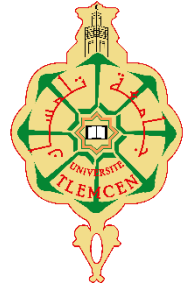




People's Democratic Republic of Algeria
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University of Abou-Bekr Belkaid – Tlemcen
Natural and Life Sciences and Earth and Univers
Department of Agronomy

Master's thesis

To obtain a Master's degree in Agronomy, specializing in Plant Production

Theme :

**Diagnosis of Certain Olive Tree Diseases in the
Tlemcen Region**

Presented by : Laredj Youcef

Defended on : 09/06/2025

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before the jury :

President of the jury

Supervisor

Examiner

Dedication

**In memory of my father,
may God grant him His mercy.**

You remain a source of inspiration and strength in my heart.

**To my dear mother,
for her unconditional love and unwavering support.**

**To my brothers and sisters,
for their presence and encouragement throughout this journey.**

To my close friends:

**Chérif, Imed, Abbes, Djebbar,
for their sincere friendship and constant support.**

**And especially to Amina,
for her support, patience, and encouragement at every moment.**

**To my teachers,
for their guidance, advice, and dedication to our education.**

**To the entire Agronomy class of 2024–2025,
with whom I shared precious memories and a beautiful human
adventure.**

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My special thanks go to Miss . LEHKHAL, Lecturer at the University of Tlemcen, for kindly agreeing to examine this work.

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Finally, our heartfelt thanks go to all our family and friends, who continuously encouraged and supported us throughout the writing of this thesis

Thank you.

التحقق من المشاكل الصحية لأشجار الزيتون في ولاية تلمسان

ملخص :

يهدف هذا البحث إلى دراسة الحالة الصحية لأشجار الزيتون في ولاية تلمسان، من خلال التشخيص الميداني للأمراض والآفات التي تصيب هذه الزراعة الحيوية. شملت الدراسة عدة مناطق (ندروما، هونين، منصوره، سيدي مجاهد...) وتم الاعتماد على استبيانات، ملاحظات ميدانية، وتحاليل فيزيائية وحيوية للكشف عن الأمراض الفطرية والبكتيرية الرئيسية. أظهرت النتائج انتشارًا لمشاكل مثل مرض التقرح، التبرقش، العفن، والذبول الفيروسي. كما تطرقت الدراسة إلى تأثير العوامل البيئية (الارتفاع، الكثافة، الري، التسميد) على الإصابة والإنتاج. توصلت إلى توصيات لتحسين المردودية والتقليل من الأمراض باستخدام ممارسات زراعية وقائية.

الكلمات المفتاحية: شجرة الزيتون، الأمراض والآفات، مكافحة الصحة النباتية، تلمسان، المرتفعات، المردود

Résumé: Vérification des problèmes de santé des oliviers dans la wilaya de Tlemcen.

Ce mémoire porte sur l'étude phytosanitaire de l'olivier dans la wilaya de Tlemcen. Une prospection a été menée dans plusieurs localités (Nedroma, Honaïne, Mansourah, etc.) afin de diagnostiquer les maladies cryptogamiques, bactériennes et les ravageurs affectant les vergers d'oliviers. L'analyse s'est appuyée sur des enquêtes auprès d'agriculteurs, l'installation de pièges, des observations visuelles et des mesures agronomiques. Les résultats révèlent la présence de maladies comme la verticilliose, la fumagine, la tuberculose et l'œil de paon. Des liens ont été établis entre les conditions agronomique (altitude, irrigation, densité, fertilisation) et la sévérité des maladies. Des recommandations sont proposées pour une gestion intégrée et durable de la santé des oliviers.

Mots-clés : olivier, maladies et ravageurs, lutte phytosanitaire, Tlemcen, zones montagneuses, rendement.

Abstract : Checking the health issues of olive trees in the Tlemcen province.

This thesis focuses on the phytosanitary assessment of olive trees in the Tlemcen region (Algeria). Field surveys were carried out across several localities (Nedroma, Honaïne, Mansourah, etc.) to identify fungal, bacterial diseases and insect pests affecting olive orchards. The methodology included farmer questionnaires, insect traps, visual inspections, and agronomic data collection. Results revealed common issues such as verticillium wilt, sooty mold, olive knot disease, and peacock spot. The study also highlights the influence of ecological factors like altitude, planting density, irrigation, and fertilization on disease occurrence and yield. Practical recommendations are provided to improve olive productivity through integrated disease management.

Keywords: olive tree, diseases and pests, plant health control, Tlemcen, highlands, yield.

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List of Abbreviations

- **INPV:** National Institute of Plant Protection
- **DSA:** Directorate of Agricultural Services
- **ITAFV:** Technical Institute of Fruit Arboriculture and Viticulture
- **Tab:** Table
- **Fig:** Figure
- **UTM :** Universal Transverse Mercator
- **NPK :** Nitrogen - Phosphorus - Potassium

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Introduction

The olive tree (*Olea europaea* L.) is a tree with great spiritual and cultural symbolism. It holds a special place in Islamic religion, where its fruit and oil are mentioned several times in the Qur'an and prophetic teachings. Surah An-Nur (verse 35) describes the olive tree as a blessed tree whose oil gives light even without fire.

In Surah Al-Mu'minun (verse 20), reference is also made to this tree growing on Mount Sinai, producing precious oil used for anointing or as a food accompaniment. The Prophet Muhammad (peace and blessings be upon him) encouraged the consumption of olive oil by saying: "Eat olive oil and anoint yourselves with it, for it comes from a blessed tree."

The history of the olive tree is closely linked to Mediterranean civilizations that have cultivated and valued it for millennia. Today, olive growing represents the second most important fruit and oil crop in the world, after the oil palm. Approximately 95% of the world's olive groves are found in the Mediterranean region, which also produces more than 95% of the world's olive oil. Thanks to its health benefits, the consumption of this valuable oil has spread beyond traditional producing countries to markets such as the United States, Australia, and Japan.

Olive cultivation holds an essential place in Algeria's agricultural sector. Practiced for thousands of years, it is an integral part of the country's cultural and economic heritage. With around 43 million olive trees covering nearly 431,506 hectares, Algeria has a rich olive-growing heritage. This crop contributes not only to the national economy but also to environmental protection and the preservation of rural landscapes.

Despite its importance, the Algerian olive-growing sector faces several challenges. Among the most critical problems are diseases that compromise tree health and productivity. Fungal diseases such as verticillium wilt (a serious vascular disease) and scab are particularly concerning. Other diseases of bacterial and parasitic origin, including olive knot, crown gall, and sooty mold, also affect this crop (Boutkhil, 2012).

In light of these issues, the present research focuses on diagnosing olive tree diseases in the Nedroma and Maghnia regions (Tlemcen province). The main objectives are as follows:

1. **Survey and localization of disease outbreaks:** A thorough exploration will be conducted to identify areas affected by fungal and bacterial diseases.
2. **Isolation and identification of pathogens:** Samples from infected olive trees will be taken to isolate and characterize the responsible pathogens, based on observed symptoms and their morphological characteristics.
3. **Biochemical study and antagonistic interactions:** An analysis of the biochemical properties of isolated bacterial strains will be carried out, particularly their antibiotic sensitivity and antagonistic potential against pathogens.

Our study aimed to examine the phytosanitary issues affecting olive trees cultivated in the Tlemcen province. The main goal was to conduct a field investigation to identify the presence of pests and various types of fungal, bacterial, and viral diseases. Additionally, we sought to evaluate the impact of several environmental and agricultural factors—such as altitude, planting density, irrigation, and fertilization—on olive tree health, in order to determine which varieties show the greatest resistance to these problems.

The survey covered several regions within the wilaya of Tlemcen, including Honaine, Nedroma, Mansourah, Sidi Medjahed, Tlemcen, Saf Saf, and Bouhanak. The work was made possible thanks to the cooperation of olive tree farmers in these areas, who kindly responded to our questions. This field investigation in the selected regions (Table 06) gave us a valuable overview of the geographic distribution of the surveyed areas.

Chapter I: General Overview of the Olive Tree

I-1 Historical Background

The olive tree is a deeply rooted symbol in Mediterranean civilizations. It is often associated with the iconic landscapes of this region and appears in the foundational narratives of many cultures. References to this tree are found in major religious texts such as the Bible and the Qur'an, as well as in classical Greek literature. The olive tree embodies values such as strength, wisdom, victory, loyalty, immortality, hope, wealth, abundance, longevity, and peace (Breton et al., 2006).

According to Amouretti and Comet (2000), two main theories exist regarding the origin of olive cultivation. Some researchers believe that Phoenicia was the first region to cultivate this tree, while others favor Crete. Archaeological discoveries—including amphorae called *pithoi* dating back to 3500 B.C.—confirm the importance of the olive oil trade at that time. These amphorae, sometimes nearly two meters high, contained this precious oil, and its trade was meticulously recorded on accounting tablets found in the region.

In ancient Greece, the olive tree held an almost sacred status. Strict laws governed its protection: it was forbidden to sell olive wood, and even pruning the trees was regulated. This tight control was due to the economic and religious significance of olive oil.

I-2 Nutritional Value

Today, the olive tree is widely cultivated for its fruit, which is consumed either directly—as green or black olives—or more importantly, for the production of oil renowned for its nutritional benefits. Olive oil is particularly rich in unsaturated fatty acids, which are beneficial for health.

In addition to its oil, olive leaves possess remarkable medicinal properties. They are known for their hypotensive (blood pressure-lowering), vasodilatory (blood vessel-widening), and hypoglycemic (blood sugar-lowering) effects, among others (Meslaycet, 2007).

Beyond these medicinal benefits, olives also contain various essential nutrients. The following table presents the average nutritional content of 100 grams of black olives (Simpson and Orgozaly, 2001).

Table 1: Average Nutritional Content of 100 g of Black Olives (Simpson and Orgozaly, 2001).

Nutrient	Concentration
Water	77%
Calories	103 kcal
Protein	0.9 g
Fat	11 g
Carbohydrates	0 g
Vitamin A	180 mg
Vitamin C	0 mg

I-3 Geographical Distribution

I-3-1 Origin

The olive tree is believed to have originated in the region known as the “Fertile Crescent,” which includes present-day areas such as Mesopotamia and the Levant (Rugini et al., 1998; Loumon and Giourage, 2003). This area is historically recognized as the cradle of several major agricultural species.

The introduction of the olive tree to the western Mediterranean is generally attributed to the Phoenicians—great navigators and traders of antiquity—who played a key role in spreading this tree (Loussert and Brousse, 1978).

As for Algeria, some historians believe that the olive tree was already present well before the 7th century B.C., highlighting its ancient roots in local culture and agriculture.

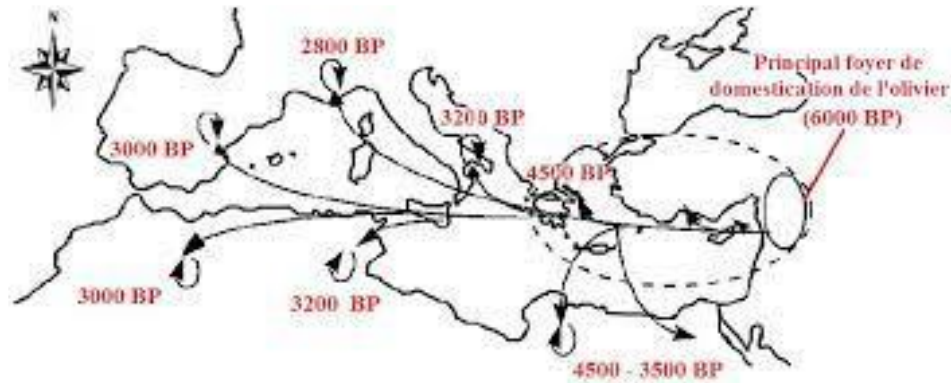


Fig. 01: Dissemination of Cultivated Olive Trees from the Eastern to the Western Mediterranean
(Besnard, 2009) (BP: Before Present)

I-3-2 Situation in the World

With an area of approximately 9.6 million hectares, the olive tree ranks 24th among the 35 most important crops worldwide (FAO, 2012).

