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RESEARCH ARTICLE

TRUFFLES FROM THE NORTHEAST REGION OF THE KINGDOM OF MOROCCO: GEOGRAPHICAL DISTRIBUTION AND PRODUCTION POTENTIAL

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ABSTRACT

Moroccan truffles, relatively well known ecologically, their potential and spatial distribution at regional and national scales remain unknown. The aim of this study is to determine and define the geographical area of truffles in the north-eastern zone of the Kingdom in order to produce their distribution map and assess their productivity. The study area includes the Oriental High Plateaus and pastoral plains, High Moulouya and part of Tafilalet. The methodology was based on a documentary analysis, field surveys, interviews and workshops with the various stakeholders. The maps were produced by a GIS and verified in the field. The region is characterized by 5 species of truffles: Tirmania nivea, T. pinoyi, Terfezia boudieri, T. claveryi and Picoa juniperi. They are associated with host plants of the genus Helianthemum on sandy soils. Their distribution concerns almost the entire region. The production of truffles is linked to several factors, including the development of host plants, the amount of rainfall and the type of soil. The highly productive sites are located in the north-eastern part with flat relief. This knowledge of truffles and their distribution is decisive for the use of this product in the sustainable development of the country.

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INTRODUCTION

The expression of desert truffle or terfes is used to designate the wild hypogeal fungi, belonging to the Ascomycetes, which develop in areas with a typically arid and semi-arid climate of the Mediterranean region, some of which are endemic. it mainly designates species of the genera Terfezia, Tirmania and tuber. (Alsheikh, 1994; Morte & al, 2008; Rodriguez,2008; Trappe & al, 2008). The natural production of desert truffles depends on an established symbiotic association with the roots of suitable host plants usually members of the annual and perennial Cistaceae, and mainly with the *Helianthemum* species.(Dexheimer & al 1985, Fortas & Chevalier, 1992; Bouziani & al, 2010; Laessoe & Hansen, 2007 Bradai &al, 2013). The north-eastern region of the kingdom is counted among the four truffle areas of the country which are: the Oriental, the forest of Maâmora, the Sahel of Abda-Doukkala and the Moroccan Sahara (Abourouh, 2011; Khabar, 2017). Moroccan truffles have benefited from several taxonomic, floristic, ultra-structural and cytological studies. (Malençon, 1973; Khabar, 1988; Abourouh, 2000; Khabar, 2002). In this regard, truffles, fairly well known on ecological aspects, are very poorly known from the point of production potential and geographical distribution at regional and national scales. This knowledge can help decision-making for the development of the truffle sector in Morocco and consequently fight against

poverty locally and alleviate human pressure on natural forest and pastoral resources.

It is within this framework that this study aims to:

- Know and specify the geographical area of truffles in the North-East zone of the Kingdom in order to produce their distribution map; and
- Evaluate their productivity.

MATERIALS AND METHODS

Study area: The study area is located in the North-East of Morocco and includes the High Plateaus and the pastoral plains of the Oriental, High Moulouya and part of Tafilalet. (Fig.1).

