Poster paper

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Factors Affecting Revegetation Success of Bulong Nickel Operation

K. S. George[A] and R.W. Bell*
School of Environmental Science, Murdoch University, Murdoch, WA 6150 Western Australia
rbell@central.murdoch.edu.au
[A] *Environment Branch, Department of Minerals and Energy, PO Box 10078, Kalgoorlie 6433*

Introduction

In many parts of the arid zone of Western Australia, regolith overburden is characterised by high levels of salinity and or sodicity (Osborne *et al.* 1996). In addition, on base metal mines, the overburden may still contain significant levels of the minerals of interest. In other cases, sulfide minerals in the overburden require special handling strategies to avoid acid mine drainage. Thus waste dumps containing overburden embrace a range of difficult constraints to revegetation. The chemical properties of two waste dump substrates derived from overburden and one sub-soil at Bulong Nickel Operation (BNO) were investigated to determine the nature of the material and its suitability for growth of the legume, *Acacia acuminata* ssp. burkittii and the salt tolerant blue bush, *Maireana pyramidata.*

Materials and Methods

Mining for nickel ore has commenced in several pits at BNO, 30 km east of Kalgoorlie. Topsoil was sampled in summer from a woodland site in an unmined area near the Mints stockpile. Sub-soil was sampled from an alluvial channel near the Albion pit. Samples were also collected from waste dumps of overburden from the Albion and Mt Lyall pits. Samples were analysed for chemical properties (Rayment and Higginson 1992).

Two kg (topsoil) or 1.7 kg (sub-soil and overburden) portions of sieved substrates (< 2 mm) were placed in pots lined with plastic bags. A 10 cm layer of topsoil collected from the same site as the substrate was placed over the sub-soil and overburden materials to aid seed germination. Soils were either unfertilised or treated with complete basal fertiliser (Jasper *et al.* 1988). Nutrients were mixed in the top 5 cm of the substrate. Pots were placed in temperature-controlled water baths at 25 °C, and substrates watered to 95 % field capacity daily. Ten seeds of local provinences of acacia and maireana were sown per pot. Plants were thinned after 2 weeks to two Acacia and three maireana. After 6 and 10 weeks growth, maireana and acacia, respectively were harvested for shoot dry matter and root fresh weight.

Results and Discussion

Most substrates tested at BNO were alkaline and sodic (Table 1). The Albion overburden was only mildly acidic, whereas topsoil was non-sodic (Purdie 1998). Some of the materials also contained high levels of exchangeable Mg that may exacerbate a tendency to dispersion. Exchangeable Ca levels varied greatly among the substrates with very low levels in the Albion overburden. The Albion sub-soil and overburden were marginally saline for most plants (Purdie 1998). Low levels of Colwell-extractable P were found in all the substrates (Purdie 1998) (Table 1). By contrast, NO3- N was low in topsoil and Mt Lyall overburden but quite high in the Albion sub-soil and overburden. Levels of other essential elements (K, S, Ca, Cu, Mn, Zn, Fe) were adequate for plant growth although levels of S in topsoil and Cu in Mt Lyall overburden were marginal (Table 1: data for K, Mn, Zn, Fe and Cu reported in George 1999).

Acacia failed to respond to fertiliser application in any of the substrates. In sub-soil and overburden, growth of acacia was strongly depressed compared to that in the topsoil (Table 2). This was linked to leaf necrosis on old leaves resembling a salt toxicity, and significant plant mortality. This suggests that the sodicity of the sub-soil and overburden was the major constraint to acacia growth and survival.

Maireana responded strongly to fertiliser on topsoil (Table 2). On Albion sub-soil and Mt Lyall overburden, shoot fresh weight responded to fertiliser but growth was depressed compared to that on topsoil, and plants were relatively stunted in appearance and pale. On Albion overburden, shoot fresh weight failed to respond to fertiliser and plants were stunted with yellowish older leaves. The poor growth of maireana on the Albion overburden and the lack of response to fertiliser is unlikely to be due to the salinity of the material since none of the EC values were high enough to limit growth of a halophyte (Purdie 1998). It cannot be attributed to sodicity since this was higher on Albion sub-soil and Mt Lyall overburden where growth responded to fertiliser.

Table 1. Chemical properties of topsoil (0-10 cm), sub-soil (100 cm) and overburden substrates from Bulong Nickel Operation.

	Topsoil	Albion sub-soil	Albion overburden	Mt Lyall overburden
Exch Mg (cmol/kg)	6	16	25	5
Exch Ca (cmol/kg)	13.0	14.8	1.66	0.31
Exch Na (cmol/kg)	0.6	25	24	9
ESP (%)	2.7	45	47	61
Electrical conductivity (1:5) (dS/cm)	0.04	0.53	0.34	0.19
pH ($CaCl_2$)	7.4	7.5	5.9	8.2
NO_3-N (mg/kg)	4	22	67	7
Organic C (g/kg)	15	5	3	0.4
Colwell P (mg/kg)	7	3	2	3
DTPA Ni (mg/kg)	11	Not determined	97	0.1
Extractable S (mg/kg)	7.3	730	900	220

The very high levels of DTPA extractable Ni and high levels of $CaCl_2$ extractable Ni (20 mg/kg vs 0.5 mg/kg in Mt Lyall overburden and topsoil) are the most likely factor accounting for poor growth of maireana on Albion overburden. Bergmann (1992) suggests that total nickel concentration of 100 mg Ni/kg soil is toxic to dwarf beans and oats and that addition of 2.5 mg Ni/kg soil is toxic at pH 4.7, whereas at pH 6.2, plants tolerate up to 75 mg Ni applied/kg soil.

Perhaps the most serious constraint to successful plant growth on the waste dumps at BNO is the inhospitable nature of the overburden. Potential limiting factors identified in some sub-soil and overburden materials were sodicity, salinity and high extractable Ni levels. Options available to revegetate the sodic, saline waste dumps would be seeding with salt tolerant halophytes (Osborne *et al.* 1996) and the use of gypsum and organic matter to ameliorate the poor physical structure of the material. However, it is most important that routine characterisation of the sub-soils and overburden materials at BNO be undertaken to identify more benign substrates within the mine waste steam for capping waste dumps prior to revegetation..

Table 2. Effect of fertiliser application on shoot fresh weight of maireana and acacia on topsoil, sub-soil and overburden materials. The fertiliser treatment had no significant effect on shoot fresh weight of Acacia, so only the main effect for substrates is presented.

	Topsoil	Albion sub-soil	Albion overburden	Mt Lyall overburden	LSD 0.05
			Maireana		
Unfertilised	1.8	0.1	0.1	0.2	
Fertilised	3.3	2.2	0.5	2.2	0.07
			Acacia		
Main effect	0.99	0.19	0.16	0.22	0.06

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