The natural distribution of this tree is mainly between the 26th and 45th degrees of latitude north and south. This geographic configuration explains its successful cultivation in regions such as China, Japan, the United States (especially California), and Mexico in the northern hemisphere, as well as in South Africa and several South American countries in the southern hemisphere (Verdier, 2003).

In Africa, the main olive-producing countries, in order of importance, are Tunisia, Morocco, Algeria, Libya, Egypt, South Africa, and Angola. In Europe, we find Spain, Italy, Greece, Portugal, Albania, Cyprus, France, Slovenia, and Malta.

In the Middle East and Asia, olive-growing countries include Turkey, Syria, Palestine, Lebanon, Israel, Jordan, Iraq, Iran, and China. In the Americas, the main producing regions are Argentina, Mexico, Chile, Peru, Uruguay, Brazil, and the United States (California). Australia is also among the emerging producers.

Despite this geographical diversity, about 97% of the world's 850 million olive trees are concentrated in the Mediterranean region, where they cover nearly 9.5 million hectares. The Mediterranean climate—characterized by moderate temperatures and favorable humidity—remains a key factor in the success of this crop (Verdier, 2003).



Fig. 2: Geographic distribution zones of olive cultivation in the Mediterranean Basin (adapted from Lemée and Ramade, 2008)

I-3-3 Olive Growing Situation in Algeria

Olive cultivation in Algeria covers a total area of 431,506 hectares, with 60,632,901 olive trees recorded, including 53,982,463 grouped trees and 6,650,438 isolated trees. Among these, 43,474,145 are in production, representing approximately 71.7% of the total number of olive trees (DSASI, 2019).

Table 02: Distribution of Olive Tree Area and Number by Wilaya in Algeria

WILAYA	Superficie occupée	Oliviers en masse	Oliviers isolés	Total olivier complanté	Oliviers en rapport
	(ha)	(Nbre d'arbre)	(Nbre d'arbre)	(Nbre d'arbre)	(Nbre) arbres
1 ADRAR	0	0	0	0	0
2 CHLEF	4 718	866 184	47 200	913 384	625 124
3 LAGHOUAT	2 277	498 510	25 695	524 205	216 400
4 O.E.BOUAGHI	2 073	284 409	570	284 979	155 845
5 BATNA	11 855	2 325 373	103 622	2 428 995	1 753 385
6 BEJAIA	57 614	4 713 434	498 965	5 212 399	4 442 786
7 BISKRA	4 569	1 091 770	126 760	1 218 530	676 915
8 BECHAR	1 650	347 117	101 576	448 693	160 940
9 BLIDA	1 230	167 116	111 484	278 600	270 000
10 BOUIRA	37 309	3 496 025	292 456	3 788 481	2 698 785
11 TAMANRASSET	0	0	0	0	0
12 TEBESSA	9 534	1 775 706	17 000	1 792 706	1 009 555
13 TLEMCEN	15 546	1 994 876	160 995	2 155 871	2 140 000
14 TIARET	4 597	782 276	26 925	809 201	608 190
15 TIZI-OUZOU	38 828	4 085 944	329 319	4 415 263	3 358 878
16 ALGER	190	59 426	51 097	110 523	38 742
17 DJELFA	11 329	3 193 200	27 100	3 220 300	2 451 000
18 JIJEL	16 603	2 184 251	364 566	2 548 817	2 107 441
19 SETIF	23 611	2 386 361	363 020	2 749 381	2 295 355
20 SAIDA	5 597	1 359 534	22 750	1 382 284	719 304
21 SKIKDA	11 833	1 225 859	363 245	1 589 104	1 309 841
22 S.B.ABBES	8 781	906 486	239 300	1 145 786	573 100
23 ANNABA	969	100 746	32 816	133 562	76 778
24 GUELMA	9 531	670 646	315 336	985 982	514 832
25 CONSTANTINE	672	146 164	17 220	163 384	138 460
26 MEDEA	8 814	916 593	92 218	1 008 811	379 913
27 MOSTAGANEM	8 142	451 840	448 211	900 051	864 150
28 M'SILA	10 442	1 926 450	75 000	2 001 450	1 420 100
29 MASCARA	16 186	1 926 245	155 475	2 081 720	1 487 940
30 OUARGLA	1 269	354 702	54 124	408 826	49 134
31 ORAN	7 400	1 369 660	108 813	1 478 473	1 041 440
32 EL-BAYADH	1 191	321 750	54 265	376 015	165 605
33 ILLIZI	137	18 987	0	18 987	4 314
34 B.B.ARRERIDJ	26 319	2 418 950	84 705	2 503 655	1 764 112
35 BOUMERDES	8 346	774 980	187 763	962 743	815 790
36 EL-TARF	3 371	366 921	70 593	437 514	272 039
37 TINDOUF	148	26 560	1 160	27 720	13
38 TISSEMSILT	8 370	1 113 963	2 000	1 115 963	656 690
39 EL-OUED	3 100	1 083 860	69 500	1 153 360	718 060
40 KHENCHELA	4 428	802 771	68 270	871 041	624 461
41 SOUK-AHRAS	8 136	806 712	31 313	838 025	657 548
42 TIPAZA	2 096	323 095	349 463	672 558	386 289
43 MILA	9 778	977 750	168 200	1 145 950	850 000
44 AIN-DEFLA	6 769	981 110	168 614	1 149 724	876 113
45 NAAMA	2 067	553 538	10 547	564 085	215 213
46 A.TEMOUCHENT	5 124	606 305	525 090	1 131 395	713 669
47 GHARDAIA	1 880	192 338	204 842	397 180	193 420
48 RELIZANE	7 079	1 005 970	81 255	1 087 225	976 445
TOTAL ALGERIE	431 506	53 982 463	6 650 438	60 632 901	43 474 114

This chart shows the change in production, cultivated surfaces, and olive yield in Algeria over the period from 2015 to 2019. The blue bars represent annual production (in quintals), while the green bars indicate cultivated areas (in hectares). The red curve shows the relative stability of yield per hectare. Despite a gradual increase in production, yield remains generally constant over the years.

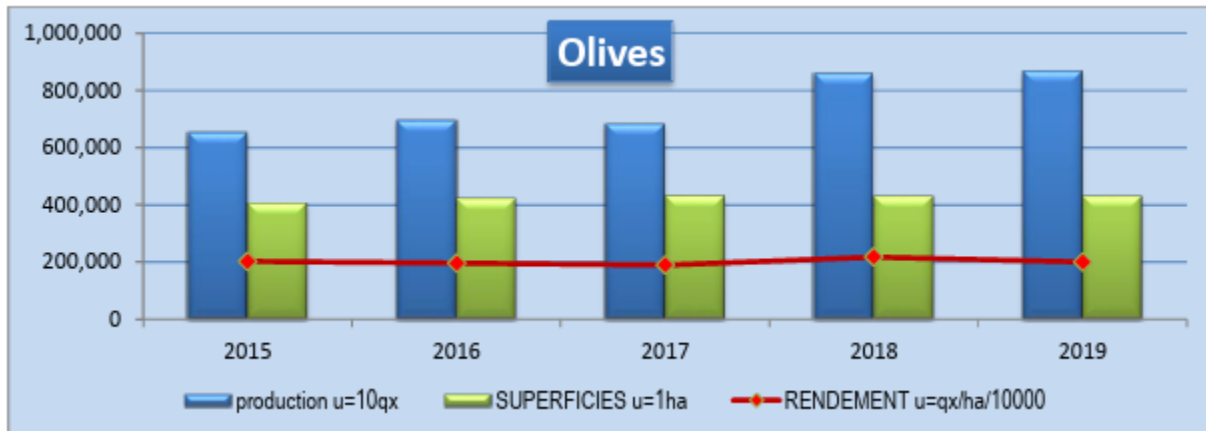


Fig. 3: Variation in olive production, cultivated areas, and yield in Algeria from 2015 to 2019.

I-4- Geobotanical Study

I-4-1- Botanical Classification and Genetic Origin

The olive tree belongs to the Oleaceae family and to the genus *Olea*, which includes 35 different species (Corderiro et al., 2008). Among these, *Olea europaea* L. is the only species that produces edible fruits (Breton et al., 2006a; Rubio de Casas et al., 2006). According to the molecular systematics established by Strikis et al. (2010), the scientific classification of the olive tree (*Olea europaea* L.) is as follows:

Kingdom:	Plant
Sub-kingdom:	Tracheobionta
Division:	Magnoliophyta
Phylum:	Spermatophyta
Sub-phylum:	Angiosperms
Class:	Dicotyledons
Subclass:	Asterids
Order:	Lamiales



Fig 04: Olive cultivation (Sigoise variety)

Family: Oleaceae
Genus: *Olea*
Species: *europaea*

Olea europaea is a complex comprising six presumed inter-fertile subspecies. One of them, *subsp. europaea*, includes two varieties: *var. europaea*, the cultivated olive, and *var. sylvestris* (Mill.) Lehr., the wild olive or oleaster (BRETON et al., 2006a; RUBIO DE CASAS et al., 2006). This complex is distinguished by its phenotypic traits, genotypic differences, and geographical distribution (GREEN, 2002; TERRAL et al., 2004).

It is found in regions ranging from South Africa to China, the Mediterranean, Macaronesia, the Saharan mountains (Fig. 5), Australia, and several Pacific Ocean archipelagos (GREEN, 2002).

Studies on the molecular diversity of olives indicate that the oleaster appears to be the ancestor of the cultivated olive (BRETON et al., 2006a ;BESNARD et al., 2009; BELAJ et al., 2010).

The combination of locally selected oleasters and imported cultivars (BESNARD et al., 2001; KHADARIL et al., 2005) has led to the identification of over 2,500 cultivars worldwide (CORDEIRO et al., 2008; OZGENTURK et al., 2010).

All cultivars are diploid ($2n = 2x = 46$), predominantly allogamous, with a genome size of approximately 1,800 Mb (LOUREIRO et al., 2007; BESNARD et al., 2008).

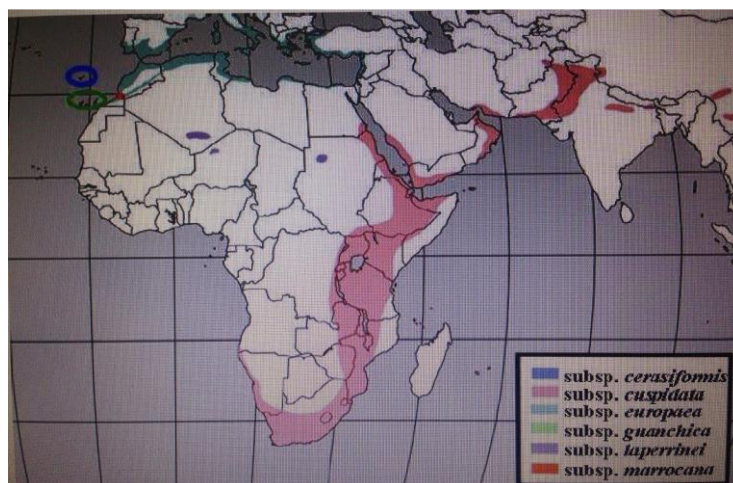


Figure 05: Natural distribution of the *Olea europaea* complex in the world (RUBIO DE CASAS et al., 2006)

I-4-2- Botanical Characteristics (ITAF, 2013)

I-4-2-1- Leaves:

The leaves are arranged oppositely, oval and elongated in shape, borne on a short petiole. They are leathery, entire, with rolled edges. Their color is a shiny dark green on the upper surface, while the lower surface is a silvery light green, with a prominent central vein. The foliage is evergreen, meaning it remains green year-round, but that does not imply the leaves are immortal. On average, they live for three years before turning yellow and falling off, mainly during the summer.

I-4-2-2- Flowers:

The flowers are white and have a corolla, two stamens, a calyx made up of four oval petals, and a rounded ovary topped with a rather thick style ending in a stigma. This ovary contains two ovules. The flowers grow in small clusters of 10 to 20, located in the leaf axils, and appear at the beginning of spring on two-year-old branches. Most olive trees are self-fertile, which means that their own pollen can fertilize their ovaries. Fertilization, mainly ensured by the wind, lasts about one week per year. If rain does not interfere during this period, about 5 to 10% of the flowers will produce fruits, ensuring a satisfactory yield.

