VOLUME 3b: COMMISSION II: POSTER SESSIONS

Transactions

15th World Congress of Soil Science
15 Bodenkundlicher Weltkongress
15ème Congrès Mondial de la Science du Sol
15° Congreso Mundial de la Ciencia del Suelo
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The Transactions of the 15 World Congress of Soil Science consist of 16 books. Volume 1 contains the Inaugural and the State of the Art Conferences. Volumes 2a to 8a contain the papers presented in the Symposia corresponding to Commissions I to VII, respectively. Volumes 2b to 8b contain the Extended Summaries of the papers presented at the poster sessions corresponding to Commissions I to VII, respectively. Volume 9 is a supplement containing papers not included in previous books.

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TRANSACTIONS

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Role of gypsum in revegetation of saline gold ore refining residues

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Introduction
Residues from gold processing in the eastern Darling Range in south-west Australia are deposited into storage dams as a slurry comprising 40% solids in saline process waters. The high salinity (10,000 to 15,000 mg/L) and fine texture (<90% less than 10 μm) severely limit revegetation options for the residue storage areas. In residue from bauxite refining, which is similar to the residue after gold extraction particularly with respect to salinity and alkalinity, Wong and Ho (1991) found that gypsum at 38.5 t/ha stimulated the growth of tall wheat grass in the field which supports the findings of Barrow (1982) that 5% gypsum is sufficient to neutralise its high alkalinity, pH 9-12. The present paper reports a preliminary investigation into the benefits of gypsum incorporation into gold ore processing residue to improve soil physical properties and ameliorate the salinity of the residue for the growth of four test species with a range of tolerances to salinity and waterlogging.

Materials and methods
Residue was treated with a factorial combination of three leaching rates (nil, 1000 mL and 2000 mL of H2O per pot) and two gypsum rates (nil, 2.5% w/w). Leaching rates were designed to simulate 75 and 150 mm of rainfall respectively, which equate to 50 and 100 %, respectively of the normal break of season rainfall at Boddington, southwest Australia. Residue was collected from the residue dam beach at Boddington and dried in the glasshouse. The dried residue was ground, sieved (4 mm), packed in 1.5 L pots at 1.45 kg per pot, treated with appropriate rates of gypsum, and then leached. Leachate was collected and analysed for electrical conductivity (EC), Na concentration and pH. Test species planted were the River saltbush (Atriplex amnicola), tall wheat grass (Agropyron elongatum), swamp paperbark (Melaleuca halmatuorum) and triticale (Tritosecale spp cv. Muir). Triticale and tall wheat grass were sown as germinated seeds at nine plants per pot. Saltbush and melaleuca were planted as potted seedlings at one plant per pot. Before transplanting saltbush and melaleuca roots were washed to minimise the carry over of soil into pots. Pots were watered daily to field capacity, and fertilised with liquid fertiliser. Paperbark was harvested at 10 weeks after transplanting and the remaining species at six. Shoots were cut at ground level, roots washed to remove residue and dried at 75 °C for dry matter determination. Residue at final harvest was sampled for EC and pH measurements using a 1:5 H2O extract (Fig 1). Gypsum incorporation improved the hydraulic conductivity of the residue.

In unamended residue, plant DM varied with the salt tolerance of the species, ranging from triticale which died to saltbush which yielded 50% of maximum plant DM (Fig. 2). Leaching the residue increased plant DM in all species. In saltbush, agropyron and melaleuca, the lower level of leaching removed sufficient Na to allow maximum plant growth. By contrast, in triticale, the least salt tolerant of the species, even at the highest leaching rate, productivity was strongly depressed. In all species, addition of gypsum completely counteracted the effects of sodium in the unleached residue.

Results
The unamended residue had an initial salinity equivalent to 600 mS/m and pH of 9.0. After addition of the equivalent of 75 mm of rainfall, gypsum decreased the pH in the leachate to 7.8, and increased EC to 720 mS/m: after the equivalent of 150 mm of rainfall, there was no further change in pH, but EC in the leachate decreased to 70 mS/m without gypsum and to 270 mS/m with gypsum. With amendment pH at final harvest decreased from 9.4 to 7.6 with gypsum alone and to 7.2 with gypsum plus leaching. Electrical conductivity also declined with leaching but increased with gypsum addition (Fig. 1).

Discussion
In unamended gold mine residue growth was very poor in all but the halophytic saltbush. Plant growth responded in all species to leaching of the residue suggesting that Na was only weakly adsorbed by the residue and readily removed by leaching. In this respect, the gold mine residue contrasts with bauxite residue (Wong and Ho 1991). Gypsum application replaced the need to leach the residue before planting and in the case of the salt sensitive triticale, was more effective in stimulating growth that leaching with the equivalent of 150 mm of rainfall. That gypsum increased EC of the residue while at the same time stimulating growth suggests that its main role was to increase Ca concentration in the soil solution, protecting membranes from high Na concentrations and depressing Na uptake (Cramer et al., 1985). Further investigations are under way to determine the extent to which improved physical
properties of the gypsum amended residue contribute to increased plant growth, and the efficacy of gypsum at higher levels of Na in the residue.

Fig. 1. Effects of gypsum (G-, nil; G+, plus) and leaching treatments on (A) the amounts of Na removed in leachate, and (B) the electrical conductivity of the residue at final harvest. Values are means of four replicates.

Fig. 2. Response of plant dry matter (DM) of (A) saltbush and (B) triticale to gypsum (G-, nil; G+, plus) and leaching treatment of goldmine residue. Values are means of three replicates.

References


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