The Plum Death Syndrome

A Complex Disease with Different Factors

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INTRODUCTION

A troublesome tendency in the plum production areas in the Western and Southern Cape is the death of young plum trees just as they reach their productive years.

An article about plum death in plum orchards in the Boland was published in 1996 in 'Die Burger' by Hans Hugo after large scale deaths occurred in this area (Van der Vyver, 1996).

These plum deaths have similarities to 'Peach Tree Short Life' (PTSL), a disease that started emerging in the seventies in the south-eastern parts of the USA (Georgia) for which bacterial canker is usually to blame. The two diseases are not exactly the same yet there are a few similarities.

SYMPTOMS

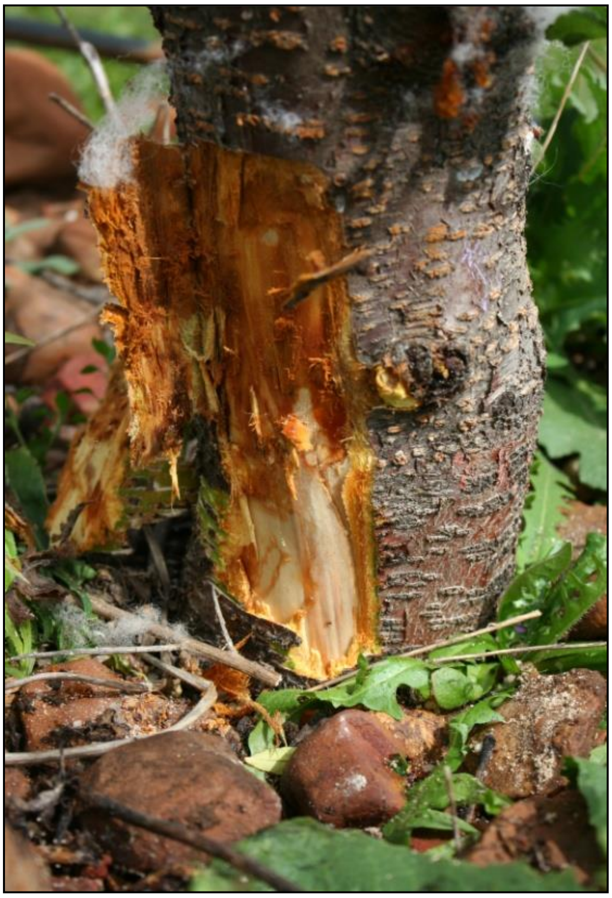
The trees typically die between the ages of 2 and 7 years. Trees that looked healthy during the previous summer suddenly die after flowering. It seems as if the tree, or some of the shoots, have a shortage of water. Single shoots from affected trees or whole trees die back all the way to the graft scion. Later in the season the trees may sprout new shoots from the base of the trees. The trees die of bacterial canker (*Pseudomonas* spp) and sometimes other stem cankers, which are all usually weak pathogens.

When the outer bark is removed discolouration of the inner-bark, cambium and xylem is revealed (Fig 1). Less visible symptoms and signs like a water-lodged appearance of shoots and cracks in the bark can be seen weeks before flowering. Some trees will bare clusters of small leaves (Fig 4). Trees with these early symptoms may not flower, have leaves, show symptoms of PTSL or grow as if they are healthy.

In serious cases yellow or orange gum drops ooze from the base of the trunk, the branches or the fork of the branch (gummosis). The characteristic sour-juice smell is associated with the discoloured bark.

Some cultivars seem to be more susceptible than others.

Fig. 1: Discolourations of the cambium tissue.



CAUSES

Various factors play a direct or indirect role in the 'domino effect' which leads to the plum death syndrome. The most prominent factors of the disease complex are bacterial canker and ring nematode.

