Possible phosphate solubilisation mechanism and growth promotion of wheat through *Bacillus megaterium* and *Bacillus subtilis*

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Phosphorus is the most critical nutrient after nitrogen for crop production. In agricultural soil, P is present in the form of inorganic and organic compounds but most of them are present in fixable or insoluble form. Plant required 30 μM L⁻¹ P for their normal growth however, its available concentration in soil is about 1 μM L⁻¹. Consequently, un-availability of P in various soils has been identified as a growth limiting factor in agricultural systems. This issue can be addressed by applying available source of P in the form of chemical fertilizers. Only 10-20% of available P contents are taken up by plants while 70-80% P concentration is lost due to runoff and leaching which is hazardous for environment. Thus, the alternative technology (biofertilizers) is required for sustainable and eco-friendly agriculture. Awareness of the mechanism describe P solubilization is the base to develop P solubilizing biofertilizers which can substitute chemical fertilizers for sustainable production. Although different mechanisms have been described as phosphate solubilizing, but no method was clearly understood. In the present study we assumed that the production of organic acid was a major mechanism of phosphates solubilization. The other mechanisms involved in P solubilization were alkaline phosphatases and soil exoenzyme activities.

**Objectives**

The study aimed to find the phosphate solubilizing mechanism through soil exo-enzymes activities, alkaline phosphatase (ALP) gene expression, and production of organic acids in presence of insoluble phosphorous. Furthermore, the potential of phosphate solubilizing strains to improve root development and seedling growth of wheat (*Triticum aestivum* L.) were also determined under controlled conditions.

**Materials and Methods**

**Phosphate solubilizing mechanism and plant growth promotion**

**Growth diversity (pH -3.0)**

**Soil Exoenzyme activities**

**Secretion of organic acid**

**Root development**

**pH depletion**

**ALP gene expression**

**Seedling growth**

An overview of seedling growth at 15th day after sowing. Phosphate solubilizing strains *Bacillus subtilis* (ZE15 and ZE32) and *Bacillus megaterium* (ZE32 and ZE15) were tested for plant growth promotion in presence of Ca₃(PO₄)₂, (a), (b) and Na₂HPO₄, (c), (d)

**Results**

The tested strains showed different behavior in the presence and absence of tricalcium phosphate (TCP). In the absence, strain’s growth reached at stationary phase at 5th day of incubation. However, in the presence of TCP, the strains ZE15, ZE32, ZR3 and ZR19 showed maximum growth at 7th day of incubation which reaches 1.11 x 10⁻⁶, 9.64 x 10⁻⁶, 1.06 x 10⁻⁶ and 9.60 x 10⁻⁶ CFU mL⁻¹, respectively. Thus, these strains solubilized considerable amount of phosphorus @ 130, 117, 76 and 42 μg mL⁻¹, respectively.

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