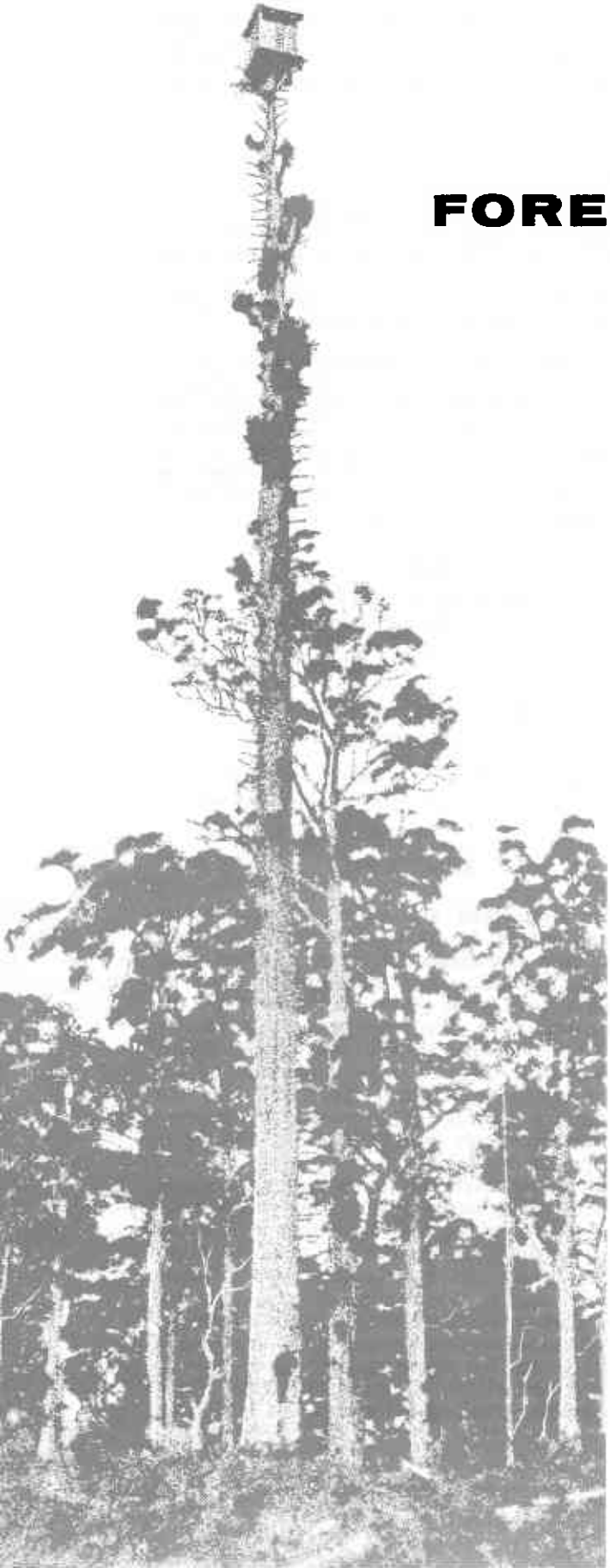

Research Paper No. 21

1976

FORESTS DEPARTMENT
OF WESTERN AUSTRALIA
54 BARRACK ST., PERTH

THE CAPACITY OF JARRAH FOREST NATIVE LEGUMES TO FIX NITROGEN

by

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SUMMARY

The mean nitrogenase activity of nodules from several jarrah forest native legumes varied from 8.22 n mol C_2H_4/g nodule fresh weight/min to 63.9 n mol C_2H_4/g fresh weight/min. The possible beneficial effect of native legumes in the jarrah forest ecosystem is discussed.

INTRODUCTION

Under a moderate-intensity control burning regime, native leguminous species occur only as a scattered understorey component in the jarrah (*Eucalyptus marginata* Sm.) forest, but following intense fires these species become dominant. For example, following the Dwellingup wildfire of 1961, large areas (approximately 25 000 hectares) regenerated with legumes—predominantly *Acacia pulchella* R.Br., *Acacia strigosa* Link. and *Bossiaea aquifolium* Benth.—forming a dense and continuous understorey. Apparently in many jarrah forest areas there is a large store of legume seed in the soil, which will germinate following high-intensity fire. McCormick (1971) has demonstrated that low-intensity burning will cause legume-dominated areas to revert to a shrub and understorey dominated by the family Proteaceae.

Lange (1959) has reported nodulation of jarrah forest legumes, but there has been no attempt to quantify their capacity to fix nitrogen. In this paper, the results of a pot trial, in which the nitrogenase activity and nodule weight of fertilized and unfertilized native legumes were measured, are recorded.

