Phytophylactica: 25: 59–63 (1993)

POWDERY MILDEW OF MANGO IN SOUTH AFRICA: A REVIEW*

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ABSTRACT

Key words: Powdery mildew, mango, *Oidium mangiferae*

Powdery mildew of mango, caused by *Oidium mangiferae*, is widespread thoughout most of the mango growing areas of South Africa and crop losses of 80–90 % have been reported. The fungus attacks the young tissue of all parts of the inflorescences, leaves and fruit. No teleomorph of *O. mangiferae* has been found in South Africa. Conidia are dispersed by wind and germinate best at 20–25 °C with moderate humidity. Disease development seems favoured by high humidity. Mango cultivars vary in susceptibility to powdery mildew and various fungicides are registered for use against the disease in South Africa. The current recommendation for commencement of fungicide application is at 50 % bloom or when the first signs of disease are observed, followed by a second application 3–4 weeks later.

Uittreksel

POEIERAGTIGE MEELDOU VAN MANGO IN SUID-AFRIKA: 'N OORSIG

Poeieragtige meeldou van mangoes, wat deur Oidium mangiferae *veroorsaak word, kom wydverspreid in die meeste mangoproduserende gebiede van Suid-Afrika voor en oesverliese van 80–90 % is aangeteken. Die swam val jong weefsel van die hele bloeiwyse, blare en vrugte aan. Geen teleomorf van* O. mangiferae *is in Suid-Afrika gevind nie. Konidia word deur wind versprei en ontkiem die beste by 20–25 °C en matige humiditeit. Siekte-ontwikkeling word deur hoë humiditeit bevoordeel. Mangokultivars varieer in vatbaarheid vir poeieragtige meeldou en verskeie chemiese middels is in Suid-Afrika teen poeieragtige meeldou geregistreer. Huidige aanbevelings vir die aanvang van chemiese toediening is by 50 % blomstadium of wanneer die eerste siektesimptome verskyn, gevolg deur 'n tweede toediening, 3–4 weke later.*

INTRODUCTION

Powdery mildew of mangoes (*Mangiferae indica* L.) is widespread throughout most of the mango growing areas of South Africa (Kotzé, 1985). This disease (caused by *Oidium mangiferae* Berthet) was first reported in the eastern Transvaal region of South Africa in 1937 (Wager, 1937; Doidge *et al.*, 1953; Gorter, 1988a).

The damage caused by powdery mildew to the inflorescences of mango is often underestimated as disease outbreaks occur early during the flowering stage. Crop losses of 80–90 % have been reported in South Africa (Brodrick, 1971; Kotzé, 1985), while losses of up to 20 % have been recorded in Florida during some seasons (Cook, 1975). Although a wide range of fungicides has been registered for the control of this disease, serious losses still occur. Most of the registered fungicides are applied as curative and not preventative treatments, with the result that losses may be due to poor timing of spray applications. The increase in costs of fungicides over the years has necessitated the identification of environmental and biological factors that trigger the onset of the disease so that sprays can be applied in time to obtain maximum disease control.

A brief review of powdery mildew of mangoes in South Africa was published by Kotzé (1985). Since then, more information has been derived and higher input costs have increased the economic importance of the disease. The aim of this review is to place the current situation in perspective and to highlight areas deserving attention.

SYMPTOMS

Oidium mangiferae attacks the young tissue of all parts of the inflorescences, leaves and fruit (Fig. 1, 2 and 3). Penetration is restricted to the epidermal layers of the infected parts. Initially small isolated patches of powdery white mycelium develop on the affected organs. These may coalesce later to cover large areas of the plant (Palti *et al.*, 1974; Burchill, 1978). The characteristic symptom of powdery mildew is a velvety, powdery deposit on a dark to smoky grey background (Palti *et al.*, 1974; Kotzé, 1985). Fungal development ceases when infected tissues become necrotic (Palti *et al.*, 1974).

Crop loss from powdery mildew of mango is mainly the result of blossom infection. When infection is severe, entire inflorescences may be infected and no fruit set. When flowers become infected they fail to open and then drop from the inflorescences (Ruehle & Ledin, 1956). The sepals of the flowers are particularly susceptible, whereas the petals are more resistant. Often the inflorescences become completely covered by the mildew and eventually blacken (Palti *et al.*, 1974; Burchill, 1978).

