The Potential of Ugandan Microbiota Associated with Vegetables and Leafy Greens to enhance crop health in Sub-Saharan Africa

Adrian Wolfgang[1,2], Olivia Laggner[1], Julian Taffner[1], Lea Gibitz-Lambert[1],Gabriele Berg[1]*

E-mail: gabriele.berg@tugraz.at

[1]Graz University of Tecnology, Institute of Environmental Biotechnology, Petersgasse 12/1 8010 Graz;
[2]Austrian Centre of Industrial Biotechnology (ACIB), Krenngasse 37/II, 8010 Graz, Austria

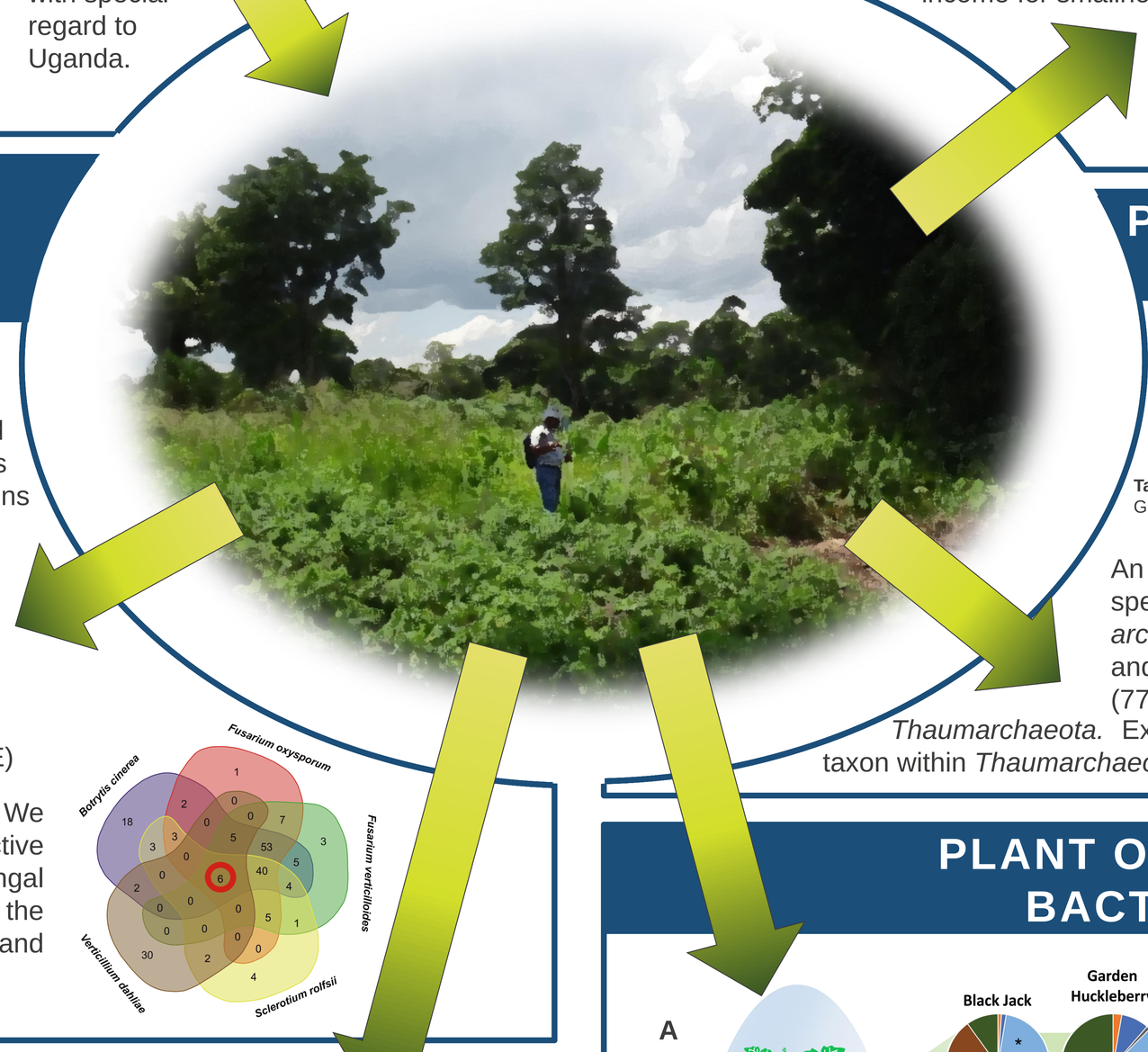
*Corresponding author

BACKGROUND

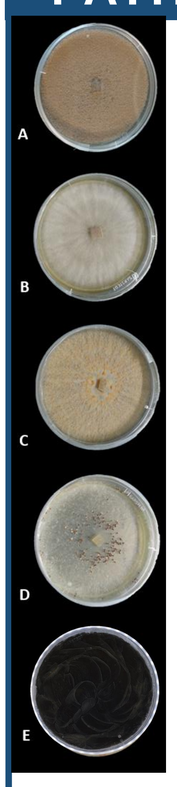
Establishing a self-supporting agriculture in Sub-Saharan Africa (SSA) is a major challenge due to an increasing human population, limited technical and educational resources as well as climate change-related weather effects [1]. Thus, developing an environment-friendly intensification agriculture is pivotal for the whole region. The project “IITA – Healthy seedling systems for safer, more productive vegetables in East Africa” aimed to provide plant health-enhancing, microbe-based strategies for small-scale agriculture, with special regard to Uganda.

