The effects of organic waste soil amendments on above ground biomass of Reed Canary Grass (*Phalaris arundinacea*) grown at a historic Pb-F-Zn mine site

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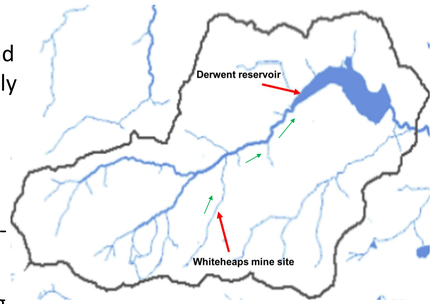
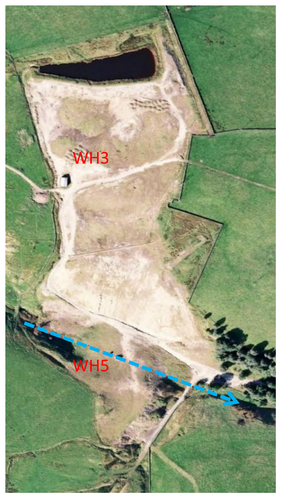
Background

- Historic metal mine tailings and spoil are typically too physically, chemically and biologically deficient for spontaneous re-vegetation.



- Studies focusing on the Upper River Derwent have highlighted the contribution of historic mining and mineral processing areas as sources of particulate and dissolved potentially toxic elements (PTE) entering river sediments.

Determined	Unit	WH3	WH5
pH	Value	6.7	7.1
Copper	mg/kg	545	890
Zinc	mg/kg	1852	5150
Lead	mg/kg	13873	9112
Arsenic	mg/kg	40.7	66.2
Cadmium	mg/kg	5.07	6.3
Nitrate Nitrogen	mg/kg	<1	<1
Ammonium Nitrogen	mg/kg	<1	<1
Totally Nitrogen	%w/w	0.09	0.14
Available Phosphorus	mg/l	<2.5	<2.5
Available Potassium	mg/l	30	34



- This study will conduct a two year field trial that aims to evaluate the potential of two organic waste soil amendments and a perennial native grass species, to immobilize PTE and stabilise impacted soils.
- In-situ biological and chemical stabilisation is increasingly considered the best option when managing the risks associated with historic mining [1].

Acknowledgments

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Reed Canary Grass (RCG)

- Quickly establishes a fine binding network of rootlets capable of stabilising soil
- Tolerant to biogeochemical conditions typically found at historic lead mine sites
- Tolerant to drought, frost and flooding events
- Tends to not translocate contaminants to the above ground parts of the plant
- Potential for use in the biofuel industry [2]

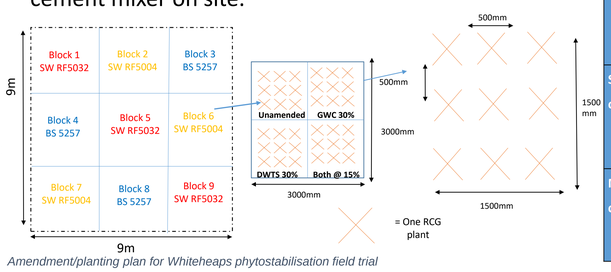
Cultivar	Cultivar traits	Seed origin
BS 5257	Game cover crop	Institute of Biological, Environmental and Rural Sciences – IBERS Aberystwyth
SW RF5004	Selected for high biomass and seed production for use in the biofuel industry	Lantmännen Lantbruk, Sweden
SW RF5032	Bellevue cultivar bred for vigour, seed retention and low alkaloid concentrations as a forage crop crossed with SW RF5004	Lantmännen Lantbruk, Sweden

Organic waste amendments

Determined	Unit	GWC	DWTS
pH	Value	8.2	5.2
Copper	mg/kg	72.1	27.8
Zinc	mg/kg	293	595
Lead	mg/kg	159	50.5
Arsenic	mg/kg	9.03	6.32
Cadmium	mg/kg	0.55	1.5
Nitrate Nitrogen	mg/kg	<10	<10
Ammonium Nitrogen	mg/kg	23.8	<10
Total Nitrogen	%w/w	1.23	1.07
Leachable Phosphorus	mg/kg	65.2	<0.01
Leachable Potassium	mg/kg	2629	194
Organic Matter	%	26.4	30.5

Experimental design

324 Plants planted in three types of amended soil and one unamended control soil on two sites(July 2019). Plant plugs grown under grow lamps in laboratory (3 seeds in each plug) for 8 weeks.
Amended soils homogenized with mine soils in a cement mixer on site.

