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SUSCEPTIBILITY OF AIR DRIED AND HIGH TEMPERATURE DRIED WESTERN AUSTRALIAN SHEOAK (*Allocasuarina fraseriana*) TO ATTACK BY THE POWDER POST BORER (*Lyctus brunneus*)

Progress Report No. 1

by

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Summary

This report gives results of laboratory bioassays of matched air dried and high temperature dried specimens of sapwood from 10 Western Australian sheoak (*Allocasuarina fraseriana*) (Miq.) L. Johnson) trees against the powder post borer *Lyctus brunneus* (Stephens). The W.A. sheoak trees were randomly selected from a stand in Western Block, Collie District of Western Australia. Results clearly show that both air dried and high temperature dried specimens of all 10 trees were attacked by *L. brunneus*. The high temperature drying schedule employed in this study had little or no effect on subsequent susceptibility of test specimens to *L. brunneus*. Those specimens with the highest starch content recorded the greatest amount of attack.

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Introduction

Trees of Western Australian sheoak (*Allocasuarina fraseriana* (Miq.) L. Johnson) form an understorey in the jarrah (*Eucalyptus marginata* Donn ex Sm.) and marri (*Eucalyptus calophylla* R.Br. ex Lindl.) forests of south-west of Western Australia. They occur in a limited area and are very prominent on the poorer sandy soils. Timber from W.A. sheoak is currently used in the manufacture of furniture, decorative hardware and turnery, roofing shingles, flooring and panelling.

The resource of mature W.A. sheoak tees with a narrow sapwood band is declining therefore smaller trees with wider sapwood bands are becoming more widely used in the production of high value added furniture timbers. W.A. sheoak has a small market compared to karri (*Eucalyptus diversicolor* F. Muell.) but is readily sought by small cottage industries which manufacture furniture and ornamental goods.

The sapwood of W.A. sheoak is reported to be susceptible to attack by powder post borers (*Lyctus* spp.) (Forest Products Association, 1985). Prevention of attack to this sapwood would extend the resource and offer consumer protection.

Therefore, a collaborative research project was initiated between CSIRO and the Western Australian Department of Conservation and Land Management (CALM) to investigate the following:

(i) The susceptibility of a W.A. sheoak (small diameter trees with wide sapwood bands) to attack by *Lyctus brunneus* (Stephens), and

(ii) Whether high temperature drying of W.A. sheoak affects its susceptibility to *L. brunneus*.

The second investigation is an attempt to render the sapwood immune by destruction or depletion of some of its nutritional content (particularly starch); a practice that has had some success with messmate stringybark (*Eucalyptus obliqua* L'Herit.) (Creffield, unpubl. data). Harris (1961) also showed that greater starch depletion occurred in one-inch (25 mm) boards of European Oak (*Quercus robur* L.) when kiln dried compared to matched air dried material. Due to handling, health and economics, a non-chemical means by which susceptible sapwood could be rendered immune would be more advantageous than chemical immunisation.

This report presents some progress results of specimens from 10 W.A. sheoak trees when exposed to *L. brunneus* in the laboratory.

Materials and Methods

(i) Timber Samples: Ten randomly selected W.A. sheoak trees were harvested from a stand in Western Block, Collie District, Western Australia. W.A. sheoak has been cut from this area 30 years ago and was clearcut for jarrah four years ago. The tree heights ranged from 10 m to 20 m and diameter (DBHOB) ranged from 200 mm to 470 mm. Matched pairs of samples were obtained from each tree at each of three positions; the butt, midway along the bole and the crown of the log. One sample of each matched pair was seasoned by air drying whereas the other was high temperature kiln dried from green to between 10 and 12 per cent moisture content. All samples were dried at the Wood Utilization Research Centre of the Department of CALM.

(ii) High Temperature Drying Schedule: The following schedule was used for those W.A. sheoak samples assigned to high temperature drying:-

	Time	Dry Bulb Temp. ^{o}C	Wood Temp. ^{o}C
Pre-steaming	1 h	110	105-108
Drying	10 h	110	108-112
Re-conditioning	4 h	100	94-97

Fan direction was reversed every three hours during the drying procedure.

(iii) Preparation of Specimens: Test specimens, containing full sapwood width, were cut (using a tungsten-tipped saw) from each air dried (AD) and high temperature dried (HTD) sample. In most cases two test specimens were obtained from each sample i.e. two AD specimens and two HTD specimens for each of the three positions per tree. Test specimens were irregular in shape, but had approximately the same sapwood volume.

(iv) The Bioassay: Clear glass jars (1.2 L vol., 100 mm square by 150 mm high) were used as bioassay chambers. A thin layer of a forest loam was then placed into each jar to act as a beetle foothold. The jars containing soil were then thoroughly heat sterilised. After sterilisation, one test specimen was placed into each jar and allowed to condition to a moisture content of between 14 and 15 per cent in an insectary ($27^{o}C$, 75 per cent RH) for at least seven days before inoculation of test insects.

