Olea europaea

Monograph

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Introduction

The olive tree (*Olea europaea*) is one of the oldest nad most important fruit trees in the world. It has been valued for thousands of years, not only for the olives and oil it prdouces, bu also for its strength, ability to grow in dry climates, and deep cultural meaning in the mediterranean region. The olive tree belongs to the Oleaceae family and comes from wild ancestors that were first grown in areas like the middle east and north africa. Over time, people have developed many different types of olive trees, each suited to different places and uses.

This monograph looks at the olive tree from a scientific and practical view. It begging in the firts chapter agroecology, then it explores the olive biology thats the second chapter, then its propagation and management that is the third chapter, then its comercial importnace in the world that is the fourth chapter, and lastly the fifth chapter cultural importance of the plant. By the end, *Olea europaea* will be understood as a unique and important tree.

1 Agroecology

1.1: Affinity

Olea europaea L., or the olive tree, is part of the Oleaceae family, which includes about 600 species worldwide. This family belongs to the Lamiales order and is linked to other plant families like the Lamiaceae (mint family). Within the Olea genus, Olea europaea is the most important species, widely grown for its olives and olive oil. Other species highlight its diversity and adaptability. For example, Olea capensis grows in dry, high-altitude regions of Southern Africa, while Olea ferruginea thrives in the Himalayan mountains. Olea oleaster, believed to be the wild ancestor of the cultivated olive, is significant in understanding the species' evolution and agricultural history. Together, these species illustrate the wide adaptability, genetic richness, and environmental resilience of the Oleaceae family. (Parvaiz, 2013).

Figure 1

Photo of taxonomy of olive plant (Wikimedia projects, 2011)

1.2: Taxonomy

Olive trees are part of the plantae kingdom (Table 1) that are all the land plants like; sunflower, wheat, olives, etc. The plantae kingdom is plants that are eukaryotic, multicellular and autotrophic organisms. Eukaryotic is the organisms that are formed by cells and autotrophic organisms are the plants that do photosynthesis. The members of plantae have a cell wall in their multicellular organisms. The olive tree (*Olea europaea*) belongs to the Oleaceae family, which is a group of plants that produce flowers. It is part of the dicotyledons, a type of plant that has two seed leaves (called cotyledons) when it starts growing. Flowering plants, also known as angiosperms, are plants that make flowers to help them reproduce. These plants are part of a larger group called seed plants, which reproduce using seeds instead of tiny spores like ferns and mosses do. Seed plants are a type of vascular plant, meaning they have special tissues, like xylem (for moving water) and phloem (for moving food), to help them grow and survive. All these plants are part of the land plant group, which includes plants that live on land and have features like roots, stems, and leaves to adapt to life outside water. The olive tree shows how plants have developed these features over time, making it an important and useful species (Gonzalez, 1997)

Table 1

Taxonomic hierarchy of Olea europaea

Olive tree classification		
Kingdom	*Plantae*	Land plants
Subkingdom	*Tracheobionta*	Vascular plants
Super division	*Spermatophyta*	Seed plants
Division	*Magnoliophyta*	Flowering plants
Class	*Magnoliopsida*	Dicotyledons
Subclass	*Asteridae*	
Order	*Scrophulariales*	
Family	*Oleace*	Olea family
Genus	*Olea L*	Olive
Species	*Olea europaea*	Olive

1.3: Fossil Record

As olive trees were grown throughout the Mediterranean side countries like Greece, there were found fossilized olive leaves from a more than 60,000 years old volcano in Santorini (See figure 2). It was found in a quarry pumice that is where they extract rocks in Thira nowadays Santorini (Claus, 2023). This archeological find is really important for the olives' history because it means that olives have been a plant used in history and an icon of the Mediterranean countries.

Figure 2:

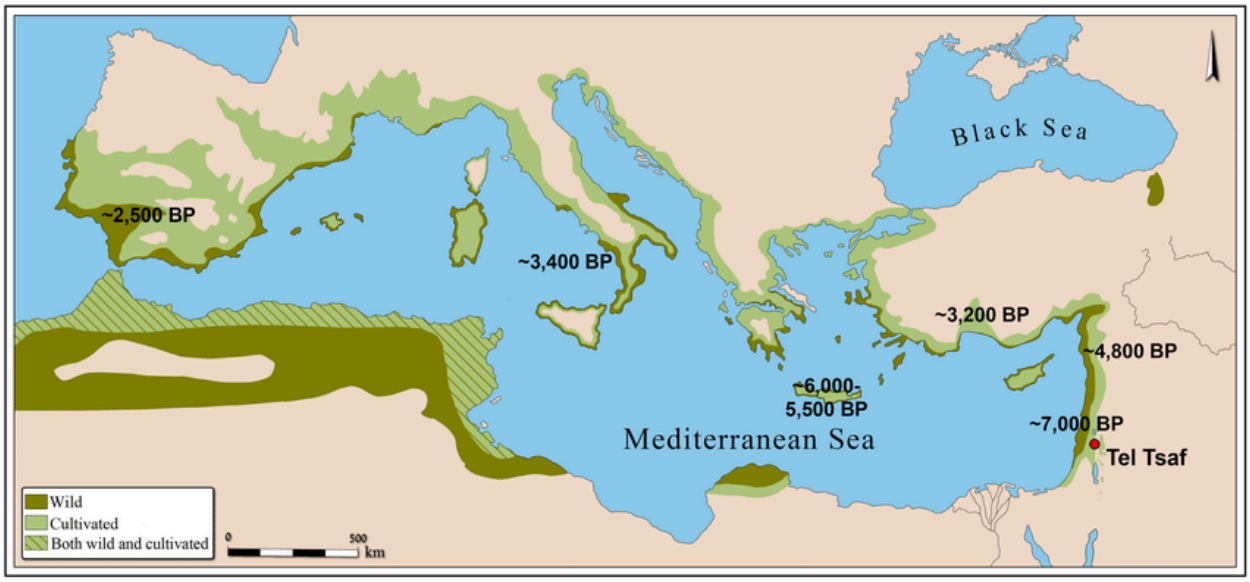
Fossilized specimens of olive leaves (Claus, 2023)

1.4: Origin

The olive tree, *Olea europaea*, originated in the Mediterranean region and Asia Minor, where wild forms grew naturally thousands of years ago (see Figure 3 below)(International Olive Oil Council, 2020). . Fossils show the tree has existed for millions of years. People began cultivating olives around 6,000 years ago in places like Syria and Palestine. From there, trade and empires like the Phoenicians, Greeks, and Romans spread its cultivation. By the 1500s, olives were introduced to the Americas. Today, olive trees are grown in many parts of the world in warm climates.

Figure 3:

Map of origin of Olive trees (Langgut, 2019).



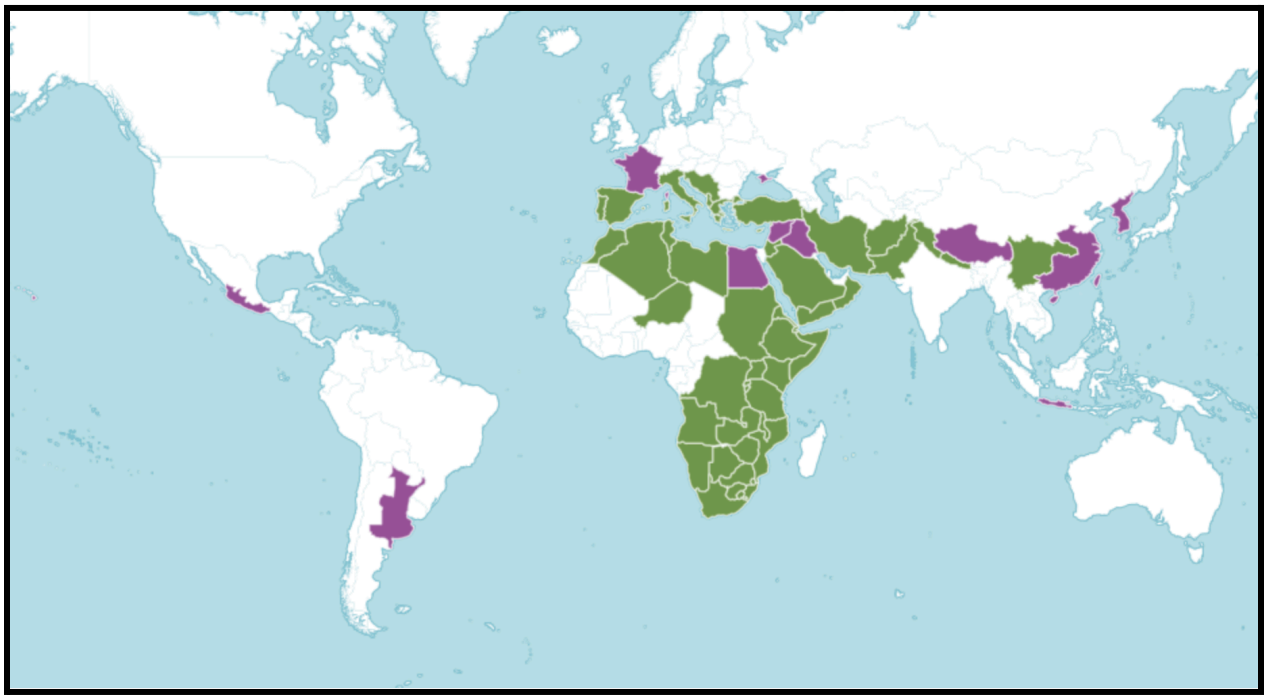
In this map you can see where it is native (dark green), where it is cultivated (light green) and where both of them are (striped).

