Essential Oil Production as an Incentive for Using Vetiver Grass in Phytoremediation of Soils Contaminated with Zinc or Copper

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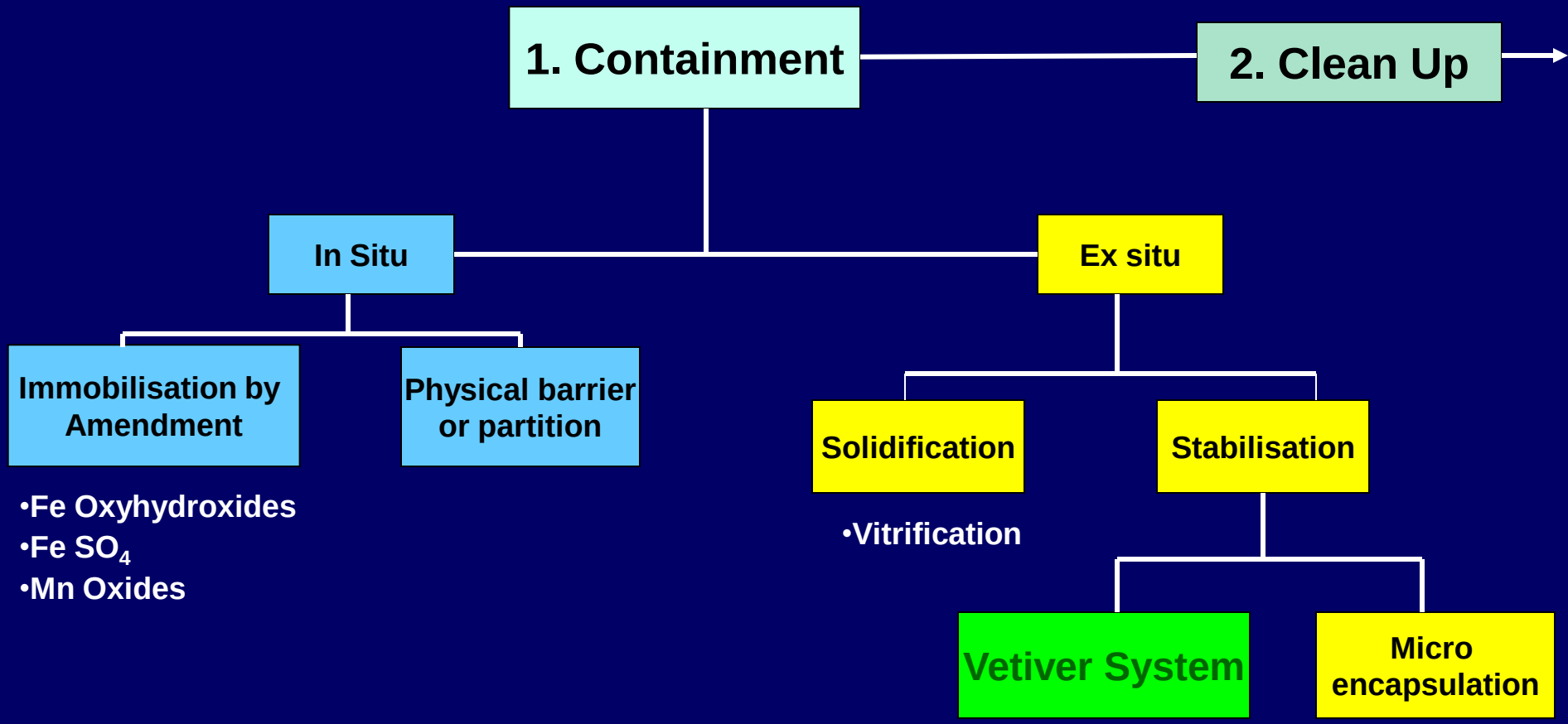
Principles of Treatment of Contaminated Sites



