Biodiv. Res. Conserv. 67: 13-20, 2022

BRC
www.brc.amu.edu.pl

DOI 10.2478/biorc-2022-0011

Submitted 25.07.2022, Accepted 30.09.2022

Preliminary study of the pre-germinative treatments of *Juniperus oxycedrus* L. and *Pistacia lentiscus* L. in the Saida region (Western Algeria)

Sid Ahmed Aouadj[1], Mohamed Zouidi[2]*, Ayoub Allam[3], Mostapha Brahmi[4,5], Mohammed Djebbouri[6], Yahia Nasrallah[4], Okkacha Hasnaoui[1], Belgacem Nouar[1] & Hadj Khatir[7]

[1]Department of Ecology and Environment, Laboratory of Ecology and Management of Natural Ecosystems, Abu Bakr Belkaid University of Tlemcen, Algeria; ORCID: SAA https://orcid.org/0000-0001-8754-4286; OH https://orcid.org/0000-0001-7599-8221; BN https://orcid.org/0000-0002-3502-127X

[2]Centre de Recherche en Aménagement du Territoire (CRAT), Campus Zouaghi Slimane, Route de Ain el Bey, 25000 Constantine, Algeria; ORCID: MZ https://orcid.org/ 0000-0001-5790-9598

[3]Centre de Recherche en Technologie des Industries Agroalimentaires (CRTAA), Compus universitaire Targua Ouzemour, Bejaia 06000, Algeria; ORCID: AA https://orcid.org/0000-0002-1913-248X

[4]Laboratory of Biotoxicology, Pharmacognosia and Biological Valuation of Plants, University of Saida- Dr Moulay Tahar, Algeria; ORCID: MB https://orcid.org/0000-0003-4131-5802; YN https://orcid.org/0000-0003-1134-2623

[5]Department of Biology, Faculty of Science and Technology, Ahmed Zabana University of Relizane 48000; Algeria

[6]Doctor of Ecology, Moulay Larbi, Saida 20000, Algeria; ORCID: MD https://orcid.org/0000-0002-6561-8683

[7]Private scientific consultant and a head of Reprodbiotech and stem cells. Montréal, Canada; ORCID: HD https://orcid.org/0000-0002-4595-6204

* corresponding author (e-mail: zouidibiologie20@gmail.com)

Abstract. *Juniperus oxycedrus* L. and *Pistacia lentiscus* L. are two taxa with a rigid or rigid enough structure caused by a solid pericarp resulting in a strong inhibition of the germination. The objective of this work was to test the effectiveness of certain pre-germinative treatments on the germination rate of the *Juniperus oxycedrus* and *Pistacia lentiscus* seeds with the aim of restoring perturbed ecosystems. In this context 180 seeds from each of the 2 examined species were tested in the laboratory (the number of repetitions is 5, to reach the degree of freedom 'ddl'). The seeds were divided into 4 groups of 20 seeds of each species and were treated as follows: 1) Immersion in the concentrated (95%) sulphuric acid (H_2SO_4) for 10, 30 and 60 minutes; 2) Mechanical scarification with a scalpel; 3) Soaking in hot water (at 100°C) for 30 seconds, 60 seconds and 2 minutes; 4) Cold stratification at 5°C for 24 hours. There is also a control group of 20 seeds representing each of the two species, which remained neutral. In the case of the *Juniperus oxycedrus* seeds the results showed that the germination rate improves after the mechanical scarification with a scalpel (92%), followed by the cold stratification with water (86%) and a treatment with a concentrated sulphuric acid for 60 minutes (82%). The seeds were treated with H_2SO_4 for 10 and 30 minutes, respectively, soaked in hot water; the control lot did not germinate. The germination rate for the *Pistacia lentiscus* seeds is 88% after the mechanical scarification and 84% after the cold water stratification. On the other hand, the treatment with H_2SO_4 or after soaking in hot water does not allow for the germination of these seeds. The same result is observed on the control group (0% for 30 days).

