BATINI

TO: ..A.D.F.O..BATINI,....

Forests Dept.,

...HARVEY.....

SEMINAR ON JARRAH DIEBACK

The following notes on sylvicultural and control aspects of Jarrah dieback are proferred for your perusal before the seminar to be held at Harvey on 19 - 20 October, 1965. They arise from a preview of literature and overseas experience with P. cinnamomi and other similar pathogens by A.D.F.O. Kimber. References are listed in the final paragraph.

1. The Fungus

The causative agent of die-back in Jarrah has been identified as Phytophthora connamomi (Podger. - unpublished.) Infection of Jarrah appears to originate in soils which are damp or have seasonally impeded drainage but the fungus, once established, colonizes trees in relatively dry and freely draining soils. Such colonization (generally uphill) appears to be much slower than colonization along natural drainage features. Hence the general die-back picture of gulley and valley forest decimated but with live and apparently healthy forest covering higher slopes and ridge tops.

Phytophthora cinnamomi, a root infecting fungus, attacks a wide range of plant species and is almost ubiquitous in warmer climates.

A brief review of pertinent literature reveals interesting comparisons from other countries, details of the movement and pathogenicity of the fungus, relative susceptibility of species, and also gives indications of approaches to make in control methods.

Kuhlman (1964) considers that movement of the fungus is by (a) mycelial growth, (b) by fungal fragments and resting spores being carried by water, and (c) movement of swimming spores. The two latter items would account for the relatively rapid spread along drainage features observable in the Jarrah forest. A fourth possible method of dispersion which Kuhlman does not mention is by resting spores carried in dust.

Uphill movement is probably mainly by mycelial growth. The rate of uphill spread in the U.S.A. due to assumed mycelial growth has been measured at 15 feet in 18 months (Zentmeyer and Klotz - reported by Kuhlman 1964). However, it has been demonstrated that the fungus is only weakly saprophytic and moves

slowly through the soil by mycelial growth, and it seems likely that growth uphill takes place mainly in live root tissue. In this connection root fusion between trees becomes important. In the United States root fusion in oaks is regarded as a major channel of spread of the oak-wilt fungus (Jones and Paltridge (1961) and Parmeter and Kunty (1954). Root fusion has recently been shown to be not uncommon in Jarrah pole stands and could partly account for uphill spread. The association of initial infection and spread of the disease with soil moisture status is common to many accounts of P. cinnamomi damage. Thus the U.S. 'littleleaf' disease of Pinus echinata caused by the same fungus, is "associated with conditions of too much soil moisture and insufficient soil aeration and nutrition" (Hepting 1960.) In New Zealand, P. cinnamomi attacks on Pinus radiata and Cupressus macrocarpa are associated with periods of heavy rainfall; and soil drainage, particularly when it is poor influences markedly the extent of the disease. (Sutherland et. al. 1959.)

The effect of the fungus on the plant is primarily one of injuring roots and death of the tree follows through nutrient (and possibly water) shortage. Hepting (1960) has described how the fungus rapidly kills the fine emerging root types and at the same time sporulates profusely in Pinus echinata. He found that if the tree is in wet soil, or soil of low oxygen content, new roots do not regenerate well and it dies of nitrogen starvation. Heptman claims that heavy doses of N. can arrest the disease in this species.

The Relative Susceptibility of Species

The pathogenicity of P. cinnamomi has been tested in Vitro on the root tips of a number of species (Zak and Campbell 1958.) and the following range of susceptibilities noted (high number - highly susceptible.)

Pinus echinata	92
P. palustris	64
P. taeda	58
P. elliottii	54
Cupressus arizonica	23
Liquidambar	0

Evidence from the field supports sections of this laboratory result. Thus Hepting (1960) records that Pinus palustris rarely becomes infected while P. taeda is less sensitive to the fungus than P. echinata. In New Zealand, Sutherland et. al. (1959) found Cupressus macrocarpa to be much less susceptible to infection than P. radiata (however, once infected the cypress succumbed more rapidly than the pine.) The same authors - cite the infection of Pinus pinaster.

Hepting also makes an interesting observation that P. echinata is rarely attacked before age 20, the inference being that younger trees have more vigour to replace killed roots. Evidence supporting this can be seen on some die-back areas where Jarrah advance growth comes away after the death of the overstorey, and remains alive for a number of years.

both root shoot rate?

