21 June 2023

WPT3.1.5 Site specific report of the on-site demonstration for vegetal production and ecocatalyst synthesis – VIEILLE MONTAGNE

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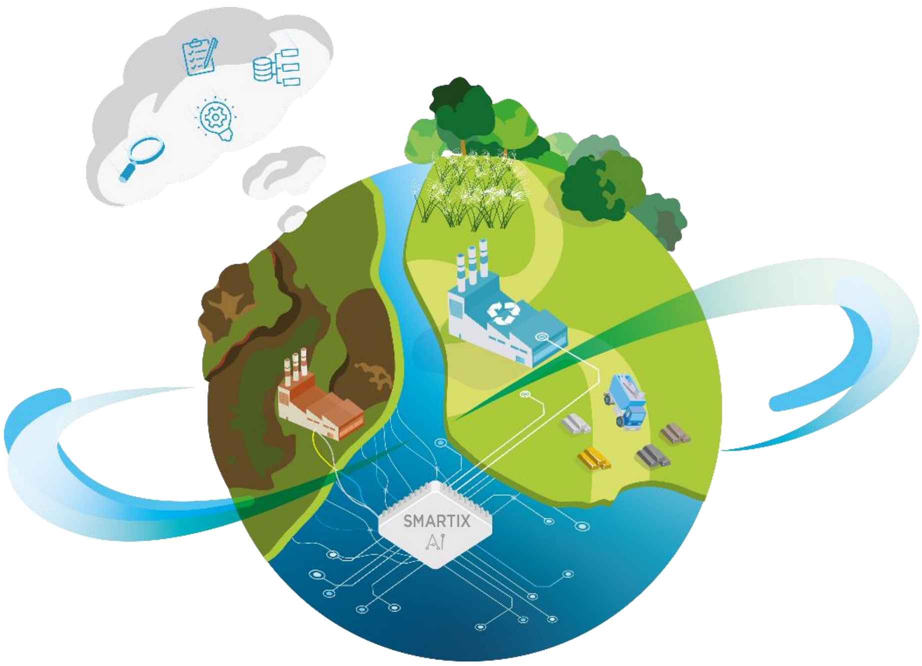

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EXECUTIVE SUMMARY

Based on ex-situ experiment realized with soils sampled from VIEILLE MONTAGNE, we selected an area considered as interesting to realise *in situ* experiment and ryegrass cultivation.

This deliverable explains the methodology employed to allow vegetal production on the VIEILLE MONTAGNE site. It described the construction condition of the experimental plots with soil preparation and ryegrass sowing.

1 SYNTHESIS OF EX-SITU EXPERIMENT

Greenhouse experiment has been realized with two soil samples collected from Vieille Montagne (VM2 and VM5). We evaluated the effects of two amendments: bone ash and hydroxyapatites.

The experiment revealed a quite good ryegrass development with high Zn (and Cd, Pb, Cu) concentrations in ryegrass. Bone ash and hydroxyapatites highly decreased Zn concentrations in ryegrass cultivated on VM2. Moreover, bone ash drastically decreased ryegrass biomass with the soil VM2. Cd and Pb concentrations in ryegrass were lower with the soil VM5 than with the soil VM2. Thus, it has been decided to launch *in situ* experiment at the location where VM5 was collected (for more information, see Deliverable DT2.3.2 *Report on lab pilot scale tests (1-25kg) for soil fertility treatment & ecocatalyst production potential undertaken on samples*).

2 SITE PREPARATION

2.1 EXPERIMENTAL DESIGN

The amendments tested in the greenhouse experiment were bone ash and hydroxyapatites. They were chosen because they have the ability to fix metals considered as undesirable for ecocatalyst production in the soil (e.g. Cd, Pb) while allowing the transfer of desirable elements from the soil (Zn) to the aerial biomass of the plant. Analyses of ryegrass biomass revealed high Zn transfer from soil to plants, with no effect of the amendments.

Thus, it has been decided to evaluate the ryegrass germination and metal transfer from soil to plant with the unamended soil only. This condition has been realized in triplicates (**Figure 1**). Ryegrass was sown at a rate equal to 180 kg $ha^{-1}$and each plot measured 6 m^2.