Key words: dormancy, *Juniperus oxycedrus*, *Pistacia lentiscus*, pre-germinative treatments, Saida

ECOLOGY

1. Introduction

The Doui Thabet State Forest occupies the western region of the Saida Mountains. These Mountains are a part of the biogeographical subsector of the Oranese Tellien Atlas. Several scientific studies on the functioning of the ecosystems in this region showed a regression of the vegetations as a result of the anthropozoogenic action and the climate aridification (Benabdeli 1996; Nasrallah 2014; Kefifa 2015; Aouadj *et al.* 2020a,

© 2022, Aouadj et al. This is an open access article licensed under the Creative Commons Attribution-NonCommercial-NoDerivs License (http://creativecommons.org/licenses/by-nc-nd/3.0/)

2020b). This regressive dynamic requires the restoration and rehabilitation of the degraded ecosystems. The plant communities of the Saida Mountains are characterized by the variable physiognomic aspects (forests, pre-forests, lawns). These communities develop on poor soils and suffer from hard climatic conditions (Zouidi *et al.* 2019; Aouadj *et al.* 2020c; 2020d). These conditions affect the biological potential of plants and the natural vegetation cover depends on these parameters (soil and climate). The anthropogenic impact is added to this dual climatic-edaphic action. Pedoclimatic synergy coupled with the anthropozoogen stress conditioned the richness of plant structures and their appearances (Hasnaoui 2008; Hasnaoui *et al.* 2014; Medjati *et al.* 2014; Hasnaoui & Bouazza 2015; Zouidi *et al*. 2018; Aouadj 2021; Kehal *et al*. 2022).

The *Juniperus* (Badri 2003; Ferradous *et al.* 2013) and *Pistacia* (Benmahioul 2009) occupy an important place in the North African landscape, mainly because of their hardiness and dynamism. They are the pioneer species that are not ecologically demanding and present from the seaside to the Atlas peaks. Their hardiness allows them to withstand intense human aggressions which they are subjected to. In fact, in many areas they represent the only tree or shrub element that can be exploited for wood, foliage or even for industrial or medicinal purposes (Nasrallah *et al.* 2021). According to Doghbage *et al.* (2020) these two species are among the threatened species in Algeria due to the scarcity of viable seeds, the limit of natural seed germination, overgrazing, cutting offences, fires and above all, the lack of effective management programs for their rehabilitation, which increases the risk of their regression (Allam *et al*. 2019; Aouadj *et al.* 2020e, 2020f). However, the concerned authorities are now more conscious than ever about the risk of the extinction of these important species. Consequently, a law was passed in 2012 by the Algerian Ministry of Agriculture and Forestry with the aim of allowing its regeneration, rehabilitation and conservation to protect the *Juniperus*.

Nevertheless, it should be noted that despite the measures taken by the managers to preserve the ecosystem of the study area, the natural germination of the species in question seems to be a real problem for the ecological restoration. This is mainly due to the formation of seeds with a solid to semi-solid protective pericarp, preventing access to the basic elements necessary for the resumption of active life (e.g., oxygen, water and light). In fact, it is estimated that only 5% of the *Juniperus oxycedrus* seeds germinate naturally. As a result, the natural regeneration of these two species and the self-repair of our ecosystem cannot take place in the long term. This would therefore imply the need for a germinative pre-treatment to increase the germination rate.

J. oxycedrus seeds are characterized by very hard pericarp (teguments) (Badri 2003) while *P. lentiscus* seeds have moderately hard pericarp (Côme 1970; Bewley & Black 1994), inducing an inhibition of natural germination. This inhibition phenomenon of the seed germination may be related to internal factors, such as: species, variety, growing conditions, genetics (seed size and weight) (Chaussat & Chapon 1981) and seed age (Barton 1936) or external factors, such as temperature, oxygen, light and water (Chaussat & Chapon 1981).

The nature of the soil also appears to be a limiting factor that can influence the germination quality, as it is responsible for the behaviour of each species according to its composition (Chaussat & Chapon 1981). All these factors allow or do not allow the successful germination of the seeds of any plant species.

Thus, the persistence of the seed coat will prevent the absorption of water and the entry of oxygen, which causes the phenomenon of dormancy. The dormancy of a seed in its state of maturation is: "the inability to germinate when all environmental conditions should apparently allow germination". While Rohde & Bhalerao (2007) define it as the inability to initiate the meristematic growth under favourable conditions. Whatever the definition, it appears that seed dormancy may be due either to the structures surrounding the embryo (Bewley & Black 1994) and/or to the phenolic compounds produced in the fruit (Isfendiyaroglu & Ozeker 2001; Baskin & Baskin 2004). In order to overcome this integumentary dormancy and increase the germination rate, the seeds should be subjected to specific pre-treatments to obtain a more satisfactory germination.

