The experimental results of Arnault et al. (2023) demonstrate that different combinations and concentrations of SynCom can affect the assembly of seed and seedling microbiota, indicating that the design of synthetic microbial communities can be used to selectively manipulate plant microbiomes. By introducing specific strains, SynCom can markedly alter the composition of soil and plant microbiomes, enhancing the presence of beneficial microbes, thereby promoting plant growth and health. In the long term, this approach may help establish more stable and healthy soil ecosystems, increase the functional diversity of soil microorganisms, and improve nutrient cycling and disease control. Through further research and optimization of SynCom composition and application, it may be possible to achieve more efficient and sustainable agricultural production systems in the future.

6.2 Long-term effective SynCom promoting growth and nutrient acquisition of soybean

In a field trial involving soybean plants, researchers constructed three SynComs based on functional screening of 1 893 microbial strains isolated from root-associated compartments (Figure 2). The application of these SynComs significantly promoted plant growth and nutrient acquisition under both nutrient deficiency and sufficiency conditions. Field trials revealed that SynComs not only stably increased soybean yield, but also systemically regulates nutrient signaling networks at the transcriptional level, enhancing important growth pathways (Wang et al., 2021).

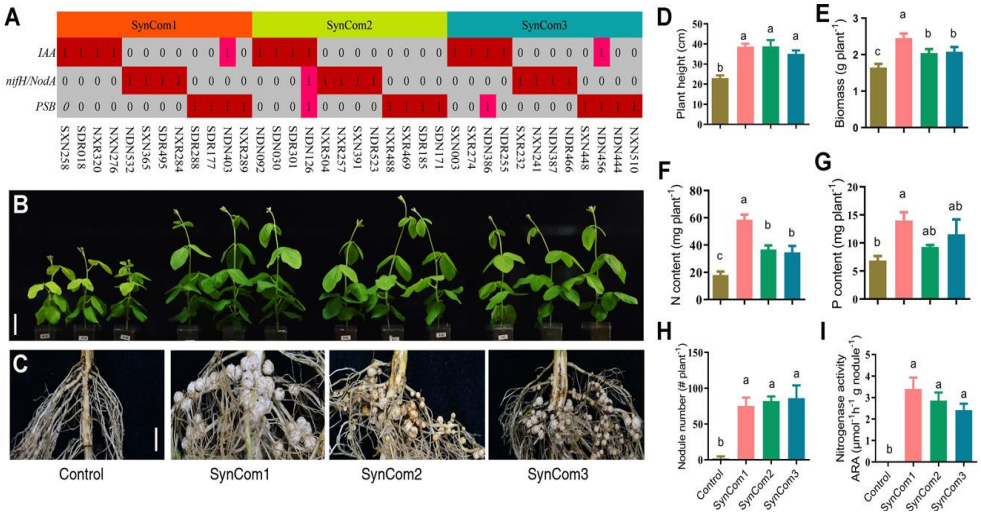

Figure 2 SynCom construction and growth chamber evaluation (Adopted from Wang et al., 2021)

Image caption: A) Schematic diagram of microbes and their functions used for SynCom construction; 1 or 0 indicates the presence or absence of the listed functions; B) Growth performance, bar = 5 cm; C) Roots and nodules, bar = 1 cm; D) Plant height; E) Dry weight; F) N content; G) P content; H, I) Nodule number and nitrogenase activity; Surface sterilized soybean seeds were inoculated with SynComs, and non-inoculated seeds served as controls; Different letters indicate significant differences among different treatments in Duncan's multiple comparisons test (Adopted from Wang et al., 2021)

Wang et al. (2021) illustrates the construction and evaluation of synthetic microbial communities (SynComs) in a growth chamber setting. Their study shows that inoculating soybeans with SynComs enhances various growth parameters, including plant height, biomass, nitrogen, and phosphorus content. This suggests that SynComs can be designed to optimize plant-microbe interactions, leading to improved nutrient uptake and overall plant health. Enhanced nitrogenase activity and increased nodule formation, as observed in the study, indicate better nitrogen fixation, which is crucial for leguminous plants like soybeans. In the long term, the use of SynComs could reduce the dependency on chemical fertilizers, promoting more sustainable agricultural practices. By improving nutrient acquisition, SynComs can lead to higher yields and better crop quality.

6.3 Long-term effects of SynComs on plant physiology and stress resistance

A case study on maize demonstrated that SynCom-inoculated maize exhibited lower leaf temperatures and reduced turgor loss under drought conditions, thereby mitigating drought-induced damage. This improvement was attributed to the regulation of water use efficiency and stress resistance mechanisms by SynComs. This study not only showcased the short-term benefits of SynComs but also provided high-resolution temporal data on their