Phytophylactica 12, 57–63 (1980)

OBSERVATIONS ON DISEASES IN PINE AND EUCALYPTUS PLANTATIONS IN SOUTH AFRICA*

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ABSTRACT

Keywords: *Eucalyptus*, forest tree diseases, *Pinus*.

Recent observations on diseases in *Pinus* and *Eucalyptus* plantations in South Africa are reported. *Diplodia pinea* was found associated with a wide range of disease symptoms. Other diseases noted were Armillaria root rot, and root diseases caused by *Verticicladiella alacris, Phytophthora cinnamomi, Polyporus baudoni* and *Rhizina undulata.*

Uittreksel

WAARNEMINGS VAN SIEKTES IN DENNE- EN BLOEKOMPLANTASIES IN SUID-AFRIKA

Onlangse waarnemings in verband met siektes van Pinus- *en* Eucalyptus-*aanplantings in Suid-Afrika word aangeteken.* Diplodia pinea *is met 'n wye reeks simptome geassosieer. Ander belangrike siektes aangeteken was Armillaria-wortelverrotting, asook wortelsiektes veroorsaak deur* Verticicladiella alacris, Phytophthora cinnamomi, Polyporus baudoni *en* Rhizina undulata.

Résumé

OBSERVATIONS SUR LES MALADIES DES PLANTATIONS DE PINS ET D'EUCALYPTUS EN AFRIQUE DU SUD

Des observations récentes sur les plantations de Pinus *et d'*Eucalyptus *en Afrique du Sud sont rapportées.* Diplodia pinea *a été trouvé être associé avec une large variété de symptômes de la maladie. D'autres maladies notées furent la pourriture radiculaire Armillaria, et des maladies des racines causées par* Verticicladiella alacris, Phytophthora cinnamomi, Polyporus baudoni *et* Rhizina undulata.

INTRODUCTION

South Africa has poor resources of indigenous forests and the forestry industry is dependent on "pure" plantings of exotic trees, especially *Pinus* spp. and *Eucalyptus* spp. Such "pure" plantings are vulnerable to forest tree diseases but, in the past, disease losses have been slight (Lückhoff, 1964). There has therefore been relatively little research work on forest tree diseases in South Africa. This paper reports observations made in a survey during 1978 and 1979 of local forest plantation diseases, with comments on previous studies.

OBSERVATIONS

Diplodia pinea *diseases*

Diplodia pinea (Desm.) Kickx is the most important pathogen in pine plantations in South Africa (Lückhoff, 1964; Van der Westhuizen, 1968). It has been associated with die-back of *Pinus patula* Schlect. & Cham., *P. pinaster* Ait. and *P. radiata* D. Don. after hail damage (Kotzé, 1935; Laughton, Elaine M., 1937; Lückhoff, 1964). However, *P. pinaster* and *P. radiata*, the species most susceptible to die-back, have generally been restricted to areas where hail is infrequent (Kotzé, 1935; Laughton, Elaine M., 1937; Lückhoff, 1964). *P. patula* is still planted in the summer rainfall areas and, according to reports by foresters, extensive die-back occurs after hail damage.

In the present study, *D. pinea* was commonly associated with a number of different disease symptoms, including bark cankers and die-back after hail, twig blight, dead top of *P. radiata*, root rot and insect damage.

Small cankers exuding resin (Fig. 1 and 2) were seen on 20–25 year old *P. radiata* in the Eastern Cape Province approximately two years after hail damage. *Diplodia* die-back after hail was recorded on *P. caribaea* Morelet in Zululand, *P. patula* in the Natal Midlands, Eastern Transvaal and Swaziland and *P. radiata* in the Eastern Cape. *P. elliottii* Engelm. & Vasey, and *P. taeda* L. are widely planted in Natal and Transvaal where hail damage occurs and, althouth they are considered to be relatively resistant to *D. pinea* (Kotzé, 1935; Laughton, Elaine M., 1937; Lückhoff, 1964), the pathogen was isolated from dying, hail-damaged trees in some stands.