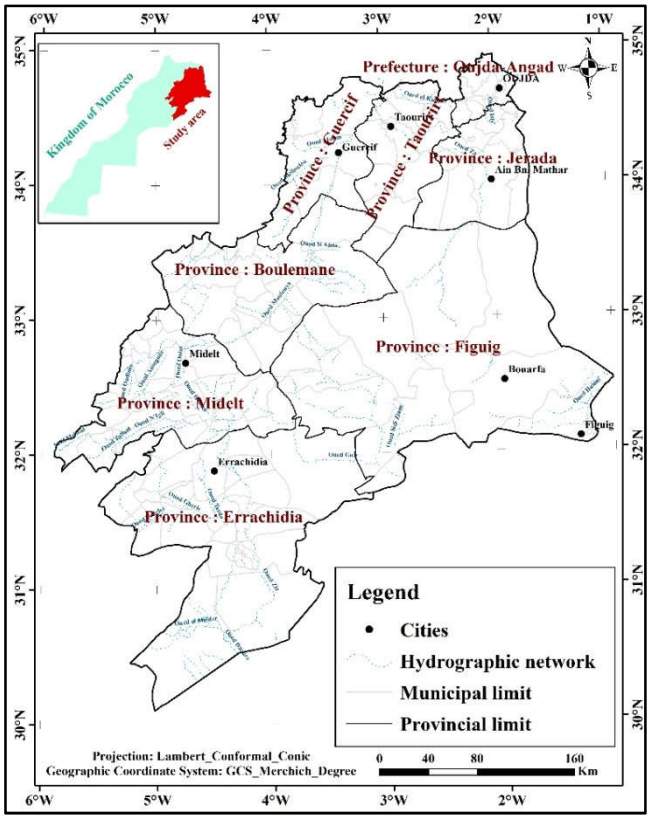

Fig.1. Situation of the study area

From north to south and from west to east, the area is characterized by a climatic gradient. In fact, in the north-west, the bioclimate is of the semi-arid type with rainfall of 400 to 600 mm / year, arid in the vast central zone of the Oriental with rainfall of 100 to 400 mm / year, and Saharan in the south towards Errachidia with rainfall of less than 100 mm / year. The aridity increases substantially in the South and East, with the significant difference being the lack of precipitations. (Watfeh& Sfa, 2007; DRAO, 2019). The area is characterized by a predominance of raw mineral soils and poorly evolved soils of erosion, especially those developed on limestone. From the north while going towards High Moulouya, calcimagnesic soils are dominant with a reduced presence of poorly evolved soils of silt, isohumic soils and vertisols developed on limestone and clay. While the pre-Saharan part is characterized by poorly evolved soils and sandy loam, raw mineral soils and poorly evolved soil of erosion. The organic matter of the soil is extremely poor, the content does not exceed 1.5%. (Watfeh & al, 2007; DRAO, 2019). The vegetation is characterized by a dominance of alfatial steppes. They are mainly concentrated in the center of the zone in the province of Figuig and Boulemane, with a reduced presence in the provinces of Jerada, Taourirt and Midelt. The natural forest, consisting mainly of holm oak, cedar and juniper is concentrated mainly in the north and west at high altitude. Other species are present in small areas, such as cedar in western Midelt province and Acacia in the northwestern part of Errachidia province. (SEIFN, 2014).

Adopted methodology: To achieve the objectives of this study, a preliminary phase devoted to a documentary analysis as exhaustive as possible was necessary. It focused on two complementary components, first on the knowledge of the North-East zone in its ecological aspects, and, then, specifically on the truffles of the region. The documents used are of various kinds: development project reports, university documents (theses, masters) and scientific papers. In a second phase, a questionnaire was sent to 35 managers and agents of the provincial and local forestry services in the region. The questionnaire focused, among other things, on the species of existing truffles, their ecology (host plants, climate, soil, relief) and the georeferencing of production sites. In a third phase, and on the basis of the results of the documentary analysis and the examination of the questionnaires, a field prospection was carried out in the geographical regions known by their truffle productions, namely the High Plateaus and the pastoral plains of the Oriental, the Pre-Saharan region of Tafilalet and High Moulouya.

The areas visited are: Debdou, El Ayoun, Jerada, Ain Beni Mathar, Mrija, Tandrara, Bouaârfa, Maatarka, Anoual, Talsint, Bni Tadjite, Bouanane, Boudnib, Erfoud, Errachidia, Midelt and Boumia. During this field phase, we were able to work on the knowledge and evaluation of the resource: spatial distribution of truffle species in these regions, production and its relations with environmental factors (precipitation, soils), the effects of change climate and the sustainability of the resource. Surveys, interviews with resource persons and participatory workshops were organized by region with the various actors in the sector (collectors, traders, development agents (agronomists, foresters)) and local authorities. The mapping of productive areas and their productivity over the years was made on the basis of documentary analysis, questionnaires, interviews and surveys with collectors in the field and resource persons and workshops with managers. The tools used are: topographic maps at different scales, National Forest Inventory maps (SEIF, 2014), and Googlearth. The preliminary maps were checked during the workshops and in the field. For the semiology of the maps, we proceeded by zoning for the dominant truffle species throughout the area and by signs to indicate the species rarely present.

RESULTS

Truffle's potential in the North-East region of the Kingdom of Morocco

Species and distribution

Species: During field surveys in April 2021, it was found that the production of truffles is almost zero this year.