METHOD

The experimental design was factorial, consisting of six species (*Acacia pulchella, Bossiaea aquifolium, Acacia extensa* Lindl., *Mirbelia dilatata* R.Br., *Acacia strigosa* and *Acacia myrtifolia* Willd.) and two levels of fertilization replicated four times. The seed was pre-treated by being placed in boiling water and soaked for 24 hours. Four pre-germinated seeds were sown in 15 cm pots of lateritic soil which was free of *Phytophthora cinnamomi* Rands. The pots were regularly watered to maintain soil moisture levels at approximately field capacity.

Six months after sowing, half the pots were fertilized with superphosphate, potassium sulphate and trace elements at the following rates:

$Ca(H_2PO_4)_2H_2O+2(CaSO_4 .2H_2O)$ =
1000 kg/hectare.
K_2SO_4 =
125 kg/hectare.
Trace elements (B, Co, Cu, Fe, Mn, Mo, Zn, Mg) =
2.21 kg/hectare of each element.

The experiment was terminated 12 months after sowing. Total height of individual seedlings, total shoot dry weight and total nodule fresh weight were recorded. Samples of nodules were excised from plants in each pot, and their nitrogenase activity was determined by the acetylene reduction technique (Dilworth, 1966; Schollhorn and Burris, 1966).

RESULTS

Results are summarized in Figure 1. During the establishment phase, some *Bossiaea aquifolium* and *Mirbelia dilatata* seedlings died, therefore these species were excluded from the statistical analysis. The differences in average height, shoot dry matter production, nodule activity and nodule fresh weight were analysed statistically.

Fertilization significantly increased height and shoot weight of all four species ($P<0.01$). The nodule fresh weight of *Acacia pulchella* ($P<0.05$), *Acacia extensa* ($P<0.01$) and *Acacia myrtifolia* ($P<0.01$) was significantly increased by fertilization, but there was no significant effect on *Acacia strigosa* nodule weight.

Fertilization had no significant effect on the nitrogenase activity of *A. pulchella, A strigosa* and *A. myrtifolia* nodules, but depressed the nitrogenase activity of *A. extensa* ($P<0.05$) nodules. As already indicated, the set of treatments for *M. dilatata* and *B. aquifolium* was incomplete, but the mean nitrogenase activity of the nodules sampled is recorded in Table 1.

TABLE 1

Mean nitrogenase activity
(n mol C_2H_4/g fresh nodule weight/min)

	Unfertilized	Fertilized
Mirbelia dilatata	17.5	6.7
Bossiaea aquifolium	48.9	107.4

DISCUSSION

The widespread and dense regeneration of legume species, in areas where previously their occurrence was sparse, following the Dwellingup wildfire, indicates that these species are an important, if often latent, component of the forest vegetation. The mean nitrogenase activity of *Acacia pulchella* (63.9 n mol C_2H_4/g nodule fresh weight/min), the most widespread of the native legumes, compares favourably with the nitrogenase activity of a number of legumes recorded by Hardy *et al* (1973). It is difficult to extrapolate the data from this trial to the field situation. However, the capacity of some native legumes to fix nitrogen at relatively high rates gives weight to the hypothesis that, before fire was controlled in the forest, periodic high-intensity fires caused the regeneration of dense legume stands, which may have contributed significant amounts of nitrogen to the ecosystem. Standing bole volume in two remnant virgin jarrah forest stands has been recorded at 43 and 83 cubic metres per hectare (Forests Dept. unpublished Working Plans data). It is difficult

