Biodiversity Journal, 2022, 13 (1): 163–170 https://doi.org/10.31396/Biodiv.Jour.2022.13.1.163.170

Effect of physico-chemical treatments on the vitality of *Pistacia atlantica* Desf. (Anacardiaceae) in Algeria: effect of provenances on germination and seed emergence

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ABSTRACT The *Pistacia atlantica* Desf. (Anacardiaceae) is widespread in North Africa, it is found in the Dayas, its extreme areas, in the form of sparse stands. It is a species that can constitute interesting populations in arid and semi-arid zones, hence the interest of studying the effect of provenances (25 regions of Algeria) on germination and seed emergence. In this context, 120 seeds were tested in the laboratory to know the effect of provenances on germination, the same procedure was used to know the effect of provenances on emergence (in the nursery). The seeds were divided into lots of 20 seeds (the number of replicates is 6 to reach the degree of freedom "DDL"). The results obtained show that the germination rate seems to be better for the provenances of Saida, Naama and EL Bayadh (≥ 90% for 45 days). On the other hand, the provenances of Relizane, Tlemcen, Guelema, Oued, Biskra, Ghardaia, Mascara, Bouira, Djelfa, Sidi Bel Abbes and Mesila give only very poor results (≤ 20%), while the other provenances give a medium result (≈ 50%). Regarding emergence, the provenances of Laghouat, Saida, Tiaret, Bechar, Naama and Batna give a good result (≥ 90%) while the result is very low for the provenances of Adrar, Biskra, Oued, Ghardaia, Mascara, Bouira, Relizane, Sidi Bel Abbes and Djelfa. In view of these results, the use of Pistacia atlantica in the restructuring of degraded arid spaces constitutes an interesting option and provides some answers to foresters in terms of the choice of provenance likely to be used in reforestation programs.

KEY WORDS Effect; emergence; germination; provenance; *Pistacia atlantica.*

Received 14.09.2021; accepted 30.12.2021; published online 30.03.2022

INTRODUCTION

In Algeria, the diverse climate, the complete bioclimatic range and the very varied pedogeological conditions contribute to the development of a rich and original flora. Thus, the vascular flora comprises around 3744 species and subspecies belonging to almost all of the known botanical families (Vela et Benhouhou, 2007, Aouadj et al., 2020a-f, Aouadj et al., 2021). The genus *Pistacia* L., of the Anacardiaceae family, includes many species that are widespread in the Mediterranean and the Middle East (Tutin et al., 1968). In Algeria, the genera *Pistacia* and *Rhus* L. are the only spontaneous representatives of this family (Fennane et al., 2007, Aouadj et al., 2020). Also, the pistachio tree is present there spontaneously under various pedo-climatic conditions and has three wild species *Pistacia atlan-*

tica Desf, *P. terebinthus* L., *P. lentiscus* L. (Abousalima & Kalli, 1992, Aouadj et al., 2020). In addition, the *P. vera* L. species is cultivated for its edible seeds "pistachios" (Nasrallah, 2019). The Atlas pistachio, named Btem (Fennane et al., 2007) includes four subspecies: *atlantica, kurdica*, *mutica* and *cabulica*; it is the latter species that is found in North Africa (Benhssaini et Belkhodja, 2004 ; Nasrallah et al., 2019). It is a powerful tree that can reach 20 m in height, with a well-individualized trunk and in which large trees can easily reach 1000 years (Benhssaini et Belkhodja, 2004). The leaves, imparipinnate with a finely winged rachis, are composed of 7-9 broad, flexible, glabrous and deciduous leaflets in autumn (Fennane et al., 2007). *Pistacia atlantica* is dioecious, the inflorescence is a compound raceme, with apetal flowers; flowering occurs in spring-summer and the fruit is a slightly fleshy drupe, first reddish, then bluish when ripe (Fennane et al., 2007). From an ecological point of view, the pistachio tree of the atlas, endowed with a great plasticity, is found in all the paid, ranging from the margins of the Sahara, in arid, semi-arid mild, cold semi-arid and sub-humid bioclimates (Fennane et al., 2007); it adapts to all types of soil except sand (Yaaqobi et al., 2009). However, *P. atlantica* no longer forms pure stands and is often mixed with *Tetraclinis articulata* (Benabid & Fennane, 1994; Aouadj et al., 2021).