MODEL ORGANISMS

Crops were chosen based on the importance for smallholders. The indigenous leafy greens blackjack (*Bidens pilosa*, **A**), okra (*Abelmoschus esculentus* **B**), garden huckleberry (*Solanum scabrum*, **C**), spiderwisp (*Gynandropsis gynandra*, **D**) were rediscovered for rural agriculture, medicine and cuisine, while tomatoes (*Solanum lycopersicum*, **E**) are the main income for smallholders [2].



ANTAGONISTS OF FUNGAL PHYTO-PATHOGENS



A total of 756 bacteria were isolated and tested for antagonism towards the fungal phytopathogens

- *Botrytis cinerea* (A)
- *Fusarium oxysporum* (B)
- *F. verticilloides* (C)
- *Sclerotium rolfsii* (D) and
- *Verticillium dahliae* (E)

in dual culture assays. We found six strains active against all tested fungal pathogens belonging to the genera *Bacillus* and *Sphingomonas* (right).

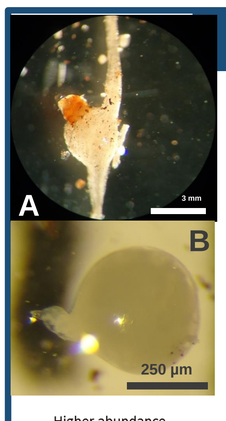
PLANT-ASSOCIATED ARCHAEA

	Rhizosphere	Endosphere	Phyllosphere
Black Jack	34	54	36
Garden Huckleberry	72	70	72
Okra	82	69	54
Spiderwisp	71	67	64
Tomato	100	94.80	x

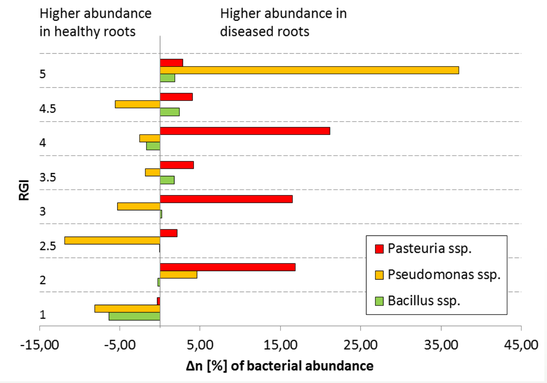
Table 1: Total relative abundance of Soil Crenarchaeotic Group (SCG) in plant-associated microhabitats.

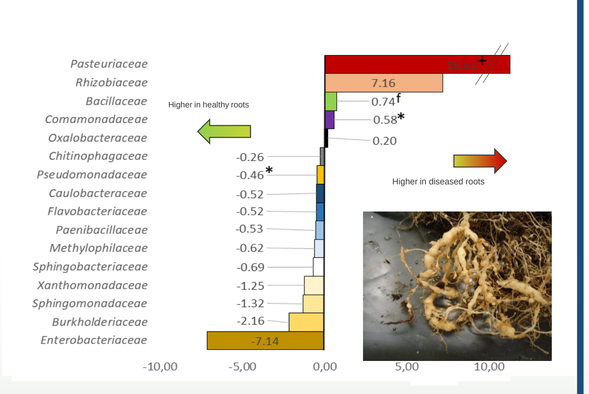
An amplicon analysis using Archea-specific primers *arch349F* and *arch519R* revealed both soil (69-83%) and all crop-associated microhabitats (77-98%) to be dominated by *Thaumarchaeota.* Except for blackjack, the dominating taxon within *Thaumarchaeota* is the SCG (**Table 1**).

