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A lethal, transmissible stem-pitting of avocados associated with Duke 6 rootstocks

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SYNOPSIS
A lethal disease of unknown cause spread from trees on Duke 6 rootstocks to other trees. Symptom development was exaggerated by stress.

INTRODUCTION

Avocado root rot is ubiquitous and severe, virtually throughout South Africa. While injectable fungicides have been used to very good effect in controlling this disease (Darvas *et al*, 1983), the long-term control strategy has been based on the use of resistant rootstocks.

Initially three "resistant" rootstock cultivars were available, namely: Duke 7, Duke 6 and G22 (Zentmyer *et al*, 1972). Due to ease of propagation, Duke 7 has been preferably propagated, but Duke 6 was also used, albeit to a much lesser extent. G22 was never distributed.

In one orchard of 4 000 trees in the Tzaneen area of the Transvaal, where Hass scions were grafted on clonal Duke 6 and Guatamalan seedling (cv Edranol) rootstocks in alternate rows, the 2 000 trees on Duke 6 started defoliating and declined rapidly after three years of vigorous growth. This malady has now spread to about 1 200 trees on Edranol rootstocks.

Apart from the decline and defoliation, the only observable symptom is a severe wood-pitting which is confined to the rootstock.

This paper describes the symptomology of this disease and reports on unsuccessful attempts to identify its cause and elucidate its etiology. It also discusses the dangers and implications of the disease.

SYMPTOMOLOGY

This disease is stress-related, and symptom initiation and severity are both enhanced by stress - in this particular case, drought.

The first symptom is a wilting of the leaves, which initially droop and then abscise, leaving the tree almost bare with resultant severe sunburn of bark on twigs and branches.

When the bark is stripped across the bud-union, a very clear pitting of the rootstock wood is observed (Figure 1) with the corresponding protuberances of the bark. Hass scions show no pitting at all. Similar pitting has been observed on Edranol and Duke 7 where it has grown in very close proximity to Duke 6.

Iodine starch tests revealed a slight accumulation of starch in the roots, as did the healthy controls.

When Duke 6 was budded to clonal Duke 7 and G6, a very distinct leaf symptom developed within six months. Controls remained normal. These indicator plants were also relatively stunted.

MATERIALS AND METHODS

While symptomology, as expressed in the field, was indicative of a viral infection, attempts were made to investigate the presence of fungi, bacteria, nematodes, nutritional imbalances, viruses and physiological disorders.

Mycological investigation

Isolations were made from roots and soil on P10 VP (Tsao, 1969) and PDA agar. Isolates were incubated at 25°C in a dark incubator for 10 days.

Bacterial investigations

Isolations were made onto nutrient agar from roots and soil and incubated at 22°C. Isolates were compared under a light microscope after being Gram stained.

