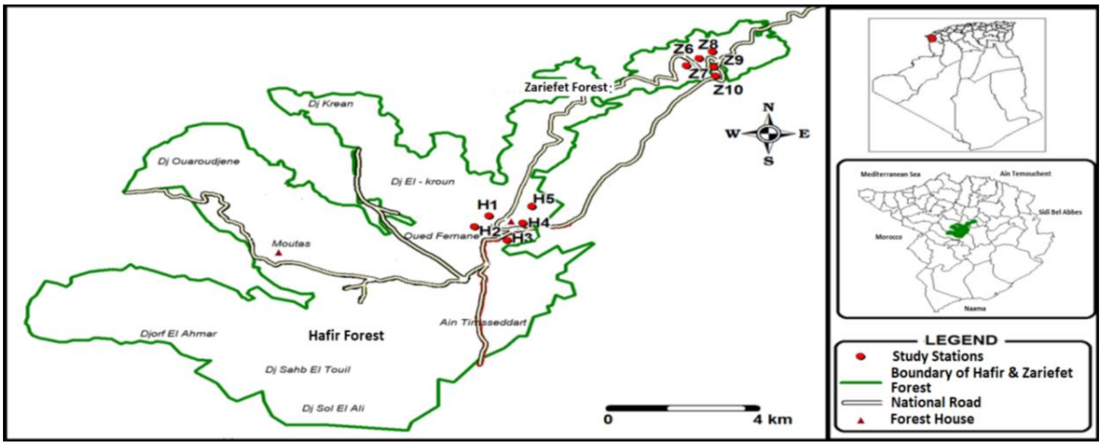

Figure 2. *Distribution of study plots in Hafir and Zariefet forests (H: Hafir – Z: Zariefet)*

Of the 50 subjects identified and studied (Bouchaour-Djabeur et al., 2020, 2021), acorns were harvested on 17 cork oaks (the others did not bear fruit). In each plot, and depending on the importance of acorns production, fresh morphologically ripe acorns were randomly collected according to two modes. The first is traditional, collecting of acorns falling on the ground. The second requires that the acorns do not touch the groundand are picked directly from the trees or by beating with a bed-sheet on the ground.

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Cultivation

The experiment took place in a nursery with the same altitudinal and climatic provisions as the forests of origin of the acorns and with semi-controlled conditions (shading + watering). The irrigation water comes from an existing well there and is analyzed to see if it is suitable for the production of the plants.

The acorn culture substrate was obtained from the experimental plots of the Hafir and Zariefet cork oak forest. The soil taken from a layer 20 to 60 cm deep was dried and homogenized. Grain size and pH analysis of a soil sample from four horizons revealed a sandy-silty-clay surface texture with a sandy depth (71-89% sand, 6-16% silt, 3-10% clay). The average pH is 7.4.

Acorns harvested from trees (17 trees) and collected from the ground (Hafir and Zariefet) were cleaned and wiped. 30 acorns per quality (3) and per lot (19) are planted (total N = 1710 acorns) (*Table 1*) according to an external examination (Weckerly et al., 1989; Branco et al., 2002; Xiao et al., 2003; Bouchaour-Djabeur et al., 2011) and a classification according to the following meanings:

- Healthy Acorns (H): with no bite,
- Slightly damaged Acorns (S): detected by adult weevil bites but no larval exit holes, they may still contain insect or young larval eggs (*Fig. 3A*),
- and Severely damaged Acorns (Sd): most with damaged embryos or more than 50% of cotyledons attacked or detected by the presence of mature larvae or exit holes (*Fig. 3B; Fig.3C* for *Curculio elephas*) and (*Fig. 3D; Fig. 3E* for *Cydiafagiglandana*).

Table 1. *Criteria and layout of seedlings (T6 to T24: acorns from Hafir Trees, T31 to T47: acorns from Zariefet trees, HS: acorns from Hafir soil, ZS: Acorns from Zariefet soil)*

Block 1 (arbres)	**Number**	**State of the acorns**
Acorns of the tree n°6 (T6H)	30	Healthy acorns (H)
Acorns of the tree n°6 (T6S)	30	Slightly damaged acorns (S)
Acorns of the tree n°6 (T6Sd)	30	Severely damaged acorns (Sd)
.	.	.
.	.	.
.	.	.
Acorns of the tree n°47 (T47H)	30	Healthy acorns
Acorns of the tree n°47 (T47S)	30	Slightly damaged acorns
Acorns of the tree n°47 (T47Sd)	30	Severely damaged acorns
Block 2 (Soil)		
Hafir soil acorns (HSH)	30	Healthy acorns
Hafir soil acorns (HSS)	30	Slightly damaged acorns
Hafir soil acorns (HSSd)	30	Severely damaged acorns
.	.	.
.	.	.
Zariefet Soil acorns (ZSSd)	30	Severely damaged acorns