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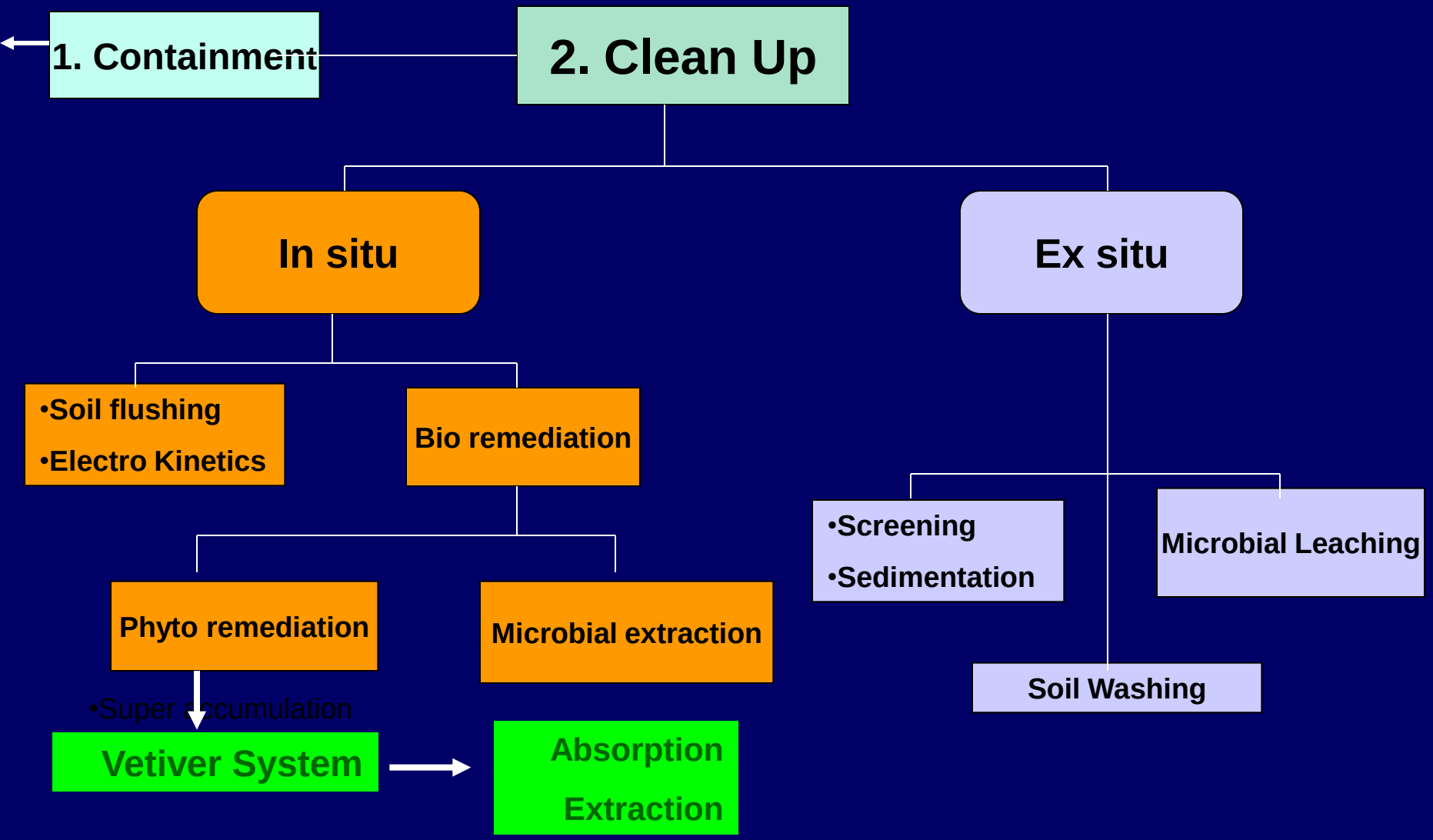


Vetiver System for Phytoremediation of Contaminated Soils

- **Extensive R & D conducted in Australia in the last 15 years have established bench marks for the use of vetiver grass for phyto-remediation of contaminated lands**

- **The following characteristics make vetiver grass highly effective for phyto-remediation of contaminated lands :**

- Vetiver is tolerant to highly adverse conditions such as saline, sodic and acidic soil conditions.

