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Review Article

Symptomology of Major Fungal Diseases on Olive and Its Management

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Abstract

The olive tree count among the most important oil-producing crops throughout the Mediterranean region. It has nutritional, social, economic, phytotherapeutic and ecological importance. All of the olive tree diseases cause considerable drops in yield and represent a permanent threat to olive growing in the world. The main fungal diseases of the olive are: Verticillium wilts, Root rot fungi, Sooty mold, Peacock spot, Anthracnose, Cercospora leaf spot of olives and Dalmaticosis of the olive. In this article we have cited for each disease the main symptoms and their means of control.

Keywords: Olive Tree; Verticillium Wilt; Root Rot Fungi; Sooty Mold; Peacock Spot; Anthracnose; Cercospora Leaf Spot of Olives and Dalmaticosis

Introduction

The olive tree (Olea europaea L.) is one of the oldest cultures in the Mediterranean. The olive tree is the main cultivated fruit species since it represents 65% of the national arboreal sole in Morocco. It occupied an area of 1 020 570 hectares in 2016/2017, of which 34910 ha were in the irrigated area and 212880 ha in Bour. It should be noted that total olive-growing area in 2016/2017 was composed of 64% in Bour and 36% in irrigated. National holdings totaled around 1.56 million tonnes of olives in 2017/2018 (Anonyme 1). However, this production experiences significant interannual fluctuations due to the alternation of olive trees, the irregularity of rainfall and the lack of maintenance of orchards driven in Bour which affect productivity. Morocco also produces 160000 tonnes of olive oil and 90000 tonnes of table olives. In terms of exports, 17000 tonnes of olive oil and 64000 tonnes of table olives are founde on international markets (Anonyme 2). Moroccan olive growing is made up of 96% of the population variety « Moroccan Picholine ». The rest of the heritage consists of Meslala, Canned Olive, Picholine from Languedoc, Dahbia Houwzia and Menara. There are also other varieaties from other cuntries such as Arbequina or Manzanille from Spain and Leccino from Italy (Anonyme 1).

World olive oil production would reach 3135000 tonnes according to the International Olive Council for 2018. Olive oil production is concentrated around the Mediterranean : Spain (1550000 tonnes), Italy (270000 tonnes), Greece (240000 tonnes), Turkey (183000 tonnes), Portugal (130000 tonnes), Morocco (145000 tonnes) and Tunisia (120000 tonnes). These countries alone represent more than 90% of world production in 2018.

The olive tree is used as a medicinal plant, in particular for its leaves which have a diuretic, hypotensive and vasodilation effect and are use in the composition of pharmaceutical specialties. For pharmacologist it is oleuropein which is hyptensive and to a lesser extent triterpene compounds derived from oleanic acid. Oleuropein is a seco-iridoid, a fairly bitter compound that breaks dawn fairly quickly, therefore it seems preferable to use standardized extracts from the olive leaf (Glycerin maceration, stabilized extract) rather than a decoction or aqueous infusion. Olive leaf is also anti-diabetic and clinical studies confirm its indication to prevent atherosclerosis (Lakache et al., 2019, Lamzira *et al*., 2014, Susalit *et al*., 2011).

Olive growing faces several problems, in particular attacks caused by microorganisms (Bacteria and Fungi) or viruses. All of the olive tree diseases cause considerable yield losses and represent a threat to olive growing. Olive pathogens exceed one hundred, but only a small number among them that cause serious economic losses to olive groves (Trapero and Blanco, 2010). The most important diseases of the olive tree known in the world are presented in thi article. An important group of diseases is the complex of leaf and fruit fungal diseases, mainly scab caused by *Fusicladium oleaginum*; anthracnose caused by *Colletothricum* spp. and Cercospora leaf sport of olives due to *Pseudocercospora cladosporioides*. These three diseases cause significant defoliation, weakening of the tree and reduction of the productivity and quality of the olive tree (Trapero and Blanco, 2010).

Verticillium Wilt

It is a disease caused by telluric fungi, Verticiullium dahliae, it is a vascular disease know in many regions of the world (Lopez Escudero and Mercado-Blanco, 2010, Bellahcene *et al*., 2000)). Verticillium dahliae penetrates first affects the roots of young plants, colonizes them xylem and phloem cells, then stems and leaves through the sap flow (Chliyeh *et al*., 2014). This causes vascular lesions with circulatory disturbances which result in two types of symtoms (Jabnoun-Khiareddine *et al*., 2007): The acute rapid dieback in young tress and the chronic dieback in old trees. Fast acute dieback in young tress and chronic slow in old trees (Bubici et Cirulli, 2011).