Precipitation was lacking. Only passionate people about truffle hunting come out from time to time to come back with only a few pieces. "Where's the truffle?" Where is its water? Where is its plant? " A shepherd said. five truffle fruiting body found in a place named *Rich Aouragh* in sandy soil were provided to us by the collectors, who use a wooden stick or a tool such as knives, screwdrivers or iron rods to bring out the truffle, the location of which is indicated by the cracked earth and the associated plant. Thus, we find the white truffle belonging to the genus *Tirmania* represented by two species, *T. pinoyi* and *T. nivea* with *Helianthemum hirtum*. The red truffle belonging to the genus *Terfezia* represented by the species T. claveryi with *Helianthemum lipii* (fig.2).

***Tirmania nivea* (Desf.) Trappe, 1971:** Locally called *Zoubeidi*. Ascomata (fig.2A) is up to 4 cm of diameter. The form is subglobose crevassed in places, white of color with brown spots. Peridium (Fig. 2B) up to 2 mm in thickness. Gleba is yellowish white formed of spherical pockets, separated by veins of a lighter color.

***Tirmania pinoyi* (Maire) Malençon, 1973:** Locally called *Chaâiria* (color of barley). Ascomata (Fig. 2C and Fig 3) is up to 4-10 of diameter. The form is subglobose, turbinate or irregular with cracks and furrows. Yellow of color or reddish brown. Peridium (Fig. 2D) up to 0,5-1 mm in thickness. Gleba white with lighter colored veins.

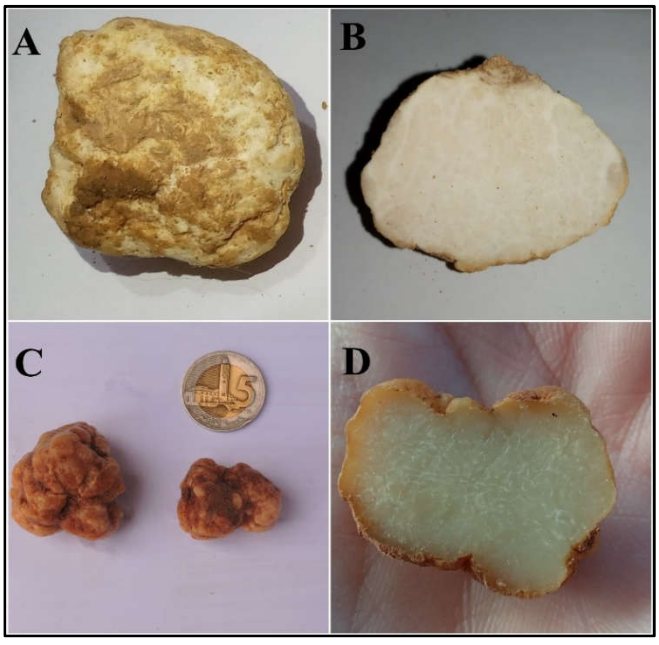

Fig.2. A *Tirmania nivea* B; a cross section of T. nivea; *T. pinoyi* D; a cross section of *Pinoyi*

***Terfezia claveryi* Chatin, 1892:** Locally called *Terfesse lahmer* (the red *Terfesse*). Ascomata (Fig.4A) is up to 12 cm of diameter presenting an irregular shape, often flattened with blackening reddish-brown color. Peridium (Fig.4B) is up to 1-2mm. Gléba yellowish to whitish, and reddish by places divided by paler veins.

Distribution: The distribution of truffles concerns almost the entire North-East region. They are distributed over vast expanses from Oujda as the northern limit to Figuig as the south-eastern limit, from the Algerian-Moroccan border in the east to the province of Errachidia in the south and from Guercif in the north-west to the south.

