Prepared by CABI and EPPO for the EU under Contract 90/399003

Data Sheets on Quarantine Pests

Fusarium oxysporum f.sp. *albedinis*

IDENTITY

Name:*Fusarium oxysporum* Schlechtendahl f.sp. *albedinis* (Killian & Maire) W.L. Gordon
Synonyms: *Cylindrophora albedinis* Killian & Maire
Fusarium albedinis (Killian & Maire) Malençon
Fusarium oxysporum Schlechtendahl f.sp. *albedinis* (Killian & Maire) Malençon
Taxonomic position: Fungi: Ascomycetes (probable anamorph of Hypocreales)
Common names: Bayoudh disease, fusarium wilt (English)
Maladie du bayoudh (French)
Bayer computer code: FUSAAL
EPPO A2 list: No. 70
EU Annex designation: II/A1

HOSTS

The principal host is dates; all high-quality North African cultivars are susceptible (cvs Mejhoul, Deglet Nour, Bou Feggous, etc.). Some cultivars show good resistance (cvs Bou Sthammi noire, Bou Sthammi blanche, Tadment, Iklane, Sair Laylet, Bou Feggous, Moussa in Morocco and Takerboucht in Algeria). However, among these cultivars, only Sair Laylet and Takerboucht are of acceptable quality although not equal to Deglet Nour or Mejhoul (Pereau-Leroy, 1954; Toutain & Louvet, 1974; Saaidi, 1979).

F. oxysporum f.sp. *albedinis* has also been reported on some plants grown in date plantations: *Lawsonia inermis*, a dye plant; lucerne and *Trifolium* sp. (Djerbi *et al*., 1985a). These plants are symptomless carriers of the pathogen and are cultivated in North African and Near East countries (Djerbi *et al*., 1986a).

The causal agent of the vascular wilt of *Phoenix canariensis* differs from *F. oxysporum* f.sp. *albedinis* in its cultural and pathological characteristics as well as by vegetative compatibility, and belongs to a different *forma specialis* of *F. oxysporum* (Djerbi *et al*., 1986b; Sedra & Djerbi, 1986; Djerbi, 1990b).

GEOGRAPHICAL DISTRIBUTION

EPPO region: Widespread on dates in Morocco and Algeria; all Moroccan oases are affected; in Algeria, bayoudh disease is present only in western and central oases (Toutain, 1965; Benzaza *et al*., 1970; Brochard & Dubost, 1970a; 1970b; Dubost, 1972); bayoudh disease reached Metlili in 1950, Ghardaia in 1965 and El-Goléa in 1978, but has been eradicated from this last oasis (Dubost & Kada, 1975; Djerbi, 1982). Egypt (unconfirmed, see below). There have been reports from France and Italy but these concern the form on *Phoenix canariensis* (IMI, 1994).
Africa: Algeria, Egypt (infected material from Egypt intercepted in Spain), Mauritania, Morocco.

EU: Absent.
Distribution map: See IMI (1994, No. 240), Djerbi (1983).

BIOLOGY

F. oxysporum f.sp. *albedinis* persists in the form of chlamydospores in dead tissues of diseased palms (roots, rachis, etc.). With subsequent disintegration of such tissues, the chlamydospores may be released into the soil where they remain dormant. The fungus may also survive on symptomless carriers, e.g. *Lawsonia inermis*, lucerne, *Trifolium*.

The fungus is distributed very unevenly in the soil and has been found at depths of 0-30 cm and sometimes more than 1 m (Tantaoui, 1989). Chlamydospores are rare but can persist in soil for longer than 8 years. Even small numbers are sufficient to initiate the disease and infection of only a few roots can result in tree death.

Under suitable conditions, chlamydospores germinate and enter the vascular tissues of roots, from which the mycelium advances to the stem. Microconidia are carried upwards in the vessels; when impeded by a cross-wall, they germinate, the germ tubes penetrate the wall and the microconidia formation is resumed on the other side of the wall. The tree dies when the fungus and its toxins reach the terminal bud. During its upward progression in the xylem, *F. oxysporum* f.sp. *albedinis* colonizes the surrounding parenchyma by inter- and intracellular mycelium. This later gives the reddish-brown colour characteristic of the diseased tree. After the death of the tree, the mycelium continues to develop in the dead tissues and forms numerous chlamydospores in the sclerenchyma cells (Louvet, 1977).