I. DIRECT FACTORS

a) Bacterial Canker

Pseudomonas syringae is a bacteria that cause diseases in many woody plants and canker in most *Prunus* species. It kills dormant peach buds, twigs and trees. Bacterial canker affects trees to just above the soil level. Infected bark has a reddish-brown colour with a definite line, which differentiates infected wood from healthy wood. According to research, peach trees that are subjected to stress or damage due to nematode feeding or other factors are more susceptible to bacterial canker infection. The etiology of the canker diseases is unknown. The disease can be dormant and may take a year or two to manifest and subsequently cause the death of the trees.

b) Climate

Climate damage causes a brown discolouration of the cambium layer underneath the bark. If the damage is great the bark can easily be separated from the wood. Warm periods, when physiological activity takes place, are common in south-east USA. Lengthy periods when the soil freezes are absent and root activity can then continue throughout winter. Some of the most severe losses take place when temperatures between 22°C or higher prevail for a few days and then temperatures suddenly drop to below -6°C.

Although cold damage can kill trees, trees with serious outer cambium tissue damage may survive and grow as if not affected. A diagonal cut of the stem can reveal that there is 20% damage of the cambium tissue in the first year and 90% in the second year. Substantial growth can still take place during the third and even fourth year and the tree only dies during the fifth year. It is thus shown that survival of trees after cold damage is dependent on other factors.

Research has shown that resistance against cold is influenced by pruning in autumn, soil fumigation, rootstocks and nitrogen levels. The question is: is cold damage relevant in South Africa?

The cold may not be an issue in South Africa, but it has been observed that short periods when sudden high temperatures are experienced at the end of winter or early spring triggers plum tree death symptoms. The last couple of winters have been characterized by a hot spell (above 25°C) towards the end of August.

II. INDIRECT FACTORS

The most important indirect factors (that do not cause the death of the trees) but that contribute to the increased susceptibility of peach trees to bacterial canker include:

a) ring nematodes
b) rootstock type
c) orchard characteristics
d) time of pruning

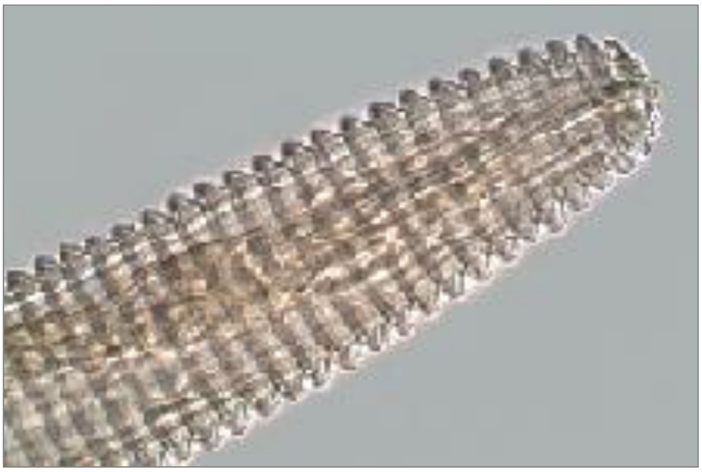
A large part of the complexity remains unknown.

a) Ring nematode

A variety of nematode species can be associated with stone fruit roots. The most common are root-knot nematode and ring nematode (Fig. 2).

Root-knot nematode in old peach orchards and in cultivated soils leads to the death or hampering of growth of young trees and has a negative impact on the size of the harvest of remaining trees. Where symptoms of root-knot nematode are very noticeable in damaged roots, the damaging effect of the ecto-parasitic ring nematode is more subtle, and the symptoms are limited to the necrosis and growth straining of young hair roots.

Fig. 2: The ring nematode, *Mesocriconema xenoplax.*



The association of ring nematode with the early death of peach trees is known. In the case of PTSL the ring nematode lowers the immunity of the peach trees against bacterial canker and cold damage by stimulating production of indole acetic acid (IAA), which then interferes with the dormancy of the trees (Lownsberry et.al., 1977). The potential to lose peach trees because of PTSL is highest when the tree is allowed to go **into the dormant stage** where high numbers of ring nematode are present. This situation can be interpreted as proof that PTSL syndrome is complex with many interactive factors.

