Exploring the role of microbial bio stimulants in enhancing phosphorus use efficiency in legumes

State Key Laboratory of Biocontrol, Guangdong Provincial Key Laboratory of Plant Resources and Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), Sun Yat-Sen University, China

Phosphorus (P) is an essential macronutrient required for various physiological processes in plants, including energy transfer, DNA

protocols for their application in legume farming systems. Additionally, the potential for scaling up the use of microbial bio stimulants in commercial agriculture requires addressing challenges such as cost-e ectiveness, ease of application, and regulatory approval.

In conclusion, microbial bio stimulants o er a promising strategy to enhance phosphorus use e ciency in legumes, thereby improving crop productivity and sustainability. By harnessing the natural interactions between bene cial microorganisms and plant roots, these bio stimulants can play a vital role in overcoming the challenges posed by phosphorus limitations in soils. With continued research and development, microbial bio stimulants have the potential to revolutionize nutrient management practices in legume cultivation and contribute to more sustainable agricultural systems worldwide [9,10].

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e use of microbial bio stimulants to enhance phosphorus use e ciency (PUE) in legumes represents a promising avenue for improving agricultural sustainability. Phosphorus, despite being one of the most critical nutrients for plant growth, o en remains inadequately available in many soils due to its poor solubility and immobilization. In legume cultivation, where phosphorus is key to optimizing growiva06(t)-5(r)5c7(gi(a)-5(l n)1)8(g3(a)9n en bx)12(t)-5(i)7(va)19(s)-8(e o)12(f micr)13(o)5

bio stimulants. Variability in microbial e cacy due to soil type, environmental conditions, and crop species requires ongoing research to identify the most e ective strains and application methods. Furthermore, scalability remains an issue, as cost-e ectiveness, ease of application, and regulatory approval must be addressed for widespread adoption. Despite these challenges, the continued exploration and development of microbial bio stimulants are critical to realizing their full potential in legume farming.

In conclusion, microbial bio stimulants represent a powerful and sustainable tool for enhancing phosphorus use e ciency in legumes. eir ability to improve phosphorus availability, reduce the reliance on chemical fertilizers, and promote soil health aligns with the growing demand for environmentally sustainable and economically viable agricultural practices. With ongoing research to optimize their application and ensure their e ectiveness, microbial bio stimulants could play a central role in transforming phosphorus management in legume cultivation and contribute to the broader goals of sustainable agriculture and global food security.

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None

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None

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