Fig.3. *Tirmania sp*

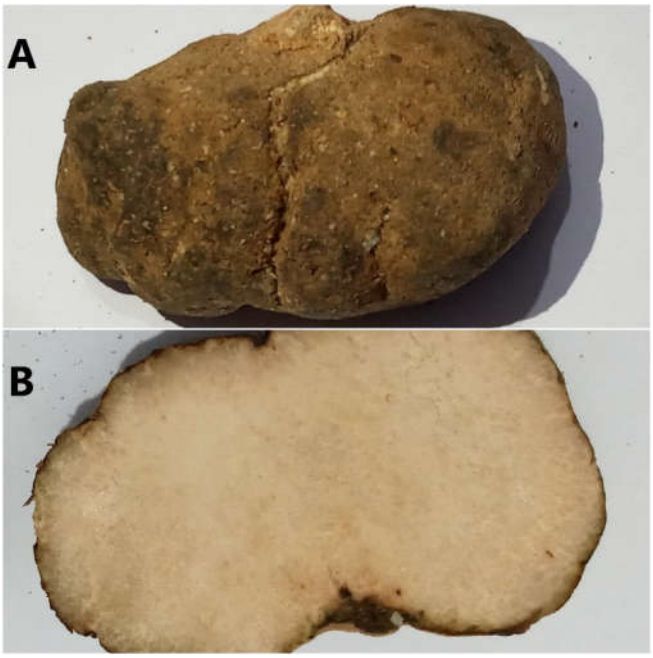

Fig.4. A. *Terfezia claveryi* B; a cross section of *T. claveryi*

High Moulouya to the west (fig.5). Red and white truffle are the two most common and most traded species. As for the black truffle, *T. boudieri*, it is rare and seems to have no market in the area. it is met in Tandrara, Bouaarfa, Ain Beni Mathar and Figuig. The same places know the production of *Picoa juniperi*, locally called *Jobber*. It always occurs first, and for the population it is an indicator of the production of truffles. In Boumia, it is called *asmegh n'terfes* (*Aâbid Terfas* - slave of truffles according to its black color). People say: "*where there are slaves, there is the king*". It is often collected near *T. claveryi* and it is not consumed due to its strong and unpleasant odor. Truffles do not grow in plowed land. The region also knows the cultivation of the black truffle, *Tuber melanosporum* by Doctor Abdelaziz Laqbaqbi on his farm in Debdou. A thousand mycorhizal holm oak plants were imported from France in 2000 and planted at a rate of 238 trees / ha with spacing of 6 m x 7 m. The basins, 2 m in diameter, are irrigated every two weeks. Each autumn, the expired truffles from last year are scattered there and the basins are fertilized with mineral fertilizer (NPK) and then weeded. Oaks are treated as tadpoles at a height of 2 m.

The harvest is done from December to February. Each basin (tree) gives 0 to 3 black truffles per year.

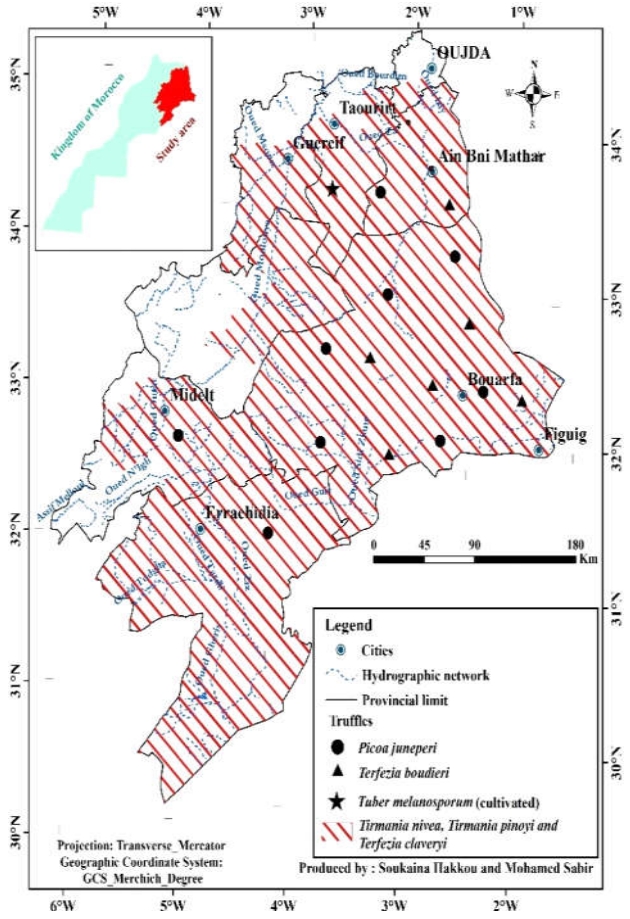

Fig. 5. Distribution map of truffles in the North-East region

Ecological conditions: The production of truffles is linked to several factors, including the host plant with which they are associated, the climate and the type of soil.

