BIOREMEDIATION OF SOIL ARSENIC AT A CONTAMINATED DIP SITE USING *PTERIS VITTATA*

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The widespread use of arsenic (As) compounds, particularly in dips, in Australia prior to 1986 has led to As being a major cause of toxicity to animals. Diagnostic records reveal a large number of cases where As residues in soil and water around old dips and chemical stores have caused cattle deaths. Subclinical intakes of As have implications for residue levels in meat and offal. Phytoremediation, the hyperaccumulation of toxic metals from soil by specific plants, may be an environmentally acceptable alternative to soil removal or exclusion policies. Recently, Ma *et al* (2001) reported that brake fern (*Pteris vittata*) could hyperaccumulate As. The aims of this trial were to determine the efficiency in removing As from soil at a dip site, and from As-spiked soil, by brake ferns growing continuously, or cut back regularly, and to determine their viability under extensive conditions.

Sixteen brake ferns were planted in each of 5 plots containing from 9 to 280 ppm As at a registered contaminated dip site near Jimboomba. At 8 weeks, half of the surviving ferns in each plot had all their fronds removed, and at 23 weeks, half of these were cut back a second time. Arsenic levels were determined in fronds on each occasion and at the end of the trial at 32 weeks. Plant growth and soil As levels were also measured. In a pot trial, (bush house experimental site), 4 ferns were planted in each of ten 40 L containers; 2 were controls, and 4 had 150 and four 250 ppm wet wt As added. They were sampled and cut back as above.

Table 1. The effect of soil arsenic (As) at a dip and experimental site on survival, biomass and As accumulation by *Pteris vittata* (see the text for details).

		Dip site					Bush house		
		Control[A]	Plot 1	Plot 2	Plot 3	Plot 4	Control	T150	T250
Soil As conc (ppm DM)		9.7	135	158	172	280	3.2	172	276
Frond Wt (g DM/fern)	UC[B]	10.4	20.2	24.2	26	26.9	26.1	30.9	26.3
Survival (%)	UC	13	63	63	88	100	100	100	100
	C1	0	38	13	38	13	50	0	50
	C2	0	13	13	13	13	0	0	25
Fern As conc (ppm DM)	UC	220	3860	4524	5186	2989	24	1880	2936
	C1	-	2868	5105	6593	6315	109	-	4531
	C2	-	5818	5159	4732	3341	-	-	5750
Total As removed	UC	2.3	77.8	109.6	134.7	80.4	0.6	60.2	78.8
(mg/fern)	C1	-	19.3	38.9	88.5	31.6	0.8	-	33.4
	C2	-	43.9	30.5	20.9	46.2	-	-	72.3

[A] Initial Frond Wt and As conc = 9.3 g and 2.2 ppm. [B] UC = uncut; C1 = cut back once; C2 = cut back twice.

Survival of uncut ferns was excellent in the bush house trial and reasonable at the dip site, except for the controls (Table 1). Cut ferns survived less well. Frond weight was not affected by As. Compared to controls, all of the ferns exposed to As accumulated significant concentrations of As in their fronds (Table 1). In the bush house trial, accumulation paralleled soil As levels. Total amounts removed per plant were up to 135 mg As, and As levels were often higher in ferns that were cut back, suggesting initial uptake was more rapid. However, frond weight (not shown) was much lower, such that total accumulation was always less than that of uncut ferns. In the bush house trial, the average amounts of As extracted by the uncut ferns in the containers having 150 and 250 ppm As added were equivalent to 10.7 and 8.4% of the load. Extraction at 8 wks was 3.1 and 2.6%, respectively. These pilot trials have shown that *Pteris vittata* can effectively remove significant amounts of As from contaminated soil in both experimental and extensive situations, and that uncut ferns accumulate As most efficiently. However, drought and unfavourable growing conditions compromised fern growth and survival, making it difficult to conclude whether this fern has any practical application in Australia.

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