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Pasture species behaviour on sulfide mine tailings rehabilitated with a designed Technosol

Diego Arán[1,2*]. Erika S. Santos[3]. Maria Manuela Abreu[3]. Juan Antelo[2]. Felipe Macías[1,4]

[1]Inproyen Consulting. Santa Comba. Spain. diegoaran@inproyen.com
[2]Instituto de Investigaciones Tecnológicas. Universidad de Santiago de Compostela. Spain
[3]Universidade de Lisboa. Instituto Superior de Agronomia. Linking Landscape. Environment. Agriculture and Food Research Centre. Lisbon. Portugal
[4]Universidad de Santiago de Compostela. Departamento de Edafología y Química Agrícola. Santiago de Compostela. Spain

INTRODUCTION: The uranium mineralization from Fé mining area (Spain) contains sulfides, resulting mine wastes generators of acid mine drainage rich in potentially hazardous elements (PHE). The improvement of the physicochemical characteristics and biogeochemical processes of sulfide mine tailings as well as their socioeconomic valorization can be achieved by the application of a green technology based on circular economy: **designed Technosol to the environmental problem**.

AIMS: i) To evaluate the efficiency of the application of a superficial layer of a designed Technosol to the rehabilitation of the sulfide tailings; **ii)** to assess the risk of the land recovery by this technology to pasture

Fig 1. Field assay: Mine tailing covered by designed Technosol layer

IMATERIALS & METHODS:

Field assay (≈625 m^2) in Fé mining area (Ciudad Rodrigo. Salamanca. Spain) → Application of a superficial layer (20 cm) of Technosol designed with andic and eutrophic properties (Fig. 1)

After 20 months:

- Technosol (<20 cm) *(Tec)*
- Recovered tailing below of Technosol (20-40 cm) *(RecT)*
- Mine tailing without recuperation (<20 cm) *(MT)*

→ **Chemical characterization:** pH, electric conductivity, fertility and PHE concentration in total and available fractions

→ **Microcosm assay:** *Lolium perenne* L. and *Trifolium pratense* L. under greenhouse conditions

→ **Plants characterization:** % plant cover, visual signs of phytotoxicity, dry shoots biomass and multielemental composition in shoots

*Values followed by * indicate significant differences (p< 0.05) between MT and RecT*

RESULTS:

Table 1. Chemical characteristics of the materials (average ± SD; n=3).

	MT	RecT	Tec
$pH_{(H2O)}$	4.3 ± 0.01*	4.5 ± 0.02*	7.7 ± 0.01
$pH_{(KCl)}$	3.4 ± 0.02*	4.1 ± 0.02*	7.6 ± 0.01
$C_{Organic}$ (g/kg)	<DL*	**3.3 ± 0.7***	40.4 ± 1.2
N_{Total} (g/kg)	0.4 ± 0.2	0.4 ± 0.2	2.6 ± 1.0
P_{Olsen} (mg/kg)	1.0 ± 0.1*	**16.2 ± 0.1***	97.9 ± 1.2
CEC ($cmol_c^+$/kg)	14.2 ± 6.7*	**26.1 ± 3.8***	41.0 ± 2.3

Table 2. PHE concentrations in available fraction of the materials (average ± SD; n=3).

	MT	RecT	Tec
Al	138 ± 1.2*	523 ± 71.6*	62.1 ± 1.1
As	<0.1	<0.1	0.1 ± 0.02
Ca	582 ± 27.3*	**2642 ± 489***	2449 ± 89.1
Cr	$(11.8 \pm 1.0)x10^{-2}$*	$(15.5 \pm 2.4)x10^{-2}$*	$(13.8 \pm 0.5)x10^{-2}$
Cu	0.4 ± 0.1*	**2.1 ± 0.6***	0.6 ± 0.02
Fe	24.7 ± 1.1*	**71.4 ± 1.9 ***	23.5 ± 0.9
K	18.0 ± 0.5*	**209 ± 3.1***	352 ± 20.5
Mg	1215 ± 148*	578 ± 84.5*	514 ± 24.2
Mn	227 ± 63.1*	53.8 ± 8.2*	1.0 ± 0.04
Na	67.3 ± 8.5*	194 ± 20.0*	197 ± 20.9
Ni	10.7 ± 2.4*	5.1 ± 0.6*	$<5.0x10^{-2}$
Pb	$<5.0x10^{-2}$	$<5.0x10^{-2}$	$<5.0x10^{-2}$
Zn	5.1 ± 0.7*	**11.1 ± 1.1***	0.1 ± 0.02

Mine tailing

- **High environmental risk**
- Total Cr concentrations (60.5 mg/kg), Mn (1.3 g/kg), Ni (103 mg/kg) and Zn (202 mg/kg) exceed limits for different land uses and protection of ecosystems
- **Negative effect on plant development of both species:**

