

Avocado fruit diseases and their control in Mexico

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SYNOPSIS

Avocado fruits in Mexico are affected by *Phytophthora citricola* causing black fruit rot with infection estimated at five per cent. Other fungi, such as *Sphaceloma perseae*, *Cercospora purpurea*, *Colletotrichum gloeosporioides* and *Diplodia sp* are of frequent occurrence and some cause increased losses. Bordeaux mixture is widely used for its good fungicidal qualities, availability and cheapness. Bacterial blast has also been recorded in the state of Mexico with estimated loss of 20 per cent. Cold weather seems to favour incidence. The main damage is done by *Pseudomonas syringae pv syringae*, but *Erwinia herbicola* may be present on some fruits. Sun blotch has been recorded with low incidence, but necrotic ring of the peduncle is serious in different areas, causing fruit drop.

INTRODUCTION

Through archeological excavations-in the caves of Tehuacan Valley in the state of Puebla, Mexico, it was found that avocado fruit was known 12 000 years ago (1).

Avocado is grown commercially in the states of Michoacan, Veracruz, Puebla, Mexico, Tamaulipas, Morelos, Chiapas and Sinaloa. It is cultivated on more than 65 000 ha, at 2 000 m above sea level and at lower altitudes. The fruit production is estimated at an average of 10 ton/ha and it is destined partially for the international market, but mainly for national consumption. The two main varieties grown are Hass and Fuerte. The diseases detected in fruits are those due to fungi, bacteria and a viroid. Approaches to control are mentioned.

MATERIALS AND METHODS

Diseased avocado fruits were collected in different states and analysed in the laboratory. Fungi and bacteria were grown on potato dextrose agar and King's B medium (3) respectively. Fungi were identified by their characteristic fructifications and type of mycelium. Characterisation and identification of bacteria were carried out using Shaad's manual (6). Fungi and bacteria were tested for pathogenicity on fruit in situ or excised. In some cases damage was recorded. Some preventive measures were also studied.

RESULTS

From diseased Fuerte variety fruits collected in the state of Mexico, the fungi identified were producing some serious problems. *Phytophthora citricola* caused a black fruit rot

during July, August and September, months of heavy rains. Fruits borne on lower hanging branches may be affected up to 1 m height. These fruits start to rot from the distal end up and in one week may be completely rotten, later falling from the tree. The fungus infects from the soil during heavy rains and also penetrates into stems. The fungus invades seed from the pulp causing brown lesions. These seeds are useless and should be destroyed. The fungus sporulates on the fruit producing bipapillate sporangia, paragynous antheridia, characteristics of taxonomic importance.

Treatment with Bordeaux mixture (1:1:100) completely prevents the entrance of the fungus when artificially inoculated on the surface of the fruits. During rainy periods, weekly sprays are suggested for control measures. Pruning of low-hanging branches is also advisable and entrance of animals into the orchards should not be allowed, in order to prevent the distribution of the fungus. The percentage infection and loss has been estimated at five per cent.

Four other fungi were identified in the state of Mexico on fruits causing variable damage. The fungus *Sphacelorna persea* causes a well-known fruit scab. *Cercospora purpurea* causes irregular to round, brown leaf and fruit spots. This fungus is superficial, but reduces fruit quality. If the attack on leaves is severe, defoliation occurs and fruits are damaged by sunrays. Anthracnose is caused by *Colletotrichum gloeosporioides*, forming circular depressions of red to black colour. The fungus sporulates easily on the surface and also affects the pulp below. Damage appears mostly on market fruit and may cause severe problems. The fungus *Diplodia* sp has also been identified causing a black fruit rot at the peduncle end. The fungus enters the excised fruit and may cause a complete loss in storage. The best and cheapest prevention method for these fungi has been the use of copper sprays, especially Bordeaux mixture (1:1:100) before flowering and after fruit-set. 30 days apart or longer, depending on precipitation and terminating about one month before harvest.

Four years ago in the summer and fall, a bacterial blast presented itself on variety Fuerte on an extension of about 50 ha in the state of Mexico, where previously frost fell lowering the temperature to -5 °C for several hours during two nights. The disease showed dark brown, sometimes raised irregular areas and frequently covered a great part of the fruit (Figure 1).

These affected areas softened or cracked. Infected fruits were irregularly distributed throughout the crowns of 10-year-old trees. Affected fruits produced white or brown exudate that was easily washed away by rain. Heavy infection resulted in fruit drop. Vascular bundles of diseased fruit turned black. Close to harvest, up to 20 per cent of the fruit was estimated to be lost.

From the diseased fruits two different bacteria were isolated, predominately 78 per cent from white, mucous, fluorescent colonies and less frequently (20 per cent) from a yellow colony. Both bacteria were purified and then separately inoculated into healthy fruits, producing the following symptoms. The fluorescent colony produced softening and darkening of the pulp and darkening of the surface and white exudate after eight days.

Fruit drop occurred within 22 days. The yellow colony produced only slight elevation and necrosis of the cortex tissue, but no rot or exudate. When the two bacteria were mixed in equal proportions (10⁸ colony forming units/ml of both bacteria) and inoculated, no difference in symptoms was found to that of the fluorescent bacterial inoculation alone.

