Chapter 12
Plant Growth Promoting Bacteria:
A Gateway to Sustainable Agriculture

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ABSTRACT

Conventional agriculture plays a substantial role in meeting the food demands of a growing human population, which has led to an increased reliance on chemical fertilizers and pesticides. Chemical fertilizers are industrially manipulated substances and composed of known amount of nitrogen, phosphorus and potassium. In appropriate and misuse use of chemical fertilizers causes air and ground water pollution by eutrophication of water bodies and causing health problem in human. Therefore, the aim of this chapter is to emphasize the importance and use of plant growth promoting bacteria (PGPB) as a gateway to sustainable agriculture that could ensure plant productivity and quality agricultural practices in an environment friendly manner. In this respect, efforts have been made to products of nutrient rich high-quality food in feasible way to ensure bio-safety. The innovative aspect of farm production attracts the need of biological based organic fertilizers, an exclusive alternative to agro-chemicals. Organic farming is one of such strategies that not only ensures food safety but also adds to the biodiversity of soil. The eco-friendly approaches trigger a wide range of application of PGPB that leads to improved plant growth, soil health, nutrient uptake and plant tolerance to abiotic and biotic stress. PGPB is an essential component of organic farming and play crucial role in maintaining long term soil fertility and sustainability and would be a viable alternative for farmers to increase productivity per unit area in organic farming for an era of prosperity and clean environment.

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INTRODUCTION

Sustainable agriculture is indispensable in today's world as it endeavours the potential to meet our agricultural needs, something that conventional agriculture fails to perform. This type of agriculture practice uses a special cultivation technique wherein the natural resources can be fully utilized. This technique is environment friendly and ensures safe and healthy agricultural products. The continuous use of chemical fertilizers, pesticides and herbicides has led to lower down soil fertility, low agricultural productivity, soil damage, loss of biodiversity, unfavourable economic returns, food poisoning, and serious environmental hazards. The quantity and quality of agricultural products affected by the use of such chemicals in agriculture practices have been discussed under the agriculture environment relationships (Eser and Gecit 2010; Meena *et al*., 2016; Sharma and Sharma, 2017). PGPB are used to replace these chemicals by a variety of mechanisms *viz.* formation of soil structure, decomposition of organic matter, recycling of elements, mineral nutrients solubilization, production of plant growth regulators, degrading organic pollutants, root growth stimulation, soil fertility enhancement, biocontrol of plant pathogens etc. (Ahemad *et al*., 2009; Akhtar *et al*., 2012; Sivasakhti *et al*., 2014; Gupta *et al*., 2015). In this regard, plant growth promoting bacteria (PGPB) are playing potential role in sustainable crop production due to their enormous plant growth promoting attributes, better adaptability to survive under stress, and other uses that result in dissipate the pesticides/fertilizers use in agriculture (Bashan *et al*., 2014; Singh, 2015; Singh *et al*., 2016). PGPB, a diverse group of soil microbes are key components of soil-plant systems, where they are employed in an intense network of interactions in the rhizosphere, thus affecting the plant growth and yield and sustain the soil health and emerged as an important and promising tool for sustainable agriculture. PGPB promote plant growth directly or indirectly, either by releasing phytohormones or other biologically active substances, enhancing the availability and uptake of nutrients through fixation and mobilization, altering endogenous levels of phytohormones, or reducing the harmful effects of pathogenic microorganisms on plants, expansion and elongation of the root system, eliciting induced systemic tolerance, production of antibiotic and 1-aminocyclopropane-1-carboxylic (ACC) deaminase in plants rhizosphere (Alori *et al*., 2017). Besides offering an economically attractive and ecologically sound route for augmenting the nutrient supply and protecting against soil-borne pathogens, PGPB are the key players in posing efforts to preserve soil fertility (Bishnoi, 2015; Gupta *et al*., 2015).

Microbial and/or soil inoculants are the beneficial microorganisms which can improve nutrient availability of host plant and promote plant growth and health when added to the soil. Generally, the inoculant means to deliver live microbes from any available source to introduce them into the soil or living plants, hence they may make the desired effects on plant growth (Tittabutr *et al*., 2007) including enhancement of mineral uptake, nitrogen fixation in legumes, weathering of soil minerals, biocontrol of soil-borne diseases, and nutritional or hormonal effects etc. They also help in stimulating the synthesis of growth hormones and provide them to plants for better nutrient uptake and increased tolerance towards abiotic and biotic stresses and do not exert any ill effect on soil health and the environment. A small dose of biofertilizer is enough to produce a desirable response because each gram of the carrier of biofertilizers contains at least 10 million viable cells of a specific strain (Anandaraj and Delapierre, 2010). Towards a sustainable agricultural vision crops produced need to be equipped with drought tolerance, disease resistance, salt tolerance, better nutritional value and heavy metal stress tolerance. To overcome the desired crop properties mentioned, one possibility is to use soil microorganisms that increase the nutrient uptake capacity and water use efficiency in the plants (Armada *et al*., 2014). In this sense, PGPB may be used to enhance plant health and promote plant growth rate without environmental contamination (Calvo

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