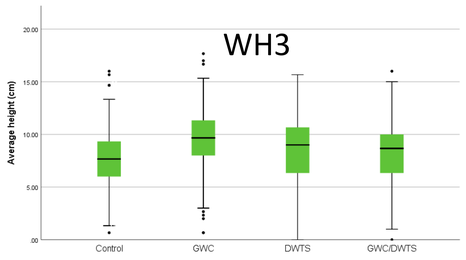


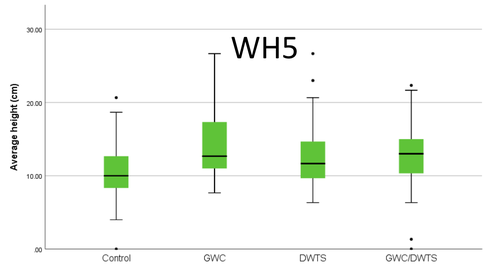
Amendment/planting plan for Whiteheaps phytostabilisation field trial

Criteria for evaluating phytostabilisation	
Plant criteria	• Biomass • Self-propagation of introduced plants • Establishment of native colonizers • Shoot metal concentrations • Plant survival and productivity maintained
Soil criteria	• Soil aggregation improved • Erosion and runoff reduced • Metal bioavailability and mobility
Microbial criteria	• Heterotrophic bacterial counts • Fungal counts

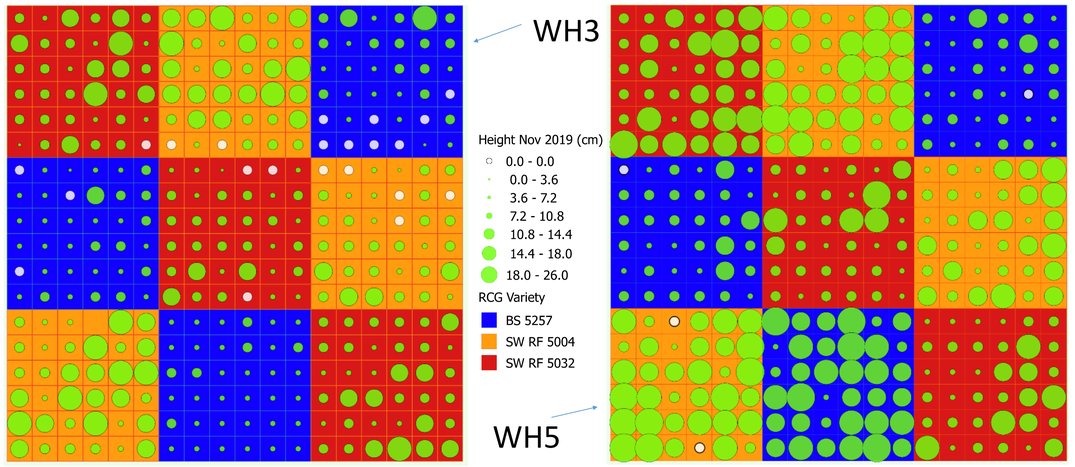
Results and discussion

Initial monthly monitoring data of RCG biomass at field trial sites began in August 2019. By November 2019 plant survival rates for WH3 and WH5 trials were 97.5% and 99.4% respectively. The greatest increases in height when compared to the plants growing in the unamended control on both trial sites was found in plants grown in mine soils amended with 30% GWC (amendment weight/soil weight) ($P<0.05$). For trial WH5, increases in the addition of all amendments resulted in a statistically significant increase in plant height ($P<0.05$).





Statistically significant increases ($P < 0.05$) in plant height were found for cultivars SW RF 5004 and SW RF 5032 when compared to BS 527 on site WH3. On site WH5 SWRF 5004 outperformed SW RF 5032 and BS 527 with significant increases ($P< 0.05$) in plant height. Data was analysed with SPSS (IBM) using a one way ANOVA - Bonferroni post hoc test.



Conclusion

It is clear that RCG and the amendments selected for this study can play a role in UK historic metal mine site remediation. Plant survival rates and significant effects of soil amendments provide a good indication that this field trial will deliver further results throughout its 2-year lifespan and a good opportunity to assess the effects of the phytostabilisation remediation strategy selected.

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References

[1] Bolan N, *et al*. Journal of Hazardous Materials. (2014), 266, pp.141-166
[2] Lord RA. Biomass and Bioenergy. (2015), 78, pp.110-125