The germination of *J. oxycedrus* and *P. lentiscus* have not been studied extensively in Algeria and definitely not yet in the Saida region, despite their ecological and economical importance, hence the pertinence of this current study.

The objective of this work was to test the effectiveness of certain pre-germinative treatments (chemical, mechanical, thermal) in order to increase the speed and rate of the seed germination of those two species.

2. Material and methods

2.1. Origin and the choice of seeds

The used seeds in this study were collected in the Doui Thabet State Forest (located in the western Region of the Saida Mountains) in October 2020 from different feet of *J. oxycedrus* and *P. lentiscus.* During the picking, we took into consideration the sanitary aspect of the plant. On the other hand, the selected seeds were used in the fresh state, were morphologically ripe, were not

Table 1. Germination pre-treatment protocol (GENMEDOC 2006)

Essences	Pre-germinative treatment
Juniperus oxycedrus and *Pistacia lentiscus*	Description of the experimental protocol 1 – Disinfection: The disinfection of all of the seeds in bleach for 10 minutes and rinsing with distilled water 3 to 4 times 2 – Separation of the seeds into different lots of 20 seeds per group: a – One group for a natural germination (as a control group without any pre-treatment) b – Three groups for a chemical treatment according to the time of exposure c – One group for a mechanical scarification d – Three groups for a hot water pre-treatment (100°C) according to the time of exposure e – One group for a cold treatment at 5°C for 30 days 3 – Pre-germinative treatments lots in detail: a – Immersion of the seeds in H_2SO_4 (95%). Each batch is soaked in H_2SO_4 for 10 minutes, 30 minutes and 60 minutes b – Mechanical scarification with a scalpel c – Soaking in hot water at 100°C of the three groups (for 30 seconds, 60 seconds and 2 minutes) d – Cold treatment at 5°C for 30 days

attacked by parasites. Those which were tested by tempering in water in order to retain only the viable ones. The floating seeds were not taken into account because we decided they were physiologically unripe.

Four pre-germinative treatments were applied: 1) sulfiric acid H_2SO_4 concentrated at 95%; 2) mechanical scarification using a scalpel; 3) hot water (at 100°C) and 4) cold stratification (at 5°C).

2.2 Seeds treatment

The different steps of the treatment are reported in Table 1 and they are related to the seeds of the two species.

2.3 Germination and the statistical analysis

The seed germination of the different lots was very well monitored. We took into consideration the percentage of the seeds that really germinated (Côme 1970), the latency T1 and T50 (the time necessary for 50% of the seeds to germinate). The T50 gives information on the germination speed. All of the obtained data were statistically analyzed using version 12.0 of the Statistica software. The difference between the growth parameters of the two species were evaluated by a variance analysis (ANOVA) of one factor.

In this context we were interested in the density of accumulation of the seedling growth each month. The obtained results were compared to the threshold value indicated in Tables 2 and 4 according to the number of degrees of freedom (DFD): If $p>0.05$: threshold difference is insignificant between averages; If $p\leq 0.05$: threshold difference is significant between averages; P: plus-value.

3. Results

3.1. Effect of the pre-germination treatments on the *Juniperus oxycedrus* seeds

The statistical analysis of the germination of the *J. oxycedrus* seeds, under the effect of various pre-germinative treatments was very significant from the 17th day (Table 2). Three out of five treatments (H_2SO_4 for 60 minutes, cold (5°C) and a mechanical one) had a very significant influence. The mechanical pre-treatment was the most effective one (92%). The pre-treatment by cold and H_2SO_4 for 60 minutes had a fairly high germination rate (86% and 82% respectively), while the hot water and the use of the Sulfiric acid (H_2SO_4) for 10 and 20 minutes, respectively, was null for the control group (Table 3; Fig 1).

It is important to consider that the results presented in this study should always be interpreted as valid only for the test lot and not for the species in general.

Table 2. Statistical results of the germination treatment of *Juniperus oxycedru*

DFD	SS	AS	F	P value and meaning
5	5002457	833743	245.18	0.0000***

Explanations: DFD – degree of freedom, SC – Sum of squares, AS – Average squares, Fobs – F. observed, P – added value, meaning

Table 3. Germination rate of *Juniperus oxycedrus*

Pre-treatment	Pre-treatment duration	Germination rate	T1	T50
Control	/	0%	/	/
Mechanical Scarification	/	92%	17 days	19 days
Sulphuric acid (H_2SO_4)	10 mn	0%	/	/
	30 mn	0%	/	/
	1 h	82%	20 days	23 days
Hot water	30 s	0%	/	/
	60 s	0%	/	/
	2 mn	0%	/	/
Cold water	30 days	86%	17 days	22 days

