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Differences in susceptibility of Eucalyptus species to Phaeoseptoria eucalypti

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Abstract

Four different *Eucalyptus* species trials, in Natal province, South Africa, were rated for susceptibility to *Phaeoseptoria eucalypti*. All species found to be susceptible to *P. eucalypti* belonged to the subgenus *Symphyomyrtus*. In contrast, species belonging to the subgenus *Monocalyptus* were resistant to *P. eucalypti*. Trials at Gowan Brae and Sutton indicated that *E. tereticornis* and *E. camaldulensis* were relatively more susceptible than other *Eucalyptus* species. *E. grandis*, *E. botryoides* and *E. saligna* were found to be the most susceptible species to *P. eucalypti* at Bloemendal and Seven Oaks.

Key words: *Eucalyptus spp.* – *Phaeoseptoria eucalypti* – Resistance.

1 Introduction

Phaeoseptoria eucalypti (Hansf.) Walker is one of the three most commonly occurring leaf pathogens of *Eucalyptus* in South Africa. It was first reported in the country by WINGFIELD (1987), and has since been recorded in all forestry areas (CROUS, KNOX-DAVIES and WINGFIELD 1988). CROUS et al. (1988) found that all *Eucalyptus* spp. that were investigated and were susceptible to *P. eucalypti* belonged to the subgenus *Symphyomyrtus*. *E. grandis*, the most widely planted *Eucalyptus* spp. in South Africa (SCHÖNAU and STUBBINGS 1987), is a member of this subgenus and is highly susceptible to *P. eucalypti* (KNIPSCHEER, WINGFIELD and SWART 1990).

At present very little is known about the impact of *P. eucalypti* on *Eucalyptus* spp. in South Africa or elsewhere in the world. For instance, no attempt has been made to evaluate trees for susceptibility to this pathogen. The rating of diseased plants to assess percentage infection provides a quick and easy method of quantifying a disease outbreak (JAMES 1971, 1974; ZADOKS and SCHEIN 1979; LUNDQUIST 1987; WANNAMAKER 1989). Disease ratings can also be used to compare the efficacy of fungicides or differences in host susceptibility.

The objective of this study was firstly, to develop a rating scale to assess the magnitude of infection by *P. eucalypti* on *E. grandis* and thus to estimate the ability of the pathogen to cause yield losses. Secondly, to identify *Eucalyptus* spp. that are resistant or susceptible to *P. eucalypti*. The effect of hybridization of *Eucalyptus* species on susceptibility was also considered.

2 Methods

2.1 Rating scale

A rating scale was developed to allow for objectivity in the evaluation of disease intensity. The scale was compiled by sketching a shoot, bearing six leaves as a basis for each different disease level. Hand drawn lesions were added to each basic diagram using infected leaves

as a guide for accuracy in terms of lesion arrangement and lesion size. Each diagram was then quantified with the aid of an image analyzer, used to count the number of pixels occupied by the lesion areas (LINDOW and WEBB 1983). By comparing each diagram with the number of pixels occupied by six totally black leaves, the percentage leaf area covered by lesions could be calculated. Drawings were altered until they represented five different levels of disease, i.e., 2, 4, 8, 16 and 32% designed to proceed on a logarithmic scale (HORSFALL and COWLING 1978). These levels of disease were rated 1, 3, 5, 7 and 9 respectively (Fig. 1).