Host plants: Truffles live in a symbiotic association with plants belonging to the *Cistaceae* family, generally *Helianthemum*. This year, host plants for truffles in the study area were scarce. We found *Helianthemum lipii* locally called *Reguig* (Fig.6A), *Helianthemum ledifolium* (Fig.6B) locally called *Tegcis* or *Tzaoua*, *Helianthemum apenninum* (Fig.6C) locally called *Serd Amalou* or *Izefzaf* and *Helianthemum hirtum* (Fi.6D) locally called *Idoudi*.

Climatic conditions

Pluviometry: The appearance of truffles and the importance of their production are determined by the quantity and especially the repair of precipitation over time, the succession of two rainy periods known locally as "*Manzla*". Rainfall in late summer and early autumn (August to November) constituting the "*Manzla Ech-Choula*" is necessary for the germination of the seeds of *Helianthemum*. The winter precipitations (December to January) constituting the second "*Manzla En-naâim*" are necessary for the constitution of the water reserve of the grounds, the development of *Helianthemum*, the loosening of the grounds and the growth and appearance of truffles on the surface. If the soils remain dry, then they are compact and the truffles fail to develop and appear on the surface of the soil. Most truffle collectors have confirmed that if it rains in August and September, it is a sign that the year will be of good productivity.

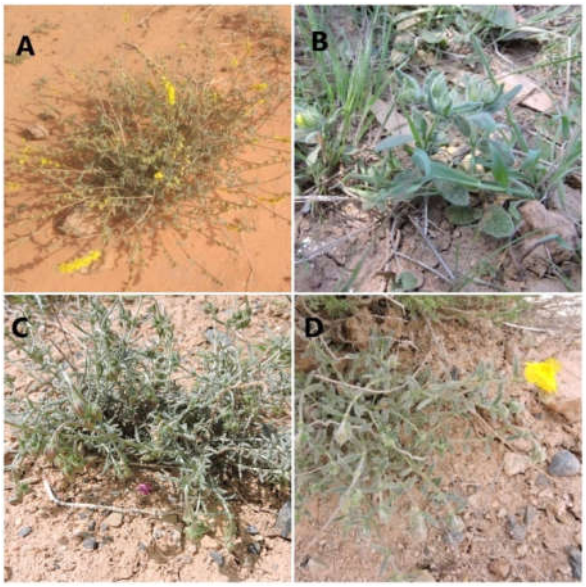

Figure 6. Host plants of truffles in the North-East region of Morocco A; *Helianthemum lipii* B; *Helianthemum ledifolium* C; *Helianthemum apenninum* D; *Helianthemum hirtum*

The amounts of rain needed for good production vary from area to area and from species to species. The averages recorded during years considered to be of good production can help to determine the favorable quantities. The estimated years of good production by the collectors surveyed are 1993 (≈ 425.4mm), 1994 (≈ 341.8mm), 1995 (≈ 347.2mm), 1997 (≈ 399.6), 2002 (≈ 369.6mm), 2007 (≈ 492.4) and 2008 (≈ 702mm). The last year of good production was 2018 (≈ 430mm). we can say that an average of 300 mm precipitation in the whole region is favorable for a good production of truffles.

Temperature: The temperature influences the start of truffle's production and its duration. For areas considered hot like Bouaânane, Figuig and Bouaarfa, where the average maximum temperatures of the hottest month (August) are 40 ° C, production begins in mid-December and ends in February. While for the Dahra, which is a cold zone at altitude in the High Plateaus and where the average maximum temperature of the hottest month (August) is 32 ° C, production does not start until February and ends around mid- May.

Soil: Field observations show that desert truffles thrive in vast plains or in hillsides on the edge of desert regions where the soils are shallow (<20 cm), light, silty-sandy texture, threshing and of neutral pH. It has been observed that truffle collectors are very knowledgeable and know well this relationship between the development of truffles and their ecology (precipitation, nature of the soils).

Truffle's productivity in the North-East zone

Relationship between pluviometry and productivity: It is true that truffles are adapted to semi-arid, arid and Saharan climates; hence their name "desert truffle". But productivity depends on the amount of rain and its distribution over time. Thus, for the local population, it is enough for them to follow the weather and the amount of rains that have fallen to know if the year will be good or bad. It may be that all other factors are favorable, but if the rain, the key factor, does not fall on time or with the necessary amount, the truffle will not occur or very

little. According to respondents, a total of 26 days of rain, half of which in late summer-early autumn and half in late winter-early spring, is sufficient for the year to experience good production. If the rain is slow to fall until February or March causing the late germination of the host plants, the truffle will not grow. Thus, it is the rain and its distribution that largely influence the productivity of truffles per site. The succession of drought years has dramatically reduced truffle production and 2018 is considered the last year of good production in the Oriental region. Productivity in the region differs from area to area. Highly productive sites are mainly located in the north-eastern part. It concerns Jerada, Tandrara, Bouaarfa, Figuig and Maatarka. While the center of the region and the far south are moderately productive areas. Productivity gets lower and lower as you move west. The truffle is found mostly in flat areas. In cold areas at high altitudes, truffles do not occur. (Figure 7).