A screw top metal lid was fitted with a paraffin wax impregnated cardboard wad to ensure a mite-proof seal. At the centre of the lid a circular hole 30 mm in diameter was punched through the metal and the cardboard wad. The

hole was then sealed with rice paper (cigarette paper) and glued down at the edges with a liquid adhesive. This allowed aeration and permitted the timber specimens to be maintained at the desired equilibrium moisture content.

Since the sexing of *L. brunneus* adults is time-consuming, it was decided (after checking that a suitable number of females were present) to place 20 adults taken at random from a daily collection, on to each specimen.

Four months after the beetle inoculation, all specimens were examined for evidence of larval activity by splitting each specimen longitudinally and noting larval channelling present. The extent of larval channelling in a timber specimen is a subjective qualitative assessment. Therefore, any larval channelling present, regardless of the amount, was considered an indication of the timber's susceptibility to attack and subsequent degrade by *L. brunneus*.

A rating of susceptible (S) is given to a test specimen where larval channelling was present. However, to give an indication of the amount or intensity of larval channelling present a rating system was used as follows:

S111 - Extensive attack, complete destruction of the sapwood.

S11 - Moderate attack, larval channelling not as extensive as S111. Frass packed galleries not as broad as S111.

S1 - Slight attack. Attack confined to a small amount of larval channelling, sometimes only 10 mm in length along the vessel.

A non-susceptible rating (NS) was given when a test specimen revealed no larval channelling.

(v) Starch Assessment: After examination for larval channelling, each test specimen was assessed for starch content in the sapwood using a semi-quantitative iodine test (see Appendix 1). The concentration of starch present in the sapwood was recorded using a visual grading system of LOW (L), MEDIUM (M), HIGH (H) or NOT DETECTED (-).

Results and Discussion

Table 1 gives details on the susceptibility rating assigned to each sapwood test specimen bioassayed with *L. brunneus*. Also listed in Table 1 are the results of the semi-quantitative starch assessments performed on each test specimen after splitting.

The qualitative results given in Table 1 show that all 10 W.A. sheoak trees were susceptible to attack by *L. brunneus*. As the susceptibility rating system adopted is based on a qualitative assessment, no statistical analyses of the results have been undertaken. However, a number of observations can be made from the results:

(i) Combining all the data for the 10 W.A. sheoak trees bioassayed, it would appear that specimens from the crown position were more susceptible to attack by *L. brunneus* (see Table 2). This is in contrast to results obtained for five trees of regrowth karri (Creffield, Brennan and Chew, 1987) where specimens from the butt position of trees were more heavily attacked. Data presented in Table 2 clearly shows that test specimens with

a rating of S111 (extensive attack) were more frequent from the crown position of trees (23) than from the butt position (12).

(ii) The HTD schedule employed in this study had little or no effect on the subsequent susceptibility of matched W.A. sheoak specimens to *L. brunneus*. However, the appearance of the starch in the sapwood of test specimens was altered by the effect of high temeprature drying. Instead of its usual granular appearance (as seen in the AD specimens), the starch, after high drying was rather 'stringy'.

(iii) As was the case with regrowth karri (Creffield, Brennan and Chew, 1987), there was a relationship beween starch content of the sapwood and the degree of susceptibility to *L. brunneus*, i.e. the higher the starch content, the greater the degree of attack. For example, comparing data for all 10 trees (total of 105 test specimens), a high starch content (H) was recorded in the sapwood of 59 test specimens (including both AD and HTD). Each one of these 59 specimens were susceptible (S) to attack; 38 being rated as S111, 19 at S11 and only two at S1. At the other end of the scale, a low starch content was assigned to the sapwood of 12 test specimens. Of these 12 specimens, none were rated as S111, two at S11, five at S1 and five were not susceptible to *L. brunneus*. The effect of starch concentration on susceptibility rating is summarised in Table 3.

Worthy of note is that a high starch content (H) was assigned to 56 per cent of all specimens bioassayed (see Table 3). No test specimens received a starch not detected (-) rating.

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TABLE 1

Susceptibility of 10 W.A. sheoak (*Allocasuarina fraseriana*) trees (matched air dried and high temperature dried test specimens) to attack by *Lyctus brunneus*. Results of the semi-quantitative starch test performed on all specimens are also included