- Rapid decline: the leaves turn yellow, then dry up while remaining attached to the branch. The bark turns brown and the twig or branch dries (Tombesi et al., 2007, Bellahcene, 2004).
- Slow decline: the color of the leaves becomes tarnished and the terminal buds necrotic, but the branches do not dry completely.

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Table 1: Integrated Management of Major fungal Diseases of Olive.

Diseases	Cultural pratices	Chemical Pratices	Biological Pratices
Verticillium wilt	Plant material must be certified. Avoid soil with previous crops favorable to this disease. Balance fertilization and irrigation. Disinfection of agricultural implements before and after use. Avoid weeds and planting susceptible to *Verticillium dahliae* around trees. During winter pruning remove and burn all twigs and branches dried out (Tombesi et *al.,* 2007).	The injection of Carbendazim into the trunk seems to stop the attack for five months (Tombesi et *al.,* 2007). Injection with benomyl, phosetyl-Al, their mixtures with quinosol or prochloraz (Trapero and Blanco-Lopez, Mule et *al.,* 2002)	Use of organic amendment against *Verticillium dahliae* (Vitullo et *al.,* 2013, Varo-Suarez et *al.,* 2018) Use of non pathogenic strain of *Fusarium oxysporum,* fungi *glomus intradices* and *Pseudomonas fluorescens* against this disease (Mulero-Aparicio et *al.,* 2019, Varo et *al.,* 2016, Mercado-Blanco et *al.,* 2004).
Root rot fungi	Avoid waterlogging and excessive irrigation. Avoid soil movement from infected areas to non-infected areas. Avoid planting is sites with prvious history of root fungal disease. Avoid intercropping with susceptible plants Use disease free planting material.	Use the fungicides : pyraclostrobin, tebuconazole+trifloxystrobin , mancazeb, bioproducts included copper oxychloride and sulphur-based product (Nitro et *al.,* 2018). Treat with Ridomil gold	Use of *Bacillus subtilis* against this disease (Nigro et al., 2018) Use of *Bacillus cereus, Azotobacter sp., Bacillus megaterium* and *Bacillus subtilis* against this disease (Abdel-Monaim et *al.,*2014) Use of *Bacillus subtilis* and *Trichoderma harzianum* (Mousa et *al.,*2006)
Sooty Mold	Make sure the plant is well nourished and well watered. A plant weakened by poor soil or lack of water is a vulnerable plant. Diversity the plants and flowers in your garden, this is the best way to offert hem naturel protection against diseases.	Sprayin the leaves with Bordeaux mixture should be enough to remove the sooty mold. An effective remedy against sooty mol is also to fight against the insects which are responible for it.	
Peacock spot	Apply cultural pratice that provides well aerated trees. This can be achieved with contoured planting to encourage air drainage through the grove followed by selective pruning to avoid dense canopy (Roca et al., 2010)	Copper An-Tracol can be viewed as the best choise for the control of the disease (Salman et *al.,* 2014).Copper-based fungicides (Copper sulfate, Cu at 3.5kg/ha) were applied during the spring and autumn to limit fungal foliar and fruit diseases (Trapero et *al.,* 2010).	Use of *Pseudomonas spp., Bacillus spp. and Microbacterium spp.* against this disease (Salman, 2017)
Anthracnose	Prune to aerate the canopy Copper can be applied as a protectant and there is also a permit for amistar, which should also be applied as a protectant	Use the fungicides : pyraclostrobin, tebuconazole+trifloxystrobin , mancazeb, bioproducts included copper oxychloride and sulphur-based product (Nigro et al., 2018)	Use of *Bacillus subtilis* against this disease (Nigro et *al.,* 2018)
Cercospora leaf sport of olives	Apply cultural pratice that provides well aerated trees. This can be achieved with contoured planting to encourage air drainage through the grove followed by selective pruning to avoid dense canopy (Roca et al., 2010)	Copper-based compounds or mixtures of these compounds with systemic fungicides, such as difenoconazole, tebuconazole and strolilurin have had successful results in controlling olive aerial diseases (Nigro et al., 2018, Obanor et al., 2008, Viruega et al., 2002)	Use of *Bacillus subtilis* against this disease (Nigro et al., 2018)
Dalmaticosis of the olive	Reason irrigation and fertilization, moderate nitrogen supply. Effective control of the olive fly seems essential ot limit the development and spread of the disease : the entry and exit holes it causes have a definite impact on the development of these diseases. In order to decease the primary inoculum rate, it is strongly advised to collect and incinerate dropped olives on the ground. (CIO, 2007)	Use Two fungicides (Nordo and Mancozebe) against the fungi C. dalmaticum (Margier et *al.,* 2014) Copper-based compounds or mixtures of these compounds with systemic fungicides, such as difenoconazole, tebuconazole and strolilurin have had successful results in controlling olive aerial diseases (Nigro et al., 2018	Use of *Bacillus subtilis* against this disease (Nigro et *al.,*2018)

Only the floral clusters are very affected and dry up (Tombesi et al., 2007).