Diplodia twig blight (Fig. 3) was found in all areas surveyed, but was not necessarily associated with hail damage. Near Bulwer (Natal) 2–3 year old *P. patula* showed extensive mortality after twig blight.

Dead top of *P. radiata* was widespread in the Southern and Eastern Cape. *D. pinea* was consistently isolated from dead tops which, according to foresters in the area, had developed in the absence of hail damage. Laughton F. S., (1937) made a similar observation and suggested that alternating conditions of waterlogging and drought increase the susceptibility of *P. radiata* to *D. pinea*. In Australia, *D. pinea* has been associated with dead top of *P. radiata* on moisture-stressed and overstocked sites (Millikan & Anderson, 1957; Stahl, 1968; Wright & Marks, 1971), but it has also been induced in the absence of the pathogen by subjecting trees in the glasshouse to moisture stress (Millikan & Anderson, 1957).

D. pinea has recently been found associated with a serious root disease of *P. elliottii* and *P. taeda* in Eastern Cape, Eastern Transvaal, Natal and Swaziland (Wingfield & Knox-Davies, 1980a). Characteristic symptoms were dark blue radial lesions in the young roots (Fig. 4) extending into the larger lateral roots and up the trunk of the tree (Fig. 5). Needles became chlorotic and were shed. *P. taeda* was the most susceptible host and the disease was always associated with stress such as overstocking, drought and poor site conditions (Wingfield & Knox-Davies, 1980a).

* Part of an M.Sc. thesis submitted by the senior author to the University of Stellenbosch, Stellenbosch 7600

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Received 24 October 1979

FIG. 1 *Diplodia pinea* canker of *Pinus radiata* following hail damage
FIG. 1 Diplodia pinea-*kanker op* Pinus radiata *na haelskade*

FIG. 2 Resin exudation from *Diplodia pinea* canker of *Pinus radiata* following hail damage
FIG. 2 *Harpuisuitskeiding vanuit 'n* Diplodia pinea-*kanker op* Pinus radiata na haelskade

FIG. 3 *Diplodia pinea* tip blight of *Pinus patula*
FIG. 3 Diplodia pinea-*topskroei op* Pinus patula

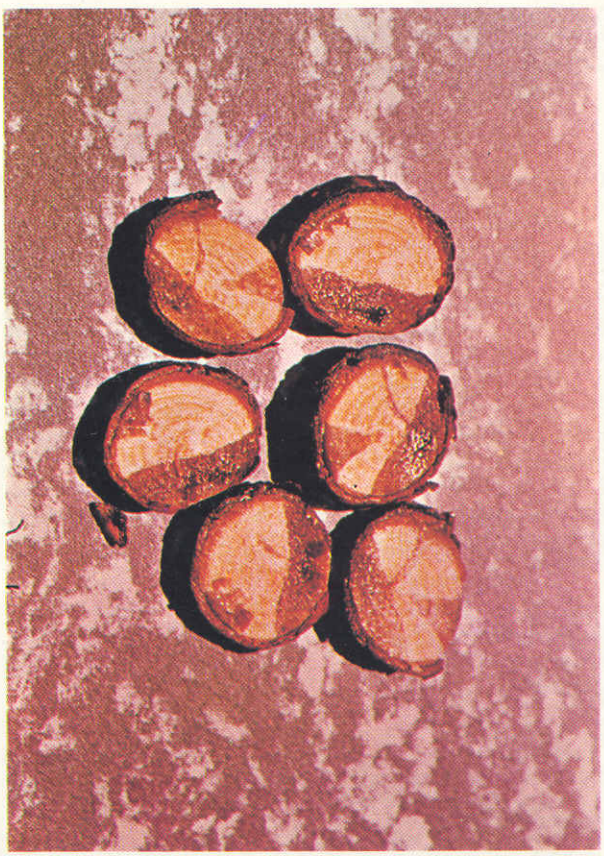

FIG. 4 *Diplodia pinea* lesions in young roots of *Pinus elliottii*
FIG. 4 Diplodia pinea-*letsels op jong wortels van* Pinus elliottii

