Test results on heavy metal uptake at German site after 2nd vegetation season

PHYTO2ENERGY

Phytoremediation driven energy crops production on heavy metal degraded areas as local energy carrier

This project has received funding from European Community´s 7th Framework Programme (FP7/2007-2013) under Grant agreement 610797.

Phyto2Energy project partner Vita 34 AG, Business Unit BioPlanta

- interdisciplinary team consists of scientists, engineers, laboratory assistants and technicians
- more than 20 years experiences in development and use of bio- and phytotechnologies
- developed technologies were awarded with several innovation prizes
- realization of projects worldwide



This project has received funding from the European Union's 7th Programme for research, technological development and demonstration under grant agreement *No* 610797

Member of research and business networks

- National delegate in the **EU-COST (European Cooperation in Science and Technology)** intergovernmental framework for European Cooperation in Science and Technology
- Vice presidency of the **IPS (International Phytotechnology Society**) worldwide society of individuals and institutions engaged in the science and application of using plants to deal with environmental problems
- Board member of **Biosaxony (Biotech Network Saxony)** network consisting of the political sector, the financial economy, technology and industry

cost
EUROPEAN COOPERATION
IN SCIENCE AND TECHNOLOGY

INTERNATIONAL
PHYTOTECHNOLOGY
SOCIETY

biosaxony

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Company profile

- since 1992 selection and mass propagation of plants for:
  - production of active pharmaceutical ingredients
  - biological treatment of water, soil and sewage sludge (phytoremediation)
- special know-how in biological treatment of water using Constructed Wetlands
- actual international projects in Poland, Hungary, Mexico, China, Vietnam, Brazil




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Phytoremediation of heavy metal contaminated sewage sludge I

- former sewage dewatering plant, north to Leipzig, Germany
- about 56 ha, about 800,000 m³ sewage sludge (1952 – 1990)
- sewage sludge mainly polluted with metals (Cd, Cr, Cu, Ni, Pb, Zn)

Contaminant	Target value [mg/kg]	Sewage sludge [mg/kg]
lead	150	580
cadmium	5	31
chromium	250	590
nickel	100	47
mercury	2	3
copper	100	1,000
zinc	500	3,200
phenols	1	2

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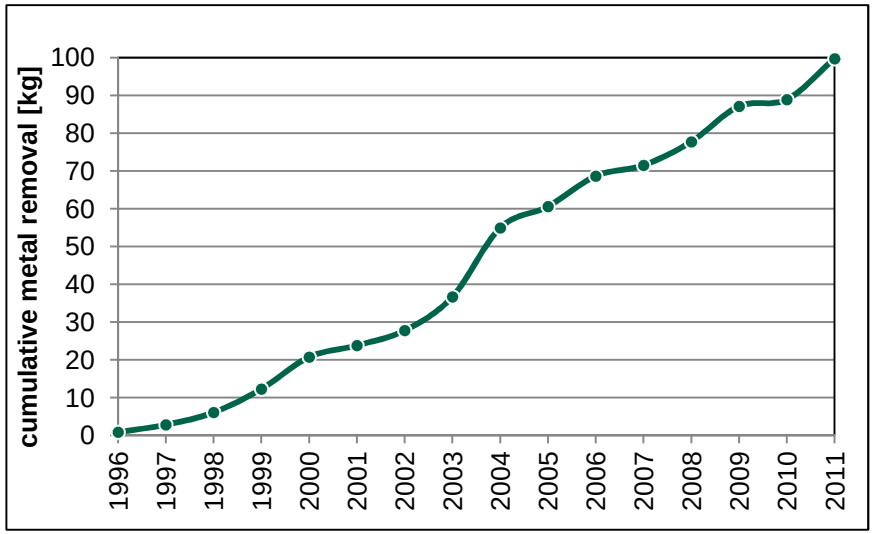
Phytoremediation of heavy metal contaminated sewage sludge II

- biological sludge covering with reed, plant cultivation on coconut fiber mats
- removal of heavy metals by harvesting plants
- humification of sewage sludge by biological processes
- cultivation of reed & sun flower in 2007 - 2008, reed & maize in 2009 – 2011
- within 15 years
  - ✓ 1.1 kg lead
  - ✓ 0.5 kg cadmium
  - ✓ 0.4 kg chromium
  - ✓ 4.4 kg copper
  - ✓ 0.7 kg nickel
  - ✓ 92.6 kg zinc

  were removed



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Resulting Phyto2Energy project

- establishment of plot experiments and first sampling in 2014
- 20 experimental plots, 16m^2 each, 4 m buffer zone
- 4 different plant species: Miscanthus x giganteus, Sida hermaphrodita, Panicum virgatum, Spartina pectinata
- objective: selection of energy crop species suitable for biomass production and phytoremediation purposes of HMC sites

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Design of field trial

1. control (no additives),
2. NPK standard fertilization,
3. Inoculum I addition in 2014,
4. Inoculum II addition (new established inoculum) in 2017,
5. Innoculum I addition in 2017 (as a control for the same conditions for inoculum I addition)