In general, conditions favourable to the host also favour disease development. The optimum range for growth of the fungus is 21-27.5°C; growth remains significant at 18 and 32°C, but stops at 7 and 37°C (Bounaga, 1975).

DETECTION AND IDENTIFICATION

Symptoms

External symptoms

Bayoudh disease attacks mature and young palm trees alike, as well as their basal offshoots.

The first external symptom of the disease, noticeable to experienced observers, appears on one or more leaves of the middle crown. The affected leaf takes on a leaden or ash-grey colour and then withers in a characteristic way: some pinnae or spines situated on one side of the leaf become white; then, the disease progresses from the base to the apex. After one side has been affected, the withering begins on the other side, progressing this time from the top of the leaf to the base, until the whole leaf dies.

During the whitening and dying of the pinnae, a brown stain appears lengthwise on the dorsal side of the rachis and advances from the base to the tip of the frond, corresponding to the passage of the mycelium in the vascular bundles of the rachis. Afterwards, the leaf appears arched, resembling a wet feather, and hangs down along the trunk. This process may take a few days to several weeks.

The same symptoms then begin to appear on adjacent or opposite leaves. The disease advances to the central cluster and the tree dies when the terminal bud is affected. Finally, offshoots at the base of the palm tree are attacked.

Sometimes, symptoms develop differently. The brown stain appears in the middle of the rachis on its dorsal side, not unilaterally, and progresses upwards until the rachis becomes so narrow that all tissues are affected, leading to the death of the tip. Thereafter, the whitening and dying of pinnae progress downwards until the leaf is killed. Other variations

may occur in the early symptoms; a general yellowing may be detected before the appearance of typical symptoms, mainly during autumn and winter.

The palm tree may die from 6 months to 2 years after the appearance of the first symptoms, depending on the cultivar and the planting conditions (Bulit *et al*., 1967; Louvet *et al*., 1970; Djerbi, 1982).

Internal symptoms

When an affected tree is uprooted, only a small number of diseased roots, reddish in colour, are revealed, out of proportion to the extent of damage observed above ground. These diseased roots correspond to several groups of vascular bundles found on the stipe which (with the sclerenchyma and the parenchyma surrounding them) have taken on a reddish-brown colour. Towards the stipe base, the coloured areas are large and numerous. Higher up, the coloured vascular bundles separate and their complicated paths, inside the healthy tissues, can be followed.

When cut, palm fronds manifesting external symptoms exhibit a reddish-brown colour with highly coloured vascular bundles.

Symptoms have not been reported in peduncles, flowers or fruits (Koulla & Saaidi, 1985).

Morphology

The pathogen can be isolated on potato dextrose agar from discoloured date palm tissue and from symptomless carriers, or on selective media from soil. Fresh cultures appear salmon-pink, but cultures maintained on synthetic media by mass transfers become peach, pink, purple or violet.

Microconidia are spherical to elongate, slightly curved, mostly unicellular, hyaline, 3-15 x 3-5 µm; they are produced by microphialides, swollen at the base and pointed at the tip. Macroconidia are falcate, usually three-septate, 20-35 x 3-5 µm. Chlamydospores are intercalary or terminal, spherical, occurring singly or in groups of two to three. Sclerotia are rare in culture, dark-blue to black, 1-2 mm diameter, either distributed

over the mycelium or in groups. See also Brayford (1992).

Detection and inspection methods

To confirm *F. oxysporum* f.sp. *albedinis* among isolates of *F. oxysporum* obtained from dates, symptomless carriers and soil, isolates can be artificially inoculated to the roots of young date plants at the two-leaf stage; *F. oxysporum* f.sp. *albedinis* is recognized by death of the plants after 1-2 months (Dubost & Kada, 1974; Watson, 1974; Saaidi, 1979).

The pathogen can also be identified by cultural characteristics of single-spore cultures (Chettab *et al*., 1978; Djerbi *et al*., 1985b; Sedra & Djerbi, 1985; Cherrab, 1989) or by the vegetative compatibility test (Djerbi, 1990a; 1990b; Djerbi *et al*., 1990). These two methods allow rapid and accurate identification of the pathogen without the need for artificial inoculations, but also require considerable experience.