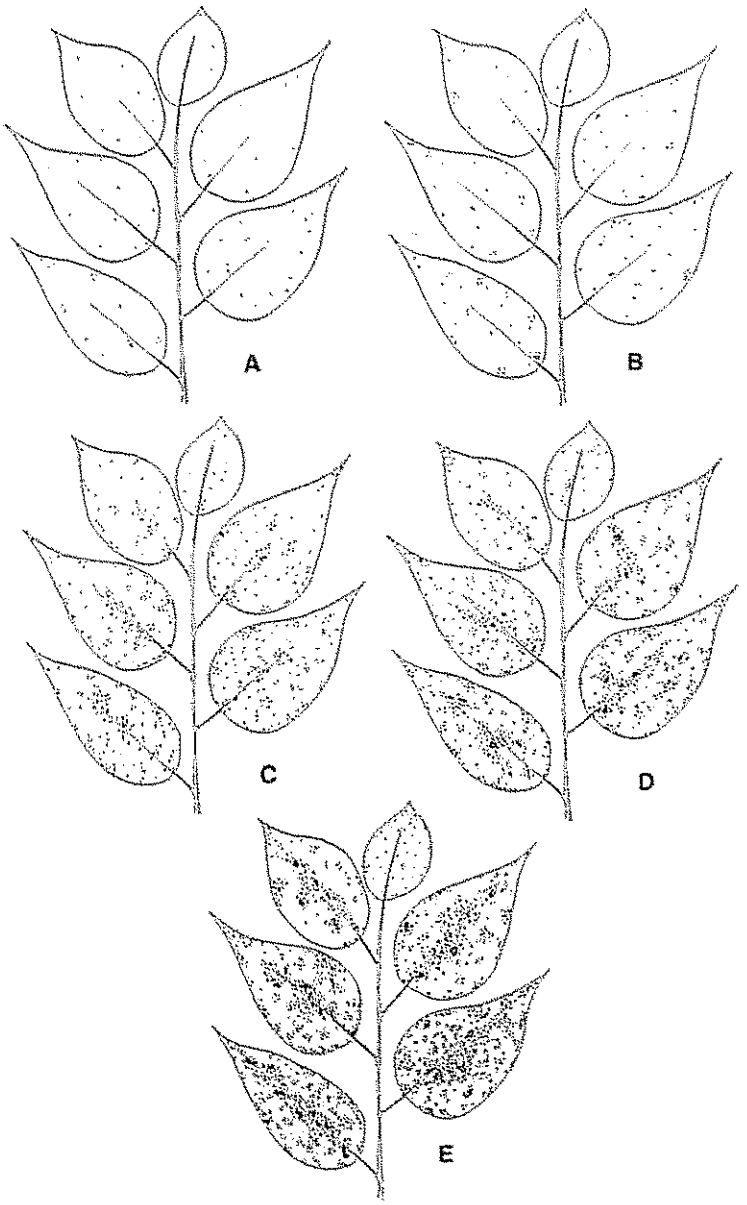

Fig. 1. A rating scale for *Phaeoseptoria eucalypti* representing 2, 4, 8, 16 and 32% disease and given a rating of 1, 3, 5, 7 and 9 respectively

2.2 Assessment of susceptibility

Four species trials were selected to assess susceptibility of *Eucalyptus* spp. to *P. eucalypti*. The trials were located in the Natal Province, South Africa; two were situated in a region defined by SCHULZE (1982) as being ideal for *E. grandis* cultivation, namely at Seven Oaks and Bloemendal Field Experiment Station, and two were in regions defined as being unsuitable for *E. grandis* cultivation due to either low temperature or low rainfall, namely Gowan Brae and Sutton (Table 1). The trials at Bloemendal, Sutton and Gowan Brae were based on replicated randomized complete block designs whereas the trial at Seven Oaks was an unreplicated trial planted for observational purposes. The trials at Gowan Brae and Sutton were year old coppice and 16 trees per plot. The trial at Bloemendal was two and a half years old when rated and consisted of 12 trees per plot whereas the tree at Seven Oaks were a year old when rated and plot size was variable.

To evaluate the level of disease on the *Eucalyptus* spp. occurring in the four species trials a shoot containing six leaves was randomly selected from the lowest branch on each of ten trees, randomly selected from each plot. The level of disease on each shoot was rated using the rating scale described previously. The rating was then converted to a percentage and the average percentage disease for each plot was calculated. The data were transformed using the arcsin transformation after which they were analysed using the two way analysis of variance and Duncan's multiple range teste. Means reported in the tables were computed from untransformed values.

A clonal hybrid trial was also rated for susceptibility to *P. eucalypti*. It was hoped that the effect of the susceptible parent in a hybrid cross could be detected by an increase in susceptibility of the resistant host. The trial was established using a randomized complete block design with two replications. The plots were of variable size but six trees per plot were rated. The trial was rated at two and a half years tree age and the average percentage disease was calculated.