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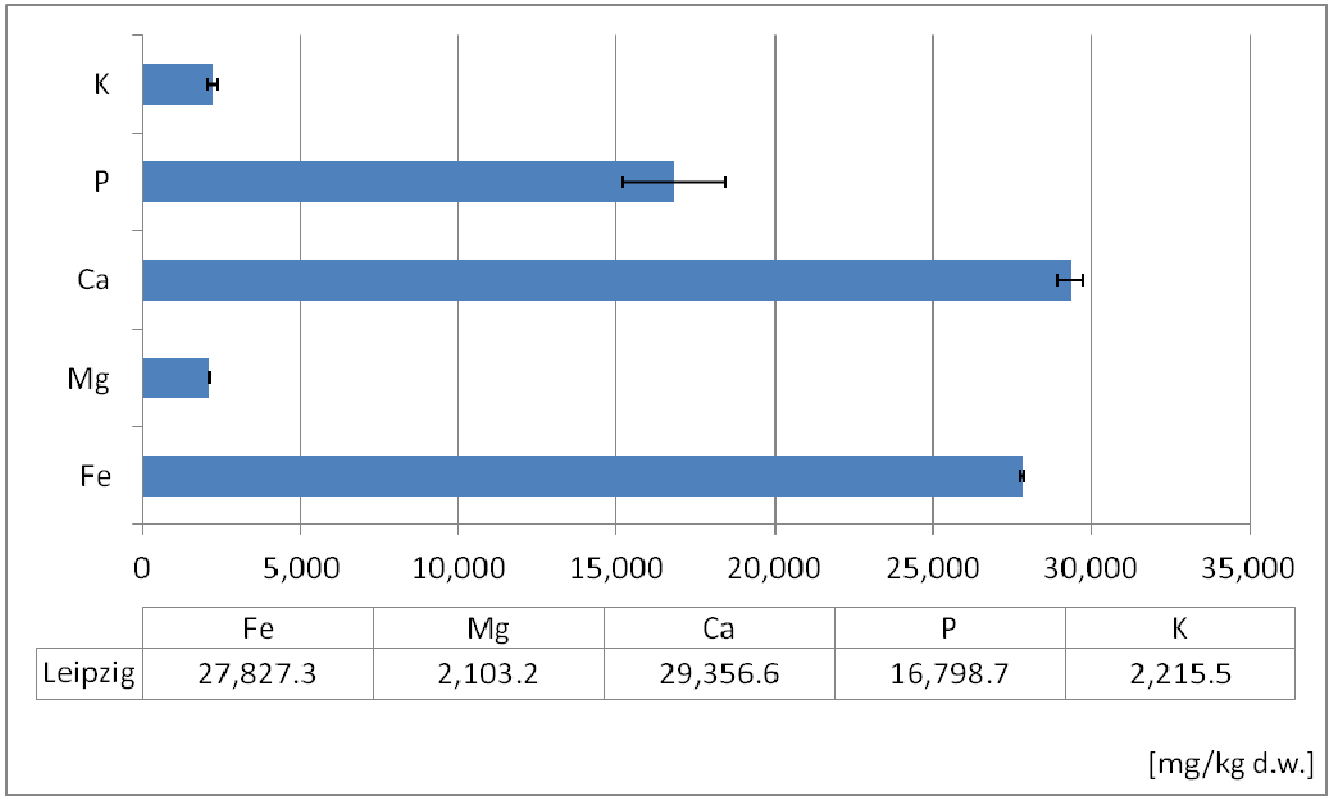
Soil properties (macronutrients)



	Fe	Mg	Ca	P	K
Leipzig	27,827.3	2,103.2	29,356.6	16,798.7	2,215.5

[mg/kg d.w.]

Values are means ± SD (n=20)

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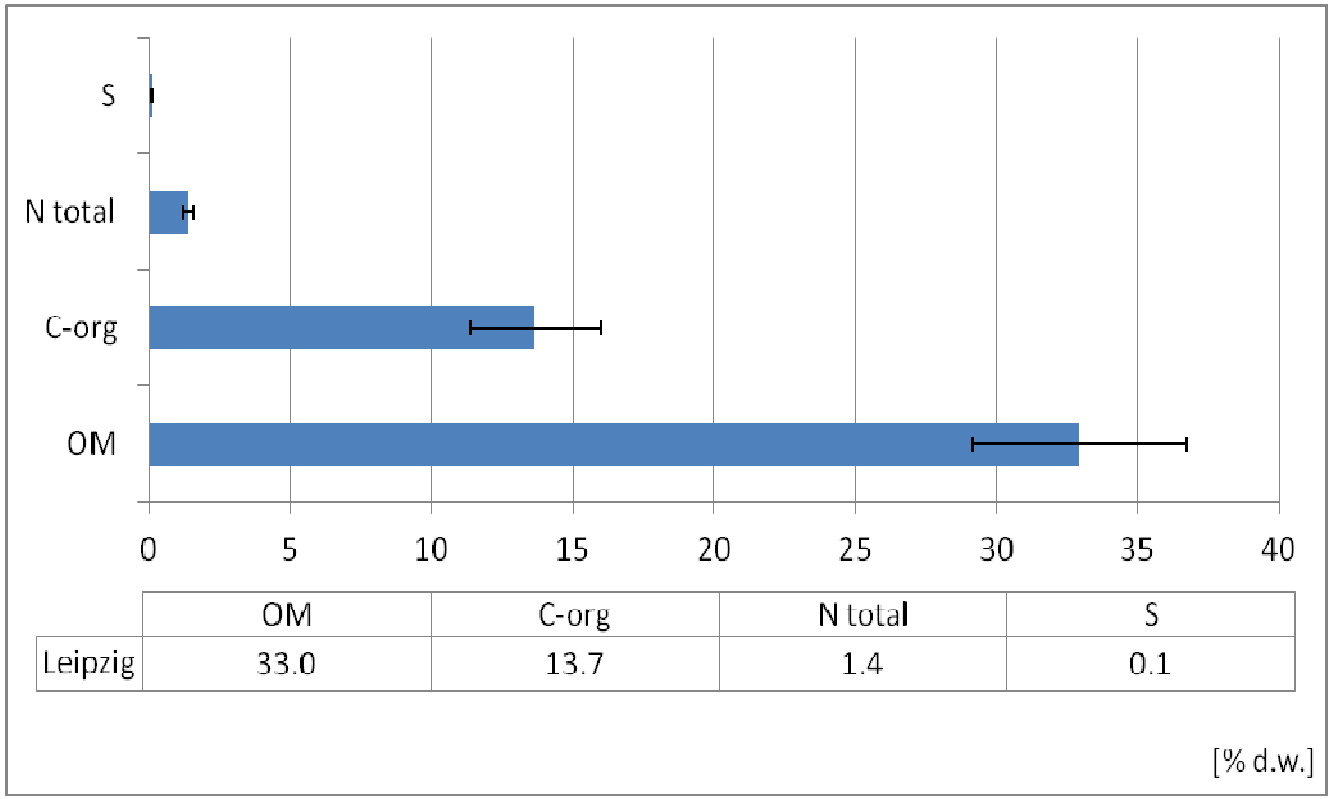
Soil properties (S, N, organic matter)