1.5: Present Distribution

The olive tree, cultivated for thousands of years, is a crop in Mediterranean countries, producing around 19 million tons of olives annually. Spain leads globally, accounting for nearly 45% of the world's production, followed by Italy (around 20%) and Greece (13%). Tunisia and Turkey are also significant contributors. The trees cover over 10 million hectares worldwide, with 75% of olives used for olive oil. (Bergmier, 2011)

Figure 4:

Map of present distribution of olives (Bergmier, 2011)



This map shows the distribution of olives in and outside its native territory.

1.6: Environmental Factors in distribution:

1.6.1: Ecoregion, Elevation and Climate

Olive trees (*Olea europaea*) thrive primarily in Mediterranean climates (22°C - 30°C), characterized by hot, dry summers and mild, wet winters. These climates are found in the Mediterranean Basin, parts of California, Chile, South Africa, and Australia. They are typically

found in ecoregions with elevations ranging from sea level to about 800 meters. The climate in these regions provides the necessary conditions for olive trees to flourish, with temperatures rarely dropping below freezing. However, olive trees can also be found in microclimates outside these regions, where similar conditions exist. Olive trees can grow in climates outside the Mediterranean that replicate its conditions, such as coastal regions with mild winters (southern Japan), high-altitude valleys (Andes in South America), islands like the Canary Islands, and arid areas like southern Arizona. These locations share characteristics of warm, dry summers and mild, wet winters, allowing olive trees to thrive.(Rallo, 2000)

1.6.2: Water

Olive trees are remarkably drought-resistant. They have adapted to survive in arid and semi-arid regions by developing deep root systems that can tap into underground water sources. While they can survive with minimal water, optimal growth and fruit production require regular watering, especially during the growing season. Olive trees typically require around 300-600 mm (12-24 inches) of rainfall annually to survive, but they thrive best with 700-1,000 mm (28–40 inches) of water when aiming for optimal fruit production. During prolonged drought, irrigation providing 40–70 liters (10–18 gallons) per tree every 10–15 days is recommended, particularly in the growing season. While highly drought-resistant, insufficient water can lead to a drop in yields and vulnerability to pests and diseases. Their deep roots help them access water in dry conditions. (Rallo, 2000)

1.6.3: Geology and soils

Olive trees prefer well-drained, loamy soils with good aeration. They can tolerate a range of soil types, including calcareous, sandy and clay, but they thrive the best in soils with a neutral to slightly alkaline pH (7.0-8.5). (Virginia, 2022) Rocky and poor soils are also suitable, provided they are not waterlogged, as olive trees are sensitive to waterlogging, which can lead to root rot. The presence of calcium in the soil helps improve the structure, making it more suitable for olive cultivation.

1.6.4: Light

Olive trees require full sunlight to grow and produce fruit effectively. They need at least 6 hours of direct sunlight per day. Shaded conditions can lead to poor growth, reduced fruit yield, and

increased susceptibility to pests and diseases. Adequate sunlight is essential for photosynthesis, fruit set, and the development of high-quality olives (Rallo, 2000)

1.7: Olea europaea as a vegetation component

1.7.1: Associated species

In their natural habitat, olive trees often coexist with other Mediterranean species such as grapevines, figs, almonds, and various herbs like rosemary and thyme. These plants share similar climatic and soil requirements. In more diverse ecosystems, olive trees can also be found alongside native shrubs like cistus and lavender, contributing to a rich and varied landscape (Parvaiz, 2013)

1.7.2: Floristic Elements

The floristic composition around Olive Groves typically includes a mix of woody shrubs, grasses, and herbaceous plants. Common species found in these ecosystems include citrus lavender and wildflowers like puppies and daisies. These plants not only in the biodiversity of the area but also provide habitats for beneficial insects and contribute to soil Health through the root system and organic matter (Popay, 2022).