  Total inhibition of *T. pratense* germination

  Very low germination (plant cover <0.1%) and plant development of *L. perenne* (Fig. 2)

Recovered tailing

- **Increase of organic C and concentrations of macro- and micro-nutrients in available fraction** (Tables 1 and 2)
- **Lower availability of Mg, Mn and Ni**
- **Stimulation of the germination (Fig. 2):** plant cover of *L. perenne:* 65% and *T. pratense:* 90%
- **Significant growth of both species** (Fig. 2) which was quite similar compared to Tec

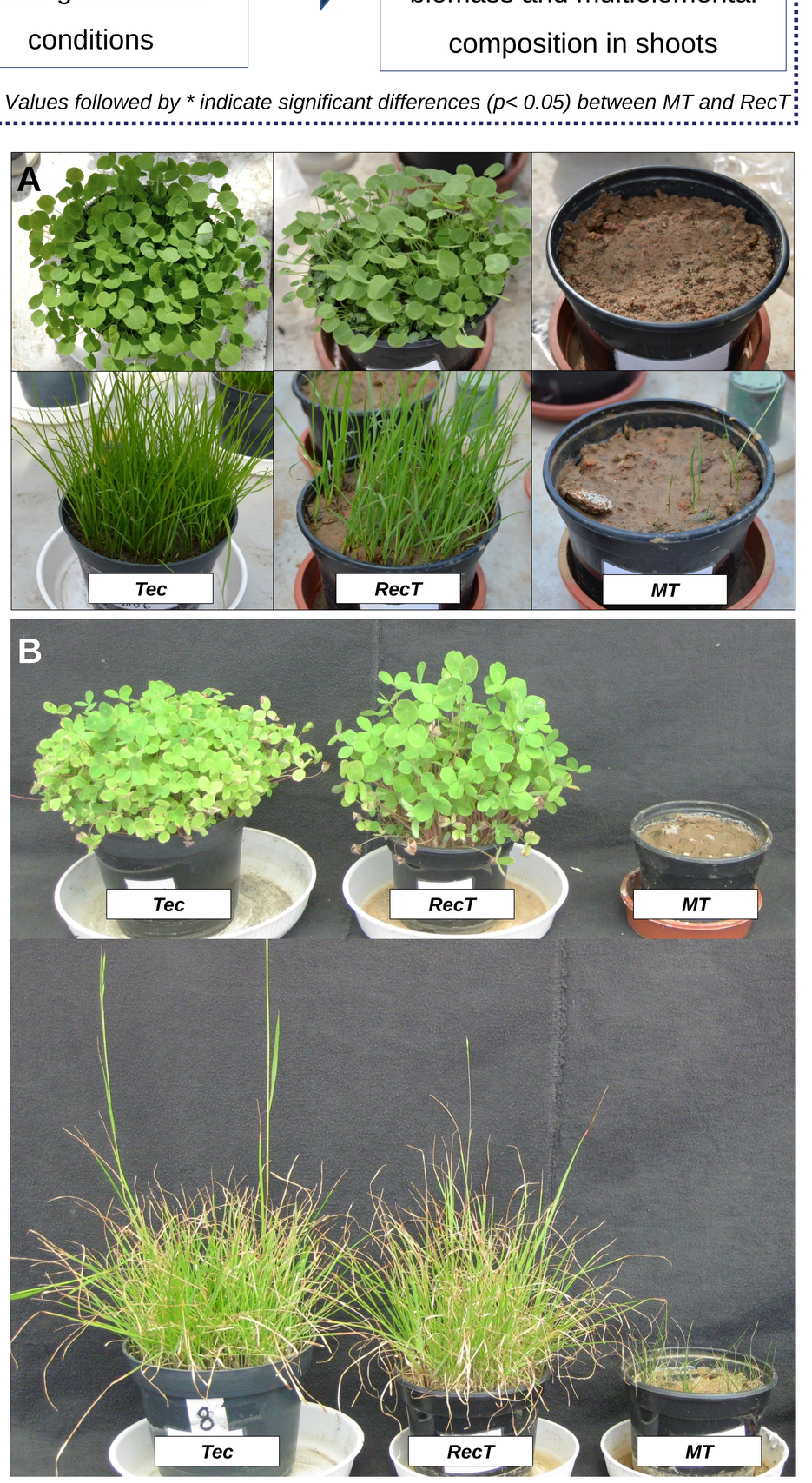

Fig 2. Plant development after one (A) and 2.5 months (B).

CONCLUSION: The application of designed Tecnosol on mine tailing with metal sulfides improved the chemical quality of its materials contributing to the establishment of a dense plant cover with significant development. The areas recovered with Technosol have potential to safe pastures.

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