	OM	C-org	N total	S
Leipzig	33.0	13.7	1.4	0.1

Values are means ± SD (n=20)

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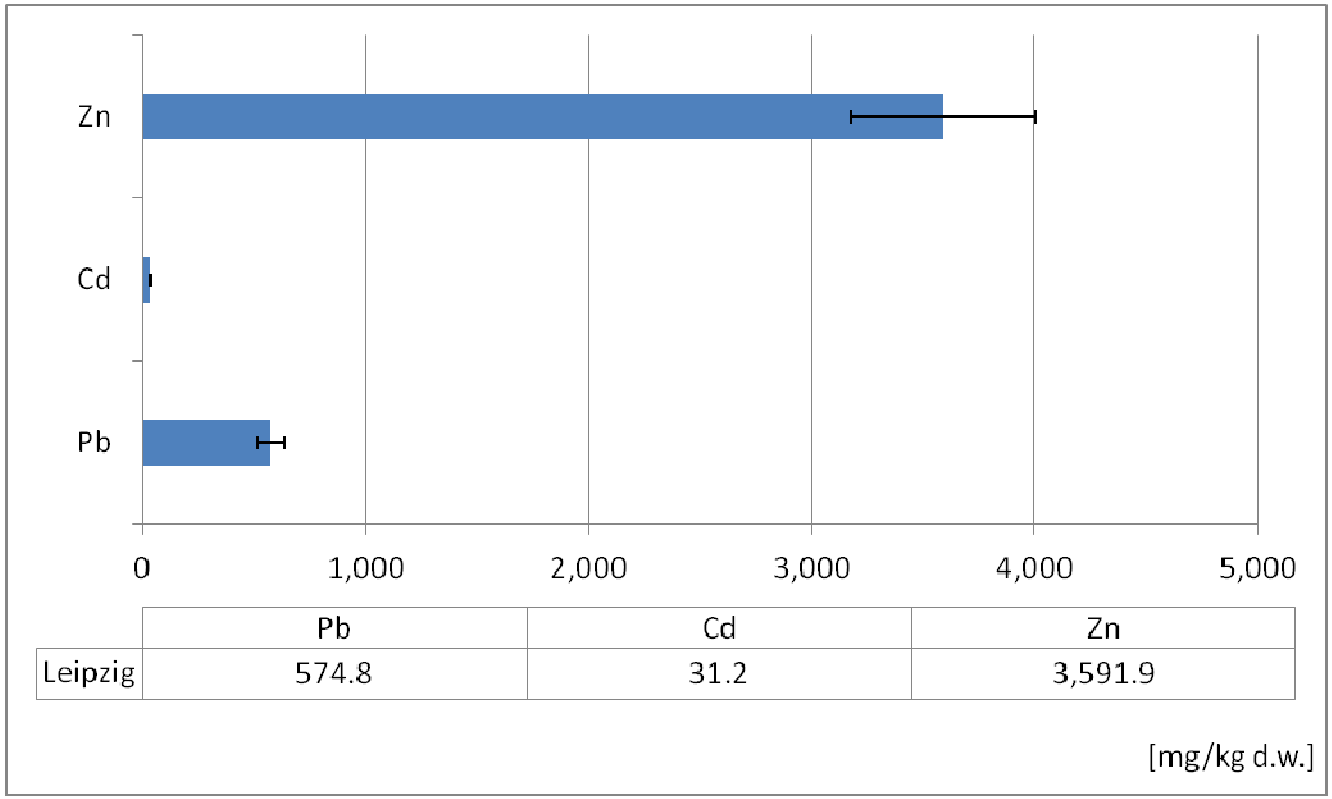
Total concentration of heavy metals in soil



	Pb	Cd	Zn
Leipzig	574.8	31.2	3,591.9

[mg/kg d.w.]