Explanations: T1 – Latency time (in days), T50 – time required to obtain 50% of the germination capacity (in days)

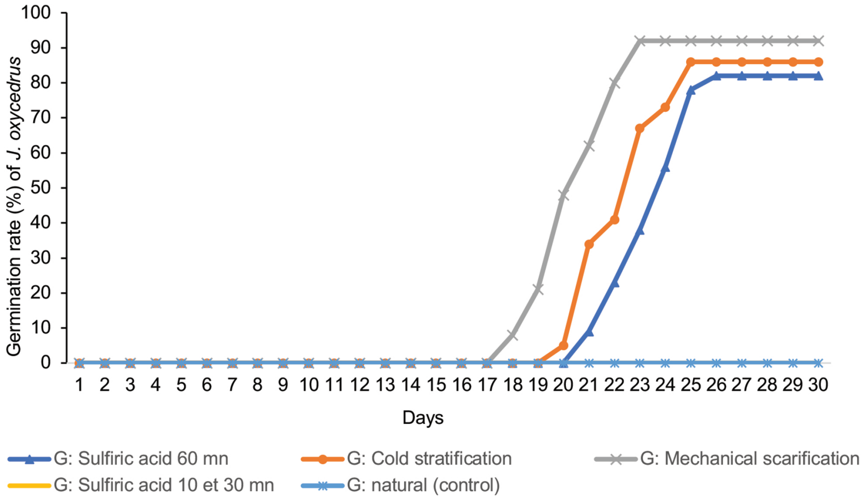

Fig 1. Kinetics of the germination of *Juniperus oxycedrus*

Table 4. Statistical results of the germination treatment of *Pistacia lentiscus*

DFD	SS	AS	F	P value and meaning
5	5444692	5444692	381128.4	0.0000***

Explanations: DFD – degree of freedom, SC – Sum of squares, AS – Average squares, Fobs – F. observed, P – added value, meaning

Table 5. Germination rate of *Pistacia lentiscus*

Pre-treatment	Pre-treatment duration	Germination rate	T1	T50
Control	/	0%	/	/
Mechanical Scarification	/	88%	10 days	15 days
Sulphuric acid (H_2SO_4)	10 mn	0%	/	/
	30 mn	0%	/	/
	1 h	0%	/	/
Hot water	30 s	0%	/	/
	60 s	0%	/	/
	2 mn	0%	/	/
Cold water	30 days	84%	11 days	14 days

Explanations: T1 – Latency time (in days), T50 – time required to obtain 50% of the germination capacity (in days)

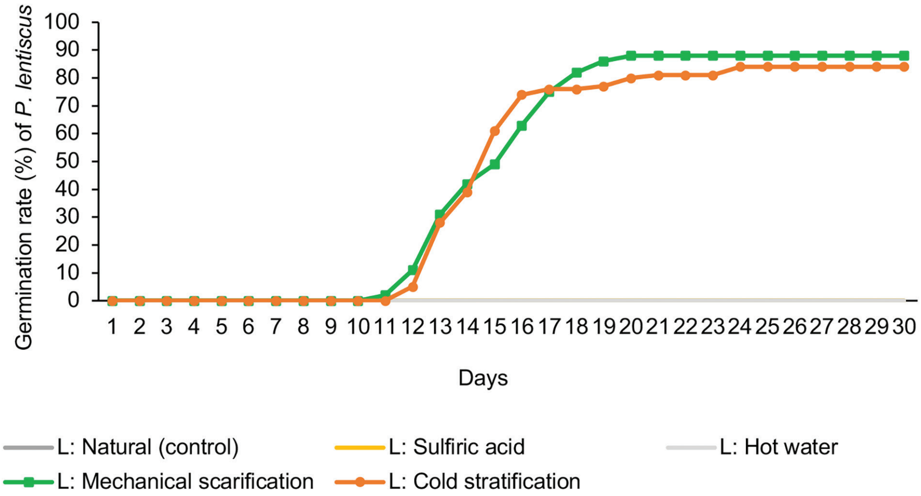

Fig 2. Kinetics of the germination of the *Pistacia lentiscus* seeds

3.2. Effect of the pre-germination treatments on the *Pistacia lentiscus* seeds

The statistical analysis of the germination of the *P. lentiscus* seeds was very significant from the 10th day (Table 5). We discovered that out of all of the experiments the two that have yielded a positive result were cold and scarification. The mechanical pre-treatment was found to be the treatment that produces a very significant germination (88%). As for the cold pre-treatment the result was also important, reaching 84% (Table 5; Fig. 2). It should be noted that other pre-treatments did not yield positive results.

