Researching black foot disease in South African vineyards and grapevine nurseries

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Cylindrocarpon spp. which cause black foot disease of grapevine, were recently found to be associated with declining grapevines in South Africa. Results obtained from the diagnostic service at ARC Infruitec-Nietvoorbij showed that Cylindrocarpon spp. were isolated from 52%, 22% and 29% of diseased vines during the 1999/2002, 2002/2003 and 2003/2004 seasons, respectively. However, it was unclear how and where these infections occurred as very little information was available regarding the aetiology and epidemiology of these fungi. Diseased plants display an array of decline symptoms. In vineyards, the first visible symptoms are usually delayed budding or absence of budding (Fig. 1).

Subsequently, shoots develop abnormally and may become chlorotic and even die during summer. When symptomatic plants are removed, inspection of the roots may reveal the presence of brown to black necrosis, which ultimately leads to the underdevelopment of the entire root system. Further root abnormalities include the development of secondary root crowns with roots growing parallel to the soil surface. Internal symptoms include brown-black discolouration of xylem vessels originating from the base of the rootstock (Fig. 2), necrosis from the bark to the centre of the rootstock (Fig. 3) and brown-black discolouration in roots (Fig. 4).

Fig 1. A Chardonnay vineyard showing severe decline symptoms including delayed budding and abnormal, weak vegetation.

Fig 2. Dark vascular streaking as seen in longitudinal section of a nursery vine.

Research objectives

The primary aims of research during the past 5 years have been (1) to conduct nursery surveys in order to determine which pathogens might be involved in the decline phenomenon, (2) to identify the organisms believed to be the causal organisms of black foot disease, and (3) the development of management strategies to prevent or eradicate infections by these pathogens.

1) Nursery surveys

Nursery surveys were conducted in three commercial nurseries in Wellington during the 1999/2000 season by means of destructive sampling. The first isolations were made in September from callused cuttings prior to planting in nurseries. After planting, asymptomatic rooted cuttings were selected from nurseries after 3, 6 and 9 months. The isolation studies clearly demonstrated that different Cylindrocarpon spp. infected cuttings from soil once planted in the nurseries. These species rarely occurred in rootstock propagation material prior to planting. At the time of planting, the susceptible basal ends (especially the pith area) of most of the nursery cuttings are partly or even fully exposed. Callus roots also break during the planting process, resulting in small wounds susceptible to infection by soilborne pathogens. The isolation studies revealed that the first infections occurred in the roots, followed by infections of the rootstocks. Furthermore, these infections also increased progressively during the course of the growing season (Halleen et al., 2003).

Fig 3. Cross-section through infected rootstock revealing necrosis extending from the bark to the pith.

Fig 4. Cross-section of an infected root.

2) Identification

According to literature, black foot disease is caused by Cylindrocarpon obtusisporum and Cylindrocarpon destructans. However, the Cylindrocarpon isolates obtained from the nursery survey, as well as from the diagnostic service, showed substantial variation in cultural and morphological characters and could therefore not be identified using "standard identification keys" like those published by Booth

(1966). Morphological and phylogenetic studies were therefore conducted to identify these species and to establish their association with black foot disease. Phylogenetic analyses confirmed the diversity observed among the isolates and four Cylindrocarpon-like species were identified. One of these groups was identified as Cylindrocarpon destructans. A second group was newly described in this study as Cylindrocarpon macrodidymum. The sexual stage, Neonectria macrodidyma, was initiated by means of mating studies. The two remaining Cylindrocarpon-like species were placed in a new genus, Campylocarpon. The two species were named Campylocarpon fasciculare and Campyl. pseudofasciculare. A growth study to determine the cardinal requirements for growth also revealed further differences between the two genera. The Cylindrocarpon group did not grow at 30°C, whereas 30°C is the optimum temperature for the Campylocarpon group (Halleen et al., 2004).

Pathogenicity

Inoculation of 6-month-old potted grapevine rootstocks with C. destructans, C. macrodidymum, Campyl. fasciculare and Campyl. pseudofasciculare resulted in death (17-35%), as well as reduced root and shoot mass of inoculated plants. Any of these species can therefore be regarded as potential pathogens of black foot disease (Halleen et al., 2004).

3) Control / Management

Knowledge obtained pertaining to the infection period and site in the nursery survey suggested that any suitable control method will have to focus on preventing or eradicating infection of the basal ends of nursery cuttings. Field trials were therefore conducted in two field nurseries. After callusing, the basal ends of grafted cuttings were dipped in various treatments prior to planting. Additional treatments involved soil amendments with Trichoderma formulations and hot water treatment of uprooted dormant nursery grapevines. Nursery plants were uprooted after eight months and evaluated by means of destructive sampling. If all factors are taken into consideration (for example the percentage fungal infection, take percentages, root- and shoot mass), none of the chemical and biological treatments prevented or reduced infection significantly and/or consistently. However, hot water treatment of uprooted dormant nursery grapevines (50°C for 30 min) completely eradicated these infections (Halleen et al., 2005).

Conclusion

The diversity of species associated with black foot disease has been confirmed by this study. The reduction of Cylindrocarpon and Campylocarpon infection in uprooted dormant nursery grapevines caused by hot water treatment clearly demonstrated the potential of this control measure. Apart from these pro-active management strategies in

grapevine nurseries, no curative strategy is known for declining grapevines in vineyards. Producers are therefore urged to heed general recommendations to prevent and/or correct predisposing stress situations, such as soil compaction and poor drainage. Stress is one of the most important aspects of this disease, and the following points are therefore very important. Soil preparation is of utmost importance, and compacted layers should be broken up. Drainage must be improved on wet or waterlogged soils. Establishment or planting of new vineyards should be done according to "best practice" procedures. This includes proper root distribution, correct plant holes, etc. Prevent and/or control other diseases and pests like Phytophthora, Pythium, nematodes, etc. Planting of certified vines according to best practice procedures, and thereafter carefully managing them to ensure proper root development, should go a long way in ensuring successful establishment of a new vineyard.

References

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