THE CITRUS ROOT ROT COMPLEX

1 INTRODUCTION

Until the inception of the Citrus Improvement Programme (CIP) in 1973, practically all commercial citrus orchards in South Africa were established on rough lemon rootstock. While this rootstock served the industry well in terms of its precocity, the production of fruit of good size and adaptability to a wide range of soil types, it had significant disadvantages, including susceptibility to *Phytophthora* and nematodes and sensitivity to poor drainage and high clay levels.

The combination of these factors inevitably resulted in root related problems having a major impact on citrus production over the longer term, especially in the older established production areas where orchards were replanted.

As a result of these and other factors, including poor internal fruit quality, annual plantings on rough lemon rootstock have since declined to approximately 14%.

During the 1980s, the foregoing problems precipitated extensive research, which lead to the development of the "citrus root rot complex" concept and a more holistic approach to managing the root and soil environment. The availability of new products to control soil pathogens, the production of nematode and *Phytophthora*-free nursery trees, better irrigation practices and greater emphasis on physical and chemical soil conditions facilitated a healthier root system.

2 THE ROOT ROT COMPLEX

In the past, growers were inclined to pay attention to above ground insects and foliar diseases only and to forget that the root systems of trees also have to be well managed for optimal production. This requires proper understanding of certain concepts.

The citrus tree absorbs water and nutrients from the soil through its root system. These are translocated upwards through the xylem vessels to the leaves. The photosynthetic products produced in the leaves are in turn translocated downwards to the roots, via the phloem tissues (bark), and supply the roots with metabolites essential for development.

Any factor limiting the functions of the phloem tissues will have a detrimental impact on root development. When root development is affected, the above ground functions of the tree are also affected, causing increased moisture stress, nutrient deficiencies or toxicities which result in reduced photosynthesis, increased respiration and a decline in the amount of carbohydrates and other metabolites that become available for root development. Unless the situation is rectified, root health may decline further and eventually a cyclical process of decline sets in. The situation with respect to root health becomes reflected in the health of the canopy, i.e. sparse foliage, small leaves, nutrient deficiencies and die-back. However, it is important to realise that there is usually a time lag between declining root health and symptom expression in the canopy.

As this situation develops, other secondary factors usually become more significant, resulting in a complex of factors contributing to the decline and eventual death of the root system. The end result is root rot, hence the term "the root rot complex".

There are many factors involved in the root rot complex and their impact on a specific orchard will vary from area to area and orchard to orchard. These factors are either biotic, such as soil-borne fungi *(Phytophthora* and *Fusarium)*, viruses (tristeza), or nematodes *(Tylenchulus)*, or abiotic, such as soil compaction, high water tables, high salt levels or pH extremes (Figure 7.1)

Extreme fluctuations in soil moisture content are probably the greatest single factor limiting plant growth and fruit production. Although trees are considerably less susceptible to short periods of moisture deficit than annual plants, they can be damaged by prolonged periods of drought. Under these conditions trees are weakened and rendered more susceptible to certain pathogens which attack the feeder roots through cracks formed as a result of desiccation.

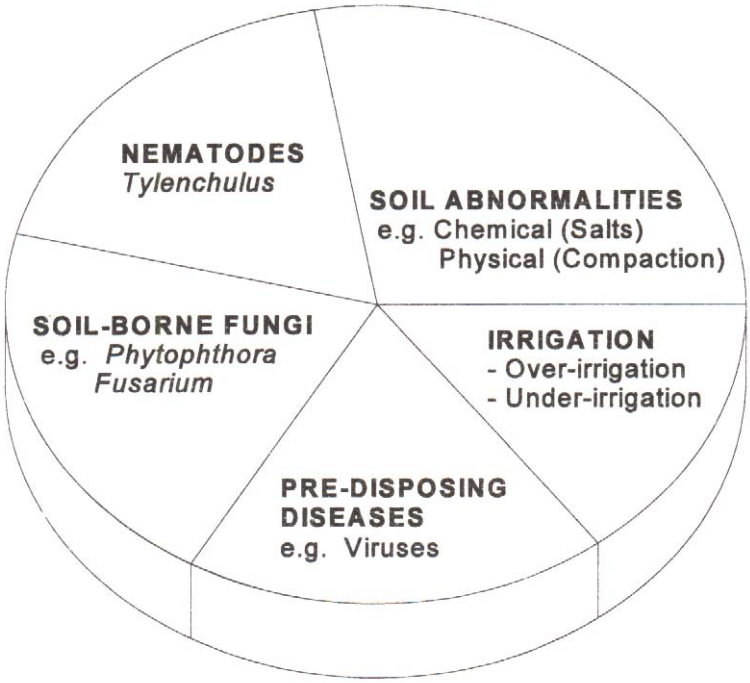

Figure 7.1: The citrus root rot complex

On the other hand, excessive soil moisture levels may result in more serious and more rapid damage to plants than that caused by a lack of moisture. Excessive soil moisture results in decay of the feeder roots. This is due to changes in the soil microflora brought about by the excess water and exclusion of atmospheric oxygen from the soil. Oxygen deprivation causes stress, asphyxiation and collapse of root cells.

Wet, anaerobic conditions also favour the growth of anaerobic micro-organisms which metabolise substances, such as nitrites, that are toxic to plants. The root cells, damaged directly by the lack of oxygen, lose their selective permeability and may allow toxic elements to be taken up by the plant. Once part of the root system is killed, conditions become more favourable for the establishment of facultative parasites which cause further deterioration such as *Fusarium* and *Armillaria*.

It is therefore important to realise that in most instances there is more than one factor involved in the decline of an orchard. The accurate diagnosis and quantification of these factors is essential to managing the root and soil environment. (Refer to the part on the Diagnostic Centre in Chapter 5 of this volume and the sections on soil preparation in Volume I and irrigation in Volume II),

In a particular orchard a single factor may be dominant and should therefore receive attention first. However, all the factors contributing to decline must be addressed before optimal production can be attained.

Management of the citrus root and soil environment therefore requires a multi-disciplinary approach and a thorough appreciation of all the abovementioned facets and begins well before the trees are planted. In the parts which follow, the most important biotic diseases, i.e., diseases involving pathogens, are discussed.