4. Release pattern of the selected fertilizer.
5. Total dissolved salts, boron and manganese.
6. Half saturation percentage now and over time.
7. Oxygen levels at saturation now and over time.
8. Any detrimental chemicals and their levels.
9. Effect of detrimental chemicals.
10. Weight per cubic yard.
11. Physical resistance to root growth.
12. Colloid level and ion exchange capacity.
13. Intrusive flora and fauna.
14. Necessary hygiene treatments.
15. Other treatments (nitrogen stabalization of sawdust).
16. Ease of usage.
17. Dust levels.
18. Customer acceptance.
19. Availability.
20. Cost per pot.

EFFECT OF SUPERPHOSPHATE AND HIGH LEVELS OF LIME ON THE GROWTH OF WESTERN AUSTRALIAN BANKSIAS[1]

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Western Australian species of the genus *Banksia* have, in general, proved very difficult to grow in Eastern Australian states. In many cases the fungus *Phytophthora cinnamomi* has been blamed.

Webb (5) has, following extensive observation as to the soil environment of successfully grown Western Australian species and on the basis of field trials, concluded that the addition of high levels of lime to soils permitted the successful growing of many Western Australian *Banksia* species in Canberra.

At the National Botanic Gardens there has been considerable difficulty in propagating Western Australian *Banksia* species. In most cases death occurred soon after pricking out into the standard UC mix used at the Gardens. This mix contains a high level of phosphate (1200g superphosphate, 1200g blood and bone/m^3). Since most Australian species, and Western Australian species in particular, have evolved in an environment

[1] This paper was presented at the 1977 IPPS Australian Region meeting.

low in phosphate it was felt that the high levels of superphosphate in the mix might be contributing to plant death. In the work presented here the effect of the presence and absence of superphosphate on the growth of 12 *Banksia* species was studied. The effect of the addition of limestone chips and powdered lime ($CaCO_3$) to the superphosphate-free mix was also studied.

MATERIALS AND METHOD

Seeds of 12 species of *Banksia* were sown in August, 1976, in a sand-perlite mix. When the seedlings were 2 to 3cm high they were pricked out into 75 mm plastic pots and placed in a cold frame. In November, 1976, the plants were potted into large plastic bags (9 litre). A basic UC mix consisting of 70% washed river sand, 25% peat, and 5% organic sand was employed. To each cubic meter was added calcium carbonate, 1200g; dolomite lime, 393g; superphosphate, 1200g; blood and bone meal, 1200g; potassium sulphate, 79g; Essminal, 111g. This was modified to give the following 5 soil mixes.

1. UC potting mix
2. UC potting mix over 3 to 4 cm limestone chips
3. UC potting mix without superphosphate, over limestone chips
4. UC potting mix without superphosphate, plus additional lime (18Kg/m^3)
5. UC potting mix without superphosphate, plus additional lime (64Kg/m^3)

The pH's of these mixes were 5.5; 5.5; 6.0; 8.1 and 8.7, respectively. Subject to seed availability, 5 replicates of each treatment for each species were used. The potted plants were arranged in five bench areas within a glasshouse. Each area contained one replicate of each treatment per species. The plants were watered by hand as required. All plants were given 2 x 1g of iron chelate (1g/L) 9 and 10 weeks after potting into the above soil mixes. The experiment was terminated 16 weeks after potting on.

RESULTS

Nine weeks after potting into the five soil mixes, data on the relative vigor and appearance of each plant within a group[2] was collected. The plants within a group were allocated the numbers 1 to 5, from least to most healthy. The rating of repli-

[2] The term "group" refers to the plants of a particular species arranged on the same bench.

cates was averaged and the data, together with deaths per treatment, is presented in Table 1.

Table 1. A comparison of the health and vigour of plants grown for nine weeks in five different soil mixes.

Species		No. of replicates	Soil Mix 1	2	3	4	5
Banksia	*ashbyi*	5	1.2¹ (3)²	1.8 —	4.2	3.6	4.2
B.	*baxteri*	5	1.2 (4)	1.2 (4)	4.8	3.8	3.4
B.	*elderana*	3	1.0 (3)	1.0 (3)	5.0	3.6	3.4
B.	*hookerana*	4	1.0 (4)	1.0 (4)	5.0	3.5	3.5
B.	*lehmanniana*	3	1.0 (3)	1.0 (3)	5.0	3.0	4.0
B.	*nutans*	5	1.8 (2)	2.2 (2)	4.0 (1)	4.0	3.4
B.	*occidentalis*	5	1.0 (5)	1.8 (2)	4.2	3.2 (1)	4.0
B.	*prionotes*	5	1.0 (5)	1.0 (5)	5.0	3.6	3.4
B.	*quercifolia*	4	1.5 (2)	1.0 (3)	4.5	4.0	3.0
B.	*sceptrum*	5	1.0 (5)	1.0 (5)	4.8	3.8	3.4
B.	*verticillata*	5	1.4 (2)	2:8 (2)	5.0	3.2	2.6
B.	*victoriae*	4	1.2 (2)	2.0 (1)	4.5	2.8	4.0

[1] Average rating of the replicates
[2] Number of deaths

For the control treatment, (soil mix 1), plant death was observed with all species. All replicates of this treatment died in the case of *Banksia elderana*, *B. hookerana*, *B. prionotes* and *B. sceptrum*. High death rates were observed for *B. ashbyi*, *B. baxteri*, *B. lehmanniana* and *B. occidentalis*. For 11 of the 12 species a death rate similar to that observed in soil mix 1 was observed for soil mix 2. With these two treatments a yellowing, then browning, of the leaves (initially the older leaves), from the margin inward occurred. This was followed by leaf curl and death.

The most vigorous plants were those in soil mix 3. Plants in the two soil mixes containing additional lime, with the exception of *B. ashbyi* and *B. sceptrum*, showed severe chlorosis especially in the new growth. This yellowing disappeared within two weeks of the application of 2 grams of iron chelate and, within six weeks, these plants were performing as well as those in soil mix 3. In the case of *B. ashbyi* and *B. sceptrum*, plants in soil mixes 4 and 5 were, for the duration of the experiment, as vigorous as those grown in soil mix 3.

DISCUSSION

It is well recognized that the Australian flora has evolved in an environment low in phosphate and studies which have been undertaken on proteaceaous species emphasize their tolerance to low phosphate availability (1,4). Lamont (3) has suggested that the presence of proteoid roots permits very efficient extraction of nutrients, including phosphate, from the soil.

The plant deaths observed in soil mixes 1 and 2 clearly suggest phosphate toxicity. Further work is required to eliminate the possibility that factors other than phosphate were involved. This result, however, is in agreement with the findings recently reported by Webb (5).

The good growth rate observed in soil mixes 4 and 5, following the application of iron chelate, clearly shows that all species studied could be successfully grown in the presence of high calcium levels and at pH's in excess of 8. The present results, however, do not indicate any direct beneficial effect of calcium or high pH. Further work is in progress to clarify this and to investigate superphosphate, calcium and pH interactions. The results reported by Webb (5) were obtained using natural Canberra soils in comparison to our use of UC mixes. It has been shown that calcium inhibits *Phytophthora cinnamomi* (2) and high pH is known to reduce phosphate availability. It is possible that the calcium effect observed by Webb is an indirect one, acting via a control of phosphate or *P. cinnamomi* levels or other factors.

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NATIVE AUSTRALIAN PLANTS FOR INDUSTRIAL DEVELOPMENT

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By definition a native plant is one which occurs naturally in any given region. Thus Australian native plants are those which occurred prior to the invasion of the white man and his