The objective of this present work is to study the effect of provenances (25 regions of Algeria) on germination and seed emergence. The results of this work are very important for the use of *P. atlantica* in the restructuring of degraded arid spaces (constitutes an interesting option) and in the fight against desertification (green dam) and to provide some elements of responses to foresters in matter of choice of provenance likely to be used in reforestation programs.

MATERIAL AND METHODS

Study area

A detailed description of geographic coordinates and ecological parameters of the provenances is given in Table 1.

Harvesting, conservation and stratification of seeds

We harvested the seeds in the different places during the month of September (biological maturation) (Monjauze, 1980), it was done on healthy, vigorous, well-formed subjects, at the level of stands well adapted to ecological conditions. The collection takes place when the seeds have attained a red color.

Choice of seeds (Viability test)

In order to have viable seeds, we have chosen seeds morphologically and physiologically. Once this step was completed, we tested the seeds by the flotation test in tap water. The seeds which float are not retained, these are not either ripe (morphologically and / or physiologically), or attacked by parasites. These seeds are excluded from our experiments.

Experimental plan

The experimental protocol as the following (GENMEDOC, 2006):

- Preparation of seeds: after elimination of the mesocarp which is considered to be a germination inhibitor.
- Disinfection of seeds: disinfect the Atlas pistachio seeds with 13% bleach (1 part bleach + 9 parts distilled water) for 10 minutes and rinsed 3 times with distilled water.
- Effect of provenance on seed emergence: the seeds are sown at a depth of 1cm, in cells (dimensions: 4cm/4cm) containing black peat. They are then covered with vermiculite to maintain the humidity of the substrate. Before placing them in a germinator set at 28 °C humidity 90%, the cells are labeled, mentioning the date of sowing and the origin of the seeds. For each provenance 120 seeds are used (20 seeds * 6 repetitions). The young plants that have emerged are transferred to the greenhouse (T = 27 °C). Watering is done daily using an automatic sprayer. This operation is repeated as needed.
- Effect of provenance on seed germination: in order to study the effect of several provenances of seeds and on the germination process of *P. atlantica*, 120 seeds for each station (20 seeds * 6 repetitions). The seeds were sown in sterile Petri dishes on double layer filter paper, the dishes were incubated at 25 °C in an oven (Memmert), and they were sprayed with sterile water as needed. The sprouted seeds

Wilaya	Station	Geographical coordinates	Altitude (m)	Bioclimatic floor
Tlemcen	Ouled Mimoun	34°55'01.0" 00°5 '04.1"	762	Semi-arid
Sidi Bel Abbes	Mcid	35°08'17.1" 00°14'45.3"	440	Semi-arid
Saida	Ain Soultane	34°55'57.2" 00°22'45.9"	969	Semi-arid
Bayadh	Sidi Taifour	33° 28' 3" 1° 54' 21.2"	1215	Arid
Laghouat	Mekhareg	33°21'52" 3°17'9.3"	802	Saharan
Tiaret	Rechaiga	35°20'9.4" 02°02'55.1"	831	Arid
Mascara	Oued EL Abtal	35°23'55.9" 00°40'41.0"	304	Arid
Naama	Ain Sefra	32°04'49" 00°35'17"	1109	Semi-arid
Bechar	Beni Ounnif	31°56'40.2" 1°32'28.8"	884	Saharan
Médea	Ouled Anteur	35°54'57" 2°39'32"	1257	Sub-humid
Djelfa	Ain Ouessera	35°20'51,6" 2°57'7.4"	744	Semi-arid
Msila	Ain Lahdjel	35°34'34.2" 03°53'10.6"	605	Arid
Relizane	Zemmora	35°46′52″ 1°07′52″	225	Semi-arid
Ghardaia	Berriane	32°50'7.1" 3°58'7.6"	487	Saharan
Khenchela	Chelia	35°28'46" 6°53'07"	1026	Semi-arid
Tébessa	El Anba	35°24'20" 8°01'11"	1014	Semi-arid
Batna	Irris	35°16'04" 6°17'48"	1214	Semi-arid
Biskra	Ras el Miad	34°17'27" 04°19'49"	490	Saharan
El Oued	Oum Tiour	34°0530" 05°19 59"	218	Saharan
Bejaia	Kherrata	36°29′34″ 5°16′39″	900	Semi-arid
Bouira	Ain Bessam	36°17'48" 3°40'12"	675	Semi-arid
Tissemsilet	Bordj Bounaama	35°51'6" 1°37'5"	1022	Semi-arid
Guelma	Houari Boumediene	36°24'58" 7°17'10"	400	Semi-arid
Bordj-Bou-Arreridj	Hasnaoua	36°9'9" 4°47'43"	1022	Semi-arid
Adrar	Timimoune	27°53′59" 0°16′59	280	Saharan

