Preliminary Studies of Water Relations of Some Tree Species at Yeelirrie

by

S.R. SHEA

J.R. BARTLE

P.C. RICHMOND

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Preliminary Evaluation of Water Relations of some tree Species at Yeelirrie, W.A.

During the mining of the Western Mining Corporation's uranium deposit at Yeelirrie it will be neccessary to reduce water table levels to enable extraction of the ore. The company is concerned that as a consequence of the reduction in water table the native vegetation (particularly trees) in the areas surrounding the mine site will be adversely affected. The impact of the lowering of the water table on the vegetation will be one factor influencing whether the mining procedure will be modified to reduce the regional effects of water table reduction.

Comprehensive ecological surveys including vegetative type mapping are being carried out by consultants to characterize the vegetation of the lease area. In the area of principal concern the vegetation consists of a savannah woodland. The principal tree species are Casuarina, Acacia aneura var. latifolia, Eucalyptus clelandii and an unknown Eucalypt species (Euc. A.). Spinifex is the major ground layer species and there are considerable areas of bare soil.

The climate is arid with an average annual rainfall of 218 mm. At the time of this study no rain had fallen for 18 months. Soils in the study area were calcareous red sandy earths (Churchwood, pers. comm.). A typical profile consisted of a red sandy loam to a depth of between 20-40 cm overlying a calcareous clay. The clay was of variable density but typically was hard and compact. Depth to water table in the study area varied from 4-6 metres. T.D.S. content of this water ranged from 3,000 to 7,000 p.p.m.

Plants have evolved numerous mechanisms to enable them to grow and survive in arid regions. The literature on the subject is large and has been comprehensively reviewed by Parker (1968). The particular type of mechanism used by

a plant to survive in an arid environment will influence its capacity to withstand additional disturbance to the environment. A variety of classifications have been proposed to categorize arid zone plants. The simplest and most pertinent (to this study) system divides drought resistant plants into-ephemeral, water savers and water spenders. Water savers are plants which have evolved mechanisms which reduce water loss (for example, thick cuticle development, reduction in leaf size and number etc). They may also have adaptions which allow them to resist permanent damage even when subjected to large diffusion pressure deficits. Water spenders survive in arid environments by ensuring maximum use of stored water. The most common adaption of these plants is extensive lateral and vertical root development.

The ability of the vegetation at Yeelirrie to withstand lowering of the water table will depend to a degree on whether the plants have become physiologically dormant to avoid drought or whether they are obtaining stored water. Plants in the latter category are likely to be severely affected by a reduction in the water table level as they are unlikely to have mechanisms which allow conservation of water and they would not be adapted to the very high plant water deficits which would develop.

Thus, a rapid assessment can be made of the impact of the reduction in water table by investigating whether the plants are consuming water and if rooting systems are present which are tapping the existing water table.

Methods

(1) Wet and dry bulb temperatures were recorded throughout the period of measurement.

(2) Measurement of Stomatal Resistance. Stomatal resistance is a measure of the resistance to water vapour diffusion from the leaf surface to the atmosphere. Resistance

simply related to water loss per unit area of leaf there is an inverse correlation between water loss and resistance.

Measurements of stomatal resistance and plant water of the major tree species present was carried out over a 24 hour period on the 29th and 30th March 1977, at four hourly intervals. Stomatal resistance was measured with a diffusive resistance meter (Kanemasu et al, 1969) on 4 leaves of two trees of each species.

(3) Leaf water potential Leaf potential is a measure of the tension at which water is held in the plant. High leaf potentials indicate that the rate of water loss from the plant has exceeded the rate of supply from the soil. Leaf water potential was determined for each tree using the Scholander (1964, 1975, 1966) pressure bulb technique at the same time that leaf resistance measurements were made.

(4) Root excavations A backhoe was used to excavate a trench approximately 3 metres deep adjacent to one tree of Euc. ~~A~~ tereticornis, E. clelandii and Casuarina cristata. In addition, a species of Melaleuca was excavated. The side of the trenches were excavated by mechanical and hydraulic methods to determine if vertical roots were present.

