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New or re-emerging fungal Citrus diseases in the Mediterranean

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Abstract: In recent years, the spread to new Mediterranean areas of citriculture with its new cultural practices, new citrus varieties and a changing climate, has led to the need to cope with new or re-emerging fungal plant diseases. The most notable are 'greasy spot' and 'alternaria spot'. A few papers have been published on this topic, but little attention has been given to them. For the last five years, many Italian orchards have been conspicuously dropping mature leaves affected with greasy spot to their undersides, which may develop groups of peritecia carrying asci which are morphologically similar to the *Mycosphaerella* genus. Potato agar cultures of the symptomatic mesophyll slowly grow greenish-brown colonies, bearing erratically multiseptate conidia, similar to the genus *Cercospora.* Some citrus species are more susceptible and may require appropriate spraying once the biological cycle of the fungus is defined. Only one out of four Alternaria diseases occurs frequently – the mandarin Alternaria brown spot, which is becoming more and more diffuse in many cultivars in Italy and Spain, damaging the leaves and fruit of mandarin hybrids despite frequent chemical spraying. Septoria spot is less common in Sicily and Calabria, where symptoms occur on the fruit and leaves of lemon and bergamot. Anthracnose is an old disease affecting citrus twigs, leaves and fruit and is caused by a primary fungus coloniser of injured and senescent tissue in the field and usually does not require spraying.

Key words: greasy spot, *Mycosphaerella* sp., *Alternaria alternata* pv. *citri*, *Septoria* spp., *Colleto-trichum gloesporioides*

Introduction

In recent years, the spread of citriculture to new areas, new cultural practices, the introduction of new cultivars and changes in climate, have led to a fight against new or (re)-emerging fungal diseases requiring unusual repeated treatments. The most significant are greasy spot (*Mycosphaerella* sp.) and Alternaria spot (*Alternaria alternata* (Fr.) Keissl. pv. *citri*). Septoria spot (*Septoria* spp.) is less common in Sicily and Calabria, where symptoms occur on the fruits and leaves of lemon (*C. limon* Burm.) and bergamot (*C. bergamia* Risso et Poit.). *Colletotrichum gloesporioides* Penz. is the agent of an old disease affecting citrus twigs, leaves and fruits. The economic significance of these diseases, their diagnosis and control measures are reported in this paper.

Material and methods

During surveys carried out in many citrus orchards at different times of the year, diseased leaves, twigs and fruits were collected and laboratory tested to make a diagnosis based on symptoms and laboratory investigation: moist chambers, isolation on artificial medium of probable microrganisms, their identification and pathogenicity.

Results and discussion

Our research ascertained the presence of the following diseases which are here reported on the basis of their frequency.

***Greasy spot* – Mycosphaerella sp.**

This disease caused by a fungus of the genus *Mycosphaerella* (Grasso *et al*., 2005), produces leaf and fruit lesions and defoliates trees, resulting in lower yield and fruit size. The spots appear yellow initially, then turn dark and appear slightly raised and greasy. With severe infection, leaves may turn yellow and drop prematurely. Affected leaves are mainly those located close to the soil. Symptoms are initially observed in early summer, like single or grouped black spots and become more marked in autumn-winter, including the leaf drop. Affected leaves show dark spots, mainly located along the lower veins and edges, and small (less than 5 mm in diameter) chlorotic and dark blotches on the upper sides (Fig. 1A). The fruit symptoms reported in Florida (Timmer et al., 2000) and Japan (Tanaka & Jamada, 1952) are unheard of in Italy. Sweet orange [*C. sinensis* (L.) Osbeck], lemon, grapefruit (*C. paradisi* Macf.) and Fortune mandarin (*C. clementine* x *C. reticulata*) are the most susceptible. In Italy, the disease has been reported since 1938 (Ruggeri, 1935), and was subsequently associated to 'Greasy Spot' (Grasso & Catara, 1982) even if its parasitic aetiology has only been recently confirmed as *Mycosphaerella* (Fig. 1B). In Japan this disease is attributed to *M. horii* (Tanaka & Jamada, l952) and in Florida to *M. citri* (Whiteside, 1970).