Rearing system and management

The perforated plastic bags on the sides and without bottoms are filled with ¾ of substrate and arranged in openwork crates also at the base and on the sides. All the crates are placed on raised boards 20 cm from the ground that we have built and installed in a semi-shaded greenhouse. This outside-ground technique makes it possible to produce plants without crippling root deformations (Harfouche, 2003). The acorns are then

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transplanted horizontally and covered with a layer of potting soil of 2 to 3 cm. This approach with bottomless bags, openwork-based crates and the raised frames cause the roots to be self-identified, but also prevent soil contamination and/or pest attack (*Fig. 4*).

Watering is manual two to three times a week, depending on the temperature and regularly controlling the humidity of the substrate.

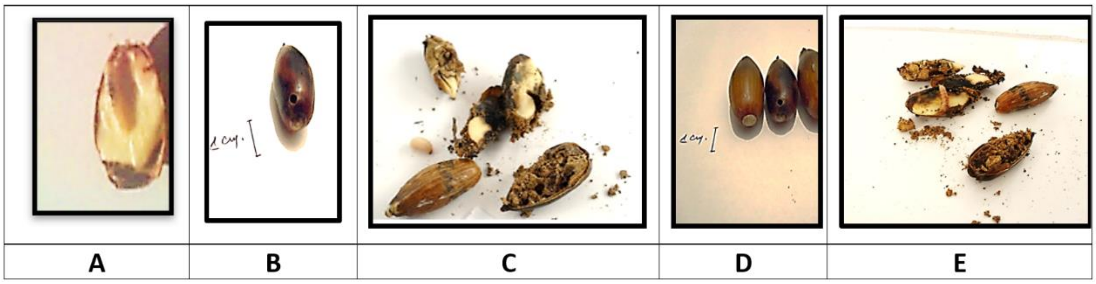

Figure 3. *Cork oak acorns Slightly (S) and Severely damaged (Sd). A: Slightly damaged Acorns (S), B, C: Severely damaged Acorns (Sd) for Curculio elephas, D, E: Severely damaged Acorns (Sd)for Cydia fagiglandana*

Figure 4. *Cultivation, system and management of cork oak seedlings*

Seedling emergence

After almost three months of sowing, we noticed the first seedling appear. An acorn is considered germinated when the radicle pierces the envelopes and manifests its positive geotropism (Merouani et al., 2001). Germination capacity is the maximum germination rate obtained under the conditions we have chosen. After ten days of germination onset, we followed the germination rate periodically (every 10 days) for ten weeks. The germination rate (GR) is calculated by the following formula (*Eq.1*) (Maziliak, 1982):

$$GR\% = \frac{Number\ of\ sprouted\ seeds}{\text{Total number of seeds}} \qquad \text{(Eq.1)}$$

Seedling survival

The survival rate was assessed at the end of the experiment, around nine months after sowing.

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Acorns that have not produced seedlings

Acorns rate that didn't produce seedlings combines acorns rate that germinated but did not give seedlings and acorns rate that did not germinate at all.

Data analysis

The different parameters studied were treated using descriptive or comparative statistics. One-way analysis of variance (ANOVA) followed by a Tukey test at the 5% threshold to test for significant differences between the different parameters. P-values ≤ 0.05 are considered statistically significant. The software used is “Minitab 16”.

Results

Germination rate (GR) was followed for all seedlings from healthy (H), weakly damaged (S) or severely damaged (Sd) acorns.

Seedling emergence

The emergence constitutes a first diagnosis of a crop’s success, a bad emergence can have several causes related to the cultivation (too deep sowing, superficial), to the climate (winter frost), or to the sanitary state (healthy glans, attacked, rotten...). This emergence is variable according to the individual producers and the different health conditions, both in rate terms and emergence period.

The emergence rate increases over time. *Figure 5* shows that the best rate is recorded in healthy (H) and slightly damaged (S) acorns ranging respectively from 33% (T22) to 100% (T9 and T45) and 20% (T46) to 100% (Zsoil). Healthy acorns from Hafir’s soil register 50% emergence. The coefficients of variation of these two categories show a more or less low dispersion around the mean.

Despite their deterioration, the severely damaged acorns (Sd), kept the embryo intact, were able to germinate and establish seedlings. They show great discrepancies between individual producers. T35 (67%) and T22 (33%) are distinguished by the emergence rate of (Sd) dominating that of healthy and slightly damaged.