Values are means ± SD (n=20)

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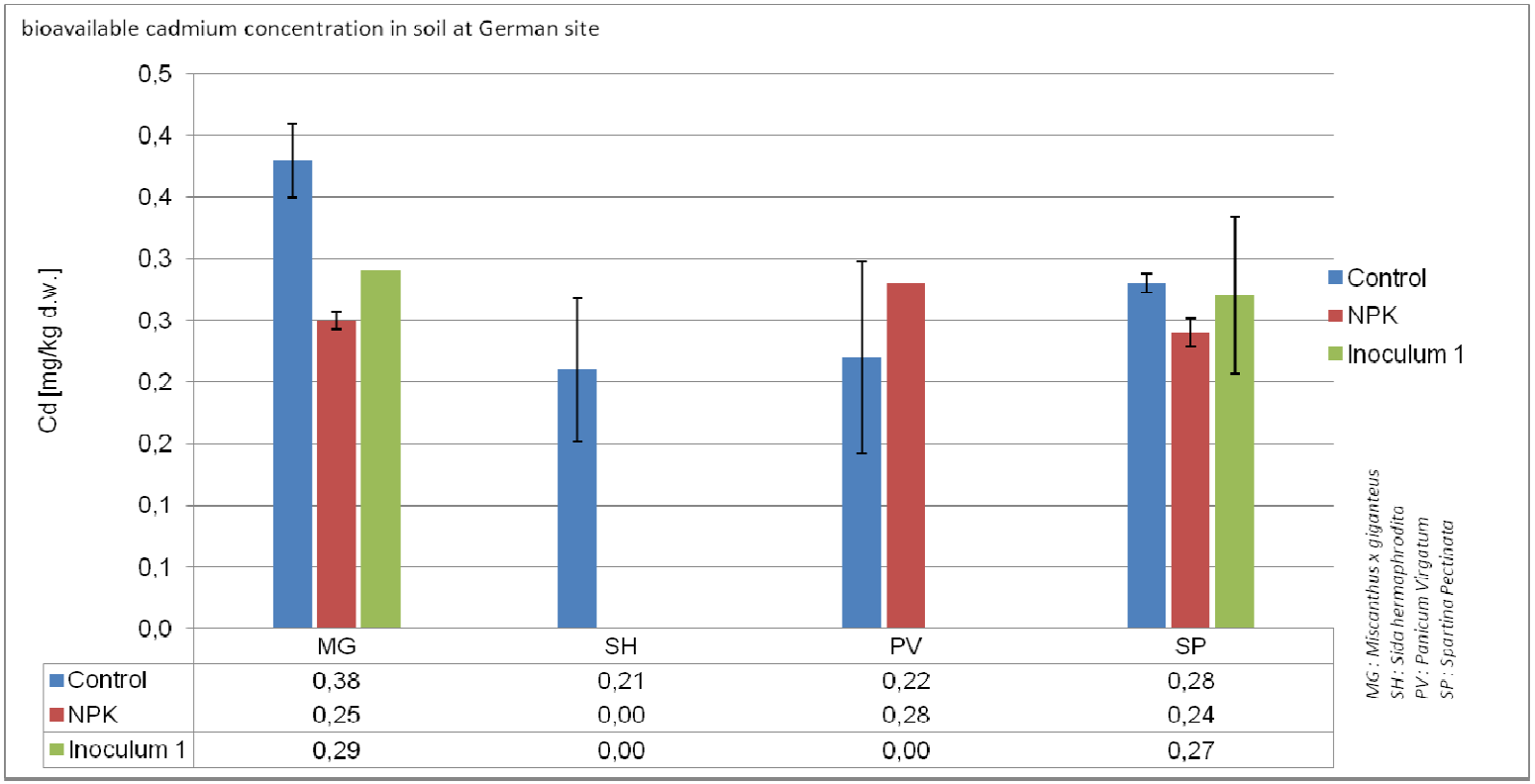
Bioavailable cadmium concentrations in soil



	MG	SH	PV	SP
Control	0,38	0,21	0,22	0,28
NPK	0,25	0,00	0,28	0,24
Inoculum 1	0,29	0,00	0,00	0,27

Values are means ± SD (n=3)