Tree No.	Position	Air dried		High temperature dried	
		Rating	Starch	Rating	Starch
1	Butt 1	S11	M	NS	L
	" 2	S11	H	NT	
	Mid 1	S111	M	S111	H
	" 2	S11	H	S111	H
	Crown 1	S11	H	S11	H
	" 2	S11	H	S111	H
2	Butt 1	NS	L	NS	M
	" 2	NS	L	NT	
	Mid 1	S11	M	S1	M
	" 2	S1	L	NS	M
	Crown 1	S111	M	S11	H
	" 2	S111	H	S111	H
3	Butt 1	S111	M	S111	H
	" 2	S111	H	S11	H
	Mid 1	S111	M	S111	H
	" 2	NT		NT	
	Crown 1	S111	H	S111	H
	" 2	S111	H	S111	H
4	Butt 1	S1	M	NS	M
	" 2	NS	L	NS	M
	Mid 1	S1	M	S11	H
	" 2	NT		NS	M
	Crown 1	S111	H	S111	H
	" 2	S111	H	NT	
5	Butt 1	S111	H	S111	H
	" 2	S111	H	NT	
	Mid 1	S11	L	S11	H
	" 2	S11	M	S11	H
	Crown 1	S1	M	S1	M
	" 2	S111	H	S1	H

... cont'd

Table 1 cont'd

Tree No.	Position	Air dried		High temperature dried	
		Rating	Starch	Rating	Starch
6	Butt 1	S1	L	S1	L
	" 2	NT		NT	
	Mid 1	S11	L	S1	M
	" 2	S1	L	NS	L
	Crown 1	S111	H	S11	M
	" 2	S1	L	S11	M
7	Butt 1	NT		NT	
	" 2	S111	M	NT	
	Mid 1	S11	M	NS	M
	" 2	NT		NT	
	Crown 1	S111	M	S1	M
	" 2	S11	M	S11	M
8	Butt 1	S1	M	NS	M
	" 2	S1	M	NT	
	Mid 1	S11	H	S1	H
	" 2	S1	M	S1	M
	Crown 1	S111	M	S11	H
	" 2	S111	H	S11	H
9	Butt 1	S11	H	S111	H
	" 2	S111	H	S11	H
	Mid 1	S111	H	S111	H
	" 2	S111	H	S111	H
	Crown 1	S11	H	S111	H
	" 2	S111	H	S111	H
10	Butt 1	S11	H	S111	H
	" 2	S111	H	S111	H
	Mid 1	S11	M	S111	H
	" 2	S11	H	S11	H
	Crown 1	S111	H	S111	H
	" 2	S111	H	S111	H

Key: S111 = highly susceptible
S11 = moderately susceptible
S1 = slightly susceptible
NS = non-susceptible
NT = not tested (insufficient material forwarded or sapwood not suitable for testing)
H = high starch content
M = medium starch content
L = low starch content
- = starch not detected.

TABLE 2

Numbers of W.A. sheoak test specimens (both air dried and high temperature dried) susceptible to *L. brunneus* and their position within the tree

	Position in tree		
Rating	Butt	Mid	Crown
S111	12	10	23
S11	6	13	11
S1	5	8	5
Total	23	31	39

TABLE 3

Percentages of W.A. sheoak (*Allocasuarina fraseriana*) test specimens, at the four concentration levels of starch, susceptible to *Lyctus brunneus*

Starch content		Susceptibility rating S111	S11	S1	NS
H	56(59)	64(38)	32(19)	4(2)	0
M	32(34)	21(7)	26(9)	32(11)	21(7)
L	12(12)	0	16(2)	42(5)	42(5)
-	0 100(105)	0	0	0	0)

Key: S111 = highly susceptible
S11 = moderately susceptible
S1 = slightly susceptible
NS = non-susceptible
NT = not tested (insufficient material forwarded or sapwood not suitable for testing)
H = high starch content
M = medium starch content
L = low starch content
\- = starch not detected.

Figures in parentheses indicate the number of specimens from which the percentage data was calculated.

APPENDIX 1

IODINE TEST FOR STARCH IN WOOD

A. Reagent

Potassium Iodide	14 g
Iodine Crystals	7 g

Dissolve the two chemicals in 20-30 ml of water and then dilute the concentrated solution to 1000 ml with water. When not in use keep reagent in dark place.

B. Preparation of Wood Surface for Test

The ideal specimen is one containing both sapwood and heartwood. The specimen could be green, but for semi-quantitative assessment it should be dry. Since, in the majority of cases, the starch grains are stored mainly in the medullary rays of the sapwood, it is desirable to cut a smooth radial surface for application of the iodine solution. However, the reaction in the presence of starch is detectable on any surface whether it be back, quarter or transversely cut, but the intensity of colour developed is more readily assessed on a true radial surface. A rough sawn surface should be avoided as the increased surface area of exposed fibres gives a false impression of the starch concentration present.

C. Application of the Test Solution

(1) The iodine solution may be applied with a brush or by smearing.

(2) Two or three minutes is usually allowed for colour to develop before the starch content is assessed.

(3) In the presence of starch, blue black particles will develop which are generally visible to the naked eye. However, if only a small quantity of starch is present its detection is more readily and effectively made by means of a hand lens (X10).

(4) In the absence of starch, the wood surface merely takes on the pale yellow colour of the iodine solution.

(5) In this test, the presence of heartwood is recommended as generally it does not contain starch grains, should starch be present in sapwood a clear line of demarkation between the two bands of wood will be obtained.