Table 1. Location and description of geographic coordinates and provenances.

were counted daily, the seeds with the radicle were noted as sprouted.

- Germination and statistical analysis: the monitoring of the germination of the seeds of the different batches was carried out with great care. We took into consideration the percentage of seeds that germinated (Côme, 1970), the latency time T1, and the T50, time necessary for the germination of 50% of the seeds. The T50 gives information on the speed of germination. All the data obtained were subjected to statistical analysis using Statistica version 12.0 software. The difference between the germination of the 25 provenances has was assessed by one-way analysis of variance (ANOVA). In this context we are interested in the cumulative germination of seedlings for each day. The results obtained are compared with the threshold value given in Tables as a function of the number of degrees of freedom.

If p> 0.05: threshold non-significant difference between the means.

If p≤0.05: threshold significant difference between the means.

P: added value.

RESULTS

Results of the effect of provenances on the germination

The statistical analysis (ANOVA) of seed germination of *P. atlantica* from 25 provenances was very significant from the 3th day (Table 2). The provenances of Saida, El Bayadh, Nama and Mechanical Tissemsilet were found to be the provenances with the highest germination rate (≥ 90%).

The provenances of Relizane, Tlemcen, Guelema, Oued, Biskra, Ghardaia, Mascara, Bouira, Djelfa, Sidi Bel Abbes and Mesila have a very low germination rate (0–20%). The rest of the provenances have a medium effect on germination (50%).

Table 3 and Figure 1 give the results of the test for *P. atlantica* (Germination kinetics according to the origin of the seeds).

Results of the effect of provenances on emergence

The statistical analysis (ANOVA) of seed emergence of *P. atlantica* from 25 provenances was very significant from the 5th day (Table 4). The provenances of Laghouat, Saida, Tiaret, Bechar, Nama and Batna proved to be the provenances with the highest emergence rate (≥ 90%).

The provenances of Adrar, Biskra, Oued, Ghardaia, Mascara, Bouira, Relizane, Sidi Bel Abbes and Djelfa show a very low emergence rate (0-20%). The rest of the provenances have a medium effect on emergence (50%).

Table 5 and figure 2 show the results of the test for *Pistacia atlantica* (Kinetics of emergence according to the origin of the seeds).

DDL	SC	MC	F	'P' value and meaning
5	5002455	833742	245.185	0.0000***

Table 2. Results of the provenances effect on germination of *Pistacia atlantica*. SC: Sum of squares, DDL: degree of freedom, MC: Mean of squares, Fobs: F. observed, P: surplus value, * = significance.

DDL	SC	MC	F	'P' value and meaning
5	5001355	833372	235.205	0.0000***

Table 4. Results of the provenances effect on emergence of *P. atlantica*.

