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BOOK REVIEW

Gopalakrishnan Subramanian, Sathya Arumugam & Vijayabharathi Rajendran (Eds.): plant growth promoting Actinobacteria: a new avenue for enhancing the productivity and soil fertility of grain legumes

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The year 2016 was designated the United Nations 'International Year of Pulses', to emphasize the centrality of these crops in global food security. The interchangeable terms 'pulses' and 'grain legumes' embrace globally important crops in the family Fabaceae (syn. Leguminosae) as diverse as beans (*Phaseolus* [syn. *Vigna*] *and Vicia* spp.), vetch (*Vicia sativa*), chickpea (*Cicer arietinum*), cowpea (*Vigna unguiculata*; syn. *V. sinensis*), groundnuts (*Arachis hypogaea*), lentils (*Lens culinaris*), lupins (*Lupinus* spp.), peas (*Pisum sativum*), pigeonpea (*Cajanus cajan*), and soybeans (*Glycine max*). All are significant sources of relatively cheap non-animal (and therefore environmentally friendly) proteins and micronutrients for the human populations of Asia, the Americas, Africa, Australasia and Europe. Finally, and of very great significance through their endophytic associations with rhizobial bacteria, these crop plants are able to fix atmospheric nitrogen, thereby reducing dependence on chemical fertilizers.

This book was produced, in response to the UN initiative, by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patanchuru, Hyderabad, India. In his Foreword, the Deputy Director, Peter Carberry, reminds us that the productivity of grain legumes, as with most crops, continues to be significantly limited by both biotic and abiotic factors, including pests and pathogens, infertile and polluted soils and climate variability and change. Research to improve both grain legume cultivars and conventional management practices is, of course, continuing at ICRISAT and at other agricultural institutes around the world. However, ICRISAT is also aware of the need to find additional, non-chemical biological strategies to improve productivity and minimize damage by pests and pathogens and is exploring the possibility of using plant growth promoting (PGP) Actinobacteria[1] as alternative biological agents to achieve these ends. These gram-positive bacteria with a filamentous form, which are ubiquitous in soils and are often associated with plants as both rhizosphere inhabitants and endophytes, show great promise in this regard. The present book documents recent research, at ICRISAT and worldwide, on this fascinating subject of study.

The editors provide a long Preface that sets the scene and gives a valuable synopsis of the nineteen chapters, most with multiple authors, that follow. These cover a wide range of topics, including the potential of Actinobacteria for:-

- Direct growth promotion of grain legumes through, for example, increased nitrogen fixation or mineral solubilization, and the production of growth promoting chemicals such as plant growth regulators like auxins, gibberellins and cytokinins.
- Indirect growth promotion by limiting the damage caused by pests and pathogens as a result of, for example, the production of natural pesticides, antibiotics and other anti-pathogen chemicals and the induction of systemic resistance mechanisms.
- Enhancing resistance to abiotic stresses (including those caused by climate change), such as high temperatures,

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[1] A group which includes one of the largest bacterial genera, *Streptomyces*.

drought and salinity, especially by reducing endogenous levels of ethylene as a result of ACC-deaminase[2] production.
- Enhancing soil health by assisting nutrient cycling and by producing antibiotics.
- Producing secondary metabolites with the potential for development and exploitation as novel pesticides and fungicides.
- Use as bio-inoculants for ecologically based strategies for the biological control of pests and diseases.
- Exploiting the synergy resulting from the co-inoculation of plants with Actinobacteria and *Rhizobium* species.
- Heavy metal phytoremediation of soils and other substrates.
- Producing metal oxide nano-particles with the potential for exploitation in the green production of nanomaterials for use in biological systems.

Other chapters explore:

- Genomic approaches to understanding the role of Actinobacteria as plant growth promoting agents.
- The potential role of Actinobacteria for the bio-fortification of pulses with mineral nutrients of benefit to consumers.
- And last, but by no means least, the potential for the mass production of beneficial Actinobacteria, the development of efficient and practical delivery systems and commercialization.

A recurring them among the conclusion sections of most of these chapters, however, is that although the laboratory and glasshouse-based research to date shows very real promise of success in most of the areas explored, there is as yet only patchy evidence of its potential for practical application in the field. The authors recognize that there is, therefore, an urgent need to build on such promise by evaluating the resulting novel strategies at the field scale using major commercial crops and methods. Moreover, I would add that, as with all proposed microbially-based systems of crop improvement (especially as here where there is the potential for the use of genetic modification to enhance effectiveness), concurrent, in-depth and sensitive sociological research amongst potential user farming communities and consumers concerning acceptability is essential before any attempt is made to evaluate new products in the field or to introduce them onto the market.

There is considerable overlap and repetition between and among the chapters in this book, as well as variation in the depth of analysis, but such things are inevitable with a multi-author work as complex as this one. Moreover, the repetition and overlap ensure that each chapter may be read in isolation from the rest and in any case are more than compensated for by the immense wealth of valuable information and new ideas, from both recent research and the literature in general, synthesized and evaluated by the authors.

Clearly the plant growth promoting, root-associated Actinobacteria constitute a most promising group for further study in the quest to improve the performance and yield of grain legumes, one of the world's most important crop groups, with great potential for success in helping to strengthen international food security.

[2] ACC (1-aminocyclopropane-1-carboxylate)-deaminase leads to the breakdown of ACC, an immediate precursor of ethylene, to ammonia and α-ketobutyrate, both nutrient sources for Actinobacteria and other bacteria.