SCAB DISEASE OF PROTEACEAE – A REVIEW

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Abstract

Elsinoë spp. cause scab disease of South African Proteaceae such as *Leucadendron*, *Leucospermum*, *Mimetes*, *Protea* and *Serruria*, as well as on the Australian genus *Banksia*. In South Africa, this disease has been observed on *Leucadendron*, *Leucospermum*, *Protea* and *Serruria*. In Australia, scab disease occurs on all the genera cited above. In California and Zimbabwe, scab disease has been observed on *Leucospermum* and *Protea*, while in Hawaii, *Leucospermum* has been observed to be susceptible. Five distinct species of *Elsinoë* have thus far been identified on Proteaceae. Two species occur on *Protea*, namely one in South Africa, and a second in Zimbabwe. A further two species occur on *Banksia* in Australia. Isolates from *Leucadendron*, *Leucospermum* and *Serruria* represent the same species in all of the host countries. For this species, scab-like lesions develop on stems and leaves of young growth. In many cases, twisting of the stems results, rendering the cut-flower unmarketable. Severe infections can kill the leaves and stems of young growth flushes of *Protea* spp., resulting in die-back of the young shoot. Differences in susceptibility have been observed between the different *Leucospermum* cultivars in South Africa, but no tolerance in the genus *Protea* has been observed in Zimbabwe. Moist conditions are a prerequisite for infection to take place, while moderate temperatures are favourable for disease development. Chemical control of the disease is poor, and only effective when applied preventatively. Control of scab disease is based on good sanitation, cultural practices and resistant host material.

1. Introduction

Species of *Elsinoë* Racib. are associated with scab disease symptoms of South African Proteaceae Benth. & Hook. f. such as *Leucadendron* R. Br., *Leucospermum* R. Br., *Protea* L. and *Serruria* Salisb. spp. (Benic *et al*., 1983; Pascoe *et al.*, 1995; Ziehrl *et al.*, 1995; Swart *et al*., submitted). Furthermore, the disease has also been observed on *Mimetes* Salisb. and *Banksia* L. f. spp. in Australia (Pascoe *et al*., 1995; Ziehrl *et al*., 1995; Swart *et al*., submitted). In South Africa, scab disease causes severe losses to *Leucospermum* plantations, but the disease also occurs on *Leucadendron* spp. and *Serruria florida* (Thunb.) Salisb. ex Knight (Benic *et al*., 1983), and one record of scab disease occurring on *P. cynaroides* (L.) L. has been reported (Swart *et al*., submitted). In Australia, scab disease occurs on all the genera cited above (Forsberg, 1993; Pascoe *et al*., 1995; Ziehrl *et al*., 1995). Scab disease has also been reported on *Leucospermum* and *Protea* spp. in California and Zimbabwe. The disease is the most serious problem encountered on various *Protea* cultivars and species in Zimbabwe (Swart *et al*., submitted). In Hawaii, *Leucospermum* spp. have also been observed to be susceptible (Protea Disease Letter, 1991).

2. *Elsinoë* species and host range

The causal agent, which was identified as a species of *Elsinoë*, was never formally

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described (Benic *et al.*, 1983). Similarities in disease symptoms on *Leucospermum* and *Leucadendron* spp. and the appearance of the causal organism in South Africa and Australia have led to speculation that the causal organism could possibly be the same species. In a subsequent study, these *Elsinoë* spp. were characterised based on morphology, symptomatology, RAPD banding patterns and DNA sequence analysis of the 5.8S rDNA gene and its flanking ITS 1 and ITS 2 regions (Swart *et al.*, submitted). Anamorph and teleomorph characteristics of isolates from *Leucospermum*, *Protea* and *Banksia* suggested that there were at least five distinct species involved. The *Elsinoë* species from *P. cynaroides* in South Africa differed from that found on *Protea* in Zimbabwe. These findings were strongly supported by phylogeny inferred from DNA sequence data. Furthermore, the *Elsinoë* isolates from *Leucospermum*, *Leucadendron* and *Serruria* in South Africa and Australia, and the isolates from *Leucospermum* in California and Zimbabwe were representative of the same species. Two additional species were also identified on *Banksia* spp. in Australia (Swart *et al.*, submitted).

3. Disease symptoms

Scab disease is characterised by scab-like lesions on stems and leaves, and in many cases, twisting of the stems, rendering the cut-flower unmarketable or marketable at reduced prices (Ziehrl *et al.*, 1995). Symptoms on pincushions appear on the young shoots of the current season. The first symptoms appear as small, elliptical, sunken, whitish lesions, normally accompanied by reddening of the surrounding tissue (Benic *et al.*, 1983; Von Broembsen, 1989; Forsberg, 1993). Lesions enlarge and coalesce to form the typical irregular, red-brown, raised, scab-like lesions that often turn white as they progress (Benic *et al.*, 1983; Ziehrl *et al.*, 1995).