1.7.3: Root System

The root system of olive trees is extensive and deep, allowing them to access water and nutrients from a large area. This root structure helps them withstand drought conditions and supports their long lifespan, which can exceed several hundred years. The deep roots also stabilize the soil, preventing erosion (Rallo, 2000)

1.7.4: Pests and Diseases

Olive trees are susceptible to various pests and diseases, which can affect their health and productivity. Common pests include the olive fruit fly (*Bactrocera oleae)*, which lays its eggs inside the olive fruit, causing damage and reducing yield. The olive moth (Prays oleae) is another significant pest that targets flowers, fruits, and leaves. Diseases such as olive knot (caused by Pseudomonas savastanoi) result in the formation of galls on branches and twigs, while verticillium wilt (caused by Verticillium dahliae) leads to the wilting and death of branches. Integrated pest management (IPM) strategies are essential for controlling these pests and diseases and maintaining healthy olive orchards (Spooner, 2024)

2 Biology

2.1 Chromosome Complement

The olive tree is a diploid species with 46 chromosomes (2n = 2x = 46). This means it has two complete sets of chromosomes, one from each parent. Some cultivars may exhibit variations in chromosome number due to hybridization events (Chiappetta, 2012)

2.2 Life Cycle and Phenology

2.2.1 Life Cycle

Figure 5

Diagram of the life cycle of the olive tree (Alagna, 2016)

2.2.1.1 Seed Germination

Olive seeds require a period of cold conditioning at temperatures between 0-5°C for 60-90 days to break dormancy and promote successful germination (Popay, 2022). After this cold treatment,

the seed absorbs water, leading to the emergence of the radicle (embryonic root) followed by the shoot.

2.2.1.2 Juvenile/Vegetative Stage:

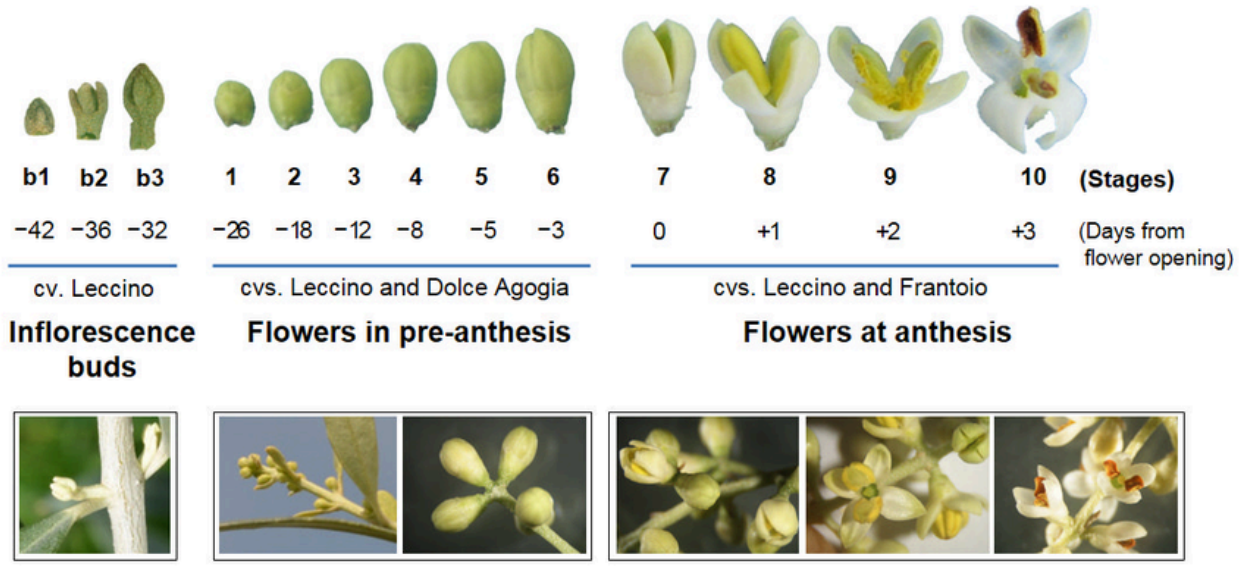
During this phase, which lasts 4-10 years, the young seedling develops a taproot and primary shoots with simple leaves. The tree focuses on vegetative growth and does not produce flowers during this period. The duration of this stage depends on environmental conditions and cultivar (Petar, 2024).

2.2.1.3 Flowering/Reproductive Stage:

The tree reaches maturity and begins annual flowering and fruit production. Olive trees are deciduous, shedding their leaves in autumn and entering dormancy. In spring, pollination occurs via wind, as most cultivars are self-incompatible and require cross-pollination (Alagna, 2016).