4. Discussion

Seed germination is a key developmental process in the life cycle of plants. Our study indicated that hardening improves the germination performance of the *P. lentiscus* and *J. oxycedrus* seeds, which was also confirmed by the previous studies on several other species. Several authors have explained this rapid and synchronized germination to be caused by the activation of the pre-germination processes which induce the quantitative and qualitative biochemical modifications at the seed level (Varier *et al*. 2010; Maroufi *et al*. 2011), such as the repair of the membranes (Jowkar *et al*. 2012), strong synthesis and activation of the enzymes involved in the degradation and mobilization of the reserves (Varier *et al*. 2010; Wattanakulpakin *et al*. 2012), as well as the activation of the endo-β-mannase, which is the enzyme responsible for the synthesis of ethylene (the hormone which allows the degradation of the albumen to break the dormancy) (Varier *et al*. 2010). De Castro *et al*. (2000), showed that priming enhances and synchronizes the DNA replication in all of the embryo cells allowing the cell cycle advancement from phase G1 to G2. This pre-activation cell cycle is one of the mechanisms by which priming induces a better sprouting performance. This mechanism is regulated by the activation of the cell cycle proteins, such as β-tubulin, cyclins and cyclin-dependent protein kinases. The improved germination in the hardened seeds may largely depend on the increased antioxidant enzyme activities (Ahmed *et al*. 2012). On the other hand, the beneficial effects of priming on the growth have been explained by Varier *et al*. (2010) by an acceleration of the nuclear replication in the roots and leaves.

It is known that the plant is highly dependent on the water supplied to it and the slightest deficit in the water balance leads to a reduction in the growth and can lead to wilting. This can be observed through our own results; stopping the watering caused the yellowing and strong wilting of the plants from the untreated seeds. At the end of this study, we could conclude that the pre-treatment of the *P. lentiscus* and *J. oxycedrus* seeds improved the germination performance.

Several pre-treatments have been tested and the germination rates vary depending on the type of the pre-treatment used, the nature of the seeds and their provenance (Mezghenni *et al.* 2014).

The obtained results of the previous studies suggest that the teguments are a significant obstacle to the germination of the *J. oxycedrus* and *P. lentiscus* seeds. The effect of the removal of the seminal envelopes on the rate and the kinetics of the germination (Coe & Coe 1987; Medjati *et al.* 2014) would be beneficial. The germination difficulties should be investigated in the structure of the tougher teguments (El Wahidi *et al.* 2013).

The results of our present study confirm that the seeds of *J. oxycedrus* and *P. lentiscus* have problems with the dormancy and that the pre-germinative treatments contribute to the lifting of it. These pre-treatments are a simple and effective way to improve the germinative rate of the concerned species (El Wahidi *et al.* 2013; Morsli *et al.* 2015).

The germination of the *J. oxycedrus* seeds is significantly influenced by the used pre-treatments (P: 0,000). The mechanical treatment, H_2SO_4 for 60 minutes and the cold scarification (5°C) provides much better results than other pre-treatments. The highest obtained germination rates are 92% with H_2SO_4 for 60 minutes, 86% by the cold treatment (5°C) and 82% with the mechanical treatment. The results of our work corroborate with the other research on the seed germination of *Olea, Argan,* and *Abies* (Derridj *et al.* 2000). These different pre-treatments seem to facilitate the release of the dormancy phenomena and allow the satisfactory germination rates.

As with the seeds of *J. oxycedrus,* the germination of *P. lentiscus* is significantly influenced by the used pre-treatments (P: 0,0000). The mechanical and thermal treatments produce much better results than the other pre-treatments. After only 11 days they gave the highest germination rates (88% and 84% respectively). In this context it should be noted that the work on the pioneer species such as *Pistacia atlantica* Desf.*, Olea laperrini* Batt. & Trab.*, Argania spinosa* (L.) Skeels*, Balanites aegyptiaca* (L.) Delile*, Cupressus atlantica* Gaussen*, Juniperus phoenicea* L. etc. confirm the resistance of seed teguments which requires artificial pre-treatment to obtain a better rate of germination (Derridj *et al.* 2000; El Wahidi *et al.* 2013). Two recent studies have reported very interesting results in terms of the germination rates (80%) of the *Pistachio* seeds with the pre-treatment with the Giberellic acid (GA3) (Poon Syverson 2019).

