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Jatropha, Challenges for a New Energy Crop

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Part III Farming

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Jatropha, Challenges for a New Energy Crop

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Arbuscular Mycorrhizal Fungi for Jatropha Production

Abstract

Arbuscular mycorrhizal fungi (AMF) are keystone mutualists inhabiting roots of most plants including the majority of oil crops under cultivation. Therefore, sustainable yield of Jatropha (*Jatropha curcas* L.) in cultivation is likely to benefit from the inclusion of AMF in crop management cycles. Studies undertaken on acid and alkaline soils in a range of site conditions (productive cropping land, degraded land, mine spoil) indicate close association between Jatropha and AMF since roots were often heavily colonized by AMF in the field. Although a diverse range of AMF genera and species have been identified in the rhizosphere of Jatropha, not all are likely to be effective for sustainable production of Jatropha in plantations. For example, of 34 species of AMF in the rhizosphere of Jatropha in Thailand, only a few species were able to be trapped by Jatropha seedlings. Techniques for assessing the need for inoculation and approaches for inoculum production are discussed. The role of AMF in alleviating stresses is discussed in relation to (1) nutrient and water constraints that are likely to be the main factors limiting the production of Jatropha in many regions of the world and (2) the presence of heavy metals and salinity that will also be challenging for this crop.

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Chapter 13

Arbuscular Mycorrhizal Fungi for Jatropha Production

Supattra Charoenpakdee, Saisamorn Lumyong, and Bernard Dell

Abbreviations

AMF	Arbuscular mycorrhizal fungi
dS m ⁻¹	Deci Siemens per meter
EC	Electrical conductivity
ha	Hectare
K	Potassium
kg	Kilogram
N	Nitrogen
NaCl	Sodium chloride
P	Phosphorus

Introduction

Mutualistic fungi depend on plants for photosynthetic carbon while host plants receive inorganic nutrients and water captured from the soil through fungal hyphae. Most *arbuscular mycorrhizal fungi* (AMF) are obligate symbionts within the monophyletic phylum, Glomeromycota. The AMF form highly branched exchange

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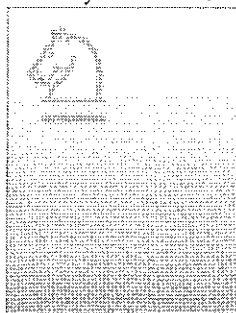
surfaces, known as arbuscules, within the cortical tissue of roots during periods of active root growth. Many AMF also form vesicles, which are lipid-filled structures produced in intercellular spaces. Their function is food storage, but can also serve as reproductive propagules for the fungus in some species. Other structures are auxiliary cells and asexual spores, which are formed in the soil (Fisher and Jayachandran 1999; Sylvia et al. 2005; Trappe 2005; Schüßler et al. 2009). These fungi cannot finish their life cycle or multiply on artificial media without their plant host (Sieverding 1991). The majority of vascular plants develop mycorrhizal associations (Smith and Read 1997; Öpik et al. 2008; Parniske 2008; Siddiqui et al. 2008; Verma 2008) that play important roles in plant fitness including suppression of soil-borne pathogens (Brundrett et al. 1996; van der Heijden and Sanders 2003; Siddiqui et al. 2008), nutrient cycling and soil conservation in natural as well as agricultural ecosystems (Boomsma and Vyn 2008). These fungi are sensitive to some agricultural chemicals; their diversity and abundance are also reduced by fertilizers, especially those containing high amounts of phosphorus (P). Many AMF produce large spores; a fact that facilitates their extraction from soil and observation under microscope (Brundrett et al. 1996; van der Heijden and Sanders 2003; Sylvia et al. 2005; Verma 2008). Hence, field surveys can readily be undertaken since the results are only limited by the capacity to identify AMF using molecular tools. Lastly, inoculation with target mycorrhizal fungi can lead to an improvement in growth and reproduction in many crops (Brundrett et al. 1996; Smith and Read 1997; van der Heijden and Sanders 2003; Öpik et al. 2008; Parniske 2008; Verma 2008) depending on the prevailing edaphic factors.

There is strong interest in bringing marginal lands, which cannot be used for food production, into cultivation for physic nut (*Jatropha curcas* L. hereafter referred to as *Jatropha*). However, in order for this plant to perform well on these marginal sites, inoculation with symbiotic microorganisms, such as AMF, is likely to be essential due to the loss of soil microflora resulting from past land management and other practices. This report explores the association of AMF with *Jatropha* including AMF diversity, compatible AMF species and known benefits of AMF for *Jatropha* growth and development. It draws heavily on work undertaken in northern Thailand, supplemented with studies elsewhere. Knowledge gaps were identified and served as guidelines to investigate future directions for research and management.

The Mycorrhizal Status of *Jatropha*

Investigations of *Jatropha* seedlings or cuttings from the field indicate that their roots are generally associated with AMF (see for example Leye et al. 2009; Kamalvanshi et al. 2011; Singh and Jamaluddin 2011). No systematic study has been undertaken on AMF associated with *Jatropha* in the wild, thus comparisons can only be drawn between *Jatropha* under cultivation. The analyses by Charoenpakdee et al. (2010a) revealed a strong relationship between *Jatropha* and AMF in the rhizosphere of *Jatropha* trees in six provinces of Thailand (Fig. 13.1). Thirty-four AMF morphospecies were identified among which the predominant

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