On the other hand, this type of acorns (Sd) of 64% of trees (T7, T8, T9, T15, T19, T31, T32, T36, T45, T46, T47) did not give seedlings. The coefficients of variation (> 165%) also indicate strong inequalities between individuals in the same forest (*Fig. 5;Fig.6*).

ANOVA with a single controlled factor of the emergence rate according to the health status of the acorns, confirms these weak or strong divergences. The difference between individuals is extremely significant for the 19 batches (17 trees + 2 batches of soil) (*Table 2*). The Tukey test reveals two homogeneous groups: A includes the healthy (H) and the slightly (S), then a second group B much lower for the severely damaged (Sd).

At forest level, the average emergence rate of trees is very high; at Hafir it reaches 81% for (H) and 67% for (S). Apart from the T46 tree, which is individualized with 100% of the (H) and 80% of the (S) having given no seedlings, the average rate of the same categories at Zariefet is almost identical to that at Hafir (*Fig. 6; Fig. 7*). Indeed, statistical tests of comparison between the 19 batches (17 trees + 2 soil lots), reveal no significant difference of the two forests for each state of health apart (*Table 3*).

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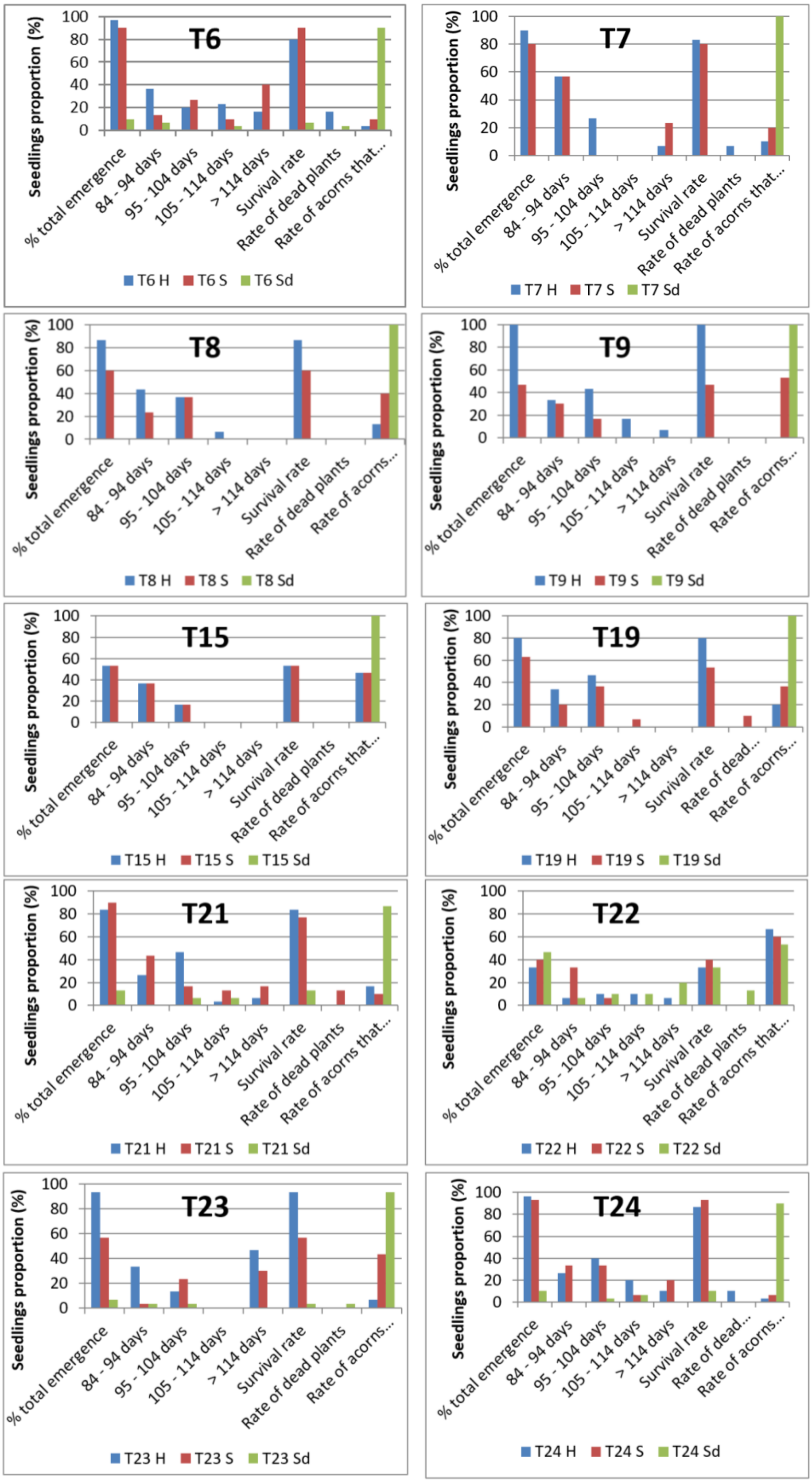

