Litchi decline in South Africa – new or old problem?

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ABSTRACT

Litchi decline has been reported in several countries over the past few years. Also in South Africa it seems to be a sporadic problem, associated with several pathogens and probably several predisposing biotic and abiotic factors. Different symptoms and possible causes are discussed with emphasis on recent observations throughout the litchi industry of South Africa. Management and research strategies, which focus on eliminating predisposing factors, are discussed.

UITTREKSEL

Lietsjie-terugsterwing is die afgelope aantal jare in verskillende lande gerapporteer. Ook in Suid-Afrika blyk dit 'n sporadiese probleem te wees, wat met verskeie patogene en heelwaarskynlik predisponerende biotiese en abiotiese faktore geassosieer word. Verskillende simptome en moontlike oorsake word bespreek met beklemtoning van onlangse verskynsels in die Suid-Afrikaanse lietsjiebedryf. Beheer en navorsingstrategieë met die fokus op eliminasie van predisponerende faktore word bespreek.

INTRODUCTION

Two kinds of decline have been described for litchi trees (*Litchi chinensis* Sonn.), namely slow decline (die back) and sudden death. The disease was first reported in Florida by Cohen (1955) and subsequently also reported in South Africa (Milne, *et al.,* 1971; Darvas, 1992), North Vietnam (www.agroviet.gov.vn/), Australia and the Philippines (www.fao.org/). Gao *et al.* (2000) reported a root rot of litchi trees in China. They did not identify the causal organisms but reported effective control with metalaxyl.

SYMPTOMS ASSOCIATED WITH LITCHI DECLINE

Slow decline and die back are general terms for trees showing reduced vigor in parts or the canopy or the whole canopy. Affected canopy normally do not set new flush, crop is poor, leaves may drop and small twigs start to die. Symptoms can also include a sudden branch wilt that is followed by decline of new growth. Die back of tips without any signs of wilting has also been reported. Temporary recovery of diseased parts have been reported, but eventually the tree dies. Slow decline is mostly associated with large trees while young trees are more prone to sudden death symptoms.

PROBABLE CAUSES OF LITCHI DECLINE

Symptoms can be caused by pathogenic microbial infections of the feeder root system, larger root system or the trunk. Similar symptoms can also be caused by drought, anaerobic conditions due to compaction or poor drainage, poor root structure, nutritional problems and toxic chemicals (fertilisers and herbicides). In general symptoms is associated with poor root systems or poor transport of nutrients and water to the canopy of affected trees. The disease is often associated with poorly drained soils.

Several pathogens have been reported to be associated with litchi decline. The major one is *Clitocybe tabescens* (Cohen, 1955; Cohen 1963). In the Philippines litchi decline, called mushroom rot, was also associated with *C. tabescens.* In Northern Vietnam, Sudden Death Disease of litchi trees occurred in almost all litchi growing areas and disease incidence ranged between 17% and 35%. *Fusarium solani, Cylindrocladium, Phytophthora, Pythium,* and *Rhizoctonia spp.* were found associated with the disease. Factors such as poor drainage and poor soil conditions as well as inadequate irrigation during dry seasons were mentioned as possible predisposing factors.

In Florida, die back of small branches and twigs, especially after cold damage, was associated with *Diplodia, Leptosphearia* and *Phomopsis spp.* Other symptoms such as sudden wilt and death of entire trees or portions of the canopy and slow decline were associated with *Armillaria tabescens* in Florida.

In South Africa, die back was reported in the early nineties after four years of drought. Trees between 6 and 40 years were affected. A number of fungi were isolated, but none could cause symptoms after artificial infection (Mannicom, pers. comm.; www.arc.agric.za/). *Armillaria mellea* was identified as the causal organism of decline and especially sudden death of litchi trees around Tzaneen, in South Africa (Darvas, 1992). Trees of various ages were affected, but young trees were more associated with sudden death while older trees showed slower decline. Darvas (1992) used blue lupine seedlings (*Lupinus angustifolius* L) to isolate various organisms from soil and feeder root samples collected from declining and healthy looking trees. Pathogenicity of isolated organisms was tested by inoculating nursery trees between the bark and the wood, approximately 50 cm above the soil level. Only *A. mellea* could produce sudden wilt and decline symptoms. Darvas (1992) also found that *Pythium spp.*, especially *P. splendens,* was isolated more often from the root zones of affected trees than that of healthy looking trees. Other organisms found by Darvas included *Rhizoctonia* and *Cylindrocarpon spp.*, *Fusarium oxysporum* and *F. solani*. Darvas (1992) concluded that in some cases of slow decline, trees might have been predisposed by other pathogens or nematodes. Milne, *et al.* (1971, 1975) reported that at least three nematode species could be involved in the litchi decline disease complex in South Africa.

OUR OBSERVATIONS

Several root and soil samples, obtained from litchi orchards with trees showing different degrees of decline, was sent to the laboratory of QMS Agri Science during February 2004 by litchi producers. These samples were from the Louis Trichardt, Hazyview and Tzaneen areas. In order to determine the causal pathogens, normal baiting procedures were done with soil samples. Root and bark tissues were surface sterilised and plated on cultural media conducive to fungal and bacterial growth. Trees obtained from Louis Trichardt showed advanced root rot symptoms. Only *Fusarium* and *Trichoderma spp.* and several other saprophytic fungi were recovered regularly. The same phenomenon was observed in samples from Hazyview, where roots were also already in an advanced stage of decline. The samples obtained from the Tzaneen area included roots and soil from apparently healthy plants, plants just starting to show decline and plants in an advanced stage of decline. All soil samples tested positive for *Phytophthora* and *Pythium spp.*, *F. solani* and *F. oxysporum.* Cultures obtained from surface sterilised roots mostly consisted of *Fusarium spp.* and an unknown dark *Rhizoctonia*-like fungus. In all three cases we concluded that the tree decline was probably caused by root rot and that the most likely causal or predisposing organisms were *Phytophthora* and *Pythium spp*. No pathogenicity tests were done with the *Phytophthora* and *Pythium spp.* on litchi trees.

