J. Krzyżak[1], M. Pogrzeba[1], S. Rusinowski[1], J. Clifton-Brown[2], J.P. McCalmont[2], A. Kiesel[3], A. Mangold[3], M. Moś[4]

[1]Institute for Ecology of Industrial Areas, Katowice, Poland, j.krzyzak@ietu.pl
[2]Institute of Biological, Rural & Environmental Sciences, Aberystwyth University, United Kingdom
[3]Biobased Products and Energy Crops, Institute of Crop Science, Hohenheim University, Germany
[4]Terravesta Ltd., United Kingdom

CAN MARGINAL LANDS HELP TO SECURE THE BIOMASS DEMAND OF THE EUROPEAN BIOECONOMY?
PERFORMANCE OF *MISCANTHUS* ON CONTAMINATED ARABLE LAND

INTRODUCTION

Presence of heavy metals (HMs) in the soil is a common environmental phenomenon, especially in the areas affected by past mining and smelting industries. Such areas are usually highly contaminated and consequently, influence cultivated crops. Therefore, if these contaminated areas are considered for arable land, precautions should be taken and when the limits for HMs content are exceeded, such areas have to be excluded from agricultural production for food and feed purposes. Biomass production using perennial plants for energy purposes may offer an alternative; such an approach could provide multiple benefits in terms of both degraded land management, as well as phytoremediation, due to the stabilization or extraction of toxic elements by plants.

MATERIALS AND METHODS

The experiment was carried out on contaminated arable land in Southern Poland (50°20'43.1"N 18°57'17.9"E). The soil was contaminated over the last century with zinc, cadmium and lead dust fall, resulting from nearby Pb/Zn smelting. Total soil HMs exceed the maximum threshold values (Table 1), excluding this area from food production. Four interspecific hybrids of *M. sinensis* and *M. sacchariflorus* were planted and the commercial *M. × giganteus* was also established as comparison, each in randomized triplicates. Each plot (25m^2) was planted with a density of 2 plants per m^2. At the end of the growing season plant biomass was collected (green harvest in Autumn and brown harvest in late Winter) to assess the yield and concentration of lead, cadmium and zinc in aboveground parts of the plants.

Table 1. Soil characteristic

Soil parameters	Value
pH	6.47 ± 0.03
EC (µS/cm)	90.63 ± 3.32
Organic matter (%)	5.00 ± 0.11
Texture	silty clay-loam
Total heavy metal concentration (aqua regia extraction, mg kg^{-1} d.w.)	
Pb	527 ± 21
Cd	19.9 ± 1.0
Zn	2769 ± 301
$CaCl_2$ extractable metal fraction (mg kg^{-1} d.w.)	
Pb	0.03 ± 0.01
Cd	1.35 ± 0.05
Zn	84.0 ± 5.6