5. Conclusion and perspectives

The results presented in this current study have highlighted the undeniable effect of pre-treatments (scarification, chemical and thermal treatment) on the germination of *J. oxycedrus* and *P. lentiscus* seeds. The three pre-treatments, that are effective for *J. oxycedrus*; mechanical, thermal (cold one) and a chemical treatment (H_2SO_4 concentrated at 95% for 60 minutes), yielded remarkable rates of the germination (92%, 86% and 82% respectively). While for *P. Lentiscus* only two out of four treatments are effective: The mechanical scarification and the thermal treatment (88% and 84% respectively). It should also be remembered that the scarification gives the best result in both species. These results are very encouraging and can be exploited by the decision makers as part of the ecological restoration of the degraded ecosystems in the study area.

In perspective it would be possible to test new techniques such as the seed pulping technique (using high-water pressure for example) in order to increase the germinative capacity of the species with the germination difficulties. Also the micro-propagation; a technique to regenerate an entire plant from the cells or plant tissues in a nutrient environment (the in vitro culture) can also be tested.

Author Contributions:

Research concept and design: S. A. Aouadj, M. Zouidi
Collection and/or assembly of data: S. A. Aouadj, M. Zouidi, A. Allam, M. Djebbouri, B. Nouar
Data analysis and interpretation: S. A. Aouadj, M. Zouidi, M. Brahmi, H. Khatir
Writing the article: S. A. Aouadj, M. Zouidi, B. Nouar
Critical revision of the article: S. A. Aouadj, M. Zouidi, M. Djebbouri, Y. Nasrallah, O. Hasnaoui, H. Khatir
Final approval of article: S. A. Aouadj, M. Zouidi, Y. Nasrallah, O. Hasnaoui, H. Khatir

References

Ahmed Z., Sheikh M. A., Hameed A. & Salah Ud Din. 2012. Investigation of antioxidant enzymes and biochemical changes in the wheat seeds (freed) induced by different pre-sowing treatments. World Applied Sciences Journal 18(1): 31-36. DOI: 10.5829/idosi.wasj.2012.18.01.46

Allam A., Borsali A. H., Kefifa A., Zouidi M. & Gros R. 2019. Effects of overgrazing on the physico-chemical and biological properties of semi-arid forest soils in western Algeria. Indian Journal of Ecology 46(4): 745-750.

Aouadj S. A. 2021. Impact of ecological restoration techniques on the dynamics of degraded ecosystems of the Saida Mountains: Case of the forests of Doui Thabet (West Algeria). 148 pp. Ph.D. Thesis, University Aboubakr Belkaïd, Tlemcen.

Aouadj S. A., Hasnaoui O. & Nasrallah Y. 2020a. Ethnobotanical Approach and Floristic Inventory of Medicinal

Plants in the Doui Thabet Region (Saida-Western Algeria). PhytoChem & BioSub Journal 14(1): 92-104. https://doaj.org/article/4820ed6c3f1b4310880de2f6ed2b17c6

Aouadj S.A., Nasrallah Y. & Hasnaoui O. 2020b. Ecological characterization and evaluation of the floristic potential of the forest of Doui Thabet (Saida Western Algeria) in the context of the restoration. Ecology, Environment and Conservation 26(1): 266-278.

Aouadj S.A., Nasrallah Y. & Hasnaoui O. 2020c. Note on the orchids of mounts of Saida (Saida Western Algeria) in the context of the restoration. Ecology, Environment and Conservation 26(2): 37-45.

Aouadj S.A., Nasrallah Y. & Hasnaoui O. 2020d. Regional phytogeographic analysis of the flora of the Mounts of Saida (western Algeria): evaluation-restoration report. Biodiversity Journal 11(1): 25-34.