FIG. 5 Radial lesions extending from *Diplodia pinea* infected roots of *Pinus taeda*
FIG. 5 *Radiale letsels wat vanaf* Diplodia pinea-*infekteerde wortels van* Pinus taeda *uitbrei*

FIG. 6 Insect damaged tops of *Pinus radiata* from which *Diplodia pinea* was isolated
FIG. 6 *Insekbeskadigde toppe van* Pinus radiata *waaruit* Diplodia pinea *geïsoleer is*

FIG. 7 *Pinus taeda* with resin production typical of *Armillaria* infection
FIG. 7 Pinus taeda *met harpuisvorming wat tipies is van* Armillaria-*infeksie*

FIG. 8 *Pinus taeda* with white mycelium under the bark, a characteristic of *Armillaria* infection
FIG. 8 Pinus taeda *met wit miselium onder die bas, 'n kenmerk van* Armillaria-*infeksie*

TABLE 1 Association between *Diplodia pinea* and insect damage to different *Pinus* spp.
TABEL 1 *Assosiasie tussen* Diplodia pinea *en insekskade aan verskillende* Pinus *spp.*

Insect/*Insek*	*Pinus* sp.	Location/*Lokaliteit*	Remarks/*Opmerkings*
Cinara cronartii T & P.....	*P. patula* *P. elliottii*	Natal	*D. pinea* isolated from diseased tissue associated with insect damage
	P. patula *P. taeda*	E. Transvaal/*O. Transvaal*	
Hylastes sp.....	*P. patula*	Natal	*D. pinea* isolated from discoloured wood in one year old trees which had previously been attacked by a *Hylastes* sp.
Orthotomicus erosus (Woll.).....	*P. pinaster*	W. Cape/*W. Kaap*	*D. pinea* isolated from diseased cambium associated with insect galleries
	P. pinaster *P. radiata*	W. Cape and S. Cape/*W. Kaap en S. Kaap*	
Pissodes sp.....	*P. radiata*	S. Cape/*S. Kaap*	Young shoots at tops of trees damaged and infected with *D. pinea* (Fig. 6)
Pissodes sp.....	*P. patula*	Natal (and Zululand)/*Natal* (*en Zoeloeland*)	*D. pinea* isolated from diseased cambium and wood associated with insect damage

The association of *D. pinea* with forest insect damage has been reported by Birch, 1936; Haddow & Newman, 1942; Eldridge, 1961; Buchanan, 1967; Marks & Minko, 1970; Wright & Marks, 1971. During the present study *D. pinea* was found associated with the forest insects listed in Table 1. The association between *D. pinea* and different forest insects needs further investigation.

Various fungicides have been tested for the control of *Diplodia* die-back after hail damage (Van der Westhuizen, 1968). At present the only practical control measures are planting of resistant species in hail belts and eliminating stress conditions as far as possible. Kotzé (1935) and Van der Westhuizen (1955) recommended site selection, early thinning and planting of mixed species.

Armillaria *root rot*

In South Africa, Armillaria root rot has been reported (principally from the Eastern Transvaal and Northern Natal) on the following hosts: *Eucalyptus paniculata* Smith (Kotzé, 1935; Bottomley, 1937; Doidge, 1950, Lückhoff, 1964), *E. globulus* Labill. (Bottomley 1937), *P. caribaea* (Pole-Evans, 1933; Doidge, 1950), *P. elliottii* (Lückhoff, 1964), *P. longifolia* Roxb. (Pole-Evans, 1933), *P. pinaster* (Doidge, 1950) and *P. roxburghii* Sarg. (Kotzé, 1935). Stumps of indigenous trees, notably *Parinari curatellifolia* Planchon ex Benth. (*P. mobola* Oliv.), are colonised and serve as sources of inoculum (Pole-Evans, 1933; Kotzé 1935; Bottomley, 1937; Lückhoff, 1964). In the present study, small infection centres were recorded in *P. taeda* stands in Northern Natal, Northern Transvaal and Eastern Transvaal, with heavy mortality in a stand of *P. elliottii* in the Eastern Transvaal. No sporophores of *Armillaria mellea* (Vahl ex Fr.) Krummer were found; however, symptoms were characteristic of Armillaria root rot. These included root rot, excessive production of resin in the root crown area (Fig. 7) and a well developed white mycelial mat under the bark of dead trees (Fig. 8). The absence of rhizomorphs associated with symptoms characteristic of *A. mellea* root rot has previously been recorded under South African conditions (Kotzé, 1935; Bottomley, 1937; Lückhoff, 1964).