(5) Soil moisture and soil potential Since no rainfall has occurred for 18 months it could be assumed that the surface soil had no "available water". If available water was present in the surface soils then water consumption by the trees would not necessarily have indicated dependence on water stores at depth. Soil samples were taken adjacent to each excavation tree at 0-20 cm, 100 cm, and 200 cm. The samples were placed in containers and sealed and their water moisture content was determined at a later date in the laboratory by gravimetric methods. Soil moisture content at 15 atmospheres was determined for each soil type using the pressure membrane apparatus (Richards and Weaver, 1943).

Results

Stomatal conductance (the inverse of resistance) of 4 species over a 24 hour period is graphed together with air temperature and relative humidity in Figure a. Stomatal conductance and water potential data for each of the species is recorded in Table 1a, 1b, 1c and 1d. Mean soil moisture content at 0-20 cm, 100 cm, and 200 cm and the moisture content of these soils at 15 bars is shown in Table 2.

E. clelandii, Euc. A. Casuarina cristata and Melaleuca had root systems which had a pronounced vertical component. E. clelandii had strong vertical roots developed from horizontal laterals within two metres of the tree stump (Fig. 3). These penetrated to at least a depth of 2.5 metres which was the limit of the excavation. Extensive proliferation of roots in the clay occurred almost throughout the exposed profile. There was also evidence of the formation of vertical roots from horizontal laterals at least 6 metres from the tree stump.

No vertical root development could be detected adjacent to the sump of Euc. A. However, a major horizontal lateral was excavated for a distance of 15 metres where a major vertical root was located (Fig. 4). The root extended approximately 2 metres to the bottom of the pit and through a less compacted zone of calcareous clay. At the base of the pit at least one of the vertical roots was 5 cm in diameter and there was no indication that its vertical extension was about to be terminated. (During excavation of this tree severed roots were observed to yield considerable quanities of water).

The root system of Casuarina cristata was similar to that of E. clelandii although vertical root development was not as strong and the diameter of the vertical roots were less than those of the two eucalypts. However, vertical root extension

observed. The Melaleuca species had similar root characteristics to the Casuarina.

Discussion

Despite the preliminary nature of the study the results obtained were clear-cut. The species examined can be clearly separated into two distinct groups on the basis of their water consumption rates. The high leaf potential and leaf resistance of A. aneura indicates that this species is a drought-evader and is not using stored water. Hence, its ability to survive is less likely to be affected by reduction of the water table. Euc. A., E. clelandii and Casuarina cristata are using considerable quantities of water.

Although the leaf potential measurements indicate that they are under some stress they are not abnormally large. For example, similar leaf potentials have been recorded for Eucalyptus marginata growing adjacent to the Darling Scarp during the summer drought period. These three species can be, thus, classified as "water spenders".

Soil moisture contents in the upper 2 metres of the profile are lower than or equivalent to the soil moisture contents corresponding to 15 bars. This level of soil potential is generally considered to indicate the lower level of water availability. Thus, since there is insignificant amounts of available water for plant use in the upper 2 metres of the profile these species must be extracting considerable amounts of water stored at depth in the soil profile.

The root excavations, although limited, were sufficient to demonstrate that these three species had an extensive vertical root system which would be sufficient to transport water from depths.

Conclusions

This study indicates that several of the tree species growing on the Yeelirrie lease are using water stored at depth in the soil profile. It is, thus, likely that they will be adversely affected by a reduction in the water table. The severity and rapidity of the effect is difficult to predict as it would depend on climatic conditions, the rate at which the water table is reduced and the level to which it is dropped. However, it is likely that a rapid reduction in water table levels in excess of three metres if maintained for over one year will result in significant mortality of those trees which have shown to be dependent on it.

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YEELIRRIE STUDY - DATA SUMMARY

Table 1A

Species Casuarina cristata

Time	Approx. leaf temp.	Corrected T	Stomatal resistance	Stomatal conductance	Water potential
0900	24	554	15.4	6.5	31.2
1200 (i)	28	559	15.6	6.4	24.4
(ii)	30	574	16.4	6.1	
1600	29	966	31.8	3.1	28.6
1800	26	-*	-*	-*	25.2

*Note: resistance too high (conductance too low) to be measured.

Table 1B

Species: Acacia aneura var. latifolia

0900	24	*	*	*	68
1200	28				68
1300	30				68
1600	29				68
1800					68

*Leaf resistance could not be obtained as they were too large to be recorded by the instrument.