Symptoms appear at the end of winter, as soon as tempratures rise during the day and spread out during the growing season. Generally it is in March and April that drying out is most spectacular (Jiménez-Diaz *et al*., 1998).

The internal pathological symtoms of Verticilliul wilt of the olive tree are manifested by browning of the xylem of the infected branches (Tombesi *et al*., 2007) and of the central cylinder of the root system (Triki *et al*., 2006).

Verticillium dahliae can survive in the soil for several years, up to 20 years, in the form of free microsclerotia or in infected tissue (Triki *et al*., 2006). This fungi spreads through the transport of contaminated tissue, whether it is vector plants or pruned wood. To a lesser extent, sawdust (Cutting tools), soil(Tillage tools), water (gravity irrigation) or wind can laso contribute to the spread of the disease (Klosterman *et al*., 2009, Chawla *et al*., 2012).

Root Rot Fungi

It is a fatal vascular disease for the olive tree, it is caused by a complex of telluric fungi (Tombesi *et al*., 2007) : Macrophomina

phaseolina (Rhizoctonia bataticola), Armillaria mellea Kumm (Glynn *et al*., 2011), *Fusarium solani sacco, Corticium rolfsi curzi, Fusarium oxysporum, Phytophtora megasperma, Corticium solani, Rosellinea necatrix*. The fungi act in synergy, each takin its share of the infection (Boulila, 1994 et 2001). Symptoms of root rot are generally manifested by slender olive trees the branches bear leaves reduced in size and number. The latter take on a yellowish appearance in spring and which later becomes accentuated to become golden yellow. This color persists throughout the summer season but with the arrival of autumn the plant begins to mor or less regain its normal appearance. Indeed, its foliage becomes pale green in color; however, it keeps its weak and bald appearance (Boulila, 1994). For a strong attack, the leaves begin to necrose at their tips and eventually dry out. There follows a significant fall which affects the inflorescences which become dehydrated, turn brown and die (Boulila, 1994, Sancher-Hernandez *et al*., 2001, Bareto *et al*., 2002, Moussa *et al*., 2006, Barrera *et al*., 2003).

Sooty Mold

The sooty mold also called « Olive black » is one of the diseases that can suffer the olive tree. The sooty mol dis the cause of the performance of genera fungi *Capnodium sp., Fumago sp and Aureobasidium spp*. It develops on honeydew secreted by insects such as mealybugs ans aphids. Mycelia settle on the surface of wodds, leaves and fruits to form a black film that causes premature aging by suffocation by blocking the photosynthesis and by reducing gas exchanges. It slows growth and leaves a blackish layer on the leaves. Tree growth and production olives are reduced. The development of sooty mould weakens tress already effected by persistence of sooty mold can cause defoliation. The exact repercussions of sooty mold on olive production remain difficult to assess but it's not trivial (LeVerge et al., 2016).

The development of sooty mold being linked to proliferation of the black scale of the olive tree, it is necessary pay more attention to the factors favoring mealybug ; the absence of size or sizes too spaced apart, insufficient spacing between foliage, excessive nitrogen fertilization, repeated applications of poorly selective insecticides leadin to reduce the auxiliary fauna, mild temperatures in winter, higher humidity in summer (LeVerge et al., 2016).