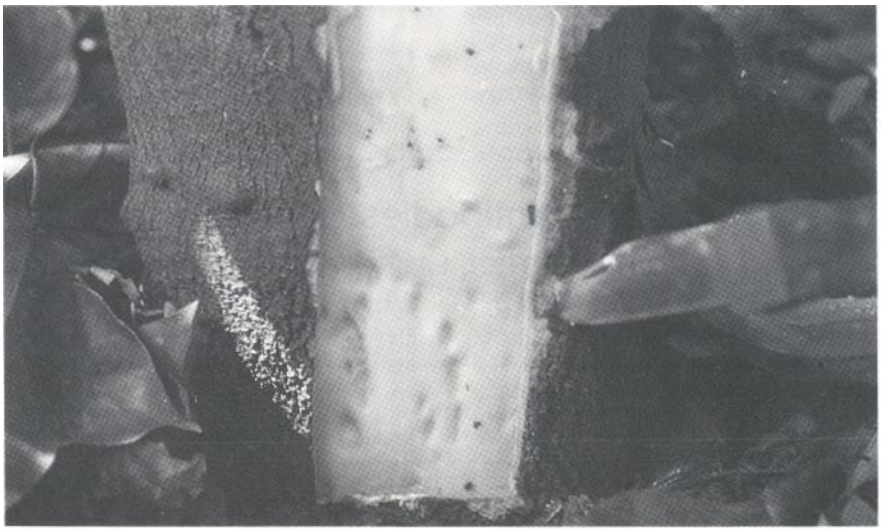

Fig 1 Stem-pitting symptoms on Duke 6

Nematological investigation
Soil samples of 250 g and root samples of 10 g were extracted for nematodes in a Behrman funnel in a mist chamber (Oostebrink, 1960) before microscopic identification. Five root and five soil samples were collected from under diseased trees and healthy trees in the orchard concerned, and soil samples were also collected from an adjacent virgin field.

Nutritional investigations
Samples of wood were obtained by drilling into primary roots, the trunk above and below the bud-union and primary branches. Samples were collected from diseased trees on seedling rootstocks and healthy Hass on Edranol trees from a separate locality. Bark was similarly collected.

These samples were analysed for N, P, K, Ca, Mg, Zn, Cu, Mn, Fe and B by the Zasoski & Buran (1977) method.

dsRNA analysis
Leaf samples from diseased trees on both rootstocks were analysed using the Bar-Joseph et al (1983) extraction technique and poly-acrylamide gel electrophoresis. Avocado samples known to be infected with sunblotch viroid and *Nicotiana glauca* infected with CMV were used as positive controls.

RESULTS
One of 15 samples tested was positive for *Phytophthora cinnamomi* and *Fusarium* was isolated from several samples. No single fungus was found throughout.

Spiral nematodes were isolated from one soil sample, and lesion nematodes from one root sample. No nematode was found distributed throughout and, where encountered, numbers were low.

Similarly, while numerous bacteria were isolated, not one genus was ubiquitous.

Zinc levels were consistently higher in diseased trees as opposed to nitrogen, phosphates, potassium and magnesium, which were higher in healthy trees. Levels of all other elements tested were the same in healthy and diseased trees.

The dsRNA analyses revealed a pattern similar to that of virus 2 described by Jordan *et al* (1983) in all Hass material both diseased and healthy. Duke 6 yielded no dsRNA at all.

DISCUSSION
The etiology of this disorder remains unexplained. The results clearly show that it cannot be ascribed to bacterial or fungal pathogens and no nutrient was either sufficiently deficient or excessive to cause the symptoms observed.

Despite the fact that no foreign RNA could be detected, the stem-pitting symptoms, the differential host sensitivity and the apparent transmissibility all indicate a viral pathogen.

The destructive potential of this disease can hardly be understated. It can be assumed that Duke 6 was established in avocado foundation blocks world-wide, particularly as it, together with Duke 7 and G22, were the first rootstocks found with proven *Phytophthora* tolerance.

Under ideal growing conditions, Duke 6 shows relatively mild symptoms on its own roots, except for severe pitting which is not obvious unless the bark is stripped.

As the disease has shown the ability to spread rapidly in the field, it is not unlikely that in foundation blocks it has spread from Duke 6 to adjacent budwood sources. It would take severe stress conditions, like the 1984 drought in South Africa, to indicate the degree of dissemination of the disease.

The only means of controlling the disease is by total destruction of all Duke 6 material plus a thorough investigation of all adjacent trees for stem-pitting.

The rapid spread of the disease could be due to an arthropod vector, but no insect was found with sufficient consistency to support this hypothesis. Root anastomosis was common and could provide a means of transmission.

The disease is similar to blackstreak in California, but Ohr (pers comm) however, reports that "... found 25 to 30 per cent Duke 6 pitted" as opposed to "pitting 50 per cent on various rootstocks in blackstreak". Ohr similarly claims to have transmitted the pitting factor. He, however, makes the point that Duke 6 is not in common use in California. Zentmyer *et al* (1972), reported that by 1971 Duke 6 was included among 2 168 trees planted out in 44 trial plots in four counties in California.

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