Table 1C

Species: Eucalyptus A. (unknown) trivalva

0800	20	352	7.0	14.2	25.2
1100 (i)	29	403	9.2	10.9	30.6
(ii)	29	434	10.5	9.5	30.6
1500	29	541	15.0	6.7	26.5
1800	27	2139	78.0	1.2	24.4

Table 1D

? E clelandii

0900	22	576	16.5	6.1	44.8
1200 (i)	29	703	21.8	4.6	44.2
(ii)	29	961	32.5	3.1	
1500	30	1234	42.5	2.4	43.8
1800	26	1604	56.0	1.8	41.4

resistance in seconds/cm

conductance in cm/sec x 10^{-2}

water potential in bars

Table 2

Depth (cm)	Soil type	Moisture content on 30/3/77	Moisture content at 15 bars
0-20	S.H. ? Sandy Loam ?	1.9%	10.3
100	Clay	11.7%	16.6
200	Clay	16.7%	23.6

FIG (a)

STOMATAL CONDUCTANCE

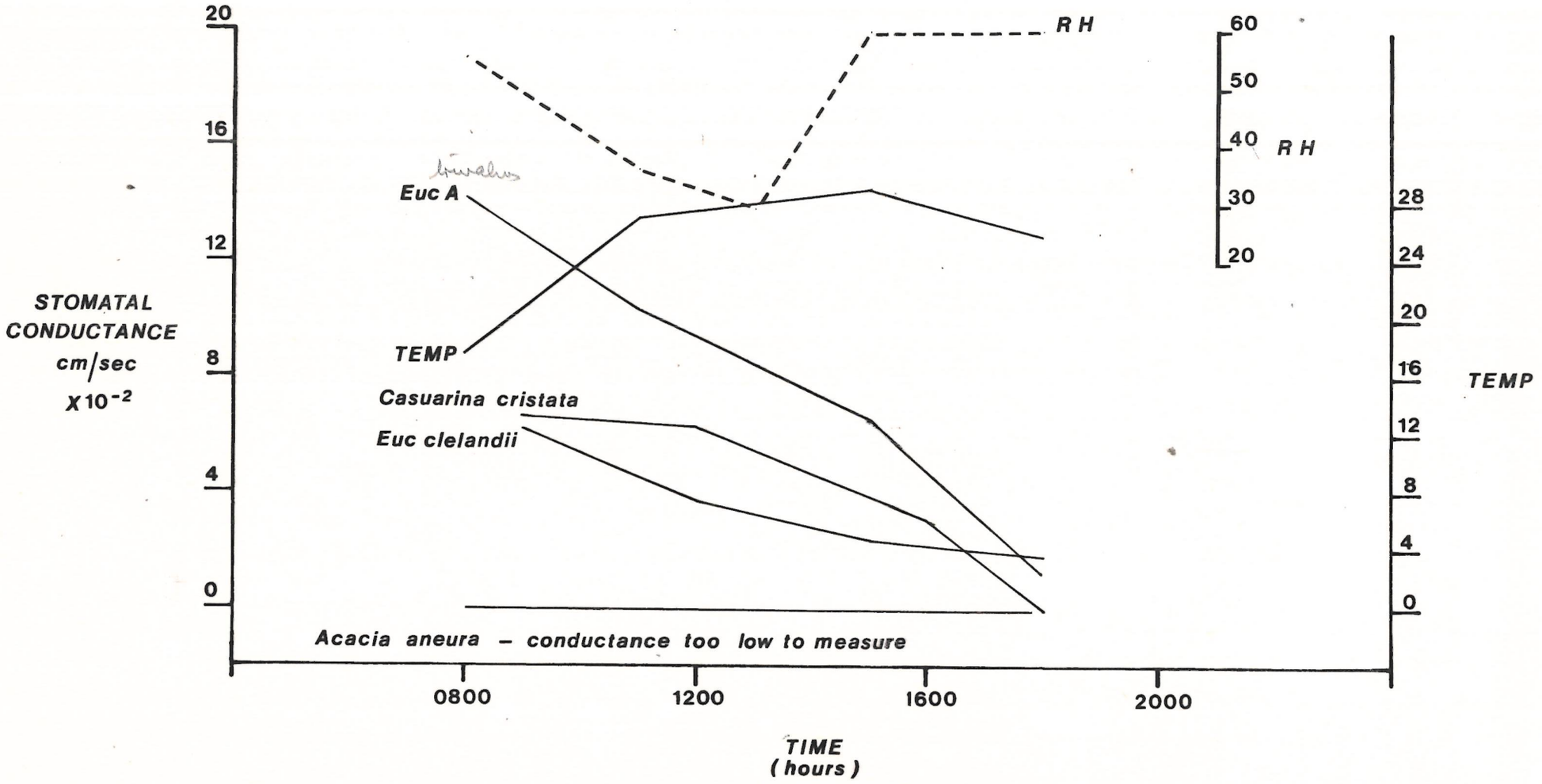


FIGURE 1 Eucalyptus clelandii

FIGURE 2 Melaleuca sp. on drainage line ~~and watercourse~~.

FIGURE 3 Vertical root formed from horizontal lateral root of E. clelandii.

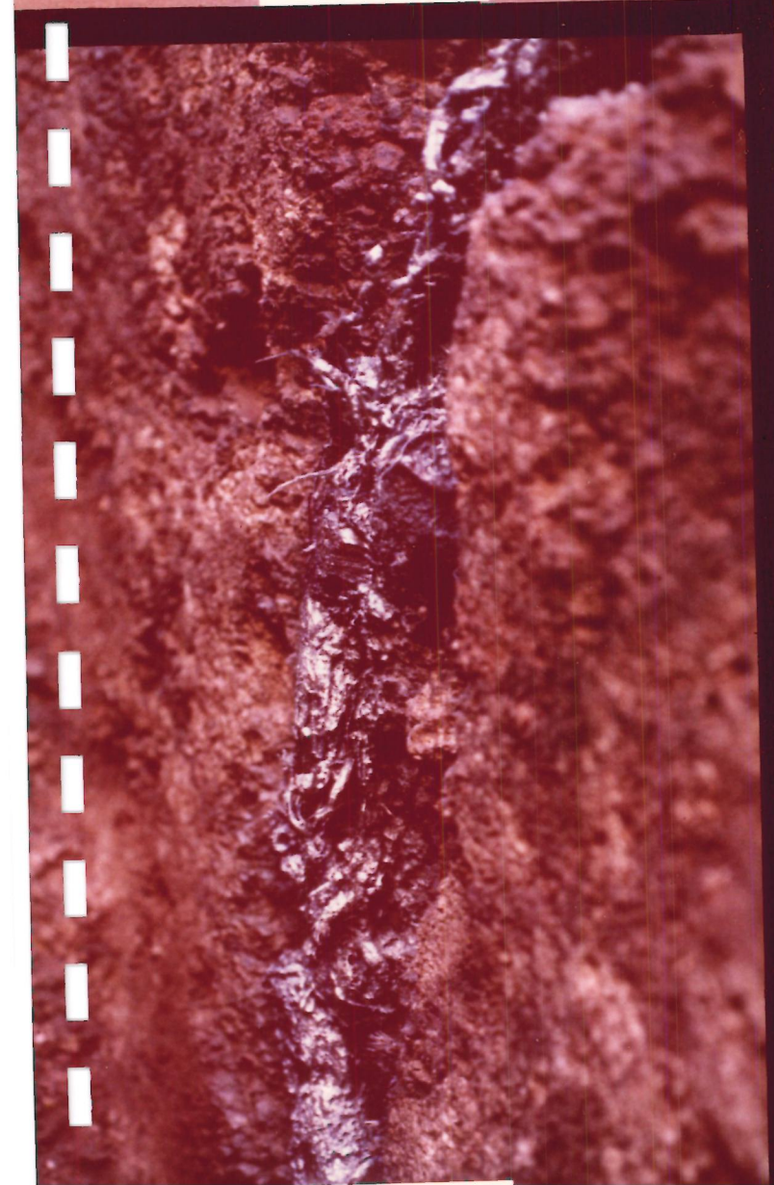
FIGURE 4. Vertical root formed from horizontal lateral root of Euc. A. (Ewadale A) 15 metres from the stump.



Fig.1



Fig. 2





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