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Research paper

Loss of soil microbial diversity may increase insecticide uptake by crop

Min Zhang[a], Yongchao Liang[b], Alin Song[a], Bing Yu[a], Xibai Zeng[c], Ming-Shun Chen[d], Huaqun Yin[e], Xiaoxia Zhang[a], Baoli Sun[c,*], Fenliang Fan[a,*]

[a] Key Laboratory of Plant Nutrition and Fertilizer, Ministry of Agriculture, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, China
[b] Ministry of Education Key Laboratory of Environment Remediation and Ecological Health, College of Environmental and Resource Sciences, Zhejiang University, Hangzhou 310058, China
[c] Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences, Beijing 100081, China
[d] USDA-ARS and Department of Entomology, Kansas State University, Manhattan, KS 66506, USA
[e] Key Laboratory of Biometallurgy of Ministry of Education, School of Minerals Processing and Bioengineering, Central South University, Changsha 410083, China

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ABSTRACT

Belowground biodiversity is essential for soil functioning, but the effect of belowground biodiversity loss on food safety is unknown. We investigated the loss of soil microbial diversity on insecticides accumulation in Brassica. We manipulated soil biodiversity using the dilution-to-extinction approach in a Brassica-soil-insecticide system, monitored microbial communities via high-throughput sequencing, and identified potential functional microbes. Compared with unsterilized soil, the richness of functional bacteria was reduced by 14.1%, 36.2%, 51.6% and 73.2%, respectively, in the corresponding sterilized soil inoculated with 1-, 10^{-2}-, 10^{-4}- and 10^{-6}-fold diluted soil suspension. The acetamiprid and imidacloprid concentrations increased significantly in Brassica tissues grown in sterilized soil inoculated with 10^{-6}-fold diluted suspension. A bacterial group predominated in functional microbes of soils inoculated with 1-, 10^{-2}- or 10^{-4}-fold diluted suspension, but the relative abundance declined in soil inoculated with a 10^{-6}-fold diluted suspension. Our findings revealed that undesirable impacts by the loss of soil biodiversity at an intermediate level on the accumulation of soil contaminant in plants could be alleviated by microbial functional redundancy through disproportionally complementary growth of specific functional microbial taxa, but severe loss of soil biodiversity would threaten food safety.

1. Introduction

Biodiversity is greatly affected by human activity, such as changes in land-use and increase in nitrogen deposition (Sala et al., 2000; Butchart et al., 2010). The relationship between biodiversity and ecosystem functioning has become one of the research focuses in the last three decades (Loreau et al., 2001; Cardinale et al., 2012). It has been shown that reduction in biodiversity results in decreases in the productivity, functionality, and stability of ecosystems (Loreau et al., 2001; Cardinale et al., 2012). However, previous studies have mainly focused on aboveground ecosystems. The relationship between belowground diversity and ecosystem functioning has remained less investigated even though biodiversity is usually richer in belowground systems than in aboveground systems (Bardgett and van der Putten, 2014).

Previous reports showed effects of reduction in soil biodiversity on soil functions were controversial. It has been hypothesized that the loss of belowground biodiversity would be less important than the loss of aboveground diversity in ecosystem functioning because belowground species are mainly microbes with high diversity and high functional redundancy (Nannipieri et al., 2003). Several empirical studies have indeed shown consistency with this hypothesis. For instance, reduction in soil biodiversity does not necessarily result in reduction in the efficiency of straw decomposition, transformation of soil organic carbon and denitrification. However, some other functions may even increase when soil biodiversity reduces (Griffiths et al., 2001; Wertz et al., 2006). It appears that whether biodiversity affects functions of ecosystems depends on the types of processes tested. The processes carried out by a large group of highly diverse microbes are usually less affected, whereas the processes carried out by less diverse

* Corresponding authors.
E-mail addresses: baolisun_6@126.com (B. Sun), fanfenliang@caas.cn (F. Fan).

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