Table 1. **Eucalyptus species occurring in four species trials rated for Phaeoseptoria eucalypti infection[1]**

Subgenus	*Eucalyptus* spp.	Seven Oaks	Bloemendal	Sutton	Gowan Brae
Symphyomyrtus	*grandis* Hill ex Maid.	×	×	×	×
	botryoides Sm.		×		
	saligna Sm.	×	×		
	globulus Labill.	×		×	×
	nitens (Deane & Maid) Maid.	×		×	×
	macarthurii Deane & Maid.	×	×	×	×
	dunii Maid.	×	×		
	smithii R. T. Bak.	×	×		
	viminalis Labill.		×	×	×
	tereticornis Sm.			×	×
	camaldulensis Dehnh.			×	×
	maidenii (F. Muell.) Kirk.			×	×
Monocalyptus	*fastigata* Deane & Maid.	×		×	×
	elata Dehnh.	×	×	×	×
	regnans F. Muell.			×	×
	fraxinoides Deane & Maid.	×			

[1] Seven Oaks: average annual rainfall 905 mm, average January temperature 21 °C, average July temperature 10 °C, altitude 980 m. Bloemendal: average annual rainfall 905 mm, average January temperature 21 °C, average July temperature 13 °C, altitude 838 m. Sutton: average annual rainfall 805 mm, average January temperature 22 °C, average July temperature 14 °C, altitude 1066 m. Gowan Brae: average annual rainfall 1022 mm, average January temperature 20 °C, average July temperature 12 °C, altitude 1450 m.

3 Results

3.1 Assessment of susceptibility

There was considerable variation in the degree of susceptibility between *Eucalyptus* spp. within each species trial. Differences in infection between different sites were also evident. The four field species trials could be differentiated into two groups according to the most susceptible species within each trial. At Bloemendal, *E. grandis*, was significantly more susceptible ($P = 0.05$) than the other species in the trial (Table 2). Since the trial at Seven Oaks was unreplicated, no statistical analysis was performed. The results were, however, similar to those recorded at Bloemendal. In both cases, *E. grandis* and *E. saligna* were most susceptible to *P. eucalypti*. The results from the trials at Gowan Brae and Sutton were similar to each other. In both cases *E. tereticornis* was severely infected with the lower leaves almost completely covered by lesions of *P. eucalypti* and therefore the mean percentage disease recorded was 30%. *E. camaldulensis* was also susceptible but infection was considerably less than that on *E. tereticornis*. *E. grandis* was slightly susceptible and the rest of the species in the trials were completely resistant (Table 3).

Table 2. **Mean percentage of disease for Eucalyptus species at Bloemendal Field Experiment Station and Seven Oaks**

Eucalyptus spp.	Mean Percentage Disease[1]	
	Seven Oaks	Bloemendal
E. grandis	7.30	5.75
E. botryoides	–	3.44
E. saligna	10.90	2.60
E. globulus	1.40	–
E. nitens	0.90	–
E. macarthurii	0.00	0.80
E. dunii	0.00	0.33
E. smithii	0.00	0.04
E. elata	0.00	0.00
E. viminalis	–	0.00

[1] Mean of ten branches rated on a scale of 1, 3, 5, 7 and 9 where these values represent 2, 4, 8, 16 and 32% diseased leaf area respectively. Mean separation by Duncan's multiple range test, 5% level.

Table 3. **Mean percentage of disease for Eucalyptus species at Sutton and Gowan Brae**

Eucalyptus spp.	Mean Percentage Disease[1]	
	Sutton	Gowan Brae
E. tereticornis	29.30	32.33
E. camaldulensis	2.80	4.50
E. grandis	1.45	1.98
E. globulus	0.00	0.00
E. nitens	0.00	0.00
E. macarthurii	0.00	0.00
E. viminalis	0.00	0.00
E. maidenii	0.00	0.00
E. maidenii	0.00	0.00
E. fastigata	0.00	0.00
E. elata	0.00	0.00
E. regnans	0.00	0.00

[1] Mean of ten branches rated on a scale of 1, 3, 5, 7 and 9 where these values represent 2, 4, 8, 16 and 32% diseased leaf area respectively.

Table 4. Mean percentage disease recorded on various Eucalyptus hybrids and species

Hybrids	Mean % disease[1]
E. macarthurii	2.00
E. dunii	2.00
E. nitens crosses	1.40
E. grandis × *E. camaldulensis*	1.20
E. grandis × *E. urophylla*	0.75
E. grandis × *E. tereticornis*	0.50
E. macarthurii × *E. grandis*	0.40
E. grandis	0.20

[1] Mean separation by Duncan's multiple range test, 5% level.

No significant differences in susceptibility to *P. eucalypti* could be found between the trees in the clonal/hybrid trial (Table 4). There was a great degree of variation within each plot and also between replications.