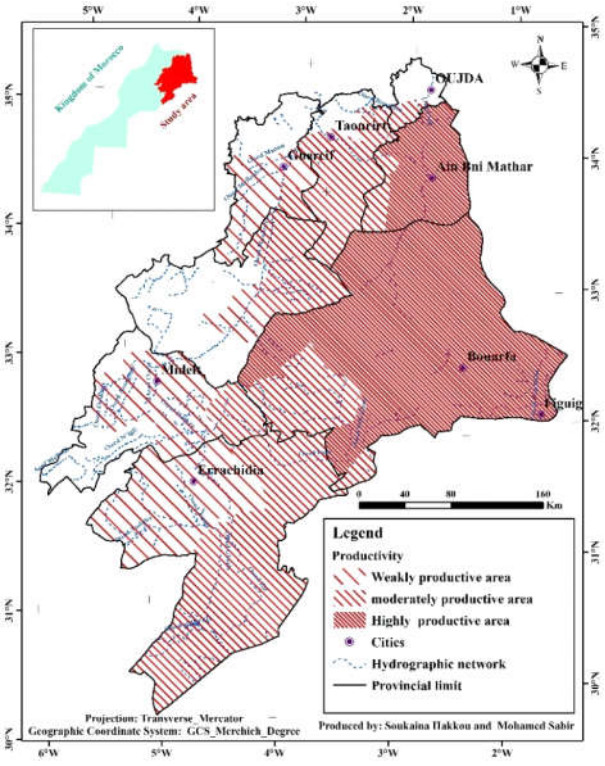

Figure 7. Truffle's productivity map in the north-eastern zone of Morocco

DISCUSSION

Plutarque (50 - 125 AD) affirmed that the truffle is generated by lightning itself, hence its surname the "daughter of thunder", especially since its appearance was conditioned by the succession of stormy rains. Some collectors have the same conviction, they confirm that the rain comes loaded with seeds which subsequently develop under the earth giving truffles. The results of this study, concerning the species of truffles present in the north-eastern region of Morocco are the same indicated by (Malençon, 1973; Serrhini *et al*., 1995; El Aji, 1999; Bouziani, 2009; Khabar, 2017), we are talking about: *Tirmania pinoyi*, *T. nivea*, *Terfezia claveryi*, *T. boudieri* and *Picoa juniperi*. Two other species, less known in the region, were encountered in 2013. These are *Terfezia Olbiensis* in the Beni Yaala Forest in Jerada under *Pinus halepensis* and *Terfezia leptoderma* collected in Ain Beni Mathar associated with *Helianthemum* sp. (El Akil *et al*., 2016). Generally, *T. nivea* has a large caliber, it even comes out of the ground which facilitates its collect. But, the harvested one has a small caliber which can be explained by the fact that it was collected before maturity or that it was surrounded by stones which limited its growth.