Figure 6

Map of the stages of olives flower (Alagna, 2016)

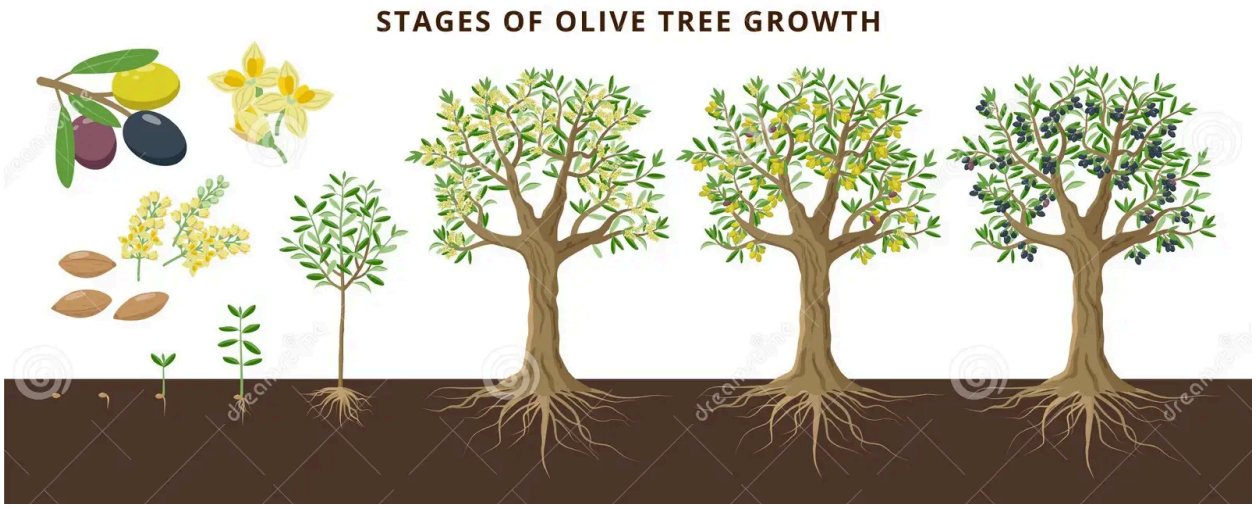


The flowering stages of olive trees begin with inflorescence bud formation (b1–b3), where small buds develop along branches about 42–32 days before flowering (Alagna, 2016). This is followed by the pre-anthesis stage (1–6), where the buds grow and swell but remain closed until around three days before blooming. Finally, in the anthesis stage (7–10), the flowers open, allowing for pollination and fertilization. By stage 10, the flowers are fully bloomed, marking the potential beginning of fruit formation. These stages are crucial for determining the tree's fruit production and overall yield (Alagna, 2016)

The growth cycle of an olive tree begins with a seed that, under the right conditions, germinates and grows into tiny roots and shoots (Figure 7). As it develops into a seedling, small leaves emerge, and the root system strengthens. The tree then transitions into the sapling stage, where it grows taller, thickens its trunk, and spreads more leaves. With maturity, the tree produces clusters of small yellowish flowers, which, after pollination, give rise to unripe green olives (Alagna, 2016) Over time, these olives ripen, turning yellowish and eventually dark purple or black, marking the tree's full maturity and readiness for harvest. This cycle continues annually, allowing the tree to sustain olive production for decades.

Figure 7

Map of the growth stages of olive trees (Bezvershenko, 2018)



2.2.1.4 Fruit Development and Maturation:

2.2.1.4.1 Oil and Sugar Accumulation in Maturation:

As olives mature, they undergo chemical changes that impact their composition. Instead of accumulating sugar, olives accumulate oil. The process begins with the conversion of carbohydrates into lipids, primarily oleic acid, that determines the quality of olives. In the cold temperature it establishes the accumulation of oil, affecting the olives final flavor and aroma (Rallo, 2000).