Provenance	Final germination rate	T1	T50
Saida, El Bayadh, Nama et Tissemsilet	≥ 90 %	4th days	16th day
Relizane, Tlemcen, Guelema, Oued, Biskra, Ghardaia, Mascara, Boumerdes, Djelfa, Sidi Bel Abbes, Mesila	≤ 20 %	9th day	2nd day
Other	≈ 50 %	4-6th day	6-8th day

Table 3. Germination rate of seeds of *Pistacia atlantica* according to provenance.
T1: time spent until the first germination (in days); T50: time necessary to obtain 50% of the germination capacity (in days).

Provenance	Final germination rate	T1	T50
Laghouat, Saida, Tiaret, Bechar, Nama et Batna	≥ 90 %	5th day	11th day
Adrar, Biskra, Oued, Ghardaia, Mascara, Bouira, Relizane, Sidi Bel Abbes et Djelfa	≤ 20 %	11th day	0-2nd day
Other	≈ 50 %	5-8th day	11th day

Table 5. Emergence rate of seeds of *Pistacia atlantica* according to provenance.

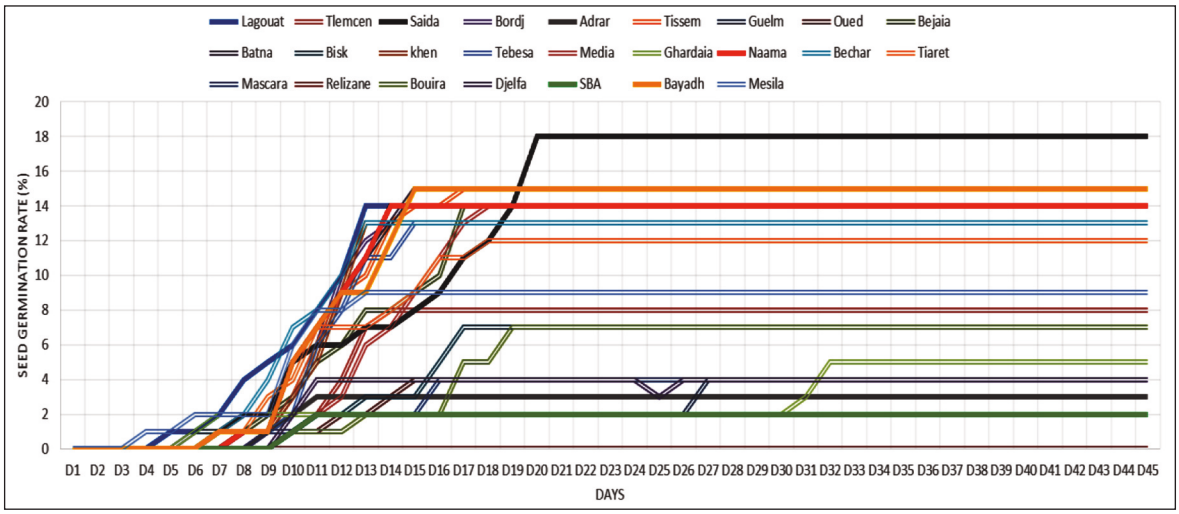

Figure 1. Germination kinetics as a function of time of seeds of *Pistacia atlantica* under the effect of different provenances (D: day).