RESULTS

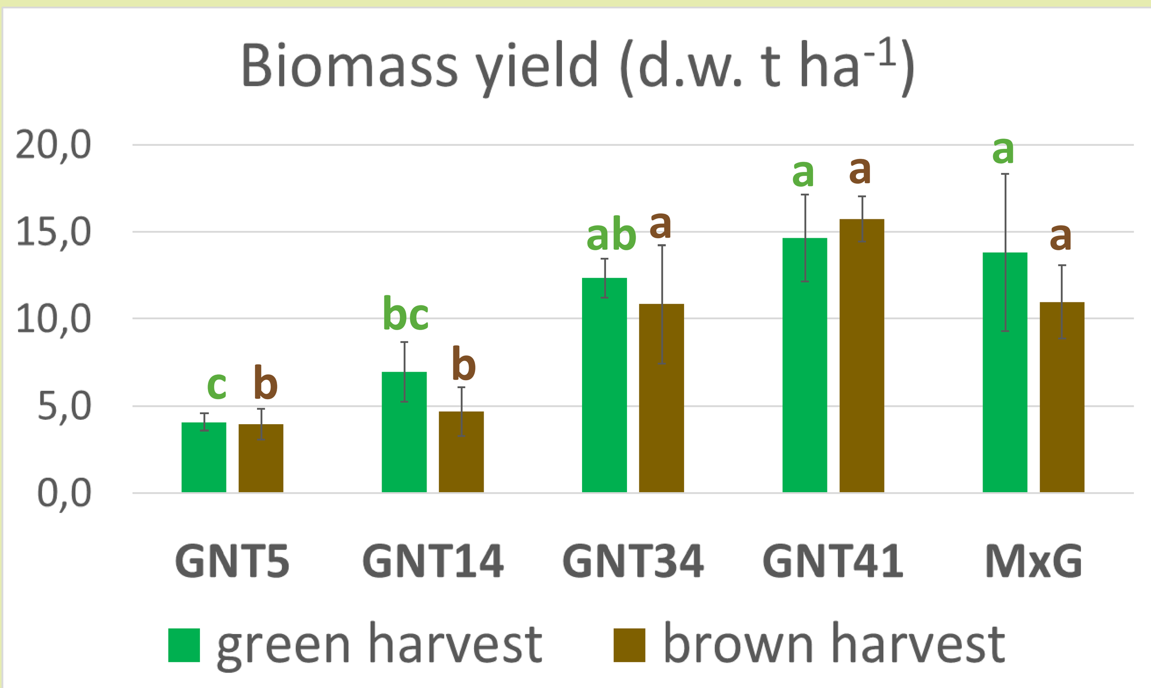

Figure 1. Biomass yield after the second growing season. Letters denotes significance between genotypes, (n=3).

The highest yield was found for GNT34, GNT41 and MxG, while GNT5 and GNT14 produced significantly lower amount of biomass (Fig 1). Taking into account unfavorable soil conditions (heavy metals presence), yield after the second growing season about 15 tones of dry matter per hectare seems to be very promising. No statistically significant differences were found between Autumn and Winter harvest.

All tested genotypes, including MxG, showed low concentration of lead cadmium and zinc in the aboveground biomass (Fig. 2). Lead concentration was significantly lower for seed-based hybrids in Autumn harvest, when compared to Mxg, while reverse phenomenon was found during the Winter one. The highest concentration of Cd was found for GNT14 in the Winter biomass, while no significant differences in Zn concentration were found between the tested genotypes and time of harvest.

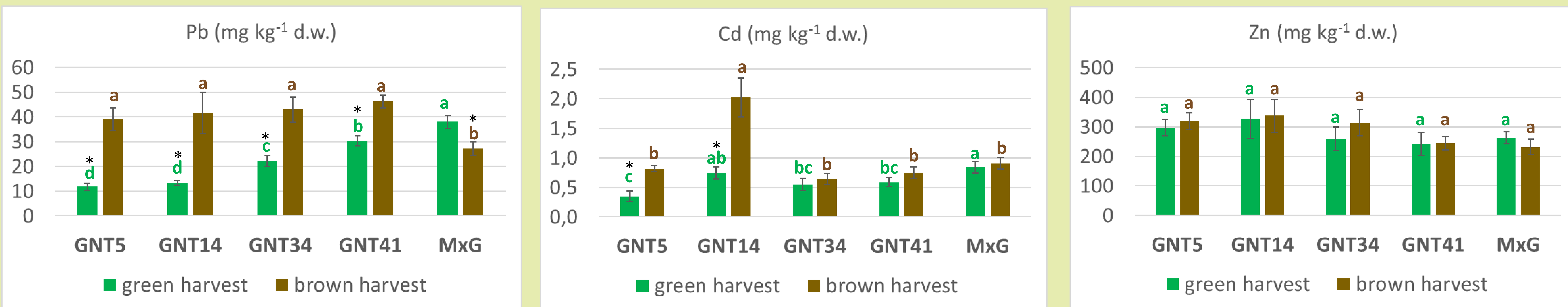

Figure 2. Concentration of lead, cadmium and zinc in aboveground part of plants. Letters denotes significance between genotypes, while asterisks between harvest time within the genotype, (n=9).

CONCLUSIONS

Based on the obtained results it could be concluded, that tested seed-based hybrids could be successfully cultivated at heavy metal contaminated arable land. Obtained high yield, especially for GNT34 and GNT41 did not differ from standard MxG. Level of contaminants in the aboveground biomass did not influence suitability for biogas production (methane specific yield) and combustion (ash melting behaviour), what was confirmed in the tests within MISCOMAR project. However, residues management after those processes should be further investigated.

Funding
FACCE SURPLUS SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 652615.
Partners
Aberystwyth University
University of Hohenheim
IETU
Co-Funding
Federal Ministry of Education and Research
The National Centre for Research and Development
defra