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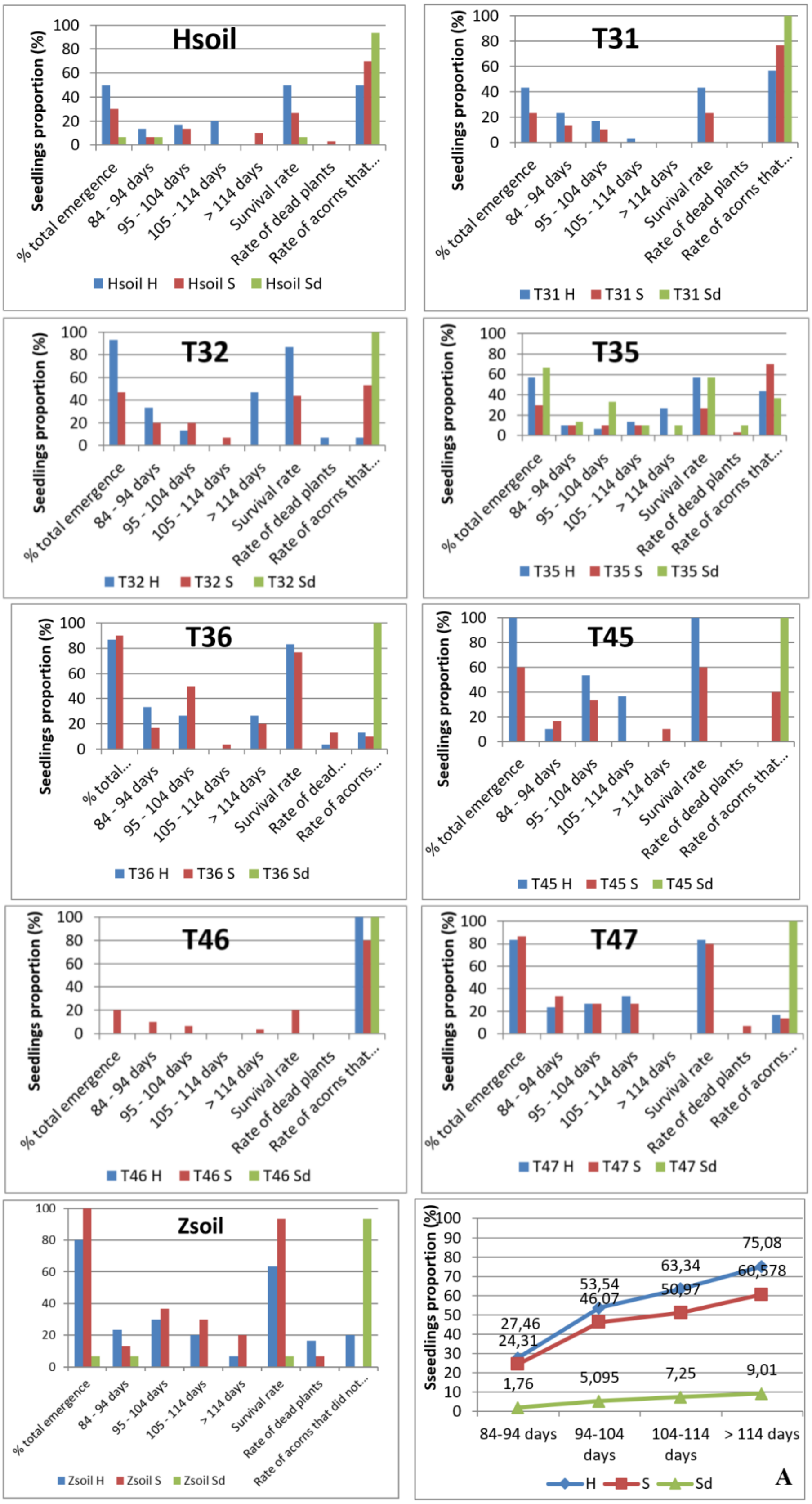

Figure 5. *Rates of emergence, survival, dead seedlings and acorns that did not give seedlings, as a function of time and acorns health status. A: EmergenceKinetics of corkoakseedlings of the 19 batches (Trees and soils)*