4 Discussion

The rating scale devised here proved to be effective in establishing the relative susceptibility of *Eucalyptus* spp. to infection by *P. eucalypti*. The use of such a rating scale allows for different trials and different tree ages to be compared. The efficacy of the scale was increased with the use of six leaves to represent each level of the scale. Since the leaves at the tip of the shoot are usually more resistant than those further along the branch (HEATHER 1967), the high degree of variation in susceptibility of individual leaves was reduced, as six leaves covered a fairly wide range of leaves with increasing degrees of susceptibility.

Only *Eucalyptus* species occurring in the subgenus *Symphyomyrtus* were found to be susceptible to *P. eucalypti*. Species occurring in the subgenus *Monocalyptus* appeared to be resistant to the pathogen. This is consistent with the preliminary findings of CROUS et al. (1988). Within the subgenus *Symphyomyrtus* the subseries Tereticorninae and Saligninae appeared to be the most susceptible to *P. eucalypti*. *E. tereticornis* and *E. camaldulensis* belong to the former series, whereas *E. grandis*, *E. botryoides* and *E. camaldulensis* belong to the latter series (BRICE BRUCE 1985). *E. tereticornis* and *E. camaldulensis* were not included in the trials at Bloemendal and Seven Oaks and therefore their relative susceptibility at these sites are unknown. At Gowan Brae and Sutton, however, *E. tereticornis* was considerably more susceptible to *P. eucalypti* than was *E. grandis*.

The results obtained from Gowan Brae and Sutton are similar to those reported in Malawi. CHIPOMPHA (1987) reported that *E. tereticornis* and *E. camaldulensis* showed high levels of infection whereas low levels of infection were found on *E. grandis*. From these reports and the results reported in the trials rated in Natal, it appears that *E. tereticornis* is considerably more susceptible to *P. eucalypti* than is *E. grandis*. Climatic conditions could play a role in the degree of susceptibility within species. Differences in susceptibility are therefore difficult to ascertain due to the different climatic and edaphic conditions required for growth by each species.

In all cases reported (CROUS et al. 1989), species of *Eucalyptus* belonging to the subgenus *Monocalyptus* were resistant to *P. eucalypti*. *E. tereticornis* and *E. grandis*, of the subgenus *Symphyomyrtus*, appeared to be two of the most susceptible species. Nearly eighty percent of *Eucalyptus* plantations in South Africa are comprised of *E. grandis* (SCHÖNAU and STUBBINGS 1987) and the susceptibility of this species to *P. eucalypti* is therefore of concern. The susceptibility of *E. grandis* is also important since the genetic diversity of the species is being reduced through the extensive utilization of clonal propagation. Although clonal propagation in forestry is desirable due to the uniformity of the crop obtained, the likelihood of an epidemic caused by pathogens such as *P. eucalypti* would be enhanced.

Summary

Twelve *Eucalyptus* spp. belonging to the subgenus *Symphyomyrtus* and four belonging to the subgenus *Monocalyptus* were rated for susceptibility to the leaf pathogen *Phaeoseptoria eucalyptii* by

means of a specially developed rating scale. All species belonging to *Monocalyptus* were resistant. In contrast, species belonging to the subgenus *Symphyomyrtus*, especially *E. tereticornis* and *E. grandis*, were susceptible to *P. eucalyptii*.

Résumé

Différences de sensibilité des Eucalyptus à Phaeoseptoria eucalypti

Douze *Eucalyptus* spp. du sous-genre *Symphyomyrtus* et quatre du sous-genre *Monocalyptus* ont été évalués pour leur sensibilité au pathogène foliaire *Phaeoseptoria eucalyptii* selon une échelle d'évaluation mise au point à cette occasion. Toutes les espèces du sous-genre *Monocalyptus* étaient résistantes. Par contre, celles du sous-genre *Symphyomyrtus* étaient sensibles, particulièrement *E. tereticornis* et *E. grandis*.

Zusammenfassung

Unterschiede in der Anfälligkeit von Eucalyptus-Arten gegenüber Phaeoseptoria eucalypti

Zwölf *Eucalyptus*-Arten der Untergattung *Symphyomyrtus* und vier Arten der Untergattung *Monocalyptus* wurden auf die Anfälligkeit gegenüber *Phaeoseptoria eucalyptii* getestet. Dabei wurde das Ausmaß des Befalls mit einer speziell entwickelten Beurteilungsskala klassifiziert. Alle *Monocalyptus*-Arten waren resistent. Dafür waren Arten der Untergattung *Symphyomyrtus* anfällig, insbesondere *E. tereticornis* und *E. grandis*.

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