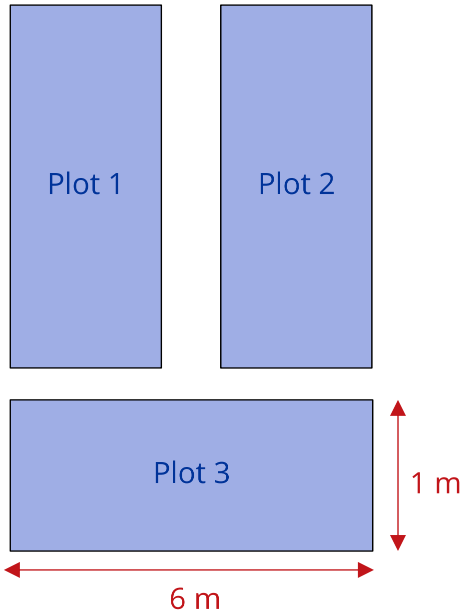

Figure 1: Experimental design on VIEILLE MONTAGNE site for ryegrass cultivation

2.2 SITE PREPARATION

Based on the greenhouse results, the *in situ* experiment has been realized on the VM5 area (**Figure 2**).

Figure 2: Location on VIEILLE MONTAGNE site for in situ experiment

Ryegrass cultivation has been launched the 12th of September 2022, following a soil preparation: a shovel excavated soil at a depth of 50 cm and then the soil was sieved with a wheelbarrow sieve (mesh size: 17 x 40 mm) and placed on the plots.

Figure 3 presents some pictures of the area preparation.

Figure 3: Soil preparation for ryegrass cultivation (12/09/2022)

3 RYEGRASS CULTIVATION AND HARVEST

3.1 RYEGRASS DEVELOPMENT

Regularly, SPAQUE checked the ryegrass development and took pictures. **Figure 4** presents ryegrass development during autumn 2022.