The symbiotic relationship between truffles and their host plants has been well studied since the beginning of research on truffles, collectors have been able to discover this relationship of mycorrhization by observation and by linking the places of production with the places where the plants are distributed. probably they don't know what's really going on underground, but they know that without the *helianthemum* there will be no truffle. *T. pinoyi and T. nivea* are associated with *H. hirtum*, *T. claveryi* is associated with *H. lipii, T. boudieri* is associated with *H. lipii var. sessiliflorum* and *H. ledifolium and Picoa juniperi* is associated with *Helianthemum lipii* (Malençon, 1973; Serrhini *et al*., 1995; El Aji, 1999; Bouziani, 2009; Khabar, 2017).Helianthemum is the host plant of truffles also in adjoining countries even if the subspecies may be different, so in Algeria we find that *T. claveryi* is associated with *H. Guttatum* and *H. Hirtum*, *Tirmania pinoyi* is associated with *H. Guttatum* while *T. nivea* is associated with *H. lipii*. (Zitouni-Haouar, 2016). The distribution concerns the eastern highlands during the months of March to Mai for T. Claveryi, T. Pinoyi and T. Nivea and from mid-March to mid-April for Picoa juniperi. (Khabar, 2017). The appearance of truffles and the importance of their production are determined by the quantity and especially the repair of precipitation over time, for the most productive areas, the Average rainfall is 246 mm in Ain Beni Mathar, 209mm in Tandrara and 196 mm in Bouaarfa (Khabar, 2017). The year 1990/91 and 1993/94 are considered as good productions in Bouaarfa, the annual rainfall was 226.6 mm for the year 1990/91 and 214.9 for the year 1993/94 (Serrhini, 1995; El Aji, 1999). Khabar (1988) indicated that in the truffle-producing areas, the average daily temperature drops from September to January (26 to 8 ° C), then a gradual rise to reach mild values in March. and April (14-18 ° C) while continuing to rise until August (31 ° C). The edaphic conditions presented in this study have also been reported by other authors (Tahiri, 1997; El Aji, 1999). Terfezia claveryi is found in humus-rich hillsides, while Tirmania nivea and Terfezia boudieri occur in soils with high sandy fraction as well as low organic matter (El Aji, 1999).

CONCLUSION

Through this study, we were able to specify the species of truffles existing in the north-eastern region of Morocco while determining their geographical distribution. These are 5 species of Truffles: *Tirmania pinoyi*, *T. nivea, Terfezia claveryi. boudieri* and *Picoa juniperi*. Truffles are distributed over almost the entire Northeast region, from Oujda as the northern limit to Figuig as the south-eastern limit, from the Algerian-Moroccan border in the East to the province of Errachidia in the South, and from Guercif in the North. West to High Moulouya to the West. Field prospecting, surveys with collectors enabled us to note that the two red and white truffles are the most common and most traded species. The production of truffles is linked to several factors, including the host plant, the climate and the type of soil. The climatic conditions are the main factor. The amount of rain needed varies from area to area and from species to species. The optimum is to have two periods of precipitation, inputs in late summer - early fall and winter. As for the temperature, it influences the start of truffle

production and its duration. For areas considered hot, production is early and begins in mid-December and ends in February. While for cold areas at high altitude, production is late and does not start until February and ends in mid-May. Cartography of productivity shows that the highly productive sites are mainly located in the north-eastern part. It concerns Jerada, Tandrara, Bouaarfa, Figuig and Maatarka. While the center of the region and the far south are moderately productive areas. Productivity gets lower and lower as you move west. The truffle is found mostly in flat areas. In cold areas at high altitudes the truffle does not occur. The region produces significant quantities of truffles, the marketing of which to external and local markets contributes to the economy of the region. This resource deserves to be valued. However, it still faces several constraints including anarchic exploitation and climate change (drought) which influences production.

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Glossary of Abbreviations

GIS: Geographic information system.
NPK: Azote (N), Phosphor (P) and Potassium (K).

REFERENCES

Abourouh M. 2011. "Truffes du désert" du Maroc : diversité et modes d'exploitation. 6ème Rencontre de MICOSYLVA, Mértola (ADPM), Portugal, 15-18 Mars 2011. 23p.

Abourouh, M. 2000. Mycorhizes et mycorhization des principales essences forestières du Maroc. Thèse de Doctorat d'Etat, Université Mohammed V, Faculté des Sciences, Rabat, Maroc.

Alsheikh, A.M. 1994.Taxonomy and mycorrhizal ecology of the desert truffles in the Genus Terfezia. Ph.D. thesis, Oregon State University, Oregon, USA.

BOUZIANI *et al*, 2010. Le Terfess au Maroc Oriental : Isolement et culture in vitro. Rev. Microbiol. Ind. San et Environn. Vol 4, N°2, p : 110-120.

BRADAI L. *et al*, 2013. Étude mycologique et bio-ecologique de la truffe blanche du desert (Tirmania nivea Desf. Trappe 1971) dans la région de Oued M'ya (Ouargla, Sahara Algérien). Revue des BioRessources Vol.3 N.1: Juin 2013.

Dexheimer, J., Gerard, J., Leduc, J. P. and Chevalier, G., 1985.Comparative ultrastructural study of symbiotic mycorrhizal associations between Helianthemum salicifolium-Terfezia claveryi and Helianthemum salicifolium-Terfezia leptoderma. Canadian Journal of Botany, 63 : 582–591.

