Journal of the Saudi Society of Agricultural Sciences (2016) xxx, xxx–xxx

King Saud University

Journal of the Saudi Society of Agricultural Sciences

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REVIEW ARTICLE

Acacia: An exclusive survey on *in vitro* propagation

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Received 12 December 2015; revised 14 March 2016; accepted 20 March 2016

KEYWORDS

Callogenesis;
Explant;
Organogenesis;
Plant growth regulators;
Somatic embryogenesis;
Woody plant

Abstract The current survey exemplifies the achievements on experimental results of production of planting materials through *in vitro* direct or indirect organogenesis of genus *Acacia*. Several species of *Acacia* have been given due importance in tree tissue culture owing to their proven wasteland reclamation ability, ecological and economical significance. Plant cell, tissue and organ culture-based techniques have been employed in forest tree research for successful reforestation and forest management programs. The relevance of tissue culture methods has gained impetus to meet the growing demands for biomass and forest products. Ever since the last four decades, *in vitro* protocols are being developed with the aim to regenerate several woody species. This survey strives to serve as a compendium of various routine processes involving organogenesis of *Acacia* via *in vitro*; which would encouragingly be worthwhile for researchers to exploit this perennial woody legume with enormous multidimensional value, via more innovative approaches, in order to promote the cause for its improvement.

Abbreviations: 2,4-D, 2,4-dichlorophenoxy acetic acid; AdS, adenine sulfate; B5, Gamborg et al. (1968); BA, N_6-benzyladenine; BAP, N^6-benzylaminopurine; BD, Bonner–Devirian medium (Bonner and Devirian, 1939); Ca, callus; CW, coconut water; DKW, Driver Kuniyuki medium (Driver and Kuniyuki, 1984); GA_3, gibberellin A_3; IAA, indole-3-acetic acid; IBA, indole-3-butyric acid; KB, Knop and Ball medium (Hustache et al., 1986) Kinetin, 6-furfurylaminopurine; KT, Kathju Tewari medium (Kathju and Tewari, 1973); MSt, multiple shoot; MS, Murashige and Skoog medium (Murashige and Skoog, 1962); NAA, α-naphthalene acetic acid; PGR, plant growth regulator; Q-LP, Quoirin Lepoivre medium (Quoirin and Lepoivre, 1977); Rt, root; SH, Schenk and Hildebrandt medium (Schenk and Hildebrandt, 1972); SR, adventitious shoot regeneration; TDZ, *N*-phenyl-*N*′-(1,2,3-thiadiazol-5-yl) urea or Thidiazuron; WPM, Woody Plant Medium (Lloyd and McCown, 1981); Zeatin, 4-hydroxy-3-methyl-terms-2-butenyl aminopurine.

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Peer review under responsibility of King Saud University.

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http://dx.doi.org/10.1016/j.jssas.2016.03.004
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Please cite this article in press as: Gantait, S. et al., *Acacia*: An exclusive survey on *in vitro* propagation. Journal of the Saudi Society of Agricultural Sciences (2016), http://dx.doi.org/10.1016/j.jssas.2016.03.004

Contents

1. Introduction

Since last three decades, the population in tropical countries has been rising at an annual rate of 2.8% and as a result the overall forest area in those countries has been declining at 0.8% per year. The year-wise afforestation and reforestation area in those countries was projected to be 1.8 million ha during the period 1981–1990, ensuing in an annual net reduction in forest area of 13.6 (15.4–1.8) million ha (Kozai et al., 2000). Moreover, the decline in biomass of woody plants owing to desertification in arid regions is remarkable as it acts as a precursor of recent climate changes on several geographic zones. It has been foreseen that a demand for woody transplants will rise considerably in future decades for paper, timber, plantation, horticulture and furniture industries, as well as, in environment conservation (Kozai et al., 1997). The usage of plant biomass can be an alternative to the overconsumption of fossil fuels and thus lowers the atmospheric CO_2 levels which ultimately assuages climate changes. A steady supply of quality planting materials becomes increasingly important to satisfy the ever increasing growing demand that conventional propagation based plantlet production fails. *In vitro* propagation system holds its merits over that of the conventional propagation since the *in vitro* system ascertains the phenotypically and genotypically uniform disease-free propagules in a sustainable manner (Aitken-Christie et al., 1995). In this review we demonstrate the achievements made (based on experimental results) on *in vitro* propagation system of an important tropical tree legume genus *Acacia*, along with *ex vitro* acclimatization and clonal fidelity assessment.

Comprising around 1200 species, *Acacia* (family Fabaceae and sub family Mimosaceae) is ample in Australia, Africa, India and America (Simmons, 1987). Typically, to reforest and reclaim the wastelands (Skolmen, 1986) and to improve soil health, as well as to serve as the rich source of fuel wood, timber, and shelter belts (Palmberg, 1981) the genus *Acacia* plays an enormously essential role. Majority of its species generates exceptional firewood and a few are the source of an affluent supply of tannin, protein, ink, paint, pulpwood, flavoring agents, and gum. From the environmental perspective, *Acacia* can acclimatize to extreme atmospheric conditions and consequently, can adapt to both arid and moist areas of tropical soils. Various species are capable of increasing soil fertility by undergoing in a symbiotic association with *Rhizobium* and Mycorrhizal fungi. Moreover, it minimizes soil erosion and assists in sand dunes stabilization (Skolmen, 1986).

2. *In vitro* organogenesis

In vitro organogenesis, particularly for tricky and recalcitrant species is chiefly reliant on the type of explants and manipulations of several plant growth regulators (PGRs) in culture media. Accelerated *in vitro* propagation is the unique feature of plant tissue culture that has been credibly acknowledged with respect to its practicability in bulk and commercial-scale multiplication of propagules. Successful *in vitro* regeneration of the plant material depends on numerous aspects such as genetic makeup, explant type, media composition, PGRs as well as the culture conditions. Direct regeneration and indirect regeneration via an intermediary callus phase are the two chief fundamental approaches engaged as an efficient *in vitro* regeneration of forest trees. Among these two approaches indirect organogenesis is less enviable for clonal multiplication due to its reported cases of somaclonal variability. Hence, direct regeneration (devoid of callus-stage) is considered as a consistent approach for clonal propagation. A variety of *in vitro* culture approaches, for instance *de novo* organogenesis, callogenesis, and somatic embryogenesis have been used comprehensively for large-scale micropropagation and the production of genetically true clones in bulk quantities. Vigilant selection and collection of explants, with apposite use of basal media, PGRs, antioxidants and additives are the fundamental criteria for standardizing consistent and reproducible micropropagation protocols. There have been scores of reports on *in vitro* growth and multiplication of *Acacia* attained through embryogenesis or organogenesis. Nevertheless, explant source and their disinfection process along with the media formulations, culture conditions, accumulation of phenolics in media

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