South African Avocado Growers' Association Yearbook 1987. 10:89-91
Proceedings of the First World Avocado Congress

Root rot control in South Africa: Past, present and future

JM KOTZÉ[1], JN MOLL[2] and JM DARVAS[3]
[1]Department of Microbiology and Plant Pathology,
University of Pretoria, Pretoria 0002, RSA
[2]Citrus and Subtropical Fruit Research Institute,
Private Bag X11208, Nelspruit 1200, RSA
[3] Letaba Estate, PO Box 6, Letaba 0870, RSA

SYNOPSIS
The different strategies for the control of Phytophthora root rot are discussed, which include the trunk injection technique. Possible improvements for the accurate timing of the injections are considered by monitoring phosphite in the plants and phytoalexins after injection. A total strategy is discussed based on chemical control, resistant rootstocks, cultural practices and disease-free nurseries.

INTRODUCTION

The serious nature of Phytophthora root rot in South Africa is stressed by nearly every report on the subject. Yet, it was only in 1972 that *Phytophthora cinnamomi* was identified as the main cause of avocado tree decline in South Africa (Milne, Brodrick & Hughes, 1975). At that time, nurseries were (unknowingly) effective distribution points of the disease. Rootstocks were mostly either of unknown origin, or Mexican or Guatemalan seedlings. Certain prominent nurserymen worked on the theory that a Phytophthora-infected nursery was advantageous because of the selection pressure, so that only the resistant plants survived. Those were the pioneering days when opinions ruled over facts.

The first avocado disease-free nursery was established at Westfalia in 1974. Several others followed. Today there is the Avocado Nurserymen's Association, which encourages nurseries not only to be completely *Phytophthora* free, but also to test all the propagated material for sunblotch viroid.

Although *P. cinnamomi* is by far the most important pathogen of avocado roots, other fungi are also sometimes associated with root rot. These fungi include *Verticillium theobromae, Rhizoctonia solani, Fusarium oxysporum, F. moniliforme, Pythium* spp, *Macrophomina phaseolina, Cylindrocladium scoparium* and *Cylindrocarpon destructans.*

The severity of Phytophthora root rot in South Africa is probably due to the prevailing high soil temperatures, summer rains which sometimes cause water logging, badly drained soils, lack of rootstock resistance and the low calcium status of the soils (Zentmyer, 1979).

RESEARCH STRATEGY

Since 1977, an intensive research programme was sponsored by the S Afr Avocado Growers' Association in order to find means of controlling the disease. The objectives of this programme were: to evaluate fungicides and techniques of application in order to save existing orchards; to develop methods of establishing disease-free nurseries; to improve orchard practices which will suppress disease development; to encourage biological control and to introduce resistant rootstocks.

It will be noted that these objectives were short, medium and long term. The research programme yielded positive results within a year, when very promising results were obtained with soil applications of metalaxyl (Darvas, Kotzé & Toerien, 1978).

After a few years, the results with metalaxyl were less convincing and the trees deteriorated despite treatment. There is evidence now that *P. cinnamomi* has become insensitive to metalaxyl in some localities (Darvas, 1983).

Phosetyl-Al was introduced as a foliar spray, but up to six applications were recommended per season. This control programme was laborious and expensive and the recovery of infected trees was slow. Alternative methods of application were explored by Snyman & Kotzé (1983) who showed that phosetyl-Al applied as a stem paint or in a plastic sponge-band around the trunk, was just as effective as foliar sprays. Darvas, Toerien & Milne (1983) demonstrated that diseased trees recovered remarkably well when injected with a water solution of phosetyl-Al. This technique is a significant breakthrough, especially under severe disease conditions. Two to three injections per season were sufficient to effect almost complete recovery of severely infected trees.

THE PRESENT SITUATION

Control of avocado root rot depends on the following principles: disease-free nurseries, resistant rootstocks, judicious use of fungicides and sound cultural practices.

Complete elimination of *P. cinnamomi* is practised in nurseries. Sterilisation of soil and potting media with methyl bromide, is common practice. Copper sulphate powder for wiping of feet, is found at the entrance of most nurseries to prevent the introduction of soil-borne pathogens. The plant material used in nurseries is usually washed and treated with fungicides. Water, an important distributor of *Phytophthora* inoculum, is closely scrutinised. Borehole water is preferred because most of the rivers are heavily infected. River water is sometimes filtered, but always chlorinated before use. Hygiene standards are high and are applied voluntarily by nurserymen. If there is relaxation of standards, *Phytophihora* claims a high toll.

Duke 6 and 7 were introduced as seedlings or clonal, Duke 6 has lost favour because of a suspected virus infection. Duke 7 is popular, but not resistant. A crown canker associated with *P. cinnamomi,* is now observed on Duke 7. G6 and G755 stems were highly susceptible in greenhouse experiments. Clonal Duke 7 should, however, be treated with care, as it is not as robust as Guatemalan seedlings and farmers are sometimes disappointed with these trees if they are not properly irrigated and cared for

during the initial stages after planting. Duke 6 is no longer considered as a future rootstock. Other rootstocks from California which are being tested, are G6 and G755, Bar Duke, G1033, Duke 9, Thomas and some local selections.

There is a tendency in South Africa to consider rootstocks primarily for resistance against *Phytophthora.* This is risky because there are other potentially dangerous pathogens to which the new rootstock may be susceptible. This weakness often manifests itself rather rapidly after a few years of good performance. The horticultural characteristics of a rootstock should never be underestimated.