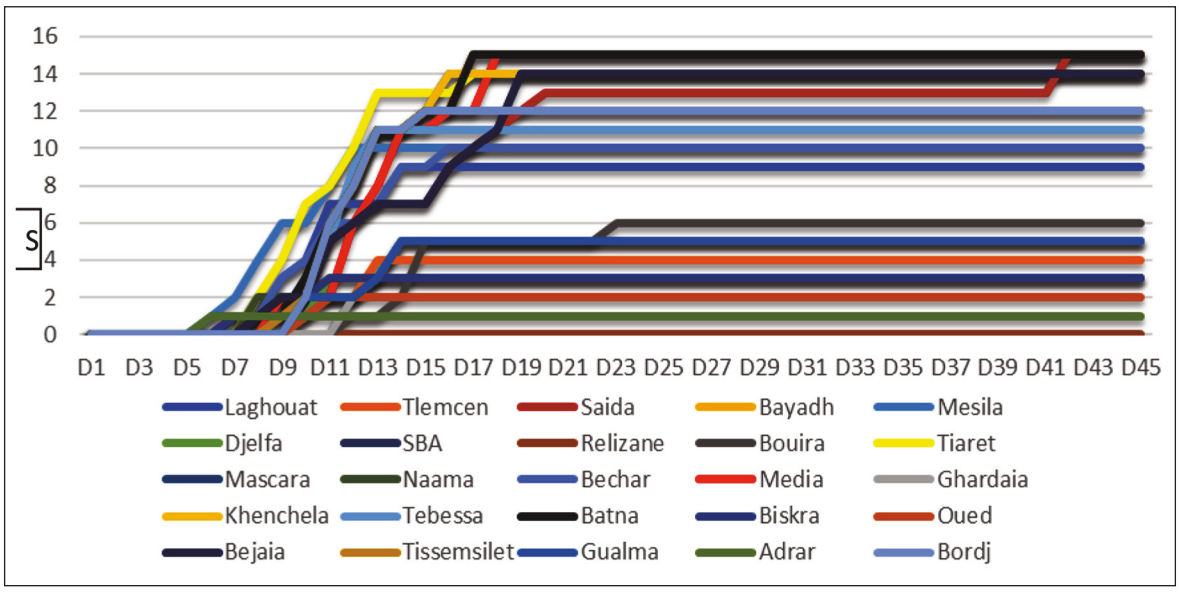

Figure 2. Emergence kinetics as a function of time of seeds of *Pistacia atlantica* under the effect of different provenances (D: day; S: seeds).

DISCUSSION

In general, germination is easy for most species of the genus *Pistacia*, although it is closely related to the origin of the seeds (Aleta et al., 1997).

The objective of provenance trials is to obtain well adapted and productive forests, this productivity does not always imply rapid growth; survival, resistance to unfavorable environmental factors or pests, wood quality, seed production (through the creation of local stands) could be important criteria (Burley, 1969). Studies of seed sources provide evidence of the suitability of provenances to gradually eliminate the less suitable and select those for later use (Van de Sype, 1994).

The majority of species and environments are too variable to be able to carry out an analysis in a single test, in fact it is necessary to carry out, first of all, orientation tests, where seeds from many provenances are tested, then more detailed experiments are made with seeds from the best seed companies taken from the most interesting sources (Callaham, 1964).

Five or six successive trials would give fairly good indications, but for a given area, determining the best provenance takes quite a long time. In addition, studies of seed sources in semi-arid regions face particular problems (low precipitation and or very large variation in average precipitation), so slight climatic changes can be critical in these regions (Callaham, 1964). It came have two effects: a direct effect on the expression or plasticity of the phenotype and an indirect effect, by directing the evolution of populations (Callaham, 1964).

A diverse environment within the natural range of a species corresponds to a genetically variable species, the widely distributed species are the most variable (Callaham, 1964). Indeed, certain characteristics of the climate and of the soil can play a role in the genetic differentiation of forest trees, by adapting to climatic conditions - the adjustment of the vegetative rhythm of the different populations to the local climate causes differences between provenances in this regard. Concerning the average date of bud break and vegetation stop - and those of the soil - the most important factors could be the physical and hydromorphic structure more than the chemical composition (Bouravel, 1974). Sampling of the natural area must take into account the variation of environmental factors which we know a priori, that they are determining for genetic differentiation (Pesson, 1974). In fact these studies will only be meaningful if they relate to characters with strong heritability, because the differences will be attributable both to genetic variability and to the influence of ecological factors at the place of origin of each provenance (Bouravel, 1974).

Comparable specimens, from many origins, should be studied for their similarities and differences in shape and structure. In fact, research should be done on variability in leaves, fruits, wood, bark and other tissues, since organ morphology, internal anatomy, chemistry of essential oils can vary in the extent of the species' range. It should also be noted that the behavior of a species disturbed by humans for a long time (such as the Atlas pistachio) is impossible to predict (Callaham, 1964).