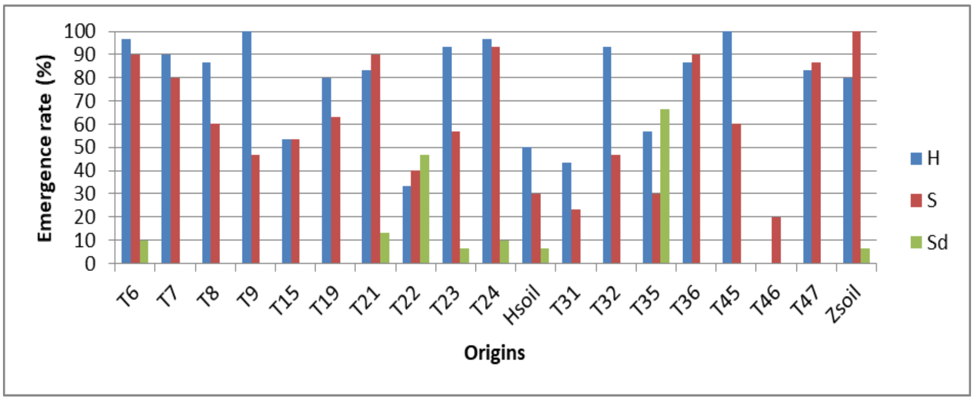

Figure 6. *Seedling emergence rate as a function of acorn health*

Table 2. *Effect of acorns health on the emergence rate of the 19 batches and means estimated by Tukey test for 95% confidence level*

Source	df	Sum of squares	MS	F	P-value	Meaning
Model	2	45349	22675	39,42	0,000***	
Error	54	31060	575			ExtremelySignificant
Total corrigé	56	76409				
Modality	**Estimated mean**	**Groups**				
1	74,03	A				
2	61,05	A				
3	8,77	B				

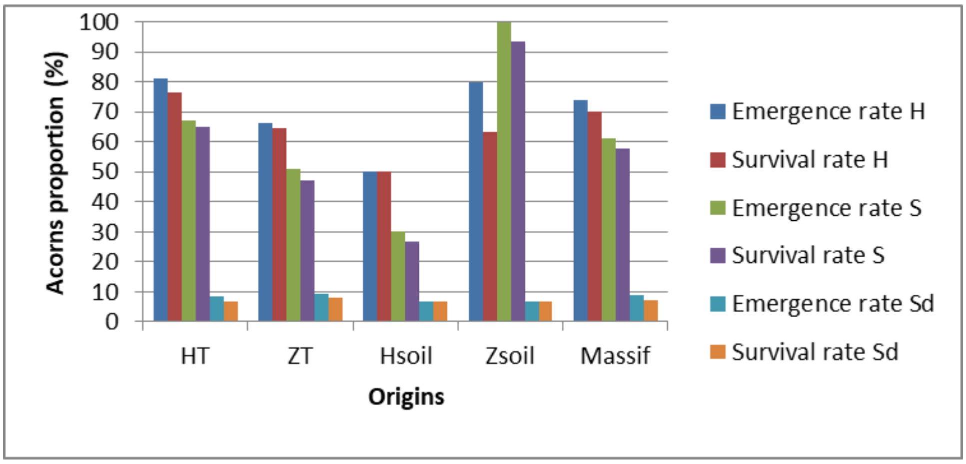

Figure 7. *Emergence and survival seedlings of Hafir trees (HT), Zariefet trees (ZT), Hafir soil (Hsoil) and Zariefet (Zsoil)*

Table 3. *T-test for two samples 2 (forests) of the germination rate of the 19 batches (each health status of the acorns)*

Acorn's health status	N	df	T_{Table}	$T_{Calculated}$	p-value	Meaning
H	19	17	2,1098	0,829	0,419	
S	19	17	2,1098	0,559	0,584	Not significant
Sd	19	17	2,1098	-0,080	0,937	

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Seedlings survival

Plant survival ranges from 100% in the (H) (T45) to 93,33% in the (S) (T24 and Zsoil). The lowest rates are recorded in T22 (33%) and T46 (20%) respectively for (H) and (S). For Sd, exceptionally, plants of T35 have an acceptable survival rate (56.66%) (*Fig. 7; Fig. 8*). Variation coefficient values indicate that this parameter changes similar to the emergence rate (*Table4*).