- Vetiver is highly tolerant to elevated levels of heavy metals in mine tailings

- Vetiver is tolerant to fire, frost, drought, water logging and inundation

Saline threshold level is at EC_e=8 dsm^{-1}, 50% growth reduction at 17.5 dsm^{-1}. Salt level of sea water is about 45-50 dsm^{-1} and vetiver can survive at 47.5 dsm^{-1} under dry land salinity conditions

Threshold levels of heavy metals to vetiver growth as compared with other species

Heavy Metals	Threshold levels in soil ($mgKg^{-1}$)		Threshold levels in plant ($mgKg^{-1}$)	
	Vetiver	**Other plants**	**Vetiver**	**Other plants**
Arsenic	100-250	2.0	21-72	1-10
Cadmium	20-60	1.5	45-48	5-20
Copper	50-10	Not available	13-15	15
Chromium	200-600	Not available	5-18	0.02-0.20
Lead	>1 500	Not available	>78	Not available
Mercury	> 6	Not available	>0.12	Not available
Nickel	100	7-10	347	10-30
Selenium	>74	2-14	>11	Not available
Zinc	>750	Not available	880	Not available

Vetiver thrives at soil pH=3.8 and Al saturation percentage of 68% and 87% under field conditions

pH	2.0	2.2	3.8	4.4	4.8	5.5	7.3	7.6
Al%	90	90	68	36	11	2	trace	trace

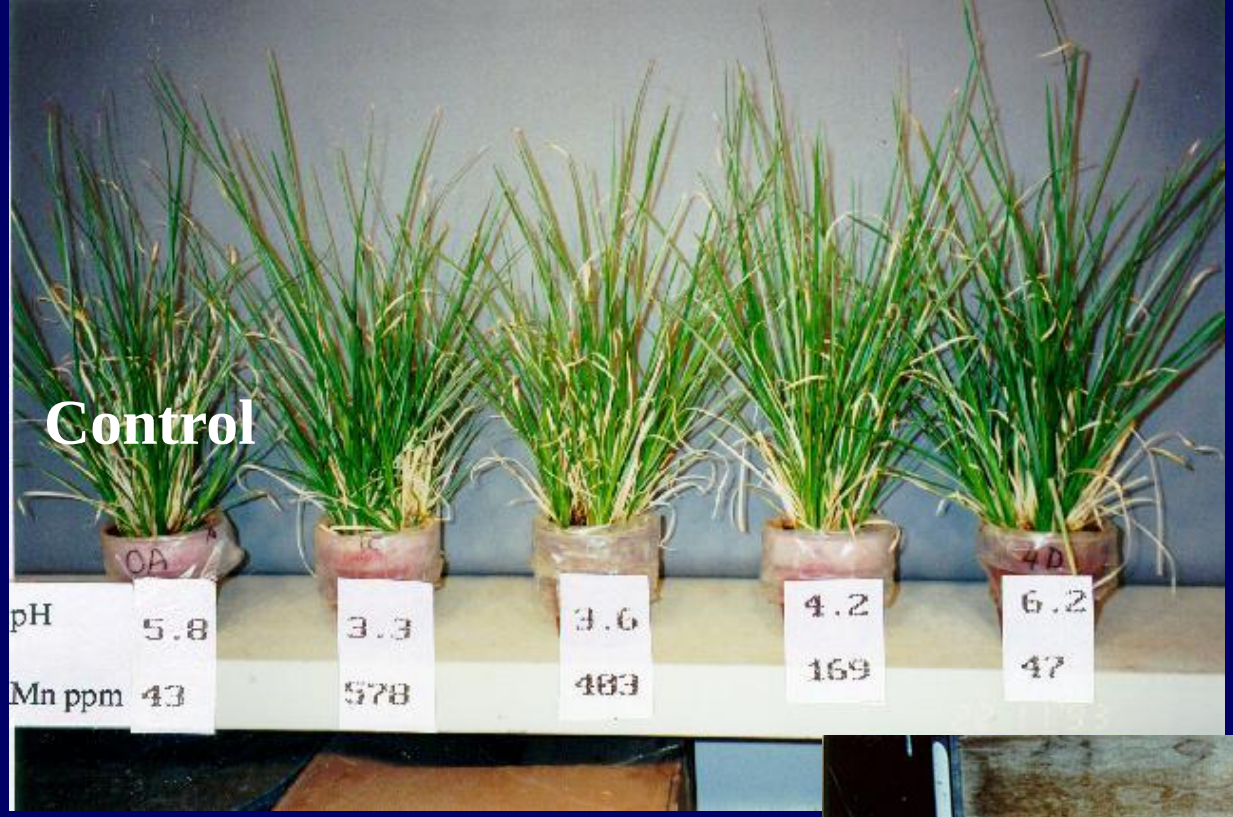
Highly erodible acid sulfate soil (pH 3.0) in coastal Australia

