Chapter 6

ROLE OF CYTOKININS IN PLANT GROWTH PROMOTION BY RHIZOSPHERE BACTERIA

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Abstract: Plant growth regulators (PGRs) are organic substances that influence the physiology and development of plants at very low concentrations. Cytokinins are one of the five major groups of PGRs or phytohormones and regulate cytokinesis in plant cells. Soil microorganisms are capable of synthesizing PGRs such as cytokinins in pure culture, soil and in association with plant tissues. This chapter reviews the structure and function of cytokinins in plant tissues and their production by plant growth promoting rhizobacteria (PGPR). A role for microbially-produced cytokinins in plant growth and development is proposed. Cytokinin production by PGPR is an innovative alternative to enhance plant growth and may be a sustainable approach to improve the yield and quality of agricultural crops. However further research is necessary to understand the principles underlying cytokinin production by rhizobacteria and to develop cytokinin-producing inoculants for practical application by growers.

Key words: cytokinins; phytohormones; plant growth regulators; PGPR; rhizobacteria

1 INTRODUCTION

Plant growth regulators (PGRs) are organic substances that influence the physiology and development of plants at very low concentrations. They are often effective at internal concentrations lower than 1 μM, whereas amino acids, organic acids, sugars, and other metabolites necessary for growth and development are usually present at concentrations of 1 to 50 mM. Plant growth and development are likely to be governed by PGR
concentration and tissue sensitivity to PGRs (Venis, 1987). PGRs also play a crucial role in controlling the way in which plants grow and develop. “While metabolism provides the power and building blocks for plant life, it is the hormones that regulate the speed of growth of the individual parts and integrate them to produce the form that we recognize as a plant” (Davies, 2005).

Auxins, gibberellins, cytokinins, ethylene and abscisic acid (ABA) are the five major groups of PGRs, usually called phytohormones, are synthesized endogenously by plants and have beneficial effects on plant growth and development (Salisbury and Ross, 1992; Arshad and Frankenberger, 1993). Brassinosteroids and polyamines are also PGRs endogenously synthesized by plant tissues (Sasse, 1991; Galston and Sawhney, 1990). PGRs also include synthetic compounds that cause many physiological responses when they are exogenously applied to plant tissues (Salisbury and Ross, 1992).

Soil microorganisms can promote plant growth by enhancing soil organic matter transformations, mobilizing inorganic nutrients, producing PGRs, acting as antagonists against pathogens and by several other mechanisms (Bolton et al., 1993). Scientists have attempted to alter the microflora of agricultural soils in order to favor plant growth and yield. Rhizobacteria that exert beneficial effects on plant growth and development have been termed plant growth-promoting rhizobacteria (PGPR) by Kloepper and Schroth (1978). Some PGPR are capable of synthesizing PGRs in pure culture and soil and these PGRs can be estimated by different techniques (Arshad and Frankenberger, 1993). In this chapter we shall discuss the structure, function and analysis of cytokinins. We shall also discuss PGRs in the rhizosphere, effects of PGPR on plant growth and development and PGPR and PGRs production.

2 CYTOKININS

2.1 Structure and function in plant development

Cytokinins are PGRs that regulate cytokinesis in plant cells (Skoog et al., 1965). Following the discovery of kinetin (6-furfurylaminopurine), a compound isolated from autoclaved herring sperm DNA and exhibiting potent cell-division-promoting activity (Miller et al., 1956), a naturally occurring kinetin-like compound was isolated from maize, sunflower fruits and soybean (Miller, 1961). The first naturally occurring pure crystalline cytokinin was isolated from Zea mays and named zeatin (Z) by Letham (1963). The structure of zeatin, (E)-4-(hydroxy-3-methyl-but-2-enyl)