I-4-2-3- Fruit:

The olive is a drupe, whose skin (epicarp) is covered with a waxy, water-impermeable substance called bloom (pruine). The pulp (mesocarp) is fleshy and rich in fats, which accumulate during lipogenesis, occurring from the end of August until veraison. Initially, the olive is green, then turns black once it reaches full maturity. The pit, very hard and bony, is composed of a shell (endocarp) that hardens starting from the end of July. Inside the pit is a seed with two ovaries, one of which is generally sterile and non-functional. This seed (which rarely contains two kernels) gives rise to an embryo, which can produce a new olive tree if conditions are favorable.



Fig 06: The leaf, flower, and stem of the olive tree, Aberkane variety (Catalogue of Olive Tree Varieties in Algeria, ITAF 2023)

I-4-3- Vegetative Characteristics

I-4-3-1- Trunk:

The trunk of the olive tree can reach an impressive circumference of 10 to 20 meters and a height of up to 12 meters. In young trees, the bark is smooth and grayish-brown in color, while it becomes more or less deeply cracked with age. The olive tree can live for several hundred years (Courboulex, 2002).

I-4-3-2- Leaves:

The leaves, which are evergreen and oppositely arranged, have an oval shape. The upper surface is shiny and green, while the lower surface, which is curved, shows a pale green to whitish hue (Courboulex, 2002).

I-4-3-3- Flowering:

In Algeria, olive tree flowering occurs in April. A notable feature of this flowering is the abortion of a large number of flowers, a phenomenon frequently observed in this species (ITAF, 2013).

I-4-3-4- Maturity Period (ITAF, 2013):

The maturation period of olives extends from November to January, allowing the harvest to be spread over several months.

I-4-3-5- Fruiting Habit (ITAF, 2013):

The olive tree bears fruit on the wood of the previous year.

I-4-3-6- Different Productions of the Olive Tree (ITAF, 2013)

- **Wood shoot:** This type of shoot, with an upright habit and dark green foliage, only bears vegetative buds.
- **Fruit shoot:** It presents three types of buds, distributed from the base to the top:
 - **Basal buds**, receiving little sap and sunlight, remain dormant. These are called latent buds.
 - **Terminal buds**, well-supplied with sap, will produce wood.
 - **Middle buds**, moderately nourished, will develop into flowers. These are known as flower buds.
- **Buds:**
 - **Terminal bud:** It extends the shoot and can sometimes produce flowers, thus forming a crown shoot.
 - **Axillary bud:** Located at the axil of each leaf, it can produce either flowers or wood depending on the quality of the sap it receives.
 - **Two lateral buds:** Located on either side of the axillary bud, they can eventually replace it if needed.

I-5- Olive Tree Varieties (Villa, 2003)

The different olive varieties are classified according to the final use of the fruit into three main categories:

I-5-1- Oil Olives:

These varieties are characterized by regular production and high profitability, both in terms of quantity and quality of the oil obtained.

I-5-2- Table Olives:

These olives are selected for their large size, high pulp content, and relatively small pit. They have a low oil content.

I-5-3- Dual-purpose Olives:

These varieties have intermediate characteristics between the previous two categories. Depending on the harvest time and their adaptation to the growing area, they may be used either for table consumption (when the size is suitable) or for oil extraction.

I-5-4- Olive Varieties Around the World:

The olive tree (*Olea europaea* L.), an iconic species of the Mediterranean landscape, exhibits great phenotypic diversity (Kamoun et al., 2007). The exact origins of these many varieties remain uncertain.

Studies have suggested that inter-fertility between cultivated and/or wild forms may have contributed to the diversification of the cultivated olive tree. Today, each Mediterranean olive-producing country has hundreds of varieties (Tab. 3), some of which are very old and still cultivated (Loussert & Brousse, 1978; Barranco & Rallo, 2005; Idrissi & Ouazzani, 2006).

Olive varieties are grouped into three main categories:

- **Oil varieties:** Mainly intended for oil extraction, these varieties generally offer a yield higher than 16–18%.
- **Table varieties:** These are selected for direct consumption due to the quality of their fruits.
- **Dual-purpose varieties:** These can be used both for oil production and for consumption as table olives.

All types are in the table at the end (**Annexes 01**)

I-5-5- Main Olive Tree Varieties in Algeria

In Algeria, several olive tree varieties are cultivated, each presenting specific characteristics in terms of yield, climate adaptation, and fruit destination. The main varieties are listed in (**Annexes 02**).

I-6- Study of Olive and Olive Oil Productivity (2019):

The table details the production of olives and olive oil in Algeria, classified by wilaya. The table is structured into several columns that provide specific information on the distribution of this production throughout the country. The main data include the quantity of olives produced for canning as well as those intended for oil extraction. One column also aggregates the total olive production per wilaya, providing an overview of the geographical distribution of this crop in Algeria.

Another essential element of the table is the yield of olive trees, expressed in kilograms per tree, which helps evaluate the productivity of plantations in each region. This yield varies significantly from one wilaya to another, ranging from a few kilograms to over 30 kg/tree in some areas where olive cultivation is well developed, such as in Tlemcen (35.0 kg/tree) and Mascara (53.4 kg/tree).

Regarding oil production, the table shows the volume of oil extracted from olives in each wilaya, expressed in quintals, as well as the oil yield, measured in liters per quintal of pressed olives. This oil yield ranges between 13 and 21 liters per quintal, reflecting the quality of the olives produced and their fat content. The wilayas of Béjaïa, Bouira, Tlemcen, Mascara, and Boumerdès rank among the largest olive oil producers in Algeria, with volumes exceeding several tens of thousands of quintals.

Overall figures show that the total olive production in Algeria reaches 8,687,541 quintals, while olive oil production amounts to 1,053,234 quintals, with a national average oil yield of 18.5 liters per quintal of olives. This table thus highlights the importance of olive growing in Algerian agriculture and emphasizes the differences in production and yield among the wilayas, some of which benefit from more favorable climatic and agronomic conditions for this crop than others.

Table 03: Olive and Olive Oil Production in Algeria by Wilaya (DSASI Series B 2019)

WILAYA	Production d'olive			Rendement d'olive	Production d'huile	Rendement d'huile
	pour la conserve	pour l'huile	Total Prod. Olives			
	Qx	Qx	Qx	Kg/arbre	HI	Litres/quintal
1 ADRAR	0	0	0	0	0	0
2 CHLEF	25 863	51 633	77 496	12,4	7 233	14,0
3 LAGHOuat	32 460	21 640	54 100	25,0	0	0,0
4 O.E.BOUAGHI	1 749	17 528	19 277	12,4	2 808	16,0
5 BATNA	196 070	259 875	455 945	26,0	46 063	17,7
6 BEJAIA	482	889 851	890 333	20,0	194 713	21,9
7 BISKRA	123 540	52 950	176 490	26,1	7 408	14,0
8 BECHAR	5 473	4 489	9 962	6,2	462	10,3
9 BLIDA	23 714	41 350	65 064	24,1	6 203	15,0
10 BOUIRA	2 490	429 952	432 442	16,0	92 440	21,5
11 TAMANRASSET	0	0	0	0	0	0
12 TEBESSA	9 400	61 200	70 600	7,0	10 424	17,0
13 TLEMCEEN	300 000	450 000	750 000	35,0	81 000	18,0
14 TIARET	34 000	30 000	64 000	10,5	3 900	13,0
15 TIZI-OUZOU	0	504 208	504 208	15,0	103 074	20,4
16 ALGER	1 828	3 488	5 316	13,7	501	14,4
17 DJELFA	23 250	316 550	339 800	13,9	46 010	14,5
18 JIJEL	480	555 379	555 859	26,4	109 791	19,8
19 SETIF	830	340 219	341 050	14,9	69 717	20,5
20 SAIDA	112 078	38 020	150 098	20,9	4 460	11,7
21 SKIKDA	0	222 732	222 732	17,0	35 650	16,0
22 S.B.ABBES	163 072	60 752	223 824	39,1	8 506	14,0
23 ANNABA	2 096	12 569	14 665	19,1	2 188	17,4
24 GUELMA	0	72 275	72 275	14,0	11 641	16,1
25 CONSTANTINE	4 295	7 085	11 380	8,2	961	13,6
26 MEDEA	18 088	39 435	57 523	15,1	5 289	13,4
27 MOSTAGANEM	212 252	0	212 252	24,6	0	0
28 M'SILA	46 046	127 169	173 215	12,2	21 388	16,8
29 MASCARA	770 550	23 700	794 250	53,4	2 870	12,1
30 OUARGLA	3 480	4 977	8 457	17,2	686	13,8
31 ORAN	142 370	10 223	152 593	14,7	1 588	15,5
32 EL-BAYADH	2 928	12 954	15 882	9,6	1 926	14,9
33 ILLIZI	39	0	39	0,9	0	0
34 B.B.ARRERIDJ	17 733	364 583	382 316	21,7	72 718	19,9
35 BOUMERDES	747	36 556	37 303	4,6	5 688	15,6
36 EL-TARF	12 230	45 600	57 830	21,3	6 914	15,2
37 TINDOUF	0	0	0	0,0	0	0
38 TISSEMSILT	14 200	77 800	92 000	14,0	12 448	16,0
39 EL-OUED	22 820	23 500	46 320	6,5	2 800	11,9
40 KHENCHELA	2 844	92 847	95 691	15,3	18 511	19,9
41 SOUK-AHRAS	23 906	78 238	102 144	15,5	12 518	16,0
42 TIPAZA	11 335	30 909	42 244	10,9	4 375	14,2
43 MILA	22 445	116 044	138 489	16,3	20 043	17,3
44 AIN-DEFLA	108 001	82 000	190 001	21,7	8 270	10,1
45 NAAMA	1 195	6 863	8 058	3,7	889	13,0
46 A.TEMOUCHENT	55 701	61 867	117 568	16,5	8 049	13,0
47 GHARDAIA	20 818	5 000	25 818	13,3	418	8,4
48 RELIZANE	424 543	6 090	430 633	44,1	693	11,4
TOTAL ALGERIE	2 997 441	5 690 100	8 687 541	20,0	1 053 234	18,5

I-7- Development Cycle of the Olive Tree

Throughout its annual cycle, the olive tree goes through the following phases (Walid et al., 2003):

- Induction, initiation, and floral differentiation: From January to February.
- Growth and development of inflorescences at the leaf axils: During March.
- Flowering: In April.
- Fertilization and fruit setting: From late April to early May.
- Fruit enlargement: From June to August.
- Veraison: In September.
- Maturation: The fruit reaches its final size in October and begins to accumulate oil.
- Fruit harvest: From mid-November to January.

It is important to note that the most intense period of the olive tree's annual cycle extends from March to June. During this crucial phase, the tree requires a significant amount of water and nutrients (Erraki et al., 2005).

Naturally, in the absence of pruning, the olive tree follows an alternate bearing rhythm, with fruiting occurring every other year. Its production cycle unfolds in several stages:

- Non-productive establishment period (1 to 7 years): The tree begins its development without producing fruit. This period can double in case of drought.
- Productive growth phase (up to 35 years): The olive tree develops and its production gradually increases.
- Full maturity (from 35 to 150 years): The tree reaches its optimal and regular production.
- Aging phase (beyond 150 years): Production becomes irregular and yields decline (ITAF, 2013).