Hormone theory

Dormancy is controlled by hormones (auxins (IAA) and cytokinins). Renewed cambium-activity is initiated by auxins that are produced in eg the tips of shoots. Nematode damage alone causes increased auxin-levels that lead to a break in dormancy. A cambium that becomes active too early is prone to cold or hot damage. The dormant vascular cambium is highly resistant to cold or hot damage. Damage to the vascular cambium interferes with water holding capacity which causes less vigorous trees.

Carbohydrate-separating theory

Root-knot nematode resistant rootstocks transfer more carbohydrate reserves from the shoots to the roots in reaction to parasitism by the ring nematode. The depleted carbohydrate reserves are positively correlated to the inability to protect against stress such as cold or heat damage. Above-ground depletion of nutrients in trees that are exposed to ring nematode feeding causes tree death because of factors that will not affect healthy trees.

Table I: Root knot and ring nematode resistance in stone fruit rootstocks.

Rootstock	Resistance	
	Root-knot nematode	Ring nematode
GF 677	Susceptible	Susceptible
Kakamas	Susceptible	Tolerant
Viking	?	Mildly susceptible
SAPO 778	Mildly susceptible	Susceptible
Maridon	Immune	Susceptible
Marianna	Immune	Very susceptible
Nemaguard	Resistant	Susceptible
Flordaguard	Resistant	Susceptible
Nemared	Resistant	Susceptible
Garnem	Resistant	Susceptible
Atlas	Resistant	Tolerant
Tsukuba	Resistant	Very susceptible
Guardian	Resistant	Tolerant

b) Rootstock

High numbers of root-knot nematode can lead to the death of young stone fruit trees. Pre-plant fumigation drastically reduces the risk of root-knot nematode populations but does not eliminate them. When susceptible rootstocks are planted in these soils, root- knot nematode will become a serious problem again within a few years. Rootstocks that are resistant to root-knot nematode can thus be very valuable. Root- knot nematode resistant rootstocks (Marianna, Maridon, Nemaguard Nemared and Tsukuba) were proposed. Rootstocks that are resistant to root-knot nematode would seem to be more susceptible to ring nematode (Fig 3). Trees on these rootstocks are thus more susceptible to Plum Death Syndrome. It seems that Marianna rootstock is a good host for ring nematode. (This situation is a repetition of the rootstock problems in America with regard to the PTSL-syndrome). The high ring nematode numbers cause stress that make trees more susceptible to cankers that are weak pathogens.

Fig. 3: The difference between root-knot nematode resistant (right) and susceptible (left) rootstocks.

c) Orchard properties

Plum death syndrome is more prevalent on soils where stone fruit or vines were previously planted and especially those with a history of ring nematode.

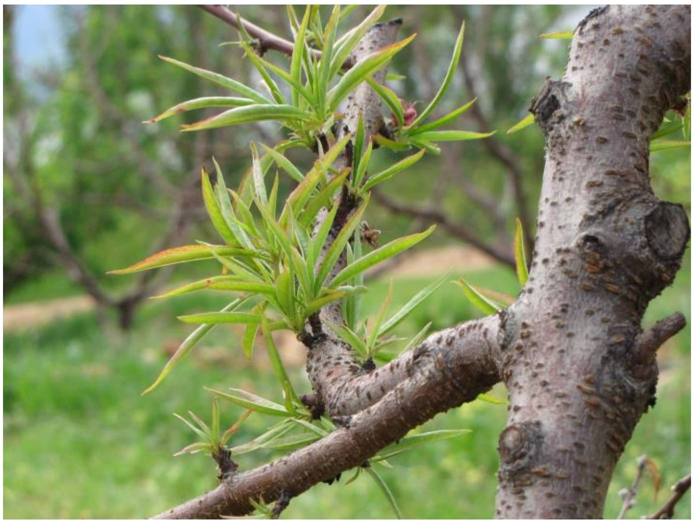
It has indeed led to the theory that pre-disposing factors persist on cultivated soils and old peach orchards, even after trees have been taken out. This makes new trees more susceptible to bacterial canker and hot and cold damage. Soil pH is for example such a factor because it is known that soil pH also exposes peach trees to PTSL. The addition of agricultural lime on soil with a pH of 4.8-5.2 influenced the growth and vigour of the trees positively. Soil pH can thus affect root growth, soil- and root microflora, nematodes and susceptibility to bacterial canker. Physical structure of the soil, eg. hard-pans, can also hamper growth and survival of trees.