Attempts to control Armillaria root rot by trenching to isolate diseased trees have been unsuccessful (Kotzé, 1935; Lückhoff, 1964); however, *Armillaria* appears to be causing only slight damage to forest plantations in South Africa.

Verticicladiella *root disease*

A *Verticicladiella* root disease (associated with *Verticicladiella alacris* Wingfield & Marasas) of *P. pinaster* and *P. radiata* trees, has recently been described (Wingfield & Knox-Davies, 1980b; Wingfield & Marasas, 1980). It appears to be of particular significance in the Western Cape where, according to Poynton (1957), *P. pinaster* and *P. radiata* are the most suitable *Pinus* spp. for commercial planting.

The disease has been recorded from a number of plantations in the Western Cape where infection centres range from a few trees to 2 ha in size (Fig. 9). Trees show gradual wilting, chlorosis of the needles (Fig. 10) and a dark blue discolouration of the roots (Fig. 11). The disease appears to spread from tree to tree by root grafts and there are indications that an insect vector may be involved in the long distance spread of the pathogen (Wingfield & Knox-Davies, 1980b).

Phytophthora *root rot*

Phytophthora cinnamomi Rands is a serious pathogen of forest trees (Zak & Campbell, 1958; Newhook, 1959; Roth, 1963; Podger & Battini, 1971; Newhook & Podger, 1972). Donald & Von Broembsen (1977) recovered it from plants and soil in many forest nurseries in the Western Cape, while Von Broembsen (personal communication) has also isolated it from the roots and surrounding soil of 10–20 year old *P. radiata* growing on a poor site in the Grabouw area.

In the present study, *P. cinnamomi* was found associated with root rot and death of: (a) *P. radiata* (40–50 year old trees) on a poor site in a plantation near Swellendam, Western Cape; (b) *P. clausa* (Engelm.) Sarg. (rated by Ross & Marx, 1972, as highly susceptible) in an arboretum in Zululand, while *P. caribaea* and *P. elliottii* surrounding the infected trees were unaffected; (c) *Eucalyptus fraxinoides* Dean & Maiden (Fig. 12) near Nelspruit, Eastern

