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Eradication of apple scab

By John Cripps, Senior Horticultural Research Officer, South Perth and Ralph Doepel, Consultant Plant Pathologist

The detection of apple scab in two orchards at Pemberton and Newlands in December 1989 ended Western Australia's 41-year, scab-free span for apple growers.

Without eradication orchardists would have had to apply up to 20 fungicidal sprays a year, at an annual cost of $1-2 million, to be able to market a high proportion of scab-free fruit. The industry chose eradication as the cheaper alternative, but the location of infected orchards at Pemberton in particular, with its high rainfall, suggested that it would be difficult.

Scab, or black spot, is the most serious fungal disease of apples in the world. It affects leaves and fruit. Severely scabbed fruit cannot be sold.

Previous outbreaks

Western Australia is the only Australian State, and probably the only apple growing region in the world, where scab disease is not established.

Several earlier outbreaks from 1930 to 1941 at Manjimup, Mount Barker, Porongurup and Kalgan River were eradicated successfully after removal of trees, sprays of Bordeaux mixture and destruction of leaf litter.

Scab was also eradicated in 1947-48 after outbreaks developed in 21 orchards and one nursery at Manjimup. These latter outbreaks were linked to the importation of trees with budscale infections from Victorian and Tasmanian nurseries in the winter of 1947. Subsequently, all such imports were banned.

Defining the extent of outbreaks

Once initial scab infections were discovered in 1989, the main apple growing districts in the State were checked for the disease. This was important because of possible scab spread with young trees into other districts.

Department of Agriculture staff and casual labour, recruited and trained for the purpose, spent thousands of hours walking up and down rows of trees, with one person on each side of a row, scanning leaves for scab. Most infected leaves were detected by this method. The search was at eye level rather than in tree tops because foliage at this level is more protected, humid and shaded. Irrigation water and rainfall dries more slowly in this part of the canopy, favouring spore germination and leaf infection.

The disease was detected in another 21 orchards in the Manjimup-Pemberton area; in the one Pemberton nursery (but only late in the season); in another orchard at Newlands; on two young Lady Williams trees in an orchard at Donnybrook; and on one Sundowner tree in a Dwellingup orchard. The industry was shocked by the severity and widespread nature of the outbreak.

In the 1990-91 season, a further severely affected orchard was detected at Manjimup. This infection was probably missed during the previous season's survey. A repeat infection involving three young trees was also found in another orchard in that district.

During the 1991–92 season, one infected tree was found in a backyard in the Manjimup townsite; an outbreak was discovered in one orchard at Brookhampton; and a serious repeat outbreak was detected in the Dwellingup orchard. In April, scab was detected at the Department of Agriculture's Stoneville Fruit Research Station. In late November 1993, unexpected and serious outbreaks were detected in two orchards, at Manjimup and Balingup.

Duration of campaign

Infected orchards were placed under quarantine and have to be free of scab for three successive years before they can be released from restrictions. This is in addition to the year in which the infection was found.
Prevention of scab spread

Restrictions on the movement of fruit from infected orchards were put in place before harvest to prevent distribution of infected leaves during transport from orchards to packing sheds. Fruit sales were restricted and fruit from infected orchards was sold outside other apple growing areas.

Other young trees at the Dwellingup location and the infected young trees in the Brookhampton orchard were 'skeletonised' by removing all foliage and small limbs. Cuts were covered with white acrylic paint to prevent sunburn. Successful regrowth subsequently occurred on such trees before leaf fall, enabling a suitable framework to be created during winter pruning.

Containment of outbreaks

In most affected orchards, depending on tree size, infected shoots and leaves were pruned off and bagged for subsequent burning, or whole trees were sawed down, collected and burnt. Initially, spraying with fungicides within a 25 m radius of an infected tree was considered adequate. However, when infected trees were found scattered throughout some orchards at Manjimup, the spraying practice was changed to cover the whole orchard. Eventually the Warren Shire was gazetted as a quarantine area and spraying made compulsory for all orchardists.

Groups or blocks of infected trees and even whole orchards were either bulldozed or removed because trees were too large and spreading for satisfactory spraying, or because growers did not want to undertake spraying, given the low price for Granny Smith apples.

A few unaffected orchards had reached ‘organic’ status. As spraying with fungicides would have negated that status, owners chose to remove trees.