Peacock Spot

The disease is also known as the peacock eye or olive leaf spt (Macdonald *et al*., 2000). It is due to the fungi *Venturia oleaginea (Castagne)*(Rossman et Crous, 2015) which is answered in the Mediterranean area and in the areas of live growing (Trapero *et al*., 2017), it is responsible for serious yield losses in many olive growing region all over the world (Graniti, 1993, Romero et *al.,* 2018). The fungi attacks all the vegetation of the plant in autumn and spring, but especially forms brownish spots distributed irregularly on the top of the leaves, these spots can wait between 0.5 to 1.2 mm in diameter. They then turn greyish brown surrounded by a a yellow halo like the eye on the peacock's tail feathers. Diseased leaves fall faster causing imbalances in the plant and drying of its branches (Obanor, 2005, Trapero and Blanco, 2008, Alsalimiya et *al.,* 2010, Viruega et *al.,* 2013). The fungus overwinters as a mycelium mainly on the leaves attacked in previous years. Contamination occurs in cool weather (12-15°C) and humidity, and the optimum germination is 20°C. High temperatures hinder the development of the disease. (Hajjeh et *al*., 2014, Moral et *al.,* 2014, Rhimini et *al.,* 2014, Lopez et *al.,* 2000).

Anthracnose

Anthracnose may be regarded as the most damaging disease of olive fruit worldwide (Farr and Rossman, 2013). It is produced by fungi *Colletotrichum acutatum* and *colletotrichum gloeosporiodes.* Initially it only affected olives, but currently fungi produce a toxin that weakens the olive tress by drying the affected branches. It is the rainy autumn when the fungi has a greater development and produces significant damage, especially in the olive varieties more sensitive to the disease. The olive anthracnose occurs in the branches with a significant amount of infected fruits and produces the dry of branches up to 5 centimeters in diameter (Achbani et *al.,* 2013). In the first stage of development, symptoms are only detected in olive (Agostero et *al.,* 2005). The frist symptoms are round and necrotic spots with brown color (Oliveira et *al.,* 2005), ocher or brown. Initially the fruits have one or more round and growing spots. In the final phase, the spot grow and come together, completely infecting the olive. When the humidity is high, on the spots it forms a jelly-like and orange substance with as lot of spores. As the infestation profresses, the olive fall to the ground or remain dry and mummified in the tree (Moral et *al.,* 2009, Moral and Trapero, 2009). Olives infected by th fungi emit a toxin that produces an effect similar to that leaf chlorosis. These chlorotic spots expand covering almost the entire leaf. Finally, the leaves dry and fall to the ground, causing significant defoliation. Anthracnose develops well with condition of temperature of 10-30°C and high relative humidity more than 93% (Moral et *al.,* 2011, Oliveira et *al.,* 2005). The main source of anthracnose inoculum is the mummified olives that remain in the top of the tree (Graniti et *al.,* 1993, Moral and Trapero, 2012).

Cercospora Leaf Spot of Olives

Cercospora leaf spot is a serious disease of olives it is caused by *Pseudocercospora cladosporioide (*Garcia Figueres, 1991). The disease primarily affects the foliage and more rarely the fruits symptoms in the foliage are generally observed from autumn to Spring on leaves over one year old. On the upper side of the leaves yellow chlorosis tends to gradually become necrotic, especially at the tip and on the sides, while the lower side in covered with a characteristic grayish felting linked to th multiplication of conidia. This felting may disappear due to the entrainment of conidia by the rains (Crous et *al.,* 2000, Trapero & Blanco 2004, Tombesi et al., 2007).

The rare symptoms on the fruit correspond to more or less circular spots of 3 to 7 mm in diameter, the color of which varies according to maturity: on green olives, the lesions are ocher to brown in color while during version; the spots turn gray, sometimes with a pale or yellowish halo. Spores can be kept on crop waste and keep their temperatures are betweenn 10 to 20°C and high relative humidity. The pathogen spreads from a short distance, leaf by leaf, by conidia or mycelial fragments, favored by wind and rain (Avila and Trapero, 2010).

Dalmaticosis of the Olive

Dalmaticosis is an olive disease caused by the fungi *Botryospharia*

dothidea (formerly known as *Camarosporium dalmaticum*) (Arambourg, 1986, Phillips et *al.,* 2005). At the beginning of infection, dalmaticosis is manifested by a more or less circular spot of brown color, a few millimeters in diameter, forming a necrotic depression on the surface of the fruit. Once infected, the olive gradually dries up, mummifies and usually ends up falling. These symptoms appear during the summer, during the laying activity of the olive fly (*Bactrocera oleae*) (Margier et *al.,* 2014). The damage tends to intensify from the end of August. Dalmaticosis leads to a fall in olives, sometimes massive, with losses of up to more than half the harvest. The necrotic lesion makes the fruit unsuitable for processing for the table olive. When necrotic olives are harvest the quality of the oil is degraded (Jelena et *al.,* 2013).

The damage is very variable depending on the geographic location the varieties planted, the method of irrigation and the strategies used in the fight against the olive fly (Margier et *al.,* 2014).

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