As infected newly-set fruit develop, the epidermis of the infected area cracks and corky tissue is formed (Fig. 4 and 5). The entire fruit may become covered by the mildew. Fruit-drop frequently occurs once a

* Part of an M.Sc. thesis submitted by the first author to the University of the Orange Free State, Bloemfontein 9300, South Africa

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Received 24 April 1992; accepted for publication 26 November 1992

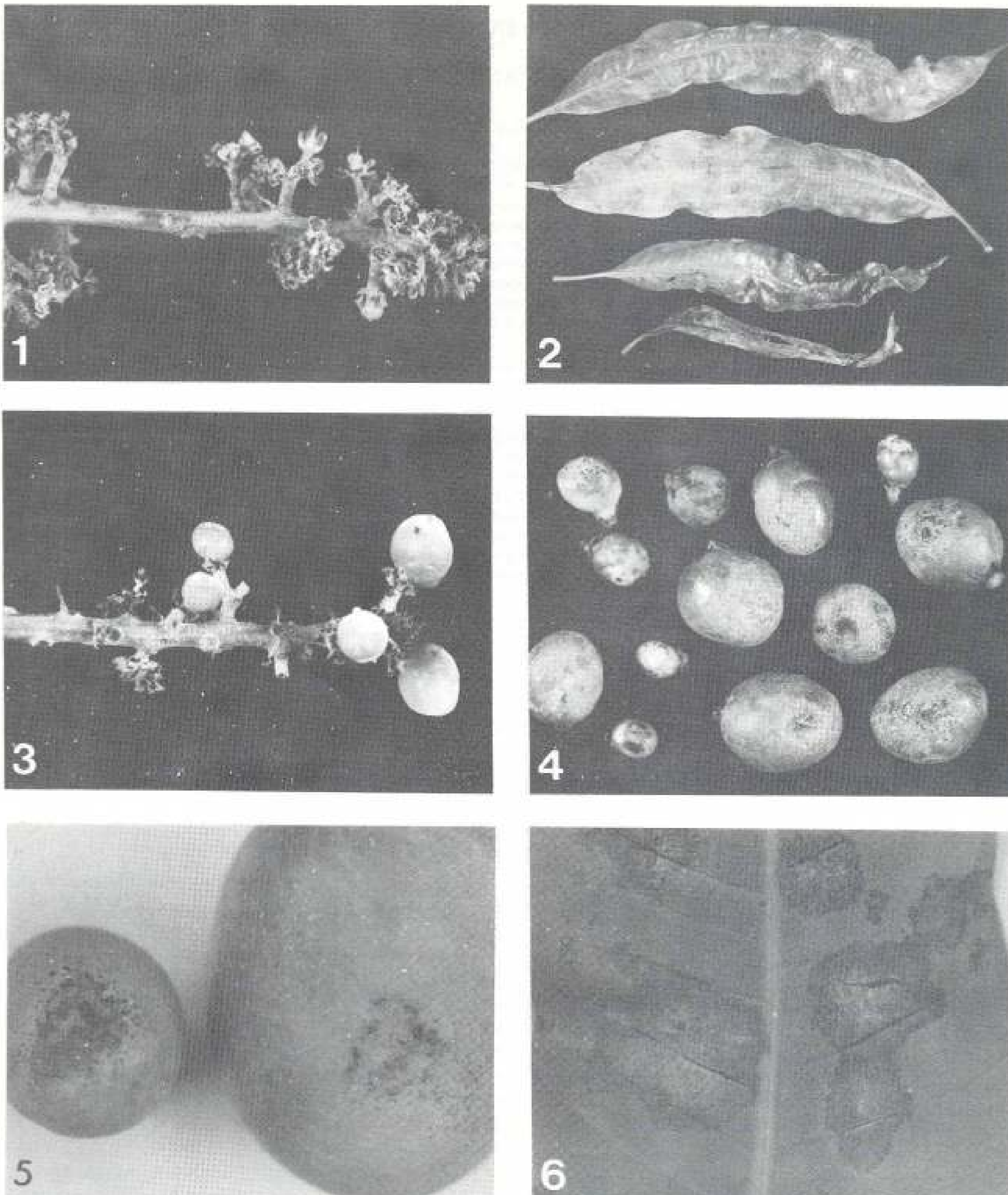

FIG. 1–6 Symptoms of powdery mildew on mango caused by *Oidium mangiferae*

FIG. 1 Infection on inflorescences showing necrosis and white powdery mycelium

FIG. 2 Infected leaves showing symptoms on upper and lower surfaces

FIG. 3 Symptoms on young fruit and stalks

FIG. 4–5 Symptoms on young mango fruit showing corky tissue

FIG. 6 Lesion on a mango leaf covered with white mycelium diseased fruit has reached pea size (Palti *et al.*, 1974; Burchill, 1978).