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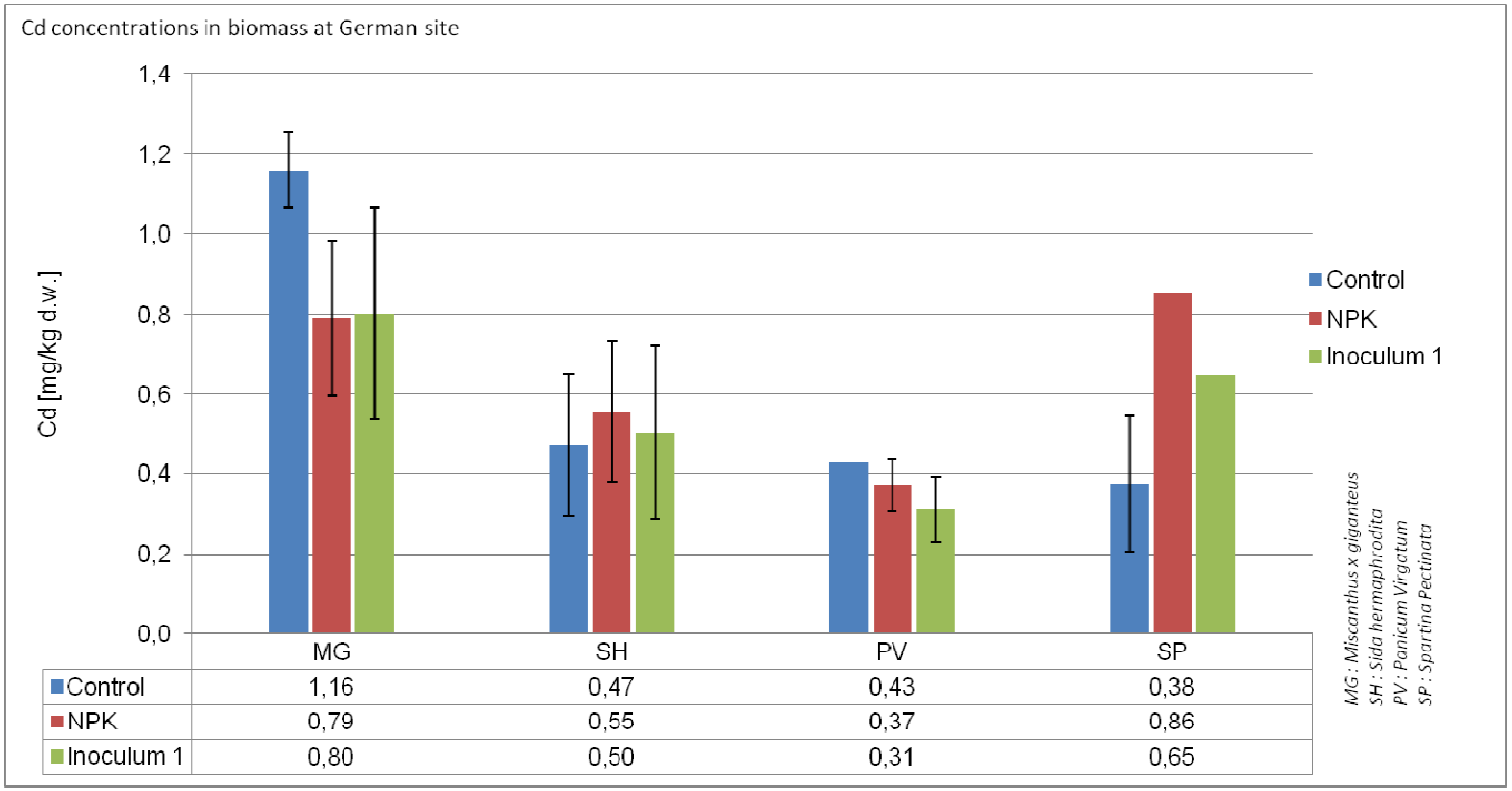
Cadmium concentrations in biomass



	MG	SH	PV	SP
Control	1,16	0,47	0,43	0,38
NPK	0,79	0,55	0,37	0,86
Inoculum 1	0,80	0,50	0,31	0,65

Values are means ± SD (n=5)

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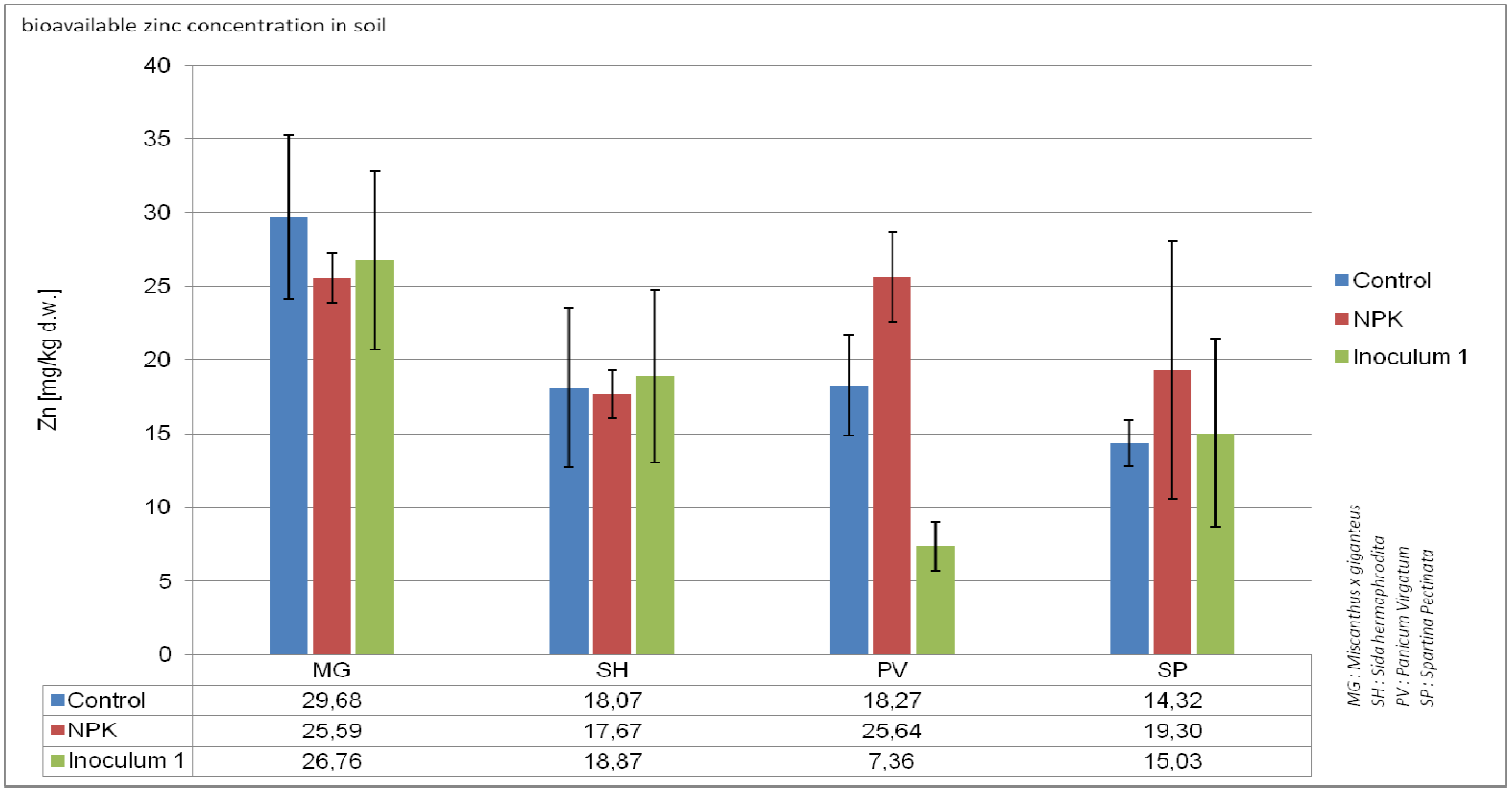
Bioavailable zinc concentrations in soil