3. Control Methods

For a complete review of possible control methods it has been necessary to consider both work on P. cinnamomi (which is sparse) and on control of other species of root infecting fungi. Probably the most thoroughly worked on disease is oak-wilt (Ceratocystis fagacearum) in the United States which has some similarities to die-back in its method of spread. The most successful control method against oak-wilt is that of felling infected trees and poisoning the stumps (usually with ammate) or formation of a poisoned band of trees round areas of infection.

Heptmans suggestion of heavy doses of N to prevent death of infected P. echinata stands supports a similar approach to fungus control by Caroselli (1956) Dealing with maple-wilt (Verticillium sp.), he found that heavy doses of fertilizers (including $CaCN_2$ and $(NH)_2SO_4$) controlled infection of maple trees. However, $NaNO_3$ caused the infection to be more severe.

The injection of fungicides into the stems of infected trees, or those likely to become infected by a fungus parasite has been attempted to curtail the ravages of "ink disease" in Chestnut (also cuased by a Phytophthora sp.) Fernandes (1959) used copper sulphate but found certain unspecified technical difficulties. NaF has also been tried but found inferior to $CuSO_4$.

Of control methods advocated specifically for P. cinnamomi, trenching and draining appear to have possibilities in the Jarrah forest. Zentmeyer et. al. (1962) advocate these methods in Avocardo orchards in the U.S.A. Further evidence of the trenching technique being successful is given by Wallace and Buckland (1955) who cite and example of the root infecting fungus Poria weirii being successfully contained for a period of 20 years by two trenches 1.5' deep x 1' wide.

4. References to Literature

(Those marked with an asterisk can be found in Forestry Abstracts.)

* Caroselli (1956) - Phytopathology 46 (4) 1956.

* Fernandes (1959) - Publ. Serv. Flor. Aquic., Portugal 26 (1/2) 1959.

Hepting (1960) - From Proceedings of a Special Field Institute in Forest Biology, 1960 Ed. by T. Maki.

* Jones and Paltridge (1961) - Plant Dis. Reptr. 45 (7) 1961.

Kuhlman (1964) - Forest Science 10 (2) 1964.

* Parmeter and Kuntz (1954) - Abstr. in Phytopathology 44 (9) 1954.

(Nd) Sutherland et. al. (1959) - N.Z. Journal of Agric. Research 2 (4) 1959.

Wallis and Buckland (1955) - Forestry Chronicle 31 (4) 1955.

Zak and Campbell (1958) - Forest Science 4 (2) 1958.

(No) Zentmeyer et. al. (1962) - Circular No.511 (1962), California Agricultural Experiment Station.

Recommended reading:- "Experimental Studies on Control of Oak Wilt Disease" by Himelick and Fox. - Bulletin 680 of the University of Illinois Agricultural Experimental Station, 1961.

New Look?

A.C. HARRIS
CONSERVATOR OF FORESTS.

JARRAH DIEBACK SEMINAR

HARVEY

19th - 20th OCTOBER, 1965

Organiser:	Mr. J. B. Campbell	
Discussion Leaders:	Mr. J. B. Campbell	- Forests Dept.
	Mr. F. Batini	- Forests Dept.
	Mr. F. D. Podger	- Forest Research Institute.

19/10/65

Seminar Commences	9.00 hours	at Harvey Office
Preliminary Briefing	9.00 hours	Mr. J. B. Campbell
First Day	9.15 hours	Field Inspection
	12.30 hours	Lunch in field provided
	13.00 hours	Field inspection
	17.30 hours	To Harvey Hotel prepare for dinner
	19.15 hours	Evening session at Working Plans Office Harvey

20/10/65

Seminar Reconvenes	8.45 hours	At Harvey Office
Second Day	8.45 hours	Field Inspection
	13.00 hours	Lunch provided at Harvey
	13.45 hours	Discussion session
Seminar Closes	15.45 hours	

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JARRAH DIEBACK SEMINAR

HARVEY

19th - 20th OCTOBER, 1965

The programme has been planned to consider each of the following aspects -

A. The Nature of the Problem.

1. Its extent.
2. Recognition of early symptoms.
3. Distribution of the disease in relation to stand and site factors.
4. Persistence of the disease in affected areas.
5. Susceptibility of species and evidence of natural rehabilitation.
6. The potential of the disease for destruction.

B. Mapping of the Problem.

1. How useful is aerial photography in mapping the occurrence of dieback.
2. Can the precise location of boundaries of diseased areas be mapped. { photo / ground.

