***Cite this as*:** Hongfu LI, Yaxin HU, Siqi CHEN, Yusufjon GAFFOROV, Mengcen WANG, Xiaoyu LIU, 2025. Harnessing chemical communication in plant–microbiome and intra-microbiome interactions. *Journal of Zhejiang University-SCIENCE B*, 26(10):923-934. https://doi.org/10.1631/jzus.B2500099

Harnessing chemical communication in plant–microbiome and intra-microbiome interactions

Key words: Plant–microbiome interaction; Intra-microbiome interaction; Chemical communication; Click chemistry; Genome editing; Artificial intelligence (AI)

Summary

This review mainly focused on the chemical communication in plant-microbiome and intra-microbiome interactions, presenting an interdisciplinary framework for dissecting and leveraging this intricate network to address global challenges in crop productivity, food security, and climate change.

1. Plant-microbiome and intra-microbiome interactions through chemical communication

1. Representing a systematic summary of plant-microbiome and intra-microbiome interactions in the form of bacteria-bacteria (a), fungi-fungi (b), bacteria-fungi (c), and plant-microbe (d).
2. Mutualism, competition, and antagonism occur through small chemical molecules of plants and microbes.
3. Revealing that the hidden chemical communication is the key to research the interaction network.

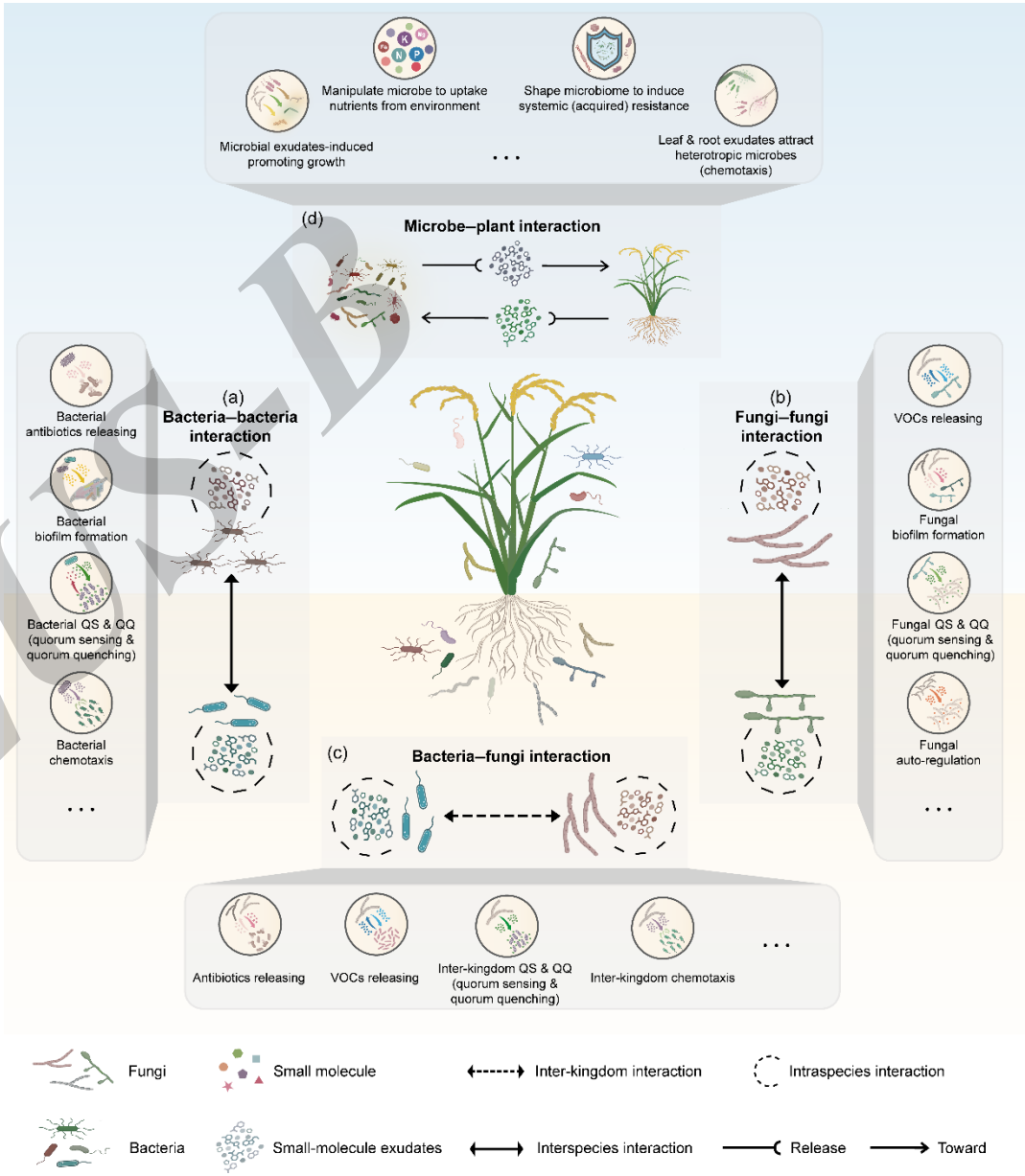
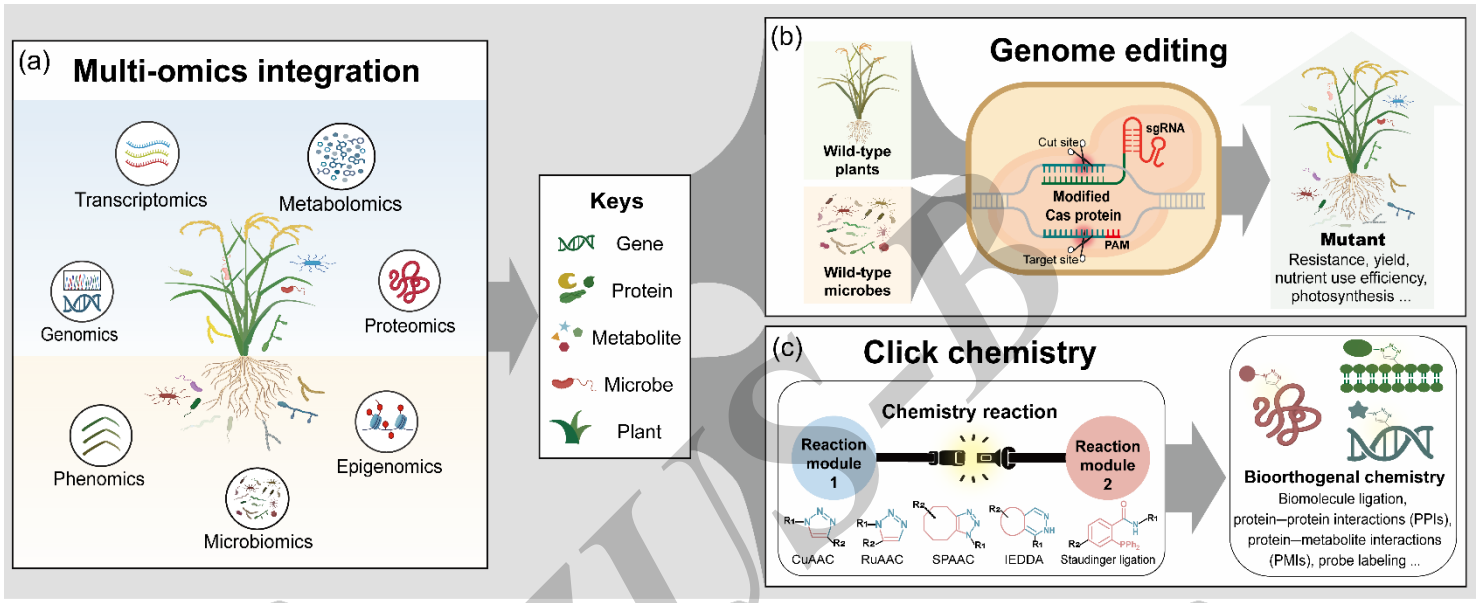