***Alternaria brown spot* – Alternaria alternata *pv.* citri**

Alternaria brown spot attacks young fruit, leaves and twigs producing small brown-to-black spots surrounded by a yellow halo after a 24 - 36 hr incubation period (Fig. 1C). The leaves may drop or the entire shoot may die (Fig. 1D). On fruits, symptoms include light brown, slightly depressed spots to circular dark brown blotches. Infected young fruits often fall and the mature fruits are unmarketable due to lesions, resulting in important economic losses (up to 80 %) (Fig. 1E). The causal agent was originally described as *Alternaria citri* Pierce and later renamed *A. alternata* pv. *citri* (Pegg, 1966). In Italy, on Fortune mandarin, the disease was reported by Bella *et al*., 2000. Two main pathotypes are described: "tangerine" and "rough lemon" according to the host plant (Peever *et al*., 1999).

***Septoria spot* – Septoria spp.**

Septoria spot (*Septoria* spp.) symptoms include both small rusty spots and large depressed areas on fruits, and small (few mm in diameter) depressed and round brown spots with a dark halo and an inner clear area on the leaves (Fig. 1F). Lemon (Grasso & La Rosa, 1983) and bergamot (Agosteo, 2002) are the most affected citrus species.

***Anthracnose* – Colletotrichum gloesporioides**

Antrachnose is commonly found on mal secco affected trees. Symptoms include very small pin (acervuli, fruiting bodies) in concentric rings on the twigs (Fig. 1G), dry, depressed, rounded and dark areas on the fruits, and dark gray or brown necrotic areas, of variable size (5 mm or more) with clear cut edges on the leaves. The causal agent is *Colletotrichum gloeosporioides*, a weak pathogen, that occasionally is responsible for heavy yield losses (Grasso, 1981) (Fig. 1H).