Aouadj S.A., Nasrallah Y., Hasnaoui O. & Khatir H. 2020e. Impacts of anthropogenic pressure on the degradation of the forest of Doui Thabet (Saida, Western Algeria) in the context of the restoration. Acta Scientifica Naturalis 7(2): 68-78. DOI: https://doi.org/10.2478/asn-2020-0022

Aouadj S.A., Nasrallah Y., Hasnaoui O. & Khatir H. 2020f. Impact of ecological restoration techniques on the dynamics of degraded ecosystems of the mounts of Saida: Case of the forests of Doui Thabet (West Algeria). Acta Scientifica Naturalis 7(2): 68-77. DOI: https://doi.org/10.2478/asn-2020-0023

Badri W. 2003. Structure and functioning of stands in Juniper thurifera (*Juniperus thurifera* L.) in the Moroccan Atlas. 244 pp. Doctoral Thesis. Faculty of Science, Semlalia, Marrakech.

Baskin J. M. & Baskin C. C. 2004. A classification system for seed dormancy. Seed Sci Res 14: 1-16. https://doi.org/10.1079/SSR2003150

Barton L. V. 1936. Germination of some desert seeds, Contr. Boyce Thompson Inst. 8: 7-11.

Benabdeli K. 1996. Physiognomy-structural and dynamic aspects of forest ecosystems in the face of anthropozogenic pressure in the Tlemcen and Dhaya Mountains. 356 pp. Western Algeria. Ph.D. Thesis in Science. UDL.

Benmahioul B. 2009. Improvement of in vitro micropropagation of pistachio (*Pistacia vera* L.) for the extension of orchards in Algeria. 129 pp. Ph.D. Thesis Oran, University of Sciences and Technology of Oran,

Benmahioul B. 2017. Factors affecting in vitro micropropagation of Pistachio (*Pistacia vera* L.). Agriculture and Forestry Journal 1(1): 56-61.

Bewley J. D & Black M. 1994. Seeds. Physiology of Development and Germination. https://www.springer.com/gp/book/9780306447471.

Chaussat R & Chapon M. 1981. Comparative study of the weights and germ properties of the epileped grains of some wild and cultivated Triticum. Bulletin de la Société d'Ecophysiologie, Flight 6(1-2): 15-21.

Coe M. O & Coe C. 1987. Large herbivores, Acacia trees and bruchid beetles. South African Journal of Science 83(1): 624-635.

Côme D. 1970. Barriers to Germination, Masson Edition, 162 pp.

De Castro R. D., Van Lammeren A. A., Groot S. P., Bino R. J., & Hilhorst H. W. 2000. Cell division and subsequent radicle protrusion in tomato seeds are inhibited by osmotic stress but DNA synthesis and formation of microtubular cytoskeleton are not. Plant Physiol 122(2): 327-336. https://doi.org/10.1104/pp.122.2.327

Derridj A., Boughanem K. & Saadi F. 2000. Study of biometrics and germination of Tindouf's argan tree seeds and almonds (*Argania spinosa* L.). Acts of the international seminar, Djanet (Algeria).

Doghbage A., Belhadj S., Erridj A., Mevy J. P., Gauquelin T., Merdas S., Tonetto A. & Foulla H. F. 2020. Comparative eco-botanical analysis of *Pistacia lentiscus* l. In Algeria through morphological and ultra-structural markers related to leaves and stomata. Agrobiologia 10(1): 1826-36

El Wahidi F., El Alaoui El Fels A., El Mercht S., Abou Sy., El Wahidi A., Romane A. & Roques Y. 2013. Contribution to the improvement of germination among a forest endemic of Morocco, the Atlas cypress. Ecologia mediterranea 39(1): 201-208. DOI: 10.3406/ecmed.2013.1306

Ferradous A., Alifriqui M., Hafidi M. & Duponnois R. 2013. Trials of artificial regeneration of Incense juniper (*Juniperus thurifera* L.). Ecologia Mediterranea 39(1): 215-221. DOI: 10.3406/ecmed.2013.1298

Genmedoc 2006. Germination practices in genMEDOC seed banks. 175 pp. European Union.

Hasnaoui O. 2008. Contribution to the study of Chamaeropaies in the Tlemcen region, Botanical and map aspects. 210 pp. Ph.D. Thesis. University of Abou bekr Belkaïd; Tlemcen.

Hasnaoui O., Meziane H., Borsali A. H., & Bouazza M. 2014. Evaluation of Characteristics Floristico-Edaphic of the Steppes at Alfa (*Stipa tenacissima* L.) in the Saida Region (Western Algeria). Open Journal of Ecology 4: 883-891. http://dx.doi.org/10.4236/oje.2014.414074

Hasnaoui O. & Bouazzam M. 2015. Indicators of degradation of natural bio-resources of western Algeria: case of the steppe of the Wilaya of Saida. Algerian Journal of Arid Environment 5(1): 63-75.