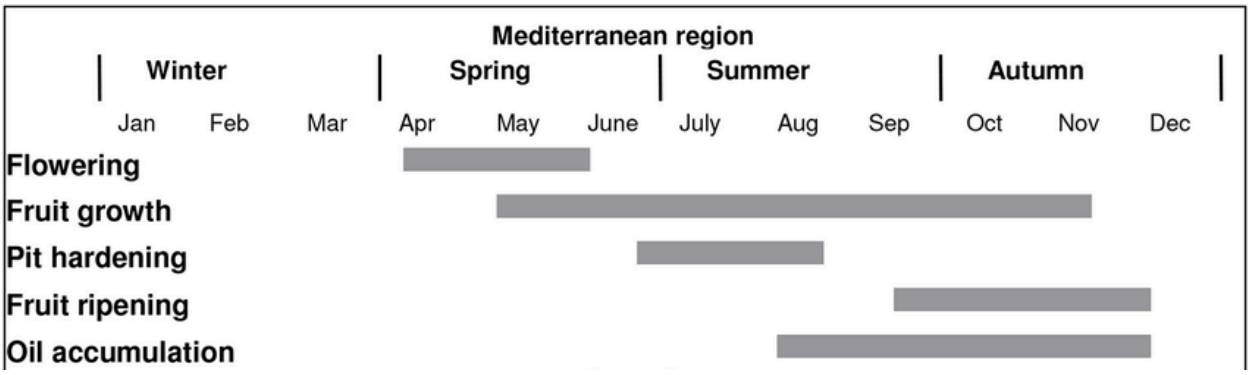
2.2.1.5 Senescence and Death

Over the decades, productivity declines. The tree survives 50-100 years, but disease, environmental stress, and pruning affect longevity. Commercial orchards replace trees after 20-30 years due to reduced productivity (Popay, 2022).

2.2.2 Phenology

Figure 8

Graph of the phenology of *olea europaea* (Torres, 2017).



2.2.2.1 Deciduousness

Olive trees (*Olea europaea*) are evergreen rather than fully deciduous, meaning they retain most of their leaves throughout the year, but they do shed older leaves seasonally. This process occurs mainly in late spring or early summer rather than autumn. The controlled shedding of older leaves allows the tree to conserve resources and maintain efficiency in photosynthesis by replacing aging leaves with new ones. This adaptation is particularly useful in Mediterranean climates, where hot, dry summers can stress the tree. Leaf drop can happen when there is too much rain like 1,000 mm per year, not enough nutrients like sulfur, nitrogen and calcium, or a disease that spreads quickly. (Brugnara, 2022).

2.2.2.2 Flowering and fruiting

The time when olive trees bloom depends on the variety and climate. In Mediterranean areas, flowers usually appear in late spring, around April or May, and fruit starts forming soon after pollination. The small, creamy-white flowers grow in clusters on branches from the previous year. However, only a small percentage of flowers, less than 5% turn into olives (Figure 6). Once fertilized, olives develop over several months and ripen between late summer and autumn. As they mature, their color changes from green to purple, red, or black, depending on the variety and harvest time (Brugnara, 2022).

2.2.3 Year-to-year variation in flowering and fruiting

Each year, olive trees may flower and fruit differently due to changes in temperature, pollination, and overall tree health. If the winter is warm, flowers may bloom earlier, while sudden cold weather can delay or harm them. Since olive trees rely on wind for pollination, bad weather like rain or strong winds can lower fruit production. Olive trees also have a natural cycle called "alternate bearing," where a high-yield year is followed by a lower-yield year. Proper care, including pruning, watering, and fertilizing, can help keep fruit production steady (Brugnara, 2022).

2.2.3.1 Temperature fluctuations

Temperature plays a major role in how well olive trees grow and produce fruit. If frost occurs during the blooming period, it can damage flowers and reduce fruit production. On the other hand, if temperatures get too warm early, trees may bloom before pollinators are active, lowering fruit yield (Petar, 2024). Heat waves during early fruit development can also cause fruit to fall off, shrink, or have less oil. To manage temperature risks, farmers use frost protection, shading, and choose heat-resistant tree varieties.

2.2.3.2 Tree Health

The health of an olive tree affects how well it flowers and produces fruit. Taking care of the orchard by watering, fertilizing, and pruning helps keep trees strong. Pests like olive fruit flies and scale insects, along with diseases like verticillium wilt, can weaken trees and reduce yields. Nutrient limitations, especially in nitrogen and potassium, also affect fruit production (Parvaiz, 2013). Farmers use pest control, soil management, and organic fertilizers to maintain tree health and ensure good harvests.

2.2.4 Effects of Climate Change

Climate change is shifting the timing of olive tree flowering and fruiting. In some areas, warmer temperatures cause trees to bloom earlier, which can disrupt pollination and reduce fruit quality (Brugnara & Sabião, 2022). Droughts and extreme heat also stress trees, leading to lower oil content in olives. Scientists are developing new olive varieties that can handle hotter, drier conditions. Farmers are also using better irrigation, mulching, and adjusting planting schedules to help trees cope with climate changes.