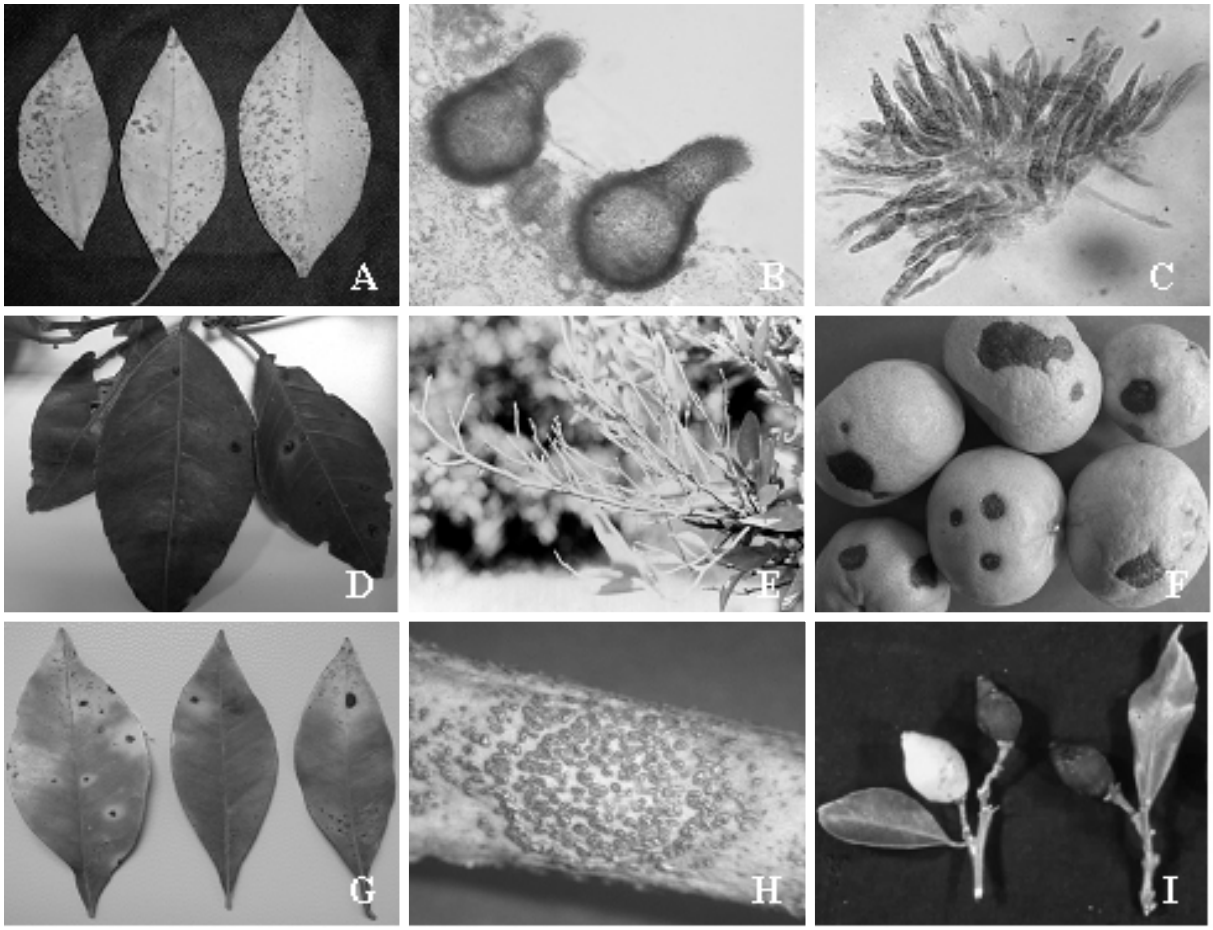

Figure 1. (A) Greasy Spot on sweet orange leaves; (B) Peritecia of *Mycosphaerella* sp.; (C) Asci of *Mycosphaerella* sp.; (D) Alternaria Brown Spot on sweet orange leaves; (E) Twig dieback caused by *Alternaria alternata* pv. *citri*; (F) Alternaria brown spot on Fortune mandarin fruits; (G) Septoriosis on sweet orange leaves; (H) Acervula of *Colletotrichum gloesporioides* on lemon twig; (I) Anthracnose on young lemon fruits.

Conclusions

In recent years, these diseases have shown significant outbreaks in many citriculture areas. *Mycosphaerella* sp. and *Alternaria alternata* both need more than one chemical spraying. The distinctive character of each disease, based on the evaluation of both leaf and fruit symptoms, are crucial in defining spray timing. Fungicides like Fenbuconazole and Propamocarb are successfully utilized in the U.S.A. as well as copper compounds and/or mineral oils. Some of them are currently being evaluated in Italy, but copper compounds are currently the only ones allowed by Italian pesticide regulations to prevent the spread and infection of pathogens. Since the disease is strictly related to climate, the treatments may in some circumstances be ineffective. In highly humid conditions the choice of resistant cultivars may be essential for quality fruit citriculture in the Mediterranean area. The symptoms of the four diseases are summarized in table 1.

Table 1. Symptoms description for a differential diagnosis.

Symptoms	Greasy spot	Alternaria brown spot	Septoria spot	Anthracnose
Leaves				
Side of leaves	both	both	both (up)	both
Type of lesion	raised	flat	raised	flat
Yellow halo	+	+	+	–
Color of spot	yellow-brown	brown	black	grey -brown
Size of lesion (mm)	1-4	variable	1-4	variable
Necrosis along the vein	–	+	–	–
Leaf drop	+	+	+	–
Twigs				
Lesion on twigs	–	+	–	+
Size of lesion (mm)	/	1-10	/	variable
Fruits				
Type of lesion	–	depressed	depressed	depressed
Colour of lesion	–	dark speck to large black lesions	light tan with reddish brown margin	brown
Size of lesion (mm)	–	1-10	1-2	15
Fruit drop	–	+	–	–

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