It is also necessary to take into account the stands chosen as provenances, which must represent a good sampling of the natural range of the species (no major provenance trial grouping together origins of the natural range of the Atlas pistachio tree has been possible to achieve), trees from which seeds have been collected are in sufficient number and well distributed in the chosen stand (so as to faithfully represent the average characteristics of the population), objectives and available resources (Burley, 1969; Bouravel, 1974).

CONCLUSIONS

The arid zones in Algeria occupy more than 36 million hectares, they receive annually only a rainfall range oscillating between 150 and 350 mm. These areas are characterized by a long summer drought (6 months) and by very restrictive edaphoclimatic conditions hampering the development of perennial vegetation.

Among the three species of *Pistacia*, some have an ecological interest and are not valued at their fair value in the arid and Saharan marginal areas; *Pistacia atlantica* forms natural populations in degraded areas threatened by desertification under the effect of climatic and human pressure. The fruit of this species is still a harvest product providing an agro-food and fodder supplement, both to populations and to animals. The presence of stands of *P. atlantica* is remarkable in this region since this species manages to subsist and produce green biomass and fruits. The choice of the *P. atlantica* population among the other

formations is justified by the little scientific work carried out in Algeria on this species.

It constitutes a determining element in a process of rehabilitation of degraded steppe areas threatened by silting up. A study of the ecological, botanical, morphological and dendrometric characteristics of this species provides a better understanding of its use in arid zones. The failure of attempts to rehabilitate perennial vegetation in these arid regions points to the rehabilitation of this neglected species despite its ecological potential. Because of its hardiness, it is a very interesting species for regions with arid and sub-arid climates. Further research should be undertaken to complement our work. They could approach the analysis of production and regeneration factors and also even better specify the adaptation of this species to the edapho-climatic conditions of the environment.

REFERENCES

Abousalima A & Kalli E.M., 1992. D'élimination des zones à vocation Pistachier au Maroc. Département d'Horticulture/ Institut Agronomique et Vétérinaire Hassan II. Rabat, Maroc.

Aouadj S.A., Hasnaoui O., Nasrallah Y. & Khatir H., 2019. Traitements pré-germinatifs des graines du *Juniperus oxycedrus* L et *Pistacia lentiscus* L. Séminaire international 'Valorisation des bio-ressources: applications et impact sur le développement durable'. Université de Boumerdes, Algérie (26.11.2019).

Aouadj S.A., Hasnaoui O. & Nasrallah, Y.,2020. 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: 266–278.

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

Aouadj S.A., Hasnaoui O., Nasrallah Y. & Khatir H., 2020. 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: 68–78.

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

Aouadj S.A., Hasnaoui O., Nasrallah Y. & Khatir H., 2020. 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: 78.

Aouadj S.A., Hasnaoui O., Nasrallah Y. & Khatir H., 2020. Rare, endemic and threatned flora of the mounts of saida (western Algeria). Agrobiologia, 11: 45–57.

Aouadj S.A., Hasnaoui O. & Nasrallah Y., 2020. Ethnobotanical Approach and Floristic Inventory of Medicinal Plants in the Doui Thabet Region (Saida-Western Algeria). PhytoChem & BioSub Journal, 14: 92–104.

Aouadj S.A., Djebbouri., Nasrallah Y., Hasnaoui O., Seddiki AEK., Torchi D. & Khatir H., 2021. *Asparagus altissimus* Munby (Endemic North-West Algeria and South Morocco): new Species for the Flora of Saida (West Algeria). Journal of Ecology & Natural Resources, 5: 000241.

Aouadj S.A., 2021. Impact des techniques de restauration écologique sur la dynamique des écosystèmes dégradés des monts de Saida: Cas des forêts de Doui Thabet (Ouest Algérie). Thesis of Doctorat, University of Tlemcen, Algeria, 167 pp.

Benabdeli K., 1996. Aspects physionomico-structuraux et dynamique des écosystèmes forestiers face à la pression anthropozoogène dans les monts de Tlemcen et les Monts de Dhaya. Algérie occidentale. Thèse de doctorat ès Sciences. UDL, 356 pp.