	MG	SH	PV	SP
Control	29,68	18,07	18,27	14,32
NPK	25,59	17,67	25,64	19,30
Inoculum 1	26,76	18,87	7,36	15,03

Values are means ± SD (n=3)

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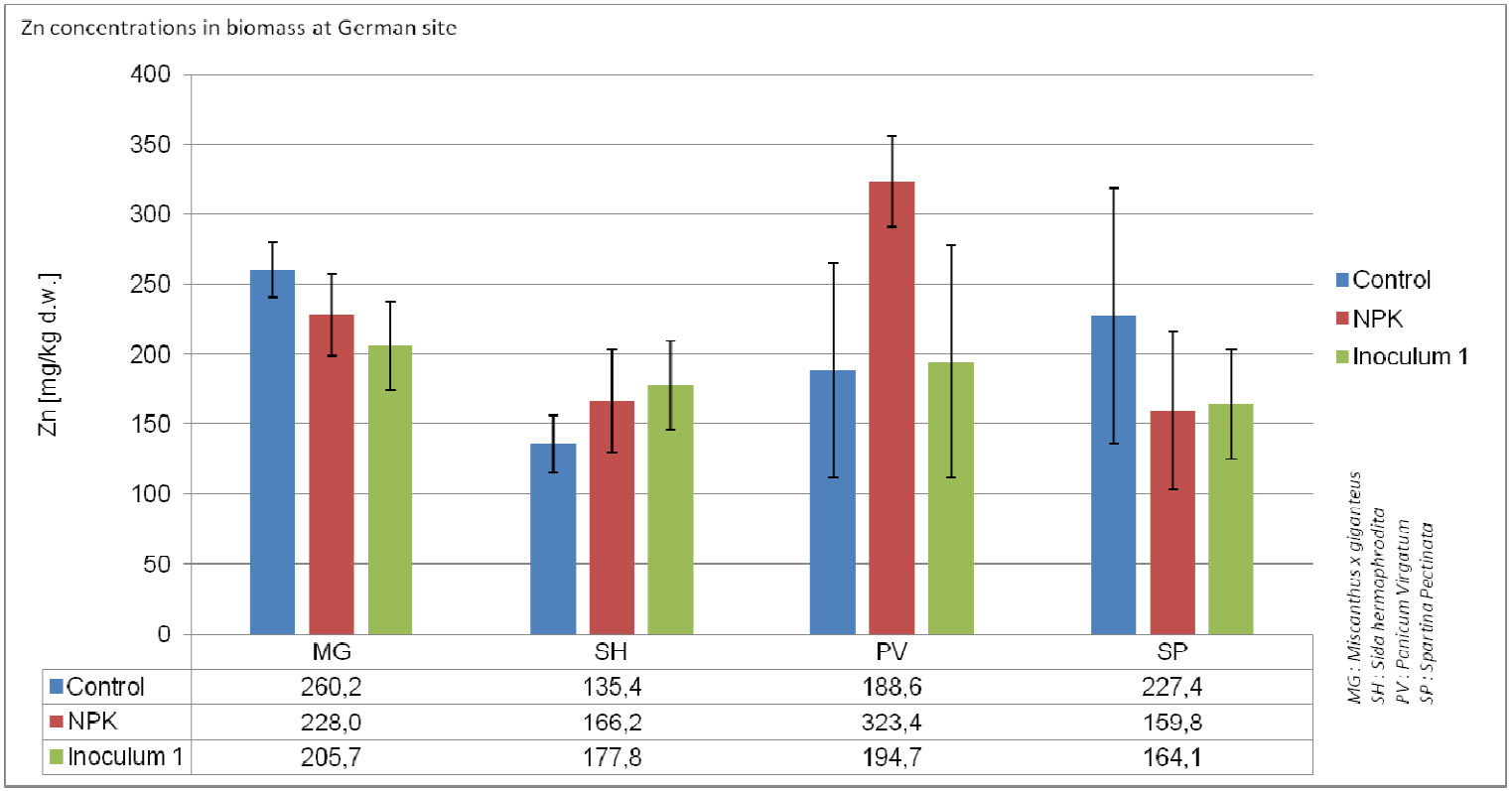
Zinc concentrations in biomass



	MG	SH	PV	SP
Control	260,2	135,4	188,6	227,4
NPK	228,0	166,2	323,4	159,8
Inoculum 1	205,7	177,8	194,7	164,1

Values are means ± SD (n=5)