ROOT-KNOT NEMATODES

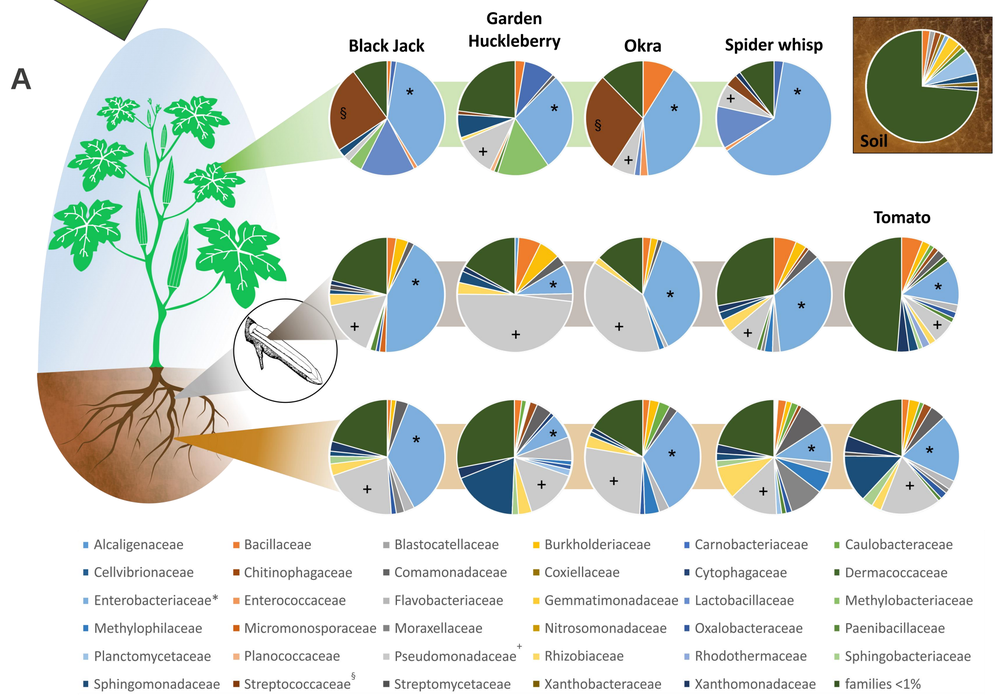


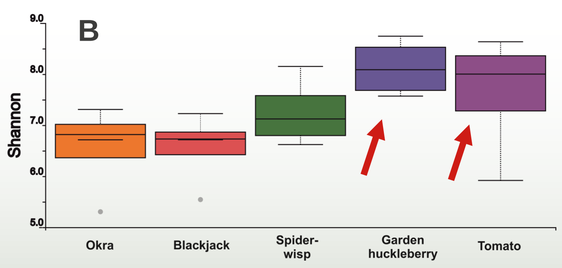
Six strains of *Pseudomonas*, *Comamonas* ans *Variovorax* produced nematicidal volatiles against the root-knot nematode *Meloidogyne incognita*. A cross-check with 16S rRNA amplicon data revealed no trend for antagonist abundance with increasing disease severity (C), but a significant influence of infection on relative abundance of *Pasteuriaceae*, *Rhizobiaceae* and *Enterobacteriaceae* (D).

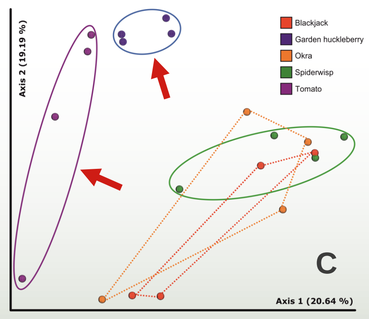




PLANT ORGANS SHAPE THE BACTERIAL COMMUNITY







Plant associated bacterial communities were dominated by *Pseudomonadaceae* and *Enterobacteriaceae*, plant-specific differences were highest in rhizosphere communities (**A**). Both *Solanaceae* show higher alpha diversity (Shannon index, **B**) and clear separation from other crops in beta diversity indices in rhizosphere (PCoA plot of Bray-Curtis dissimilarity, **C**).

CONCLUSION

A base work on microbial communities in African crops was performed, new strategies for pest and pathogen control were suggested and a strain collection, providing several strains that can be used for biological control in Uganda, were created.

[1] Vanlauwe, B. *et al.* (2014), Sustainable intensification and the African smallholder farmer. *Curr. Opin. Environ. Sustain.* **8**, 15–22 (2014).
[2] Ssekyewa, C. (2006). Incidence, Distribution and Characteristics of Major Tomato Leaf Curl and Mosaic Virus Diseases in Uganda. PhD-thesis. Faculty of Bioscience Engineering, Ghent University, Ghent.

FOR DETAILS, VISIT POSTER Oliv 1A

ACKNOWLEDGMENT: This work was done as part of the research project ‘IITA - Healthy seedling systems for a safer, more productive vegetables in East Africa’ (F37139), funded by the Austrian Development Agency (ADA). The authors would like to thank Günther Raspotnig (University Graz), Johannes Hallmann (Münster) and Wim Bert (Ghent). For help in the lab we thank Tobija Glawogger, Nikolina Todorovic, Jelena Gagic, Ingrid Matzer, Barbara Fetz, Isabella Wrolli, Monica Schneider-Trampitsch, Maria Schmuck and Doreen Nampamya (Graz, Kampala). Alexander Mahnert, Henry Müller and Tomislav Cernava (Graz) supported the bioinformatic analysis.