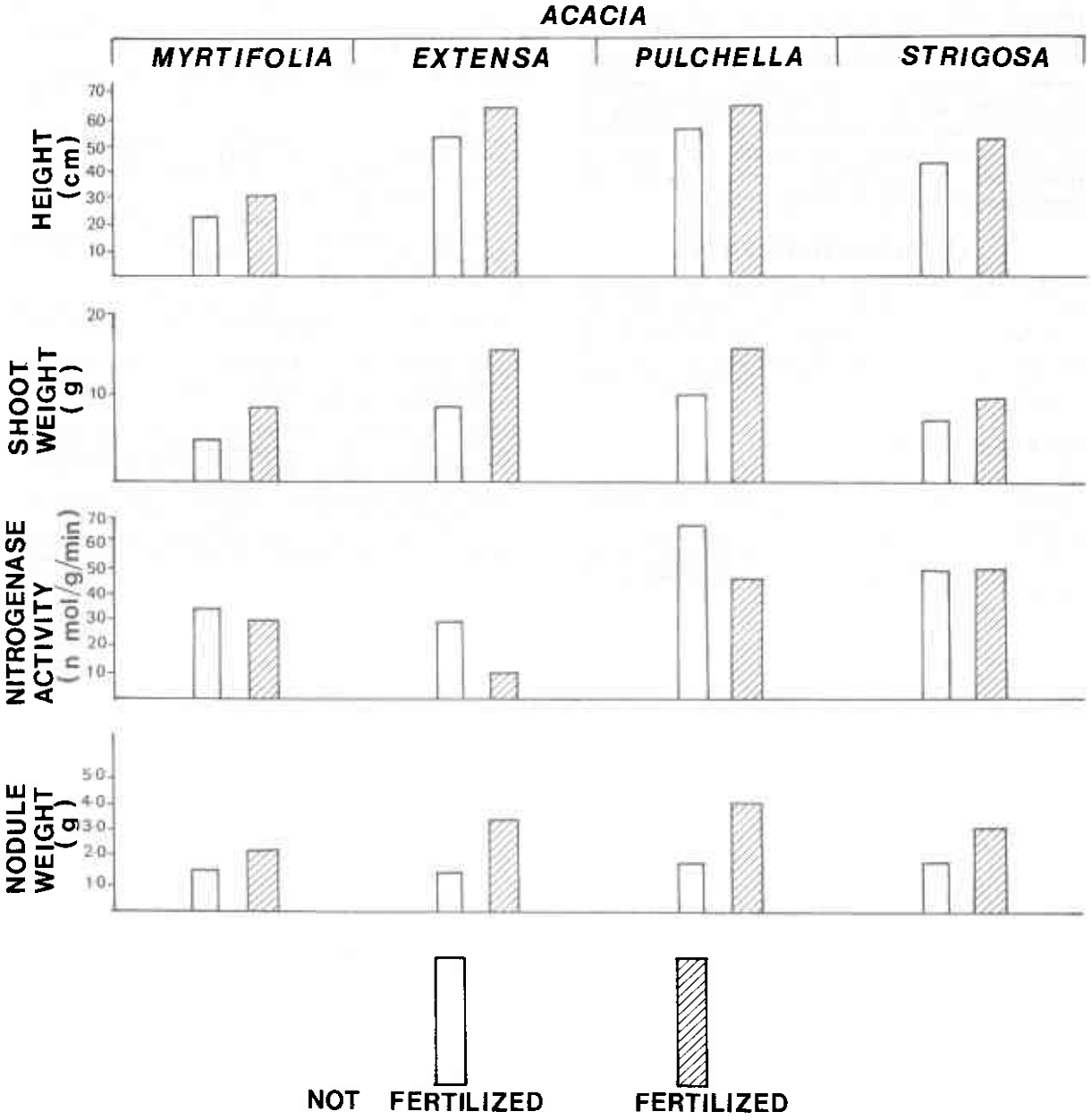

FIGURE 1: *Height, shoot weight, nitrogenase activity and nodule weight of four jarrah forest native legumes.*

to explain this high accumulation of dry matter in an environment from which nitrogen must be continually withdrawn as a consequence of frequent controlled or wild fire (Ovington, 1962; Vines *et al*, 1971) without the presence of a mechanism for inputs of nitrogen, although it has been shown (Hatch, 1959) that regular prescription burning did not cause a significant loss of nitrogen from the A1 horizon of jarrah forest soils.

Over a period of years, low-cost prescribed burning techniques have been developed for the jarrah forest (Peet, 1967), primarily to reduce fire hazard. Currently, the forest is burnt on a 5 to 7 year cycle to a prescription which is aimed at maintaining fire intensities at levels which ensure that no crown scorch occurs. Fire at these intensities does not cause germination of the legume seed stored in the upper soil profile. It is possible that the marked reduction of the native legume component of the understorey which results from this prescription burning programme has a long-term deleterious effect on forest nutrition.

In addition to the possible beneficial nutritional effects of legumes in the understorey, studies by Shea (1975) and Shea, Malajczuk and Kitt (report in preparation) indicate that soil

physical and microbiological conditions under dense legume stands are unfavourable for *Phytophthora cinnamomi*, a pathogen causing serious damage to the forest. A research programme which is aimed at determining if native legumes have significant beneficial effects on the jarrah forest ecosystems, and if it is practicable to regenerate native legumes by prescription burning, has been initiated.

ACKNOWLEDGEMENTS

Mr Jake Halliday, University of Western Australia Botany Department, carried out the acetylene reduction assays; Mr David Ward assisted with the statistical analysis; and the staff of the Dwellingup Research Station provided technical assistance.

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