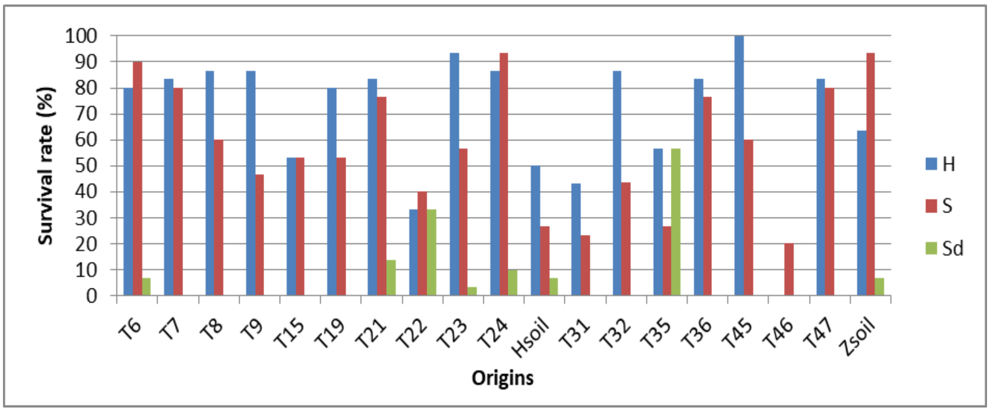

Figure 8. *Seedling survival rate as a function of acorn health*

Table 4. *T-test for two samples 2 (forests) of survival rate of the 19 batches (each health status of the acorns)*

Acorn's health status	N	df	T Table	T Calculated	p-value	Meaning
H	19	17	2,1098	0,821	0,423	Not significant
S	19	17	2,1098	0,753	0,462	
Sd	19	17	2,1098	-0,177	0,862	

ANOVA with a single controlled factor of survival rate, according to acorn's health, also confirms an extremely significant difference for the 19 batches (*Table5*). The Tukey test shows two groups: A contains the (H) and (S), and a second group B with very low mean for the (Sd).

Table 5. *Effect of acorn health on survival rate of the 19 batches and means estimated by Tukey test for 95% confidence level*

Source	df	Sum of squares	MS	F	P-value	Meaning
Model	2	42340,575	21170,287	44,669	0,000***	Extremely significant
Error	54	25592,842	473,942			
Total corrigé	56	67933,417				
Modality	**Estimated mean**	**Groups**				
1	70,172	A				
2	57,909	A				
3	7,208	B				

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Dead seedlings

The rate of dead plants is generally low (*Fig. 9*), with little divergence between individuals. Curiously, the healthy category shows the highest rate of dead plants in T6 and Zsoil (16.66%); T24 (10%); T7 and T32 (6.66%) and T36 (3.33%). The slightly damaged category shows 13.33% on T21 and T36; 10% on T19; 6.66% on T47 and Zsoil; 3.33% on T35 and Hsoil. Severely damaged: 13.33% for T2, 10% for T35 and 3.33% for T6 and T23.

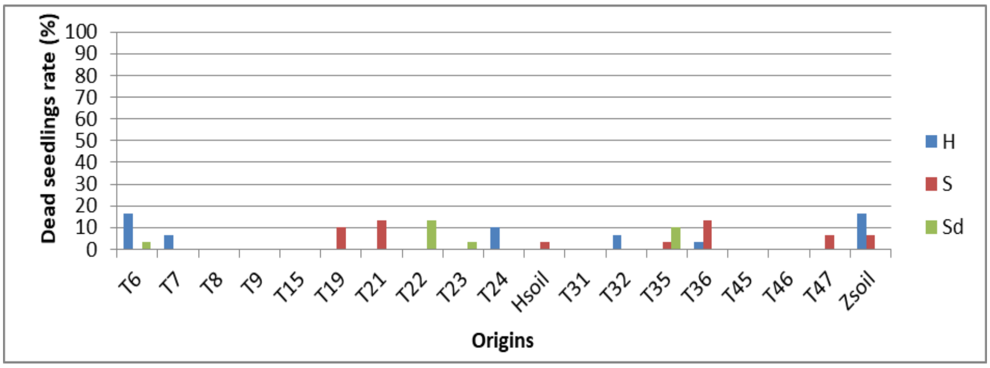

Figure 9. *Dead seedlings rate as a function of acorn health*

One-Way Analysis of Variance with a single controlled factor reveals no significant difference between individuals (17 trees) or batches (19) for the rate of dead seedlings and as much for the rate of acorns that did not give seedlings(*Table 6*).

Table 6. *Effect of acorn health on the rate of dead acorns and acorns that did not produce plantsof the 19 batches and means estimated by Tukey test for 95% confidence level*

Source	**df**	**Sum of squares**	**MS**	**F**	**P-value**	**Meaning**
Model	2	28,423	14,212	0,631	0,536	Not significant
Error	54	1215,577	22,511			
Total corrigé	56	1244,000				
Modality	**Estimated mean**	**Groups**				
1	3,156	A				
2	2,981	A				
3	1,578	A				

Acorns that have not produced seedlings

The rate of acorns that did not give seedlings is the rate of acorns that germinated but did not give seedlings and the rate of acorns that did not germinate at all. At the forest level, this rate is generally important for (H) and (S), reaching respectively 66.66% in Hafir and 80% in Zariefet.