One year after planting

Copper: Toxic threshold level between 35-60 mg/kg

Zinc: Toxic threshold level higher than 750 mg/kg

Lead: Toxic threshold level higher than 1 000 mg/kg



Manganese: Growth was not affected at pH=3.3 and extremely high Mn level of 578 mg/kg

Arsenic: Toxic threshold level between 100-250 mg/kg

Chromium: Toxic threshold level between 200-600 mg/kg

Nickel: Toxic threshold level between 50-100 mg/kg

RESULTS AND DISCUSSION

1. Yield of Vetiver Oils

- In general, increments in the concentration of heavy metals corresponded to reduction of oil content and yield.

- Lead affected oil content even at low concentration, 500 mg Pb kg^{-1} dry soil, caused a 50% reduction in oil content compared with the control.

- The oil content of plants cultivated in soils contaminated with 1600 mg Cu kg^{-1} dry soil was reduced by about 73% compared with the corresponding control. Oil yield decreased with the increase of Cu concentration in soil.

The chemical composition of VG essential oil was almost unchanged by the application of Zn and Cu, but was significantly affected by Pb. Particula

2. Chemical Composition of Essential Oil

1. The chemical composition of VG essential oil was almost unchanged by the application of Zn and Cu,

2. But was significantly affected by Pb, as Pb concentration in soils increased, the khusimol content decreased whilst zizanoic and hexadecanoic acids content increased ,

3. The results can be explained on the basis that Cu and Zn are essential elements for plant growth and are involved in several metabolic processes . Excess levels of Cu and Z in plants may be directed toward such metabolic processes, hence their interference with other processes, such as essential oil synthesis, can be contained.

3. Heavy Metal Content in Essential Oil

1. Pb, Zn and Cu were not removed from the root tissues during the process of hydrodistillation.

2. The finding is consistent with other studies that heavy metals remain in the extracted plant residues in the process of oil extraction by hydrodistillation

3. confirming that oil extracted from VG grown on heavy metal contaminated soils can be acceptable in the market.

4. Effect of N on Oil Yield

1. **Oil yield was reduced as the level of applied nitrogen increased**

2. **The yield obtained from Pb control treatments (with high N content) being nearly seven times lower than that of Zn/Cu control (with low N content) .**

Phytoremediation of Mining Wastes

Coal tailings

Bauxite tailings

Bentonite tailings

Old gold tailings

Fresh gold tailings

Wind erosion and dust storm

Permanent wind barrier unaffected by strong winds

THANK YOU