Isfendiyaroglu M & Ozeker E. 2001. The relations between phenolic compounds and seed dormancy in *Pistacia* spp. In: Ak Be (ed.). XIGREMPA seminar on pistachios and almonds, pp. 227-232. Zaragoza, CIHEAM.

Kefifa A. 2015. Contribution to the study and mapping of the impact of anthropozoic and climatic pressures on the natural resources of the Saida Mountains (Algeria). 401 pp. Ph.D. Thesis. Tlemcen University.

Kehal L., Zouidi M., Keddari D., Hadjout S. & Borsali A. H. 2022. Comparative analysis of forest soil properties from sub-humid and semi-arid areas of Djebel El Ouahch biological reserve in Algeria. South Asian Journal of Experimental Biology 12(3): 349-356. https://doi.org/10.38150/sajeb.12(3).p349-356

Jowkar M., Ghanbari A., Moradi F. & Heidari M. 2012. Alterations in seed vigor and antioxidant enzymes activities in *Silybum marianum* under seed priming with KNO_3. Journal of Medicinal Plants Research 6(7): 1176-1180. https://doi.org/10.5897/JMPR11.812

Maroufi K., Farahani H. A. & Moradi O. 2011. Increasing of seedling vigor by hydro priming method in cowpea (*Vigna sinensis* L.). Advances in Environmental Biology 5(11): 3668-3671.

Medjati N., Hasnaoui O., Hachemi N. & Babali B. 2014. Study of germinative behaviour and tests to remove tegumental inhibition of the seeds of *Chamaerops humilis.* var. *André argentea* (Arecaceae). Arid Regions Review, Special Issue 35(3).

Mezghenni H., Hamrouni L., Hanana M., Jamoussi B., Bouzid S. & Khouja M. L. 2014. Multiplication de l'arganier *Argania spinosa* (L.) Skeels. Journal of New Sciences 10(2): 1-12.

Morsli A., Tahar S., Lellouchi M., Titouh K., Amiali M., Benmazhar H., Benslimani N., Khelifi-Slaoui M. & Khelifi L. 2015. New advances in the regeneration of Algerian thuriferous juniper (*Juniperus thurifera* L.) trees. Wulfenia 22(6): 429-444.

Nasrallah Y. 2014. Characterization of the morphological variability of the 21 Algerian Green Chenet feeders (*Quercus rotundifolia* Lam.), evaluation of their ecological adaptation in the semi-arid region of Saida. 213 pp. These PhD in Agricultural Sciences. El Harache Higher School of Agricultural Sciences.

Nasrallah Y., Aouadj S. A. & Khatir H. 2021. Impact of the exploitation of medicinal plants on biodiversity conservation in the region of Saida and El Bayadh, Algeria. Biodiversity, Research and Conservation: 60(1): 11-22. DOI: https://doi.org/10.2478/biorc-2020-0011

Poon Syverson D. Y. 2019. Efficacy trials of new dormancy-breaking treatment in Pistachio. A thesis to obtain a degree in Master in Plant Science. The Jordan College of Agricultural Sciences and Technology California State University, Fresno December 2019, pp. 1-126.

Rohde A. & Bhalerao R. P. 2007. Plant dormancy in the perennial context. Plant Science 12(5): 217-223. doi:10.1016/j.tplants.2007.03.012

Varier A., Vari A. K. & Dadlani M. 2010. The subcellular basis of seed priming. Current Science 99(4): 450-456. http://www.jstor.org/stable/24109568

Wattanakulpakin P., Photchanachai S., Ratanakhanokchai K., Kyu K. L., Ritthichai P. & Miyagawa S. 2012. Hydropriming effects on carbohydrate metabolism, antioxidant enzyme activity and seed vigor of maize (*Zea mays* L.). Afr J Biotechnol 11(15): 3537-3547. https://doi.org/10.5897/AJB11.3020

Zouidi M., Borsali A. H., Allam A. & Gros R. 2018. Characterization of coniferous forest soils in the arid zone. Forestry Studies 68(1): 64-74. https://doi.org/10.2478/fsmu-2018-0006

Zouidi M., Borsali A. H., Allam A. & Gros R. 2019. Microbial activities and physicochemical properties of coniferous forest soils in two forest areas (arid and semi-arid) of western Algeria. Bosque 40(2): 163-171. http://dx.doi.org/10.4067/S0717-92002019000200163