A more structured preliminary survey was done in the Hazyview and Nelspruit areas during March 2004. Samples, consisting of soil and roots, were taken from the root zones of apparently healthy litchi trees and trees showing various degree of decline. In some cases samples were taken from diseased and healthy sides of the same tree. Bark samples were taken at soil level to check for the presence of *Armillaria* rot. *Phytophthora* and *Pythium spp.* were isolated regularly from soil samples obtained from healthy and diseased litchi trees. *Fusarium* and *Trichoderma spp.* were present in all soil and root isolations.

Although we examined all samples for the presence of *Armillaria spp.* it was not observed often in our study. *Armillaria* was only observed in an old orchard near Nelspruit, with trees showing slow decline. This orchard contained several dead trunks, mostly with large wounds, where branches were torn off, which probably served as infection sites for *Armillaria*. Darvas (1992) did note that he could not find basidiocarps of *Armillaria* in his study and that identification was mainly done on the basis of white mycelial sheets between the bark and wood. These symptoms were very pronounced on young wilted trees, but not very clear on old, slowly declining trees.

Nematodes were found in soil and root samples of healthy and diseased trees, but mostly numbers were not very high and not correlated with tree condition. However, it is a known phenomenon that high nematode counts are seldom found on poor root systems. This does not exclude the fact that nematodes could have played an important role during the onset of the problem.

CONTROL STRATEGIES

In order to set up management strategies, the cause of the problem should be identified by a process of elimination through soil and tissue analysis and pathogenicity tests. Not all symptoms, even though they look similar, are caused by the same factor in all situations. In most cases more than one factor might be responsible, and therefore, possible predisposing factors should also be identified. Currently no chemicals are registered in South Africa for the control of root rot or decline of litchi trees (Nel, *et al.*, 2003).

In the case of *Armillaria* root rot, new litchi orchards should not be planted on recently cleared land, especially close to stumps and roots of previous carrier hosts such as oak (*Quercus spp.*) or bluegum (*Eucalyptus spp.*). Stumps and roots should be removed completely if fruit orchards are going to be established. Land should lie fallow for as long as possible. Trees should not be replanted where trees have died because of decline, unless all affected plant material was removed and soil was fumigated. Soil fumigation can reduce inoculum where new plantings are planned.

Armillaria is a natural inhabitant of the natural forest ecosystem and normally it does not cause any significant damage. *Armillaria* root rot is extremely difficult to control after the pathogen has established in the host. Inoculum is found in the soil and in trunks of healthy and partially decomposed trees. In healthy trees, even systemic fungicides can only be transported in living tissue. Therefore, it is difficult to get fungicides in contact with pathogens situated in dead affected areas. Several systemic fungicides such as phosphorous acid, fenpropimorf, cyproconazole and propiconazole have shown some efficacy against *Armillaria* rot. Curative control options are limited and success depends on how advanced the infections are. The collar and upper parts of the main roots should be uncovered, diseased parts cut out and wounds should be treated with fungicides. Main roots should be exposed to air for a period of time to retard progression of the infection and to facilitate follow-up application of fungicides.

Biological control agents such as *Trichoderma* and *Gliocadium spp.* were effective during *in vitro* tests and also in trials conducted under semi natural conditions but not under field conditions. Resistant rootstocks are a possibility, but the status regarding resistance to *Armillaria* and other potential root pathogens of local litchi rootstocks is unknown. Rootstocks tolerant to *Armillaria* have been identified for walnuts, citrus, cherry, peaches, almonds and apricots.

CONCLUSION

Darvas (1992) reported inconsistencies during pathogenicity tests with *Armillaria* and remarked on the high levels of *Pythium* and the possible role of other biotic and abiotic predisposing factors associated with litchi decline. Pathogens were tested for activity on above ground plant parts, but not below the soil surface on feeder roots. This test might be suitable for a pathogen like *Armillaria mellea*, which is a natural wood coloniser, but probably not the best test for root rot pathogens like *Phytophthora* and *Pythium spp.*, which might have a specific affinity for feeder root infections.

Our investigation included analysis of soil and feeder roots, obtained from healthy and diseased plants. In most cases litchi decline was associated with a poor root system and *Phytophthora* and *Pythium* were isolated from the soil. *Phytophthora* could not be isolated from severely rotted root systems, mostly due to the presence of abundant *Fusarium* and *Trichoderma spp.*, both superior saprophytic colonisers. *Phytophthora* and *Pythium* are often difficult to isolate at the time when above ground symptoms attracts attention, especially on perennial crops like fruit trees, due to the fact that this pathogen is a poor saprophytic competitor. Therefore, these pathogens are often not recognised as the primary or predisposing organisms. An extensive investigation into litchi decline in South Africa is currently in process. The focus will mainly be on identifying primary pathogens and to introduce management strategies to eliminate predisposing factors such as feeder root rot, which could enhance *Armillaria* decline.

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