MEANS OF MOVEMENT AND DISPERSAL

F. oxysporum f.sp. *albedinis* can be spread by infected offshoots, soil, symptomless hosts, infected date tissues (especially infected pieces of rachis) and by irrigation water passing through infested fields. It is not carried by date fruits or seeds.

Within a plantation, the disease is spread by contact between diseased and healthy roots; the extent of such spread varies according to cultural conditions (copious irrigation, fertilization, etc.) and temperature.

PEST SIGNIFICANCE

Economic impact

Bayoudh disease occurs in major epidemics and causes death of trees. In one century, the disease has destroyed more than two-thirds of the Moroccan palm groves (12 million trees), and it continues to cause the death of 4.5 to 12% of date palms per year (Djerbi, 1983). Morocco, which was formerly an exporter of dates, is now an importer. In Algeria, more than 3 million trees have been destroyed, particulaly in Tidikelt, Touat and M'Zab (Brochard & Dubost, 1970b; Dubost & Kellou, 1974). Surveys in the Drâa Valley (Morocco) in 1981 revealed 165 574 date palms killed among 2 million trees (Djerbi *et al.*, 1986a).

In the majority of oases, more than half the commercial cultivars have been destroyed; this has resulted in the progressive disappearance of high-quality cultivars in favour of poor-yielding, seedling trees. Oases that formerly had 300-400 palms per hectare have been reduced to 40-50 palms per hectare (Saaidi, 1979; Djerbi *et al*., 1986a).

The disease has caused not only the loss of a staple food for the Saharan population (187 kg per capita), but also the loss of a major source of income and foreign currency. Damage by bayoudh disease has also reduced the annual crops formerly protected by date palms, and has accelerated desertification.

Since the best North African commercial cultivars are highly susceptible, bayoudh disease constitutes a major catastrophe for Moroccan and Algerian Saharan agriculture.

Control

Control of bayoudh disease depends on strict internal quarantine measures. Soil disinfection is uneconomic and difficult, except perhaps at a primary focus of infection in a disease-free area; in this case, soil can be treated with methyl bromide (Frederix & Den Brader, 1989). Soils suppressive to bayoudh disease have been identified in Morocco and Algeria; the mechanisms of suppressiveness of these soils may be biotic or abiotic.

Promising results have been obtained in selecting resistant high-quality cultivars among the natural date-palm population or in breeding such cultivars (Louvet & Toutain, 1973; Toutain & Louvet, 1974; Djerbi *et al.*, 1986a). The first rehabilitations of palm groves damaged by bayoudh disease in Morocco were made in 1990 by planting 200 000 plants propagated *in vitro*. The same programme has been operating since 1981 at Adrar, Algeria (Djerbi, 1982).

Phytosanitary risk

F. oxysporum f.sp. *albedinis* is listed as an A2 quarantine pest by EPPO (OEPP/EPPO, 1982) and is also of quarantine significance for IAPSC. In view of its considerable potential for spread, it poses extremely serious human, social and economic risks to other date-producing areas in the EPPO region (eastern Algeria, Tunisia, and other North African countries), and also throughout the Near East.

The related *Phoenix canariensis*, widely grown as an ornamental in many Mediterranean countries, is affected by a fusarium wilt which is not strictly bayoudh disease, since cross-infection studies show that different *formae speciales* of *F. oxysporum* are involved. Fusarium wilt of *P. canariensis* is a much less severe disease, and does not deserve quarantine status in its own right. However, a certain ambiguity remains on the status of the two forms and on the possibility that *P. canariensis* might carry bayoudh disease.

PHYTOSANITARY MEASURES

Algeria (1942 and 1949) and Morocco have implemented internal quarantine on all infested oases to prevent the movement of offshoots from diseased areas to healthy ones.

EPPO (OEPP/EPPO, 1990) recommends date-producing countries should prohibit the importation of the following from countries where bayoudh disease is present: (i) all date-palm material (offshoots, leaves, handicrafts, etc., but not fruits); (ii) soil and plants for planting (with roots, cuttings) accompanied by soil; (iii) plants for planting of *Lawsonia inermis* (except seeds).

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