At the individual level, no acorns of healthy T46 germinated and 67% of T22 also. Slightly damaged also exposes very severe rates for three individuals T46 (80%), T35 (70%) and T22 (60%). The severely damaged, naturally express the highest rates: 64% of the trees (T7, T8, T9, T15, T19, T31, T32, T36, T45, T46, T47) gave no seedlings. For other individuals, the rate ranges between 36.66% (T22) and 93,66 (Hsoil) (*Fig. 10*).

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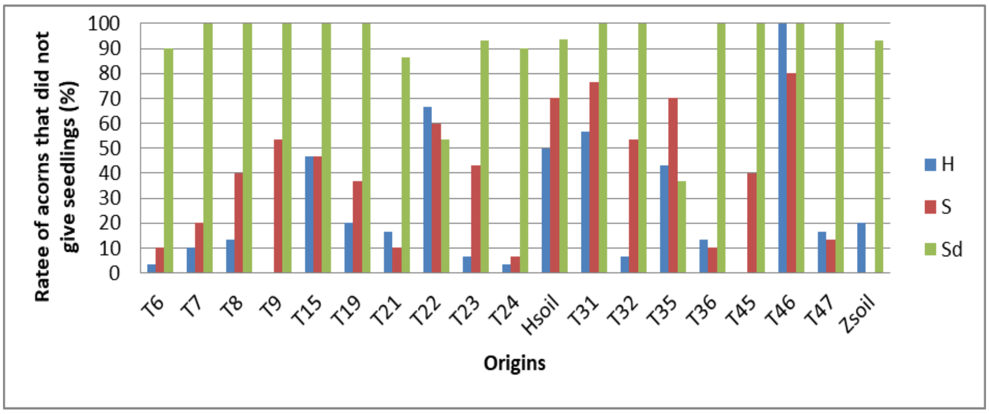

Figure 10. *Rate of acorns that have not produce seedlings as a function of acorn health*

Discussion

The process of germination of cork oak acorns is a complex physiological phenomenon involving the physiological and, above all, morphological integrity of the acorns; insect attack intervenes to disturb this integrity by modifying the morphology of the acorns (consumption of the endosperm), but also by exerting permanent stress on the acorns, the physiological capacities are diminished and result in a negative effect on the germinative power (Merouani et al., 2005).

The results show that healthy (H) and slightly damaged (S) acorns achieve 100% germination, whether harvested from trees or picked up from the ground without much dispersion around the average which is estimated at 69% and 62%, respectively. The average emergence of healthy acorns from trees reaches 81% at Hafir. However, severely damaged acorns (Sd) generally show the lowest rates with large differences between producing individuals, the maximum recorded is 67% in T35, the average is 8%. More than 90% of acorns (Sd) of 64% of trees remain metabolically inactive. The survival rate of the plants varies in the same way as the emergence rate, it reaches 100% in healthy and 93.33% in the slightly damaged. Sd also has a low rate of dead plants (RDP).

Exceptionally, acorns (Sd) of A35 have a survival rate of 57%. The presence of larvae in the large gallery that it drills in the cotyledons, their stress and deterioration, did not affect the embryo, which remained intact with all its physiological capacities. These acorns were able to germinate and establish seedlings with a rate dominating the healthy and slightly damaged acorns.

We also note that under the same conditions, originating from the same individual, and from the same apparent health state, the acorns may be in a different physiological state. They don't all germinate at the same rate and speed. Apparently healthy ones generally give a satisfactory emergence rate within 20 days of the appearance of the first seedling. Otherwise, they will take longer to emerge. This has been observed by Come (1975) in a natural environment.

The rate of reduction of germination of cork oak acorns due to infestation: 7% for the slightly damaged and 60% for the strongly damaged, is different from that obtained by Saadi (2013) in north-east Algeria for the slightly damaged (30%) and similar (60%) for the strongly damaged. Leiva and Fernandes Ales (2005), report a 15% reduction in germination of holm oak acorns due to attacks by *Cydiafagiglandana* and *Curculio elephas* in Spain (Sierra Morena). Insect depredation of acorns was relatively high (about

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30-90%) in other oaks around the world (Oliver and Chapin, 1984; Steele et al., 1993; Crawley and Long, 1995; Kajimura, 2001; Yu et al., 2001, 2003; Xiao et al., 2001, 2004b; Branco et al., 2002; Maeto and Ozaki, 2003; Leiva and Fernandez Ales, 2005).