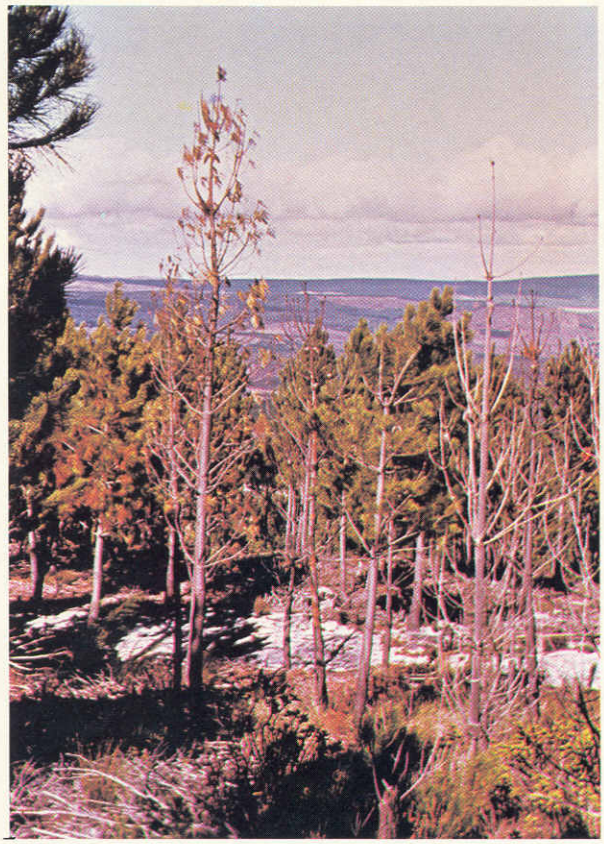

FIG. 9 *Verticicladiella alacris* infection centre in a *Pinus pinaster* stand
FIG. 9 Verticicladiella alacris-*infeksiemiddelpunt in 'n* Pinus pinaster-*aanplanting*

FIG. 10 Dead and dying *Pinus pinaster* trees infected with *Verticicladiella alacris*
FIG. 10 *Dooie en sterwende* Pinus pinaster-*bome wat met* Verticicladiella alacris *geïnfekteer is*

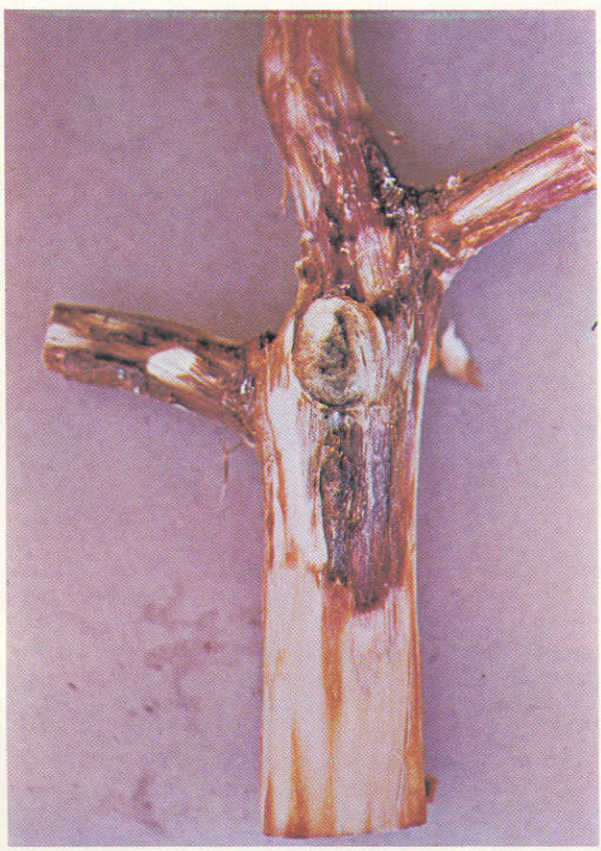

FIG. 11 Stained *Pinus pinaster* root crown infected with *Verticicladiella alacris*
FIG. 11 *Gekleurde* Pinus pinaster-*wortelkraag wat met* Verticicladiella alacris *geïnfekteer is*

FIG. 12 Dead and dying *Eucalyptus fraxinoides* trees infected with *Phytophthora cinnamomi*
FIG. 12 *Dooie en sterwende* Eucalyptus fraxinoides-*bome wat met* Phytophthora cinnamomi *geïnfekteer is*

FIG. 13 *Polyporus baudoni* fruiting body extending from *Eucalyptus maculata* root (Photo by Dr G. C. A. van der Westhuizen, Plant Protection Research Institute, Pretoria)

FIG. 13 Polyporus baudoni-*vrugliggaam wat vanaf 'n* Eucalyptus maculata-*wortel ontwikkel* (*Foto deur dr. G. C. A. van der Westhuizen, Navorsingsinstituut vir Plantbeskerming, Pretoria*)

FIG. 14 *Polyporus baudoni* fruiting body at the base of *Eucalyptus maculata* tree (Photo by Dr G. C. A. van der Westhuizen, Plant Protection Research Institute, Pretoria)

FIG. 14 Polyporus baudoni-*vrugliggaam op die basis van 'n* Eucalyptus maculata-*boom* (*Foto deur dr. G. C. A. van der Westhuizen, Navorsingsinstituut vir Plantbeskerming, Pretoria*)

Transvaal; (d) *E. fastigata* Dean & Maiden near Sabie, Eastern Transvaal and near Cedara, Natal. With the exception of *P. radiata*, these forest tree species are not widely planted in South Africa. The most important species are not recorded as highly susceptible to *P. cinnamomi*.

