

## Research Paper

# Molecular diversity and multifarious plant growth promoting attributes of Bacilli associated with wheat (*Triticum aestivum* L.) rhizosphere from six diverse agro-ecological zones of India


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The diversity of culturable Bacilli was investigated in six wheat cultivating agro-ecological zones of India viz: northern hills, north western plains, north eastern plains, central, peninsular, and southern hills. These agro-ecological regions are based on the climatic conditions such as pH, salinity, drought, and temperature. A total of 395 Bacilli were isolated by heat enrichment and different growth media. Amplified ribosomal DNA restriction analysis using three restriction enzymes *AhaI*, *MspI*, and *HaeIII* led to the clustering of these isolates into 19–27 clusters in the different zones at >70% similarity index, adding up to 137 groups. Phylogenetic analysis based on 16S rRNA gene sequencing led to the identification of 55 distinct Bacilli that could be grouped in five families, Bacillaceae (68%), Paenibacillaceae (15%), Planococcaceae (8%), Staphylococcaceae (7%), and Bacillales incertae sedis (2%), which included eight genera namely *Bacillus*, *Exiguobacterium*, *Lysinibacillus*, *Paenibacillus*, *Planococcus*, *Planomicrobium*, *Sporosarcina*, and *Staphylococcus*. All 395 isolated Bacilli were screened for their plant growth promoting attributes, which included direct-plant growth promoting (solubilization of phosphorus, potassium, and zinc; production of phytohormones; 1-aminocyclopropane-1-carboxylate deaminase activity and nitrogen fixation), and indirect-plant growth promotion (antagonistic, production of lytic enzymes, siderophore, hydrogen cyanide, and ammonia). To our knowledge, this is the first report for the presence of *Bacillus endophyticus*, *Paenibacillus xylanexedens*, *Planococcus citreus*, *Planomicrobium okeanokoites*, *Sporosarcina* sp., and *Staphylococcus succinus* in wheat rhizosphere and exhibit multifunctional PGP attributes. These niche-specific and multifarious PGP Bacilli may serve as inoculants for crops growing in respective climatic conditions.

 Additional supporting information may be found in the online version of this article at the publisher's web-site.

**Keywords:** 16S rRNA gene / Agro-ecological zones / Bacilli / PGPR / Extreme habitat

Received: July 21, 2015; accepted: October 24, 2015

DOI 10.1002/jobm.201500459