The life cycle of the olive tree is illustrated in Figure 07:

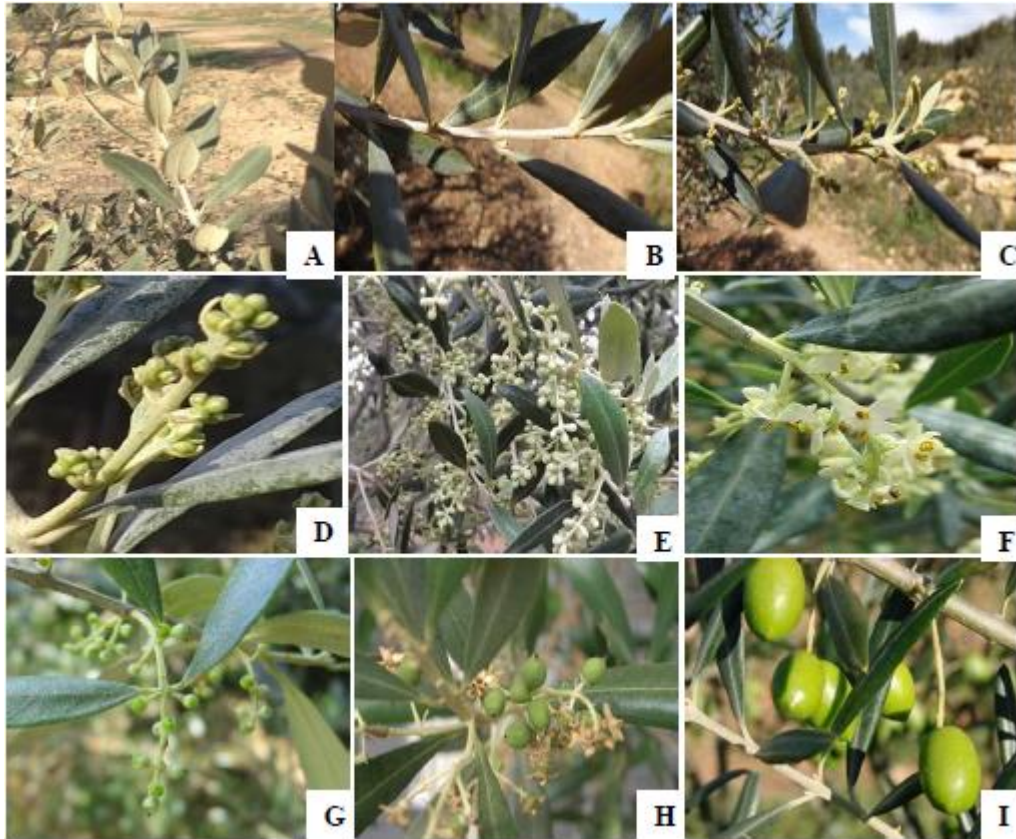


Fig. 07: Development Cycle of the Olive Tree (COLBRANT and FABRE, 2011)

A: Winter stage, B: Vegetative awakening, C: Formation of flower clusters, D: Swelling of flower buds, E: Differentiation of corollas, F: Flowering, G: Petal fall and fruit set, H: Fruit enlargement, I: Fruit maturation (Green Olive).

Chapter II: Diseases and Pests of the Olive Tree

I- Pests and Insects:

I-1 The Olive Fly (*Bactrocera oleae*)

The olive fly is one of the most destructive pests of the olive tree in Mediterranean regions. It is a dipteran (like the common housefly), whose larva develops inside the olives, causing premature fruit drop and a significant decrease in oil quality (acidity, rancidity) (**Delrio & Lentini, 2018. Integrated pest management of olive**).

- The female lays eggs under the olive skin.
- The larva feeds on the pulp and tunnels galleries.
- This also favors secondary infections (fungi, bacteria).

I-2 The Black Scale of the Olive Tree (*Saissetia oleae*)

Saissetia oleae, commonly called black scale, is a hemipteran insect of the family Coccidae. It is a sedentary pest that mainly attaches to twigs, leaf veins, and sometimes olive fruits.

- It feeds by piercing plant tissues to suck sap, weakening the tree.
- By excreting honeydew, it promotes the development of sooty mold (a black fungus), which reduces photosynthesis.
- Severe infestations cause general weakening, leaf drop, reduced flowering, and yield. (**Moreno, A., & Campos, M., 2000.**)

I-3 The Olive Psyllid (*Euphyllura olivina*)

Euphyllura olivina, known as the olive psyllid, is a small hemipteran insect of the family Psyllidae. It mainly attacks young shoots, flower buds, and olive inflorescences.

- Adults and larvae suck sap, causing deformities, drying, and flower drop.
- It also secretes abundant honeydew, attracting ants and promoting sooty mold formation.
- Infestation during flowering can seriously reduce fruit set and yield. (**Tena, A., & al., 2007**)

I-4 The Olive Moth (*Prays oleae*)

Prays oleae, commonly called the olive moth, is a small moth (Lepidoptera) of the family Praydidae. It is an important pest of the olive tree in the Mediterranean region because it develops three annual generations, each targeting a different part of the tree:

1. **Phyllophagous generation (March-April):** larvae attack young leaves.
 2. **Anthophagous generation (May-June):** larvae penetrate flowers causing their drop.
 3. **Carpophagous generation (June-August):** larvae develop inside fruits, tunneling the pulp, making them unsellable.
- The carpophagous generation is the most harmful as it causes direct fruit loss and favors secondary infections. (Bento, A., &all 2001)

I-5 The Black Capnode (*Capnodis tenebrionis*)

Capnodis tenebrionis is a beetle of the family Buprestidae, feared for its wood-boring larvae that cause severe damage to roots and the collar of young olive trees.

- The adult is black, elongated, and feeds on foliage (limited damage).
- The very voracious larvae burrow into underground woody tissues, tunneling the root system.
- Infested trees show symptoms of wilting, slowed growth, general weakening, or death if infestation is severe.
- This pest is especially dangerous for young plantations. (Paulian, R., 1986. Les insectes nuisibles aux cultures méditerranéennes. Éditions Lavoisier, Paris.)

I-6 Olive Mites

Mites are microscopic arthropods belonging to the class Arachnida. Several species can attack the olive tree, the most frequent being:

- *Aceria oleae*: responsible for leaf gall mite (bulbous deformations on leaves).
- *Tetranychus urticae* (two-spotted mite): causes yellowing and premature leaf drop.

- *Eutetranychus orientalis*: mainly present in hot climates, it sucks leaf sap, reducing photosynthesis.

Damage can cause tree weakening, reduced growth and production, especially in cases of massive or prolonged infestations. (Kreiter, S., & Tixier, M. S., 2010.)

I-7 The Fig Tree Leopard Moth (*Zeuzera pyrina*)

Zeuzera pyrina is a lepidopteran (moth) of the family Cossidae. Although it is known for attacking fig trees and other fruit trees (apple, pear, etc.), it can also attack olive trees, particularly young plants or weakened trees.

- The larvae bore galleries into the wood of branches and trunks.
- This causes breakages, structural weakening, reduced sap flow, and even death of the attacked shoots.

The galleries are often accompanied by sawdust and visible exudates on the bark. This pest is particularly feared in nurseries or young olive orchards. (Tixier, P., 2015)

I-8 The Olive Bark Beetle (*Phloeotribus scarabaeoides*)

Phloeotribus scarabaeoides is a beetle from the family Curculionidae (subfamily Scolytinae), known as a wood-boring insect specifically associated with the olive tree. It is also called the olive bark beetle.

- Adults excavate mating galleries in young shoots, dead, or weakened branches to lay eggs.
- The larvae bore secondary galleries that disrupt sap flow.

These galleries weaken the tree, cause branch dieback, and facilitate the entry of pathogenic fungi such as *Verticillium dahliae* or *Ceratocystis* spp. (Rhouma, A., 1994.)



Fig. 08: Olive fruit fly (*Bactrocera oleae*)



Fig. 09: Black scale insect on olive (*Saissetia oleae*)



Fig. 10: Olive psyllid (*Euphyllura olivina*)



Fig. 11: Olive moth (Teigne de l'olivier - *Prays oleae*)



Fig. 12: Flat-headed root borer (*Capnodis tenebrionis*)



Fig. 13: Olive mites (*Aceria oleae*)



Fig. 14: Fig tree moth (*Zeuzera pyrina*)



Fig. 15: Olive bark beetle (*Phloeotribus scarabaeoides*).

II – Fungal Diseases:

II-1 Peacock Spot of Olive (*Spilocaea oleagina*)

Peacock spot is a fungal disease caused by *Spilocaea oleagina*, a fungus that primarily attacks the leaves of the olive tree.

- It is characterized by the appearance of circular spots on the leaves, surrounded by a yellow halo, resembling a peacock's eye — hence the name.
- Infected leaves fall prematurely, causing general weakening of the tree.
- This disease reduces the tree's photosynthetic capacity and can significantly lower olive production.
- It is favored by humid and temperate conditions (rain, fog, excessive irrigation).

(*Trapero, A., & Blanco, M. A. 2008*)

II-2 Sooty Mold

Sooty mold is not caused by a single pathogenic fungus, but by a group of opportunistic fungi (mainly from the genus *Capnodium* spp.) that grow on the honeydew secreted by sap-sucking insects (such as scale insects, aphids, psyllids, and flies).

- It appears as a blackish deposit on the surface of leaves, twigs, and sometimes fruits.
- This black layer blocks photosynthesis, slows growth, and affects fruit quality.

- Sooty mold is therefore an indirect consequence of insect infestations that produce honeydew.
- Although mainly an aesthetic problem, it can weaken trees in the case of massive infestations.
(*Schena, L., et al. 2018*)

II-3 Root Rot (*Armillaria* and *Rosellinia* spp.)

Root rot is a fungal disease affecting the roots, primarily caused by fungi such as *Armillaria mellea* and *Rosellinia necatrix*.

- These fungi attack the root system, progressively degrading the wood and absorbing tissues.
- Infected trees exhibit symptoms of decline, yellowing of the foliage, wilting, and eventual progressive death.
- The disease is often detected late, as above-ground symptoms appear long after root infection has started.
- Root rot is favored by heavy, poorly drained soils and conditions of water stress.
(*Rhouma, A. 1994.*)

II-4 Verticillium Wilt

Verticillium wilt is a serious vascular disease of the olive tree, caused by the soil-borne fungus *Verticillium dahliae*.

- This fungus enters the tree through the roots, invades the xylem (the sap-conducting tissue), and causes vascular blockage.
- Typical symptoms include sudden or gradual wilting of leaves, internal browning of the vessels, and sometimes the death of branches or the entire tree.
- The disease is especially severe in young trees and in infested soils where crop rotation is absent.
- It is very difficult to eradicate once established, as *V. dahliae* produces survival structures (microsclerotia) that can persist in the soil for several years.
(*López-Escudero, & all 2011.*)



Fig. 16: Peacock Spot (Fabre 2011)



Fig. 17: Sooty Mold (Fabre 2011)



Fig. 18: Root Rot (Fabre 2011)



Fig. 19: Verticillium Wilt (Fabre 2011)

III- Bacterial Diseases:

III-1 Olive Knot Disease (Olive Tuberculosis)

Also known as "knot," "gall," or "olive canker," this disease is caused by the bacterium *Pseudomonas savastanoi*, which infects the tree's sap circulation system. It mainly attacks olive trees weakened by frost, hail, or mechanical harvesting. The disease causes wart-like swellings (galls) on branches and twigs.

Control measures include:

- Pruning and burning infected branches
- Disinfecting pruning tools
- Spraying with Bordeaux mixture

(Source: ITAF, 2009)



Fig. 20: Olive Knot Disease (Fabre 2011)

Experimental Part

Chapter 1: Materials and Methods

I- Geographic Location:

The wilaya of Tlemcen is located in the northwestern part of Algeria, on the border with the Kingdom of Morocco. It belongs to Western Orania and covers an area of **9,017.69 km²**, with an average altitude of approximately **800 meters**.

It is bounded by the following geographic coordinates:

- **Longitude:** between 1°16'12" and 1°22'58" West,
- **Latitude:** between 34°47'52" and 34°52'58" North.

Tlemcen lies on the northern slope of the Tlemcen Mountains, which are part of the westernmost extension of the Tellian Atlas (D.S.A, 2008).

It is bordered by:

- **West:** the Kingdom of Morocco,
- **East:** the wilayas of Aïn Témouchent and Sidi Bel Abbès,
- **North:** the Mediterranean Sea,
- **South:** the wilaya of Naâma.

II – Objective of the Study:

The aim of our work was to study the phytosanitary problems affecting olive trees cultivated in the wilaya of Tlemcen. The purpose of this study is to carry out a field survey in order to identify pests and the different types of fungal, bacterial, and viral diseases, and to evaluate the effect of various factors such as **altitude, planting density, irrigation, and fertilization**, in order to determine which olive variety is the most resistant to the various threats affecting cultivated olive trees.

