Abstract

Legumes are important sources of proteins for the growing population in many developing countries of the world. Their production is limited due to the crop's susceptibility to fungal, bacterial and viral diseases, insect pests and besides many other undesirable agronomic traits. Genetic improvement of legumes by classical breeding has met with limited success due to the lack of genetic variability within the germplasm. Strategies for increasing and stabilizing the production of legume crops depend on the development of varieties resistant to diseases, pests and with other desirable agronomic traits. Recent biotechnological advances have offered the opportunity to develop new germplasms. The development of such technology largely depends on the availability of efficient regeneration protocols. In the present review, regeneration via organogenesis in legumes is described. The advantages and limitations of this technique along with directions for future research are discussed.

1. Introduction

Plant tissue culture began as an intellectual curiosity. At present it has gained respect because of its significant contributions to our basic knowledge of plant biology. As early as 1902, Haberlandt, a German plant physiological anatomist stated that “every living plant cell is endowed with the potential to produce a whole plant”. The concept of totipotency put forth by him provided impetus to the development of plant tissue culture.

The technique of plant tissue culture involves isolation of an organ, tissue, cell or protoplast from a plant under aseptic conditions and their growth in a well defined nutrient medium under a controlled environment. Like hydroponics – the art of growing plants without soil – tissue culture became an occupation for many scientists. A wide range of excised plant parts were grown on several nutrient formulations, supplements, extracts and juices such as coconut milk.

IN VITRO ORGANOGENESIS

A. GANAPATHI, V.R. ANBAZHAGAN, S. AMUTHA AND R. PREM ANAND
Department of Biotechnology, School of Life Sciences, Bharathidasan University, Tiruchirappalli – 620 024
e-mail: ganap@bdu.ernet.in
Plant tissue culture has presently developed into a full-fledged technology with immense practical value. Its potential for large-scale applications in agriculture, horticulture and forestry has been visualized. This review reveals an important aspect of tissue culture, i.e. organogenesis which is currently used as one of the basic biotechnological tools for the improvement of crops in general and legumes in particular.

Legumes are one of the most significant groups of agriculturally important crops and have consequently been the subject of widespread efforts to improve desirable traits through in vitro manipulations. Legumes are next to the grasses in terms of diversity and economic importance, and are grown throughout the world as sources of food, feed, oil, forage, fuel, wood and even fiber. Legumes are also used as ornamentals, green manure and ground cover to control soil erosion. Many species within this family have been the subject of efforts towards non-conventional plant improvement using cell culture techniques. These efforts have resulted in the availability of a large number of in vitro protocols. Much effort has been expended to develop and optimize efficient regeneration systems in order to facilitate development of a variety of technologies. Despite the widely reported in vitro recalcitrance of legumes, at least 75 species from 25 genera have undergone de novo regeneration. To date, successful regeneration has been accomplished in species and specific determination of parameters critical to regeneration such as explant source, genotype and media constituents has been reported. Depending on several factors, regeneration occurs via organogenesis and/or embryogenesis, either directly from explanted tissue or indirectly after an intervening callus phase. While several species responded to either organogenesis or embryogenesis, only a few species regenerate via both the pathways. Methodologies leading to a diversity of in vitro responses are relatively a new accomplishment. With few exceptions, legumes are generally recalcitrant with respect to tissue culture. In recent years, attention has been focused on the development of regeneration systems amenable for gene transfer (Ramsay, 1993). Organogenic systems have been successfully employed in transformation of some legumes such as *Vigna unguiculata* (Muthukumar et al., 1996; Prem Anand et al., 2001). Presently, sufficient knowledge exists to design and optimize de novo regeneration systems for most legumes (Jaiwal and Gulati, 1995; Nagl et al., 1997).

2. Organogenesis

Organogenesis is a process by which a cell, tissue, isolated protoplast or microspore differentiates to form adventitious organ or primordia in a well defined nutrient medium under controlled environmental conditions. Organogenesis refers to the formation of roots or shoots. The callus may remain in an undifferentiated condition regardless of the hormones and nutrients to which it is exposed. Organ formation generally follows cessation of unlimited proliferation of callus. Individual cells or groups of cells of smaller dimensions may form small nests of cells scattered throughout the callus tissue, the so-called meristemoids. These meristemoids become transformed into cyclic nodules from which shoot bud or root primordia may grow as shoots/roots. Shoot bud formation may decrease with age and subculture duration of the callus tissue but the capacity of rooting may persist for longer period. In some calli, rooting occurs more often than in other forms of organogenesis. During organogenesis, if the roots are first formed, then it