Young leaves usually become infected on the lower surface, although both surfaces are infected in some cultivars (Fig. 2 and 6). Infected leaves usually become curled and distorted (Ruehle & Ledin, 1956; Palti *et al.*, 1974; Cook, 1975).

THE CAUSAL FUNGUS

Palti *et al.*, (1974) have shown that mango is the only known host of *Oidium mangiferae*. These authors also report that no teleomorph is produced by the fungus. However, the globular haustoria and the mode of conidial germination place the fungus in the *Erysiphe polygoni* group.

There is some doubt as to the correct identity of the mildew fungus on mango in South Africa. According to Boesewinkel (1980), the *Oidium* sp. attacking mangoes in New Zealand is identical to the oak powdery mildew *Microsphaera alphitoides* Griff & Maubl. *M. alphitoides* has also been recorded on a variety of other hosts. Oak powdery mildew in South Africa was originally also caused by *M. alphitoides*, the European oak mildew. At present it has been overtaken by another powdery mildew similar to the North American oak mildew *Microsphaera extensa* Cook & Peck and *M. alphitoides* is no longer evident in South Africa (Gorter, 1984). Another factor contributing to the uncertain identity of mango powdery mildew is that conidiophores produced on mango have two cells, whereas those on oak have three to five cells. Clearly, cross-infection studies need to be conducted on oak and mango and further taxonomic work is needed. For the time being however, we believed that the anamorph name, *O. mangiferae* should be used for the mildew fungus on mango in South Africa. This is consistent with the view of Gorter (1988a).

The morphology of *O. mangiferae* has been described in detail by Uppal *et al.* (1941) and also recently by Gorter (1988a, b). The distinguishing morphological characteristics of *O. mangiferae* are 40–80 µm long hyphal cells, conidiogenous cells of moderate length (27,4–40,0 µm) and conidia that are barrel shaped and produced singly (Fig. 7).

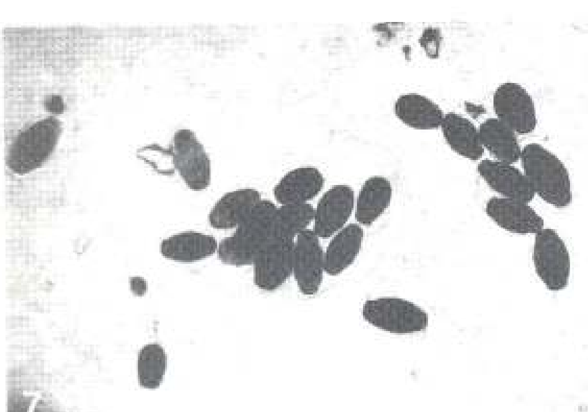

FIG. 7 Barrel shaped conidia of *Oidium mangiferae*

EPIDEMIOLOGY

Conidia of *O. mangiferae* are dispersed by wind reaching new growth flushes and young flowers. They germinate, producing germ tubes which give rise to appressoria on the host surface. After penetration of the cuticle and cell walls by penetration pegs from appressoria, tubelike haustoria develop, which then swell inside the epidermal cells to form globular structures (Palti *et al.*, 1974).

Under conditions unfavourable for infection, or when susceptible tissue is not available, the fungus will presumably survive as mycelium on older leaves (Corbett, cited by Palti *et al.*, 1974). Butt (1978) reported that powdery mildew fungi of many deciduous woody plants, such as peach, apple, rose and oak, are less active between epidemics and remain in the conidial state on leaves or within dormant buds. Latent powdery mildew infections in buds are ideally positioned to initiate epidemics immediately after growth commences and as soon as conditions allow these foci to spread. Mango buds examined throughout a growing season in South Africa did not show symptoms of infection at any stage and buds, covered with paper bags before any powdery mildew conidia were detected by spore traps, were still free of the disease when the bags were removed, although severe powdery mildew was present in the orchard (author, unpublished data). This suggests that no latent mycelium was present inside the buds prior to the epidemic and that latent infections are ı ot important in the epidemiology of *O. mangiferae*.

According to Palti *et al.* (1974), *O. mangiferae* is capable of germinating at low humidities. At 20 % relatively humidity (RH), 70 % germination occurred and at 100 % RH, this decreased to 33 %. Uppal *et al.* (1941) stated that the minimum, optimum and maximum temperatures for germination are 9, 22 and 30–32 °C respectively. Palti *et al.* (1974), also established that germination rates were higher at low and intermediate humidities (20–65 %) than at high humidities (81–100 %). These studies were, however, conducted under laboratory conditions using glass slides. Field studies to confirm these results have not been carried out. Despite the above studies questions, such as when the disease appears in different climatological areas and what factors trigger the onset of the disease, remain unanswered.