Trees from abandoned or neglected orchards were removed to reduce the risk of disease development and fungus carry-over in fallen leaves.

In the Manjimup district 45,000 trees were removed and burnt by the end of winter 1990. A log loader was used to remove 700 trees for burning each day. Before orchards were bulldozed, 3000 sheep were agisted on several Manjimup properties to graze weeds and fallen leaves. After trees were removed, cleared areas were ploughed with a mould board to bury remaining leaf litter.

Orchardists received some compensation from Fruit Industry Trust Funds as part recompense for destruction of scab-affected orchards. The State Government granted the funds, a $525,000 interest-free loan, repayable over five years.

In the 1990-91 season, the infected half of one orchard at Manjimup was removed, as was part of the infected block of young trees in the Dwellingup orchard. A block of mature trees at Stoneville Research Station was removed in 1991-92.

Other young trees at the Dwellingup location and the infected young trees in the Brookhampton orchard were 'skeletonised' by removing all foliage and small limbs. Cuts were covered with white acrylic paint to prevent sunburn. Successful regrowth subsequently occurred on such trees before leaf fall, enabling a suitable framework to be created during winter pruning.

Prevention of scab spread

Restrictions on the movement of fruit from infected orchards were put in place before harvest to prevent distribution of infected leaves during transport from orchards to packing sheds. Fruit sales were restricted and fruit from infected orchards was sold outside other apple growing areas.
If trees remain wet the germinating spores grow as fungal threads into the leaf and fruit tissues just beneath the cuticle (skin). The length of the wetting period required for successful ascospore germination and infection (primary infection) is known as an infection period. It can extend from about eight to 16 hours or more, depending on the prevailing temperature. Wind may distribute the ascospores throughout an orchard, to neighbouring orchards and most probably to more distant orchards.

The fungus continues to grow beneath the cuticle and in about 10 days produces scab spots visible to the naked eye. These spots are composed of fungal stalks that have broken through the cuticle and which bear masses of the dark coloured conidia. Conidia are washed or splashed by rain onto other leaves and fruit within the tree and are carried by wind to neighbouring trees and possibly nearby orchards. They can be present in the air both in rainy weather and on dry days. However, successful germination and infection by conidia depends on leaves and fruit remaining wet long enough.

Secondary infection by conidia can continue from the appearance of the first primary spot to the end of the season if the weather is...
favourable. Overhead irrigation during summer creates artificial infection periods and favours continued disease build-up.

Leaves older than about 16 days are considered to be resistant to infection, but old leaves become susceptible again late in the season.

**Symptoms**

Spots can develop on either the upper or lower surfaces of leaves. They first develop as light green areas that later turn olive-green or black and velvety. Numerous spots on a leaf may merge along veins and extend over much of the surface. Older spots on the upper surface become raised and give infected leaves a blistered, scabby appearance. Leaf infection late in the season shows as dark grey to black angular spots on the under surface.

Fruit infections are at first small, black and circular. As the spots enlarge, the central area becomes brown and corky and the surrounding border shows a greyish-white band of loosened skin. Fruit infected early in the season becomes badly scabbed, while late infection results in small spots only. Infection just before harvest may not be detected when fruit is picked but can develop into small black spots during cold storage.

**Conclusions**

The eradication of apple scab from Western Australia from 1989 onwards was initially difficult for several reasons.

- Most of the infected orchards were in a higher rainfall area (Manjimup-Pemberton), and nearly all of these had overhead irrigation.
- Trees in older plantings at Manjimup-Pemberton were often multi-leadered, vase-shaped and spreading. If left unpruned they were unable to be satisfactorily sprayed with fungicide.
- Air-blast sprayers needed recalibrating to ensure effective tree coverage with fungicides.
- Containment of outbreaks by destruction of infected foliage and fruit and prevention of further spore (conidia) production with fungicidal sprays.
- Removal of blocks of trees or else all trees from infected orchards.
- Removal of abandoned and neglected orchards and also some 'organic' status orchards.
- Prevention of scab spread through restrictions on fruit movement from infected orchards and on marketing of fruit from such orchards.
- Breaking the life cycle of the scab fungus with fungicide sprays after harvest but before leaf fall, followed by the destruction of leaf litter in winter.
- Spraying with fungicides during spring and early summer to prevent early infection and so reduce disease build up.
- The dedication of all individuals involved who refused to be disheartened by the enormity of the task.