Benabid A. & Fennane M., 1994. Connaissances sur la végétation du Maroc phytogéographie, phytosociologie et séries de végétation. Lazaroa, 14: 21–97.

Benhssaini H. & Belkhoja M., 2004. Le pistachier de l'Atlas en Algérie entre la survie et disparition. La feuille et l'aiguille, 54: 1–2.

Bouravel P., 1974. L'adaptation écologique des arbres forestiers. Application à la sélection. Pp. 153-173. In: Pesson P., Ecologie forestière - La forêt: son climat, son sol, ses arbres, sa faune. Ed. Gautier-Villars, Paris, 382 pp.

Burley, J. 1969. Méthodologie sur les essais de provenances dans les tropiques. Revue Internationale des Forêts et des produits forestiers. Unasylva n°94, FAO, Rome, s.p.

Calaham R.Z., 1964. La recherche sur les provenances. Unasylva. Revue Internationale des forêts et des produits forestiers, 18 : 40–49.

Fennnane M., Ibntatou M., Ouyahya A. & Eloualid J., 2007. Flore pratique du Maroc: manuel de détermination des plantes vasculaires. Travaux de l'Institut scientifique. Série Botanique (Rabat. 1984), 36, 635 pp.

GENMEDOC, 2006. Pratiques de germination dans les banques de semences du réseau GENMEDOC. Union Européen, 175 pp.

Letreuch-Belarouci N., 1981. Les reboisements en Algérie et leur perspective d'avenir. Vol. I/V. Thèse de Doctorat, Faculté Université des Sciences Agronomique de Gembloux, Belgique, 608 pp.

Letreuch-Belarouci N., 1991. Les reboisements en Algérie et leur perspective d'avenir. Vol. I. Alger, Office des Publications Universitaires (O.P.U.), 294 pp.

Monjauze A., 1980. Connaissance du bétoum *Pistacia atlantica* Desf. Biologie et foret. Revue Forestière Francaise, 4: 357–363.

Nasrallah Y., 2014. Caractérisation de la variabilité morphologique des 21 provenaces algériennes de Chenet vert (*Quercus totendifolia* Lam.), évaluation de leur adaptation écologique dans la région semi-aride de Saida. These Doctorat en sciences agronomique. Ecole Nationale supérieur d'agronomie El Harache, 213 pp.

Nasrallah Y., 2019. *Pistacia vera*. Séminaire national Valorisation et réhabilitation des zones arides et semi-arides en Algérie. Communication orale. Université de Saida.

Nasrallah Y. & Khelifi L., 2010. Diagnostic précoce de la reprise des jeunes plants de onze provenances algériennes de chêne vert (*Quercus rotundifolia* Lam.): conséquences pour le reboisement. Revue d'Écologie (La Terre et la Vie), 65: 359–368. https://infodoc.agroparistech.fr/index.php?lvl=notice_display&id=138139

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

Pesson P., 1974. Ecologie forestière. La forêt: son climat, son sol, ses arbres, sa faune. Ed. Gauthier-Villars, Paris, 328 pp.

Tutin T.G, Heywood V.H. & Burgess N.A., 1968. Flora Europaea. Cambridge University Press: Cambridge, UK, vol. 2, 237 pp.

Van De Sype H., 1994. Choix de provenances: exemple de l'épicéa commun. Forêt- entrprise, 96 : 21–22.

Véla E. & Benhouhou S., 2007. Évaluation d'un nouveau point chaud de biodiversité végétale dans le Bassin méditerranéen (Afrique du Nord) Assessment of a new hotspot for plant biodiversity in the Mediterranean basin (North Africa). Comptes Rendus Biologies, 330: 589–605. https://doi.org/10.1016/j.crvi.2007.04.006

Yaaqobi A., El Hafid L. & Haloui B., 2009. Etude biologique de *Pistacia atlantica* Desf de la région orientale du Maroc. Biomatec Echo, 3: 39–49.