The disease progresses to form large, dark, raised, roughened, often cracked areas with a corky appearance, which may eventually girdle the stem. Older lesions often cause localised splitting of the stem and heavy infection may cause abnormal growth and twisting of the stem. Symptoms take between 3-5 weeks to develop after infection has occurred. Flowering is reduced and in extreme cases shoot tips and leaves on infected shoots can be killed (Benic *et al.*, 1983; Forsberg, 1993; Ziehrl *et al.*, 1995). In South Africa, affected tissue is attacked by chewing insects (Benic *et al.*, 1983). Subsequent insect damage causes the surrounding tissues to proliferate and take on a corky appearance, hence the common name "corky bark" (Von Broembsen, 1989).

Leaf lesions are less prominent than the extensive stem lesions. They are initially translucent, then dull, white to tan-coloured, raised, hard, rough and corky (Benic *et al.*, 1983). Symptoms on *Leucadendron* and *Serruria* spp. are quite similar to those found on *Leucospermum* spp. (Swart *et al.*, submitted).

Scab symptoms vary considerably between the different genera. Distinctive white-grey, scab-like lesions appear on the older leaves of *P. cynaroides*, while only restricted lesions are observed on the petioles (Swart *et al.*, submitted). These are in direct contrast to the symptoms caused by scab on pincushions. Symptoms also vary between species and cultivars. In Zimbabwe and California, symptoms on *Protea* cultivars appeared on the leaves, as well as on stems. Stem lesions were similar to the scab lesions found on pincushions, but the leaf lesions differed considerably. Leaf lesions were small, circular, red-brown, eventually coalescing and killing the entire leaf. Heavy infections killed off all the young leaves, creating typical anthracnose-like symptoms. Scab disease on *Protea* cultivars in Zimbabwe is severe, compared to the single stand of *P. cynaroides* that became infected in South Africa (Swart *et al.*, submitted). Given the fact that different *Elsinoë* species are involved, however, this is not totally surprising.

On *Banksia*, leaf lesions are round to irregular, grey specks with a brown margin, surrounded by a chlorotic zone. Round to irregular medium brown lesions also develop on stems and midribs of leaves (Swart *et al.*, submitted).

4. Species susceptibility

Different cultivars and seedlings differ greatly in susceptibility to scab. In Hawaii, 'Hawaii Gold' appears to be moderately resistant to scab, while 'Coral' is highly susceptible (Protea Disease Letter, 1991). A selection of *L. saxosum*, identified as highly resistant to scab, has produced hybrid seedlings which appear to have inherited its resistance (Leonhardt, 1998.). In South Africa, *L. cordifolium* cultivars such as 'Gold Dust', 'Helderfontein', 'Luteum', 'Scarlet Ribbon' and 'Vlam' are extremely susceptible. Field observations suggest that *L. cordifolium x patersonii* 'High Gold' is resistant to scab infection in South Africa. Inoculation studies also indicated that 'High Gold' is resistant to scab under highly favourable conditions for infection. *Leucospermum patersonii* also showed no scab symptoms after inoculation. There is no indication of any *Protea* cultivar in Zimbabwe showing resistance or tolerance against scab disease.

5. Economic importance

In a survey conducted on scab disease of Proteaceae in Australia, scab disease was shown to be the most important disease problem to both plantation and nursery growers, especially those in Victoria, where the disease is very severe (Ziehrl *et al.*, 1995). Furthermore, the disease has also been found in a number of wholesale nurseries that provide the majority of their plants to plantation growers, frequently interstate. The disease thus has the potential to continue to spread throughout the industry (Pascoe *et al.*, 1995). According to a survey held by the Institute for Horticultural Development in Australia in 1994, the disease affected 31% of the area used for the cultivation of South African Proteaceae in Australia. This represented an average loss of 52% of potential revenue in affected crops (Ziehrl *et al.*, 1995). In Zimbabwe, entire plantations of *P. compacta x susannae* 'Pink Ice' were destroyed by scab disease. As no similar surveys have, however, been undertaken in California, Hawaii, South Africa or Zimbabwe, the wider impact of this disease complex remains to be determined.

6. Favourable conditions for infection

Only young, actively growing tissue is susceptible. Infection therefore only occurs during periods of active growth (Ziehrl *et al.*, 1995). Young pincushion plants grow vigorously during spring and early summer and will therefore be most susceptible to scab during this period (Benic *et al.*, 1983). Vigorous shoot development occurs after abscission of the flower heads (October to March) (Jacobs, 1983). Plants that have reached the flowering stage will therefore be most susceptible to scab during the summer months (Benic *et al.*, 1983). Depending on the time of pruning, plants will be susceptible to scab disease during the flush period after pruning.