The use of fungicides against root rot has become established practice. At this stage, the South African grower has only one fungicide to rely on, *viz* phosetyl-Ca, if he has metalaxyl-resistant *Phytophthora.* Phosphorous acid is not being used as it is in Australia. There are, however, several methods of application to choose from. When the disease is mild, regular stem sprays or painting will halt progress of the disease. The sponge-band appears to be equally effective. If, however, the disease gets out of hand, trees can be saved by stem injections. The latter method is widely used, even for ailments which are not caused by *Phytophthora.* Results are sometimes disappointing.

New orchard soils are often not infested with *P. cinnamomi* and it was proved that, if a grower fumigates planting holes of old orchard soils with methyl bromide, it takes much longer before tree decline sets in. Some growers fumigate planting holes with methyl bromide at least a month before planting. A cheaper method, namely solarisation, was evaluated in areas with long periods of summer sunshine, but the results were disappointing. Solarisation is not recommended for the control of *P. cinnamomi* at present. A phenomenon was recorded in Queensland, Australia, where *P. cinnamomi,* although present in the soil, caused no significant disease (Broadbent & Baker, 1974). Soil which behaves like this is called suppressive; and, although there is no lack of theories, the authors do not fully understand the suppressive soil phenomenon, but they do know that it is a form of biological control, where antagonists are at work. The emphasis in their case is on the reduction of inoculum and on preventing any soil situation that will predispose the tree to infection. Biological control is encouraged.

Liming of soils before planting was found to be beneficial. Surface and subsoil drainage is very strongly recommended. The calcium status of soils is carefully monitored and amended.

FUTURE STRATEGY

Research on chemical control is centered around the trunk applications techniques. The injection technique is being refined. It will not be surprising if applications directly to the bark will replace the injection technique in the long term. At the moment, the injection technique seems to be limited by the chemical used. It also seems possible that phosphorous acid may be improved by additives, or that equally good combinations will be registered in future.

The possibility of *P. cinnamomi* becoming resistant to phosphorous acid, poses an interesting problem. This may happen when the fungus comes in direct contact with the chemical.

When phosetyl-Al is injected into the tree, it gradually breaks down and releases phosphorous acid, which is the active part (Fenn & Coffey, 1984). If the concentration of phosphorous acid can be monitored, it could be useful to determine when follow-up injections should be made. This technique was developed by Bezuidenhout & Kotze and will be reported later today. It is a useful tool for more accurate timing of treatments.

Labuschagne & Kotze (unpublished) investigated the possibility that the mode of action of injected chemicals was not based on the antifungal nature of the chemicals themselves, but on the stimulation of metabolites which were antifungal in the plant. The authors suggest an indirect effect, which is referred to by some workers as phytoalexins. This suggests that the control of *Phytophthora* may be achieved with any chemical that will stimulate phytoalexins. Furthermore, this suggests that phosphorous acid is not the only material that achieves this.

Chemical control of *P. cinnamomi will* remain a vital component of future research programmes.

The search for resistant rootstocks will continue. Local selections under South African conditions, as well as screening of rootstocks from other parts of the world, are being given top priority.

The value of sound orchard management is gaining popularity. A true suppressive soil has not yet been found or created in this country, but liming and the application of calcium carriers before the planting of orchards, have become popular. It is well documented that calcium is beneficial under root rot conditions.

P. cinnamomi plays such a dominating role in avocado production, that it is safe to predict that it will remain a major issue in years to come.

Any disease control in which antagonists are involved, is called biological control. In practice it means integrated control or disease management, because chemicals will form part of the whole. The future lies in an integrated control approach.

REFERENCES

1 Broadbent, P, Baker, KF, 1974. Behavior of *Phytophthora cinnamomi* in soils suppressive and conducive to root rot. *Australian Journal Agricultural Research,* **15**, 121 -127.

2 Darvas, JM, Kotzé, JM & Toerien, JC, 1978. Preliminary results on chemical control of Phytophthora root: rot in avocados. *Citrus and Subtropical Fruit Journal,* **537**, 6-7.

3 Darvas, JM, 1983. Five years of continued chemical control of Phytophthora root rot of avocados. *S Afr Avocado Growers' Assoc Yrb*, **6**, 72-73.

4 Darvas, JM, Toerien, JC & Milne, DL, 1983. Injection of established avocado trees for the effective control of Phytophthora root rot. *S Afr Avocado Growers' Assoc Yrb,* **6**, 76-81.

5 Fenn, ME & Coffey. MD, 1984. Studies on the *in vitro* and *in vivo* antifungal activity of fosetyl-Al and phosphorous acid. *Phytopathology,* **74***,* 606-611.

6 Snyman, CP & Kotzé, JM, 1983. Efficacy of systemic fungicides applied as a trunk paint and a sponge band for the control of root rot on five-year-old avocado trees. *S Afr Avocado Growers' Assoc Yrb,* **6**, 70-71.

7 Wolstenholme, BN, 1979. Prospects for integrated and biological control of avocado root rot - some overseas impressions. *S Afr Avocado Growers' Assoc Yrb,* **3**, 17-20.

8 Zentmyer, GA, 1979. Report on Phytophthora root rot of avocado in South Africa. *S Afr Avocado Growers' Assoc Yrb,* **3**, 7-9.