Our work covered different regions within the wilaya of Tlemcen, namely: **Honaine, Nedroma, Mansourah, Sidi Medjahed, Tlemcen, Saf Saf, and Bouhanak**, where we were kindly welcomed by olive tree growers who clearly and willingly responded to our questions. This field survey in the selected regions (**Table 06**) gave us an overview of the geographical distribution of the surveyed areas.

The selection of the field sites was based on several criteria that ensured the feasibility of visiting them. The survey period extended from **February to the end of April**. Each visit lasted approximately **30 minutes**. The main criteria used for selecting the sites were as follows:

- Accessibility of the field;
- Availability of transportation;
- Access to reliable information about the plots;
- Possibility of detecting new diseases;
- Collaboration and hospitality of the farmers;
- Prior declaration of diseases by the farmers themselves.

Tab. 04: Surveyed Fields

Location	Altitude (m)	Spacing (m)	Density (plants/ha)
Ghazaouet	87	6 × 6	≈ 278
Nedroma (2)	224	5 × 6	≈ 333
Nedroma (1)	261	5 × 6	≈ 333
Honaine	324	6 × 6	≈ 278
Sidi M'Djâhed	444	5 × 7	≈ 285
Tlemcen	678	7 × 7	≈ 204
Saf Saf	648	6 × 7	≈ 238
Mansourah	791	7 × 7	≈ 204
Bouhanak	783	7 × 6	≈ 238
Aïn Ghoraba	801	7 × 7	≈ 204

III- Creation of the Survey Form:

To better understand the olive-growing sector, we collected a set of preliminary data on olive cultivation. This approach was enriched through exchanges with several institutions specialized in training, research, and agricultural development, such as the **National Institute for Plant Protection (I.N.P.V.)**, the **Directorate of Agricultural Services (D.S.A.)**, and the **Chamber of Agriculture**. Based on this input, a **survey form** was specifically designed to meet the objectives of our study. (**Appendix 03**).

IV – Materials Used:

IV-1 Sexual trapping with pheromones

In order to effectively diagnose olive tree diseases, I carried out an internship at the *National Institute of Plant Protection (I.N.P.V.)*. However, the institution was urgently mobilized to respond to a locust invasion that recently affected several regions in Algeria. Despite this, **Mr. Belout** supported me by providing traps to be installed on the surveyed plots to check for the potential presence of the olive fruit fly.

He gave me two traps along with two sachets containing specific attractants: the first one targeted **Prays oleae**, and the second one **Bactrocera oleae**. These attractants are **pheromones** designed to effectively lure the targeted insects, making their detection easier.

Thus, I installed the traps in two different plots: the first located in **Honaïne** and the second in **Sidi Medjahed**. The selection of these sites was based on two main criteria:

1. Reports from farmers indicating the presence of flies observed on their plots.
2. The **absence of recent insecticide treatments**, which allowed for more reliable observation of pest populations.



Fig. n°22: Trap No.1 (Honaine)



Fig. n°23: Trap No.2 (Sidi Medjahed)

IV-1-1 Pheromones *Bactrocera oleae* & *Prays oleae*

Pheromones of *Bactrocera oleae* (Olive Fruit Fly):

The pheromones used for *Bactrocera oleae* are sex attractants released by the female flies to lure males for mating. Synthetic versions of these pheromones are used in traps to attract and capture male olive fruit flies, helping to monitor and control their populations. These pheromones are highly specific and effective, enabling early detection and reducing infestation levels in olive orchards.

Pheromones of *Prays oleae* (Olive Moth):

Prays oleae females emit sex pheromones that attract male moths during their mating period. Researchers have isolated and synthesized these chemical signals, which are then used in pheromone traps to monitor

adult moth populations. By capturing males, these traps help track the presence and density of Prays oleae, facilitating timely pest management interventions in olive groves.

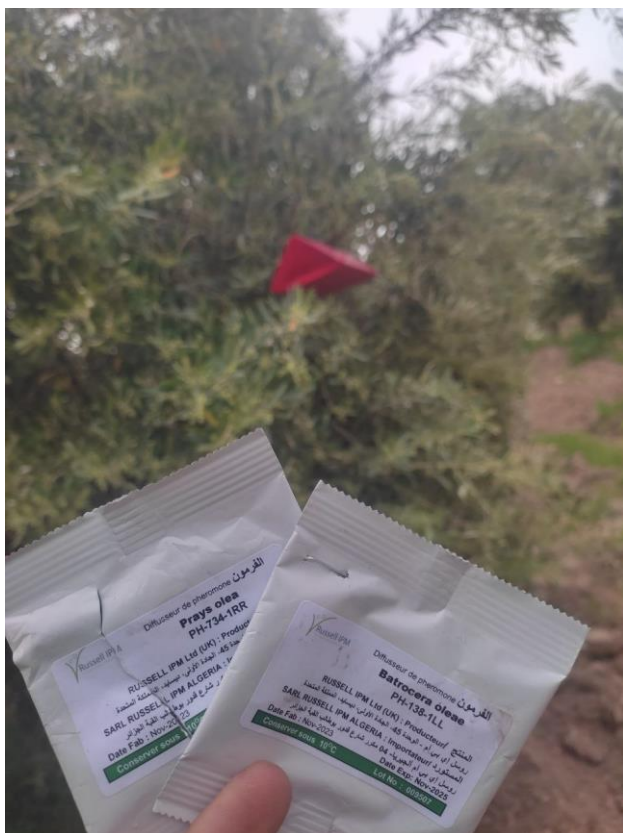


Fig n° 24: Pheromones Bactrocera oleae & Prays oleae (original)

IV-2 Google Earth: (pc)

The Google Earth software was used to accurately record the UTM coordinates of each surveyed site.

IV-3 Questionnaire:

A structured questionnaire was used to collect and organize the responses of the interviewed farmers.

IV-4 Camera:

A camera was used to visually document the visited orchards through on-site photographs.



Fig n°26: Screenshot took from google earth (original)

IV-5 Sampling method :

The sampling method used was based primarily on the accessibility of the farms. Information was obtained through face-to-face interviews with the farmers.

Chapter 2: Results and Discussion

I – Effects of Altitude on the Olive Tree:

The studied localities present varying altitudes, ranging from 87 m (Ghazaouet) to 801 m (Aïn Ghoraba), allowing us to compare the effect of altitude on olive tree health. Overall, low-altitude areas such as Ghazaouet and Nedroma are exposed to higher temperatures, which favor the development of certain fungal diseases such as peacock's eye (*Spilocaea oleagina*). In contrast, in higher-altitude zones like Mansourah or Aïn Ghoraba, cooler temperatures tend to limit the development of such pathogens but may slow down the tree's vegetative cycle, affecting flowering or fruit ripening.

These observations confirm the findings of Tous and Romero (1993), who reported increased susceptibility of olive trees to fungal diseases in warm and humid regions. **(Tous J. & Romero A. 1993.)**

The agro-ecological stage, particularly altitude, plays a crucial role in the adaptation of olive trees and directly affects their performance. In our study, the altitudes of the surveyed localities ranged from 87 m (Ghazaouet) to 801 m (Aïn Ghoraba), illustrating a wide range of ecological conditions. This altitudinal variation helps assess the adaptability of the trees to different microclimates, their sensitivity to diseases, and their production potential.

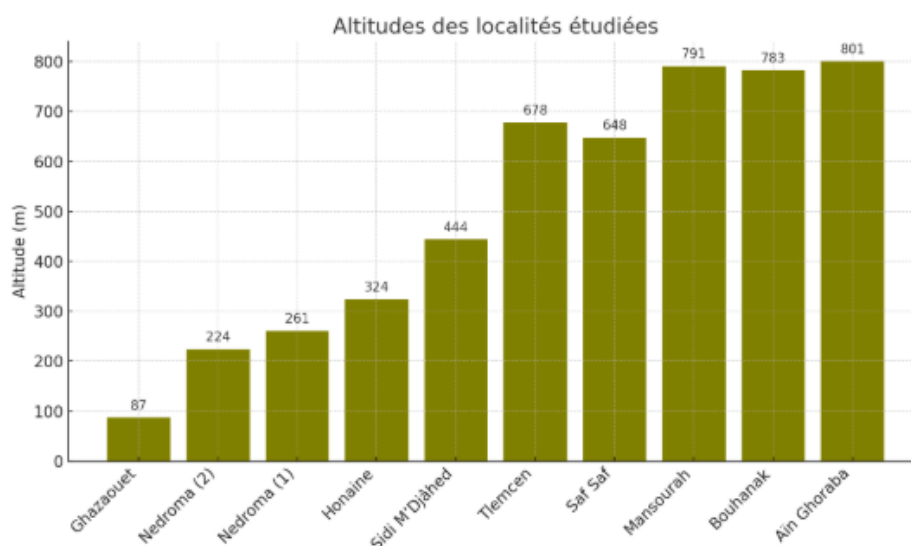


Fig. 27: Altitude Results of the Surveyed Fields

II- Planting Density:

During the field survey conducted in various olive-growing areas of the Tlemcen wilaya (Nedroma, Ghazaouet, Honaine, Tlemcen, Mansourah, Sidi M'Djâhed, etc.), we observed a wide diversity in planting densities adopted by farmers. These variations are influenced by local soil and climate conditions, access to mechanization, and production goals.

Our results show that the majority of farmers (around **60%**) use moderate planting densities ranging from **6 × 6 m** to **7 × 7 m**, particularly in mid-altitude areas such as Nedroma (261 m), Honaine (324 m), and Tlemcen (678 m). These spacings allow for good air circulation around the trees, facilitate mechanical interventions (plowing, treatments), and reduce the risk of spreading fungal diseases.

About **25%** of the plantations are established at a closer density of **5 × 5 m**, especially in lowland areas like Ghazaouet (87 m) and Nedroma (224 m). This density reflects a more intensive approach, where farmers aim to maximize the number of trees per hectare to increase overall yield, while maintaining minimum spacing for light equipment access.

A smaller proportion (about **10%**) corresponds to widely spaced plantations of **8 × 8 m**, often found in more mountainous areas like Aïn Ghoraba (801 m), Mansourah (791 m), or Bouhanak (783 m). In these regions, topographic constraints limit intensification, and wider spacing allows for broader tree development better suited to slopes and shallow soils.



Fig n°28: Planting density 8×8 m (Mansourah)



Fig n° 29: Planting density 6*5 (Sidi Medjahed)

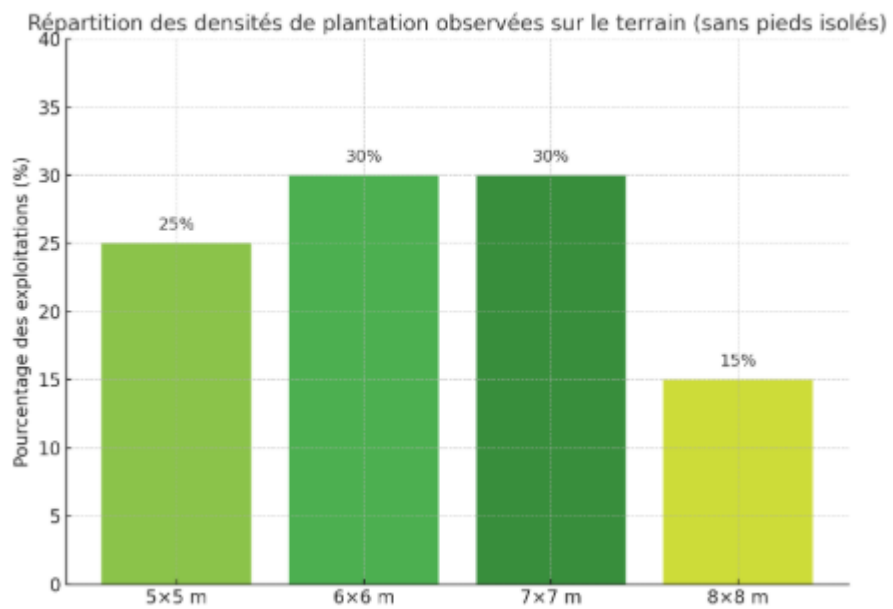


Fig. No. 30: Results of planting density

Siouda and Lalami (2020) indicate that planting distance varies according to the geographic zones of the study. In the northern zone, characterized by steep slopes, farmers plant following contour lines to combat erosion. The most common spacing is 8 meters between trees and 8 meters between rows, corresponding to a planting density of 156 trees per hectare. In contrast, in the central zone, where the slope is gentle, limited availability of agricultural land has led to a reduced planting distance, with 6 meters between trees and 6 meters between rows, resulting in a density of 277 trees per hectare. Finally, in the southern zone, where orchards are larger due to poorer soils, the spacing between trees is greater, with 7 meters between trees and 7 meters between rows, corresponding to a density of 204 trees per hectare. The choice of planting density depends on several factors, including regional rainfall, availability of irrigation water (from lakes or dams), the vigor of the olive variety and rootstock, as well as the chosen cultivation method.