C. Evening Session.

Two short illustrated addresses.

A. "The Case Against Phytophthora cinnamomi - What can we expect in the future?" - F. D. Podger.

B. "Mapping Jarrah Dieback - Its Extent and rate of Development" - F. Batini.

C. Discussion on extent and potential of the disease.

D. Reforestation.

Examination of the results of some early attempts of reforestation of dieback sites to illustrate :

1. The range of sites requiring reforestation.
2. Some indications of the need for site preparation and fertiliser applications.
3. Examples of the range of success achieved in early reforestation trials.
4. Consideration of site preparation techniques for reforestation.

E. Afternoon Discussion Session.

1. The need for reforestation.
2. Research and Action required.

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D I E B A C K S E M I N A R

H A R V E Y

19th and 20th OCTOBER, 1965

PROGRAMME - First Day 19th October

9.00 hours	Briefing by Mr. J. B. Campbell.
9.15 hours	Depart Harvey.
9.30 hours	Stop 1. Five year old tallowood plot on marginal P. radiata soils.
9.37 hours	Depart Stop 1.
9.40 hours	Arrive Stop 2. To examine a small dieback area showing extension and early symptoms. This is the first well established dieback encountered en route and illustrates the association between understorey deaths and subsequent death of jarrah. Understorey deaths may be found well in advance of jarrah deaths and it is these understorey deaths which indicate the extent of the infection. It is suggested that during the remainder of today's travel special note is made of the extent of areas of mass understorey dying in relation to the area of clearly established dying of the jarrah overstorey.
10.10 hours	Depart Stop 2.
10.25 hours	Stop 3. Dieback in poor quality forest on black gravels perhaps typical of the situations in which the earliest dieback was reported. After turning note dieback on a very high point two areas of dieback joining over a ridge. Note seedlings of Banksia just becoming established - suggests dieback is not due to some permanent soil toxic factor. Note also lower down slope the wide band of dead and dying understorey indicating a recent extension of dieback.
10.55 hours	Depart Stop 3.
11.00 hours	Stop 4. Marri regeneration on a dieback site.
11.10 hours	Depart Stop 4.
11.15 hours	Stop 5. Dieback in good quality pole forest. Note evidence of stumps and large stag to indicate that this is a prime jarrah site. Walk up hill through a narrow strip of healthy forest to a very small patch of dieback. Then discuss location of dieback boundary to illustrate that even on the ground the boundaries of dieback area are not always easy to delimit.
11.45 hours	Depart Stop 5. Enroute to Stop 6. Note one mile beyond Stop 5 breaking up of good quality pole stand. Just before the swamp note scattered but good formed Marri regeneration.
12.05 hours	Stop 6. Healthy Blackbutt and Blackbutt regeneration in an old dieback area. This indicates that the pathogen is host selective.
12.15 hours	Depart Stop 6. Lunch at Hoffman.

AFTERNOON 19TH OCTOBER

For the next two hours intend to concentrate on showing examples of the extent to which aerial photographs are useful in mapping the location and extent of dieback areas. Mr. Batini to lead discussion.

13.00 hours	Depart Hoffman.
13.10 hours	Stop 7. Affected stands can be recognised on photos. As we proceed along Morrisey's Road the light photo tones will be seen to coincide with dieback affected stands.
13.20 hours	Depart Stop 7.
13.25 hours	Stop 8. The precise location of the dieback boundary on aerial photographs may be difficult particularly if there are not substantial differences in understorey and overstorey mortality along the boundary on the ground. At this point definite evidence of dieback, but the photo evidence does not indicate dieback.
13.55 hours	Depart Stop 8.
14.00 hours	Stop 9. An example of low incidence patchy dieback over a fairly wide area in prime jarrah pole stands.
14.10 hours	Depart Stop 9.
14.20 hours	Stop 10. Recently dead jarrah and dying jarrah with mortality in a wide range of size classes in prime forest on deeper laterites.
15.00 hours	Depart Stop 10.
15.05 hours	Stop 11. Willowdale Eucalypt plantings.
15.15 hours	Depart Stop 11.
15.20 hours	Stop 12. Pinus pinaster planted 1959 without site preparation in a dieback site.
15.25 hours	Depart Stop 12.
15.55 hours	Stop 13. Pinus pinaster plantings with and without ploughing. Also evidence of the persistence of lethal factor in deaths of jarrah coppice. Further evidence that dieback is not due to some sudden change to a permanent toxicity in presence of apparently healthy Banksia grandis seedlings.
16.05 hours	Depart Stop 13.
16.20 hours	Stop 14. Via very bad dieback areas to 1964 E. microcorys plantings.
16.30 hours	Depart Stop 14.
16.40 hours	Stop 15. Unsuccessful trials with Marri. Note the proportion of the area traversed in Park Block which has been naturally regenerated by Marri.
16.50 hours	Depart Stop 15 for Harvey.

