Allelopathic substances may shape secondary chenopod communities on restored mine site waste material

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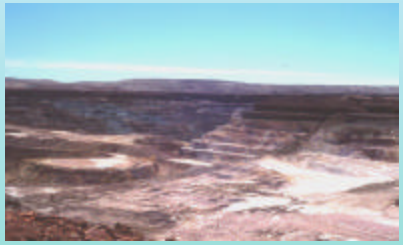

Fig. 1. Open pit mine.

INTRODUCTION

In current Western Australian mining practices (Fig. 1,2) waste rock on mine sites in semi-arid zones are often restored with salt tolerant plants of the family Chenopodiaceae . The seed mixture, broadcast over these disturbed areas is comprised of species with densities that are thought to reflect the resulting vegetation. This is not always the case, however. *Atriplex bunburyana* and *A. codonocarpa* often dominate restored areas. *Maireana georgei* and *Enchylaena tomentosa* are subordinant species within the resulting plant community.

Fig 2. Processing plant: gold is extracted from rock.

METHODS

Seedling Recruitment

Seed were tested for quality, viability and final germination percentage. Seed weight (number per gram) was also determined. Seed of the four chenopods were broadcast onto waste material at a density of 24 germinable seed per m ^{2}.

Plants were assessed five to six months (October, 1998) and 14 months (June, 1999) after seeding.

Allelopathy

The leaves of each species were dried and ground into a fine powder. Leaf powder was successively extracted with hexane, followed by dichloromethane, methanol and then deionised water. The aqueous extracts were tested on the seeds of each of the four species. Four progressively greater concentrations were tested.

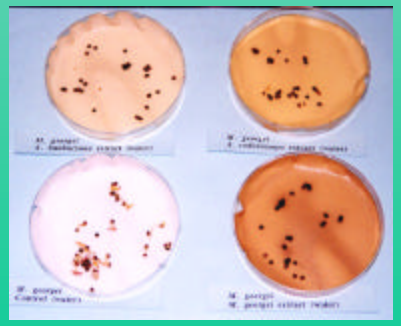

Fig. 3. *M. georgei* germination following treatment from the extracts of *A. bunburyana*, *A. codonocarpa* and *M. georgei* extracts.

RESULTS

Seedling Recruitment

***Atriplex bunburyana* and *A. codonocarpa* showed poor seedling establishment in comparison to *Maireana georgei* and *E. tomentosa* (Fig. 4). These results did not support observations of established community structure. Therefore, the effects of allelopathic substances on seed germination were explored.**

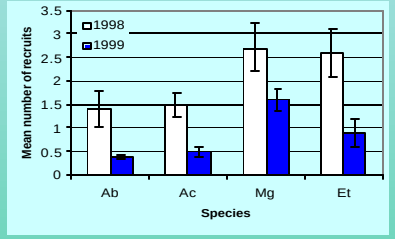

Fig. 4. The mean number of *A.bunburyana* (Ab), *A. codonocarpa* (Ac), *M. georgei* (Mg) and *E. tomentosa* (Et) recruits per m ^{2} in 1998 and 1999 when sown at a density of 24 germinable seeds per m^2.

Allelopathy

1. **Germination of *M. georgei* seeds was inhibited by leaf extracts of *M. georgei*, *A. bunburyana* and *A. codonocarpa* (Table 1).**
2. **Final germination of *E. tomentosa* was stimulated and RG increased when treated with *E. tomentosa* leaf extracts (Table 2). However, *E. tomentosa* germination was inhibited by A. *bunburyana* and *A. codonocarpa* leaf extracts (Table 2).**
3. ***A. codonocarpa* seed germination was only inhibited by extracts of its own leaves (Table 3).**
4. ***A. bunburyana* seed germination was inhibited by leaf extracts of the four species. Inhibition was greatest when treated with leaf extracts of *A. bunburyana* (Table 4).**

Table 1. *M. georgei* seed germination.

Seed Species	*Maireana georgei*		
Extract	Conc. (g/l)	FG %	RG
Mg	6.25	15_D	0.5_C
	3.12	42C	2.8B
	1.55	63B	4.2AB
	0.006	77AB	5.0_A
	p-value	*p<0.001*	*p<0.001*
Ab	6.25	5_D	0.2_C
	3.12	31C	2.0BC
	1.55	56B	3.8AB
	0.006	71AB	5.2_A
	p-value	*p<0.001*	*p<0.001*
Ac	6.25	4C	0.1C
	1.55	38B	3.1B
	p-value	*p<0.001*	*p<0.001*
Control		87A	6_A

Table 2. *E. tomentosa* seed germination.

Seed Species	*Enchylaena tomentosa*		
Extract	Conc. (g/l)	FG %	RG
Et	6.25	54_A	4.8_A
	3.12	57_A	5.9_A
	1.55	58A	5.5A
	0.006	75B	7.8B
	p-value	*0.044*	*0.019*
Ab	6.25	18B	1.3C
	3.12	44A	4.0B
	1.55	62A	6.3A
	0.006	59A	5.3A
	p-value	*p<0.001*	*p<0.001*
Ac	6.25	0B	0B
Control		59_A	5.9_A

Table 3. *A. codonocarpa* seedgermination.

Seed Species	*Atriplex codonocarpa*		
Extract	Conc. (g/l)	FG %	RG
Ac	6.25	10B	0.3B
Et	6.25	85A	6.7A
Mg	6.25	82_A	6.8_A
Control		86A	6.5A
	p-value	*p<0.001*	*p<0.001*

Table 4. *A. banburyana* seedgermination.

Seed Species	*Atriplex bunburyana*		
Extract	Conc. (g/l)	FG %	RG
Ab	6.25	8_C	0.4_D
Et	6.25	43_B	3.6_B
Mg	6.25	27_B	1.7_C
Control		67A	5.9A
	p-value	*p<0.001*	*p<0.001*

Key to tables: Final germination percentage (FG%) and rate of germination (RG) after treatment with extracts of *M. georgei* (Mg), *E. tomentosa* (Et), *A. bunburyana* (Ab) and *A. codonocarpa*(Ac).

DISCUSSION

Inhibition of germination of *M. georgei* and *E. tomentosa* may be detrimental to successive generations:

• delayed germination and retardation of seedling growth is detrimental to survival in a semi-arid environment, and

• smaller plants will be at a disadvantage when competing with others for limiting resources.

***A. codonocarpa* seed germination was not inhibited by leaf extracts from other chenopods and *A. bunburyana* seed germination was only slightly inhibited, providing evidence of at least one causal factor for their dominance.**

Inhibition of *A.bunburyana* and *A. codonocarpa* seed germination by the extracts from their own leaves may be a self preservation mechanism. Self-preservation reduces the likelihood of resource competition and self-pollination.