In the same range, Bouchaour-Djabeur et al. (2011) found that 80% of unstratified, heavily damaged acorns either did not germinate or did not give seedlings. The embryo consumed and cotyledon reserves destroyed, the acorn is not able to start a new life.

This could be explained by changes in their physiological state reflected by a decrease in fresh weight, accompanied by an increase in humidity (Branco et al., 2002). Consumption of endosperm by larvae probably exerts a decrease in physical pressure on the germ which results in a slowing of the germination rate expressed by the mean germination time (MGT) (Montaya and Iranzo, 1997; Soria et al., 1997; Branco et al., 2002).

The reduction in the germination rate (60%) for the severely damaged ones is perhaps linked to the small size of acorns in western Algeria, which are approximately half of those in eastern Algeria. The weight varies widely and very significantly between individual producers and between plots (a minimum of 0.35 g and a maximum of9.61 g). Additionally, many infested acorns have the lowest length, width and weight. When larvae feed on acorns, this leads to a loss of weight, unless insect infestation prevents the acorns from developing properly and reaching an appreciable length and weight.

However, infestation is random, and insects are indifferent to acorn size and shape, they attack both large and small acorns without distinction (Bouchaour-Djabeur et al., 2021) for fresh acorns and (Bouchaour-Djabeur et al., 2011) for preserved acorns from the same massif. Around half of the acorns produced from Hafir-Zariefet fall into the category of acorns with a high vulnerability to insects according to Siscart et al.(1999) who revealed that oak acorns of 1,5 g fresh weight, infested by weevil, are generally free of damage (embryo) and are able to germinate; and any acorns less than 0,5 g fresh weight, show complete destruction of the endosperm and do not germinate.

The interaction of defense and resistance mechanisms appears to be important, as they can to some extent survive damage caused by predatory insects. First, it is a kind of "escape" because the acorns, ripe before the maturity of the larvae, can germinate and begin to transfer the reserves stored in the roots of the seedlings quickly before insects or other parasites completely consume the almond. In the wild, this has already been observed in other oaks (*Q. variabilis, Q. serrata et Q. liaotungensis*), which burrow to reproduce, because autumn germination results from the maturity of the acorn before that of predatory insects (Fox, 1982; Yu et al., 2003).

Secondly, a large cotyledon mass would allow tolerance of insect infestation by the rapid mobilization of stored reserves. It reduces the loss rate compared to small seeds with the same intensity of infestation. Thus, the mechanisms of defense and resistance remain closely linked to the acorns behavior, the infestation rate, and the cotyledon mass.

Steele et al.(1993) also showed that tannin concentration in oak acorns was much higher in the apical half (including embryos) than in the basal half (containing cotyledons). Thus, tannins, as a general resistance trait, may also be responsible for protecting the embryo.

Thus, given the physiological integrity, quantity and quality of cotyledonary reserves (if feeding by carpophagous insects does not injure the developing embryo), these slightly damaged acorns succeed in germinating, as has also been noted by other authors (Oliver and Chapin, 1984; Kaushal and Kalia, 1989; Weckerly et al., 1989; Andersson, 1992; Steele et al., 1993; Leiva and Fernandes Ales, 2005; Bouchaour-Djabeur et al., 2011).

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They subsequently establish viable seedlings up to 65% of the survival rate of slightly damaged acorns comparable to those derived from healthy acorns. These result Leiva and Fernandez Ales (2005); Xiao et al. (2007); and Bouchaour-Djabeur et al. (2011).

Conclusion

Despite their fundamental role in ecosystems, insects are still poorly known. Their relationship with the plant kingdom, whether as a bio-pest or as an auxiliary, is of vital importance for a better understanding of their individual and population functions, and their interactions with ecosystem components.

A complex relationship seems to exist between acorns and insects. Apart from insecticides, other studies of treatments of acorns or producing trees would merit particular interest, in particular, the development of strategies for optimizing natural defenses.

Thus, as measures to be taken to deal with this phenomenon, specific forestry is inthe first position. And to promote the species' adaptation and diversity, it is essentialthat reforestation by natural regeneration is favored; and/ or by the use of local provenances or possibly by seeds able to adapt to the station.

It's important to remember that regeneration will need to be controlled by studying the physical and biotic factors responsible, because the recruitment of a species into a plant community is often limited by events occurring during the early stages of its life. Seed production, germination and the first phase of survival and growth are under the control of numerous abiotic factors. However, these factors are not the only ones acting on the regeneration of a given species: biotic interactions, which include plant-plant interactions as well as plant-organism interactions (predation), are all equallyimportant.

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