2.3 Reproductive Biology

2.3.1 Pollen

Olive flowers produce pollen in their anthers, which is carried by the wind for pollination. Olive pollen is very light and can travel long distances (Parvaiz, 2013). While this makes pollination easier, it also causes allergies in many people living in Mediterranean regions. The amount of pollen produced depends on the tree variety, weather, and tree health.

Figure 9

Image of Olive flower during pollination time (Mapes, 2021).

2.3.2 Sexuality

Olea europaea mostly have hermaphroditic flowers, meaning they contain both male and female parts. However, some flowers are only male and can't produce fruit. (Popay, 2022). Since many olives trees don't self pollinate well, they rely on cross- pollination with other trees, usually carried by winds, to grow olives.

2.3.3 Anthesis

Anthesis is when flowers are fully open and ready for pollination. This phase lasts a few days and is affected by temperature, humidity, and wind (Rapoport, 2014). The best temperatures for pollination are between 18°C and 25°C. If it gets too hot or rains too much, pollination may not be as successful.

2.3.4 Pollination and potential pollinators

Unlike many fruit trees that rely on insects, olive trees depend mostly on wind to carry pollen between flowers. Since olive flowers do not produce nectar, they do not attract bees. However, some insects, like beetles and flies, may still visit the flowers occasionally (Rapoport, 2014). Even when pollination happens under ideal conditions, only a small percentage of flowers turn into mature olives. This is due to factors like nutrient availability, weather stress, and tree genetics.

2.3.5 Fruit development and seed set

2.3.5.1 Ovule development

After successful pollination, the ovules inside the flower’s ovary develop into seeds. Good seed development is essential for producing high-quality olives (Popay, 2022). Factors such as soil nutrients, water, and plant hormones all affect how well the seeds form. If fertilization is incomplete or nutrients are lacking, the fruit may be small or deformed.

2.3.5.2 Ovary wall development

As seeds develop, the ovary wall thickens and becomes the fleshy part of the olive, called the pericarp. The pericarp determines the olive's size, texture, and oil content. Environmental conditions like drought, extreme heat, or poor soil can affect the fruit's growth and quality (Rapoport, 2014). Farmers manage these challenges by improving soil conditions, using irrigation, and selecting the best varieties for their region.

2.4 Ecophysiology

Olive trees respond to their environment, and factors like temperature, light, and water availability play a big role in their growth. Temperature changes affect photosynthesis, respiration, and flowering. Light exposure influences how well trees produce energy and how olives develop their color. Water is also crucial because drought can reduce fruit yield and oil production (Rapoport, 2014). To deal with these challenges, farmers use advanced irrigation methods like deficit irrigation, which saves water while keeping trees healthy. Good farming practices help maintain high olive production and support sustainable agriculture.

3 Propagation and Management

3.1 Natural Regeneration

Olea europaea don't grow naturally very well on their own because they usually need to be grown from cuttings or grafting. In the wild, their seeds spread through birds and animals, but when farmers grow them, they prefer using other methods to keep the same traits in each tree (Barranco, 2017). When olives grow from seeds, the trees can turn out very different, which can make the fruit less predictable.

3.2 Nursery Propagation

3.2.1 Propagation from Seed

3.2.1.1 Pre-preparation and Germination Process

Olive seeds have a hard shell that makes it difficult for them to sprout. To help them grow, people soak the seeds in acid for about 20–30 minutes and then store them in a cold place at 5°C for about 40–60 days. This helps break their dormancy so they can sprout more easily (Fabbri, 2004). Without this treatment, most seeds won't grow.

3.2.1.2 Sowing and Germination Process

To grow olive trees from seed, first remove and clean the pit, then gently crack or file it to help it sprout. For better results, the seed can be kept in a moist paper towel in the fridge for 1–2 months (a process called cold stratification). After that, plant it about 1–2 cm deep in well-drained soil and keep it in a warm, sunny spot. The soil should stay moist but not too wet. Germination is slow and may take up to 3 months. Once the seed sprouts and grows a few leaves, it can be moved to a bigger pot and cared for like a young tree (Rallo, 2008)

3.2.1.3 Storage

After picking the olive seeds, they should be cleaned and left to dry so they don't get moldy. Keep them in a cool, dry place, away from the sun. It's better to store them in paper or cloth bags so air can get in. If you want to keep them for a long time, you can put them in the fridge. Also, write the date you stored them, because olive seeds don't last forever and might not grow if kept too long (Barranco, 2017).