D I E B A C K S E M I N A R

PROGRAMME - Second Day, 20th October.

8.45 hours	Briefing by Mr. J. B. Campbell.
8.50 hours	Depart Harvey.
9.05 hours	Stop 1. Pinus pinaster planted without site preparation in old dieback patch. Supered 1957.
9.20 hours	Stop 2. Convoy to pull up on eastern end of planting trials. Area cleared to edge of dieback 1960. Extension since has provided further salvage. Note the massive laterite at shallow depth along roadside erosion channel. Site preparation complete ploughing, but note that there are still occasional susceptible native plants present. These represent possible sources of reinfection if the area is planted to susceptible species or if the soil is transported. Observe the effect of supering in July 1962. Move through belt of dying forest on south side of road. Note current dieback activity and that the extension of dieback is not uniform around perimeter of the patch. Note that there are a number of ground flora species dying. How many of the ground flora species are hosts is not known. It is quite possible that there may be present among them species which harbour the disease but are not adversely affected; i.e. tolerant hosts. These also would serve as sources of reinfection. Draw attention to the condition of crown which in the view of Mr. Campbell represents the last stage before death and indicates that the tree will die in the near future. Cross road to E. saligna planting, examine effects of super application and suspected Potassium deficiency. Cross road to Pinus pinaster planting of 1957. No site preparation at planting. Soil disturbed in 1963. Further evidence of persistence of dieback factor can be seen in the death of jarrah advance growth amid P. pinaster planting. Examine most recent plantings and then move back along 5 chain break to motor vehicles.
10.50 hours	Depart Stop 2.
11.00 hours	Stop 3. Tallanalla planting of several wildling E. microcorys.
11.10 hours	Depart Stop 3.
12.00 hours	Stop 4. Examine current site preparation techniques in use at Harvey.
12.30 hours	Depart Stop 4.
13.00 hours	Lunch at Harvey.
13.45 hours	Discussion in Working Plans Office, Harvey.

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HARVEY,
29th September, 1965.

REFORESTATION OF DIEBACK AREAS

For some years small field trials have been initiated to test the suitability of different tree species on dieback areas.

To my knowledge this work has not been written up in a composite report. The oldest trials have been in the Gleneagle, Dwellingup and Harvey Divisions. The trials can be grouped into three main headings of -

Natural regeneration of Marri combined with Marri spot sowing,

Planting with P. pinaster, and

Planting with eucalypts.

Natural Regeneration of Marri:

Marri has regenerated some dieback areas and in small patches the regeneration has been quite satisfactory (vide Teesdale area). Generally, however, not only is the regeneration very scattered, it does not occur in all dieback areas; it serves to give some cover on some areas.

Marri Spot Sowing:

This has been tried in several areas with very limited success. Although some Marri germinated and is still living, the plants have stagnated into the lignotuberour stage.

P. pinaster Planting:

This species has been planted on a range of dieback sites with fair success. It is essential to cultivate the site before pinaster will grow. Survival can result without cultivation but it will not grow. The effect of super has not been conclusively demonstrated but it is felt that a response could result. Super without cultivation is unsatisfactory.

Eucalypt Planting:

Only latterly has much planting been done on dieback sites with eucalypts and even then only a small range of species has been tried. Spot sowing has been tried with a range of eucalypts in Harvey with no success whatever.

Planting of eucalypts is a waste of time if the site is not cultivated as they respond much the same as P. pinaster. Successful plantings have been carried out with Eucalyptus microcorys, saligna and globulus. It has been reported that Angophora has also done well.

In Harvey it has been shown that a response can be obtained from the application of super, particularly to Eucalyptus microcorys and saligna. To obtain best survival of young plants in the field it appears that manurial treatments should not be applied at least in the first few months and possibly not until age one year. Plantings to date have been of trayed stock which have severe limitations both cost wise and for best treatment of the young plant.

