Research summary of master's thesis project:

Influence of residues from black soldier fly larvae (*Hermetia illucens*) rearing on the plant-associated microbiome

Introduction

The larva of the black soldier fly (BSFL, *Hermetia illucens*) is considered to have great potential for the promotion of a circular economy, being able to metabolize a wide range of organic side streams. Next to the production of nutrient rich insect biomass – a valuable animal feed-, the residues arising from the process are a promising plant fertilizer. Particularly in tropical countries climatic conditions meet the biological needs of BSFL. For Sub-Saharan African states like Rwanda BSFL rearing can additionally be a response to socioeconomical challenges. In widespread chicken farming for example locally sourced insect larvae can serve as a sustainable alternative to imported fishmeal. For smallholder farmers the extensively accruing residues from rearing can be a versatile source for plant nutrition. Beyond that, fertilizer trials suggest that the residues can have beneficial effects on the plant-associated soil microbial community via inherent microbes or bioactive compounds. The soil microbial community plays a key role for the sustainability of agroecosystems by influencing among others nutrient cycling and soil health.

It was the aim of this master's thesis to assess the impact of BSFL residues a on the plant-associated soil microbiome and to further identify underlying drivers as well as implications for soil fertility. To that end a pot experiment was conducted contrasting the soil application of BSFL residues with sterile BSFL residues and an organic compost, which were provided by Rwandan waste management companies.

Methods

In the beginning of the 42-day greenhouse trial BSFL residues, sterilized BSFL residues, organic compost, and sterilized organic compost were mixed with soil at rate of 150 kg N ha $^{-1}$ and filled in pots. Including a non-fertilized control soil a clover-grass mix was sown in the pots. Soil samples were drawn at three times throughout the experiment (days: 0, 24, 42). The bacterial and the fungal communities in all soils as well as fertilizers were assessed by high throughput sequencing of ribosomal markers. Likewise physicochemical parameters including plant-available nitrogen were assessed in all soil and fertilizer samples. For the last sampling day soil basal respiration and the aboveground plant biomass were assessed.

Results and discussion

The application of BSFL residues changed the soil microbial community structure,

tended to increase microbial activity and aboveground plant biomass in comparison to the compost treatment or the non-fertilized control, respectively. Results suggest that the effects were mediated by the introduction of microbes and abiotic substances inherent to BSFL residues influencing soil fertility and plant performance. Taxa commonly associated with organic matter decomposition and plant growth promotion were enriched under soils treated with BSFL residues. Further we assume that organic compounds characteristic for BSFL residues used in our experiment such as chitin derivates played a key role in altering the soil microbiome.

Conclusion

This study indicated that BSFL residues can impact the soil microbiome by the introduction of microbes and abiotic components to the soil resulting in positive effects on soil fertility. The findings suggest that BSFL residues can support plant growth in a versatile way rendering farmers less dependent on additional agricultural inputs such as mineral fertilizers or pesticides. Thus, especially in low-income countries the application of residues from local BSFL rearing constitutes an opportunity to improve the sustainability of agricultural production. Further research should focus on the quantification of bioactive components in BSFL residues and the functional response of the microbial community to their application. To corroborate the results of this study further plant trials over a range of environmental conditions applying BSFL residues based on different substrates should be conducted. It will facilitate the practical exchange with farmers about the benefits of the application of BSFL residues.

Background information

The RUNRES project funded by the Swiss Agency for Development and Cooperation supported this project by facilitating the collaboration with the International Institute of Tropical Agriculture (IITA) in Rwanda and the two participating Rwandan bioconversion companies COPED Ltd. and Maggot Farm Ltd.

By shedding light on the versatile implications of using BSFL residues as a fertilizer, findings from this master's thesis stimulated a local on-farm demonstration trial in which BSFL residues are applied to soy and maize.

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