Polyporus baudoni *root disease*

Polyporus baudoni Pat. causes a minor root and collar disease of *P. caribaea*, *E. punctata* DC., *E. maculata* Hook., *E. citriodora* Hook. and *E. paniculata* Sm., mainly in Zululand (Lückhoff, 1955; Lückhoff, 1964; Van der Westhuizen, 1973), and produces large, orange-yellow, poroid, mushroom-like fruit-bodies (Fig. 13 and 14). In the present survey, dead and dying *P. caribaea* and *E. maculata* trees were seen in areas where *P. baudoni* had previously been reported, but damage was limited.

Rhizina *root disease*

Rhizina undulata Fries causes group dying of conifers (Booth & Gibson, 1972) on burnt sites and forms irregularly lobed, flat, convex or undulating, dark brown or black fruiting structures with paler

FIG. 15 *Rhizina undulata* fruiting body associated with *Pinus patula* trees following burning of a clearfelled site (Photo by Mr J. P. Marais, Usutu Estates, Swaziland)

FIG. 15 Rhizina undulata-*vrugliggaam geassosieer met* Pinus patula-*bome na die brand van 'n skoonafgekapte aanplanting* (*Foto deur mnr. J. P. Marais, Usutu-landgoed, Swaziland*)

coloured margins and tough, fibrous, reddish-brown flesh (Fig. 15). This pathogen was first recorded in South Africa from Knysna in the Cape Province (Doidge, 1950). Recently, up to 80% mortality of *P. patula* seedlings was reported from Swaziland (Germishuizen, 1979). Following this outbreak, the practice of burning after felling was discontinued (Germishuizen, 1979).

In the present study, *R. undulata* was found associated with a few dead *P. roxburghii* trees in the Eastern Cape. The fungus is also occasionally reported by foresters from other forest areas, but at present it does not appear to be very important in South Africa.

Other plantation diseases of less importance

Other diseases of less importance on *Pinus* spp. and *Eucalyptus* spp. have been reported from South Africa (Fisher, 1912; Bottomley & Carlson, 1920; Kotzé, 1935; Bottomley, 1937; Doidge, 1950; Doidge *et al.*, 1953; Lückhoff, 1955; Van der Westhuizen, 1959; Lückhoff, 1964; Van der Westhuizen, 1965a; Van der Westhuizen, 1965b; Gorter, 1977). They were not observed in the present survey.

Conclusions

Commercial timber plantings in South Africa cover 1 080 929 ha (Department of Forestry, 1978) with an estimated expected return from the timber of R926 million (D. L. Staal, Department of Forestry, Pretoria, personal communication). Plantations consist entirely of exotic tree species and many diseases have not yet been introduced into the country. In addition, the forestry industry is relatively young and the full impact of "pure" plantings of trees (monoculture) and progressive soil depletion have not yet been felt. The problems that have arisen have largely been dealt with by planting resistant species in areas favourable for the development of disease (Kotzé, 1935; Laughton, Elaine M., 1937; Lückhoff, 1964).

Because of the slight impact of tree diseases on the forestry industry in the past, forest pathology has been seriously neglected in South Africa. However, the present study has shown that a number of important diseases are causing serious losses in principal timber growing areas throughout the country. Considerably more attention must therefore be given to forest pathology to protect this industry.

Acknowledgements

Acknowledgement is made to Dr Sharon von Broembsen, Miss Anthea Clarke, Prof. D. G. M. Donald, Dr H. Geertsema, Dr N. J. van Rensburg, Dr G. C. A. van der Westhuizen and many South African foresters, particularly Mr J. Chedzey and Mr D. Dobson, for assistance during this investigation.

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