Steps have been taken this year to raise plants in jiffy pots and these should prove both economical and more successful as regards survival.

It is a costly operation to clear land ready for complete ploughing. To test this in the 1965 planting, ploughing one furrow has been tried. Also we have tried a modified tyne on a 3-point linkage tractor. Next year it is intended to fully test a single tyne subsoiler on the back of a 3-point linkage tractor. With these methods it is hoped that a complete cleaning up of the ground will be avoided and establishment costs of £10. per acre plus the cost of the plants, approached.

The reasons for the need of ploughing are not fully understood. It is difficult to believe that reduction of scrub competition is the sole benefit and it is felt that the aeration and possible alteration to the structure of the soil is a benefit.

Large trials are being initiated to test a range of species over a range of conditions with a range of soil preparations and fertiliser treatments. Locally it is believed the species that will give the best results will be E. microcorys, E. saligna, E. globulus and E. pilularis.

Of these, because of wood quality and therefore value return, it is hoped that Tallowood will give best results. In addition this species would best fit into the Department's control burning programme. In addition it is hoped that tending by way of pruning can be avoided and this would not be the case with pines.

We have some evidence to support the fact that Tallowood is well suited to our climatic conditions. It has done well in a moist site at Willowdale, being over 100 feet high at age 30, with girths up to 62 inches. Several trees have done well on a lateritic site at Tallanalla and there is a fair area of good Tallowood adjacent to the Harvey Weir Plantation which at age 5 years is 25 feet high. In addition, the species is colonising at Willowdale. Most important of all, to date we have seen no evidence that Tallowood is susceptible to Phytophthora cinnamomi.

Trial Plantings on Dieback Site - Quindanning Road Kent Block

Plot 1

This plot of about two acres was cleaned up ready for ploughing in 1960. It was ploughed and planted with E. microcorys in August 1961 at a spacing of 15 x 15. In the following year 1962, after a good survival of over 75%, half of the plot was given 4 oz. of superphosphate per tree. In the late summer of 1962 many plants appeared to suffer very much from the long dry conditions and looked as if many would die. Following the early winter rains, however, the majority of trees recovered and have continued to look good since. Today at age 4 the trees are upwards of feet high and inches d.b.h.o.b. The lack of insect and other attack on the microcorys leaves is very noticeable. Ash bed effect is noticeable on both supered and unsupered plots, but more particularly on the unsupered plots. It is believed that both plots would respond to a potassium treatment. Many of the trees have double leaders from near the ground. This could be caused by the drought year in 1962 or it could be an hereditary trait as many of the plants in the original plots at Willowdale have double leaders. It is intended to cut these double leaders off this year.

The site on which these trees are planted has a North-East aspect and is a particularly poor lateritic gravel with quite an amount of black gravel present. Sheet rock is present at fairly shallow depth over much of the site.

Today it is obvious that those plants that received super one year after planting are markedly better than the control.

Plot 2

This plot on the opposite (North) side of the Quindanning Road was cleaned up, ploughed and planted with E. saligna in July - August 1962. Half of the plot (to the West) was given 4 oz. of super per tree.

The survival on this plot was not as good as with the microcorys and it is suspected that apart from the trayed stock, the application of super so soon after planting had a detrimental effect on surviva l. Once again there is an ash bed effect which is most pronounced on the supered plot. There is a marked response to super. It is suspected that these trees would benefit from an application of potassium.

The larger trees on the supered plot at age 3 are up to high and inches d.b.h.o.b.

Plot 3

(a) Eucalyptus microcorys planted in 1963 after ploughing. The eastern half of the plot had 4 oz. of Super-Copper-Zinc mix per tree applied at the time of planting. There was a high mortality in the SuCuZn mix thought to be due to the early application of Cu. The western section had super added at time of planting and although survival was not good, there are sufficient vigorous plants living to produce a crop.

(b) A similar plot of E. saligna was ploughed and planted in 1963 and half given 4 oz. of super, the other half 4 oz. of Super-Copper-Zinc mix. As for the Tallowood there was a high mortality in first year in the SuCuZn plot.

Plot 4

A small plot of E. microcorys that was planted in 1964 after soil preparation in 1963. To date the plot has had no manurial treatment but it is intended to apply 4 oz. of super per tree to the whole plot and then apply 1 oz. of Potassium Chloride to half of the plot.

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