DRAO. 2019. Elaboration du schéma directeur d'aménagement des parcours et du développement de l'élevage dans la région de l'oriental. Etude de base. Marché N° 24/2019.180 p.

El Aji A. (1999). Contribution à l'étude des Terfez des parcours de l'oriental marocain : germination des ascospores in vitro et mycorhization de l'Helianthemum ledifolium. Mémoire de troisième cycle en agronomie, Ecole nationale d'agriculture, Meknès. 84 pages.

El Akil M., Outcoumit A., Ouazzani Touhami A., Benkirane R. et Douira A. (2016). - Study of eastern Morocco desert truffles. International Journal of Current Research. Vol. 8, Issue, 07, pp.33922-33929.

Fortas, Z. and Chevalier, G. 1992. Effet des conditions de culture sur la mycorhization de l´Helianthemum guttatum par trois espèces de terfez des genres Terfezia et Tirmania d´Algérie. Can. J. Bot., 70 : 2453-2460.

Khabar L. (1988). Le genre Terfezia Tull. (Terfass) de la forêt de la Maâmora (Région de Salé) : étude systématique, écologique, morphologique, cytologique et ultra structurale. Thèse, faculté des sciences, Université Mohammed V, Rabat.

Khabar L. (1988). Le genre Terfezia Tull. (Terfass) de la forêt de la Maâmora (Région de Salé) : étude systématique, écologique, morphologique, cytologique et ultra structurale. Thèse, faculté des sciences, Université Mohammed V, Rabat.

Khabar L. (2017). Les Terfess et les truffes du Maroc, biodiversité et valorisation. Éd : Univ Européenne. 276 pages.

Khabar, L. 2002. Etudes pluridisciplinaires des truffes du Maroc et perspectives pour l'amélioration de production des "Terfess" de la forêt de la Maâmora. Doctorat d'Etat ès Sciences, Université Mohamed V, Faculté des Sciences, Rabat, Maroc.

Laessoe, T. and Hansen, K. 2007. Truffle trouble: what happened to the Tuberales, Mycological Research, 111:1075–99.

Malençon G., (1973). Champignons hypogés du Nord de l'Afrique. I. Ascomycètes. Persoonia 7: 261–288.

Morte, A., Honrubia, M. and Gutierrez, A., 2008. Biotechnology and cultivation of desert truffles. In: Varma A, ed. Mycorrhiza: state of the art genetics and molecular biology, eco-function, biotechnology, eco-physiology, structure and systematics. Berlin, Heidelberg : Springer Verlag. P. 467–483.

Rodriguez, A. 2008. Desert truffles. Sur http://www.trufamania.com/desert-truffles.htm

SEIFN (2014). Inventaire forestier national (IFN). Service des Études et de l'Inventaire Forestier National, Département des eaux et forêts, Rabat.

Serrhini M. N., El Youssoufi Kh. *Et* Allali Kh. (1995). Une ressource naturelle exceptionnelle des milieux pastoraux de l'Oriental et du centre Sud Marocain : le « terfèze », situation actuelle et perspectives

Tahiri A. (1997). Relation mycorhizienne entre Helianthemum ledifolium(L) Mill, et des espèces de Terfez du Maroc. Mémoire de troisième cycle en agronomie, Ecole nationale d'agriculture, Meknès, 80 pages.

Trappe, JM., Claridge, AD., Arora, D. and Smit, WA. 2008. Desert truffles of the African Kalahari: Ecology, ethnomycology, and taxonomy. Economic Botany, 62 : 521-529.

Watfeh A., et Sfa M. (2007). Carte des précipitations annuelles du Maroc. Chaire UNESCO-Gaz Natural, Faculté des lettres et sciences humaines, Université Mohamed V, Rabat.

Watfeh A., Tailassane M., Laouina A., Sfa M. et Naimi K. (2007). Carte morpho-pédologique du Maroc. Chaire UNESCO-Gaz Natural, Faculté des lettres et sciences humaines, Université Mohamed V, Rabat.

Zitouni-Haouar F.E-H. 2016. Etude de la diversité des truffes du désert et de leurs associations mycorhiziennes. Thèse de doctorat. Université d'Oran 1 Ahmed Ben Bella.95 p

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