III- Fertilization:

The analysis of fertilization practices across the different study areas reveals a diversity in fertilizer choices, adapted to the local agroecological conditions. The most commonly used fertilizer type is NPK, with various formulations (mainly 0-15-15 and 0-20-25), reflecting a balanced need for phosphorus and potassium to support olive tree growth and fruiting. The use of NPK (0-15-15) is more frequent in moderately fertile zones such as Nedroma and Bouhanak, while NPK (0-20-25) is preferred in more demanding areas like Tlemcen or Mansourah, suggesting an effort to enhance performance on poorer soils or at higher altitudes (**Appendix 03**).

Organic fertilizers are used in warm and humid climates, such as Ghazaouet, or as a complement to NPK in higher zones like Aïn Ghoraba, illustrating a desire to improve soil structure and water retention while enriching the soil with organic matter. Manure, on the other hand, is mainly applied in medium to high altitude zones where soil biological activity can be slower, requiring a gradual supply of nutrients.

Urea, as a rapid source of nitrogen, is often used alongside NPK in well-irrigated zones, indicating a goal of stimulating vegetative growth during active growth periods (**Appendix 03**).

This diversity in fertilizer use demonstrates a reasoned adaptation of inputs according to altitude, soil type, and water conditions, which is essential to ensure optimal olive development while preserving soil sustainability.

According to Bouaziz et al. (2015), balanced fertilization in olive groves plays a crucial role in maintaining productivity and oil quality, especially when pedoclimatic conditions vary. The authors specify that “the combination of mineral fertilizers (such as NPK) and organic amendments not only provides essential nutrients but also improves soil structure, water retention capacity, and microbial life,” which is particularly beneficial in poor soil or difficult climate zones. **(Bouaziz, A& all. 2015.)**

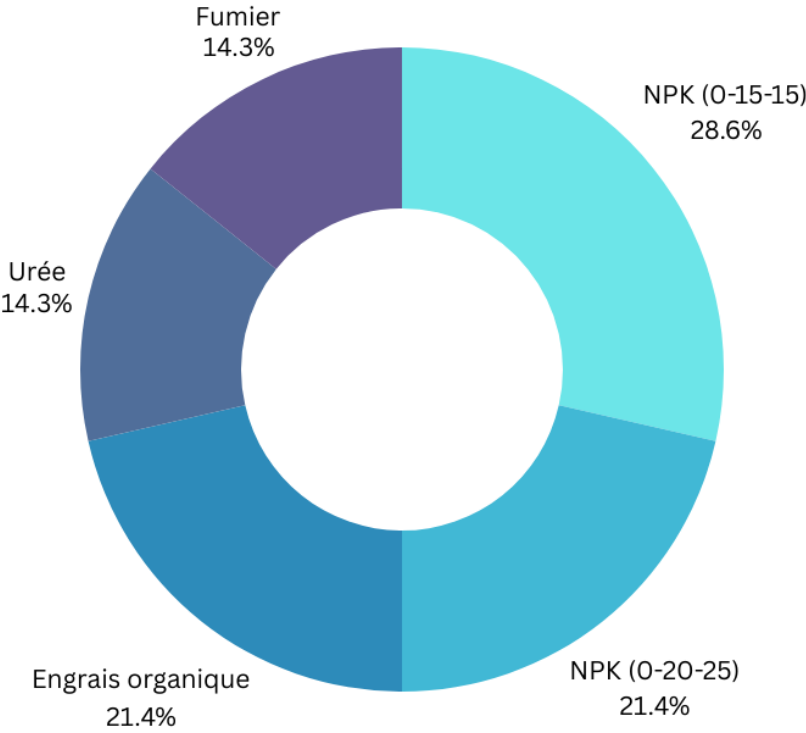


Fig n° 31: Percentage of Each Type of Fertilization

IV- Irrigation:

The drip irrigation system is increasingly used in olive groves due to its efficiency in water use and its ability to reduce losses through evaporation and infiltration. This system works by delivering water directly to the roots of the plants through emitters, allowing targeted and economical irrigation. It is particularly suitable for regions where water is a limited resource, which explains its popularity in hot and dry areas.

According to the data from our study, 60% of the studied areas (such as Ghazaouet, Nedroma, Honaine, and Sidi M'Djâhed) use drip irrigation, demonstrating its effectiveness and popularity in olive cultivation. This system allows precise water management, reducing waste and improving yields. For example, in regions like Ghazaouet, where irrigation is crucial to compensate for irregular rainfall, drip irrigation enables more rational use of water, with watering for 3 hours per week.

The advantages of drip irrigation are numerous: it reduces water consumption, improves plant growth by ensuring even water distribution, and prevents soil leaching. However, this system also presents challenges. Its installation and maintenance can be costly, and regular upkeep is necessary to avoid clogging of the emitters. Moreover, it may not be suitable for very uneven terrains, limiting its use in certain soil types.

According to the results obtained in our study, 40% of the studied areas (notably Tlemcen, Saf Saf, Bouhanak, and Aïn Ghoraba) use flood irrigation, indicating its significant presence in these regions. This system is widely appreciated on lands where water access is relatively easy and where crops do not require as precise irrigation as drip systems. For example, in areas like Tlemcen and Saf Saf, where the land is relatively flat and water is available, flood irrigation ensures sufficient water coverage for olive plantations.

The advantages of flood irrigation include its simplicity of installation and management, as well as its low cost compared to more complex systems like drip irrigation. It is especially beneficial for small farmers who do not have the resources to invest in advanced technologies. This system also helps better manage soil moisture by ensuring a more uniform distribution of water.

Irrigation systems, notably drip and flood irrigation, are key elements for effective water management in agricultural crops. According to **Missat Lakhdar (2012)**, in the semi-arid regions of Algeria, localized irrigation, especially drip irrigation, has become increasingly common due to its water-saving benefits, unlike flood irrigation, which remains popular but is less efficient in water management. The study highlights the importance of adapting irrigation techniques to climatic conditions and water availability, recommending drip irrigation as the preferred method in areas where water access is limited. (**Missat Lakhdar, 2012.**)

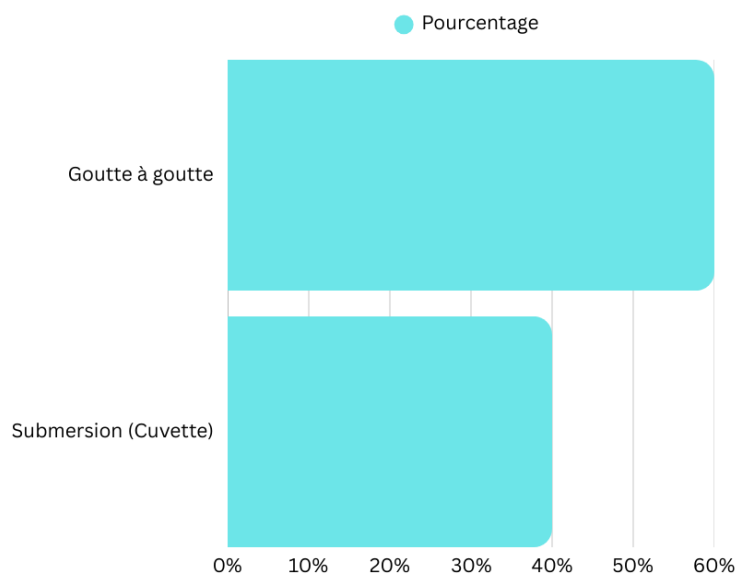


Fig n° 32: Percentage of Each Type of Irrigation



Fig n° 32: Irrigation par Submersion Originale (Ain Ghoraba)

IV- Survey Results on Diseases:

According to Ben Jamaa et al. (2013), the control of olive pests, especially the olive fruit fly and the olive moth, should be based on an integrated strategy combining monitoring, targeted chemical treatments, and alternative methods (trapping, biological treatments, sanitary pruning). They emphasize that the preventive use of phytosanitary products, particularly against verticillium wilt, can reduce disease incidence by more than 60% when treatments are well timed and accompanied by good cultural practices (drainage, tool disinfection, selection of healthy plants).

(Ben Jamaa M.L.& all 2013).

After setting up traps for 7 days, following the director's instructions and the method recommended by the INPV, I placed them in the southwest of the plots where sun exposure is maximal during the day. Additionally, through naked-eye observations, I was able to diagnose the presence of certain diseases in the fields. **(Appendix 04)**

The phytosanitary analysis conducted across the different cultivation zones shows that several diseases and pests affect the olive groves, with variations according to the agroecological conditions of each region. Among the 10 zones studied, 8 have at least one disease or pest, representing an overall incidence of 80%, while 20% of the sites (Ghazaouet and Saf Saf) reported no attacks.

The main diseases observed are verticillium wilt (Nedroma 2 and Mansourah), olive knot disease (Tlemcen), sooty mold (Bouhanak), and peacock spot (Aïn Ghoraba). Regarding pests, there is notable presence of psyllids (Honaine, Bouhanak), olive fruit fly (Honaine, Sidi M'Djâhed), olive moth (Sidi M'Djâhed), and arthropods (Nedroma 1 and 2). The olive fruit fly is the most frequent pest, affecting 20% of the sites, reflecting its wide distribution in olive-growing areas.

Regarding treatments, 50% of the affected zones use chemical methods (Ghazaouet, Nedroma 1, Honaine, Tlemcen, Mansourah), sometimes combined with physical methods as in Honaine. The other 50% of affected zones (Nedroma 2, Sidi M'Djâhed, Bouhanak, Aïn Ghoraba) apply no treatment, which may be explained either by the absence of visible symptoms requiring intervention, economic constraints, or lack of awareness.

The predominant use of chemical treatments shows a curative control strategy focused on reducing pest populations or disease spread. However, the absence of treatments in several zones highlights the importance of a preventive and integrated approach, especially within the context of sustainable pest management and environmental preservation.

The photos presented above illustrate some of the diseases observed in the field, accompanied by the results from the installed traps. These visual elements help confirm the presence of certain pests and diseases identified during direct observations, thereby reinforcing the reliability of the phytosanitary diagnosis carried out in the different plots.



