



Insight into the mechanisms of enhanced production of valuable terpenoids by arbuscular mycorrhiza

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Abstract Terpenoids, in addition to being essential for plant growth and survival, are commercially valued for their medicinal properties, ecological significance, and used as flavors and fragrances. Prospective role of arbuscular mycorrhiza (AM) symbiosis in improving the accumulation of secondary metabolites especially terpenoids has gained recognition over the past two decades. Increased production of terpenoids in aboveground parts of AM-colonized medicinal plants has extensively been described. Understanding the mechanisms underpinning increase in accumulation of specific terpenoids in AM plants is important for obtaining higher yield and to improve the potential of AM in sustainable cultivation of plants harboring these compounds. Enhanced phosphorus uptake in the mycorrhizal plants has been largely credited for the increase in terpenoid production. However, recent findings have suggested AM mediated manipulation of morphology, biochemistry and gene transcription in plants. The review provides an

update on recent findings in the field of AM research with a special focus on production of pharmaceutically important terpenoids. Several points are highlighted for future research to elucidate probable mechanisms underlying increase in terpenoids in mycorrhizal plants.

Keywords Nutrient uptake · Glandular trichomes · Methylerythritol 4-phosphate pathway · Mevalonate pathway

Introduction

Isoprenoids also known as terpenoids, are plausibly the most diverse and largest family of natural plant products with more than 40,000 compounds (Sacchetti and Poulter 1997). Besides being essential for plant growth and survival, many isoprenoids have commercial value owing to their therapeutic properties (Ku and Lin 2013; Martin et al. 2013), antimicrobial and antioxidant activities (Heldt 2005), and industrial relevance as pigments, fragrances, and flavorings (Liu et al. 2005). The immense utility of terpenoids has compelled to develop strategies for improving their yield in plants such as mass propagation, metabolic engineering, and *Agrobacterium* mediated transformation (Liu et al. 2005; Oksman-Caldentey and Inzé 2004). While low cost effectiveness and less practicability have been realized as the

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