Improving Crop Yield and Nutrient Use Efficiency via Biofertilization-A Global Meta-analysis

ID 4638436
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Year 2018
Title Improving Crop Yield and Nutrient Use Efficiency via Biofertilization-A Global Meta-analysis
Journal Frontiers in Plant Science
Volume 8
Pages / **Article-Number** 2204
Keywords Meta-analysis,biofertilizer,microbial inoculants,agricultural productivity,nitrogen use efficiency,phosphorus use efficiency,arbuscular mycorrhizal fungi,PGPR
The application of microbial inoculants (biofertilizers) is a promising technology for future sustainable farming systems in view of rapidly decreasing phosphate stocks and the need to more efficiently use available nitrogen (N). Various microbial taxa are currently used as biofertilizers, based on their capacity to access nutrients from fertilizers and soil stocks, to fix atmospheric nitrogen, to improve water uptake or to act as biocontrol agents. Despite the existence of a considerable knowledge on effects of specific taxa of biofertilizers, a comprehensive quantitative assessment of the performance of biofertilizers with different traits such as phosphate solubilization and N fixation applied to various crops at a global scale is missing. We conducted a meta-analysis to quantify benefits of biofertilizers in terms of yield increase, nitrogen and phosphorus use efficiency, based on 171 peer reviewed publications that met eligibility criteria. Major findings are: i) the superiority of biofertilizer performance in dry climates over other climatic regions (yield response: dry climate +20.0 ś 1.7%, tropical climate +14.9 ś 1.2%, oceanic climate +10.0 ś 3.7%, continental climate +8.5 ś 2.4 %); ii) meta-regression analyses revealed that yield response due to biofertilizer application was generally small at low soil P levels; efficacy increased along higher soil P levels in the order arbuscular mycorrhizal fungi (AMF), P-solubilizers and N-fixers; iii) meta-regressions showed that the success of inoculation with AMF was greater at low organic matter content and at neutral pH. Our comprehensive analysis provides a basis and guidance for proper choice and application of biofertilizers.
ISSN/ISBN 1664-462X
URL https://www.frontiersin.org/article/10.3389/fpls.2017.02204
edoc-URL https://edoc.unibas.ch/86919/
Full Text on edoc No;
Digital Object Identifier DOI 10.3389/fpls.2017.02204
PubMed ID http://www.ncbi.nlm.nih.gov/pubmed/29375594
ISI-Number 000419866900001
Document type (ISI) Journal Article