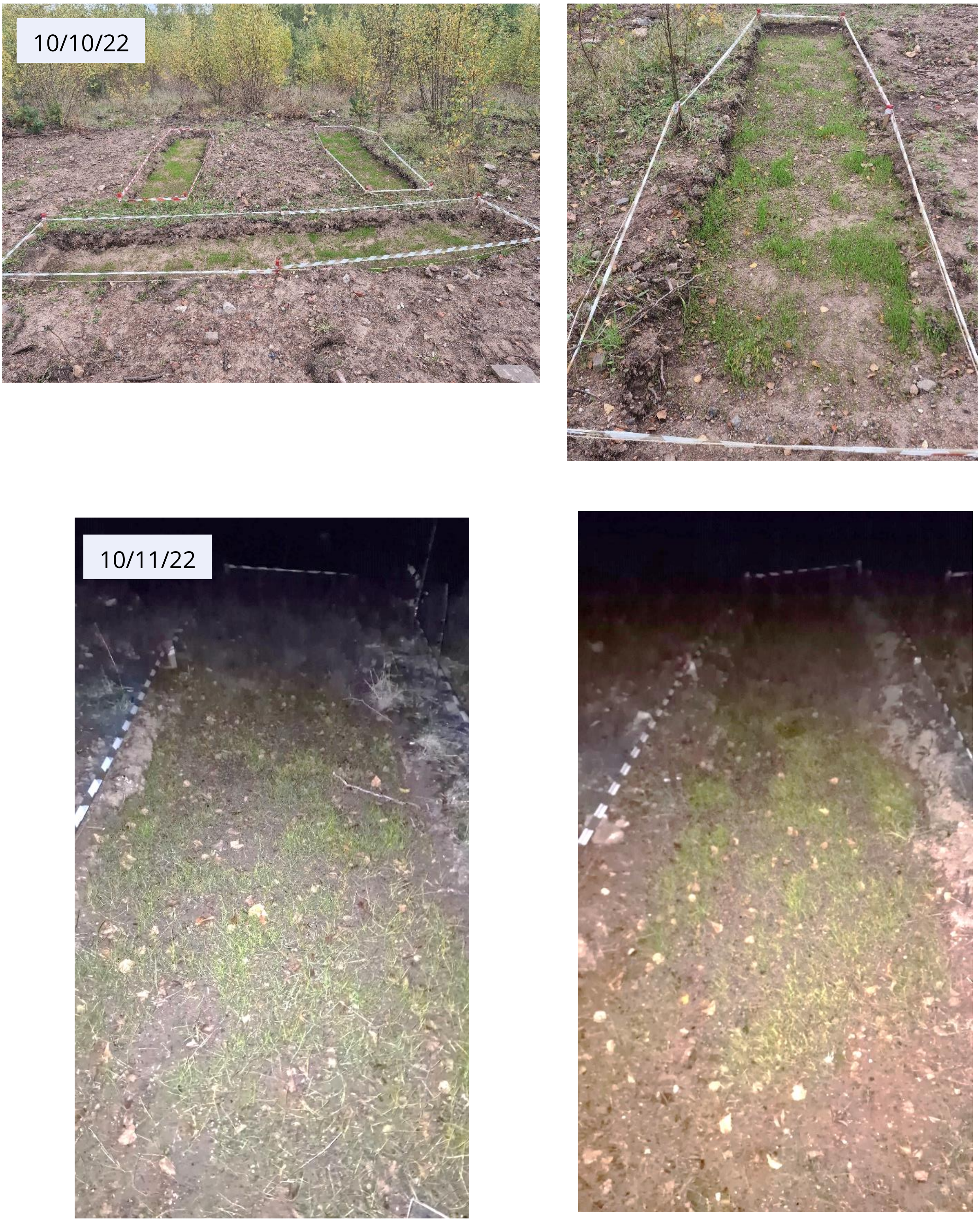

Figure 4: Ryegrass development during the autumn 2022

3.2 RYEGRASS HARVEST

Due to a slow ryegrass development and signs of phytotoxicity (yellowing of the extremities), it has been decided to collect ryegrass in order to measure their metal concentrations and evaluate the metal transfer from soil to plant.

Ryegrass harvest was realized the 17^{th} of November 2022. **Figure 5** presents the ryegrass development at this step.

Figure 5: Ryegrass harvest (17/11/2022)

After harvesting, ryegrass was washed three times (twice with tap water and once with osmosed water) and dried at 40°C (**Figure 6**). The concentrations of metals in the ryegrass shoots were determined by atomic absorption spectrophotometry after an acidic digestion with HNO_3 and H_2O_2.

The concentrations of Zn, Cd, Pb and Cu in ryegrass are presented in **Table 1**. The measured concentrations are high for all the plots, especially for Zn and Pb. Thus, it can be supposed a phytotoxic effects of metals on ryegrass.

Table 1: Metal concentrations (mg kg^{-1}) in ryegrass harvested in November

	Zn	Cd	Pb	Cu
	mg kg^{-1}			
Plot 1	987,10	4,85	124,67	9,17
Plot 2	1647,14	4,36	233,21	3,22
Plot 3	893,22	3,66	122,04	2,16

Moreover, in addition to the high metal concentrations in ryegrass, the weather conditions were not optimal for ryegrass germination and development. Indeed, after ryegrass sowing (September and October), rainfall was quite low and the soil was therefore dry. In November, the temperature tends to decrease, slowing down the ryegrass development.

A last site visit was realized the 14th of March 2023. **Figure 6** presents the ryegrass development at this step. This visit confirms the absence of ryegrass development during the winter.

Figure 6: Ryegrass development (14/03/2023)

4 Conclusion

Greenhouse experiment conducted with two soils from VIEILLE MONTAGNE allowed us to select one area (VM5) potentially interesting to cultivate ryegrass and extract Zn from soil to produce ecocatalyst.

Based on greenhouse experiment results, we evaluated ryegrass development on the site with no amendment. Soil preparation and ryegrass sowing were realized in September 2022. Signs of phytotoxicity appeared in November (low ryegrass development, yellowing) so a harvest was realized in November 2022 to measure metal concentrations in ryegrass. Results revealed high metal concentrations in ryegrass, explaining the sign of phytotoxicity observed. In addition, the weather conditions were not optimal for ryegrass germination and development. Indeed, after ryegrass sowing (September and October), rainfall was quite low, and the soil was therefore dry. In November, the temperature tends to decrease, slowing down the ryegrass development. The site visit, realized the 14th of March 2023, confirms the absence of ryegrass development during the winter.