Fig. No. 33: Verticillium wilt (original)



Fig. No. 34: Signs of Arthropods (original)



Fig n°35 : The olive fly

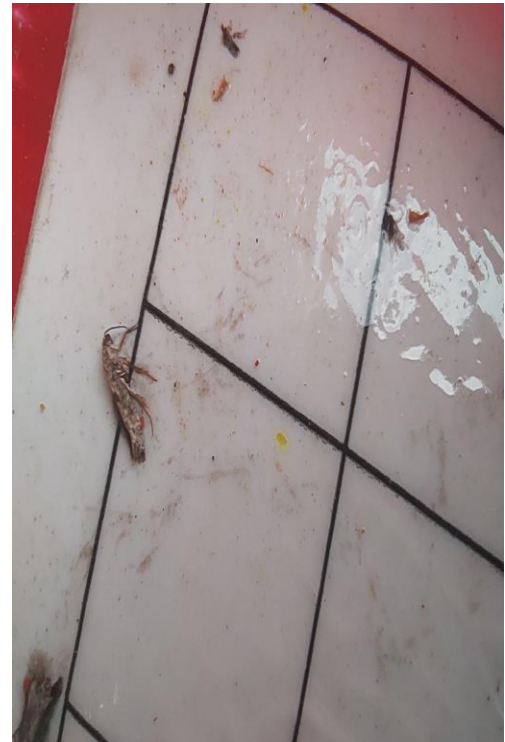


Fig n°36 : Présence de la Teigne

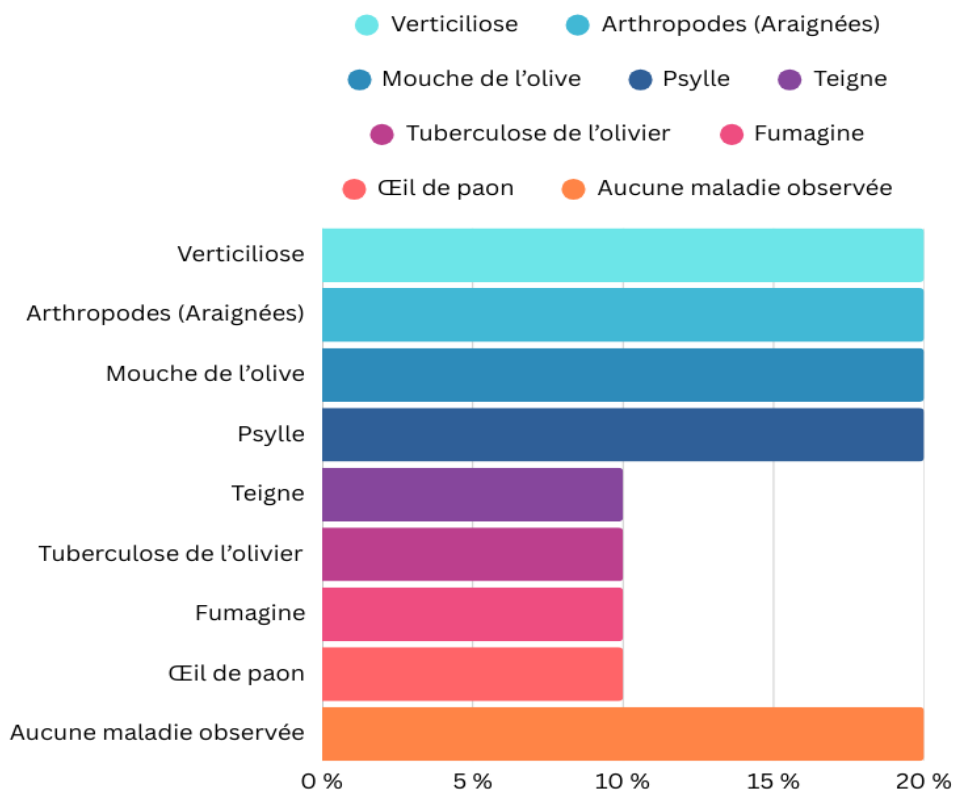


Fig. No. 37: Percentage of Each Disease

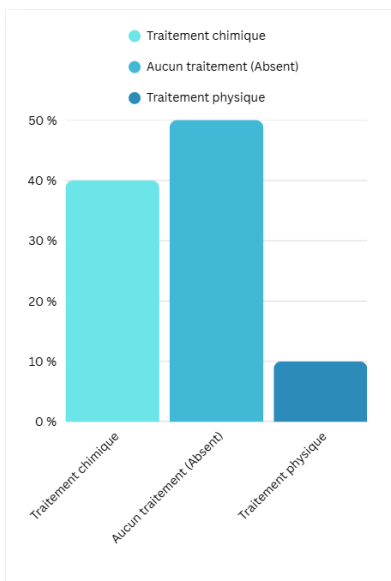


Fig. No. 37: Percentage of Treatment Methods

IV- Yield Survey Results:

The estimated yield per tree in the various olive groves studied shows significant variability influenced by agroecological and technical factors. The highest yields were observed in Ghazaouet (40 kg/tree), Nedroma (2) (35 kg/tree), and Nedroma (1) (33 kg/tree). This can be explained by a favorable combination of climatic conditions, moderate altitude (below 300 m), good water accessibility, and systematic use of localized irrigation (drip irrigation), which effectively optimizes water absorption and limits water stress.

Conversely, the lowest yields were recorded in Aïn Ghoraba (17 kg/tree) and Bouhanak (18 kg/tree), high-altitude areas (>780 m) where cooler temperatures, slower growth, and inefficient flooding irrigation contribute to limiting vegetative development and productivity. These sites are also less protected phytosanitarily, with diseases such as Peacock Spot and sooty mold affecting photosynthesis and fruiting negatively.

The sites in Tlemcen (22 kg/tree) and Saf Saf (20 kg/tree) show low to medium yields despite adequate fertilization. This could be related to their high altitude (over 640 m) and infrequent flooding irrigation (2 to 3 hours per month), insufficient to maintain optimal soil moisture during dry periods.

The sites of Sidi M'Djâhed (30 kg/tree), Honaine (32 kg/tree), and Mansourah (28 kg/tree) present intermediate yields. These results are explained by relatively balanced cultural practices: moderate to high altitudes, mixed fertilization (manure + NPK), and regular drip irrigation. Some phytosanitary pressures, such as the olive moth or olive fly, remain controlled thanks to preventive or curative treatments.

These results confirm that olive productivity is strongly conditioned by a combination of factors, notably altitude, irrigation technique, fertilization regime, and phytosanitary management. Optimizing these parameters—especially through reasoned intensification of localized irrigation and regular phytosanitary monitoring—could significantly improve yields in the less productive zones.

According to **Tous and Romero (1999)**, olive yield is closely linked to agroecological factors such as altitude, water availability, and fertilization strategy. They specify that “olive groves located at low altitudes with regular localized irrigation can produce between 30 to 50 kg per tree, whereas those at high altitude, poorly irrigated or exposed to diseases, see their yield drop to less than 20 kg/tree.” These results

align with the observations recorded in our study, where the best performances are registered in well-irrigated low-altitude zones.

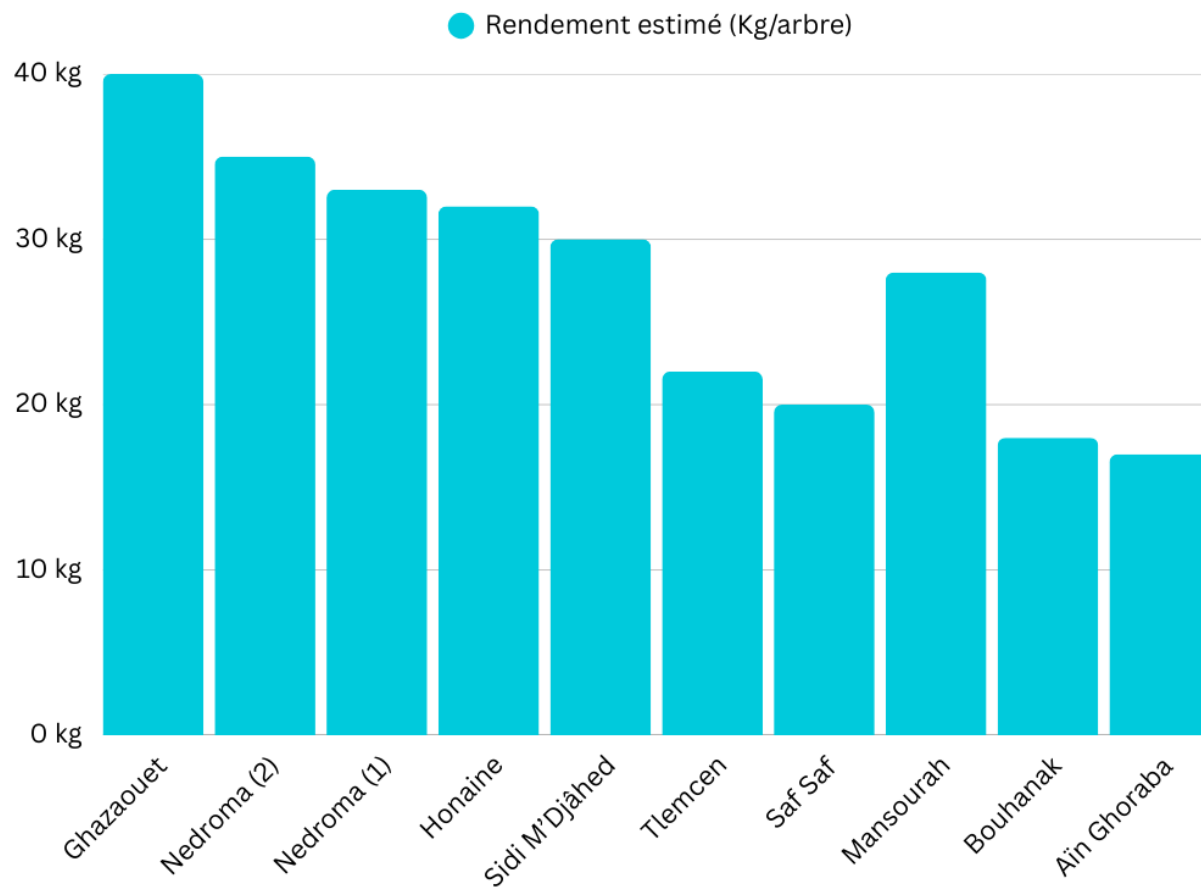


Fig n°38: Yield (Kg/Tree) for Each Site

IV - Survey Results on Fruit Destination:

The olive harvesting period in the study region generally extends from late October to late December, coinciding with the optimal maturity stage of the fruit, primarily intended for oil extraction. This timeframe is strategic to ensure a good oil yield and high organoleptic quality. During this period, the harvested olives are usually transported quickly to oil mills or markets depending on their quality and type of production.

The analysis of the different sites shows that parcels well-equipped with localized irrigation systems (drip irrigation), benefiting from balanced fertilization (organic and mineral fertilizers), as well as good phytosanitary monitoring, are those offering the highest yields (up to 40 kg/tree) and the best fruit quality. These optimal agro-technical conditions are mainly found in Ghazaouet, Nedroma (1 and 2), Sidi M'Djâhed, and Mansourah, naturally directing their production towards local oil mills. Moreover, the varieties cultivated in these zones are traditionally selected for oil extraction, with higher fat content and chemical properties sought by oil producers. (Table 08)

Conversely, higher altitude areas such as Tlemcen, Bouhanak, or Aïn Ghoraba, where submersion irrigation is rare and fertilization is more limited, show lower yields. In these cases, the olives are often destined for the local market for direct consumption, notably as table olives, or sold on a small scale.

According to the IOOC (International Olive Council, 2022), “Olives from irrigated, well-maintained, and adequately fertilized orchards have an oil content 15 to 25% higher than olives from rain-fed high-altitude crops.” Furthermore, “varieties aimed at oil production exhibit better extraction yields, justifying their primary destination towards oil mills.”

Tableau n°05 : Olive destination of each location

Terrain	Estimated Yield (kg/tree)	Likely Destination
Ghazaouet	40	Oil mill (Huilerie)
Nedroma (2)	35	Oil mill (Huilerie)
Nedroma (1)	33	Oil mill (Huilerie)
Honaine	28	Oil mill (Huilerie)
Sidi M'Djâhed	30	Oil mill (Huilerie)
Tlemcen	20	Local market
Saf Saf	22	Local market
Mansourah	26	Oil mill (Huilerie)
Bouhanak	25	Local market
Ain Ghoraba	18	Local market

The high percentage of lands designated for oil mills (66.7%) is explained by the predominance of localized irrigation systems, adequate fertilization, and the presence of olive varieties adapted for oil extraction. These lands, generally located at medium altitudes, offer olive yields often exceeding 40 kg per tree.