3.3 Planting

The best time to plant olives is in spring or Autumn, so olives don't get too hot or cold. They grow best in sandy soil that drains well and has pH between 6.5 and 8.5. The distance between trees depends on how they are grown, space between 6–10 meters apart, while in big farms, they are spaced 2–4 meters apart (Rallo, 2018).

3.4 Management

3.4.1 Tending

Taking care of olive trees includes watering them, especially when they are flowering or setting fruit. Mulching, which is covering the ground with organic material, helps keep moisture in the soil and stops weeds from growing. Pruning is also important because it helps shape the tree, keeps it healthy, and improves fruit production (Hartmann, 2018).

3.4.2 Fruiting

Olive trees start making fruit about 3–7 years after they were planted, depending on how they were grown. Framers don't usually thin out the fruit, but sometimes they do to make the olives bigger and better. Some varieties of olives need cross-pollination, which means they need pollen from another tree to produce fruit (Rallo, 2018)

3.4.3 Pests and disease control

Olive trees can be attacked by pests like the olive fruit fly (*Bactrocera oleae*), scale insects, and the olive moth (*Prays oleae*) (Barranco, 2017). Some common diseases that affect olives are Verticillium wilt (*Verticillium dahliae*), olive knot (*Pseudomonas savastanoi*), and peacock spot (*Spilocaea oleaginea*). To prevent these, farmers plant resistant trees, use copper-based sprays, and keep their orchards clean (Fabbri, 2004).

3.4.3.1 Common olive pests

Olive Fruit Fly (*Bactrocera oleae*): This is the most destructive pest in olive farming. The larvae feed inside the fruit, causing it to rot and drop early. Control methods include mass trapping, biological control with parasitoid wasps, and the use of organic or synthetic insecticides (Daane & Johnson, 2010).

Figure 10

Image of the Olive Fruit Fly (Mosca del olivo, n.d.).

Olive Moth (*Prays oleae*): It affects the flowers, leaves, and fruit, depending on its stage. Pheromone traps and selective insecticides are commonly used for its control (Civantos, 2001).

Figure 11

Image of the Olive Moth (Owel, 2022).

Black Scale (*Saissetia oleae*): These insects suck sap from the plant and produce honeydew, which attracts sooty mold. They weaken the tree and reduce yields. Natural predators like ladybugs and parasitoid wasps are effective in managing them (Longo, 1994).

Figure 12

Image of the Black Scale (Luis, 2014).

Olive Psyllid (*Euphyllura olivina*): This pest damages new growth and flowers. It is mainly controlled by natural enemies and, if necessary, insecticidal treatments (Martín, 2005).

Figure 13

Image of the Olive Psyllid (Agrologica, n.d.)

4. *Olea Europaea* Commercial Importance

4.1 Exporting and Importing of the Product

Olives (*Olea europaea)* are one of the most widely traded fruit world wide. The largest exporters include Spain, Italy, Greece, and Turkey. According to the international Trade Centre (ITC), Spain alone exported over 340,00 metric tons of olives in 2022, valued at more than $800 million dollars. The top importer include the United States, Brazil, and other EU countries (International Trade Centre, 2023).

International olive oil trade is also important. The International Olive Council (IOC) reported that global oil exports exceeded 1.1 million metric tons in 2022 - 2023. Spain is the largest exporter, while the United Staes is the biggest non EU importer (IOC, 2023).

4.2 Importance in the Economy

The olive industry plays a key role in the economies of Mediterranean countries. In Spain, it contributes more than €4 billion annually, employing over 250,000 people (Spanish Ministry of

Agriculture, 2022). In Greece, olive products make up 10% of the country's agricultural output. That is what the countries produces (Greek Ministry of Rural Development, 2021).

Globally, olive cultivation supports rural economies and helps maintain cultural landscapes. In countries like Tunisia and Morocco, olives are a primary source of income for smallholder farmers, supporting food security and export earnings (FAO, 2023).

5. Cultural Importance

The olive tree hold cultural and historical importance, mainly on the mediterranean region, where they have been cultivated for thousand of years. They symbolize peace and they appaear mayorly in aancient greek and roman traditions (Fabbri, 2004). In greek mythology, the goddess athena gifted the olive tree to the city of athens, a symbol of civilization (Internationa Olive Council, 2023). The olive branch continues to serve as a symbol of peace, even used in the emblem of the Untied Nations. Culturally, olives are central to mediteranean food. In Islamic, jewish and cristian traditions, olive oil is considered sacred and used in ceremonies. (Barranco, 2017).

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