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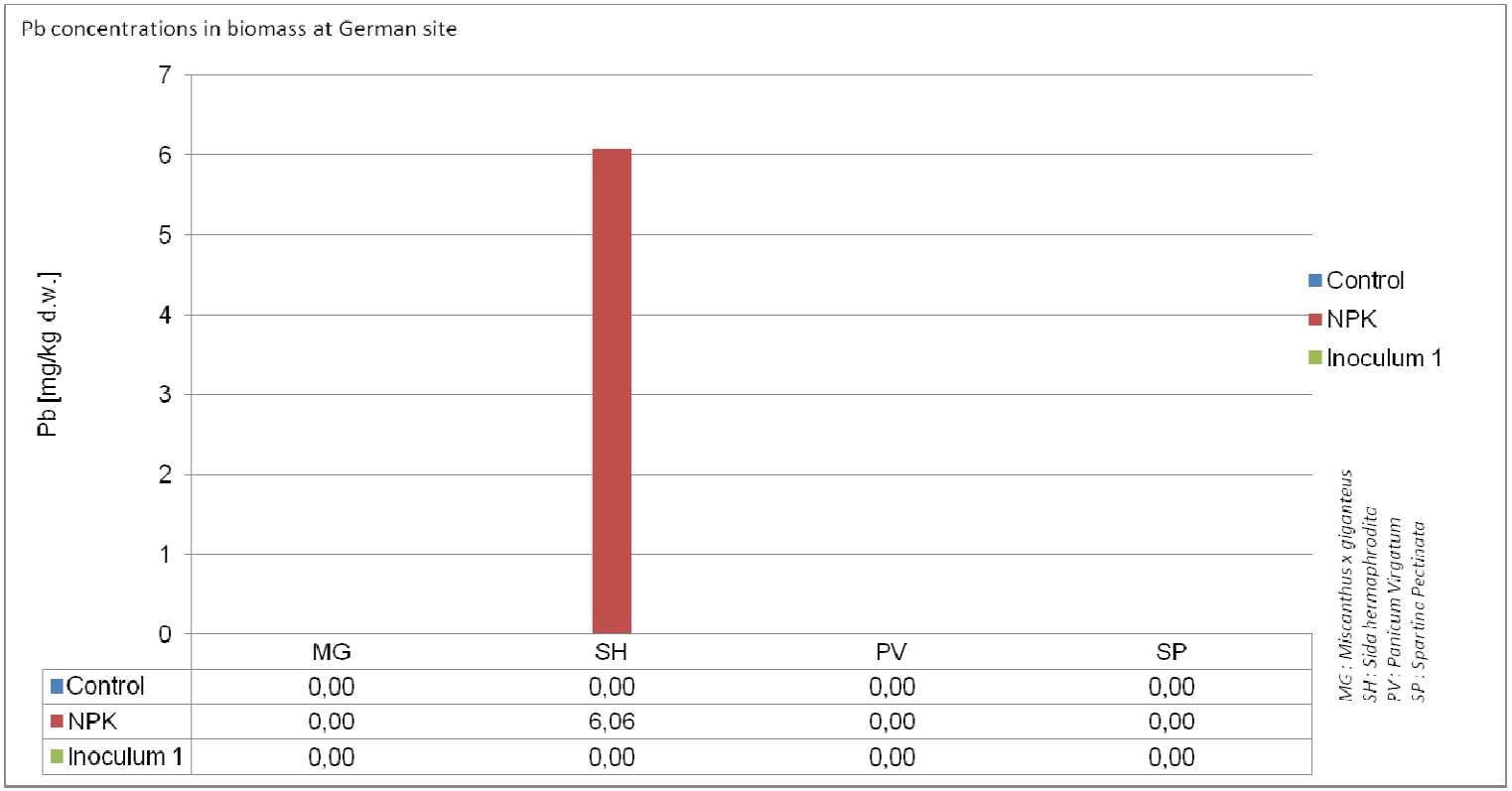
Lead concentrations in biomass



	MG	SH	PV	SP
Control	0,00	0,00	0,00	0,00
NPK	0,00	6,06	0,00	0,00
Inoculum 1	0,00	0,00	0,00	0,00

Values are means ± SD (n=5)