Conversely, 33.3% of the lands are intended for the local market. These are mainly plots situated at high altitude, less irrigated, and with lower yields. According to Bchir et al. (2020), the average olive oil yield is about 1 liter for every 10 kg of harvested olives, or 10%, which confirms the economic viability of lands oriented towards oil mills. (See Fig. n°39)

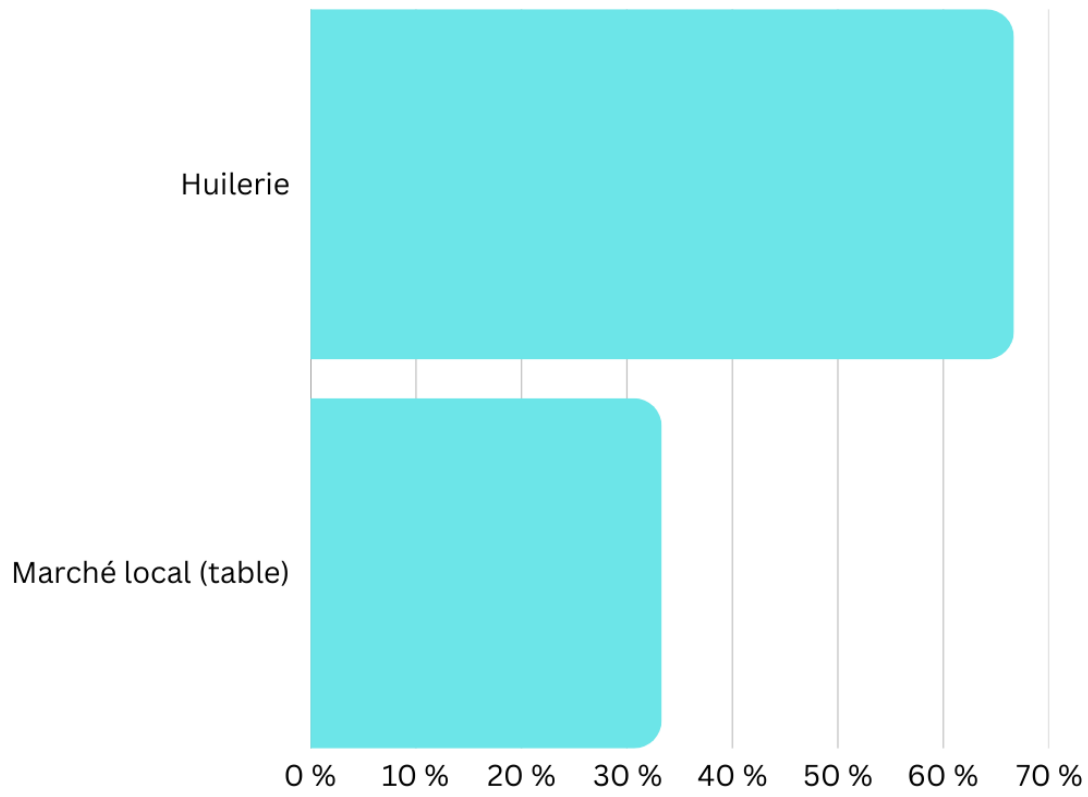


Fig n°39: Percentage of Each Destination

Conclusion

This thesis allowed the evaluation of the phytosanitary status of olive trees in the Tlemcen region, highlighting the main pests and diseases affecting this strategic crop. The results reveal a high prevalence of sanitary problems, with 80% of the surveyed areas affected by at least one disease or pest. Among the most frequent pathogens, verticillium wilt (20% of cases) and olive knot (10%) emerge as major threats, while pests such as the olive fruit fly (20%) and psyllid (20%) significantly impact productivity. Fungal diseases like Peacock Spot (10%) and sooty mold (10%) are also concerning, particularly in humid or poorly ventilated areas.

The study also highlighted the influence of cultural practices on the health of olive trees. Plots benefiting from drip irrigation (60% of cases) and balanced fertilization (NPK + organic) showed higher yields (up to 40 kg/tree), compared to only 17–25 kg/tree in less well-managed areas. However, the absence of phytosanitary treatment in 50% of infected zones underscores an urgent need for awareness on integrated pest management methods (chemical, physical, and biological).

Economically, 66.7% of the olives produced are destined for oil mills, mainly in high-yield areas (Ghazaouet, Nedroma), while 33.3% supply the local market, often in less productive regions (Aïn Ghoraba, Bouhanak). These disparities reflect the impact of agroecological constraints (altitude, climate) and technical factors (irrigation, planting density) on the olive sector.

To enhance olive farming in the Tlemcen region, several key perspectives should be prioritized. Strengthening phytosanitary surveillance through the widespread use of pheromone traps and early disease detection will enable more timely and effective interventions. Promoting sustainable agricultural practices such as localized drip irrigation, balanced organic and mineral fertilization, and the adoption of disease-resistant olive varieties like Sigoise can improve both yield and tree health. Additionally, providing targeted training for farmers on integrated pest management techniques will reduce reliance on chemical pesticides, supporting environmental preservation and long-term orchard resilience. Implementing these strategies collectively will contribute to more productive, sustainable, and climate-resilient olive cultivation.

Perspectives: To improve the resilience of olive groves, we recommend:

- Strengthening phytosanitary surveillance through pheromone traps and early diagnostics.

- Promoting sustainable practices: localized irrigation, organic fertilization, and resistant varieties (e.g., Sigoise).
- Training farmers in integrated pest management methods to reduce pesticide dependence.

In conclusion, this diagnosis provides a solid basis to optimize the management of olive groves in Tlemcen, aligning productivity with sustainability. Further studies on the effectiveness of biological treatments and varietal adaptation to climatic stresses would be relevant extensions.

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Appendixes

Appendix 01: Main Olive Varieties Cultivated Worldwide

Country	Varieties	Use	Area (in Ha)
Argentina	Arauco, Arbequina	Oil + Table	28,670
Spain	² Picual, Hojiblanca, Cornicabra, Lechin, Manzanilla, Verdal de Badajoz, Empeltre, Arbequina, Cacerena	Oil, Oil + Table, Table + Table	2,127,000
United States	Manzanilla, Mission	Table	12,150
France	Picholine, Tanche, Aglandau	Table, Oil	20,000
Greece	Koroneiki, Conservolia, Kalamata, Mastoidis	Oil, Table, Table + Oil	630,800
Italy	Frantoio, Moraiolo, Leccino, Coratina, Carolea, Nocellara, Belice, Itrana, Ascolana tenera	Oil, Oil + Table, Table	1,140,685
Lebanon	Soury	Oil + Table	32,000
Morocco	Moroccan Picholine	Oil + Table	412,000
Portugal	Galega, Carrasquenha, Redondil	Oil + Table	316,000
Syria	Al-Zeiti, Al-Sorani, Al-Doebly	Oil, Oil + Table	405,000
Tunisia	Chemlali, Chetoui, Meski	Oil, Table	1,538,000
Turkey	Ayvalik, Cakir, Gemlik, Memecik, Dornat	Oil, Table	877,700
Former Yugoslavia	Oblica, Zutica	Oil + Table	29,960

Appendix 02: Main Olive Varieties Cultivated in Algeria

Variety	Growing Area	Use	Importance	Oil Yield (%)	Observations
Sigoise	Western Algeria (Oran, Tlemcen)	Table + Oil	25%	18–22%	Highly valued for preservation and oil; high oil yield; self-fertile variety.
Cornicabra	Western Algeria (Oran, Tlemcen)	Table + Oil	5%	20–24%	Very good pollinator of Sigoise; originally from Spain.
Sevillance	Western Algeria	Table	3%	18–22%	Noted for its large fruit size.
Chemlal	Central Algeria, Kabylie	Oil	10%	18–22%	Highly appreciated oil. Drought-resistant. Drawbacks: self-sterile, late bloom.
Azradj	Central Algeria	Table + Oil	15%	24–28%	Very good pollinator of Chemlal.
Bouchouk la fayete	Central Algeria	Table + Oil	2%	22–26%	Suitable for the Bougaâ region.
Boukhenfas	Central Algeria	Oil	2%	22–26%	Performs best at the Sidi-Aich station.
Limli	Eastern Algeria	Oil	8%	20–24%	Recommended in the Jijel to Sidi-Aich region.
Blanquette	Eastern Algeria	Table + Oil	20% of orchards	18–22%	—
Rougette	Eastern Algeria	Oil	12%	18–22%	—
Neb Djmel	Southeastern Algeria	Table + Oil	5%	14–22%	Variety of pre-Saharan regions.
Frontoio	Central and Eastern Algeria	Oil	1%	20–24%	Italian variety; good pollinator of Chemlal.
Coranita	Central and Eastern Algeria	Oil	1%	18–24%	Italian variety; very hardy and productive.
Longue de Miliana	Central and Western Algeria	Table + Oil	5%	22–26%	Very localized in the Miliana region.
Ronde de Miliana	Central and Western Algeria	Table + Oil	5%	18–22%	Very localized in the Miliana region.
Moroccan Picholine	Western Algeria	Oil	30%	20–26%	Very common; shares characteristics with Sigoise.
Ascolana	West	Table	—	18–22%	Excellent and consistent fertility. Hardy and cold-resistant. Promising for Algeria.

Hama de Constantine	Eastern Algeria	Table	–	18–22%	Best variety in Constantine for preservation; needs irrigation.
Bouricha	Eastern Algeria (Collo–Oued El Kebir)	Oil	5–6%	20–24%	Grown in high rainfall areas.

Appendix 03: Diseases, Pests, and Treatments by Location

Location	Disease and Pest	Treatment
Ghazaouet	None	Chemical (preventive)
Nedroma (2)	Verticillium wilt, Arthropods (spider mites)	None
Nedroma (1)	Arthropods (spider mites)	Chemical
Honaine	Psyllid, Olive fruit fly	Chemical, Physical
Sidi M'Djâhed	Olive fruit fly, Olive moth	None
Tlemcen	Olive knot (<i>Pseudomonas savastanoi</i>)	Chemical
Saf Saf	None	None
Mansourah	Verticillium wilt	Chemical
Bouhanak	Sooty mold, Psyllid	None
Aïn Ghoraba	Peacock spot (<i>Spilocaea oleagina</i>)	None

Appendix 04: Altitude, Spacing, Density, Fertilization, and Irrigation System

Location	Altitude (m)	Spacing (m)	Density (plants/ha)	Fertilization Type	Irrigation System
Ghazaouet	87	6 × 6	≈ 278	Organic fertilizer + NPK (0-20-20)	Drip, 3 hours/week
Nedroma (2)	224	5 × 6	≈ 333	NPK (0-15-15) + Urea	Drip, 2 hours/week
Nedroma (1)	261	5 × 6	≈ 333	NPK (0-20-25)	Drip, 2 hours/week
Honaine	324	6 × 6	≈ 278	NPK (0-20-25)	Drip, 4 hours/week
Sidi M'Djâhed	444	5 × 7	≈ 285	NPK (0-15-15) + Manure	Drip, 3 hours/week
Tlemcen	678	7 × 7	≈ 204	NPK (0-20-25) + Organic fertilizer	Flood, 2 hours/month
Saf Saf	648	6 × 7	≈ 238	NPK (0-15-15)	Flood, 3 hours/month
Mansourah	791	7 × 7	≈ 204	Organic fertilizer + NPK (0-20-25)	Drip, 4 hours/week
Bouhanak	783	7 × 6	≈ 238	NPK (0-15-15)	Flood, 2 hours/week
Aïn Ghoraba	801	7 × 7	≈ 204	Manure + NPK (0-20-25)	Flood, 3 hours/month

Appendix 05:

Farmer Questionnaire – Study on Olive Tree Diseases

I. General Information

1. **Farmer's full name:**
2. **Municipality / Locality:**
3. **Total area planted with olive trees (ha):**
4. **Number of olive trees:**
5. **Average age of the trees:**
 Less than 10 years 10–30 years More than 30 years
6. **Cultivated variety/varieties:**
.....
.....

II. Agricultural Practices

7. **Type of irrigation used:**
 None (rain-fed cultivation) Drip irrigation Other:
8. **Do you perform regular pruning?**
 Yes No Occasionally
9. **Do you apply fertilizers?**
 Yes No
If yes, specify the type:
 Organic Chemical Both
10. **Do you use plant protection treatments?**
 Yes No
If yes, please specify the product(s) used and the frequency:
.....
.....

III. Observation of Diseases and Pests

11. **Have you noticed any suspicious symptoms on your olive trees?**
 Yes No
If yes, specify:
 Yellowing of leaves
 Leaf fall
 Spots on leaves (e.g., Peacock's eye)

- Branch dieback
- Others:

12. Have you noticed the presence of pests?

- Yes No

If yes, which ones:

- Olive fruit fly (*Bactrocera oleae*)
- Olive moth (*Prays oleae*)
- Scale insects
- Others:

13. Have you ever contacted a technical service or organization for help in identifying or treating a disease?

- Yes No

If yes, which one:

IV. Additional Comments

14. Do you have any remarks or specific needs regarding the health of your olive trees?

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