Morphological, physiological and biochemical tests were performed in triplicate on both bacteria (six fluorescent and two yellow isolates). Under the electron microscope, the fluorescent bacteria presented one to three polar flagella and the yellow bacteria was peritrichous. On the basis of characteristics presented in Table 1, it was evident that the fluorescent bacteria was identical to *Pseudomonas syringae* pv *syringae* and that the yellow colony was *Erwinia herbicola*.

Control of this disease has not been well-documented, but it appears that copper sprays have diminished its spread and lowered incidence, where they have been used.

Other problems have been noted on fruits in Mexico. In Necaxa, state of Puebla and Uruapan, Michoacan, typical sun blotch fruit was seen, forming yellow depressed longitudinal areas. Removal and destruction of whole trees have been common practice. Another problem recorded was a necrotic ring formation on a peduncle of the fruit and sometimes a necrotic area on a fruit. The result of the ring on the peduncle is dropping of the fruit as the abscission area is affected.

This has been a serious problem in the states of Mexico, Morelos and Michoacan, because fruits of different ages may be affected. The reason for this malady is unknown.

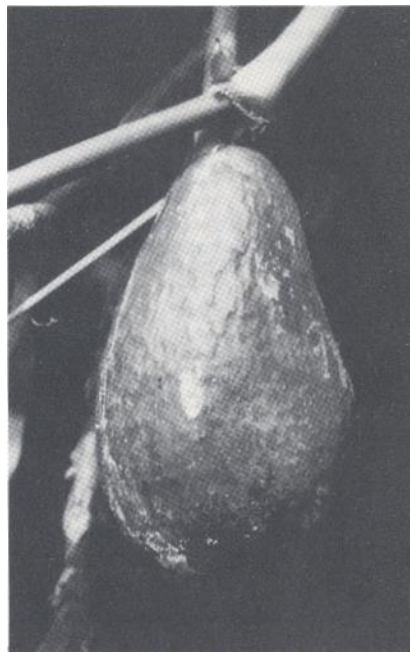


Fig 1 Bacterial avocado blast showing dark areas and white exudate on surface.

TABLE 1 Characteristics of the isolates from avocado fruits.

Characteristics	Fluorescent isolate	Yellow mucous isolate
Colony type on King B medium	Circular white	Circular yellow
Bacillar cell type	+	+
Symplasmata and Biconvex bodies	--	+
Ice nucleation at -5°C	one strain tested	
	+	
Gram reaction	--	--
Fluorescence on King B medium	+	--
O/F metabolism	+/-	+/+
Hypersensitivity on tobacco	+	
Potato rot	--	
Oxidase	--	
Arginine dihydrolase	--	
Levan	+	
Gelatine liquefaction	+	
Nitrate reduction	--	
Growth at 28°C on King B medium	+	
Growth at 41 °C on King B medium	--	
Growth 5% NaCl in 1 % peptone water	--	
Pectolytic activity at pH 4,6 and 8.5	--	
Acid production:		
Glucose	--	
D-Arabinose	--	
L-Arabinose	+	
Cellobiose	--	
Galactose	+	
Mannose	+	
Rhamnose	--	
Sucrose	+	
Threhalose	--	
Xylose	--	
Homoserine	--	

DISCUSSION

The black fruit rot caused by *P. citricola* has been noted throughout the years, but another *Phytophthora* namely *P. boehmeriae* has been implicated in the state of Michoacan, causing the same symptoms on low-hanging fruits (8). It is evident that more attention should be given to these fungi through ecological studies.

S. perseae is a common fungus in Mexico, and has been reported in the states of Colima, Jalisco, Mexico, Michoacan, Morelos, Puebla, Queretaro, San Luis Potosi and Zacatecas (5) causing damage in unattended orchards. *C. purpurea* has been reported

in the states of Mexico, Puebla, Sinaloa and Veracruz (2,5). Quality reduction has been noted, but it is not a serious disease. Anthracnose has been present practically in all the avocado producing states (5). Of the other fungi causing fruit rot, *Diplodia* sp has been implicated and found in the state of Mexico (2), *Dothiorella* sp and *Alternaria* sp in the states of Michoacan, Puebla and Queretaro (5). All these fungi are usually controlled in well-managed orchards, but sometimes escape control in less well-managed areas.

The bacterial blast is a disease reported for the first time in Mexico. Low temperatures are apparently necessary for this disease to be a problem, since both *P. syringae* pv *syringae* and *E. herbicola* has been known for its ice nucleation activity under these conditions. However, below-zero temperatures do not occur too often in avocado growing areas and it seems that frequent problems may not be encountered. This disease was described for the first time in 1926 in California (7) and later in Israel (9).

The sun blotch has not been studied in Mexico, because of its extremely low incidence and distribution, but from the literature (4) it is known that it is a disease where a viroid is involved. The necrotic ring of the peduncle has been an enigma, although various unproven explanations have been offered, such as zinc or calcium deficiency, or different fungal infections.

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