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ScienceDirect
South African Journal of Botany 77 (2011) 996 – 1011
SOUTH AFRICAN JOURNAL OF BOTANY
www.elsevier.com/www.elsevier.com/locate/sajb

Review

Plant biotechnology in South Africa: Micropropagation research endeavours, prospects and challenges

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Abstract

Research in plant biotechnology is playing a crucial role in the production and conservation of plant-based resources globally. Being a country with rich and diverse floral resources, South Africa has a genuine opportunity to develop efficient and competitive plant biotechnology sectors. South Africa has a policy framework, in the form of a National Biotechnology Strategy that supports biotechnology research. The presence of competitive research infrastructure coupled with the government's willingness to commit significant resources will certainly help realise this. South Africa's plant biotechnology research has potential to make more significant contributions to the national economy. In this review, whilst highlighting the success, the research endeavours, prospects and challenges hindering the practical application of micropropagation research outputs are discussed.

Keywords: Biotechnology sector; Conservation; *In vitro* propagation; Plant biotechnology strategy; Plant biodiversity; Secondary metabolites

Contents

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doi:10.1016/j.sajb.2011.06.003

1. Introduction

According to the United Nations Environment Programme (UNEP) Convention on Biological Diversity, biotechnology is defined as a body of techniques that use biological systems, living organisms, or derivatives thereof to make or modify products or processes for specific use (UNEP, 1992). This definition is also adopted by the South African Biotechnology Strategy (DST, 2001). Although biotechnology is perceived as a modern science, the above definition shows that it is an old science which has been used for many years. The use of fermentation agents in breweries and bakeries, processing of dairy products, development of new animal breeds and crop cultivars have all used living organisms to improve or modify a product, hence fully satisfying the definition. The discovery of DNA and development of gene technologies however, gave biotechnology a new dimension giving it a modern look.

Despite its rich history of using biotechnology, South Africa has not fully exploited the full benefits of the recent advances in biotechnology which triggered the need for a national biotechnology strategy to make up for lost ground (DST, 2001). Ten years have elapsed since the adoption of the National Biotechnology Strategy. This review aims to assess the research endeavours, economic prospects and challenges of plant biotechnology research in South Africa with special emphasis on the use of plant tissue culture in the propagation, conservation, commercialization as well as improvement of economically important plant species. Although biotechnology of food crops is briefly discussed, most emphasis is given to research on the biotechnology of non-food plants.

1.1. Plant biotechnology research in South Africa

Biotechnology research and its application in South Africa are not very far behind when compared to the world's developed countries. One could even argue that the country is progressing well given the fact that it was politically isolated from the international community for many years which resulted in excessive reliance on local innovations (Cloete et al., 2006). In as much as the reliance on domestic technology contributed to the country's economy and innovation, it appears that only few sectors such as mining, chemical and military were given national priority and little emphasis was given to plant biotechnology (Ofir, 1994). This however, changed since the year 2000 when the South African government made biotechnology one of its main research focus areas by significantly increasing its support (Cloete et al., 2006). The adoption, by the Department of Science and Technology of the National Biotechnology Strategy in 2001 (DST, 2001) with the fundamental mission of creating several Biotechnology Regional Innovation Centres (BRICs) to act as nuclei for the creation of essential biotechnology platforms was a key step. The strategy also addresses issues such as funding, human resource development, regulatory and legal issues as well as trying to close the gap between research and commercialization (Cloete et al., 2006). These BRICs recently formed the Technology Innovation Agency (TIA) under the National System of Innovation (NSI) (DST, 2009).

Micropropagation, conservation and commercialization-based research on the biotechnology of plants are relatively new in South Africa. The past couple of decades however, witnessed a boom in research outputs on biotechnology of plants. This is mainly due to the following important interrelated factors:

1. The need to maximise food productivity;
2. Acknowledgement of the concept of indigenous knowledge — there is a strong relationship between the history of the people of South Africa and the traditional use of plants. This rich history and knowledge of plant use is serving as the foundation for cutting edge biomedical research ranging from the characterization and isolation of active principles to their mass production *in vitro* using bioreactor systems;
3. Environmental issues — due to the impact of fossil fuel on the environment, the use of plants as a substitute to fossil fuel is gaining popularity. This has resulted in an increase in research endeavours geared towards realising the potential of plants as a source of environmentally friendly energy;
4. Availability of rich floral resources — southern Africa is amongst the richest regions of the world in floral diversity with about 30 000 species of higher plants (Goldblatt, 1978), many of which are traditionally used for various purposes. South Africa, with less than 2% of the world land surface, is endowed with an estimated 10% of plant species (SANBI, 2011). Biotechnology has emerged as an essential tool to realise the full economic potential of these rich floral resources through various laboratory-based techniques; for instance the production of secondary metabolites *in vitro* for the pharmaceutical and cosmetic industries using bioreactor systems and research associated with it;
5. The need for conservation — the growing world population has resulted in an increase on the demand of plants for food, energy, cosmetic and pharmaceutical uses, which in turn exerted huge pressure on wild populations of plants. Such consumption-driven pressure coupled with unsustainable use of plants has warranted the need for urgent conservation measures. Plant tissue culture is playing a key part in this regard; especially for plants that are difficult to propagate as well as those that have lost their natural pollinators due to habitat loss.