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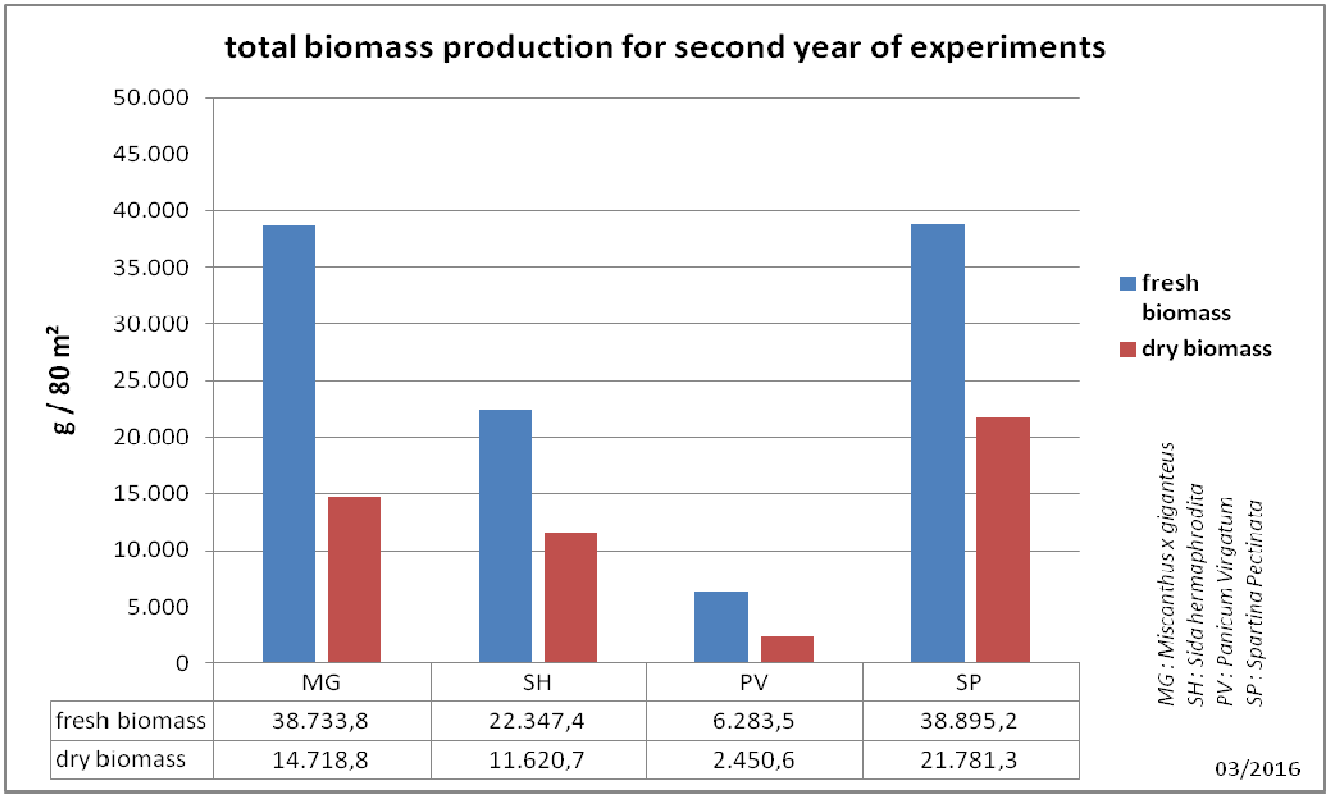
Biomass production after 2nd vegetation season



	MG	SH	PV	SP
fresh biomass	38.733,8	22.347,4	6.283,5	38.895,2
dry biomass	14.718,8	11.620,7	2.450,6	21.781,3

Values are means ± SD (n=5)

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In vitro production of plants

- mass propagation of suitable plants for remediation and energy production by in vitro cultivation
- capacity of Vita 34 about 10.4 Mio plants/year

planting/ remediation ↑ conversion

from *in vitro* to *ex vitro* plant →

rootage (by hormones) and acclimatization

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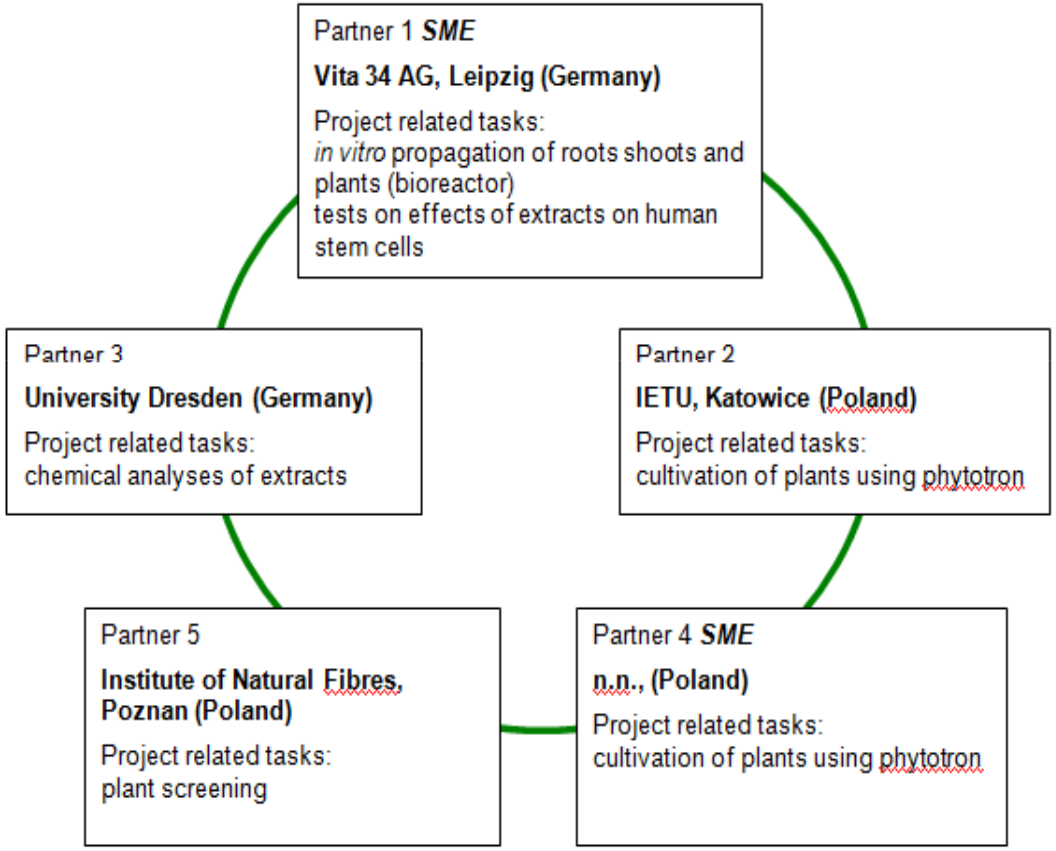
Outlook for further cooperation

- Proposal for new project idea:

  "**Pro**duction of bio**active** compounds by medical plants under controlled **phyto**tron conditions and their effect on human stem cells" (Proactivephyto)



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Many thanks for your attention!

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