Moist conditions are a prerequisite for infection to occur. Optimum conditions of humidity, temperature or duration of moist conditions are, however, not known (Benic *et al.*, 1983; Ziehrl *et al.*, 1995). Shaded plants are more subject to scab than those in exposed sites. This is also prominent on the same plant, where the shaded side is usually more severely affected (Benic *et al.*, 1983).

7. Transmission

The disease spreads relatively slowly in the field (Von Broembsen, 1989). *Elsinoë* spp. have been reported to spread by wind, rain-splash, dew, overhead sprinkler irrigation and other spraying operations (Fawcett, 1936; Bitancourt *et al.*, 1937; Whiteside, 1975; Von Broembsen, 1989; Forsberg, 1993). Insect dissemination is also possible (Jenkins, 1930; Forsberg, 1993) since scab lesions and fungal structures are very often attacked by chewing insects. Various small insects, their larvae and mites also commonly occur on scab lesions. These insects and the larger chewing insects possibly play a role in

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dissemination of the fungus (Benic *et al*., 1983). Cultures of *Elsinoë* sp. have also been revived from insect faeces on *Leucospermum* spp. (L. Benic, ARC-Fruit, Wine and Vine Research Institute, Stellenbosch, pers. comm.). Infected plant material often serves as an inoculum source for new infections. It is often the smaller shoots that were not harvested the previous season, that harbour the fungus (Ziehrl *et al*., 1995). Infected nursery plants and cuttings are, however, the main means of long distance dissemination of the fungus.

8. Control

Chemical control is poor. Young plants must be sprayed preventatively with contact fungicides (mancozeb, chlorothalonil) or systemic fungicides (benomyl) while they are actively growing (flushing), and moisture and temperature conditions favour infection. Mature plants must be sprayed for the period after flowering or after flowers are cut when young growth is expected. Systemic fungicides will probably be more effective, particularly in plantations of non-clonal material in which flowering and growth flushes are not uniform (Benic *et al*., 1983).

Several different fungicides and various control methods are used by growers in Australia in an attempt to control scab disease. Chemical control of the disease has, however, proven to be difficult due to the lack of registered fungicides for use on Proteaceae for scab disease, and lack of knowledge of efficacy of fungicides. Several fungicides have been listed by growers in Australia for the control of scab, namely prochloraz, chlorothalonil, propiconazole, phosphorous acid and benomyl. There is, however, some controversy regarding the efficacy of these chemicals (Ziehrl *et al*., 1995), suggesting that further screening would be required to solve this problem. The Protea Disease Management Group (Protea Disease Letter, 1993) conducted fungicide experiments on potted *L. cordifolium x lineare* 'Red Sunset' in Hawaii. They reported that at maximum recommended rates, chlorothalonil (2.5 ml/l) gave excellent control, followed by benomyl, flusilazole, prochloraz, mancozeb and iprodione. Phytotoxicity, as seen by the reddening of the leaves, was, however, observed with chlorothalonil and flusilazole.

Fungicidal control of scab disease is poor, and sanitation pruning must be done to reduce infected stems. In spring and early summer, lesions are often inconspicuous and difficult to detect, but typical scab lesions should be easily seen by late summer. Sanitation pruning should be carried out at this stage (Coetzee *et al.*, 1988).

Symptoms take 3-5 weeks to develop after infection has taken place. Since it is impossible to visually detect latent infections, cuttings should only be taken from mother plants that have never shown any symptoms of scab disease.

Areas that favour moisture retention on foliage should be avoided, as well as overhead irrigation. Practices that allow adequate movement of air around and through plants, such as weed control and pruning, should be employed.

Leucospermum cultivars are currently screened for tolerance against scab disease. Highly susceptible cultivars must be avoided in areas where scab infestation is severe every year.

Nursery quarantine, and sanitation in the nursery and orchard must be implemented, especially when working with diseased plant material. Growers introducing new planting stock from any source should quarantine that stock for six months (Benic *et al.*, 1983; Von Broembsen, 1989).

9. Concluding Remarks

The host range of the various species of *Elsinoë* indicates that all genera of Proteaceae are at some risk of becoming infected with scab disease. We are already aware of the importance of the disease on *Leucospermum* plantations in Australia and South Africa. Furthermore, the severity of the symptoms and the devastating effect of the disease on the *Protea* plantations in Zimbabwe is an indication of the threat that this disease poses to *Protea* plantations in other *Protea* producing countries. Since there is currently no information on the cross-pathogenicity of these various *Elsinoë* isolates, other genera of the Proteaceae may also be at risk of becoming infected with the *Elsinoë* spp. known to date. The *Elsinoë* species complex, therefore indicates the importance of strict phytosanitary measures between countries and regions, thereby preventing the spread of the disease and foreign species of the fungus to other protea producing areas.

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