Butt (1978) reported that free water generally causes damage to superficial mycelium of powdery mildews and that spore numbers are low for several days after rain. This author also reported that rain is not always harmful as showers can stimulate powdery mildew by raising the atmospheric humidity. According to Kotzé (1985), outbreaks of powdery mildew do not have to be preceded by rain or dew. This view was confirmed by the author (unpublished data) as heavy powdery mildew out-

TABLE 1 Fungicides registered for control of powdery mildew in South Africa[1]

Time of application	Recommendations	Type of application
Flowering When trees are 50 % in bloom or when first signs of disease observed	Benomyl (500 g/kg a.i.) plus Triforine (190 g/ℓ a.i.) @ 15 g plus 100 mℓ/100 ℓ	Cover spray applied to blossoms in each case. Growers must then inspect trees on a regular basis for signs of re-infection which can occur at any time until fruit reaches 10–20 mm in diameter. If re-infection occurs, repeat application providing that 14 d have lapsed between applications
	Bupirimate (233 g/ℓ a.i.) @ 40 mℓ/100 ℓ	
	Chinomethionate (250 g/kg a.i.) @ 25 g/100 ℓ	
	Triforine (190 g/ℓ a.i.) @ 150 mℓ/100 ℓ	
	Pyrazophos (305 g/ℓ a.i.) @ 40 mℓ/100 ℓ	
	Triadimefon (50 g/kg a.i.) @ 200 g/100 ℓ	
	Sulphur dust (980 g/kg a.i.) @ 250–750 g/tree	Dust applied as a preventative treatment to flowers. Amount per tree is dependant on tree size
	Sulphur/Copper oxycloride dust (900/85/kg a.i.) @ 250–750 g/tree	

[1] These recommendations have been extracted from De Villiers & Manicom (1990)

breaks were reported in places where no rain had been recorded prior to the outbreaks. Palti *et al.* (1974), however, reported that epidemics of powdery mildew were frequent when intermittent rain and temperatures of 20–25 °C occurred during the flowering period. Cook (1975) also noted that the severity of powdery mildew increased when frequent rains occurred during the flowering period and conidia were produced within 5 d after infection.

CULTIVAR SUSCEPTIBILITY

Mango cultivars vary in susceptibility to powdery mildew. Worldwide the Zill and Kent cultivars are most susceptible, followed by Haden, Smith and Keitt. Tommy Atkins and Sensation appear to be more resistant, but this is dependant on climatological factors (Palti *et al.*, 1974). In preliminary studies in South Africa we have found Zill and Tommy Atkins cultivars to be highly susceptible, whereas Sensation appeared to be more resistant (author, unpublished data).

CONTROL

Effective control of powdery mildew is essential for good fruit set. In South Africa the current recommendation for a first fungicide application is at 50 % bloom or when the first signs of disease are observed, followed by one or two further sprays, depending on the fungicide used (De Villiers & Manicom, 1990). Chemicals registered for use against powdery mildew in South Africa are listed in Table 1.

Recently, reports have been received from growers that chemical control is not always effective. It is therefore possible that the fungus has developed resistance to certain chemicals. Alternatively sprays are not applied properly or 50 % flowering is too late to begin spraying under severe conditions. These issues are in urgent need of clarification.

CONCLUDING REMARKS

Powdery mildew of mangoes is a serious disease in South Africa with significant economic implications. Despite this fact, very little is known about the pathogen. For example, the taxonomy of the pathogen has not been clarified. If the pathogen occurs on other hosts, such as the oak, this could have an influence on its epidemiology. Cross inoculation studies are therefore required.

The epidemiology of the disease also needs clarification. Most of the published studies have been conducted under laboratory conditions using glass slides. Field studies to confirm these results have not been carried out. Questions such as when the disease first appears in different climatological areas and what triggers the onset of the disease remain unanswered.

Mango growers in South Africa are often faced with the problem of not knowing when disease outbreaks can be expected and therefore when to initiate control spray programs. If sprays are applied when the first symptoms appear, it is already too late for effective control. Unnecessary sprays are costly and introduce needless pesticides into the environment. Epidemiological studies are therefore needed in South Africa to determine the climatic requirements for disease development. This information will help farmers to decide upon the best time to begin spraying.

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