VEGETATIVE COVER FOR PHOSPHOGYPSUM DUMPS: A Tunisian FIELD STUDY

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The treatment of phosphates for the production of phosphoric acid and fertilisers at Sfax, Tunisia, has resulted in the production of over 10 million tonnes of phosphogypsum per year. An environmental characterisation study followed by a risk assessment analysis performed on a source pathway- target basis has shown that phosphogypsum is characterised by residual acidity, elevated concentrations of sulphates, heavy metals and radionuclides (Sfar felfoul et al., 2002). Due to the lack of a vegetative cover aerial transportation of fine particles as well as solubilisation and migration of heavy and radioactive elements occurs contaminating surrounding soils, surface and ground waters (Kontopoulos et al., 1998).Therefore the application of a remediation scheme is considered necessary in order to prevent further contamination of the ecosystem in the area. The establishment of a vegetative cover on phosphogypsum stacks is considered as a viable option for the prevention of future environmental impacts.

In this work, the experimental study conducted in order to examine the establishment of a vegetative cover on phosphogypsum stacks is presented and discussed. The major part of this work is focused on the study of glasshouse pot experiments testing an annual plant, Helianthus annuus, which show tolerance and a potential for growth in such environments. Modification of substrates, in order to increase soil pH, add nutrients in the system and in general to provide the optimum growth characteristics for the specie planted, was performed by mixing phosphogypsum tailings with several additives such as clay, sewage sludge and clean soil in various modifications. Periodic investigations on plant growth and metal uptake in the substrates were carried out.

Substrate characteristics

All amendments selected for use contain, to a higher or lesser extent, sufficient amounts of extractable elements (Table 1). These results are in accordance with observations from other researchers (Patel et al., 1994). All have a beneficial effect in raising soil pH. The highest pH value recorded was 6.49 when all amendments were mixed with PG.

TABLE 1 Paste pH, electrical conductivity (mS/cm) and extractable elements for raw materials and mixtures (mg/kg)

Samples	pH	Electrical conductivity (mS/cm)	(mg/kg)						(g/kg)
			Cd	Zn	Fe	Na	K	Mg	Ca
PG	5,26	1,7	2,13	6,43	10,2	34	9,56	55,2	165
PG+C 50	5,77	1,5	2,08	6,46	13,9	33,3	14,1	66,2	172
PG +C100	6,36	1,4	2,07	6,47	14,8	35,1	14,9	69,5	173
PG + SS25	5,81	1,6	2,11	6,51	13,9	32,4	12,1	70,2	168
PG +SS50	6,48	1,5	2,1	6,52	15,2	34,2	13,3	72,4	174
PG+C100+SS50	6,49	1,4	2,14	6,51	18,3	35,3	14,7	83,2	187
FS + SS25	7,9	1,8	a	a	2,4	6,3	56	93,1	114
FS + SS50	8,2	1,9	a	a	3,1	7,5	57,9	94,6	132
FS	7,6	1,7	a	a	0,2	5,2	53,2	51	60

PG: phosphogypsum; C: clay; SS: sewage sludge; FS: flower soil

Plant growth characteristics

As it was mentioned previously plant growth intensity, as measured by recording the height of the planted species, the number of the branches and the leaves, as well as plant uptake in heavy metals and nutrients were recorded at specified time intervals. At the same periods all other characteristics of the substrates, including paste pH, electrical conductivity and remaining amounts of extractable elements were also recorded. These data after a test period of four months are presented in Tables 2.

The results obtained revels:

- Substrate pH and electrical conductivity in all tests is maintained at levels suitable for plant growth. Soil pH values have decreased slightly. In all cases soil pH was maintained at values higher than 4.5. Electrical conductivity values decrease steadily, apart from the tests involving the application of a soil cap.
- Sufficient amounts of extractable elements remain in the substrates after a period of 4 months. These remaining amounts of micronutrients show that plant growth will not be hindered in the following months.

TABLE 2 Extractable elements in substrates (mg/kg) after a period of 4 months

Samples	(mg/kg)					pH	Electrical conductivity (mS/cm)
	Cd	Zn	Fe	Na	K		
PG	1,1	4,13	5,5	16	3,4	5.1	1.3
PG+C 50	0,18	4,3	6,9	17,3	5,3	5.68	1.2
PG +C100	0,17	4,4	6,8	18,9	6,9	6.3	1.3
PG + SS25	0,13	4,2	8,2	17,4	4,6	5.6	1.4
PG +SS50	0,1	4,1	6,3	15,2	6,3	6.2	1.1
PG+C100+SS50	0,12	3,4	8,8	14,9	8,1	6.12	1.3
FS + SS25	[a]	[a]	0,4	2,7	43	7.32	1.8
FS + SS50	[a]	[a]	0,1	2,5	47,9	7,4	1,8
FS	[a]	[a]	-	1,2	44,1	7,7	1,9

PG: phosphogypsum; C: clay; SS: sewage sludge; FS: flower soil

References

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