d) Time of pruning

In the case of PTSL early pruning is associated with trees dying in the following spring. Trees may be pruned in autumn with no side effects, but the unpredictability of the seasons complicates matters. It seems as if autumn pruning interferes with the dormant peaches by stimulating production of indole-3-acetic acid. Wounds from autumn pruning are partly healed mid-winter, which is proof of an active cambium, which is very susceptible to frost (cold) or heat damage.

Trees that are pruned in autumn could be exposed to bacterial canker through the open pruning wounds or indirectly by the tree being more susceptible to frost (cold) or heat damage.

Fig. 4: Branches that are re-budding after losing their leaves.



POSSIBLE SOLUTIONS

Because there are no desired management practices available to prevent bacterial canker or frost (cold) damage, the management of PTSL is aimed at the indirect factors.

Management of the problem is not easy and entails thorough and comprehensive long-term planning and management with the emphasis on prevention. It already starts before the establishment of new orchards. The nematode infestation must be determined BEFORE the previous crop is removed. It is of utmost importance in the case of replanting and where the previous crop was vineyard or stone fruit.

The potential loss because of PTSL is highest when the trees are allowed to become dormant with high numbers of ring nematodes present. Nematicides may suppress and/or bring down population numbers of ring- and root-knot nematode and can thus increase survival of trees. Because of the slow process to decrease nematode populations, treatment of the soil must start before nematode populations become too high.

NEMATODE CONTROL

Immediate treatment of nematodes will not necessarily prevent tree deaths in upcoming years. The cankers are latent diseases and only show symptoms after a long period.

Replanting of trees should only be done if the hole has been fumigated, otherwise the problem will be repeated.

The rootstock which is best adapted to the nematode species in the soil should be used. It is however not that easy to decide on a suitable rootstock as more than one type of nematode is usually present.

It is advisable to let soils, that are heavily infested with nematodes, rest for a period of time (without weeds or with a multi-species cover crop) in order to lower nematode populations. The populations will start decreasing after a year but the reduction will be greater the longer the soil is left before replanting.

Soil fumigation

Soil fumigation, before planting, of sites where peach trees have died is very effective to prevent PTSL. By fumigating before planting the nematode population is lowered to a level at which trees can flourish in their early years. Fumigants with a broad spectrum may have additional benefits.

In soil that is moderately infested with nematodes, registered nematicides can be administered after planting. Fumigants should be administered before planting, but nematicides may be administered before, at or after planting.

Stress should as far as possible be limited. There should be guarded against severe summer pruning and in some cases yield control can be implemented. Young trees' yield load could be thinned, and a lighter yield left on older trees.

Producers should monitor orchards on a regular basis for the presence of nematodes to implement pro-active control measures.

10-POINT CONTROL STRATEGY

The 10-point control strategy was designed for the control of PTSL, but also to reduce stress and ensure long-lived, productive, peach and/or plum orchards.

1. Apply lime prior to planting to adjust pH to at least 6.5.
2. Break clods/hard-pans to promote better root development.
3. Fumigation should be considered in sandy soils previously planted to stonefruit or vines or where nematodes were previously a problem.
4. Plant trees that have been grown in sterilized soil or that have been certified free of nematodes.
5. Plant trees that have been grafted on root-knot susceptible rootstocks.
6. Apply lime and fertilizer as determined by soil and leaf analyses.
7. Prune as late as possible, never before June. If early pruning is inevitable, prune older trees first. Pruning is risky for old peach orchards.
8. Use recommended herbicides for weed control. Keep soil preparation (if necessary) shallow to prevent the tree roots from getting damaged.
9. Remove and burn all dead or dying trees as soon as possible.
10. In orchards where fumigation is necessary before planting, nematicides should be applied after planting as recommended for nematode populations.

A three-part series on Dieback in Plums was published in the SA Fruit Journal in the April/May 2016 edition by Glenneis Kriel.

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