Figure 1

2. The holistic engineer framework reveals chemical communication in plant-microbiome and intra-microbiome interactions



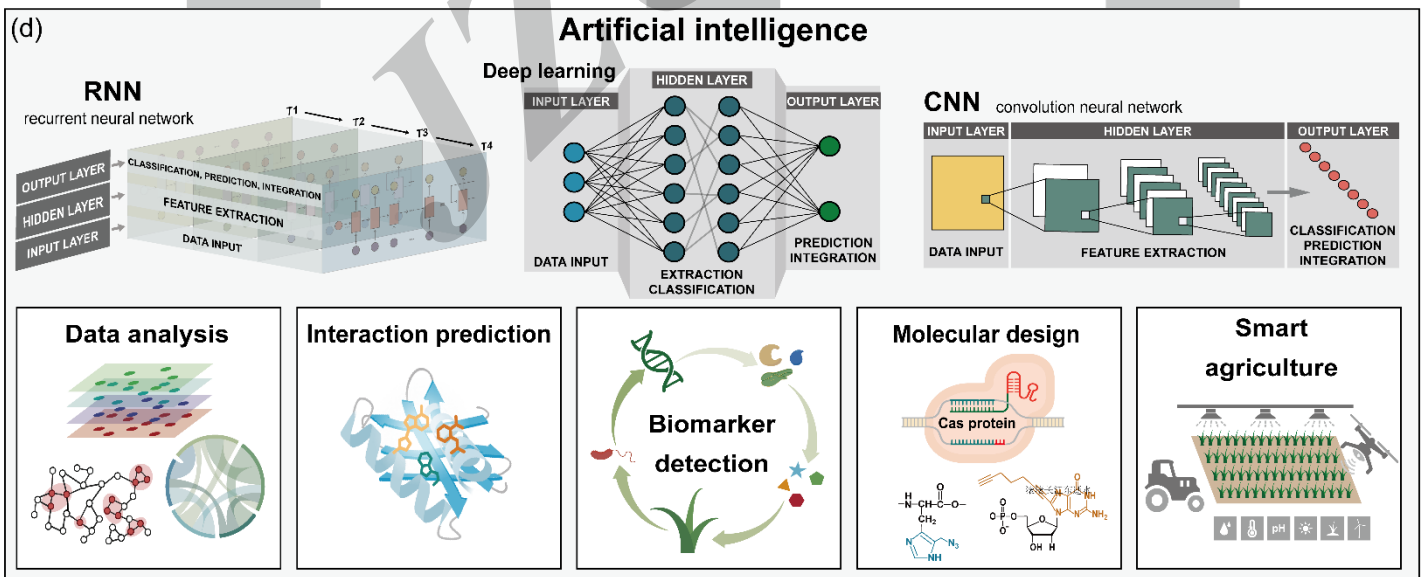


Figure 2

2. The holistic engineer framework reveals chemical communication in plant-microbiome and intra-microbiome interactions

1. Providing an interdisciplinary framework to decode multi-dimensional interactions.
2. The framework integrates multi-omics, genome editing, click chemistry, and artificial intelligence (AI). Multi-omics analysis predicts key factors (a). Genome editing (b) and click chemistry (c) technology enable analyzing chemical communication at the gene and metabolite level. Artificial intelligence supports the framework through data analysis, interaction prediction, biomarker detection, and molecular design (d).
3. The chemical communication can be applied in the agriculture system to address problems of plant disease and productivity.